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MICROECONOMETRIC ANALYSIS OF THE RETIREMENT DECISION: GERMANY
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ABSTRACT/RÉSUMÉ

This paper analyses the determinants of the retirement decision in Germany using microdata from the German Socio-Economic Panel over the period 1985-1995. Non-parametric and semi-parametric techniques have been used to describe the exit to retirement. Non-parametric estimates suggest that the incentive structure generated by the different social security schemes play a powerful role in the individual retirement decision. The semi-parametric analysis is conducted using a piece-wise constant hazard model with multiple destinations (i.e. disability scheme and old-age pension scheme) and time-varying covariates. Socio-demographic factors have a strong impact on the retirement decision. Moreover, poor health contributes to early withdrawals from the labour market, especially in the case of disability retirement. Financial incentives offered in the pension system are also powerful in shaping the age profile of retirement. In particular, we used the pension wealth and an estimate of the option value to retire to allow for a forward-looking behaviour of individuals. Older people tend to maximise the net present value of the pension wealth and retire as soon as the option value of postponing retirement becomes small (or negative). Finally, the results of the hazard model have been used to simulate the effects of a reform towards an age-neutral pension system. The results of this simulation suggest a significant rightward shift in the age profile of retirement, with the average retirement age rising by about one year.

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Ce document analyse les facteurs qui déterminent la décision de partir à la retraite, en Allemagne, en utilisant les micro-données tirées de l'Enquête Socio-Economique durant la période 1985-95. Des techniques d'analyse non-paramétrique et semi-paramétrique ont été utilisées pour décrire le processus de départ à la retraite. Les estimations non-paramétriques suggèrent que les incitations produites par les différents éléments du système de sécurité sociale jouent un rôle très important dans la décision individuelle de départ à la retraite.L'analyse semi-paramëtrique est menée en utilisant un modèle à risque constant "piece-wise" à destinations multiples (pensions d'invalidité et de vieillesse) et des variables explicatives variant dans le temps. Les facteurs socio-démographiques ont un impact important sur la décision de départ à la retraite. De plus une mauvaise santé incite à un départ anticipé à la retraite, surtout dans le cadre d'une pension d'invalidité. Les incitations financières du système de pension sont aussi importantes dans la définition de la stucture par âge du départ à la retraite. Nous avons utilisé en particulier, une estimation du patrimoine au titre de la sécurité sociale et de l' "option-value" de partir à la retraite pour tenir compte du comportement axé sur l'avenir des individus. Les personnes âgées ont tendance à maximiser la valeur actuelle du patrimoine au titre de la sécurité sociale et à partir à la retraite dès que l' "option-value" devient petite (ou négative). Finallement les résultats du modèle de hasard ont été utilisés pour prévoir l'âge de la retraite avec des facteurs d'ajustement qui rendent les régimes de retraite neutres du point de vue actuariel. Cette transformation du système de pension pourrait augmenter l'âge moyen de la retraite d'environ un an.

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MICROECONOMETRIC ANALYSIS OF THE RETIREMENT DECISION: GERMANY

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1. Introduction

1. In Germany, as in most OECD countries, the ageing of the population is creating growing concerns about the sustainability of social security arrangements and, more generally, about the prospect of growth of material living standards. While there are currently about four retired persons per every ten active persons, the ratio will reach 9/10 by the year 2050, unless participation rates among older workers increase significantly[1]. This would imply a complete reversal of the trends observed over the past three decades which have witnessed a weakening attachment of older people to working life. The average age of retirement for men was above 65 in the 1960s and fell monotonically to around 60 in the mid-1990s, a level that is close to the continental European average, but well below the average of most Anglo-Saxon countries. Moreover, the average age of retirement for women has dropped to 58 ½, towards the lower end of the OECD countries' distribution. The purpose of this paper is to analyse the determinants of retirement decision in Germany and see whether reforms of social security arrangements system could contribute to foster participation of older people in the labour market.

2. The German public pension system is mandatory for a large majority of workers and is relatively generous compared with most other OECD countries. In 1995, the net pension replacement rate for the average production worker was around 70 per cent at the age of 65 (the official age of retirement). The old-age pension system is also accompanied by other income support schemes available to older workers who "retire" before the standard age of entitlement to old-age pension. Until the Retirement Reform of 1992, male workers with a long contribution history could retire at the age of 63 without an accrual reduction of benefits. In addition, retirement at the age of 60 was possible for all women and for men who were either long-term unemployed or with officially certified handicaps. As documented by Riphahn (1997), disability retirement has also been extensively used to enter retirement before the age of 60. The 1992 reform and the following amendments have increased the accrual rate profile and introduced significant rewards for retirement after the age of 65.

3. The aim of this paper is to shed light on the incentive effects of the German social security system on retirement decisions. It is based on micro data from the German Socio-Economic Panel (GSOEP) which contains detailed information on households and individuals, including a retrospective employment history. The analysis is based on wave 2 to wave 12 of the GSOEP covering the period 1985-1995. The plan of the paper is as follows. Section 2 presents the basic features of the social security system in Germany and discusses the main reforms that have recently been introduced. Section 3 briefly presents the duration model used in the empirical analysis, while Section 4, presents the main features of

1. For the analysis of the evolution of the retired-person dependency (RPD) ratio in Germany, as well as in the other OECD countries, see Chapter VI of the OECD Economic Outlook, No. 63, June.

the GSOEP. The following section (5) discusses the main empirical results. This section also discusses the potential effects on the retirement decision of reforms in the pension system. Section 6 contains the conclusions.

2. A basic features of the German social security system

4. Germany has a mandatory PAYG public pension system. The coverage of the system is very high: only self-employed (around 9 per cent of the labour force, according to the GSOEP) and workers with earnings below the official minimum earnings threshold (15 per cent of average monthly gross wage, 10.1 per cent of all workers in 1985, according to GSOEP) are not subject to a mandatory coverage. Moreover, some professions, including civil servants, have their own mandatory retirement system. As stressed by Börsch-Supan (1997), these systems are very close to the general system and for the purpose of the empirical analysis in this paper they are assimilated to the general system.

5. The public pension system is the most important source of income for older people after they retire. According to our calculations from the German Socio-Economic Panel (GSOEP), 80.1 per cent of the elderly (65+ years of age) had only public social security benefits in 1990, 10.7 per cent had only private pension benefits and 9.2 had both public and private pension benefits. Given their limited coverage, private pensions are not considered in this study with the implicit assumption that only public pension payments affect the retirement decision.

6. In Germany, the possibility of retiring is open to all individuals with a contribution period of at least five years at the age 65. Until the reform of 1992, those with at least 35 years of contribution could enter retirement with full benefits once they had reached the age of 63. There was also a special rule for women and the long-term unemployed which allowed early retirement: women with 10 years of insurance in the last 20 years could retire with full benefits at the age of 60. A similar possibility was open to the long-term unemployed (more than 12 months in the previous 18 months) who had contributed for at least 8 of the past 10 years.

7. Older workers who cannot be appropriately employed for health or labour market reasons can also retire at the age of 60. *Occupational disability* is offered to all individuals whose ability to perform their job is less than half of a healthy individual in the same occupation, provided they had contributed to the insurance system for at least five years and had worked three of the last five years. Occupational benefits amount to two-thirds of the full old age benefits, but older workers (60 and over) are entitled to full benefits. It should be stressed, however, that after one year of unsuccessful search for part-time employment, individuals receiving occupational disability benefits could claim *general disability* benefits that entitle them to the full level of old age retirement benefits. As stressed by Riphahn (1997), general disability accounted for eighty per cent of all granted disability applications in the early 1990s, while the remainder is accounted for by the occupational disability scheme. Most of those receiving occupational disability are transferred into the general disability system after one year.

8. *Early retirement* was also allowed in the 1980s via two additional pathways. In the period from May 1984 and December 1988, employees could retire at the age of 58: until the age of 60 their employer and the labour office supported them and afterwards they moved into the unemployment retirement scheme described above. Similar features characterise the so-called 59er rule: firms often laid off older workers as many months before age 60 as unemployment insurance benefits would have run (from 60 to 67 per cent of the previous wage) with a maximum of 12 months until 1987 and up to 832 weekdays afterwards.

9. The Retirement Reform which was introduced in 1992 provided individuals with more flexible retirement options, while also increasing the neutrality of the system with respect to the age of retirement. However, since 1992, the public pension system was further reformed on several occasions, and discussions about further reforms are still ongoing. Following the 1992 reform and subsequent adjustments, the age limit for the "flexible" early pension route (at the age of 63) and early retirement for women (at the age of 60) will gradually be raised to age 65. These changes will only be fully phased in by the year 2004. All workers with a long number of years of contribution (35 at present) can retire up to five years before they reach 65 but, despite the pre-1992 regulations, benefits will be adjusted accordingly (see Box 1). For the purpose of the empirical analysis, this study does not consider the 1992 reforms nor those introduced afterwards: the dataset covers the period from 1985 to 1995 and even those individuals who retired after 1992 were still granfathered by the pre-1992 legislation. However, in the final part of this contribution, which is devoted to different simulations of policy reforms, the key changes in the 1992 reforms will be considered.

10. In the German system, benefits are computed on the basis of contributions over the entire working life and adjusted according to the age of retirement and the type of pension (see Box 1). Until 1992, benefits were indexed to the gross wage bill which, *de facto*, lead to an increase in the level of pensions with respect to net wages. Since the 1992 reform, net rather than gross wages have been used for the purpose of indexing the benefits. Moreover, the 1992 reform introduced partial retirement into the German pension system. Partial retirement is possible with 1/3, 1/2 and 2/3, with benefits adjusting proportionally. The German system also includes a strict earnings test for all early retirements (before age 65). The threshold is around 15 per cent of the average gross wage. After age 65, the earnings test does not apply, and full benefits are paid regardless of other sources of possible earnings.

3. A duration approach for the analysis of retirement decision

11. Several approaches have been used in the literature to study the decision to retire of older workers: i) the "lifetime budget constraint" approach (Burtless, 1986); ii) the hazard model approach (Diamond and Hausman, 1984; Hausman and Wise, 1985); and iii) the "option value" approach (Lazear and Moore, 1988; Stock and Wise, 1990). In this study, the retirement decision is modelled within a hazard model where the decision is treated as a dynamic discrete choice. One of the main advantages of this approach is that it allows -- in addition to pure economic variables, such as wages, pension benefits, etc. -- a number of other non pecuniary factors to be considered, including, the health status, family circumstances and eligibility to different retirement schemes. Moreover, the duration model approach permits the updating of information as individuals age. In particular, health status, the family situation, as well as eligibility conditions for entry into different "retirement scheme" may vary as each individual ages. The main drawback of the duration model approach is that it generally considers past and present values of the economic variables but not potential compensations many years in the future as in the life-time budget constraint approach and in the "option value" approach.

