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Early Retirement in West Germany: A Sequential Model of Discrete Choice*

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1. Introduction

Most of the industrialized countries can today be expected to undergo a dramatic process of population ageing during the next three to four decades. This tendency, which is due to both the decline in birth rates in the 1970s and the rising average life expectancy of individuals, is particularly pronounced in Germany: According to a forecast by the German Federal Bureau of Statistics („Statistisches Bundesamt"; see Sommer, 1992), 34.9 % of the German population will be older than 60 years by the year 2030 (compared only to 20.4 % in 1989). Unless appropriate policy reforms are undertaken, these developments are bound to put the financial basis of Germany's unfunded public pension system under considerable strain. As raising the average retirement age is often considered an appropriate means to cope with this problem, the expected demographic changes have spurred off an increasing interest in the factors determining the labour supply behaviour of the elderly. This becomes particularly obvious when considering the rules being laid down in the 1992 Pension Reform Act, which was enacted by the West German government in 1989: The new German pension law substantially reduces the financial incentives for early retirement which had been typical of its predecessor. Moreover, it prescribes that the minimum retirement age will be raised in quarterly steps from the year 2000 onwards until it reaches 65 by the time of the year 2012.

In this paper, I present an empirical analysis of retirement behaviour among male West German employees, using data from the Socio-Economic Panel (SOEP). Panel datasets of this kind provide a particularly useful basis for empirical studies of retirement behaviour because of two main reasons:

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Firstly, the multi-period structure of panel data enables the researcher to take the possibility of unobserved heterogeneity among individuals into account; and secondly, it allows to treat an individual's decision about the timing of retirement as a sequence of choices among multiple discrete alternatives (defined as the remaining possible retirement ages) under the assumption that a person decides to quit the labour force as soon as the option of an immediate exit from the labour force is more advantageous than any of the remaining possible choices. However, the problem of endogenous sample selection that arises whenever „retirement“ is understood as an irrevocable decision (as it is done here) poses an important difficulty in this context. Continuous-time duration models, the use of which has been advocated by Hausman and Diamond (1984) and, more recently, Börsch-Supan and Schmidt (1993), offer a straightforward solution to this problem; yet as there is no obvious way in which the multiplicity of alternatives, which is typical of the retirement decision, can be implicated in such a model, this approach is not adopted here. Instead, the analysis presented in this paper is based on a multi-period multiple-choice model, in which unobserved heterogeneity is captured by time-invariant random effects and the problem of endogenous sample selection is accounted for by regarding the entire sequence of decisions made between the earliest possible retirement age and the one actually chosen as a single observational unit.

Compared to the dynamic programming models employed, e.g., by Rust (1989) and Berkovec and Stern (1991), and to the option value approach developed by Stock and Wise (1990) and recently extended by Pohlmeier (1993), the model applied here is set in a rather simple utility maximization framework. This is due to two main reasons: Firstly, both dynamic programming and option value models require that the optimization problem which the individuals are assumed to face is solved for every person in every iteration of the maximum likelihood algorithm anew, which greatly increases the computational burden of the respective model's empirical implementation. Secondly, and more importantly, virtually all of these approaches are based on rather restrictive assumptions regarding the correlation pattern of the error terms entering the time- and alternative-specific utility levels. The model presented here circumvents these difficulties; yet one feature it has in common with the above-mentioned approaches is that it describes the retirement decision as a trade-off between the gain in income which can be obtained by postponing one's exit from the labour force and the gain in leisure which is implied by early retirement. It is therefore capable of integrating possible labour (dis)incentives implied by the rules of the relevant pension system into the empirical analysis of retirement behaviour.

The outline of the paper is as follows: In section 2, the assumptions of the model employed are described in detail. Section 3 contains a brief description of the data being used and of the way in which the endogenous variable is defined. The empirical results are being discussed in section 4, and the paper ends with a couple of final remarks and a brief summary.

2. The Theoretical Framework

Following the model set up by Fields and Mitchell (1984), it is assumed that the utility level U that individual i can enjoy at time $r_i \geq t$ if he (or she) chooses to retire at time can be expressed as a function of the expected present discounted value of all present and future income streams (which will be denoted by $Y_{it}(r_i)$ here and in the following), the expected length of his (her) retirement period, $L_{it}(r_i)$, and a disturbance term $\varepsilon_{it}(r_i)$. For the alternative-specific utility level $U_{it}(r_i)$ which is associated with retirement at time r_i, the following functional form is specified:

$$U_{it}(r_i) = ln Y_{it}(r_i) + \beta_{it} ln L_{it}(r_i) + \varepsilon_{it}(r_i) \tag{1}$$

The parameter β_{it} is a taste parameter which measures the relative intensity of an individual‘s preference for leisure and is allowed to vary among individuals as well as over time. It is assumed to be a linear function of a vector γ of unknown parameters and of a set of exogenous variables, which are collected in the vector x_{it} and represent certain socio-economic characteristics of the individuals observed:

$$\beta_{it} = x_{it}{}'\gamma \tag{2}$$

If $\pi_i(s|t)$ denotes the individual-specific probability that a person who was alive at time t is still alive at time $s > t$, and if S_i is the last period in which $\pi_i(s|t)$ is positive, the expected present discounted value of present and future income levels, $Y_{it}(r_i)$, can be expressed as follows:

$$Y_{it}(r_i) := \sum_{s=i}^{r_i-1} E_t(w_{is}) \cdot \pi_i(s|t) \cdot (1+\rho)^{t-s} + \sum_{s=r}^{S_i} E_t(b_{is}(r_i)) \cdot \pi_i(s|t) \cdot (1+\rho)^{t-s} \tag{3}$$

In this equation, w_{is} denotes an individual's labour income at time s, the variable b_{is} stands for the amount of retirement benefits received by the respective person, E_t is the expectations operator given the information set of time t. (Its use in this context is, of course, not meant to conceal the fact that the model described here is essentially set in a perfect-foresight world and does not account for the impact of income-related uncertainty on the utility levels associated with different alternatives). The age-specific survival probabilities $\pi_i(s|t)$ were computed from the (estimated) population averages published by the German Federal Bureau of Statistics in 1990. This implies the assumption that the mortality risk does not vary among individuals of the same age, which is, of course, somewhat implausible since differences in health, wealth, and possibly even education and marital status probably exert considerable influence on the life expectancy. Yet as there does not appear to be sufficiently exact information on the magnitude of the impact of these factors, the above-mentioned way of proceeding might nevertheless be regarded as a reasonable simplification.

