EFFECTS OF OLD-AGE INSURANCE ON FEMALE RETIREMENT: EVIDENCE FROM CROSS-COUNTRY TIME-SERIES DATA

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Abstract

I examine the effect of Old-Age Insurance (OAI) on older women's labour-force participation in fourteen countries since around 1930. Older women's participation has risen in the US, but has fallen over time in some European countries. The discontinuity of incentives at the state pension age helps separate OAI's effects from those of social mores and husbands' retirements. Clear effects of OAI on female retirement emerge slowly in time series. I find that, were Germany to adopt the US Social Security system, the participation rate of German women aged 60-4 would increase by 7 percentage points.

JEL Classification: H55, J14, J21, J26

Key words: Social Security, public pensions, economics of the elderly, labor force and employment, retirement policies.

1. Introduction

This paper asks how Old-Age Insurance (OAI) systems affect older women's labour supply. Different OAI systems' effects on retirement are relevant to US policy since future reforms may make US Social Security more similar to other countries' OAI systems. I examine data from 14 countries, and from the earliest usable censuses, dating from 1920 to 1960, to 2000. The labour-force participation of middle-aged women has risen throughout my sample since 1950. Striking cross-country differences exist, however, in the level and trend of older women's participation. Participation of women aged 60-4 has risen in the US and elsewhere but has fallen with time in many European countries. In many countries, female participation rates spike downward at the female state pension age. The age-specificity of these cross-country differences suggests they are created by government interventions in labour markets, rather than differences in preferences, health or education.

OAI could explain these age-specific differences in female labour supply across countries through two mechanisms. First, implicit taxes on the earnings of those above the state pension age could lead women to substitute away from work. Second, women might retire at the date OAI benefits start, responding not to the net present value of OAI benefits but their 'liquidity'. While husbands' retirement behaviour could affect their wives' participation decisions, male behaviour cannot explain changes in female participation at precisely the female state pension age.

I test for tax effects by constructing effective labour tax rates given OAI rules, and for liquidity effects with the replacement rates of pensions to average female earnings. Cross-country regressions for 2000 show female participation-rate differences at ages 59 and 61, 50-4 and 55-9, and 55-9 and 60-4 are negatively related to differences in effective labour taxes at these ages. However, I am unable to separate the 'tax' and 'liquidity' theories of OAI, since the age-differences in tax rates and pension flows are highly correlated in my data. My regression coefficients imply the participation rate of 60-4 year-old women in France and Germany would be around 7 percentage points higher if they adopted the rules of US Social Security. I have no data on mandatory retirement rules, but suggest these might explain pensions' apparent 'liquidity' effects. Panel regressions show older women's participation rates have responded slowly to OAI reforms, suggesting they may continue to diverge across countries.

This paper is structured as follows. Section 2 reviews previous literature on female retirement. Section 3 models OAI systems' effect on labour supply. Section 4 describes older women's labour-force participation across countries and time. Section 5 describes how I construct the labour tax rates implied by OAI. Section 6 reports cross-section and time-series regressions of female participation rates on OAI rules. Section 7 considers whether OAI reforms were endogenous to trends in female participation. Section 8 discusses possible omitted-variable bias due to mandatory retirement rules. Section 9 concludes that female data corroborate earlier findings that OAI affects male retirement, but suggest OAI's role in the trend towards earlier male retirement has been overstated.

2. Previous Analysis of Female Retirement

Studies of US micro-data have found that marital status, health, and race are correlated with older women's labour supply. Blau (1998) and Gustman and Steinmeier (2000) find that married couples tend to retire together, so retirement incentives for one spouse will affect the behaviour of the other. Both papers find that women in poor health tend to retire earlier than the average, and Blau finds that women retire later if their husbands are in poor health. Bound, Schoenbaum and Waidmann (1996) find older black and white women participate in the labour force at similar rates. Older black women have considerably worse health, however, and are more likely to apply for disability insurance benefits. Thus these authors find that older black women would work more than white women, were they equally healthy.

Studies of US micro-data have also investigated the effect of Social Security on female retirement. Reimers and Honig (1996) find US women respond differently to Social Security than do men. Women are less sensitive to currently-available benefits, and more sensitive to the rewards in the benefit formula for later retirement. However, Krueger and Pischke (1992) point out that in most single-country studies, identification of OAI's effects on retirement relies on cross-sectional variation in benefits, which are correlated with other likely determinants of labour supply such as education, earnings and marital status. Gruber and Wise (1999) respond to Krueger and Pischke's critique by examining the effects of OAI on male retirement in cross-country data, and Blöndal and Scarpetta (1998) and Johnson (2000) study male retirement across countries and time. I

am not aware of any studies attempting to explain older women's labour supply across countries.

Some existing literature suggests that older women have worked less over time in all countries. Gendell (1998) and Blöndal and Scarpetta (1998) construct women's 'average age of retirement', and find this has fallen in all countries since 1950. However, their 'average age of retirement' gives a misleading sense of women's labour supply, since it can fall as participation rates rise at all ages.[1] Goldin (1989), for example, shows labour-force participation of married US women of all ages has risen steadily since 1916. Quinn (1999) shows that in the US, participation of older women in the US has grown much faster since 1985 than before, and that a similar break in the trend of older male participation occurred at the same time. Jacobs et. al. (1991) show that older women's participation has risen in some countries but fallen in others.

A theoretical literature has calculated how Old-Age Insurance affects workers' net wages. Feldstein and Samwick (1992) calculate the net payroll tax rate under US Social Security given the linkages between payroll taxes and eventual benefits, which vary across workers. Blöndal and Scarpetta (1998) and Gruber and Wise (1999) construct effective tax rates for older men which include both net payroll taxes and effects deriving from the size of credits for deferring claimancy. Their analyses neglect the role of

[1] Population B can have higher participation than population A at every age *and* a lower 'average age of retirement' if the increase in participation in B over A is greater at lower ages. Such an increase in participation at all ages, but particularly at younger ages, is typical of women since 1950. Therefore the fall in the 'average age of retirement' shows that the age-composition of the female labour force has changed, but not that fewer older women work now than in 1950. Blöndal and Scarpetta's formula for their 'average ages of retirement' is on p.54 of their paper, at www.oecd.org/subject/ageing/awp1_4e.pdf.

earnings tests on benefits, however. Johnson (2000) shows the effective tax rate on labour is the Feldstein-Samwick term plus the minimum of those implied by the earnings test and any credit for deferred claimancy. Defined-benefit private pensions can create incentives to leave the current employer. It is less clear that they create incentives to leave the labour force, however. Therefore I do not include private-pension rules in my analysis of labour-force participation in this paper. Other literature considers how net wages affect workers' supply of labour. Stock and Wise (1990) assume re-entry to the labour market is impossible. If so, working now creates an 'option value' of working in the future, so workers' labour supply at time *t* depends on current and all future net wages in a complicated manner. In the next section, I model the effect of taxes on labour supply in a simple model of intertemporal choice, where re-entry to the labour force is possible. This model is sufficient to show that labour supply in any period will depend on net wages in all periods.

3. Theories of Older Women's Labour-Force Participation

Many factors could affect older women's labour supply. The steep declines in female participation at specific ages, and the different participation trends at different ages shown in section 4 could result from government interventions in labour markets, but not from differences in health or preferences. Husbands' retirement decisions could affect wives' behaviour, but not falls in female participation at exactly the state pension

age.[2] We need therefore to determine which government interventions are relevant, and how they operate. OAI could affect women's retirement via two mechanisms. Women may respond to taxes on labour implicit in OAI rules, or merely to the liquidity of OAI benefits. I do not have data on compulsory retirement laws, but these may explain participation-rate spikes at specific ages in some countries. This section considers the 'tax' theory in detail, and then discusses how the 'tax', 'liquidity' and 'mandatory retirement' theories could be separated empirically.

The effective labour tax rate given OAI is determined as follows. Consider a 64-year-old woman who is eligible for OAI benefits B_{64} at 64, but has the choice of deferring benefits until age 65. Annual OAI benefits from age 65 will be

$$(1) \qquad B_{65+} = B_{64}\left(1 + a.I_D\right) + k.W_{64}(1 - l_{64})$$

The OAI system's benefit formula creates the marginal 'return to contributions' k. W_{64} and l_{64} are the wage rate and the fraction of time consumed as leisure at age 64. I_D equals unity if benefits are deferred until age 65, and zero if they are claimed at 64. a is a reward for deferring benefits. I assume women can borrow and lend at the interest rate r, and that income and payroll taxes are proportional at the rates τ_I and τ_P. I assume there is an OAI earnings test at age 64 only, with a proportional labour tax rate τ_{ET}. This tax rate applies only if benefits are claimed at 64, or I_D=0. The woman's intertemporal budget constraint at age 64 is then

[2] Since the age-difference between husbands and wives has a distribution with a mean of two years,

$$(2) \qquad \sum_{i=0}^{i=\infty} \frac{C_i}{(1+r)^i} \leq \sum_{i=0}^{i=\infty} \frac{W_i(1-l_i)}{(1+r)^i}\left(1-\tau_I-\tau_P+\frac{k_i}{r}-\tau_{ET}(1-I_D)\right)+\frac{B_{64}}{r}[(1+r)+I_D.(a-r)]$$

If the returns to contributions k_i depend on earnings in other periods j, $j \neq i$, earnings in any period will change the net wage in other periods. Returns to work would then be algebraically complicated,[3] so for simplicity I assume $k_i=k\ \forall$i. If $a>r$, so long as the woman prefers more money to less, she will defer claiming benefits until age 65, setting I_D=1. Then we have that

$$(3i) \qquad a \geq r \Rightarrow \text{Tax Rate } = \tau_I + \tau_P - \frac{k}{r}.$$

If $a<r$, the worker either loses $\tau_{ET}.W_{64}.(1-l_{64})$ to the earnings test, or $B_{64}.\left(1-\frac{a}{r}\right)$ to setting I_D=1. Again, I assume women prefer more to less money, so we have that

$$(3ii) \qquad a < r \Rightarrow \text{ Tax Rate } = \tau_I + \tau_P - \frac{k}{r} + \min\left[\tau_{ET}, \frac{B_{64}}{W_{64}(1-l_{64})}\left(1-\frac{a}{r}\right)\right].$$

husbands' influences would explain an decline in female participation around two years before the typical age of male retirement.

[3] Nevertheless, many OAI benefit formulae have the feature that work in one period changes the return to work in other periods. I am grateful to Jonathan Thomas at the Bank of England for emphasizing this point. Stock and Wise (1990) model such incentives using the simplifying assumption that work is continuous until the 'optimal stopping age', at which it stops forever.

Equations (3) state that the effective labour tax rate in the presence of OAI is the minimum of those implied by the deferral credit *a* and the earnings test tax rate τ_{ET}. Interest rates which depend on the term of the loan change this analysis fairly little. For example, suppose borrowing and lending take place through perfect annuity markets. Then the effective tax rates are as stated in (3), but replacing

$$(3') \qquad \frac{1}{r} \quad with \quad \sum_{i=1}^{\infty} \frac{s_i}{(1+r)^i},$$

where s_i is the probability of surviving until age *i*.

An economic model predicts the effect of taxes on the quantity of labour supplied. Consider a worker's constrained maximisation problem, with the utility function

$$(4) \qquad \sum_{i=0}^{\infty} \left[\frac{1}{1-\theta} c_i^{1-\theta} - \frac{1}{1+\sigma} (n_i)^{1+\sigma} \right] (1+\rho)^{-i} s_i,$$

where *i* indexes time, *c* is consumption, *n* is the proportion of each period used as labour, ρ is the private discount rate, s_i the probability of surviving until time *i*, and θ>0. The solution involves a series of first-order conditions such as

$$(5) \qquad \frac{n_1}{n_2} = \left[\frac{w_1(1-\tau_1)}{w_2(1-\tau_2)} \frac{s_2(1+r)}{s_1(1+\rho)} \right]^{\frac{1}{\sigma}},$$

where w_1 is the wage and τ_1 the labour tax rate in period 1. Absent wage growth over time, perfect substitutability of different ages of workers in production will imply $w_1=w_2$. The age-specific taxes τ_1 and τ_2 will then affect the labour supplies n_1 and n_2 if leisure is substitutable across ages (σ is finite). By contrast, were workers of different ages perfect complements in production, in aggregate the young and old would be employed in fixed proportions. While we cannot go directly from this aggregate statement to an individual-level statement,[4] perfect complementarity would create a constraint at the individual level much like $n_1=h.n_2$. Net wages across ages would have to remain constant to induce such labour supplies, so age-specific taxes τ_1, τ_2 would only change the gross wages w_1 and w_2. Therefore my regressions jointly test women's willingness to substitute leisure over time, and the substitutability of women of different ages in production.

Labour taxes affect labour supply through income and substitution effects. Given the utility function (4), if $w_1=w_2$ and $\theta=1$,[5] age-constant taxes, such as income and payroll taxes τ_I and τ_P, will induce income and substitution responses which exactly cancel out, and thus have no effect on labour supply. Higher τ_2 has a greater substitution than income effect, reducing n_2 and increasing n_1. Thus taxes applying only to a few years of working life are likely to induce substitution effects which dominate their income effects. The a,B and τ_{ET} terms apply only from the pension eligibility age, so they are age-specific, and k also differs by age. In their regression equations, Blöndal and Scarpetta (1998) and Gruber and Wise (1999) constrain the elements of (3) to have identical

[4] Here I lack of a general-equilibrium model with overlapping generations and endogenous labour supply. Blanchard's overlapping generations model (Blanchard and Fischer, 1989), has no labour-leisure choice.
[5] Blanchard and Fischer (1989) p.338-9 work through the implications of this model.

effects. Given the different income and substitution effects these elements are likely to create, it is preferable to allow for different effects of age-specific and age-constant taxes.