Box 1: **The pension formula**

The pension formula can be described as follows:

$$p\mathbf{ension} = \alpha * \mathbf{a}W * \mathbf{c}Y * \beta$$

where:

α = accrual rate: 1.5 per cent until 1992, 1.0 per cent afterwards;
aW = assessed wage;
cY = years of service.
β = adjustment factor for pension type (since 1992).

The pension formula also contains a cap, which is revised annually.

The *assessed wage* is the product of two elements: i) *the employee's relative position*; and ii) the current "general computation base".

The *employee's relative position* is the average of the individual's relative annual contribution position over the entire earnings history. In 1972, a redistribution was introduced: the relative position of an individual with at least 25 years of employment and whose contributions over the entire period before 1972 were on average below 75 per cent of the average was raised to 75 per cent. Following the 1992 reform, the relative position of an individual with at least 35 years of contributions and whose average contributions over the service period were less than 75 per cent of the nation-wide average is treated as if her/his contributions were 50 per cent higher, with a cap at 75 per cent of the average contribution.

The *computation base* corresponds to the monthly pension paid to an average earner. It is adjusted annually to keep pace with gross wages (until 1992) and net wages (since 1992).

Years of service include active contributions plus credited periods for sickness, military service, unemployment, and education (after 16 years of age). Parents who were born after 1920 are credited with the first 12 months after the birth of a child as an insured period, if they stayed at home to look after the child. For parents with children born from 1992 onwards, the period credited for bringing up children has been increased to 36 months.

Before the 1992 reform, there was no benefit adjustment in case of early retirement, apart from the implicit adjustment via years of service in the computation of the pension level. There was, however, an adjustment for later retirement: deferred pension increments were 0.5 per cent per month worked between 65 and 67 in addition to increases due to longer contributions. With the 1992 reform, stronger adjustment for earlier and later retirement has been introduced. For each year of retirement before 65, up to a maximum of five years, benefits are reduced by 3.6 per cent, in addition to the implicit reduction due to the fewer years of contribution. For each year of retirement after 65 the pension is increased by 6 per cent, in addition to the implicit increase due to more years of contribution.

12. As discussed below, the lack of a forward-looking dimension in the hazard model approach is handled in this study by replacing the usual social security replacement rate as a measure of the

incentive to retire with two alternative measures of the expected pension wealth: i) the net present value of the expected future stream of pension payments at the different ages of retirement; and ii) an approximation of the "option value" defined as the difference between the expected maximum attainable level of income if retirement is postponed and the net present value of pension payments[2]. The use of this variable in the duration model allows assessing whether the individual' behaviour conforms to the intertemporal maximisation process implicit in "option value" rule, while controlling for other factors which affect this decision over and above pure economic considerations.

13. The sample used in this study is restricted to individuals 55 and older, and the length of the employment spell is defined as:

Spell-length in employment = age of retirement - 55

14. Moreover, the retirement decision in Germany is a discrete choice for most individuals. The strict earnings test before the 1992 reform *de facto* prevented people from combining work with retirement income if they had retired before the age of 65, while after the official age of retirement, even if theoretically allowed, only a few individuals earned income from work.

15. As stressed above, individuals may use different retirement routes, including occupational disability pensions, unemployment pensions, early retirement and old-age retirement. It could be expected that the effects of the factors determining the retirement decision vary according to the retirement channel concerned. Therefore, a competing risk model is needed.

16. The hazard function is the conditional probability of entering retirement at age t, given that the individual has not retired at an earlier age:

$$\theta(\mathbf{t}) = \lim_{dt \to 0} \frac{\mathbf{P}(T \le \mathbf{t} + \mathbf{dt} \,|\, T \ge \mathbf{t})}{\mathbf{dt}} \tag{1}$$

17. Given our lack of knowledge as to the precise functional form of the probability of entering retirement, following Lancaster (1990) a flexible functional form is used, a piecewise constant hazard:

$$\theta(\mathbf{t}) = \begin{cases} \theta_1, & 0 \le \mathbf{t} \le \mathbf{c}_1 \\ \theta_2, & \mathbf{c}_1 \le \mathbf{t} \le \mathbf{c}_2 \\ \ldots & \\ \ldots & \\ \theta_M, & \mathbf{c}_{M-1} \le \mathbf{t} \le \infty \end{cases} \tag{2}$$

The survivor function is:

$$\overline{F}(\mathbf{t}) = \exp\left\{-\int_0^t \theta(\mathbf{s})\,\mathbf{ds}\right\} = \exp\left\{-\sum_{j=0}^{m} b_j \theta_j - (\mathbf{t} - \mathbf{c}_m)\theta_{m+1}\right\} \tag{3}$$

2. Börsch-Supan (1994) uses a similar approach by introducing an "option value" into a Gompertz hazard rate model for Western Germany.

$c_m < t \leq c_{m+1}$ *and m = 0, 1, 2, ..., M - 1,* and $b_j = c_j - c_{j-1}$

18. The main advantage of using a flexible hazard rate specification is that no unjustified restriction is imposed on the data. As stressed by Lancaster (1990), the piecewise-constant hazard is essentially a way to let the data tell us how the hazard behaves as a function of time. The non-parametric estimates of the hazard discussed below (see also Figures 1 to 4), show that the hazard from employment to retirement evolves over time in a non-monotonic way with rapid increases toward the age which allows early and old age retirement. Consequently, alternative specifications such as the well-known Weibull are not suitable. The explanatory variables **x** enter the model as follows:

$$\theta(\mathbf{t}) = \left(\exp[\mathbf{x}(\mathbf{t})'\beta]\right)\theta_m; \qquad \mathbf{c}_{m-1} < \mathbf{t} \leq \mathbf{c}_m, \qquad m = 1, 2, ..., M \tag{4}$$

where it is assumed that some of the explanatory variables vary over the employment spell of the individuals. The pure dependence on time of the instantaneous probability of moving to the retirement state is captured by the piecewise constant baseline hazard θ_m.

19. Given data availability, it is possible to consider two different destinations out of employment: 1) early and old age retirement; and 2) disability retirement[3]. Moreover, right censoring is treated as an additional destination as suggested by Lancaster (1990). By definition, these destinations are mutually exclusive and exhaust the set of possible exit options. It was assumed that η_k (k = 1,..K) is a set of dummy variables that take value one if the individual exits to state k and zero otherwise. Therefore, the K transition intensities are:

$$\theta_k(\mathbf{t}) = \lim_{dt \to 0} \frac{\mathbf{P}(\mathbf{t} \leq T \leq (\mathbf{t} + \mathbf{dt}), \eta_k = 1, | T \geq \mathbf{t})}{\mathbf{dt}} \tag{5}$$

20. The total of the survivors at time t who leave in the following period is the sum over k of those who leave for destination k, which also provides the relationship between the hazard function θ(t) and the transition intensities θ_k(t). Formally:

$$\theta(\mathbf{t}) = \sum_{k=1}^{K} \theta_k(\mathbf{t}) \tag{6}$$

3. Unemployment was not considered as a separate destination because of the very limited number of older workers who were classified as being unemployed. This is likely to be the result of a common practice of using unemployment compensation as an unofficial pre-retirement income support scheme. Income support bridges have been frequently used up to the age of 60, when unemployed people could enter the public pension system. These bridges include a combination of unemployment compensation, employer's supplements or severance pay. See also Börsch-Supan (1997).

the hazard function is the sum of the transition intensities over the different destination states. The probability of exiting to state k in a short time interval (t, $t + dt$) can be written as:

$$\text{P(left for k at the time t)} = \mathbf{P}(\ ) = \theta_k(\mathbf{t}) \exp\left\{-\int_0^t \sum_{k=1}^{K} \theta_k(u)\mathbf{d}u\right\}\mathbf{dt} \qquad (7)$$

21. From the above, the log-likelihood contribution for a single person is given by:

$$L_i = \sum_{k=1}^{K}\left[\eta_{ik} \log\theta_{ik}(\mathbf{t}_i) - \int_0^t \theta_{ik}(u)\mathbf{d}u\right] \qquad (8)$$

where η are the dummy variables for the k possible destinations.

22. From the previous discussion, it was assumed that the θ_{ik} are specified as functions of the observable explanatory variables **x.** As suggested by Narendranathan and Stewart (1991) -- under the assumption of absence of omitted heterogeneity terms correlated across the cause-specific hazards -- the log-likelihood for the competing risks model is additively separable into terms each of which is a function of the parameters of a single cause-specific hazard. Therefore, maximising the likelihood for the entire competing risks model is equivalent to separately maximising the likelihood for the k^{th} retirement state, while treating employment spells ending in other retirement states as right censored. The full log-likelihood is the sum of terms such as (8) over i =1,2,....N and is therefore:

$$L = \sum_{i=1}^{N}\sum_{k=1}^{K}\left[\eta_{ik} \log\theta_{ik}(\mathbf{t}_i) - \int_0^{t_i} \theta_{ik}(u)\mathbf{d}u\right] \qquad (9)$$

4. The dataset for the empirical analysis: the German Socio-Economic Panel

23. The data set used in this study is based on 11 waves of the German Socio-Economic Panel (GSOEP). The dataset only includes individuals in Western Germany even for the years after the Reunification of Germany.

24. The GSOEP is a longitudinal data set where the same individuals are interviewed every year. In each wave, it provides information on individual characteristics (e.g. sex, age and nationality), family status (e.g. marital status, relationship with respect to the head of the household and number of members of the household), human capital variables (e.g. education and occupational characteristics), as well as labour market variables (e.g. labour market status, work history, industry of affiliation and tenure in the last job). Moreover, the GSOEP contains information on earnings, income from self-employment and social transfers.

25. The empirical analysis developed in this study is based on stock sampled spells in the job. Individuals at work aged 55-65 in 1985 were selected from the original sample and followed up to 1995.

This dataset was expanded with data on new entrants in the GSOEP panel in 1986 (aged 56 to 65 and in employment) and in 1987 (aged 57 to 65 and in employment)[4]. Moreover, those individuals who did not report their educational attainment and those who were working in agriculture have been removed from the sample[5].