The discount factor ρ is set to 0.03 for the sake of simplicity. Clearly, this is one of the most questionable characteristics of the model under discussion, since ρ mirrors the relative importance ascribed to present and future income streams by an individual. Nonetheless, the introduction of a fixed discount factor is a rather common practice in studies directed at assessing the relative financial attractiveness of different retirement ages under a given pension schemes (see, e.g., Schmidt, 1995). In this paper, it is adopted for the sake of computational simplicity in order to avoid the necessity of computing alternative-, individual- and time-specific values of $Y_{it}(\cdot)$ in every iteration of the estimation algorithm anew.

Due to a lack of appropriate data – the corresponding statements in the German Socio-Economic Panel, which is the data base used here, were found to be rather imprecise and incomplete –, the amount of assets held by an individual is not included as an argument of the utility function within the framework of this model. As a consequence, the coefficients referring to variables correlated with wealth will „absorb" some of the unobserved wealth effects, which has to be kept in mind when interpreting the estimation results.

Assuming time intervals of unit length and recalling that the terms $\pi_i(s|t)$ denote age-specific survival probabilities computed from official estimates of the corresponding population averages, the expected duration of a person's retirement period can be expressed as

$$L_{it}(r_i) = \sum_{s=r_i}^{S_i} \pi_i(s|t) \tag{4}$$

Let t_{i0} denote the period in which person i first has the opportunity to retire and $r_i^{\max}$ the latest possible year of retirement for the same person. (For reasons that will become obvious later, t_{i0} is assumed to be the year of the corresponding individual's 58th birthday). This implies that an individual who has not retired until the beginning of period t can either opt for immediate retirement or plan to retire at one of the $(r_{it}^{(\max.)} - t)$ remaining future years of retirement. Thus, an individual can be said to have the choice between a total number of $(r_{it}^{(\max.)} - t_{i0} + 1)$ different retirement ages at time t_{i0}. These alternatives are henceforth numbered in consecutive order beginning with zero. In order to retain relative computational simplicity while adding some stochastic flexibility to what otherwise would be a restrictive multinomial logit or independent probit model, a so-called „one-factor" decomposition (Amemiya, 1985, p. 323 f.) is chosen as to the stochastic error terms $\varepsilon_{it}(r_i)$:

(5) $$\varepsilon_{it}(r_i) = \delta_{r_{it}-t_{i0}} \cdot v + u_{it}(r_i)$$

The error components $u_{it}(r_i)$ and v_i are assumed to be normally distributed with mean zero; the factors δ_0 to $\delta_{r_i^{(\max)}-t_{i0}}$ are unknown parameters which have to be estimated. From an economic point of view, the random effects v_i represent unobservable but time-invariant individual characteristics, while the δ coefficients capture their influence on the utility levels associated with different retirement ages. In accordance with the general conditions for the identification of parameters in multinomial choice models, which are summarized, e.g., in the paper by Börsch-Supan et al. (1990), the following normalizations are introduced:

(6) $$E[u_{is}(r_i)v_i] = \text{for all } r_i\,,$$

(7) $$E[u_{is}(r_i)^2] = 0.5\,,$$

(8) $$E[u_{is}(r_i)u_{is}(r_i{}')] = 0 \text{ for all } r_i, r_i{}' \text{ if } s \neq s'\,,$$

(9) $$E[v_i{}^2] = 1\,,$$

and

(10) $$\delta_0 = \delta_1 = 1\,.$$

If the number of panel waves, T, falls short of the number of possible retirement ages or if not all retirement ages are observed with sufficient frequency, even further equality constraints as to the covariance structure of the error terms have to be added.

Following a suggestion made by Pudney (1989, p. 127 - 131), an individual is assumed to retire at time t if this is the period in which the utility level associated with the option of immediate retirement exceeds the maximum utility level that can be achieved by postponing retirement for the first time. Let $\bar{r}_i$ denote the year of retirement that has actually been chosen by individual i (which is observable for the econometrician if it lies within the sampling period) and r_i^* be the corresponding person's optimal year of retirement (which is a discrete random variable from the econometrician's point of view because it is a function of the unknown parameters and the stochastic components of the individual's utility function). Then, the probability that this individual retires at time t given he/she has not retired until t-1 and conditional on v can be expressed as follows:

$$
\begin{aligned}
& \Pr(r_i^* = t | r_i^* > t-1; v) \\
(11) \qquad & = \prod_{r=t+1}^{i^{(\max.)}} \Pr\left[U_{it}(t) > U_{it}(r) | r_i^* > t-1; v\right] \\
& = \prod_{r=t+1}^{r_i^{(\max.)}} \Phi\left[\ln Y_{it}(t) - \ln Y_{it}(r) + z_{it}{}'\gamma \cdot [\ln L_{it}(t) - \ln L_{it}(r)] + [\delta_{t-t_{i0}} - \delta_{r-t_{i0}}] \cdot v\right]
\end{aligned}
$$

Here and in the following, $\Phi(\cdot)$ denotes the cumulative distribution function and $\phi(\cdot)$ the probability density function of the standard normal distribution. It follows from equation (11) that the unconditional probability of individual i retiring at time t is

$$
(12) \quad Pr(r_i^* = t) = \int_{-\infty}^{\infty} Pr(r_i^* = t | r_i^* > t-1; v) \cdot \prod_{s=t_{i0}}^{t-1} \left[1 - Pr(r_i^* = s | r_i^* > s-1\,;\, v)\right] \phi(v) dv
$$

(The probability of a person retiring before is zero by definition).

As the term $(r_i - t_{t_{i0}})$ measures the length of the time interval between the earliest possible retirement age and the one actually chosen, this model can be understood as a duration model in which time is measured in discrete intervals. Seen from this angle, the right-hand side of equation (11) equals a hazard rate (conditional on v) with regard to the transition from work to retirement. Together with the alternative-specific income variables introduced in equation (1), the one-factor structure chosen as to the error terms renders this hazard rate dependent on age, allows for a large variety of correlation patterns among the hazard rates referring to different retirement ages and thus mirrors the fact that apart from the explanatory variables in use, individual-specific but time-invariant factors can influence the probability of an immediate exit from the labour force differently at distinct ages.

It becomes obvious that the unknown parameters of the decision model described here can be estimated by the method of maximum likelihood.