The discontinuity of the labour tax rate at the OAI eligibility age permits its effects to be separated from those of health or social mores via an identification strategy based on 'regression-discontinuity' theory.[6] Below I estimate regressions of the form

$$(6) \qquad LFP_{A2,i} - LFP_{A1,i} = \alpha + \beta\left(TR_{A2,i} - TR_{A1,i}\right) + \varepsilon_i ,$$

where LFP_{A2} is the labour-force participation rate in age-band A2, TR_{A2} the tax rate in this age-band, and i indexes countries. Regression discontinuity theory states that, if A2 and A1 are the limits of a point in time approached from above and below, the tax rate as a function of age is discontinuous at A1, and all other variables are continuous at A1, β is estimated consistently. β estimates how the participation difference would fall were τ_2 reduced to τ_1, but not[7] the behavioural parameter σ^{-1}. Effective taxes on the old given OAI, τ_2, apply to a minority of potential working years, so were τ_2 reduced to τ_1, there would be a greater participation-rate increase at higher ages than a participation-rate decrease at younger ages. To give a sense of the size of β, below I assume all the response to a reduced τ_2 would occur at the higher ages to which it applied.

[6] Regression-discontinuity theory is analysed by Hahn, Todd, and Van der Klaauw (2001).

[7] I do not estimate (4) since this would require cross-country income tax-rate data, and would create problems where the total tax rate was calculated to be greater than 100%, which is possible in this context.

Omitted variables could bias regression (6), despite my appeal to regression-discontinuity theory, for two reasons. First, my data do not allow A2 to be arbitrarily close to A1. Omitted-variable bias in the estimate of β due to social mores, husband's retirements, or income and payroll taxes thus depends on how much these variables affect female participation between ages A2 and A1.[8] These influences seem unlikely to affect female participation very differently between ages 59 and 61, though husbands' retirements could cause differences in female participation between the 55-9 and 60-4 age-bands. The model above with θ=1 is a special case in which income and payroll taxes do not affect labour supply, but in general we would not expect these taxes to affect labour supply very differently across ages.

Second, institutions besides the tax rate differ discontinuously at the OAI eligibility age. Pensions begin to be paid at this age, and I add the difference in OAI replacement rates across ages, ($RR_{A2,i}$ - $RR_{A1,i}$), to the right-hand side of (6), to test whether the onset of OAI benefits induces retirement. Kahn (1988) argues an inability to borrow might induce poorer workers to retire as soon as benefits are available. However, previous literature does not provide a satisfactory model of liquidity constraints. It is incorrect, for example, to replace r in (2) with the private discount rate ρ, as do Diamond and Gruber (1999) and Blanchet and Pelé (1999), since ρ multiplies *utils*, not money values.[9] Further, we would expect older workers to lend rather than borrow. If we model workers as having no assets at some starting period t_0, they will build up assets thereafter,

[8] In a similar imperfect application of regression-discontinuity theory, Black (1999) estimates the valuation of schooling by comparing house prices within 260 yards of school attendance district boundaries.
[9] Note that private preferences or beliefs do not enter the tax (2) so long as workers can borrow and lend at equal rates.

and therefore may escape liquidity constraints. The choice of starting date t_0 would thus be crucial to such a model. Still, a liquidity-constraint theory of pensions' effects appears in much previous literature. Compulsory retirement rules, which may apply at the state pension age, are also government interventions discontinuous by age. Like, the 'liquidity effect' of pensions, these would cause participation to spike downward in the absence of age-specific taxes on labour. However, mandatory retirement laws would affect all women, while any 'liquidity effect' of pensions would be more important to single, poor women without assets or another stream of household income. Thus the 'liquidity' theory could be tested by comparing the age-profile of participation rates of single and married women, or rich and poor women, as in Kahn (1988).

4. Older Women's Labour-Force Participation Across Countries and Time

Participation Rates in 2000

Participation rates by single year of age show different levels and age-gradients of participation across countries.[10] Figure 1 shows female participation rates at ages 55 to 64 in 1999 or 2000 in the US, Denmark, Germany, Ireland and Sweden. Ireland has lower participation than the US at all ages. Participation rates in the other countries are similar to or above those in the US at age 55, but fall below that of the US by age 64. In

[10] Gruber and Wise and Blöndal and Scarpetta transform participation rates such as lfp59, lfp60 into the 'hazard rates' of exit (lfp59-lfp60)/lfp59. Participation rates are more informative than hazard rates, since they show the level of participation as well as changes in this level. Hazard rates are also volatile when their denominator is small.

Denmark and Germany, participation falls dramatically (by 24 and 29 percentage points, respectively) at age 60, when women can first claim OAI benefits.[11] The differences in female participation rates are large; were German women aged 55-64 to participate in the labour force at the same (age-specific) rate as US women, the total German labour force would rise by 2.1 percent. Figure 2 shows female participation rates at ages 55 to 70 in the US, UK, Canada and France. Again participation rates are comparable at age 55, but much higher in the US at higher ages.[12] French participation falls both before and after age 60, when OAI benefits are first available. Canadian and British participation falls at age 60, the female pension eligibility age in both countries. These falls are surprising, since the OAI tax on labour at age 60 is minimal in Canada, and British OAI has no earnings test, so OAI taxes are close to zero at all ages. While we could interpret the spike in British women's participation at age 60 as a response to the 'liquidity' of OAI benefits, no such response of women is evident to the onset of OAI benefits at 60 in Sweden or at 62 in the US.

I have participation rates by single year of age for eight countries. Table 1 compares rates of female labour-force participation in or shortly before the year 2000, at ages 40-4, 55-9 and 60-4, in fifteen developed countries.[13] The first four countries have high female participation at age 40-4, and a majority of women aged 55-9 in the labour

[11] No obvious feature of the Swedish OAI system explains the steep decline in the participation of Swedish women at age 63. Wadensjö (1991) identifies the same phenomenon in the 1970s and 1980s, and attributes it to retirement of female health workers with pensions through their employers in local government.

[12] I do not analyze labour supply of women over 65 in this paper, since this is low in all countries. The higher participation of women over 65 in the US than in other countries is surprising, however, since these data are from 1999, before the Social Security earnings test was abolished for those over age 65, in 2000.

force. Between 30 and 50 percent of women aged 60-4 are in the labour force. In the next five countries, participation of women aged 40-4 is again around 80 percent. Participation at age 55-9 is also quite high, but participation at age 60-4 is much lower than in the first group. Norway and Sweden fit in the high-participation group, whereas Denmark and Finland have much lower participation at age 60-4. Thus age-specific differences in female participation rates exist even between culturally similar countries.

Participation of women aged 40-4 is slightly lower in Belgium, Austria and the Netherlands than in the countries above. Strikingly, however, participation at ages 55-9 is only about half that in the countries described above, and participation at ages 60-4 is less than 10 percent. Participation of Belgian women aged 55-9 is less than half that of French women this age, despite many similarities between these countries. The same comparison holds between Austria and Germany. Australia and Canada have high female participation at age 40-4, but moderate participation at ages above 55. Ireland has substantially lower female participation at all ages, which we might expect given that it legalized divorce only in 1995 and still bans abortion.

Measures of the labour-force, the sum of those employed and those unemployed and seeking work, may differ because countries employ different definitions in their collection. The ILO has, however, attempted to standardize these definitions across countries. My prior is that European unemployment benefit systems apply a loose test of 'seeking work', so that some European women are counted as unemployed who would be

[13] I include Finland and the Netherlands in Tables 1 and 2, but not in the regression analysis, because retirement in these countries appears driven by disability schemes, wherein the strength of medical

described as inactive under US concepts. Table 2 shows female unemployment rates by age in 1998-2000. These are particularly high in France, Germany and Finland at age 55-9. The female unemployment rate at age 59 in Germany is 28 percent. I find these levels incredible as measures of the US concept of unemployment. Therefore I suspect the European participation-rate differences between ages 55-9 and 60-4 would be smaller were US definitions applied.

Countries with early female retirement typically also have early male retirement. Figure 3 shows participation rates of women (on the *x*-axis) and men (on the *y*-axis) aged 60-4 in or shortly before the year 2000. The correlation between male and female participation rates at this age is 0.86. Several interpretations of this high correlation are possible: OAI systems may cause both sexes to retire, or other phenomena may cause men to retire, who persuade their wives to retire at the same time. However, figure 3 rules out the possibility that women's participation is low in some countries due to social mores which demand that women remain at home while men work.

Participation-Rate Changes, 1970-2000

Table 3 compares changes in female participation rates between 1970 and 2000 across countries. Participation of women aged 40-4 rose substantially in all countries in this period. At age 55-9, participation rose everywhere but in Austria, where it fell markedly. Particular divergence is evident at age 60-4. Participation of women aged 60-4 has risen greatly since 1970 in Sweden, Norway and New Zealand, and modestly in the

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screening for benefits is hard to judge from written program rules.

US. Participation at this age has fallen in the remaining nine countries, substantially so in France, Finland and Austria. Table 3 shows that female participation rates exhibit age-specific differences in trends across countries, as well as difference in levels. This shows that the differences in participation rates by age do not result from cohort-specific factors, such as an opening of universities to women which affected some cohorts more than others. Were such effects important, eventually participation would rise at all ages.

Quinn (1999) finds older people in the US started to work more after 1985, and we might expect the same in other countries, as governments paid more attention to early retirement. Table 4 shows participation changes during the 1990s. Similarly to table 3, we see a mixture of rises and falls in participation of women aged 60-4, and that participation of women aged 55-9 fell only in Austria. In contrast to table 3, in table 4 the UK and Ireland are in the high-growth group, and Sweden is in the declining-participation group. Participation of women aged 60-4 grew strongly in New Zealand during the 1990s, while the OAI eligibility age was raised from 60 to 64.5. Overall table 4 shows there was strong growth in female participation in the 1990s in some countries only, whereas in others older women worked the same or less than before.

Long-Run Trends in the US

Figure 4 shows the participation rates of older women in the US from 1940 to 2000.[14] Participation has risen steadily at all ages, apart from a slight decline in the

[14] The sources for this graph are the censuses of 1940-1990 and the Bureau of Labor Statistics' Office of Employment and Unemployment Statistics, at ftp://ftp.bls.gov/pub/special.requests/lf/aat3.txt, for 2001.

1970s. Were sociological variables the most important to participation, we would expect this pattern of rises at all ages in other countries. Table 2 showed, however, that many countries have experienced declining female participation at some ages.

5. Old-Age Insurance Data

I now describe how I construct typical age-specific OAI tax and replacement rates for women in each country. I suggest my variables be understood as dividing countries into those with high and low OAI taxes. I include in OAI benefits available to all workers without work-search requirements, though these are sometimes described as unemployment benefits. I omit public-sector pensions and disability benefits, due to insufficient data. Assessing who is eligible for disability benefits is hard, since the screening process for applications is typically obscure to the outside observer. I do not consider private pensions since I do not believe these tax labour earnings.[15] Our limited data on private pensions would also not allow us to compare them across countries. The appendix discusses OAI data and assumptions I make for each country.

I construct OAI tax rates for 2000 for the cross-section regressions according to equation (3'). I omit payroll and income taxes, due to a lack of data on income tax systems. I use benefit formulae to calculate the return to contributions k, and set r=0.03

[15] This position contrasts with that of Gruber and Wise (1999), who include private pensions in their incentive calculations for the Netherlands only.

and for s_i use age-specific survival rates for the US in 1997[16], which I assume apply to all countries. I construct the benefit *B* of a single woman who had worked continuously from age 20 to each age from 50 to 64. I therefore ignore any dependents' or survivors' benefits. I assume a long earnings history because many OAI systems credit years spent caring for young children or unemployed as contribution years. Some OAI systems condition benefits on marital status, implying married women could face different labour tax rates. For example, US Social Security pays a wife the maximum of the benefits generated by her own earnings and half those generated by her husband's. Thus *k=0* for married women with small lifetime earnings relative to their husbands'. By contrast, the European OAI systems with high effective tax rates do not condition benefits on marital status. I use average full-time female earnings for *W(1-l)*, and construct the average earnings-test tax rate τ_{ET} as it would apply to a woman with these earnings.[17] The average earnings-test tax rate would be higher with slightly lower earnings, but also zero below some earnings threshold.[18] Table 5 shows the tax rates I construct for 2000. Some of these are negative, in particular those in some European systems, because the 'return to contributions' *k* enters the OAI tax negatively, and is large in some OAI systems with large benefits. I describe *B/[W(1-l)]* as the replacement rate of benefits. The correlation between the tax and replacement-rate differences at ages 55-9 and 60-4 is 0.64 in 2000.

[16] These are taken from the Social Security Administration's Office of the Actuary, at www.ssa.gov/OACT/STATS/table4c6.html.
[17] Where I did not have these for older observations, I extrapolated recent female earnings backward using the wage indices in Mitchell (1998).
[18] Denmark and Sweden have 'partial pension' systems subsidising older part-time workers, but since full-time workers would receive no subsidies, I omit these systems from my calculations.

I construct OAI tax rates for the panel regressions which are a simplification of equation (3). I set the real annuity rate r=0.07 in all countries and periods.[19] I also omit the return to contributions k, due to a lack of data on historical benefit formulae. Therefore in the panel regressions my 'OAI tax rate' is zero if a>0.07, and otherwise

$$(7) \qquad \min\left[\tau_{SS}, \frac{B_{64}}{W(1-l_{64})}\left(1-\frac{a}{0.07}\right)\right].$$

The true k was probably high during the introduction of some systems. For example, before 1960, the US Social Security benefit formula averaged earnings over periods as short as one or five years, so earnings in these years were heavily rewarded. I calculate that in 1940 and 1950 Social Security effectively subsidised work by 64-year-olds at the rate of 143 percent.[20,21] While such episodes are interesting, I suggest we would not wish them to dominate our analysis of retirement incentives.

Table 6 shows the OAI tax rates at ages 60-4 used in the panel regressions. Four episodes of large time-series variation stand out. The French and Danish reforms of 1977 and 1979, respectively, are important to identifying OAI effects in time-series. New Zealand's 1938 reform and Germany's 1957 reform, both of which reduced the pension age for women from 65 to 60, had little immediate effect, perhaps because fewer older

[19] Seven percent is often considered a fair accrual penalty around age 64.
[20] I am grateful to my research assistant Jonathan Corning for work on the history of US Social Security.
[21] Ida May Fuller received the first monthly Social Security benefit, in 1940. Her first monthly checque was for $22.54, after lifetime nominal payroll-tax contributions of $24.75. Each dollar Ms. Fuller earned in 1939 was rewarded by an extra 3.43 cents per year of Social Security benefits in perpetuity, so k=0.0343. If r=0.07, Social Security subsidised Ms. Fuller's earnings at a rate of 3.43/7=49% in 1939.

women worked in earlier periods. I also construct OAI tax rates at age 55-9, which are non-zero only for Austria and Belgium. There is time-series variation in both countries.