26. Annual transitions that occurred between 1986 and 1995 were computed. An individual left the sample for two reasons: first, (s)he retired[6]; secondly, the individual dropped out from the GSOEP sample. In the latter case the individual observation is considered as right-censored.

27. The dataset used in this study is purely longitudinal insofar as it permits following individuals over 11 years, from 55 years of age to the official age of retirement. However, there are some disadvantages, namely: a 20 per cent of right censored cases; and a limited sample size, at least compared with studies based on cross-sections.

28. The definition of retirement is always problematic, especially in countries where the elderly combine pension benefits with part-time employment (Lazear, 1986). In Germany, although legally possible after the official age of retirement, only a few older people work part-time while receiving pension benefits after 65. Moreover, for those on early retirement it was impossible to retire partly over some years, until the 1992 reform. Therefore, people have been considered in the employment state if they indicated full or part-time employment; they have been considered in retirement if they were not working, started to receive retirement benefits since the previous survey and qualified for early or old age benefits[7].

29. Within the group of retirees, workers moving into disability retirement have been identified using the following additional criteria: i) the individual retired at the age of 56 or 57 (not allowed officially under the unemployment or the early retirement schemes); or ii) the reason for ending the last employment between age 58-59 (women) or 58-62 (men) was due to occupational or general disability.

30. Apart from age, the following variables have a time dimension in the sample: self-assessed health status[8]; wage earnings; and the potential pension entitlements (function of age and previous earnings). The other explanatory variables are considered as time invariant and are computed at the time the individual takes the decision to retire, i.e. for an individual who leaves the sample at $t+1$, his/her age, educational attainment, industry, occupation etc. were those at the time t.

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4. The original sample included 613 workers (1985) plus 9 individuals in 1986 and 5 in 1987. There were no more cases in subsequent years.

5. Given their very limited number in the sample, workers in the agriculture sector were excluded from the database. In fact, it was not possible to add a separate sectoral dummy variable in the duration model and we did not consider appropriate to merge workers in agriculture with any other sectoral group. Furthermore, farmers are subject to a special retirement scheme.

6. Surprisingly, only 0.5 per cent of individuals in the sample, and only in the first transition (i.e., 1985 to 1986) moved to unemployment or inactivity before moving into retirement. We consider that the move to unemployment or inactivity is a move to retirement if the following transition is retirement.

7. As suggested by Lazear (1986), the combination of these two criteria offers an appropriate framework for studying the retirement decision of older workers and the role of social security systems.

8. The use of a time-varying measure of health is very important. As suggested by Bound *et al.* (1997), the labour force decision seems to be more sensitive to changes in health than to the overall health status.

31. Table 1 shows the main characteristics of the individuals in the sample at the time of their transition from work to retirement. Table 2 presents a breakdown of the sample according to year of exit, the retirement pathway chosen, including the right-censored observations.

32. The main variables that have been considered as affecting the retirement decision include socio-demographic characteristics as well as variables attempting to describe the health status of elderly persons:

- *Educational attainment.* Three categories have been retained: i) primary or less; ii) secondary education; iii) upper secondary and higher education;

- *Family and household characteristics* include: civil status (married, single); whether the individual is the head of the household; the household size (i.e., number of people living in the household);

- *Nationality*: the sample only includes individuals living in the Western Länder. Two groups are considered: those with German citizenship and those without.

- *Occupational or professional status* (based on the ISCO-68 classification). The original groups include:
    1. Technical and related specialists;
    2. Managers in public service and in business;
    3. Office workers and related occupations;
    4. Business occupations;
    5. Service occupation (includes the defence sector);
    6. Occupations in farming, forestry, fishing, and hunting;
    7. Production industry and related occupations, transportation services, and handymen.

These different occupations have been re-grouped in the empirical analysis into 3 broad categories: i) professional workers (1, 2 and 4); ii) white collar workers (3 and 5) ; and iii) blue collar workers (6 and 7).

- *Industry affiliation*:
    1. Mining, energy and manufacturing;
    2. Construction;
    3. Wholesale and retail;
    4. Transport, communications and finance;
    5. Education, sports and health services;
    6. Other services;
    7. Others.

Given the limited sample size, these sectors have been re-grouped into broader groups: industry (1+2); service sector (3-6); and others (7).

- *Tenure*: this variable indicates the number of years the individual spent in the last job before retiring.

- *Type of work activity*: three main categories of workers have been considered: i) employee in the private sector; ii) civil servant; and iii) self-employed.

- *Health status*: the GSOEP includes several variables that describe the health status of the individuals, including the certified degree of disability. This variable has been used to identify those who entered retirement via a disability pension scheme. Another variable available in the GSOEP is the self-assessed indication of the "satisfaction with health". The latter ranges from 0 (very dissatisfied) to 10 (fully satisfied)[9] and given the greater coverage in the sample compared with the certified degree of disability, it was retained in the empirical analysis.

- *House ownership*. The GSOEP does not permit the clear identification of the wealth and non-wage income of individuals. As a crude proxy for wealth, a dichotomous variable for home ownership was used.

33. As stressed above, different measures of the economic incentives to retire were considered. The *replacement rate* is the ratio of the first pension payment from retirement relative to the last wage. The second measure is the *net present value* of the total pension payments over the remaining life of each individual. This measure requires additional information: i) the future pension payments, according to the pension formula; ii) the life expectancy of the individual; and iii) the discount factor. The third measure is the "*option value*" of postponing the retirement decision. As discussed in Box 2, this measure requires information on expected earnings for future years if retirement is postponed; the future pension payments; the conditional survival probability; an index of the marginal disutility to work; and the discount factor.

34. All three measures require information on the level of pension at different ages of retirement. The GSOEP contains information on the level of pension benefits received by the elderly but with a significant number of cases of non-reporting and miss-reporting. Moreover, for the right-censored cases there is no information on the pension level, which complicates the calculations. It should also be stressed that the calculation of both the NPV of the pension wealth and the option value require the knowledge of the potential pension levels for ages before the decision to retire is taken and for the years thereafter. To overcome these problems, the pension is calculated for every individual in the sample and for all ages from 55 onwards. As shown in Box 1, retirement income is a function of the age of retirement and on the entire stream of earnings during the contribution life. The assessed earnings of each individual over the working life have been derived from a semi-logarithmic regression of earnings on age, human capital variables and sector of affiliation[10]. Based on the cross-section of people (20+) in 1985, the earnings

9. There is a lively debate about the appropriate measure of the health status for empirical analyses of retirement (see, amongst others, Parsons, 1982; Anderson and Burkhauser, 1985). Self-reported health satisfaction may be endogenous: people may miss-represent their health if they have applied for a disability or an early retirement pension. To test the sensitivity of the empirical results to the choice of the health variable, the self-assessed measure of health status has been replaced by the certified degree of disability. The empirical results remain largely unchanged. see also Riphahn (1997) who obtained similar results.

10. In the absence of detailed information on the entire work history of the individuals in the sample, it was assumed that all people in employment at the age of 55 started to work at the age of 20 and continued contributing until they retired. This is a rather plausible assumption given that years of unemployment, years of military service, three years of education for each child and years of education after 19 are counted as years of contributions.

function displays an inverted U shape age-earnings profile, with a significant increase in earnings in the early phases of the working life and a moderate decline in old age[11].

35. In addition to the pension levels at different hypothetical ages of retirement and of the earnings over the past and potential future years of work for each individual, the calculation of the option value requires information on the marginal utility of leisure, the conditional survival rates and the discount rate. The conditional survival rates were obtained from the UN Life Tables for the specific cohort of people aged 55 and more in 1985. The definitions of the other parameters was based on "plausible" assumptions: the marginal utility of leisure was estimated by Stock and Wise (1990) for the US and by Börsch-Supan (1992) for Germany to be around 1.2-1.3. According to these values, a person is indifferent between one dollar obtained as a pension transfer and 1.2-1.3 dollars earned from work; the discount rate is set at 4.5 per cent, equivalent to the long-term real interest rate in Germany in 1985. This latter value is very low compared with those estimated in most studies based on the option value approach. For example, in the dynamic programming models by Stock and Wise (1990) and by Lumbsdaine, Stock and Wise (1994) for the United States, or in the simplified model proposed by Börsch-Supan (1992) for Germany, the estimated discount rate was in the range of 14-20 per cent. These values implicitly suggest a rather myopic behaviour of older workers. Alternatively, the high discount rate emerging in the definition of the option value may reflect unobserved and age-related factors, such as the increase of job insecurity with age and/or the expectation that jobs may become scarce as the individual ages, implying a fall in earnings compared to the acquired pension rights[12]. In order to assess the sensitivity of the estimated coefficient for the option value to changes in the discount rate, the hazard model has been re-estimated using a discount rate of 13.8 per cent as suggested by Börsch-Supan (1992).

11. The wage equation was estimated using the cross-section for 1985 of individual 20 years and older. Wage data reported in the GSOEP were used as the dependent variable. The equation used a cubic age profile estimated by a semilogarithmic regression. The other explanatory variables are education attainment (in number of years of schooling), gender, occupation, industry affiliation (using the 7 branches presented in the main text) and the number of years of tenure in the last employment. The evidence of an inverted U-shaped age profile of earnings is broadly consistent with that reported by Börsch-Supan (1994).

12. This latter point is difficult to verify with available data. Civil servants and workers in some other private sectors have a mandatory retirement at the age of 65 and even in the other sectors most workers move into retirement before or at 65 years of age.