Suppose that the individuals in the sample are observed during a period of T consecutive years. In this case, there will be some persons who did not choose to quit the labour force during the sampling period although they were already entitled to retire. Taking this phenomenon (which can be thought of as a kind of right-hand-side censoring if this model is understood as a duration model in discrete time) into account, and recalling that the date of retirement actually chosen is denoted by $\bar{r}_i$, the contribution of individual i to the sample likelihood function (Λ_i) can be expressed as follows:

$$(13) \quad \Lambda_i = \begin{cases} Pr(r_i^* = \bar{r}_i) & \text{if } r_i \leq T \,(\Leftrightarrow \textit{observed}) \\ \int\limits_{-\infty}^{\infty} \prod\limits_{s=t_{i0}}^{T} \left[1 - Pr(r_i^* = s | r_i^* > s-1; v)\right] \phi(v) dv & \text{if } \bar{r}_i > T \,(\Leftrightarrow \textit{unobserved}) \end{cases}$$

Then, the log-likelihood function for an entire sample of N individuals simply is

$$(14) \qquad ln\,\Lambda = \sum_{i=1}^{N} ln\,\Lambda_i$$

and can be maximized by means of conventional numerical optimization techniques.

3. The Data

3.1 The definition of „retirement“

In previous micro-econometric studies of retirement behaviour, a variety of different definitions of the endogenous variable have been used. To a certain extent, this is due to the fact that the questions of main interest within this field vary considerably among researchers. Another reason is that the informational content of the datasets in use differs from case to case. The striking differences among the results of previous empirical investigations concerning the labour force exit behaviour of elderly Americans can, in part, be attributed to these factors. Hurd and Boskin (1984), for instance, who use the „Retirement History Survey“ (RHS) as a data base, only consider a person as retired if he or she has left the labour force finally and irrevocably. Contrary to that, in a study by Burtless and Moffitt (1984), which is based on PSID data, an elderly employee's retirement age is defined as the age in which a sudden and pronounced decline in the individual's number of working hours occurs. If the incentive effects of firm pension plans are being analyzed, it is most appropriate to equate a person's date of retirement with the period when he or she first receives pension benefits, as it is done by Stock and Wise (1990).

In an empirical study of retirement behaviour in West Germany conducted by Börsch-Supan (1992) using the 1984 cross-section of the SOEP, the period of retirement is defined as the year in which the number of a person's working hours per week first falls short of fifteen. However, as „retirement" is understood as an absorbing state in the model described in section 2, it seems more reasonable in this context to equate a person's date of retirement to the moment in which he/she first declares himself/herself retired. This is possible with data from SOEP because it contains a very detailed set of information on a person's present and past labour force status in which „retirement" is a separate category.

One of the main goals of the empirical study described here is to explain the effect of Germany's pension system on retirement behaviour. Nevertheless, it is assumed here that individuals can opt for retirement up to two years before they reach the age of 60, which is the minimum age for the receipt of old-age pension benefits in this system. The reason for this assumption is that, according to the rules of § 105c of the German Employment Promotion Act („Arbeitsförderungsgesetz" = AFG), unemployed individuals aged 58 or above can receive full unemployment benefits without having to declare explicitly that they are willing to work as long as they are ready to apply for the receipt of pension benefits at the earliest possible age (see Bundesminister für Arbeit und Sozialordnung, 1993, p. 111). As an evaluation of the labour force histories of all male SOEP respondents born between 1915 and 1925 reveals, less then 3 % of all persons in this category who were either unemployed or out of the labour force at the age of 58 returned to employment afterwards. This indicates that setting the minimum retirement age („retirement" being defined as a state in which a person does not intend to return to paid employment) to 58 is a reasonable choice.

3.2 Explanatory variables

The intensity of an individual's preference for leisure, which is measured by the parameter within the framework of the model described in chapter 2, is assumed to be influenced mainly by the person's current health status and educational background. In addition to these variables, the dummy variable PUBLIC, which indicates whether a person is or was a public sector employee, is included in order to control for the influence of possible differences between the pension systems applying to public and private sector employees, respectively. From a psychological point of view, it might be interesting to find out whether married persons exhibit a higher preference for leisure than others; therefore, a corresponding dummy variable (MARRIED) is taken account of.

A particular difficulty arises when it is attempted to examine in how far macroeconomic conditions on the labour market influence retirement behaviour. Clearly, it would be reasonable to assume that cases of involunatary early retirement following untimely layoffs occur more often in times of high unemployment than otherwise. Pohlmeier (1993) argues that therefore, the gender-specific unemployment rate in the corresponding age group, UR, should be included in the set of explanatory variables. However, a problem associated with this way of proceeding is that, due to a number of peculiarities of the German labour market legislation, by no means all cases in which persons had to retire before the age of sixty following a dismissal by their employer are registered in the official unemployment figures. For example, one possible „exit route" frequently chosen by people with health-related problems who would otherwise become unemployed (as it is defined in the official statistics) is to apply for disability pensions, which, according to Zimmermann (1992), are much more generously granted in times when (re-)employment prospects are dull (see Riphahn, 1994, for a thorough theoretical and empirical analysis of disability retirement). Another means by which individuals aged 58 or 59 could be „bought off" the labour market was the so-called Precipitous Retirement Act („Vorruhestandsgesetz"), which was in effect from 1985 to 1988 in West Germany and prescribed that under certain conditions, individuals laid off as a consequence of personnel reductions in their firms could claim a specific early retirement allowance until being entitled to regular old age pensions (see Lampert, 1988, for a more detailed summary of the legal framework). Both of these findings indicate that the official unemployment statistics are subject to considerable measurement error. Nevertheless, the age- and gender-specific unemployment rate will be used as a regressor here, firstly because not taking account of the macroeconomic environment at all might even bias the results to a larger extent, and secondly in order to test the robustness of a result by Pohlmeier (1993), who finds a positive correlation between UR and the probability of early retirement.

From a life-cycle point of view, the omission of wealth indicators from the set of regressors might give rise to some criticism. Yet while pointing out that initial asset holdings do influence retirement behaviour because wealthier persons can afford to retire earlier than others, existing theoretical analyses of retirement behaviour (see, e.g., Genosko, 1985) also assert that individual decisions on wealth accumulation and the planned date of retirement have to be regarded as interdependent. As a consequence, the use of wealth-related variables as regressors in this context results in the probable occurrence of a simultaneity bias in the resulting estimates. As to non-financial assets, this difficulty is even aggravated by the presence of substantial valuation problems. Given the very limited informational content of the corresponding statements in the SOEP, these considerations might suffice to provide a justification for the disregard of wealth indicators in this particular investigation.

Definitions and descriptive statistics of the explanatory variables used are gathered in tables 1 and 2.