Sensitivity of the Constructed OAI Tax Rates to Assumptions

I could construct OAI tax rates on the basis of different assumptions about the typical woman's marital status, earnings, or career length. However, in countries with no earnings testing or large rewards to deferred accrual, the OAI tax rate would be small in most scenarios. For example, in the US, were older women dependent spouses, their OAI tax rates would be exactly zero, rather than the small numbers in table 5. A more pertinent concern is that alternative assumptions would reduce the high OAI tax rates I construct in France, Germany, Denmark or Austria. The Danish Post-Employment Wage would create large tax rates for all but very high-earning women. German and Austrian pensions do not depend on marital status. They depend on lifetime earnings, and thus would be smaller for a shorter working history. The French tax rate at ages 60-4 is the most sensitive to assumptions. French OAI penalizes workers heavily if they have less than 157 quarters of covered employment. Therefore, a shorter assumed earnings history would produce a large *k* at age 60-4 and a much smaller tax rate at this age. Were we to assume a shorter earnings history, the low participation of French women aged over 60 would become a puzzle.[22] Under either assumption the OAI system would reward work by women aged 55-9, so their low participation, shown in figure 3, is surprising.

6. Empirical Method and Results

Regression Specifications

In section 2 I argued that regressions involving participation and tax differences are preferable to regressions of levels. In the limit as the differences are taken between neighbouring moments in time, all omitted-variable biases disappear. I also report regressions in levels, for comparison with earlier work. I use the panel specifications

$$(8) \qquad LFP\_604_{i,t} = \alpha_i + \beta_1 . TR\_604_{i,t} + \beta_2 . YEAR_{i,t} + \varepsilon_{i,t} \qquad \text{and}$$

$$(9) \qquad (LFP\_604 - LFP\_559)_{i,t} = \alpha_i + \beta_1 . (TR\_604 - TR\_559)_{i,t} + \beta_2 . YEAR_{i,t} + \varepsilon_{i,t} .$$

Here *i* indexes countries, *t* years, *LFP* is the labour-force participation rate, *TR* the OAI tax rate, and *YEAR* the census year. The cross-country regressions in 2000 drop the *YEAR* term and the separate country intercepts. As discussed above, I interpret β as how much participation at the higher age would rise were the spike upwards in tax rates across age-groups removed. Regressions in levels imply a fall in participation from 60 to 30 percent is larger than a fall from 20 to 10 percent. Regressions in log participation rates would give equal weight to both falls. I present both types of regression below.

[22] I have corresponded with Ronan Mahieu of INSEE on this point. My translation of his answer is that 'what with high unemployment, it is for old people to get a job in France, so they stop looking.' I feel there must be some other institutional reason for the behaviour of French women aged 60-4.

The method of controlling for time trends turns out to be crucial to the coefficients I estimate on OAI tax rates. Enforcing a common time trend across countries, as in (8) and (9), implies the null hypothesis $\beta_1=0$ is that changes in OAI taxes do not help explain different directions in the trend of female participation across countries.[23] If estimated time trends are allowed to differ across countries, the null hypothesis $\beta_1=0$ becomes that OAI tax rates do not explain any sharp deviations in participation from a smooth time-trend, whether up or down.

Cross-Country Regressions for 2000

Table 7 presents cross-country regressions of female participation rates in or shortly before the year 2000. Column 1 regresses female participation at age 60-4 on the OAI tax rate averaged across these ages. Figure 5 plots this regression. The negative relationship evident is similar to that Blöndal and Scarpetta and Gruber and Wise observe for men. The relationship between participation at age 60-4 and the OAI replacement rate at this age is negative but insignificant, because Sweden pays large benefits at this age, without earnings tests, and has high participation. Deleting Sweden, this relationship becomes significant. If male participation at age 60-4 is added to the right-hand side of this regression, it is highly significant, and the OAI tax rate becomes insignificant.

Column 2, using the countries in figures 1 and 2, shows that countries with high OAI tax-rate increases between ages 59 and 61 suffer large participation declines between these ages. Were the OAI tax difference replaced by the replacement rate

[23] Regressions including time fixed effects had nearly identical results to those using specification (3).

difference, this would again be highly significant. Column 3 includes both regressors, and neither dominates the other. Evidence for the 'tax' theory is that participation declines in the UK and Sweden at 60, in both cases the female pension age, are small, consistent with the absence of earnings tests on benefits in these countries. However, the French participation decline between ages 59 and 61 is small compared to the tax-rate difference I construct. This makes the UK decline seem relatively large, raising the regression's weight on replacement rates. Omitting France, column 3 would show a significant effect of OAI taxes but none of OAI benefits alone.

Column 4 regresses the difference between participation rates at ages 60-4 and 55-9 on the difference between OAI tax rates at these ages. Figure 6 plots this regression. Assuming participation at age 55-9 remained fixed, the coefficient of -0.17 implies that, were Germany to adopt the US OAI system, a 7 percentage-point increase in the participation of women aged 60-4 would increase its total labour force by 0.5 percent.[24] Austria and Belgium are outliers in figure 6, because their participation is so low at age 55-9 that it cannot fall far to age 60-4. Dropping Austria and Belgium, the OAI tax-rate coefficient would be bigger, at –0.29. Column 5 shows that, in a regression of levels, we cannot distinguish between the roles of OAI taxes and benefits in causing retirements between ages 55-9 and 60-4. As an alternative to dropping Austria and Belgium, column 6 regresses the differences in log participation rates on the tax-rate difference. The fit is considerably better than in column 4. This OAI coefficient implies that German adoption of the US OAI system would increase participation of women aged 60-4 by 9 percentage

[24] Under the same assumptions, French adoption of the US OAI system would increase participation of women aged 60-4 by 10 percentage points, increase the French labour force also by 0.5 percent.

points. Column 7 shows that, with this regressand, OAI tax rates are more important than replacement rates. This result is driven by Sweden and Austria, and the form of the regressand is important because when the difference in logs is taken, the increase in Austrian tax rates around age 60 explains its participation decline at 60 better, whereas Austrian replacement rates are roughly equal at ages 55-9 and 60-4.

Column 8 compares the difference between participation at ages 55-9 and 50-4 with the difference between OAI tax rates at these ages. Figure 7 plots this regression. The large Austrian fall-off of participation between ages 50-4 and 55-9 generates a statistically significant negative relationship between these participation and OAI differences. The slope coefficient implies that, were Austria to raise its female pension age to 60, participation of women 55-9 would rise by 21.7 percentage points, equal to 1 percent of the total labour force. Column 9 adds the difference in replacement rates at these ages to the right-hand side, and this dominates the effect of tax rates, because Austrian replacement rates exceed OAI taxes at age 55. Thus in the cross-country data no consistent pattern emerges as to whether OAI tax rates dissuade participation, or whether simply the payment of benefits encourages retirement.

Panel Regressions of Women Aged 60-4

Table 8 reports panel regressions, which include country dummies. Column 1, with a common time trend, estimates a statistically significant, negative effect of OAI taxes at age 60-4 on participation of women that age. This OAI effect vanishes in

column 2, with country-specific time trends. The OAI effect also becomes insignificant if France is dropped from the sample. These regressions are therefore explained by figure 8, which compares census participation rates of older women in France and the UK. The trends are similar at ages 50-4 and 55-9, but differ at age 60-4, where participation of French women has been falling since 1954[25]. French pensions for women were reformed in 1977, and the OAI tax rate increased from 0 to 50 percent.[26] The smooth French participation decline at age 60-4, which predates the 1977 reform, gives no sense of a crucial role for it. If the OAI replacement rate is substituted for the tax rate in these regressions, no significant effect is estimated in either specification.

Columns 3 through 6 of table 8 regress the difference between participation rates at ages 60-4 and 55-9 on the difference between OAI tax rates at these ages. Columns 3 and 5, with common time trends, shows significant negative effects of the OAI tax difference, or of its ten-year lag. These effects disappear in columns 4 and 6, however, which include country-specific time trends. The OAI coefficients in columns 3 and 5 also become insignificant if both France and Denmark are dropped from the sample. Figure 9 compares participation of men and women aged 55-9 and 60-4 in Denmark over time. The OAI eligibility age was effectively reduced from 67 to 60 in 1979 by the 'Post-Employment Wage', which is strictly earnings-tested. A sharp fall in male participation at age 60-4 is evident between 1976 and 1981, but the reversal of the pre-existing upward trend in female participation at this age is much more gradual. Once country-specific time trends are included in the regression, there is little other movement in the female

[25] Different methods of ascertaining labour-force status were used in the French census of 1946, so the participation rates it quotes are not comparable to those in later censuses.

participation rate to identify an OAI effect. The importance of the Danish benefit extension in these regressions means all these results would hold were the OAI replacement rate substituted for the OAI tax rate, and that it is impossible to distinguish between the two variables' effects.[27]

Panel Regressions of Women Aged 55-9

Columns 7 and 8 of table 8 report regressions of the difference between women's participation rates at 55-9 and 50-4 on the difference between OAI tax rates at these ages. In column 7, with a common time trend, a negative effect of the ten-year lag of this tax difference is apparent, but this disappears once more in column 8, which includes country-specific trends. The OAI effect in column 7 also disappears if Austria is omitted from the sample. Figure 10 compares participation rates in Germany and Austria at ages 50-4, 55-9 and 60-4 since 1950.[28] While the participation trends are fairly similar at ages 50-4 and 60-4, participation of German women aged 55-9 has increased over time whereas that of Austrian women this age has decreased. The two countries have very similar OAI systems, but the female benefit eligibility age in Germany was 60 from 1957, whereas Austria reduced its female benefit age from 60 to 55 between 1961 and 1966. Participation at age 60-4 has declined in both countries, in contrast to the US.

[26] See the description of the French OAI system in the Appendix.

Effects of Macroeconomic Variables

The business cycle may affect older women's labour-force participation. Table 9 adds controls for GDP growth over the preceding ten years and the overall unemployment rate to the regressions in table 8. The macroeconomic variables will themselves be endogenous to the size of the labour force, so the identification of these regressions is somewhat suspect. The coefficients on the OAI tax rates are nearly identical to those in table 8, and GDP growth and unemployment are in general insignificant. Therefore the measured effects of OAI would not appear confused with those of the business cycle.

Magnitudes of the Coefficients

In table 8, columns 1, 3, 5 and 7, with common time-trends, report significant coefficients on OAI tax rates. Their total effect is found by summing the coefficients on the lags of OAI tax rates. In columns 5 and 7, this sum is –0.14, slightly smaller in magnitude than the coefficient of –0.17 in column 4 of table 7. However, the twenty-year lag of the tax-rate difference between ages 60-4 and 55-9 also has a significant negative effect on participation, giving a total effect of –0.21. Therefore, the panel and cross-country regressions show similar long-run effects of OAI on female participation. As lags are added to the panels, the sample size falls, as earlier observations must be dropped. Therefore it is difficult to use the panel to gain a good sense of the long-run

[27] Including either the tax or replacement rate difference the regression with a common time trend, both are significant at the 1% level. Including both at once, only the tax difference is significant, at the 10% level.

effects of OAI reforms. The importance of the twenty-year lag reinforces the result that these are very slow to emerge, however.

Summary

Both cross-country and time-series evidence suggest OAI taxes substantially affect older women's labour-force participation. Cross-country regressions for 2000 show a strong relationship between participation rates and OAI taxes. Panel regressions with common time trends show that differences in OAI systems are associated with different directions of the trend of female participation. However, female participation responses to OAI reforms are much slower than those of men, as figure 9 shows in the Danish case,[29] so country-specific trends make OAI effects disappear in the panel regressions. OAI tax and replacement rates are highly correlated in my data, so distinguishing between their effects is difficult.

7. Exploring Endogeneity of OAI Systems

If OAI eligibility ages were reduced in response to lower participation, this would bias the regression coefficients on the OAI tax rate reported above towards finding negative effects of OAI on participation. The existence of spikes in labour-force participation rates by age give some defense against this theory, however. It is not

[28] The Austrian census of 1950 reported participation at ages 50-9 but not at 50-4 or 55-9.
[29] Participation responses were also slower among women than men after Austria's 1961-6 reform.

plausible that spikes in participation rates such as those figure 1 shows in Denmark and Germany at age 60 would exist without discontinuities in laws relating to women above and below 60. Indeed, figures 11 and 12 show that the participation spike at 55 in Austria and 60 in Denmark developed only after Austria's reduction of its female eligibility age from 60 to 55 in 1961-6[30] and Denmark's reduction of the OAI eligibility age from 67 to 60 in 1979.[31] By contrast, figure 8 is consistent with French benefits having been increased in 1977 in response to lower female participation. Formal methods are necessary to weigh this mixed evidence.

My previous paper on male retirement tests for endogeneity of OAI reforms to trends in labour-force participation using regressions on annual data of the type

$$(10) \qquad TR_{i,t} = \alpha_i + \gamma.TR_{i,t-1} + \beta_1.LFP_{i,t-1} + \beta_2.LFP_{i,t-2} + \varepsilon_{i,t}, \qquad i=1,\ldots,N,\ t=1,\ldots,T$$

where endogeneity of tax rates is assessed by an F-test of whether $\beta_1=\beta_2=0$. Two problems with this test are that the coefficients will be biased when T is small, and that trends in labour-force participation might affect OAI through some other functional form. A different approach suggested by female data is to run the cross-country regression

$$(11) \qquad LFP_{i,2000} - LFP_{i,1980} = \alpha + \beta_1.TR_{i,1980} + \varepsilon_i .$$

[30] The Austrian data are for its census (1971-91) and Eurostat (2000). The participation rates in the Eurostat data imply higher participation rates at age 55-9 than data from the Austrian Statistical Office for

Under the hypothesis that causation runs from labour-force participation rates to OAI variables, and not the reverse, β_1=0. One might argue that OAI tax rates are endogenous to anticipated future changes in participation, but this theory is observationally equivalent to that in which OAI tax rates are causal. Figure 13 plots regression (8), using labour-force participation and OAI tax rates at age 60-4. The coefficient β_1 is negative and significant, suggesting that OAI variables affect the future path of female participation. An explanation for this gradual effect of OAI could again be that successive cohorts of women have longer earnings histories and are thus more affected by OAI rules.