Box 2: **The option value**

The economic incentives of the public pension system can be assessed by the option value of postponing retirement at any age (Lazear and Moore, 1988; Stock and Wise, 1990). At each retirement age, the option value represents the difference between a stream of retirement benefits and a stream of earnings and retirement benefits if the decision to retire is postponed to some later date. The key element of the option value model is the expected discounted stream of utility from consumption at age *t* if the worker retires at age *r* :$V_t(r)$. This value can be expressed as:

$$V_t(r) = \mathbf{E}_t\left[\sum_{j=t}^{r-1}\mathbf{U}\left(Y_j\right)\cdot \mathbf{s}_j \cdot \delta^{j-t} + \lambda\sum_{j=r}^{\infty}\mathbf{U}\left(RB_j\left(r,Y\right)\right)\cdot \mathbf{s}_j \cdot \delta^{j-t}\right]$$

where:
Y_j = earnings from work at age *j* with *j = t. r-1*;
$RB_j(r,Y)$ = retirement income at age *j* with *j = r, ...*∞;
r = retirement age;
s_j = survival probability at age *j*, assessed at the time *t*;
λ = marginal utility of leisure;
δ = the discount factor;
E_t = the expectation at time *t.*

If the individual retires at age *r*, he will receive retirement benefits RB(r,Y) which depend upon the age of retirement and on previous earnings (according to the pension formula described in Box 1). Retirement benefits have been calculated for each individual on the basis of the pension formula and his/her wage and work history. Moreover, the earnings function discussed in the main text has been used to calculate the expected earnings for years after the individual actually retired. Ignoring savings in old age, the utility function can be specified as (Stock and Wise, 1990):

$U(Y_j) = Y_j^{\gamma} + \varepsilon_j$

and

$$\mathbf{U}\left(RB_j\left(r,Y\right)\right) = \left(RB_j\left(r,Y\right)\right)^{\gamma} + \xi_j$$

where ε_j and ξ_j are individual specific random effects, which account for unobserved characteristics of the individuals; γ is the risk aversion parameter. For simplicity, the random individual effects are supposed to evolve according to a random walk [i.e., $\varepsilon_j = . \varepsilon_{j-1} + \nu_j$; with $E_{j-1}(\nu_j) = 0$] and we assume that γ is equal to 1 .

.../...

Box 2**: continued**

If we denote r^{max} the age that maximises $E_t V_t(r)$, then the option value at the age *t* is:

$O_t(r) = E_t V_t[r^{max}(t)] - E_t V_t(r)$

The option value rule suggests that the individual, at the age t, will postpone retirement if $O_t(r^{max}) > 0$, otherwise he/she will retire.

5. Empirical results

36. This section presents the empirical results of the non-parametric and semi-parametric analysis of the hazard rates from employment to retirement.

5.1 Non-parametric hazard from employment to retirement

37. Figure 1 presents the non-parametric hazard function from employment to retirement for the entire population of workers aged 55 and older[13]. These figures are broadly consistent with those presented in Blöndal and Scarpetta (1998) for Germany based on Labour Force Survey data. The figure clearly shows three spikes in the hazard function: at the age of 60, when women and the unemployed became entitled to early-retirement benefits (under the pre-1992 regulations); at the age of 63 which entitles men with 35 years of contributions to old-age pensions and, finally at 65 which is the official age of retirement. Excluding the self-employed from the sample (Figure 2) does not change dramatically the picture. The only notable variation is the hazard rates after 65 years of age, which are generally below those observed for the entire population. As in most OECD countries, the self-employed retire later and more gradually than employees thereby reducing the strength on the hazard peaks in the aggregate distribution.

38. Figure 3 distinguishes hazard function by gender. As expected, the peak in the age-profile of the hazard rates for women is at the age of 60. Thereafter there is a rather homogeneous (conditional) probability of moving from employment to retirement. The 63 and 65 peaks are features of the men hazard rate distribution and, as stressed above, account for the early retirement and old age retirement regulations. Finally, Figure 4 considers the two alternative destinations out of employment: disability retirement and early and old age retirement. This shows the clear interactions between the disability

13. The non parametric estimates of the hazard rate are based on the Kaplan-Meier estimator:

$$\tilde{\theta}_j = \frac{\mathbf{n}_j}{r_j}$$

where n_j is the number of people observed to leave at time t_j and r_j is the number of people in the risk set at time t_{j-1} and the subscript *j* goes over the *T* distinct times at which exits from employment to retirement are observed. From this estimator the survivor function can be estimated as:

$$\overline{F}(\mathbf{t}) = \prod_{t_j < t} (1 - \theta_j)$$

pension scheme and the old age pension scheme. Disability accounts for the large majority of exits from employment to retirement up to age 60 when women and the unemployed started to be entitled to early retirement benefits. The ages 60-61 are the only age groups in which there is an overlapping between the two schemes: men with a short spell of unemployment before the age 63 could only receive an occupational disability pension.

5.2 Maximum likelihood estimates of a competing risk model for transitions from employment to retirement

39. The maximum likelihood estimates of the competing risk model are based on a sample of 617 individuals aged 55 and older who were employed in 1985. These indivuduals have been followed for 11 years, from 1985 to 1995. Out of the total sample, 417 individuals had a transition from employment to retirement in the time interval covered by the data. Given the structure of the dichotomous variables considered, the "reference" person is a married man, who is the head of the household, has a secondary education, a German citizenship and a professional occupation in the "industry" sector and does not own a flat or a house. In the following tables, positive coefficients of the explanatory variables suggest a higher probability of moving into retirement with respect to the "reference" person, while the contrary holds if the sign of the coefficients is negative.

40. To ensure consistency with the underlying maximum likelihood estimation approach, Table 3 presents a specification which includes all socio-demographic variables, while Tables 4 to 6 present the results of restricted models incorporating different measures of the pension wealth and wages[14]. Considering the entire population (first two columns of Table 3) it can be noticed that workers with higher levels of education have a lower probability of moving into retirement than those with lower levels of education. Similarly, self-employed stay longer in employment, *ceteris paribus*, as workers without a German citizenship. Women tend to have a slightly higher propensity to move into early retirement than men but a much lower propensity to move into disability retirement. This phenomenon can be largely explained by the early retirement regulations which allowed (before the 1992 reform) women to go on early retirement before men. The recourse to disability retirement is more likely amongst white collars and especially blue collars than professional workers. Moreover, while workers in the service sector have a tendency to stay longer in employment, civil servants have a decisive higher probability of moving into early retirement and into disability retirement than workers in industry.

41. The highly significant coefficients of health status in the two columns on transition to disability conform to the expectations. Poor health strongly affects the probability of leaving employment to disability retirement. This result is also confirmed if the self assessed measure of the health status is replaced with the more objective measure of the certified degree of disability. However, it should be stressed that even the latter may not be a fully acceptable measure of the "true" health status of the individual given the way in which the assessment was usually made in the 1980s and early 1990s[15]. The final observation regarding Table 4 is about the wealth variable. Contrary to expectation, the coefficient

14. In particular, variables referring to years of tenure, sector of affiliation and occupation have been used to calculate the age profile of wages for each individual and should not be included in the hazard model which include among the regressors either the assessed wage or a measure of the pension wealth which depends on the assessed wage. A different grouping of the education data in the earnings function with respect to the duration model allows considering this factor in the latter without incurring in severe identification problems.

15. As stressed by Börsch-Supan (1992, 1997) and Riphahn (1997), relatively high degree of disability were certified to workers who could not find a suitable job.

is negatively signed, but is also characterised by a high standard error. One would have expected that the wealth would increase the hazard to retirement, other things being equal, rather than depressing it since people with accumulated wealth may be less concerned with a reduction in income due to the transition from work to retirement. However, the surprising results may also be due to the fact that the proxy used for the wealth is not accurate, and other factors over and above the ownership of a house/flat contribute to the individual's wealth.

42. Tables 4 to 6 focus on employees and consider different measures of the financial incentives to retire. The coefficient of the simple pension replacement rate is wrongly signed and characterised by a large standard error in the transition from employment to early retirement and it is not statistically significant, though rightly signed, in the transition from employment to disability retirement. Since the replacement rate increases with the age of retirement, this is not surprising. It can be plausibly assumed that, while making the decision to retire, people compare the stream of benefits from pension to the stream of wages for some more years and pension benefits thereafter, rather than the simple ratio between the pension and the previous wage. Table 5 considers the net present value of the pension wealth for each age of retirement. As expected, the pension wealth plays an important role in the decision to move into early and old-age retirement. The probability of moving from work to retirement is higher the higher the net present value of the pension wealth, which in turn, depends upon years of contribution and years of expected fruition of the pension benefits.

43. Table 6 presents the estimated hazard models, which use the option value as an indicator of the incentive to retire. Model A (first two columns) uses a discount rate of 4.5 per cent while model B uses a discount rate of 13.8 per cent, as estimated by Börsch-Supan (1992) for Germany. In both cases, the option value coefficient is highly significant and has the negative sign (i.e., a lower probability of retirement if the option value is large). The transition from work to retirement is postponed until the option value is low or becomes negative. The use of a higher discount rate (model B) leads to a higher estimated coefficient for the option value. However, for the purpose of the analysis developed in this paper, it is important to notice that the retirement behaviour of the elderly in our sample seems to conform to the basic intuition of the option value even if the latter is defined using parameters which are not derived from a dynamic optimisation procedure (model B), i.e. when they are estimated in order to fit the observed retirement patterns.

5.3 Simulations of the effects of reform in the pension system

44. The results of the duration model of the previous section can be used to assess the potential effects of reforms in the social security system[16]. The baseline hazard rates are the piece-wise constants from the hazard model and refer to the "typical" individual, as discussed above. Two scenarios are considered: i) a reform of the social security provisions that make the pension system actuarially neutral, that is to say, a system that does not distort the retirement age decision (see Box 3); ii) a proportional reduction in pension benefits of 20 per cent. For each person in the sample, the age-specific pension benefits were replaced with the values resulting from the revised pension formulae. Subsequently, the piece-wise constant hazards were re-calculated using the parameters of the model presented above.

16. While reading these simulations it should be born in mind that they only offer a partial picture of the potential effects of reforms. Implicitly, the simulations are based on a *ceteris paribus* condition and do not take into account the potential consequences that changes in the retirement behaviour of older workers may have on aggregate savings, social security expenditures and overall labour market conditions.

45. Figures 5 and 6 present the results of these microsimulations. The upper panel presents the hazard rates under the baseline and the reform scenario, while the bottom panel plots the "employment survival functions": the proportion of individuals in employment at different ages. These simulations suggest significant effects of pension reforms on retirement patterns. The transition from the pre-1992 system with strong incentives to retire early to a more age-neutral system would significantly shift the age profile of retirement, even maintaining the same net present value of the pension wealth. Figure 5 indicates that even under the assumption of a low discount rate (3 per cent) the move to a non-distortionary system would shift the average age of retirement of male household heads by almost one year[17]. Given the assumption that no pension can be claimed before the age of 60, the most significant effect of the pension reform is on early retirement. Fewer male employees at work at the age of 58 will leave employment before the age of 60, while the probability of retirement converges to similar values after 65 years of age. The estimations of these latter hazard rates are, however, less reliable than those for earlier retirement ages given the limited observations available after 65 years of age in the sample. It should also be stressed that such a reform will have even stronger effects on female participation rate. By shifting from a system in which women can obtain their full pension at the age of 60 to one in which their pension will be reduced using the adjustment factors presented in Box 3, the reform will eliminate the strong incentives to retire early.