Table 1

Definitions of explanatory variables in β_{it}

D_DISAB	Degree of disability with regard to the requirements of the corresponding person's job. $0 \leq$ D_DISAB ≤ 1.
PUBLIC	Dummy variable; PUBLIC = 1 if a person is or was formerly employed in the public sector.
CH_MAL	Dummy variable; CH_MAL = 1 if a person suffers from a chronic malady.
UR	Gender-specific unemployment rate in the age group a person belongs to.
FOREIGN	Dummy variable; FOREIGN = 1 if a person is not a German citizen.
MARRIED	Dummy variable indicating whether a person is married.
HAUPTS REALS ABI	Dummy variables for the highest grade in general education achieved; HAUPTS = 1 corresponds to 9 years, REALS to 10 years, and ABI to 13 years of schooling.
UNI	Dummy variable; UNI = 1 if a person holds a degree from a university or polytechnic.

Table 2

Descriptive statistics of the exogenous variables in β_{it}

Variable	Mean	Standard Deviation	Minimum	Maximum
D_DISAB	0.2832	0.2404	0.0000	1.0000
PUBLIC	0.1203	0.3254	0.0000	1.0000
CH_MAL	0.3839	0.4864	0.0000	1.0000
UR/100	0.1055	0.0080	0.0823	0.1173
FOREIGN	0.2832	0.4506	0.0000	1.0000
MARRIED	0.6888	0.4630	0.0000	1.0000
HAUPTS	0.3533	0.4780	0.0000	1.0000
REALS	0.0745	0.2625	0.0000	1.0000
ABI	0.0599	0.2372	0.0000	1.0000
UNI	0.0409	0.1980	0.0000	1.0000

3.3 Selection of sample

In order to implement the model described in section 2, it is necessary to confine the sample to the persons whose earliest possible year of retirement lies within the sampling period. This implies that in case described here only individuals born between 1926 and 1933 were included in the dataset used for estimation. As the pension systems that apply to most of the self-employed in Germany differ significantly from the one which is relevant for employees, persons who report to have been self-employed in one of the years of the the sampling period were excluded from the sample. The same applies to a total of twelve individuals whose statements about their labour force status were found to be self-contradictory or incomplete. Women were not included in the sample because the significant differences between the labour force participation patterns of males and females make it an unrealistic assumption that the factors influencing their respective job exit behaviour can be reasonably examined with the same type of model.

3.4 Income forecasts

Individual-specific forecasts of net labour income levels were computed on the basis of a classical, Mincer (1974)-type earnings function. In order to avoid the problem of a possible selectivity bias in the earnings estimates, the model was extended to a „type-two-Tobit" model (see Amemiya, 1985, p. 385 - 389) by including a separate selection equation. The results, in turn, can be combined to panel estimates by means of a minimum distance method described by Gouriéroux and Monfort (1989, pp. 385 - 387). In the particular case discussed here, this was done for a balanced panel of 1.633 male SOEP respondents born between 1925 and 1959. Let w_{it}^* denote a person's market wage (in DM per annum) net of taxes, d_{it} a dummy variable indicating whether individual i is employed at time $t (\Leftrightarrow d_{it} = 1)$ or not $(\Leftrightarrow d_{it} = 0)$, and d_{it}^* the latent variable determining a person's employment situation. Then, this model can be summarized by the following system of equations:

$$\ln w_{it}^* = z_{it}^{(1)\prime} \alpha^{(1)} + \omega_{it}^{(1)}, \tag{15}$$

$$d_{it}^* = z_{it}^{(2)\prime} \alpha^{(2)} + \omega_{it}^{(2)}, \tag{16}$$

$$d_{it} := I(d_{it}^* > 0), \tag{17}$$

$$w_{it} = \begin{cases} w_{it}^* & \text{if } d_{it} = 1, \\ 0 & \text{if } d_{it} = 0, \end{cases} \tag{18}$$

and

$$[\omega^{(1)}, \omega^{(2)}] \sim N(0, \Sigma)\,, \tag{19}$$

with

$$\Sigma \equiv A\,A'\,; A := \begin{bmatrix} a_{11} & 0 \\ a_{21} & 1 \end{bmatrix}. \tag{20}$$

A total of T consistent cross-sectional estimates of this system's unknown parameters can be obtained by maximizing the within-period quasi-log-likelihood function

$$\begin{aligned} l_t(\tilde{\alpha}_t^{(1)}, \tilde{\alpha}_i^{(2)}, \tilde{\alpha}_{11,t}, \tilde{\alpha}_{21,t}) = \sum_{i=1}^{N}(1-d_{it}) \cdot \ln \Phi\left(\frac{-z_{it}^{(2)\,\prime}\tilde{\alpha}_t^{(2)}}{(1+\tilde{\alpha}_{21,t})^{1/2}}\right) \\ + d_{it} \cdot \ln\left[\frac{1}{\tilde{\alpha}_{11,t}}\phi\left(\frac{w_{it}-z_{it}^{(1)\,\prime}\tilde{\alpha}_t^{(2)}}{\tilde{\alpha}_{11,t}}\right) \cdot \Phi\left(z_{it}^{(2)\,\prime}\tilde{\alpha}_t^{(2)} - \frac{\tilde{\alpha}_{21,t}}{\tilde{\alpha}_{11,t}}(w_{it}-z_{it}^{(1)\,\prime}\tilde{\alpha}_t^{(1)})\right)\right] \end{aligned} \tag{21}$$

with respect to all of its arguments. The results, in turn, can be combined to panel estimates of $\alpha^{(1)}, \alpha^{(2)}, \alpha_{11}$ and α_{21} by means of a minimum distance method described by Gouriéroux and Monfort (1989, pp. 385 - 387). In the particular case discussed here, this was done for a balanced panel of 1.633 male SOEP respondents born between 1924 and 1959. Descriptive statistics of the explanatory variables of this model are given in table A.1. and the estimation results in tables A.3. and A.4. of the appendix.

If the normality assumption (19.) concerning the random variates $\omega^{(1)}$and $\omega^{(2)}$ is true, the following equality holds (cf. *Ronning*, 1991, p. 213) :

$$E(w_{it}) = exp\,(z_{it}^{(1)\,\prime}\alpha^{(1)} + 0.5 \cdot \alpha_{11}^2)\,. \tag{22}$$

Replacement of the unknown quantities $\alpha^{(1)}$ and α_{11} in (3.7.) by their estimated values makes it possible to use the right-hand side of that equation as a basis for income forecasts. According to Laisney et. al. (1993), it is reasonable to assume that a German employee's annual labour income (including regular voluntary bonuses paid by the employer) can be approximated by thirteen times the monthly labour income with sufficient accuracy, as it is done here.