8. Omitted-Variable Bias: Mandatory Retirement Rules

The participation-rate data imply institutions with discontinuous effects at specific ages are important omitted variables in the analysis of the effects of OAI. While I have no data on mandatory-retirement rules, they would explain labour-supply differences between the US and UK, and Switzerland better than the 'liquidity' theory of OAI.

Recall from figure 2 that many UK women stop working at their state pension age of 60, whereas there is no such spike among US women at the Social Security eligibility age of 62. Figure 14 compares participation rates of men in the US and the UK. Many British men retire at their state pension age of 65, while the fall in the participation of US men at 62 is modest. OAI taxes cannot explain UK behaviour, since there is no earnings

1999. Therefore I am not confident that the participation levels in the Eurostat and census data are entirely comparable, but the changes in levels are more likely to be so.

test on UK pensions. While a 'liquidity effect' of pensions could explain UK participation rates, no comparable liquidity effect appears to obtain in the US. The differences between the US and UK are consistent, however, with rules in the UK compelling or encouraging men and women to retire at their respective state pension ages.

Switzerland, like the UK, has no earnings test on OAI pensions, but downward spikes in labour-force participation rates at its state pension ages of 62 (for women) and 64 (for men), as figure 15 shows with data from the 1990 Swiss census. These data are consistent either with a 'liquidity effect' of pensions or mandatory retirement at the state pension ages. Married women are less likely to respond to the liquidity of pension flows, since their husbands' earnings, assets or pension are likely to remove liquidity constraints. In Swiss data, however, both single and married women's participation rates spikes down sharply at age 62, so a response to the liquidity of pensions does not appear to explain Swiss women's behaviour.

9. Conclusion

Older women's labour supply differs greatly across countries. I find significant effects of OAI on older women's labour supply in both cross-country and panel regressions. I am unable to separate the effects of taxes on labour implied by OAI or a 'liquidity effect' of the flow of benefits in my data. Effects of OAI emerge gradually in

[31] The sharp fall in participation appears to have occurred at age 61 in 1980 but age 60 in 2000.

time-series, so older women's participation rates may continue to diverge across countries. More older women work in the US than in most other countries. I find this is partly due to US Social Security's not restricting work by older people, though OAI cannot explain why more older women work in the US than in the UK or Canada.

These effects of OAI on female retirement corroborate Gruber and Wise's finding that OAI incentives affect male retirement across countries. Female data suggest previous authors have 'over-interpreted' the trend towards earlier male retirement, however. Samwick (1998), for example, argues the male trend reflects distortionary effects of OAI and private defined-benefit pensions. These institutions have not prevented strong growth in older women's labour supply, so much of the male trend may be attributable to other influences. Cross-country analysis of OAI and retirement is vulnerable to omitted-variable bias due to mandatory retirement rules. Data from Britain and Switzerland would be more consistent with compulsory retirement or encouraged retirement by unions at the state pension age than either the tax or liquidity theories of OAI. Understanding the role of mandatory retirement rules would be a useful task for future research.

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Appendix: Construction of the OAI Variables

OAI systems are complex, and in some countries the boundaries between them and other state benefits is disputable. This section details the sources I used to construct variables measuring national OAI systems. If readers feel I have missed details, I hope they will correct me.

Australia

Australia pays OAI benefits at flat rates to single people and married couples. The pension means test applies at the level of the household. Therefore a married woman would face a large tax on earnings if her husband had retired, or no tax on earnings if her husband earned enough to preclude any pension. I assume the typical woman is single, to avoid constructing tax rates under a variety of assumptions about husbands' ages and earnings. I ignore the capital taxes in the pension means test.

Austria

The OAI tax rate constructed for Austria is sensitive to the length of the contribution history assumed. In 2000, Austrian pensions equaled 2 percent of workers' average revalued wages per year of contributions, up to a maximum of 80 percent. Thus there are considerable rewards to working for an extra year, which stop abruptly after 40 years' work. I assume that women had worked continuously from age 20, so this reward to extra work ends at age 60. Austria also pays earnings-tested pensions to women from age 55, though with some reward for claiming later.

Belgium

My OAI variables for Belgium include explicit old-age pensions but also the 'Pre-pension', nominally an unemployment benefit but without any job-search requirement. Gruber and Wise (1999) also include this measure in their incentive calculations. Copeland (1977) describes the 1976 legislation which introduced pre-pensions for voluntary retirees. One feature was a requirement that the firm losing the older worker hire another worker under 30. I include a similar system in my French OAI variables.

Canada

My OAI variables are based only on the rules of the Canada Pension Plan. I ignore the Spousal Allowance (SPA) because I assume the typical woman is single, and also because it is an asset-tested benefit only for the poor. OAS/GIS pensions paid from age 65 do not affect tax rates below 65 since only a history of residence in Canada, not a contribution history, is necessary to qualify for them.

Denmark

The 'Post-Employment Wage', introduced in 1979, is sometimes referred to as a type of unemployment benefit, though no job search requirement is attached. The ATP

earnings-related pension, paid at age 67, would become relevant to tax rates below 67 were I to include the return to contributions *k*. I do not include the Partial Early Retirement Pension, introduced in 1986. This pays older workers who work from 10 to 30 hours per week on a sliding scale, with those working 10 hours receiving the most. I calculate OAI variables as they would apply to a woman working full-time, who would not be eligible for this pension.

France

Most private-sector French workers have a pension through the Social Security system's Regime General and also through a (compulsory) complementary scheme. The rules of the complementary schemes are rather obscure, so my constructed variables are based only on the Regime General. Different sources give a confusing picture of whether there is an earnings test for French pensions. Blanchet and Pele (1999) state that pensions may be combined with work if the worker changes jobs, but judge this impossible for an older French worker. The Charpin report (1999) says that since 1982 the combination of a pension and earnings has been 'strictly regulated' and that only 2 percent of pensioners over 60 have labour income. I conclude that there is an earnings test in France from age 60. Guillemard (1991) describes a system of unemployment benefits without job-search tests opened to voluntary retirees aged 60-5 from 1977-1983. Therefore my OAI variables summarize French OAI as introducing an earnings test for women's pensions at age 60 in 1977 which remains in force now.

Germany

The German pension age for women was 65 prior to 1957, when it was revised down to 60. German pensions are earnings-tested until age 65.

Ireland

Ireland pays no OAI benefits until age 65, so my constructed tax rates are all zero for Ireland. In the OAI tax rates I construct for the cross-country regressions in 2000 and quote in table 5, qualification for benefits from 65 on affect tax rates below age 65.

New Zealand

My data for the year 2000 are constructed using the pension eligibility age that year of 64.5; this has since risen to 65. The surcharge tax on recipients of OAI pensions (a tax on both labour and capital income) was abolished in 1998.

Norway

The Norwegian OAI system pays pensions from the age of 67. Haugen, Hernies and Strom (2001) describe the AFP early retirement pension system, created in 1989, which pays pensions from the age of 62. The AFP system is described by. I do not include the AFP in my incentive calculations because it appears more like a private-

sector pension than OAI. It was negotiated between employers and unions, and covers 43 percent of the private labour force, plus all government employees. Workers claiming AFP pensions cannot work for any firm covered by the AFP system.

Sweden

Retirement pensions in Sweden are available from age 60, but are not means-tested. I omit the Partial Pension system, which subsidises part-time workers aged 61-4, since I assume the typical woman would work full-time if at all.

Switzerland

In 2000, state pensions for women were available at age 62; this eligibility age will rise to 64, the male pension age, by 2005. There is no earnings test on the receipt of these pensions, despite which the 1990 census shows distinct downward spikes in female participation at 62 and male participation at 64. In 1950, pensions were paid to single women at 65 and married women at 60, which I code as implying no pension at ages 60-4,since I assume the typical woman is single. In 1960, pensions were paid to single women at 63 and married women at 60, which, similarly, I code as a pension age of 63.

UK

I assume the typical woman received the Basic State Pension for a single person. I do not include the State Earnings Related Pension Scheme, since workers can leave it if they contribute to an approved private pension scheme.

USA

My OAI tax rates for the US are low because the deferred retirement credit, at the rate of 6.67 percent per year, is close to the market return I assume on an annuity of 7 percent. The phased increase in the standard age of retirement form 65 to 67 does not affect the tax rate constructed in 2000.

Table 1: Labour-Force Participation Rates of Women by Age, 1998-2000			
	Age 40-44	**Age 55-9**	**Age 60-4**
High Participation at All Ages			
Norway	86.5*	72	48.4
Sweden	88.6	79.1	48.2
USA	78.7	61.2	40.1
New Zealand	78.7	60.1	31.9
Participation Drops After Age 60			
Denmark	86.9	66.9	22.6
Finland	89.3	62.3*	21.4*
Germany	81.1	56.9	13.2
France	81.7*	53.2*	14.2*
Switzerland	77.8	66.9	34
United Kingdom	76.9	58.2	26.4
Participation Drops by Age 55			
Belgium	73.4*	27.6*	6.3*
Austria	73.9*	24.4*	5.9*
Netherlands	64.5*	29.1*	6.4*
Moderate Participation at All Ages			
Australia	74.4	47.2	21.8
Canada	80.9	53.4	27.2
Low Participation at All Ages			
Ireland	56.8†	35	19.5
Data are from 2000 except for * from 1999. British participation is that of women aged 35-44, not 40-44.			

Table 2: Unemployment Rates of Women by Age, 1998-2000			
	Age 35-44	**Age 55-9**	**Age 60-4**
Norway	2.2	1.2	0
Sweden	5.9	3.8	6.8
USA	3.3	2.7	2.5
Denmark	4.0	6.3	3.3
Finland	9.0	10.2	6.9
Germany	8.6	19.4	7.5
France	11.8	10.2	3.7
Switzerland	3	1.9	3.2
United Kingdom	4.1	3.6	2.2
Belgium	8.9	9.8	1.6
Austria	3.8	3.2	4.5
Netherlands	6.9	4.0	0
Australia	5.9	5.2	3.1
Canada	6.4	5.4	5.0
Ireland	4.9	2.7	2

All data are from *OECD Labour-Force Statistics 1999*, except for the Netherlands (1999 Labour Force Survey), Germany (2000 Microcensus), and Ireland (Quarterly National Household Survey, Q1 2001). For Ireland, I take the raw mean of the age-specific quarterly unemployment rates in 2000.

Table 3: Changes in Female Labour-Force Participation Rates, 1970 to 2000, by Age			
	Age 40-44	**Age 55-9**	**Age 60-4**
Rising at All Ages			
Norway	57.1*	38.9	23.8
Sweden	25.2	31	17.6
New Zealand	39.6	32.6	16.4
Australia	25.6	18.9	5.8
Switzerland	33.1	27.5	4.1
USA	26.3	13.8	4
Falling Above Age 60			
France	38	10.9	-18.2
Finland	18.3**	12.9*	-7.8*
Netherlands	49.9*	11.3*	-5.6*
Germany	33	22.2	-4.6
Denmark	29.9	25.9	-3.2
Canada	34.5	14.7	-1.9
United Kingdom	19.9	7.5	-1.6
Ireland	37.5	13.2	-1.2
Belgium	39.7	6.3*	-1.2*
Falling Above Age 55			
Austria	20.8*	-11.4*	-7.3*

* Growth 1970-1999. ** Growth 1970 to 1997.
New Zealand growth is from 1971 to 2000.
French growth is from 1968 to 1999.
For Australia and the UK changes in younger women's participation are for those 35-44.
For Belgium, the Netherlands, Norway and Finland, these are for women 30-44.

Table 4: Increase in Female Participation Rates from 1990 to 2000		
Country	**Age 55-9**	**Age 60-4**
Strong Growth at Age 60-4		
New Zealand	13.9	14.3
Switzerland	17	9.1
Ireland	15.2	6.2
Australia	10.8	5.4
USA	5.8	5
UK	5.6	4.4
Norway	10.1	4.3
Belgium	10.8	2.5
Weak Growth or Declines at Age 60-4		
Finland	1.8	1
Germany	13.1	0.7
Canada	3.5	-0.9
France	7.1	-2.6
Denmark	4.8	-3.8
Sweden	2.3	-4.9
Decline at Age 55-9		
Austria	-1.6	0.9
Note: for Austria, Belgium, the Netherlands, Finland and France, the participation changes are recorded from 1990 to 1999.		

Table 5: OAI Tax Rates Constructed for 2000					
	Age 50-4	Age 55-9	Age 60-4	Difference 55-9 – 50-4	Difference 60-4 – 55-9
OAI Tax Jumps at Age 55-9					
Austria	-30	6.1	53.8	36.1	47.7
Belgium	-19.2	6.8	50.4	26	43.6
OAI Tax Jumps at Age 60-4					
Denmark	-2.1	-2.4	64.1	-0.3	66.5
France	-15.7	-28.1	50	-12.4	78.1
Germany	-17.7	-20	27.9	-2.3	47.9
Little or No Tax at Higher Ages					
Australia	0	0	17.5	0	17.5
Canada	-7.5	0	3.3	7.5	3.3
New Zealand	0	0	0	0	0
Norway	-8.2	-9.1	0	-0.9	9.1
Ireland	-10.1	-11.4	-12.9	-1.3	-1.5
Sweden	0	0	0	0	0
Switzerland	-6.2	-7.4	-3.4	-1.2	4
UK	-6.3	-7.4	0	-1.2	7.4
US	-6.8	-4.8	-0.8	2	4

Note: these tax rates are constructed from each age d from 50 to 64 as

$$\sum_{i=d}^{i=100} \frac{-k_i s_{d,i}}{1.03^{i-d}} + \min\left(\tau_d, \frac{B}{W}\left(1 - \sum_{i=d}^{i=100} \frac{a_i s_{d,i}}{1.03^{i-d}}\right)\right), \text{ where}$$

k_i is the increase in benefits in year i due to earning the average female wage at age d.
$s_{d,i}$ is the probability someone alive at age d will live to age i.
τ_d is the earnings-test tax rate at age d.
a_i is the reduction in benefits in year i due to having claimed them one year early.
The tax rate quoted for ages 50-4 is the average of those constructed at aged 50, 51, 52, 53 and 54, and similarly for tax rates at ages 55-9 and 60-4.

