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Incentive Effects on Old-Age Labor Supply

by

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Abstract

This research analyses retirement behaviour in Austria based on a combined administrative dataset. Data from the Austrian social security database is merged with a dataset that contains very detailed information on all pension-relevant information on the individual level, e.g. insurance records as well as complete earnings histories. Based on this data a comprehensive microsimulation model of the Austrian pension system is developed and applied to calculate retirement benefit entitlements for each and every individual, double-checking the calculation rules with the actual, administratively calculated pension entitlements. A range of (forward-looking) incentive measures that describe the individual decision problem is constructed. Specifically, social security wealth, accrual rate, peak and option values are computed for more than 300,000 individuals within each year of the observational period (2002-2009). Based on this characterisation of the incentive structure an econometric model is developed, thus providing robust evidence for the effects of the incentive measures on old age labor supply. Simulation of several reform scenarios shows that a stronger emphasis on financial incentives in the pension system (the introduction of additional bonusses and deductions) reduces the out-of-labor-force ratio of individuals aged 56-65 by 16.3% for females and 13.4% for males.

Keywords: Retirement Decision; Option Value; Social Security Wealth

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1 Introduction

Most European countries, just as other developed countries around the world, are facing funding problems in their public pension systems. In particular, pay-as-you-go pension systems are confronted with two major developments: the trends of declining fertility and increasing life expectancy led to population ageing and therefore to an increase of the number of retirees relative to the working age population. Compounding this demographic development is the tendency towards later entry and earlier exit from the labor market. The total number of years spent in the labor force thus decreased in all European countries during the past decades, putting further financial pressure on those currently in the labor force.

In Austria this development is particularly pronounced since life expectancy and living conditions are comparatively high while actual retirement age is among the lowest in all OECD countries. As has been repeatedly argued, for instance by Gruber and Wise (1999), the incentives delivered by the pension system are a major driving force of individual retirement behaviour. Although this conjecture has often been disputed in Austrian public debates, a more thorough analysis of the incentive structure hinges on the ability to capture the full complexity of the Austrian retirement regulations while linking them to individual level data.

This paper analyses retirement behaviour in Austria based on a large adminstrative dataset that contains information on 314,805 Austrian individuals who were exiting the labor market in the period 2002 to 2009 (approximately 50%). As the data includes complete insurance records on an individual basis retirement benefits can be calculated with very high precision conditional on the observed retirement date. However, to quantify the extent to which retirement behaviour is affected by the incentive structure of the Austrian pension system, counterfactual retirement benefits are computed for every possible retirement date within the window period.

To describe the incentive structure as perceived by the individual decision makers the *option value* framework is adopted (Stock and Wise, 1990). This approach is built on the empirical observation that retirement is basically irreversible. Typically, an individual acquires pension entitlements over his or her employment career depending on work duration and income. However, once he or she becomes eligible and decides to transform these entitlements into actual benefits, it is uncommon to return to the labor market and begin another employment spell[1]. To account for this irreversibility, the option value captures the opportunity costs of immediate retirement as measured by the maximum utility gain that can be obtained by staying in the labor market.

Framing the decision problem in this way implies that an individual compares the utility value of immediate retirement with the utilities associated with *any* future retirement option. Immediate retirement can thus be an optimal choice only if the individuals expected present discounted utility cannot be further increased through an extension of the employment career. The inclusion of the option value in a (pooled) cross-sectional analysis thus implies that each individual reevaluates all future options associated with a continuation of work at each point in time. This forward-looking character of the option value therefore allows for the construction of an essentially static model that is still able to account for the intertemporal nature of retirement behaviour, albeit within a comparatively simple framework.

Although this representation of individual behaviour can be derived from the standard dynamic model of labor supply in discrete time on the basis of some additional assumptions (for a formal statement of this model see e.g. Cahuc and Zylberberg (2004)), it is not equivalent to the discrete choice dynamic programming (DCDP) model as developed by Rust and Phelan (1997). While the latter approach has recently been applied to model retirement decisions (Karlstrom et al., 2004; Heyma, 2004), its behavioural assumptions are at odds with (experimental) evidence on individual decision making in the context of complex intertemporal retirement choices (see e.g. Duflo and Saez (2003) or Vonkova and van Soest (2009) and Mastrobuoni (2011)).