Because of the complexity of the German pension law, the computation of hypothetical pension benefits (b_{it}) proved to be a rather difficult task. In Germany, an individual's pension level is a function of both the person's number of years of service and of all past and present labour income streams (for details, see, e.g., Schmidt, 1995). Fortunately, the SOEP contains rather detailed information on the labour force histories of the individuals, so that at least the number of years in which a person paid social security contributions could be computed with adequate accuracy. Moreover, figures published by the Board of Trustees to the German Statutory Pension System (Verband Deutscher Rentenversicherungsträger, 1992) indicate that the ratio between the pension level of a hypothetical worker with average earnings and 40 years of service on one hand and the average per capita net labour income on the other amounted to 62 % during the sampling period (with very little variation over the years). By multiplication of this figure with a lifetime average of individual net labour income streams computed using the estimation results from the earnings function, and with a correction factor accounting for deviations of the total years of service from 40, it was possible to evaluate a person's claims on the pension system in an approximate manner. The mean absolute forecast error of this approximation with regard to the monthly pension income levels of persons already retired proved to be less than DM 100.

4. Empirical Results

The model described in section 2 was estimated on two samples. Sample I consists only of German citizens, whereas in sample II, foreigners are included, as well. It is difficult to assess which one of these two datasets leads to more reliable results when being used for estimation: On one hand, including foreigners raises the sample size by almost one third, which is due to the fact that immigrants are deliberately oversampled in the SOEP database. But on the other hand, many immigrants can be expected to have claims on the pension systems of their home countries, which are likely to differ enormously among nations as well as individuals. Steiner and Velling (1993) argue that the desire to re-migrate to one's country of origin might produce a tendency towards early retirement among elderly foreigners. The estimation results for sample II (see table 3) support this hypothesis, as the estimated coefficient referring to the dummy variable FOREIGN is statistically significant at the 95 % level. It should be noted, however, that at least some of the elderly „guest workers" currently living in Germany have no intention to leave their „host country" after having retired. This gives rise to the supposition that the probable presence of discrimination against foreigners on the labour market, which can result in a higher disutility of labour or in untimely retirement following involuntary unemployment, can also contribute to an explanation of the above-mentioned finding.

Furthermore, the estimation results reveal that an individual's health status has considerable influence on the timing of retirement. The coefficients belonging to both of the health-related variables in this model, D_DISAB (= degree of job-related disability) and CH_MAL (dummy variable indicating the presence of a chronic malady) bear the expected positive sign, indicating that, on average, a bad health status leads to a higher probability of early retirement. While being far from surprising, this finding has an important implication: If raising the average retirement age is a goal of public policy, measures directed at improving employees' health and removing working conditions that are potentially hazardous in this respect can be expected to be highly effective in this context. Yet it has to be taken into consideration that the increase in longevity brought about by an improvement of individuals' health might limit the financial relief this involves for the prevailing pension system.

It cannot be told unequivocally from the estimation results whether married men have a significantly higher preference for leisure than others. The related parameter estimate for sample II suggests that they do, but for sample I it is statistically insignificant and bears the opposite sign. A similar ambivalence can be verified with regard to the effect of the actual unemployment rate on the probability of early retirement. A possible explanation for this phenomenon is that, on one hand, untimely retirement due to layoffs probably occurs more frequently in times of high unemployment, whereas on the other, people still employed might tend to feel more pessimistic as to their future income prospects and are therefore inclined to postpone their retirement. The fact that, for both samples, the estimated coefficient belonging to the variable „UR" is not statistically significant at conventional significance levels might indicate that the two above-mentioned effects of the unemployment rate on the mean retirement age cancel out on average. A recent study by Riphahn and Schmidt (1995), which investigates the impact of unemployment on the frequency distribution of retirement ages on by using aggregate-level data, also confirms this impression.

Interpreting the coefficients referring to the impact of education on retirement behaviour is rather difficult. A person's educational status can reasonably be expected to be positively correlated with wealth, which, seen from a life-cycle point of view, would imply that highly educated people tend to quit the labour force earlier than others. However, persons with rather low educational status are probably more likely to be laid off immediately when or even before reaching the minimum retirement age. The estimation results presented here do not permit an unequivocal conclusion as to which one of these two factors dominates the other.

Table 3

Parameter Estimates

Variable	Sample I: German citizens only		Sample II: Germans and foreigners	
	Estimate	t-statistic	Estimate	t-statistic
CONSTANT	2.3975	0.856	-1.5596	-0.729
D_DISAB	4.8436	4.232	4.4203	4.912
HAUPTS	2.1553	5.122	1.6587	4.115
REALS	2.8181	4.882	2.0863	3.655
ABI	1.2155	1.158	0.7307	0.702
UNI	2.2651	1.771	1.5887	1.328
MARRIED	-0.4826	-1.193	0.5803	1.911
PUBLIC	-1.7346	-3.246	-1.4168	-3.756
CH_MAL	1.2083	3.233	1.0620	3.137
UR	-0.0619	-0.243	0.2959	1.535
FOREIGN	-	-	0.9819	2.772
δ_2	-2.8447	-1.351	-1.5456	-1.370
δ_3	-2.2364	-1.104	1.3586	13.769
δ_4	1.1895	7.474	-0.7519	-0.717
δ_5	1.4450	8.029	1.4268	9.376
δ_6	-2.6571	-1.162	-1.4604	-1.132
Mean $\hat{\beta}$	5.0754		4.5659	
Mean Log Likelihood	-1.1165		-1.0658	
# of cases	419		586	

Unobserved wealth effects might also be one of the reasons why the preference for early retirement appears to be significantly lower than average among public sector employees. Another possible explanation for this phenomenon is that, for the vast majority of the public sector employees in Germany, the probability of involuntary early retirement following a dismissal by the employer is virtually reduced to zero by the relevant legal regulations. But also readers who simply consider public sector employees as overpaid and underworked on average compared to their private sector colleagues might regard the above-mentioned result as a confirmation of their verdict.

The estimation results displayed in table 3 can be used as a basis for estimation of age-specific retirement probabilities. In figure 1, the estimated cumulative retirement probabilities are compared to the observed cumulative frequency distribution (as it can be computed from the observed age-specific hazard rates with regard to retirement) of the retirement ages of a group of male SOEP respondents born between 1917 and 1932, of which the persons whose data were actually used for estimation simply constitute an adequately selected sub-sample.