46. Figure 6 offers another policy scenario in which pension benefits are reduced but the age profile is left unchanged. This alternative reform also produces a significant shift in the average age of retirement. Contrary to the previous case, the effects of benefit reduction are particularly visible for retirements in the 62-65 window, while they are broadly similar at the earlier ages of retirement.

17. These results broadly match those obtained by Börsch-Supan (1994). He found that the move to a non-distortionary system would raise the average age of retirement of all household heads by 0.8 years, using a discount rate of 3 per cent, and by 1.2 years using a discount rate of 7 per cent.

Box 3: **Adjustment factors under a non-distortionary system**

A pension system can be considered as non distortionary if it keeps the net present value of pension benefits minus contributions constant across all retirement ages:

$$N\mathbf{P}V(r) = \sum_{j=r}^{\infty} ADJ(r) \cdot RB(65) \cdot \mathbf{s}_j \cdot \delta^{(j-60)} - \sum_{j=60}^{r-1} \mathbf{c} \cdot Y \cdot \delta^{(r-1-j)} = N\mathbf{P}V(65)$$

where:

r	= retirement age;
ADJ(r)	= adjustment factor;
RB(r)	= yearly pension payment, which is function of r;
s_j	= survival rate at the age j;
δ	= discount factor;
c	= contribution rate;
Y	= annual earnings;

Individuals are assumed to have worked from the age of 20 to retirement. Contributions up to the age of 60 are considered to be sunk in the calculation of the adjustment factors. The calculations refer to an average production worker and no adjustmnent is made for contributions below 75 per cent of the average contribution (see Box 1). The equations above is solved for retirement ages r = 60,...,70 for the adjustment factor (ADJ(r)). Under the assumptions of a discount rate of 4.5 per cent, a contribution rate of 18.5, and an average net replacement rate of 72 per cent at the age of 65, the adjustment factors, normalised to ADJ(65) = 100, are the followings:

	ADJ(r)	
r	"neutral" system	pre-1992 system [1]
60	69.1	88.9
61	74.2	91.1
62	79.7	93.3
63	85.8	95.6
64	92.5	97.8
65	100.0	100.0
66	108.4	108.4
67	117.8	117.4
68	128.4	119.9
69	140.4	122.3
70	154.1	124.8

(1) The adjustment factors for ages 60-62 are those that women and the long-term unemployed would be entitled to before the 1992 reform. From 63 years of age onwards, men were also entitled to full pension before the 1992 reform.

6. Concluding remarks

47. This paper has investigated the determinants of the retirement decision in Germany using microdata from the German Socio-Economic Panel over the period 1985-1995. Non-parametric and semi-parametric techniques have been used to describe the exit to retirement. Non-parametric estimates suggest that the incentive structure generated by the operation of the different social security schemes play a powerful role in the individual retirement decision. The conditional probability of entering retirement (hazard function) over the 55-70 age span has clear spikes at the earliest age of eligibility to: i) the early pension for women and the unemployed (at 60 years of age); ii) the early pension for men (63 years of age); and iii) old-age pension at the official age of retirement (65 years of age). There are also close interactions between the disability scheme and early-retirement schemes. In particular, the hazard function for the transition from work to retirement via the disability route increases with age until 60 years -- when women and the unemployed become entitled to old-age pensions -- and then declines rapidly.

48. The semi-parametric analysis of the retirement decision is conducted using a piece-wise constant hazard model with multiple destinations (i.e. disability scheme and old-age pension scheme) and time-varying covariates. Socio-demographic factors have a strong impact on the retirement decision. Workers with higher than average education and the self-employed have a tendency to stay longer in employment, while a noticeable higher probability of retiring early is observed among civil servants and women. As expected, poor health strongly affects the decision to retire, especially in the case of disability retirement. This result holds irrespective of the choice of the health measure, i.e. self-assessed or objective indicators.

49. Financial incentives offered in the pension system are also powerful in shaping the age profile of retirement. This study considers three summary measures of the financial incentives: the ratio of pension benefit to previous wage (i.e. the pension replacement rate), the expected pension wealth relative to the previous wage and the *option value*. The replacement rate in the German pension system increases with the age and does not seem to be related with the retirement decision. However, as soon as the forward-looking behaviour of individuals is accounted for (i.e. by using the pension wealth and the option value measures), the retirement decision is consistent with financial incentives embedded in the pension system: Older people tend to maximise the net present value of the pension wealth and retire as soon as the option value of postponing retirement becomes small (or negative). The results of the hazard model have been used to predict retirement ages under alternative age-related adjustment factors in the pension formula. In particular, the age profile of benefits have been adjusted so as to keep the net present value of the pension wealth constant across all retirement ages between 60 and 70. This simulation suggests a significant rightward shift in the age profile of retirement, with the average retirement age rising by about one year. A 20 per cent reduction in the pension benefits without modifying the age profile of pensions would also produce an increase in the average age of retirement but will not affect the distribution over the retirement age of the transitions from work to inactivity.

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Table 1. ***Main characteristics of the sample***
GSOEP, individuals 55 and over, 1985-95

	Cases	%
Total	617	100
Age		
55-58	125	20.3
59-61	244	39.6
62-65	220	35.7
66 and over	28	4.5
Education		
- Non schooling	74	12.0
- Primary	79	12.8
- Secondary	338	54.8
- Vocational	62	10.1
- Higher	64	10.4
Household status		
- Married	506	82.0
- Not married	111	18.0
- Head of household	483	78.3
- Not head of household	134	21.7
- House owner	323	52.4
- Household size		
1	72	11.7
2	305	49.4
3	146	23.7
4	57	9.2
5	20	3.2
6 and more	17	2.8
Nationality		
- German	477	77.3
- Not German	140	22.7
Economic sector or industry	*546*	*88.5*
- Mining , energy and manufacturing	214	34.7
- Construction	43	7.0
- Wholesale and retail	48	7.8
- Transport, communication and finance	53	8.6
- Education, sports and health	47	7.6
- Other services	116	18.8
- Other	25	4.1
Occupational status	*462*	*74.9*
- Technical and related specialists	71	11.5
- Managers in public service and in business	12	1.9
- Office workers and related occupations	84	13.6
- Business occupations	36	5.8
- Service occupation (includes defence)	63	10.2
- Occupations in farming, forestry,fishing and hunting	4	0.7
- Production industry and related ooccupation, transportation services and handymen	192	31.1
Tenure in last employment	585	94.82
- 1 to 3 years	22	3.6
- 4 to 6 years	27	4.4
- 7 to 9 years	28	4.5
- 10 years or more	508	82.3
Self employed	58	9.4

Source:
GSOEP panel, 1985-1995 waves, workers 55+ in 1985. See text for more details.

Table 2. *D*ist*r*i*bu*tion of sa*mp*le cases *b*y yea*r* of exit, age and *r*ight-censo*r*ing

Year of leaving the sample	Right censored		Retired	
	Number	%	Number	%
1986	70	35.0	74	17.7
1987	26	13.0	66	15.8
1988	21	10.5	75	18.0
1989	26	13.0	53	12.7
1990	15	7.5	48	11.5
1991	7	3.5	34	8.2
1992	8	4.0	34	8.2
1993	4	2.0	20	4.8
1994	3	1.5	12	2.9
1995	20	10.0	1	0.2
Total	200	100.0	417	100.0

Age at which the decision is taken	Right censored		Retired	
	Number	%	Number	%
55	7	3.5	5	1.2
56	12	6.0	12	2.9
57	12	6.0	24	5.8
58	19	9.5	34	8.2
59	35	17.5	52	12.5
60	29	14.5	76	18.2
61	15	7.5	37	8.9
62	16	8.0	59	14.1
63	14	7.0	61	14.6
64	15	7.5	24	5.8
65	10	5.0	21	5.0
66	4	2.0	8	1.9
67	6	3.0	2	0.5
68	0	0.0	2	0.5
71	4	2.0	0	0.0
72	2	1.0	0	0.0
Total	200	100.0	417	100.0

So**ur**ce : GSOEP panel

Table 3. **Maximum likelihood estimates of a competing risks model with price-wise constant hazards Socio-demographic variables**

	All workers						Employees					
	Destinations						Destinations					
	Early retirement and old-age retirement			Disability retirement			Early retirement and old-age retirement			Disability retirement		
	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
Primary or less	**0.10**	**0.18**		**-0.44**	**0.31**		**0.11**	**0.19**		**-0.39**	**0.31**	
Higher education	**-0.61**	**0.24**	***	**-0.79**	**0.44**	*	**-0.54**	**0.26**	**	**-0.76**	**0.45**	*
Female	**0.47**	**0.25**	*	**-1.76**	**0.49**	***	**0.43**	**0.26**		**-1.75**	**0.49**	***
Single	**-0.07**	**0.21**		**0.16**	**0.26**		**-0.03**	**0.21**		**0.19**	**0.26**	
No head of household	**0.26**	**0.27**		**0.72**	**0.50**		**0.34**	**0.28**		**0.73**	**0.50**	
Non german	**-0.50**	**0.24**	**	**-0.45**	**0.39**		**-0.47**	**0.26**	*	**-0.50**	**0.39**	
White collar	**0.31**	**0.20**		**0.64**	**0.38**	*	**0.38**	**0.21**	*	**0.59**	**0.38**	
Blue collar	**0.24**	**0.22**		**0.80**	**0.38**	**	**0.30**	**0.23**		**0.79**	**0.39**	**
Service sector	**-0.32**	**0.16**	**	**-0.26**	**0.24**		**-0.33**	**0.16**	**	**-0.24**	**0.24**	
Civil servant	**0.76**	**0.28**	***	**1.02**	**0.33**	***	**0.72**	**0.28**	**	**1.01**	**0.33**	***
Self-employment	**-0.60**	**0.22**	***	**-2.10**	**0.73**	***						
Tenure	**-0.001**	**0.005**		**-0.03**	**0.01**	***	**0.0001**	**0.01**		**-0.02**	**0.01**	***
House owner	**-0.28**	**0.15**	*	**-0.20**	**0.20**		**-0.25**	**0.15**	*	**-0.22**	**0.20**	
Household size	**-0.003**	**0.05**		**-0.003**	**0.09**		**-0.01**	**0.05**		**0.01**	**0.09**	
Health status	**-0.02**	**0.03**		**-0.18**	**0.04**	***	**-0.01**	**0.03**		**-0.19**	**0.04**	***
Log Likelihood	-1295.5						-1212.8					
$\chi^{2(1)}$	507.6			152.3			454.4			130.5		

*** = **significant at 1 per cent**
** = **significant at 5 per cent**
* = **significant at 10 per cent**
1. Chi-squared statistic for the model above vs. the intercept-only model.