Table 6: OAI Tax Rates For Women Constructed at Age 60-4, Percent								
	1930	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**
Australia	14.4	10.4	9	18.1	21.1	26.2	27.9	17.5
Austria	…	…	48	72	64.5	64.5	64.5	70
Belgium	…	…	33.3	60	60	60	60	60
Canada	0	0	0	0	0	0	3.3	3.3
Denmark	…	…	0	0	0	80.3	79.2	67.4
France	…	…	0	0	0	50	50	50
Germany	…	…	0	60	60	60	60	47.2
Ireland	…	…	0	0	0	0	0	0
Norway	…	…	0	0	0	0	0	0
New Zealand	0	30.7	30.9	35.5	23.7	0	14	0
Sweden	…	…	0	0	0	0	0	0
Switzerland			0	0	0	0	0	0
UK	0	0	9.2	20.2	7.9	0	0	0
US	…	0	0	1.1	1.2	1.6	1.5	1.5

Note: these tax rates are constructed as $\min\left[\tau_{SS}, \frac{B}{W(1-l)}\left(1-\frac{a}{0.07}\right)\right]$.

Table 7: Cross-Country Regressions of Female Labour-Force Participation in 2000									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Dependent Variable	P60-4	P61 – P59	P61 – P59	P60-4 – P55-9	P60-4 – P55-9	Ln P60-4 – Ln P55-9	Ln P60-4 – Ln P55-9	P55-9 – P50-4	P55-9 – P50-4
TR 61 – TR 59		-0.28** (0.07)	-0.18 (0.09)						
RR 61 – RR 59			-0.17 (0.11)						
TR 60-4	-0.36** (0.11)								
TR 60-4 – TR 55-9				-0.17** (0.09)	-0.07 (0.11)	-0.013** (0.002)	-0.012** (0.005)		
RR 60-4 – RR 55-9					-0.17 (0.13)		-0.001 (0.005)		
TR 55-9 – TR 50-4								-0.47** (0.14)	0.4 (0.35)
RR 55-9 – RR 50-4									-0.65** (0.25)
N – k	14 – 2	9 – 2	9 – 3	14 - 2	14 – 3	14 - 2	14 - 3	14 - 2	14 – 3
R^2	0.46	0.71	0.79	0.24	0.34	0.71	0.71	0.47	0.68

Note: P denotes the female participation rate, TR the OAI tax rate as in table 5, and RR the OAI replacement rate B/W(1-*l*), as described in section 4. ** denotes coefficients significant at the 5% level.

Table 8: Panel Regressions of Female Participation								
Dependent Variable	**LFP 60-4**		**LFP 60-4 – LFP 55-9**				**LFP 55-9 – LFP 50-4**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Old-Age Insurance								
TR 60-4, *t*	-0.14**	-0.01						
	(0.05)	(0.04)						
TR 60-4 – TR 55-9, *t*			-0.09**	0.04	-0.03	0.03		
			(0.03)	(0.03)	(0.03)	(0.03)		
TR 60-4 – TR 55-9, *t-10*					-0.11**	-0.01		
					(0.03)	(0.03)		
TR 55-9 – TR 50-4, *t*							-0.03	0.02
							(0.05)	(0.04)
TR 55-9 – TR 50-4*, t-10*							-0.11**	0.03
							(0.04)	(0.05)
Time Effects								
Common Time Trend	Yes	No	Yes	No	Yes	No	Yes	No
Country-Specific Time Trends	No	Yes	No	Yes	No	Yes	No	Yes
N-k	96 – 16	96 – 29	87 – 16	87 – 29	82 – 17	82 – 30	71 – 17	71 – 30
R^2	0.62	0.9	0.88	0.96	0.91	0.96	0.82	0.92

Note: TR= OAI Tax Rate. All regressions include country dummies. Standard errors are in parentheses.
** Denotes coefficients significant at the 5% level.

Table 9: Panel Regressions of Female Participation, with Macroeconomic Controls								
Dependent Variable	**LFP 60-4**		**LFP 60-4 – LFP 55-9**				**LFP 55-9 – LFP 50-4**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Old-Age Insurance								
TR 60-4, *t*	-0.14**	-0.02						
	(0.05)	(0.05)						
TR 60-4 – TR 55-9, *t*			-0.09**	0.03	-0.03	0.03		
			(0.03)	(0.03)	(0.03)	(0.03)		
TR 60-4 – TR 55-9, *t-10*					-0.1**	-0.01		
					(0.03)	(0.03)		
TR 55-9 – TR 50-4, *t*							-0.01	0.03
							(0.05)	(0.04)
TR 55-9 – TR 50-4, *t-10*							-0.11**	0.02
							(0.04)	(0.04)
Macroeconomy								
Δ Ln GDP *t-10* to *t*	-3.32	5.59	4.21	3.63	3.13	1.16	2.03	1.32
	(7.07)	(4.5)	(4.26)	(3.32)	(4.47)	(4.7)	(5.05)	(5.12)
Unemployment Rate	-0.3	0.17	-0.21	-0.13	-0.13	-0.1	-0.43**	-0.38*
	(0.21)	(0.14)	(0.12)	(0.09)	(0.13)	(0.11)	(0.21)	(0.19)
Time Effects								
Common Time Trend	Yes	No	Yes	No	Yes	No	Yes	No
Country-Specific Time Trends	No	Yes	No	Yes	No	Yes	No	Yes
N-k	96 – 18	96 – 31	87 – 18	87 – 31	82 – 19	82 – 32	71 – 19	71 – 32
R^2	0.63	0.9	0.89	0.96	0.91	0.96	0.84	0.93

Note: TR= OAI Tax Rate. All regressions include country dummies. Standard errors are in parentheses.
** Denotes coefficients significant at the 5% level, * at the 10% level.

Figure 1: Female Participation Rates in the US, Denmark, Germany, Sweden and Ireland in 1999/2000

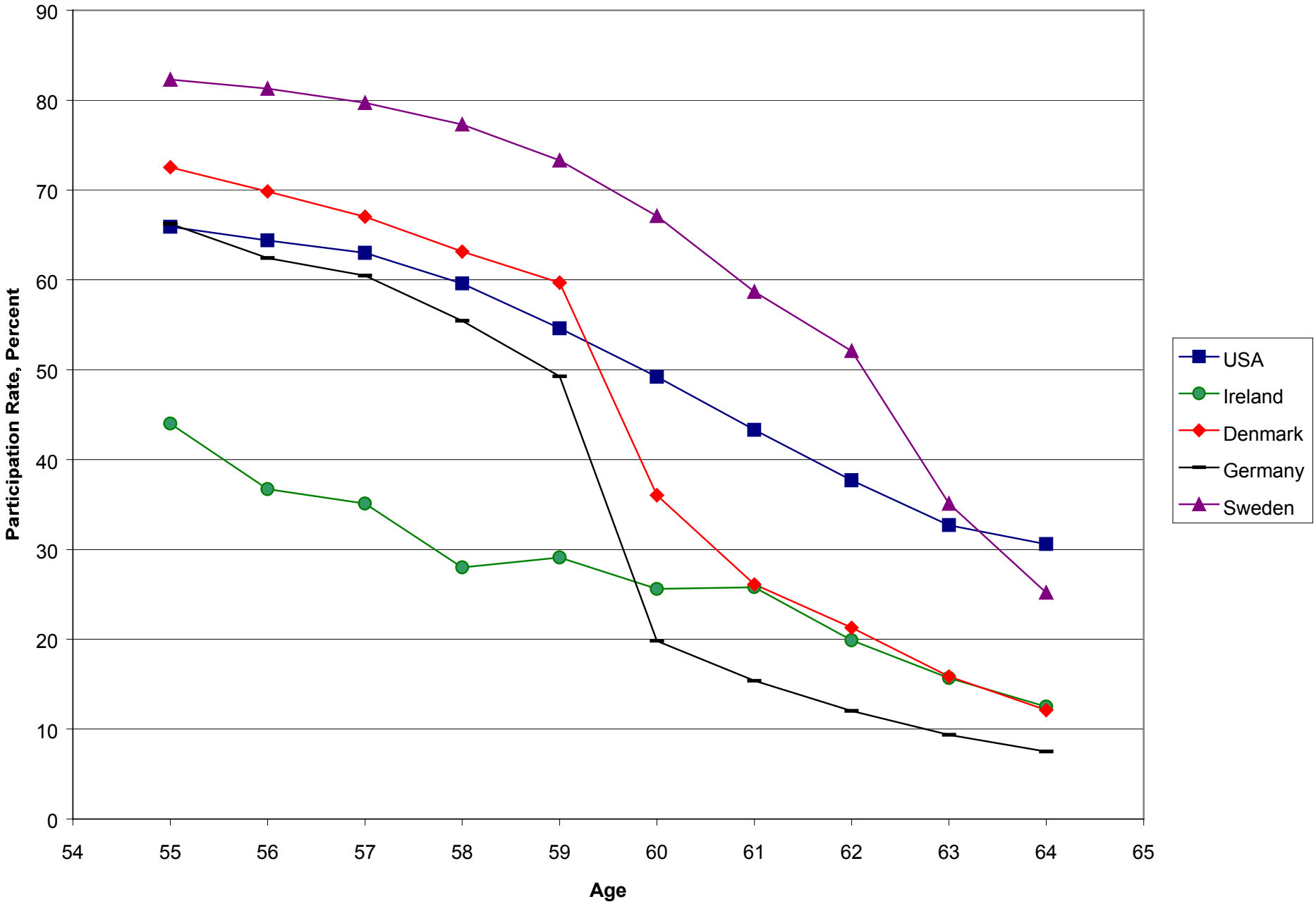
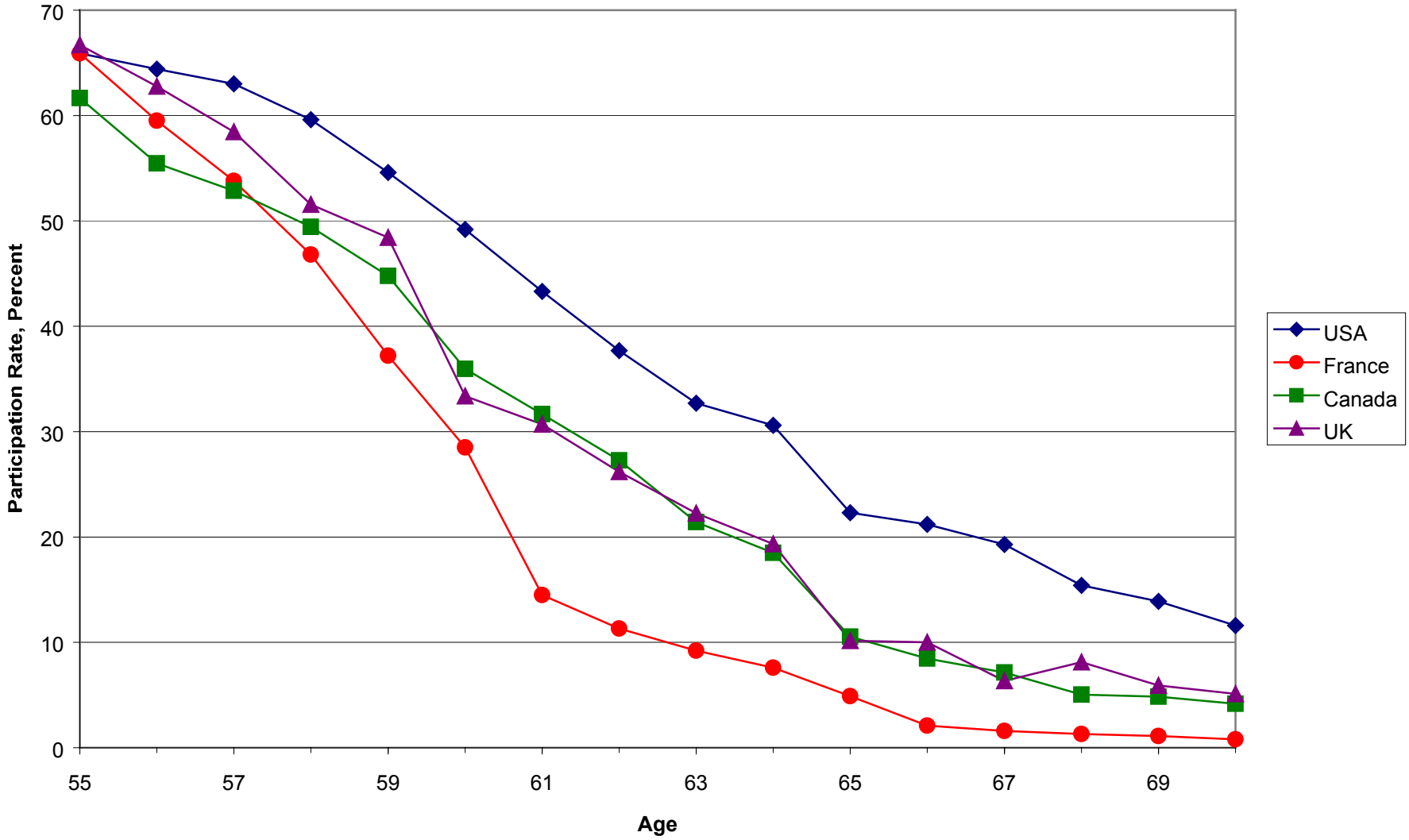