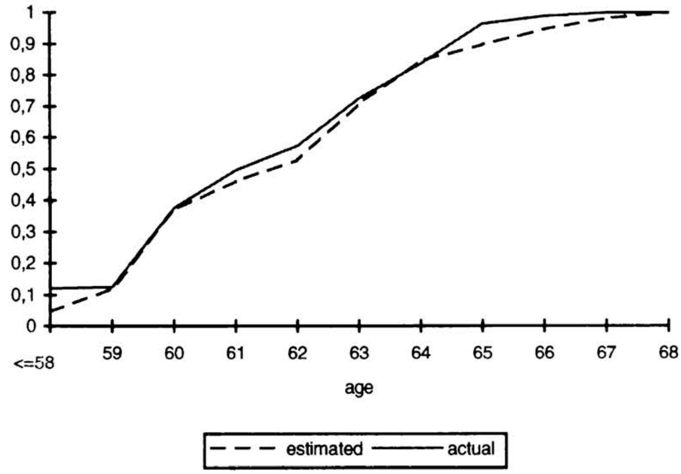

Figure 1: Cumultative retirement probabilities
(German und foreign males)

Apparently, the model underestimates the probability of immediate retirement at the earliest possible retirement age, while otherwise „fitting" the data rather well. The fact that the probability of retirement at 65 is also underestimated is probably due to the problem of right-hand-side censoring mentioned above.

5. A Policy-Related Simulation Experiment

Being deduced from a micro-economic decision model in which the individuals are assumed to balance the gain in income attainable by postponing retirement against the increase in leisure implied by opting for an early exit from the labour force, the results of the investigation presented here can be used as a basis for simulation experiments aimed at forecasting the manner in which assumed changes of the current pension system affect the frequency distribution of retirement ages. This is done in the following for two different cases. The first experiment relates to Germany's most recent Pension Reform Act, which was enacted on January 1, 1992 but of which the main constituents will only become effective after the turn of the century. One of the main goals of this new law is to reduce the financial attractiveness of early retirement by introducing an extra deduction of 0.3% from annual pension benefits for every month that lies between the date when a person first receives them and his / her 65th birthday. The second policy scenario of which the simulated outcomes are presented here is the introduction of a hypothetical, „non-distortionary" social security system in which the expected present discounted value of net transfer payments (pensions plus unemployment benefits minus taxes) is independent of the retirement age chosen. (As in the econometric model of section 2, the discount factor for future income streams is set to 0.03). In figure 2, the pension system prevailing during the sampling period is contrasted with the one coming into force after the completion of the 1992 pension reform and with the supposed nondistortionary system. This is done by comparing the age-specific expected present discounted values of the net transfer payments, computed under the assumptions of chapter 2 for a person aged 58 and with average earnings, corresponding to each of these three systems.

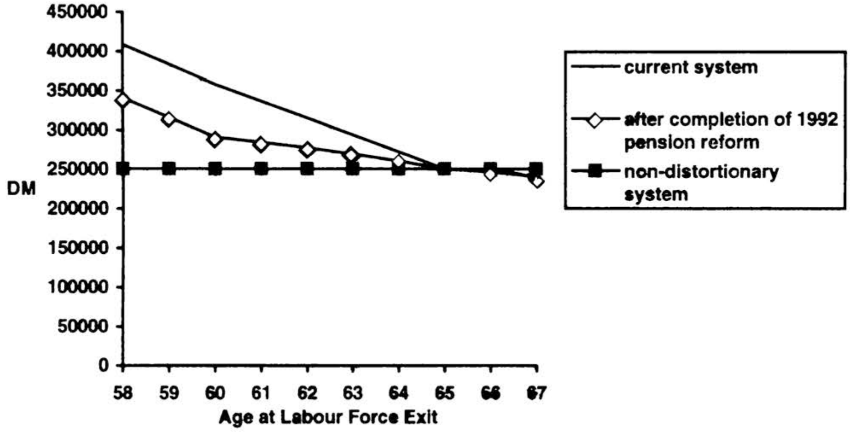

Figure 2: Expected present discounted value of net benefits depending on retirement age

If, as it is frequently done, the expected present discounted value of net benefits is understood as a measure for the relative financial attractiveness of different possible retirement ages, one can conclude from this comparison that the financial incentives in favour of early retirement which have been typical of the prevailing pension system will be significantly reduced, but not completely eliminated by the 1992 Pension Reform Act.

By replacing the original values of the income variables with the ones corresponding to the two alternative policy régimes studied here and subsequently re-estimating the age-specific retirement probabilities on the basis of these newly generated arguments, an estimate of the effect these policies can be obtained. In figure 3, the result of such an experiment is summarized.

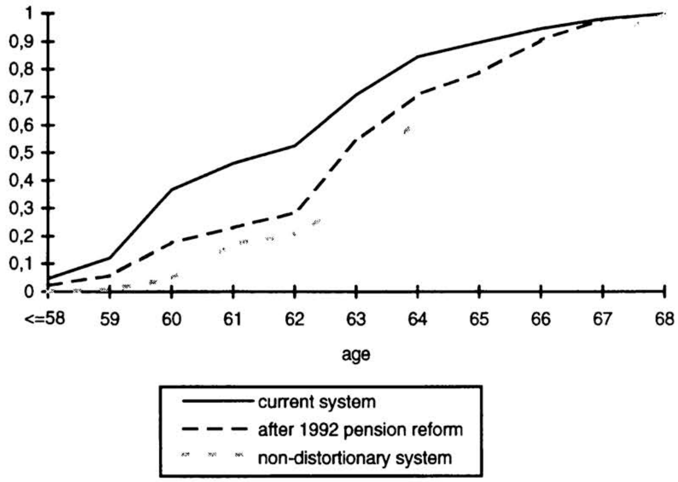

Figure 3: Estimated cumultative retirement probabilities
(German an foreign males)

Changes in the incentive structure of the underlying pension scheme can obviously exert considerable influence on the age-specific retirement probabilities. A replacement of the current German pension scheme by the one that will be in operation after completion of the 1992 pension reform raises the estimated average retirement age of men in Germany by 1.2 years, whereas the introduction of the non-distortionary system described above will result in an increase by 2.1 years. The question in how far such an increase might help to compensate the additional financial burden levied on Germany's social security system by the process of population ageing that is expected to take place during the next five decades, however, cannot be answered at this stage.