Source: **Calculations of the authors based on a sample from the** *GSOEP*.

Table 4. *Maximum* **likelihood estimates of a competing risks model with price-wise constant *R*educed form with replacement**

	Employees					
	Destinations					
	Early retirement and old-age retirement			Disability retirement		
	Coef.	Std. Err.		Coef.	Std. Err.	
Primary or less	**0.08**	**0.19**		**-0.43**	**0.30**	
Higher education	**-0.78**	**0.24**	***	**-1.07**	**0.41**	***
Female	**0.52**	**0.26**	**	**-1.83**	**0.50**	***
Single	**-0.02**	**0.21**		**0.31**	**0.26**	
No head of household	**0.27**	**0.28**		**0.75**	**0.50**	
Non german	**-0.38**	**0.24**		**-0.20**	**0.38**	
Civil servant	**0.65**	**0.26**	**	**0.63**	**0.27**	**
House owner	**-0.27**	**0.15**	*	**-0.24**	**0.20**	
Household size	**0.00**	**0.05**		**0.03**	**0.08**	
Health status	**-0.01**	**0.03**		**-0.19**	**0.04**	***
Pension replacement rate	**-0.44**	**0.24**	*	**0.25**	**0.54**	
Log Likelihood	- 1223.7					
$\chi^{2(1)}$	447.6			115.4		

*** = significant at 1 per cent
** = significant at 5 per cent
* = significant at 10 per cent
1. Chi-squared statistic for the model above vs. the intercept-only model.

***Source*: Calculations of the authors based on a sample from the *GSOEP*.**

Table 5. *Maximum* **likelihood estimates of a competing risks model with *price*-wise constant *Reduced form* with *NPV* of *p*ension**

	Employees					
	Destinations					
	Early retirement and old-age retirement			Disability retirement		
	Coef.	Std. Err.		Coef.	Std. Err.	
Primary or less	**-0.0***3*	**0.19**		**-0.44**	**0.*3*0**	
Higher education	**-0.96**	**0.*2*4**	***	**-1.14**	**0.41**	***
Female	**0.6***2*	**0.*2*8**	**	**-*2*.0*2***	**0.54**	***
Single	**0.01**	**0.*2*1**		**0.*33***	**0.*2*6**	
No head of household	**0.*2*9**	**0.*2*8**		**0.76**	**0.50**	
Non german	**-0.18**	**0.*2*5**		**-0.11**	**0.*3*8**	
Civil servant	**0.4***2***	**0.*2*6**		**0.5***2***	**0.*2*8**	*
House owner	**-0.*2*5**	**0.15**	*	**-0.*23***	**0.*2*0**	
Household size	**0.00**	**0.05**		**0.0***3***	**0.08**	
Health status	**-0.01**	**0.0***3***		**-0.*2*0**	**0.04**	***
Log annual observed wage	**0.01**	**0.*2*8**		**0.4***2***	**0.*33***	
Log NPV pension	**1.05**	**0.47**	**	**0.1***2***	**0.05**	**
Log Likelihood	- 1213.9					
$\chi^{2\,(1)}$	463.1			119.5		

*** = **significant at 1 *per* cent**
** = **significant at 5 *per* cent**
* = **significant at 10 *per* cent**
1. Chi-s*qua*red statistic fo*r* the *m*odel a*b*ove vs. the inte*r*ce*p*t-only *m*odel.

Source: **Calc*u*lations of the a*u*tho*r*s *b*ased on a sa*mp*le f*ro*m the** *GS***OEP.**

Table 6. *M*axi*mum* likelihood esti*m*ates of a co*mp*eting *r*isks *m*odel with *pr*ice-wise constant hazar*d*s
*R*ed*u*ced fo*rm* with o*p*tion val*u*e (e*mp*loyees)

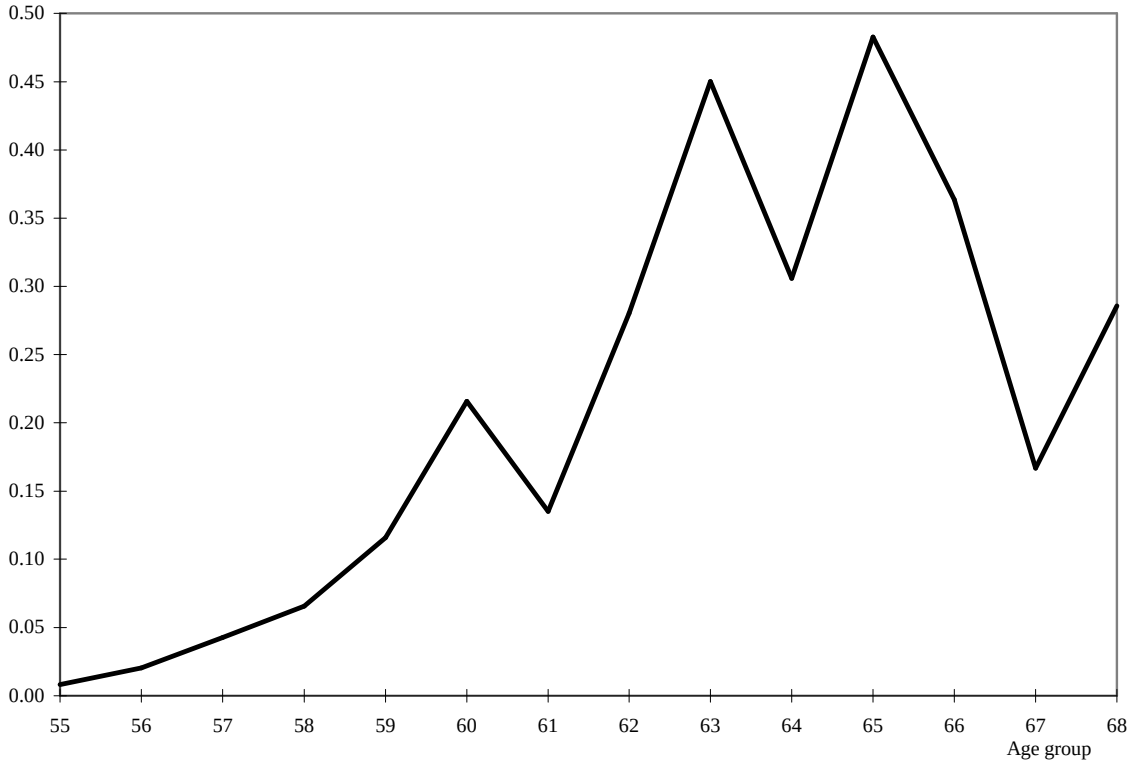
	δ = 4.5 %						δ = 13.8 %					
	Destinations						Destinations					
	Early retirement and old-age retirement			Disability retirement			Early retirement and old-age retirement			Disability retirement		
	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
Primary or less	**0.04**	**0.1897**		**-0.41**	**0.30**		**0.06**	**0.19**		**-0.38**	**0.30**	
Higher education	**-0.93**	**0.25**	***	**-1.45**	**0.46**	***	**-0.87**	**0.25**	***	**-1.47**	**0.48**	***
Female	**0.94**	**0.27**	***	**-1.25**	**0.53**	**	**0.68**	**0.27**	**	**-1.61**	**0.52**	***
Single	**-0.04**	**0.21**		**0.27**	**0.26**		**-0.05**	**0.21**		**0.25**	**0.26**	
No head of household	**0.20**	**0.28**		**0.69**	**0.52**		**0.20**	**0.28**		**0.70**	**0.52**	
Non german	**-0.43**	**0.24**	*	**-0.32**	**0.37**		**-0.44**	**0.24**	*	**-0.34**	**0.38**	
Civil servant	**0.86**	**0.27**	***	**0.96**	**0.28**	***	**0.82**	**0.27**	***	**1.02**	**0.28**	***
House owner	**-0.26**	**0.15**	*	**-0.32**	**0.20**		**-0.25**	**0.15**	*	**-0.32**	**0.20**	
Household size	**0.00**	**0.05**		**0.03**	**0.08**		**0.002**	**0.05**		**0.04**	**0.08**	
Health status	**-0.001**	**0.03**		**-0.16**	**0.04**	***	**-0.004**	**0.03**		**-0.15**	**0.04**	***
Log annual observed wage	**2.07**	**0.33**	***	**4.25**	**0.68**	***	**2.07**	**0.35**	***	**5.67**	**0.80**	***
Option value	**-0.004**	**0.001**	***	**-0.01**	**0.001**	***	**-0.005**	**0.001**	***	**-0.012**	**0.002**	***
Log Likelihood	- 1165.2						- 1156.0					
$\chi^{2(1)}$	500.0			180.1			493.1			205.3		

*** = **significant at 1 *pe*r cent**
** = **significant at 5 *pe*r cent**
* = **significant at 10 *pe*r cent**
1. Chi-s*qua*red statistic fo*r* the *m*odel a*b*ove vs. the inte*r*ce*p*t-only *m*odel.