While behavioural responses to financial incentives thus remain an unresolved issue in the context of retirement decisions, several recent studies present quasi-experimental evidence on old-age labor supply. Ichino et al. (2007) use a difference-in-difference strategy to study employment prospects of older (relative to prime-age) workers based on the Austrian social security database (ASSD). They conclude that older displaced workers face reduced re-employment probabilities, however, employment probabilities catch up over a period of the next two years. Schnalzenberger and Winter-Ebmer (2009) exploit a recent change in employment legislation in Austria, finding

[1] Although part-time work might be relevant in certain contexts, gradual pathways into retirement are not modelled here since these seem to be of lesser importance for age cohorts in this observational period.

that a new layoff tax reduced the displacement probabilities of older workers relative to the age group just below 50. Staubli and Zweimueller (2011) use two other policy changes in Austria, i.e. a reform that increased early retirement ages for men and women, to investigate their impact on labor market participation of the affected cohorts. Although these policies are shown to reduce retirement probabilities by 19 and 25 percentage points for affected males and females respectively, significant spillover effects result in corresponding increases in unemployment rates. Manoli and Weber (2011) present nonparamteric evidence on labor supply behaviour of older workers based on the ASSD. Since severance payments in Austria (i) are mainly independent of retirement benefits and eligibility in the public scheme, and (ii) depend on tenure in a step-wise function, such employer-provided retirement benefits represent a mandated discontiuous increase in overall benefits. Based on these policy discontinuities they estimate elasticities of retirement entry with regard to implicit tax rates, arguing that the resulting labor supply estimates imply only a limited impact of financial incentives on retirement decisions.

Several recent studies adopted the option value framework to quantify the incentive effects of social security on old-age labor supply (e.g. Boersch-Supan (2000); Blundell et al. (2002) and Coile and Gruber (2007). In addition, (Gruber and Wise, 2004) collects empirical evidence based on this framework for a large number of countries, including Germany, France, Italy as well as the Netherlands, US and UK. This paper aims to contribute to this discussions, it is organized as follows. Section 2 introduces a range of incentive measures. Their implementation as well as relative strengths and weaknesses are discussed. In section 3 the procedures needed to calculate counterfactual employment paths are laid out. Specifically, the method used for the projection of wage income is discussed and incentive measures are defined conditional on expected eligibility for certain disability options. Section 4 presents the econometric model and discusses the results in terms of internal validity, while section 5 examines the implications on old-age labor supply on the basis of two simulated reform scenarios. Results are summarized in section 6.

2 Incentive Measures

Social Security Wealth

A key measure for the description of the incentive structure as faced by the individuals is the Social Security Wealth (SSW), laid out for example in Boersch-Supan et al. (2002) or Gruber and Wise (2002). SSW is the expected present discounted value of all future pension benefits minus all applicable social security contributions that will be levied on gross labor income in the future. In contrast to the option value (that will be discussed subsequently) it is a pure accounting identity, however, it will also serve as a basis for other incentive measures. Explicitly, SSW at planning age S, given retirement at age R, is defined as:

$$SSW_S(R) = \sum_{t=R}^{\infty} YRET_t^{NET}(R) \cdot \nu_t \cdot \delta^{t-S} - \sum_{t=S}^{R-1} INSC_t \cdot \delta^{t-s} \tag{1}$$

With $YRET_t^{NET}(R)$ being the net retirement benefit at age t for retirement at age R; $INSC_t$ the insurance contribution (levied on gross labor income) at age t; ν_t the probability to survive at least until age t given survival until age S (as computed on the basis of the survival tables[2] Statistik Austria (2012)); δ is the discount factor $1/(1 + r)$ with rate $r = 0.03$. Insurance contributions to the pension system are typically calculated as a simple rate (potentially depending on age), however, as will be discussed in section 3, application of the Austrian tax-benefit microsimulation model ITABENA allows for a much higher level of precision (**I**HS-**TA**x-**BE**nefit-model-for-**A**ustria, see Hofer et al. (2003) for a detailed documentation).

In general, the level of SSW and its trend over time are expected to have a significant impact on retirement decisions. Individuals with higher levels of SSW should be, all other things equal, associated with higher probabilities to retire. Since leisure is assumed to be a normal good, individuals are expected to demand more of it as their SSW increases. This wealth effect on retirement is documented e.g. in Coile and Gruber (2004) and Palme and Svensson (2004). On the contrary, an increase in SSW in the future is expected to reduce the retirement probability at planning age, an effect

[2] Although Kuhn et al. (2010) argue that early retirement increases mortality of blue-collar workers due to changes in health related behaviour, this is not accounted for in the present analysis.

which is often called the accrual effect. In order to be able to describe different features of the decision problem not only SSW is calculated, but also several other incentive measures. All of these will be calculated for all feasible combinations of planning age S and retirement age R within the period of interest (see section 3 for a detailed discussion).