A few words of caution ought to be said with regard to the simulation exercise of which the results are gathered here: As can be concluded from *Lucas'* (1976) critique of econometric policy evaluation, the validity of its outcomes depends critically on the correctness of the assumption that the true parameters of the decision models set up in section 2 are independent of the rules governing the current labour market and pensions policy. Moreover, as was pointed out by a referee, the fact that the income variables used in this context are generated regressors rather than directly measured explanatory variables might affect the precision of the resulting estimates detrimentally. These problems undoubtedly are of high importance, yet there does not appear to be a manifest solution to them.

6. Summary and Conclusions

In this paper, the retirement behaviour of male employees in West Germany was analyzed empirically using a sequential multi-period decision model for multiple discrete alternatives. The estimation results reveal that health-related factors play a key role in determining the age a person chooses for the transition from work to retirement. Education, too, does matter; yet the influence a person's educational status has on the probability of an early exit from the labour force seems to follow a rather complicated, non-linear pattern. The hypothesis that the tendency toward early retirement is significantly higher in times of high unemployment could not be supported from the data. A policy-related simulation experiment leads to the conclusion that a removal of the financial incentives for early retirement implied by the current German pension scheme would raise the average retirement age of men by 2.1 years.

The main advantage of the approach presented here is that it adequately reflects the sequential nature of the retirement decision and allows for unobserved heterogeneity among individuals. One major point of criticism, of course, is that its relative computational simplicity necessitates the introduction of rather restrictive assumptions concerning the utility maximization framework it is based on. Moreover, the treatment of individual expectations as to future income streams and survival probabilities and the manner in which they are being formed has only been very sketchy in the model under discussion and clearly deserves more attention in future work. Another drawback might be that the approach presented here does not explicitly account for the possibility of rationing on the labour market. In spite of the fact that it is doubtful whether the informational content of the database used here is high enough to solve this problem in this particular case, the author believes it is the last-mentioned aspect that deserves most attention in future empirical research on retirement behaviour.

Appendix

Table A.1

Definitions of explanatory variables used for the earnings forecasts

PEXP	Potential labour experience; defined as age – years of schooling – 6
SM_FIRM	Dummy variable. SM_FIRM = 1 if a person works in a small firm (less than 200 employees)
LG_FIRM	Dummy variable. LG_FIRM = 1 if a person works in a large firm (more than 2 000 employees)
AGFF	Binary variable indicating whether an individual works in the agrarian sector, in forestry or in fishery
TRADE	Dummy variable. TRADE = 1 if a person is employed in the trade sector
AGEG50, -55, -60	Dummy variables for the age groups 50 to 54, 55 to 59, and 60, respectively
UNM	Dummy variable indicating whether an individual is unmarried
M_WS	Dummy variable. M_WS = 1 if someone is married and living with his / her spouse
VOC_D	Dummy variable pointing out whether the corresponding person holds a vocational degree
TT_SCHOOL	Binary variable indicating whether a person holds a degree from a trade school or technical school
D85, . . . , D90	Dummy variables for the years 1985 to 1990. (1984 is the reference period)

Table A.2

Descriptive statistics of explanatory variables in the earnings equation

Variable	Mean	Standard Deviation	Minimum	Maximum
PEXP / 10	2.8019	0.9964	0.6000	4.9000
$PEXP^2$ / 100	8.8434	5.7015	0.3600	24.0100
SM_FIRM	0.2282	0.4197	0.0000	1.0000
LG_FIRM	0.3009	0.4587	0.0000	1.0000
UNI	0.0808	0.2726	0.0000	1.0000
TT_SCHOOL	0.0793	0.2702	0.0000	1.0000
VOC_D	0.0688	0.2532	0.0000	1.0000
MARRIED	0.8484	0.3587	0.0000	1.0000
ABI	0.1133	0.3170	0.0000	1.0000
HAUPTS	0.4764	0.4995	0.0000	1.0000
PUBLIC	0.2005	0.4004	0.0000	1.0000
AGFF	0.0048	0.0692	0.0000	1.0000
TRADE	0.0344	0.1822	0.0000	1.0000
FOREIGN	0.2394	0.4268	0.0000	1.0000
AGEG50	0.1755	0.3804	0.0000	1.0000
AGEG55	0.1478	0.3550	0.0000	1.0000
AGEG60	0.0848	0.2786	0.0000	1.0000
UNM	0.0962	0.2949	0.0000	1.0000