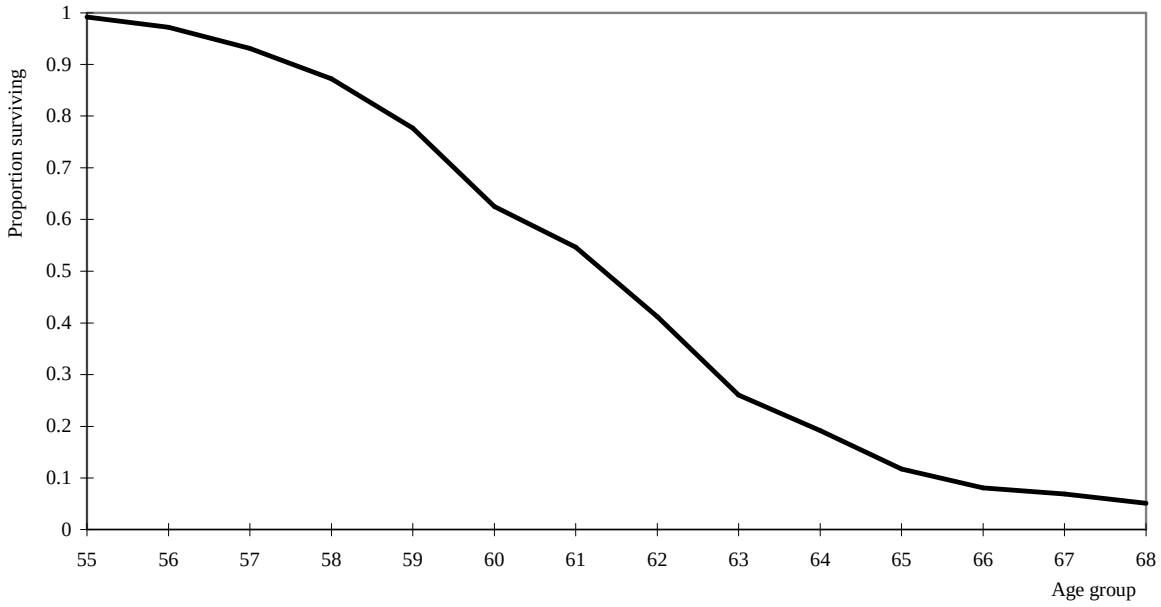
*So**ur**ce*: **Calc*u*lations of the a*u*tho*r*s *b*ased on a sa*mp*le f*r*o*m* the** *GS***OEP.**

Figure 1. **Kaplan-Meier estimates for all workers**

Hazard function

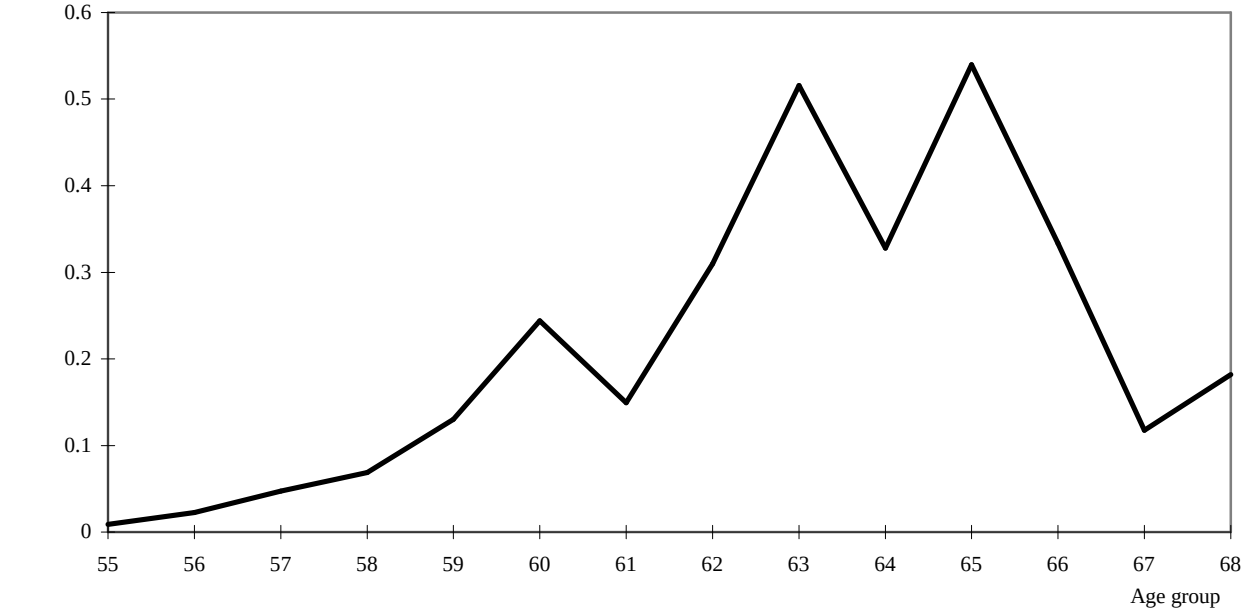


Survival function



Source: Calculations based on GSOEP data. See the text for more details.

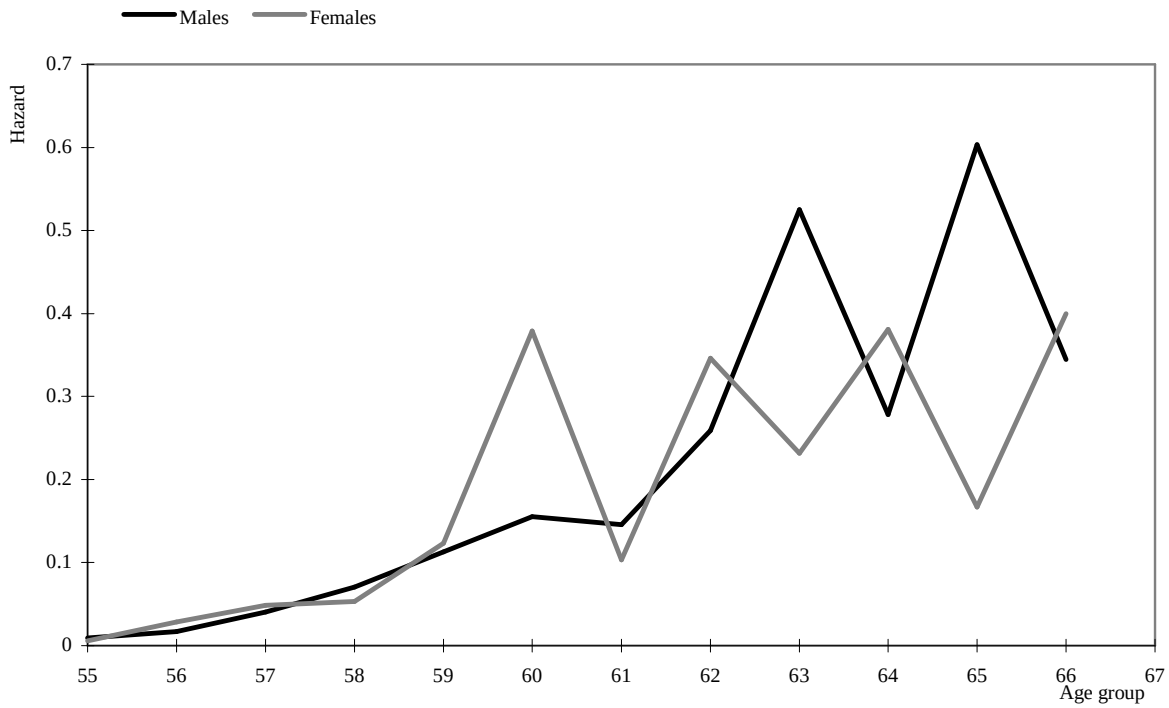
Figure 2. **Kaplan-Meier estimates for employees**



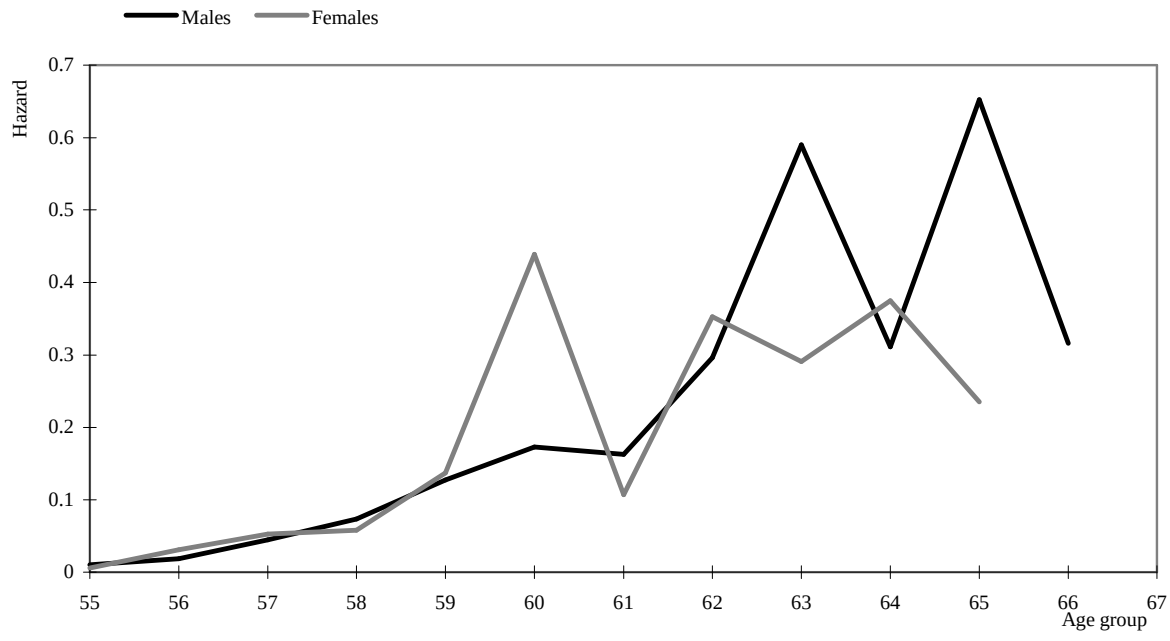
Source: Calculations based on GSOEP data. See the text for more details.