Figure 2: Participation Rates of Women in the US, UK, Canada, and France, 1999/2000



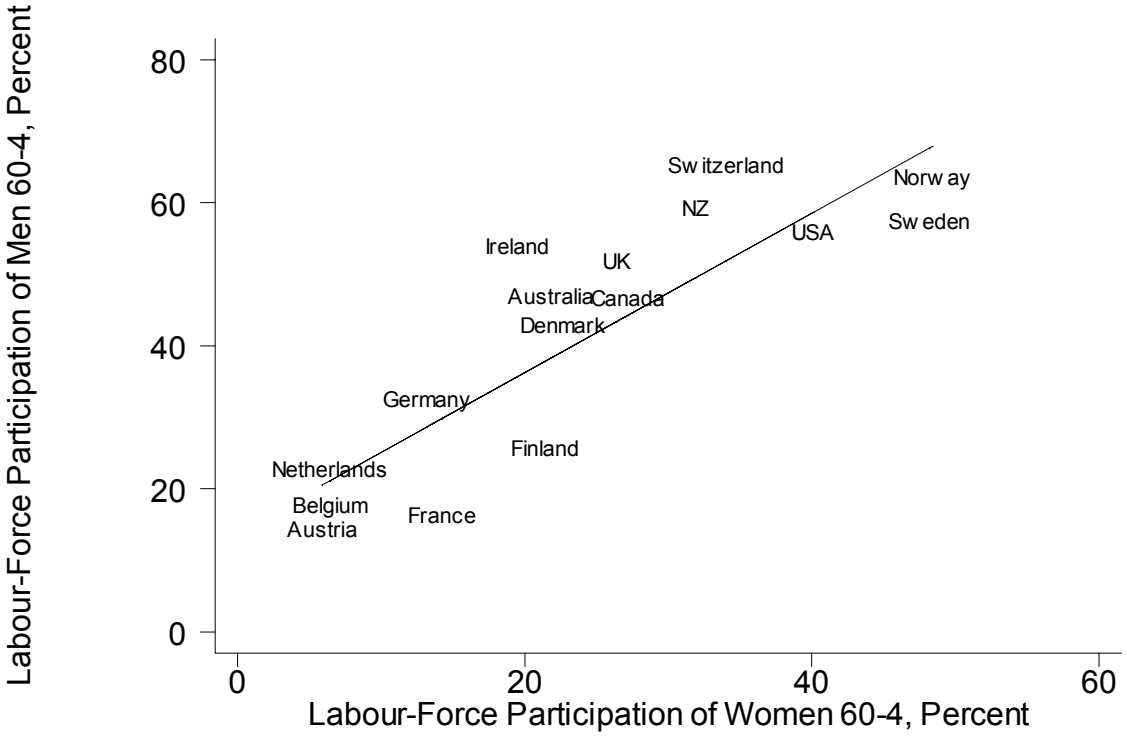
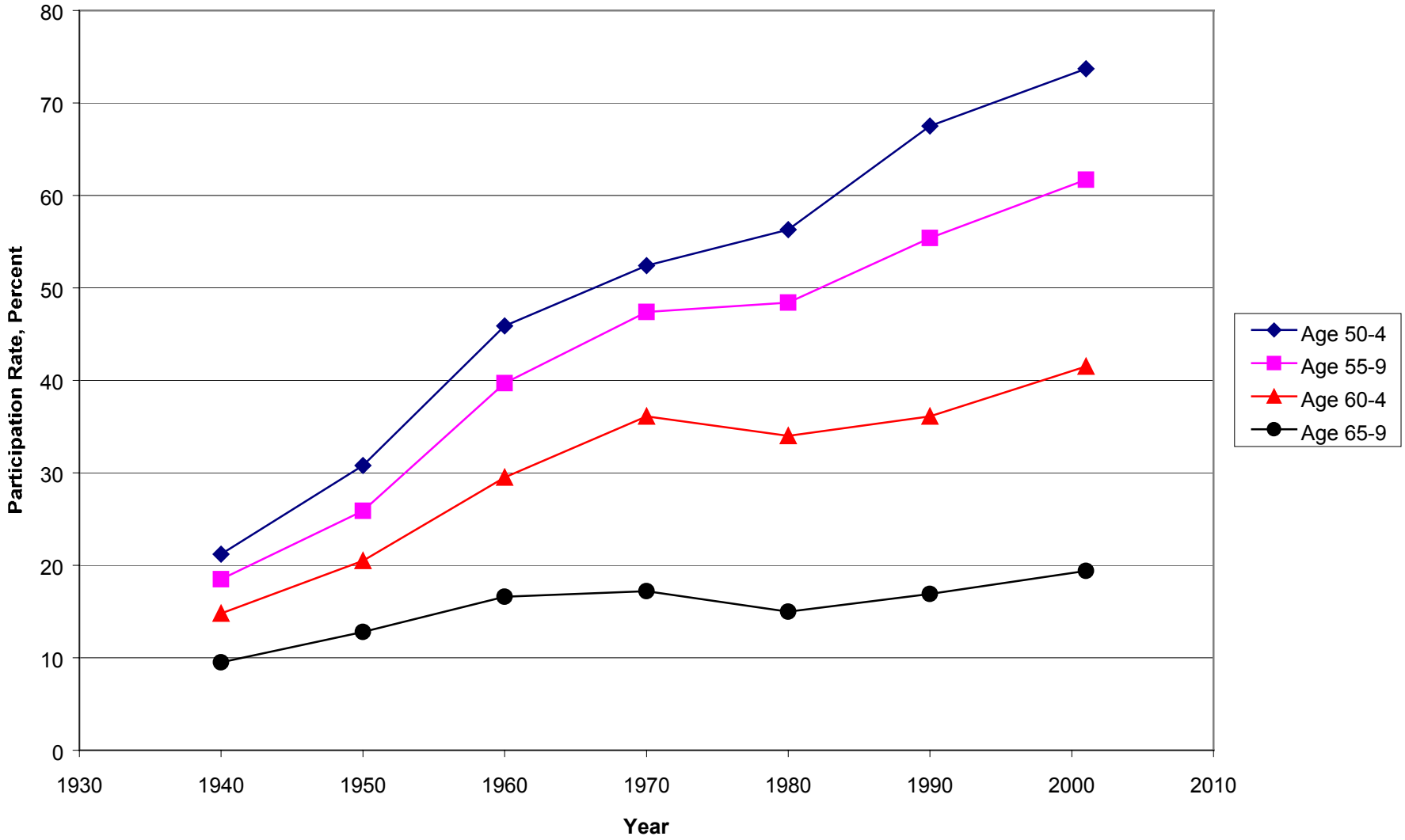


Figure 3: Labour-Force Participation of Men and Women Aged 60-4, data from 1998-2000. Correlation r=0.86.

Figure 4: Labour-Force Participation of Older Women in the US.
Census Data for 1940-1990, BLS Data for 2001.



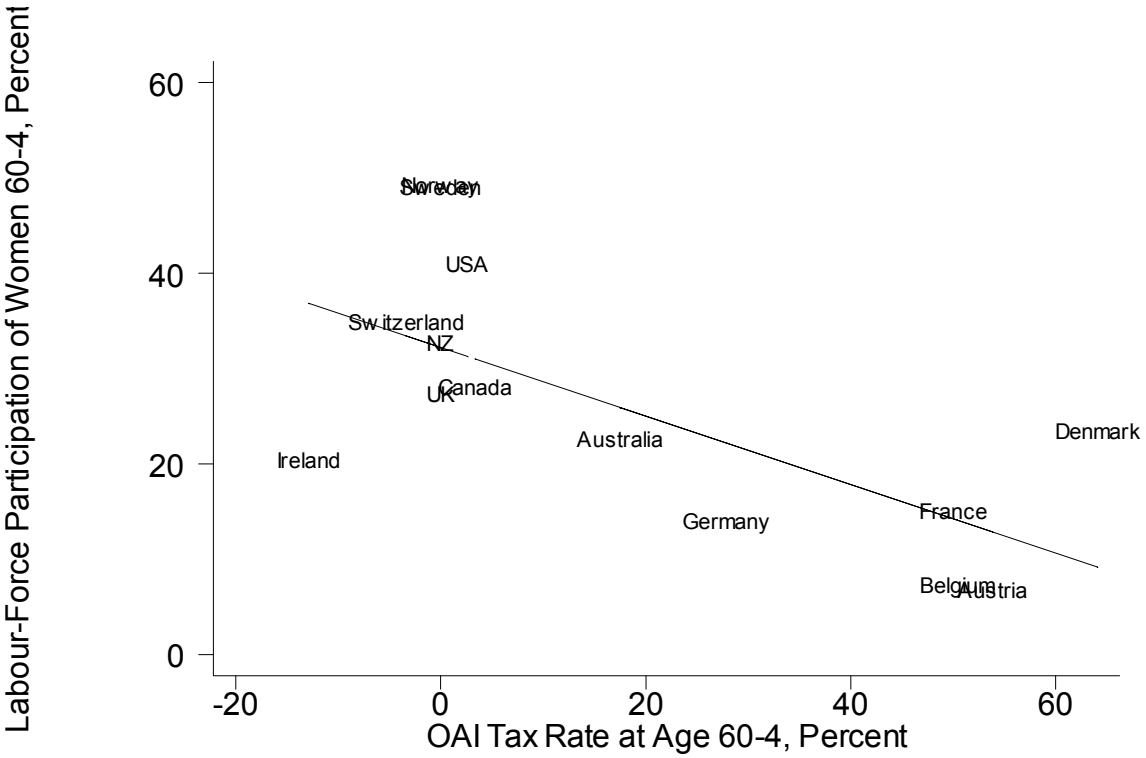


Figure 5: Participation Rate of Women 60-4 and OAI Tax Rate at this Age, 2000. (Sweden and Norway are in the top left corner).

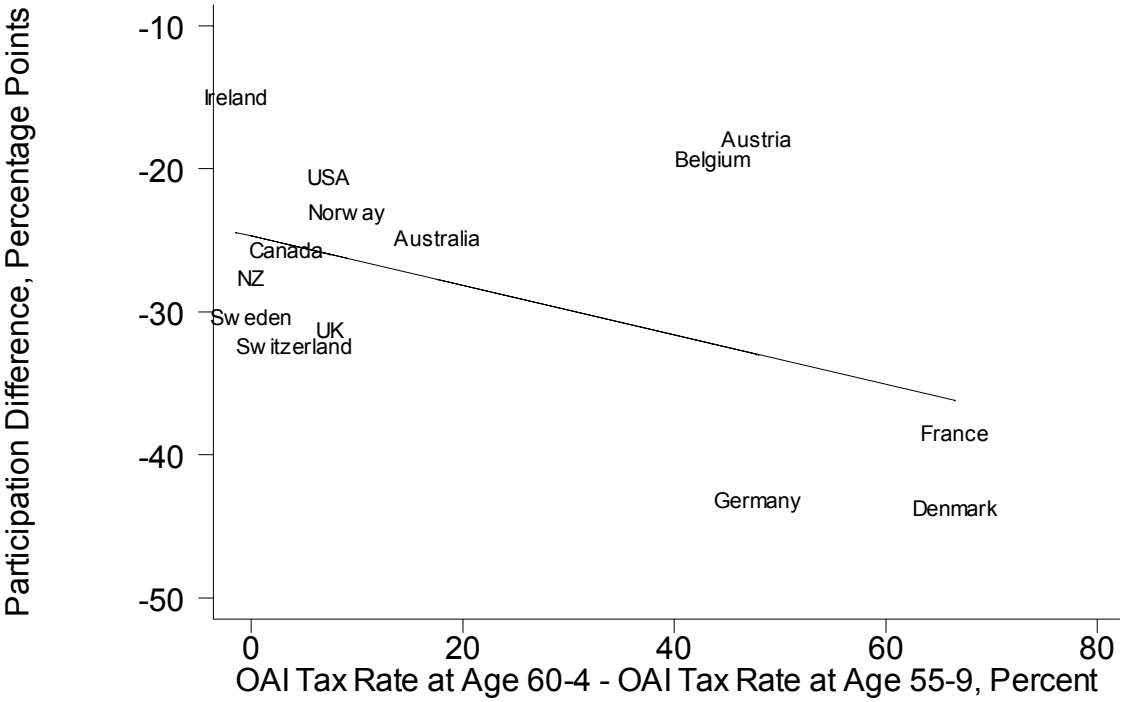


Figure 6: Participation Rate of Women 60-4 – Participation Rate of Women 55-9 and OAI Tax Rate 60-4 – OAI Tax Rate 55-9, in 2000.

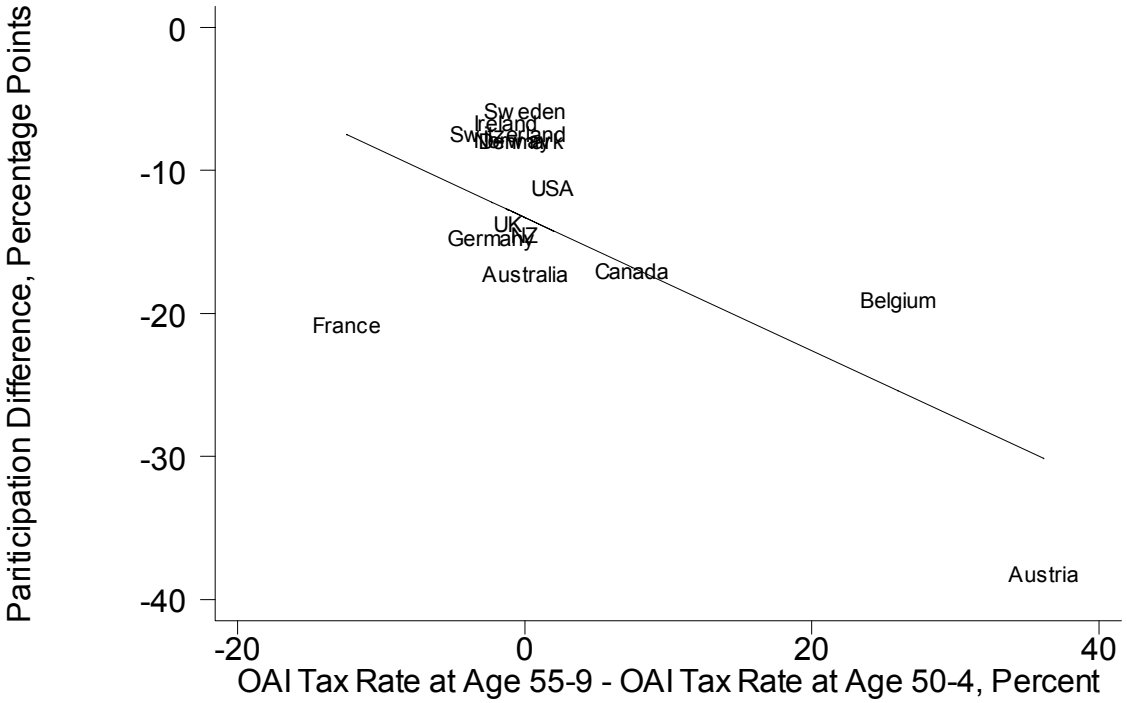


Figure 7: Participation Rate at Age 55-9 – Participation Rate at Age 50-4 and OAI Tax Rate at Age 55-9 – OAI Tax Rate at Age 50-4, 2000.
Regression coefficient = -0.45, t(11) = -3.12, R^2=0.47.