Table A.3

Cross-sectional Estimates of Earnings Equation

Variable	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7
Income Equation							
CONST	6.7998 (72.989)	6.8628 (68.969)	6.8506 (60.795)	6.8481 (63.605)	6.8496 (56.037)	6.8566 (1.219)	6.9946 (43.078)
PEXP	0.6589 (8.287)	0.6164 (7.715)	0.6879 (8.067)	0.6678 (8.301)	0.7570 (8.237)	0.7576 (0.197)	0.7155 (6.369)
$PEXP^2$	-0.1202 (-7.933)	-0.1102 (-7.318)	-0.1238 (-7.907)	-0.1179 (-8.179)	-0.1343 (-8.353)	-0.1315 (-0.208)	-0.1261 (-6.812)
ABI	0.0484 (0.898)	0.0319 (0.615)	0.0435 (0.626)	0.1419 (1.987)	0.0689 (1.218)	0.1101 (0.046)	0.0102 (0.199)
REALS	-0.0159 (-0.339)	0.0032 (0.069)	-0.0516 (-1.016)	0.0048 (0.102)	-0.0279 (-0.574)	0.0182 (0.009)	-0.0327 (-0.631)
HAUPTS	-0.1483 (-3.628)	-0.1590 (-3.988)	-0.1936 (-4.452)	-0.1491 (-3.668)	-0.1668 (-3.903)	-0.1395 (-0.085)	-0.1636 (-3.547)
TT_SCHOOL	0.1040 (1.769)	0.1161 (2.243)	0.1097 (2.113)	0.1059 (1.957)	0.0750 (1.800)	0.1073 (0.059)	0.1382 (2.980)
UNI	0.2857 (5.862)	0.3160 (5.795)	0.2883 (4.540)	0.2608 (4.159)	0.2902 (5.588)	0.3329 (0.146)	0.4347 (7.654)
MARRIED	0.2046 (4.730)	0.1806 (4.467)	0.1675 (3.922)	0.1897 (4.532)	0.1546 (3.368)	0.1576 (0.088)	0.1491 (3.056)
FOREIGN	-0.2455 (-5.572)	-0.2598 (-5.815)	-0.2915 (-6.026)	-0.2819 (-6.965)	-0.3029 (-6.785)	-0.2437 (-0.141)	-0.2610 (-5.881)
VOC_D	0.1628 (2.629)	0.1299 (2.588)	0.0854 (1.517)	0.1107 (1.823)	0.1006 (1.493)	0.1221 (0.047)	0.1666 (2.232)
PUBLIC	-0.0743 (-2.302)	-0.0653 (-2.019)	-0.0382 (-0.996)	-0.0500 (-1.301)	-0.0509 (-1.249)	-0.0791 (-0.050)	-0.0809 (-2.200)
TRADE	-0.0065 (-0.078)	-0.0124 (-0.157)	-0.0425 (-0.509)	-0.0371 (-0.384)	-0.0338 (-0.389)	-0.0011 (-0.000)	-0.0415 (-0.678)
AGFF	-0.0530 (-0.351)	-0.2502 (-1.821)	-0.1977 (-1.035)	-0.2253 (-1.446)	-0.1774 (-1.029)	-0.0736 (-0.008)	-0.1360 (-0.643)
SM_FIRM	0.0130 (0.419)	0.0040 (0.121)	0.0078 (0.244)	-0.0089 (-0.268)	0.0079 (0.243)	-0.0196 (-0.016)	0.0139 (0.410)
LG_FIRM	0.0541 (1.602)	0.0473 (1.474)	0.0767 (2.299)	0.0740 (2.397)	0.0878 (2.654)	0.0778 (0.062)	0.0928 (2.783)
Selection Equation							
CONST	0.9986 (6.891)	0.9422 (8.064)	0.7977 (5.704)	0.7470 (5.949)	0.7067 (5.905)	0.7289 (0.143)	0.5624 (4.873)
AGEG50	-0.0359 (0.297)	-0.1304 (-1.191)	-0.0617 (-0.597)	-0.1037 (-0.876)	-0.1306 (-1.076)	-0.1001 (-0.022)	-0.0855 (-0.896)
AGEG55	-0.3595 (-3.020)	-0.1969 (-1.961)	-0.3083 (-3.388)	-0.1225 (-1.359)	-0.1006 (-1.269)	-0.0651 (-0.021)	-0.0330 (-0.437)
AGEG60	-0.4577 (-1.955)	-0.5200 (-3.646)	-0.6680 (-6.277)	-0.6611 (-6.743)	-0.7818 (-8.810)	-0.8685 (-0.244)	-0.8780 (-10.898)
M_WS	-0.0302 (-0.194)	0.0276 (0.232)	0.2489 (1.723)	0.2118 (1.622)	0.2566 (2.148)	0.2390 (0.047)	0.2784 (2.383)
UNM	-0.0163 (-0.120)	-0.0286 (-0.220)	0.1413 (0.828)	0.3855 (2.560)	0.2833 (1.708)	0.3415 (0.043)	0.2710 (1.718)
α_{11}	0.1712 (7.702)	0.2017 (11.270)	0.2062 (10.732)	0.1757 (11.260)	0.1825 (9.694)	0.1520 (0.204)	0.2035 (11.346)
α_{21}	0.6036 (49.510)	0.6037 (38.987)	0.6091 (36.206)	0.6181 (45.009)	0.6186 (40.361)	0.6148 (1.192)	0.6359 (36.266)
Mean Log-Likelihood	-0.809942	-0.847198	-0.832625	-0.855222	-0.845093	-0.836828	-0.906481

Table A.4

Minimum Distance Estimate of the Earnings Equation

Dependent variable: Log of monthly labour income in DM

Income Equation		
Variable	Coefficient	t-Statistic
CONST	6.886	169.734
PEXP	0.606	20.381
PEXP2	-0.107	-20.077
ABI	0.011	0.604
REALS	-0.008	-0.519
HAUPTS	-0.153	-10.067
TT_SCHOOL	0.102	5.846
UNI	0.378	19.786
MARRIED	0.177	11.097
FOREIGN	-0.280	-16.361
VOC_D	0.133	6.537
PUBLIC	-0.064	-5.311
TRADE	-0.015	-0.547
AGFF	-0.174	-2.778
SM_FIRM	$-1.6*10^{-4}$	-0.013
LG_FIRM	0.072	6.294
CH_MAL	-0.075	-5.811
D85	0.003	0.125
D86	0.032	1.519
D87	0.089	4.285
D88	0.140	6.629
D89	0.212	10.266
D90	0.237	10.581
Selection equation		
Variable	Coefficient	t-statistic
CONST.	0.823	14.205
AGEG50	-0.068	-1.687
AGEG55	-0.088	-2.755
AGEG60	-0.074	-19.940
M_WS	0.218	4.872
UNM	0.161	3.180
FOREIGN	-0.086	-2.413
CH_MAL	-0.350	-11.064
D85	0.036	0.624
D86	0.117	2.019
D87	0.061	1.074
D88	0.104	1.819
D89	-0.050	-0.882
D90	0.011	0.202
α_{11}	0.219	39.493
α_{21}	0.582	117.508

$\chi^2(d.f. = 152) = 164.491$, p-value = 0.2309

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Zusammenfassung

In dieser Arbeit wird ein strukturelles Modell des Übergangs in den Ruhestand vorgestellt, in dem die Vielfältigkeit möglicher Ruhestandszeitpunkte, die Möglichkeit unbeobachteter individueller Heterogenität und der irreversible Charakter der Ruhestandsentscheidung Berücksichtigung finden. Die anhand einer Panelstichprobe westdeutscher Männer erhaltenen Schätzergebnisse deuten darauf hin, daß der Gesundheitszustand der jeweiligen Person eine wesentliche Rolle für die Wahl des Ruhestandsalters spielt. Außerdem erweist sich die relative Intensität der individuellen Freizeitpräferenz bei Angestellten des öffentlichen Sektors *ceteris paribus* als unterdurchschnittlich. Der Einfluß der finanziellen Anreizeffekte des geltenden Rentenrechts auf die altersspezifischen Ruhestandswahrscheinlichkeiten wird mit Hilfe eines wirtschaftspolitischen Simulationsexperiments quantifiziert.

Abstract

In this paper, I describe a structural model of retirement behaviour, which accounts for the multiplicity of alternative retirement ages, the possibility of unobserved heterogeneity and the „absorbing state" property of the retirement decision. The results of its implementation for a panel dataset of West Geman males reveal that a person's health status plays a key role in determining the timing of retirement, and that the relative intensity of the individual preference for leisure among public sector employees is, *ceteris paribus*, below average. A policy-related simulation experiment demonstrates the relevance of pension benefits for the freqency distribution of retirement ages.

JEL-Klassifikation: C32, C41, J26