Figure 3. **Kaplan-Meier estimates by sex**
Hazard function

A. **All workers**

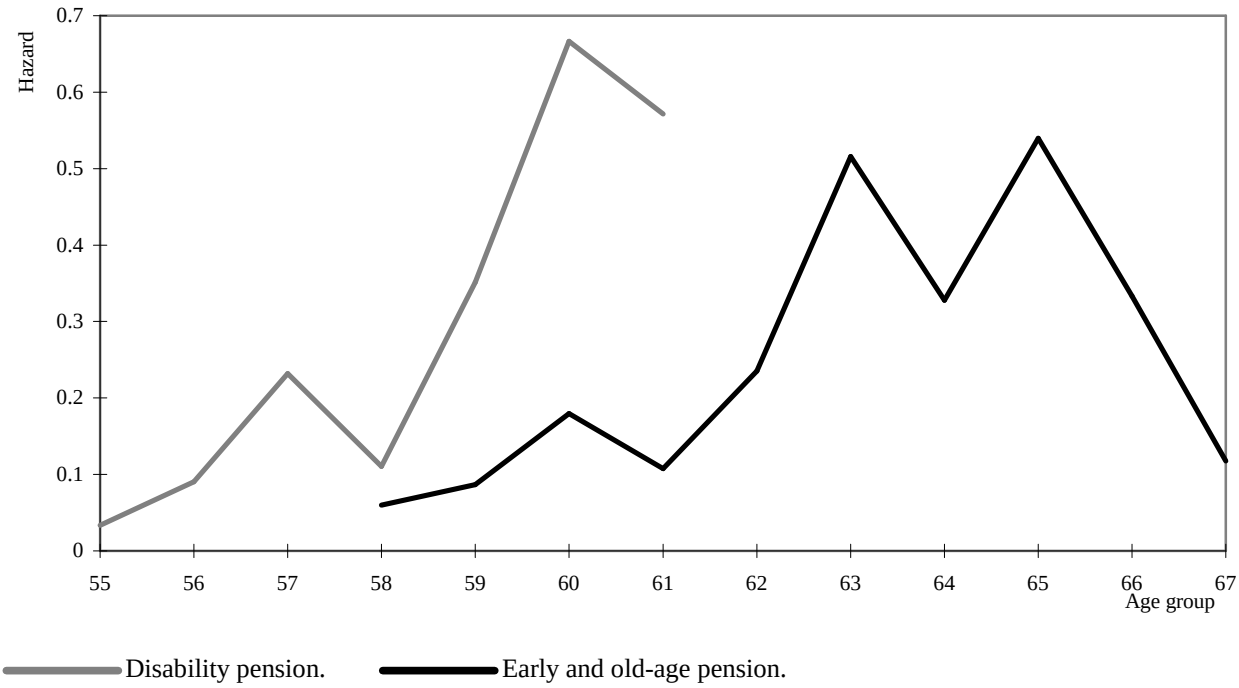


B. **Employees**



Source: Calculations based on GSOEP data. See the text for more details.

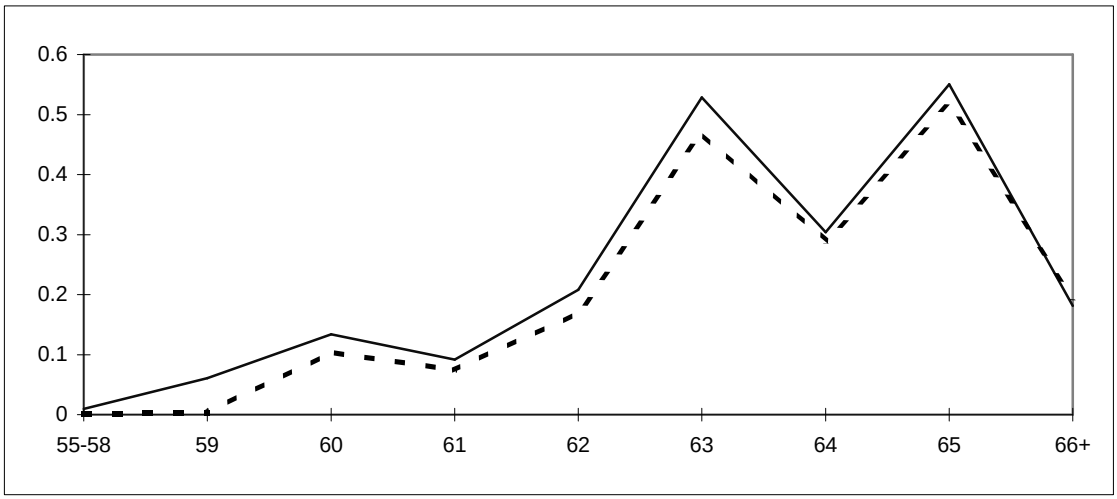
Figure 4. **Kaplan-Meier estimates for employees by disability**



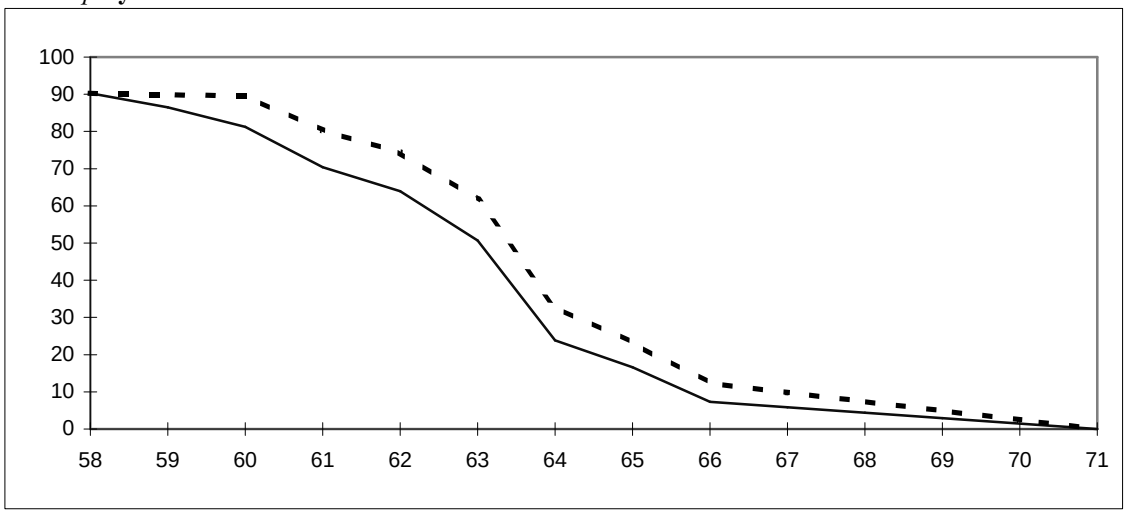
Source: Calculations based on GSOEP data. See the text for more details.

Figure 5. *Distributions of retirement by age: actual and neutral systems*
(male employees, excluding transitions from employment to disability pension)

A: **Probability of moving from employment to retirement (hazard function)**



B: **Employment survival function**



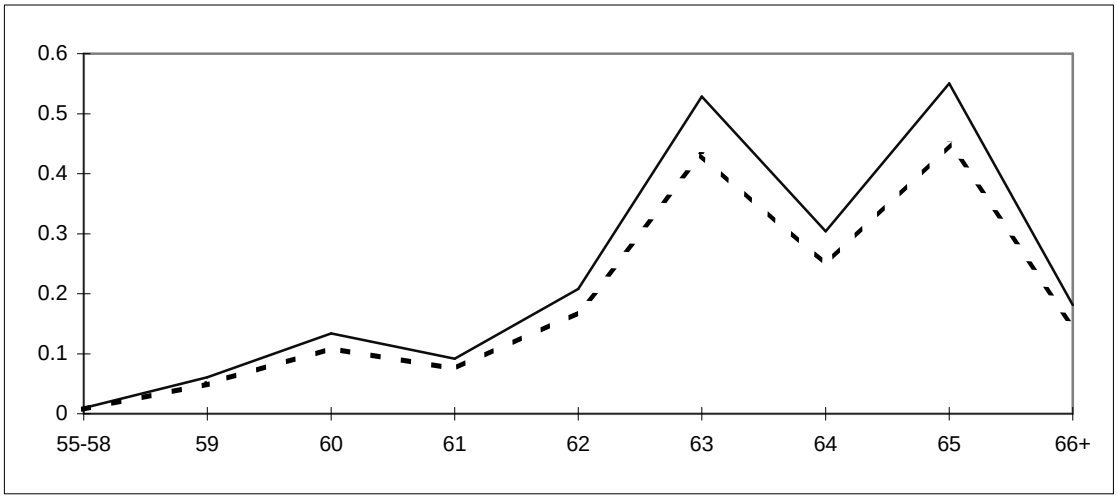
Baseline: pre-1992 pension system.
Non distortionary system

Note: The simulations are based on the results presented in Table 5 based on the NPV of the pension stream. The calculations refer to the typical individual as described in the main text. The non distortionary system is based on the pension adjustement rates presented in the Box 3.

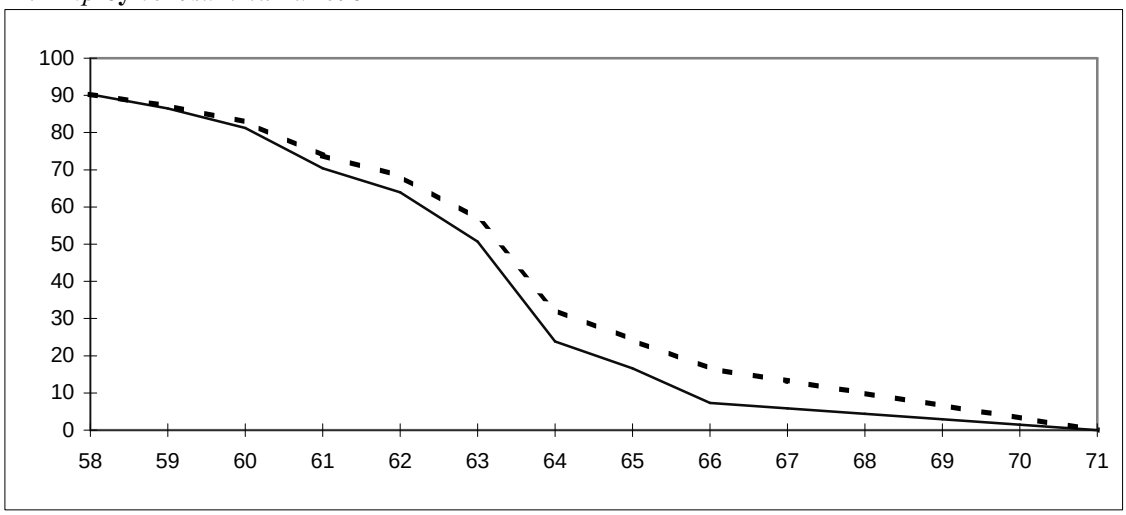
average retirement age under the pre-1992 system = 62.6
average retirement age under the non-distortionary system= 63.4

Figure 6. Distributions of retirement by age: different pension benefit levels
(male employees, excluding transitions from employment to disability pension)

A: **Probability of moving from employment to retirement (hazard function)**



B: **Employment survival function**



Baseline: pre-1992 pension system.
80% of pension benefits

Note: The simulations are based on the results presented in Table 5 based on the NPV of the pension stream. The calculations refer to the typical individual as described in the main text. The 80% scenario assumes that the pension benefits are reduced to 80 per cent of their baseline value.

average retirement age under the pre-1992 system = 62.6
average retirement age under the non-distortionary system= 63.3

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