Figure 8: Labour-Force Participation of Older Women in France and the UK

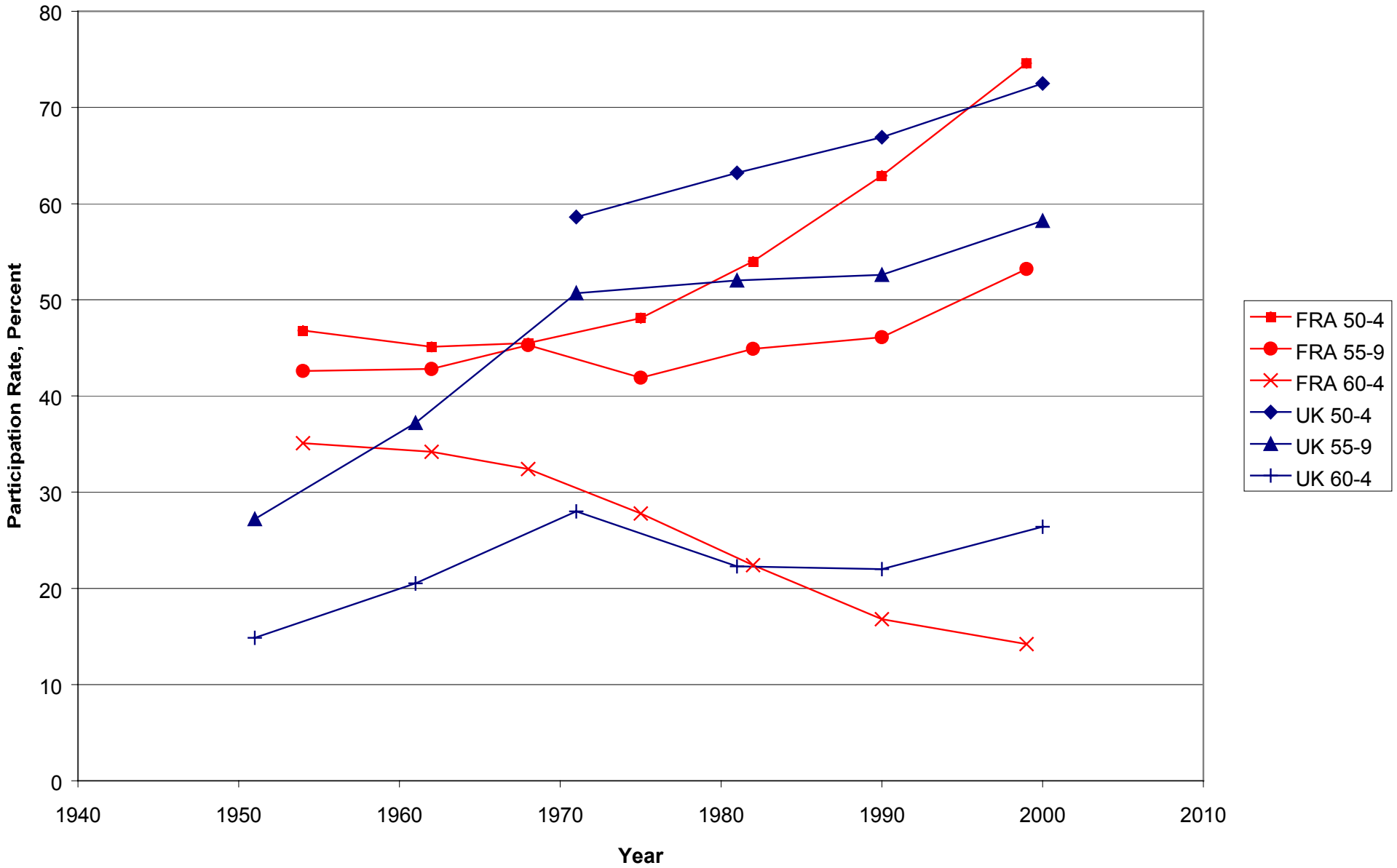


Figure 9: Labour-Force Partcipation of Older Men and Women in Denmark

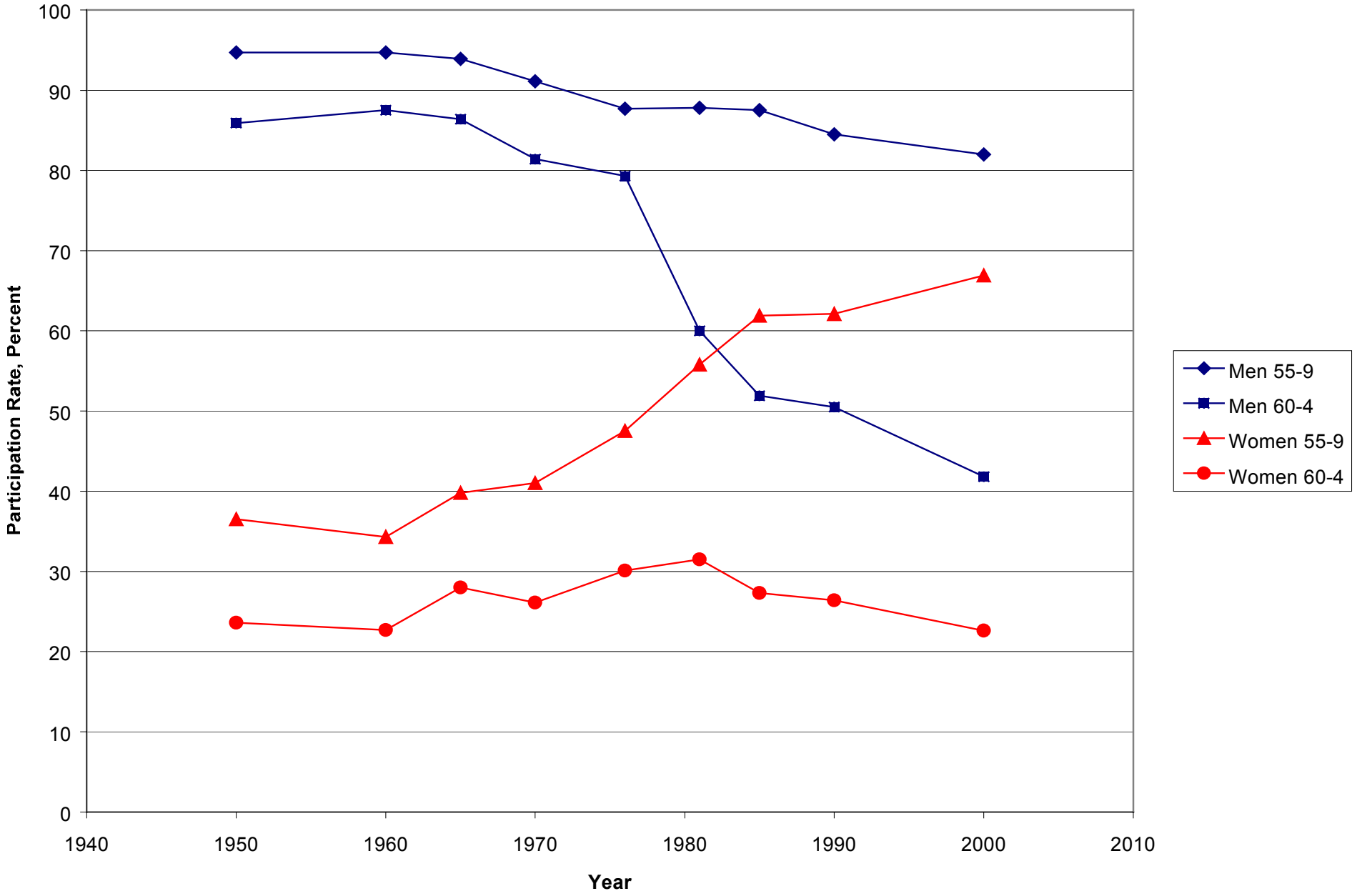


Figure 10: Labour-Force Participation of Older Women in Austria and West/ Re-Unified Germany

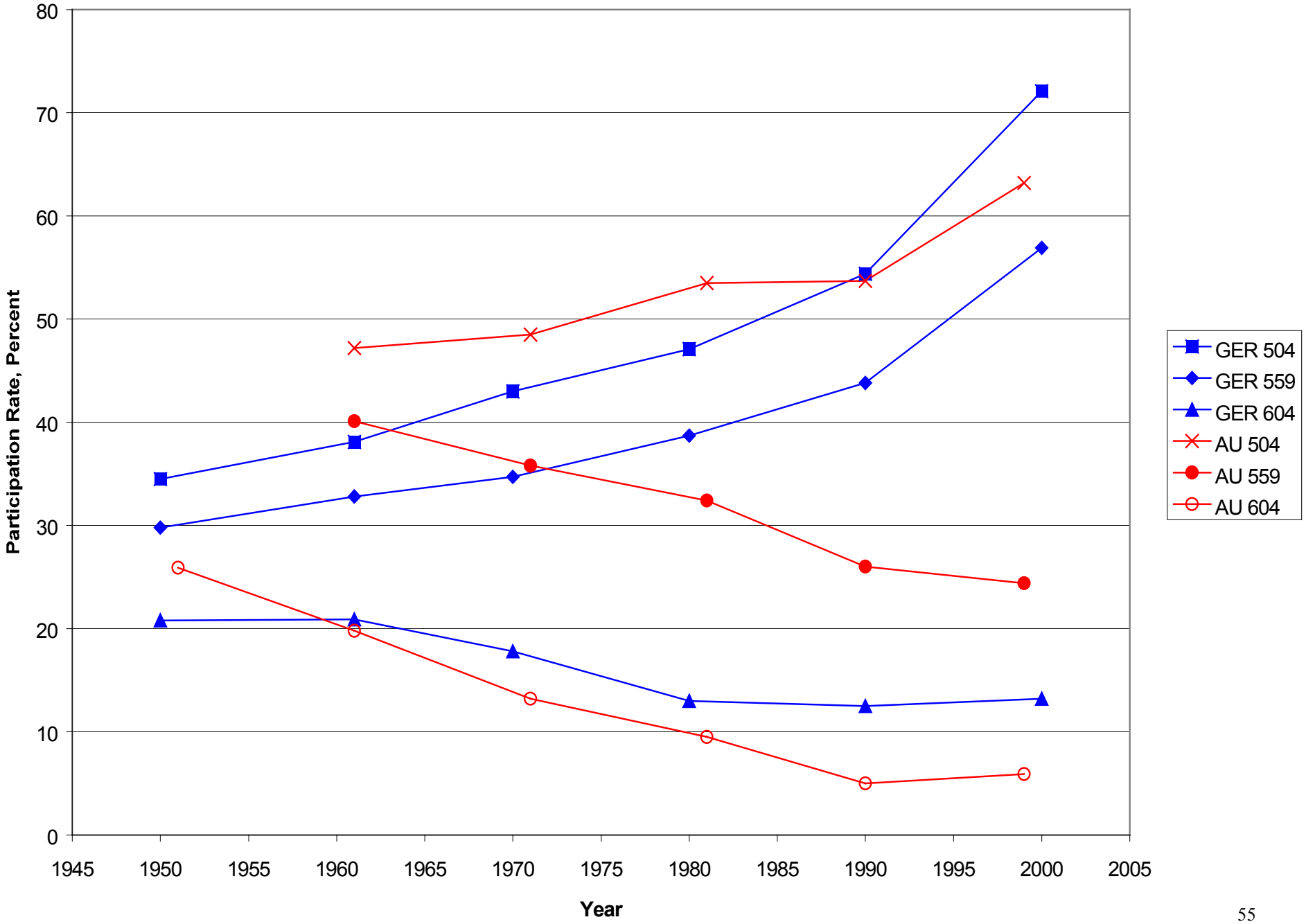


Figure 11: Labour-Force Participation of Austrian Women, by Single Year of Age. The Female Pension Age was Reduced from 60 to 55 in 1961-6.

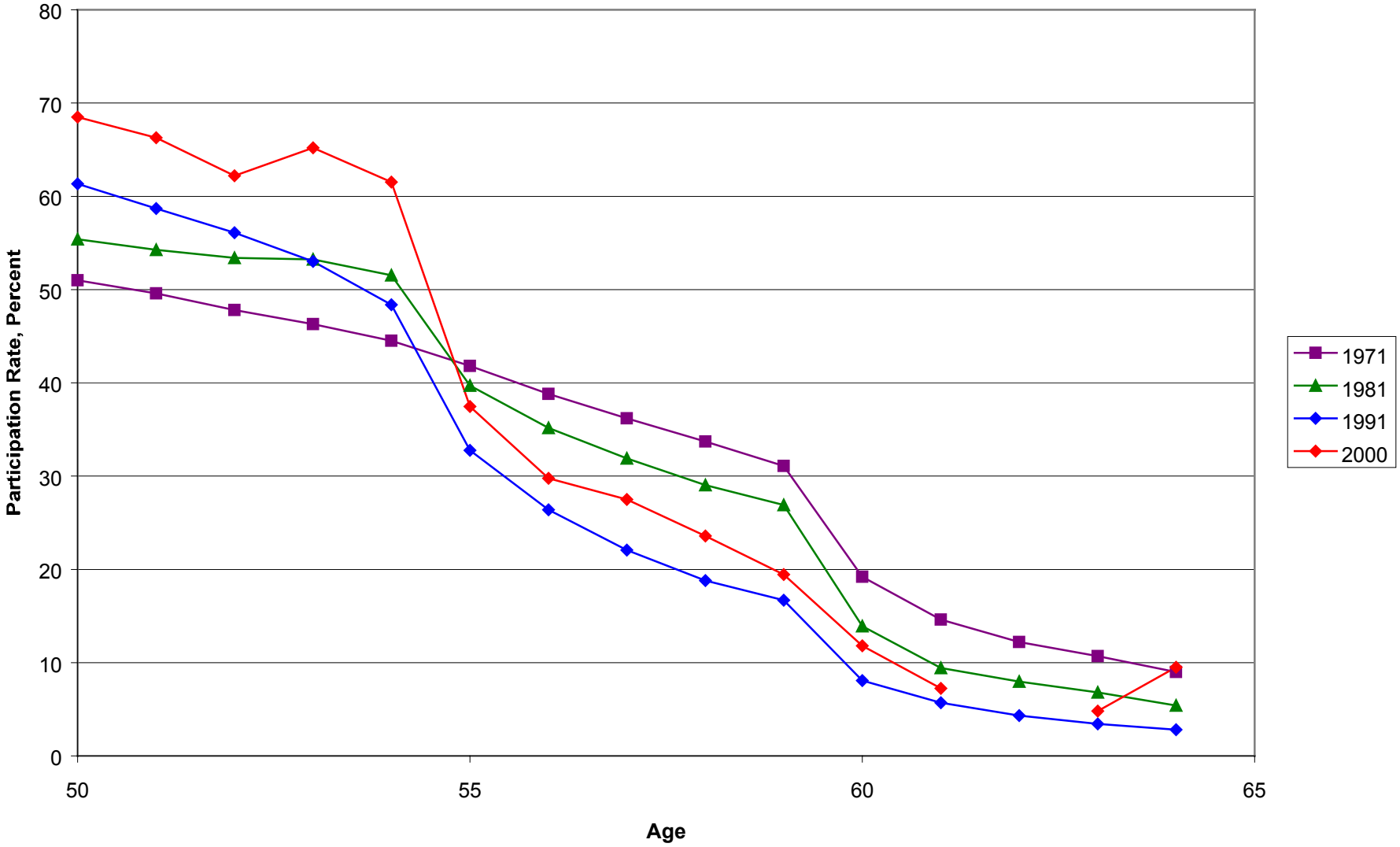
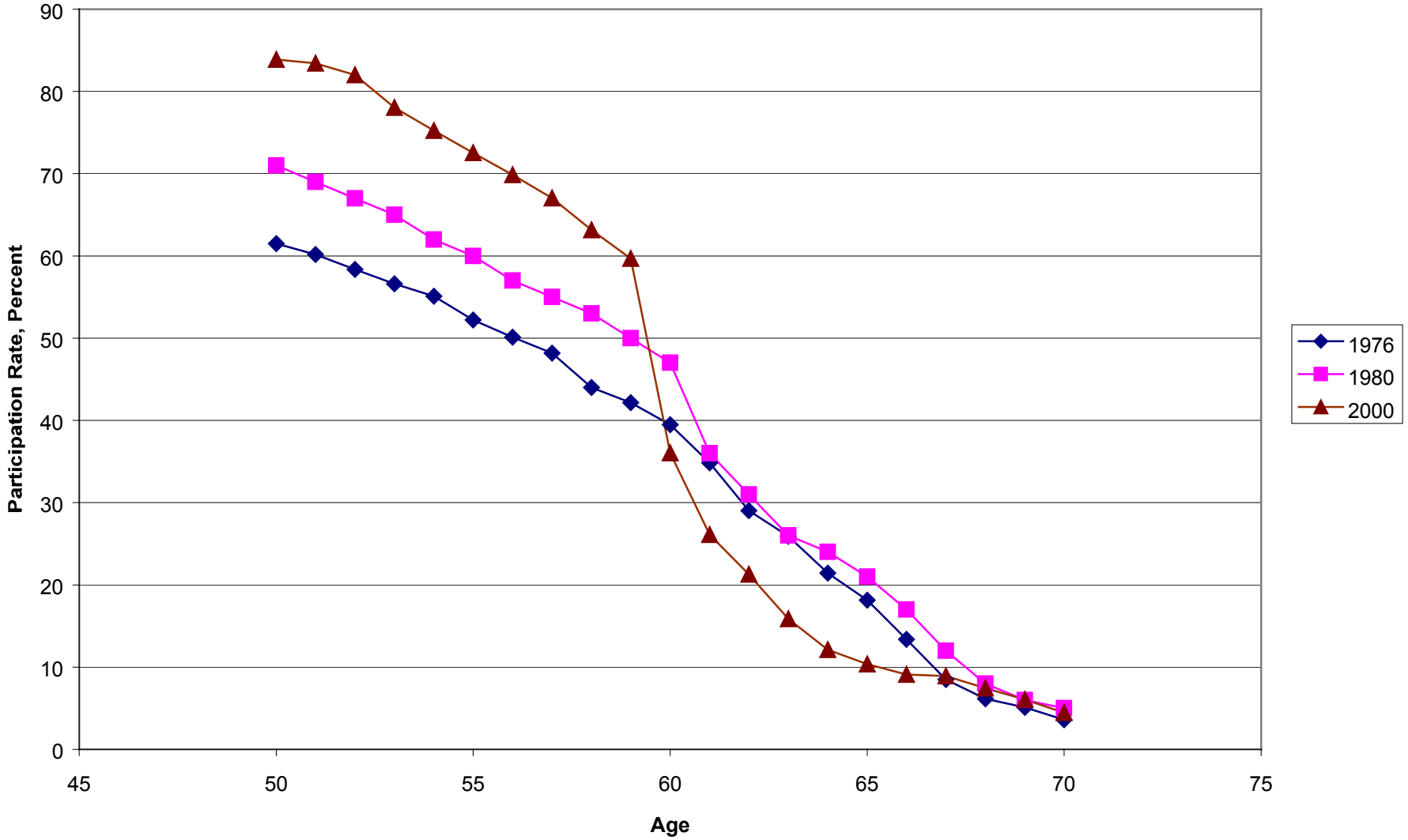


Figure 12: Labour-Force Participation of Danish Women, by Single Year of Age, Showing Effect of OAI Eligibility Age Reduction from 67 to 60 in 1979.



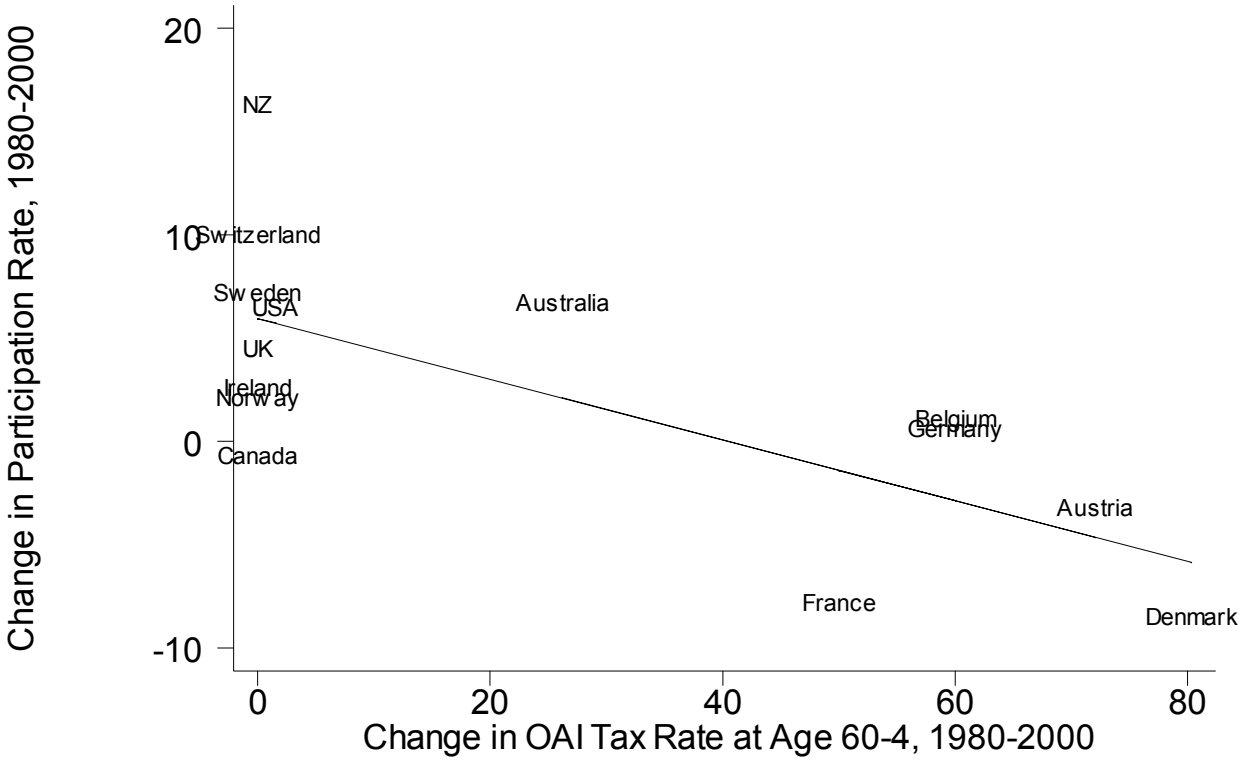


Figure 13: Change in the Participation Rate of Women 60-4 from 1980 to 2000 and the OAI Tax Rate at Age 60-4 in 1980.

Slope coefficient $\beta_1 = -0.15$, $t(11) = -3.42$.

Figure 14: Labour-Force Participation of Older Men in the US (1999) and UK (2000)

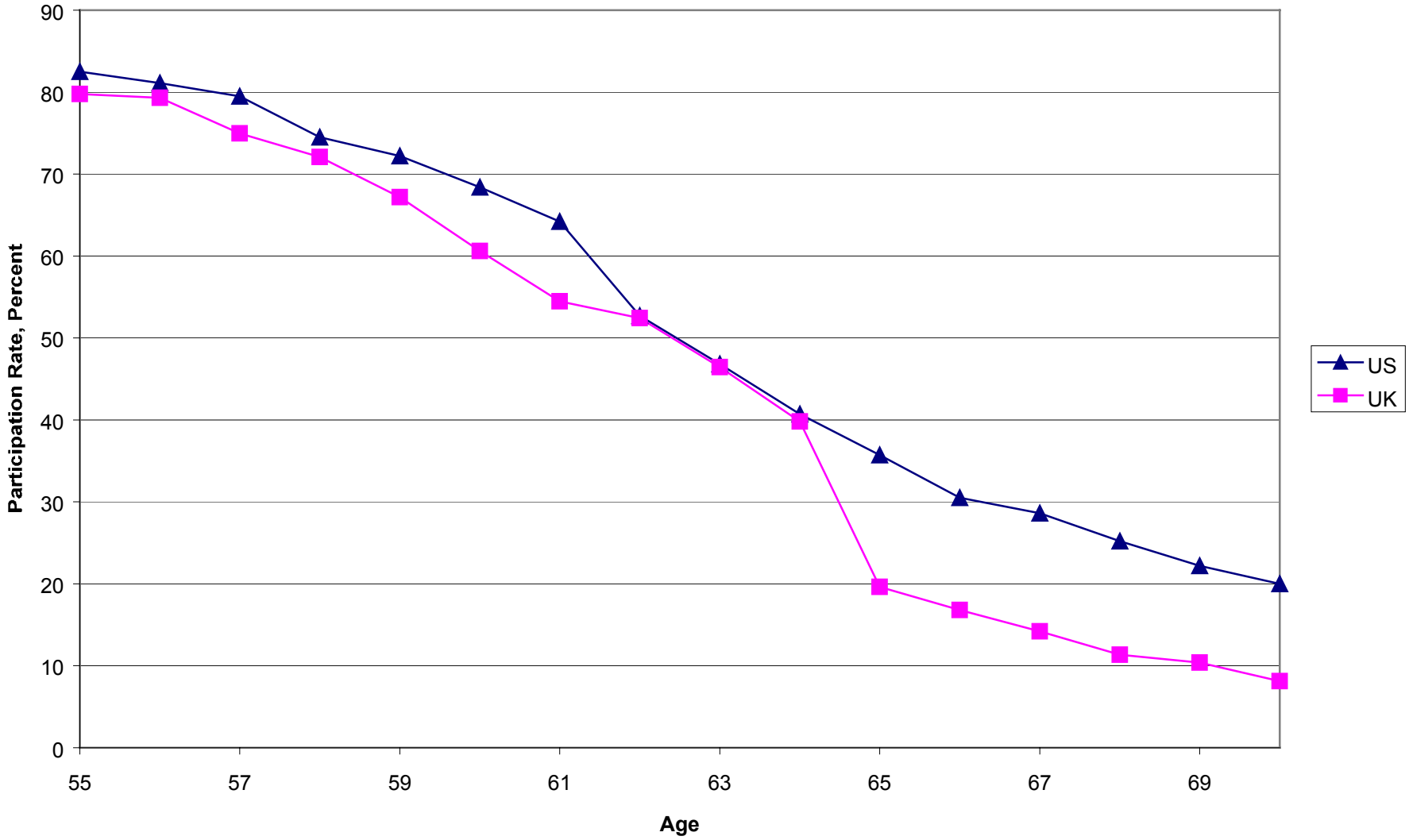


Figure 15: Labour-Force Participation Rates of Swiss Men and Women, 1990 Census