One Year Accrual

Apart from the effect of the current wealth level on retirement, it is reasonable to believe that individuals also consider the expected future development of their SSW. If individual decision makers only considered changes from one year to the next, their retirement behaviour would be influenced by the one year accrual in SSW[3]. This incentive measure compares the SSW of immediate retirement with the SSW associated with retirement in the subsequent year. At planning age S given postponement of retirement from age R to $R+1$ it is defined as:

$$ACC_S(R) = SSW_S(R+1) - SSW_S(R) \tag{2}$$

Postponing retirement by one year has three effects: First, working an additional year means social security contributions have to be paid for one more year. Second, the individual foregoes one year of receiving retirement benefits, which consequently reduces the total years of benefit receipt[4]. Both effects reduce SSW and are therefore seen as incentives to retire immediately. Third, working an additional year increases the per year retirement benefit through additional years of contribution and, in some cases, a higher assessment base, thus representing a positive incentive for staying in the labor force. Therefore, a social security system that offers no substantial growth (or even decline) in the SSW due to a postponement of retirement from one year to the next, hence a low or negative one year accrual, will be associated with high individual probabilities of immediate retirement.

The relative change of the SSW for a one year postponement of retirement, which is the one year accrual divided by the level of social security

[3]Note that this definition is not equivalent to perfect myopia since the formulation of the SSW implies an infinite planning horizon.

[4]For this to be true one has to assume that one additional year in the labor force has no detrimental effect on life expectancy. While this assumption might not hold in special cases (e.g. in occupations with hard work), the effect is expected to be negligible.

wealth, defines the accrual rate:

$$ACCR_S(R) = \frac{SSW_S(R+1) - SSW_S(R)}{SSW_S(R)} \tag{3}$$

Although this incentive measure additionally accounts for the scale of the one year accrual relative to current SSW, its expected effect on retirement probabilities is analogue to that of the simple one year accrual.

Boersch-Supan et al. (2002) define another incentive measure which directly links the one year accrual to the amount of net labor income earned through an additional year of employment, $YLAB_{R+1}^{NET}$. Since a negative one year accrual can be seen as a tax on next years labor income (and a positive accrual as a subsidy), this incentive measure is called implicit tax rate. The implicit tax rate at planning age S if retirement is postponed from R to $R+1$ is defined[5] as:

$$TAXR_S(R) = -\frac{SSW_S(R+1) - SSW_S(R)}{YLAB_{R+1}^{NET}} \tag{4}$$

In an actuarially fair adjusting pension system[6] the one year accrual would be zero and, hence, the accrual rate and the implicit tax rate as well. Again, the effects on retirement probabilities of the current period are expected to be determined through the same three channels as for the one year accrual (although with an inversed sign).

Peak Value

Although it is often hypothesized that individuals are rather myoptic in terms of their planning horizon, it is natural in this context to allow for a more forward-looking retirement behavior. Limiting the scope of the planning horizon has an obvious weakness: the design of the social security system may lead to discontinuous changes in SSW over time. Even though increases in SSW due to a postponement of retirement from one year to the next might

[5]The minus on the right side of the equation is included to get a genuine tax rate in the usual meaning of the word. A positive $TAXR_S(R)$ therefore corresponds to a tax rate, while a negative $TAXR_S(R)$ can be seen as a subsidy.

[6]The term actuarially fair is used in different ways in the literature. While Gruber and Wise (2004) or Hofer and Koman (2006) refer to a pension system with a one year accrual equal to zero as actuarially fair, Queisser and Whitehouse (2006) call this characteristic actuarially neutral. However, the former use of the term is applied in this paper.

occasionally be very low, it could very well be the case that an increase in the employment career by two or three years (or even longer) pays off substantially. Not accounting for such longer term changes in SSW could lead to a wrong representation of retirement behaviour.

The peak value takes these issues into consideration. So as to construct this incentive measure SSW has to be calculated for every possible future retirement age or, at least, until a certain planning horizon has been reached. The peak value at planning age S for retirement at age R is then defined as the maximum value of all the future SSW (i.e. for all $T > R$ within the planning horizon) minus the SSW of retiring at age R:

$$PEAK_S(R) = \max_{T>R} [SSW_S(T)] - SSW_S(R) \tag{5}$$

A higher peak value is associated with higher future gains in SSW (measured in money terms) and is, therefore, expected to lower the probability of retirement at planning age S, all other things held equal.

Option Value

All of the above incentive measures are defined in money terms, thus only taking financial aspects of retirement into account. To allow for a utility based incentive measure that is able to capture the labor-leisure trade-off inherent in this decision, one has to turn to the option value framework (Stock and Wise, 1990). The option value is defined by the difference between the maximum attainable utility through postponing retirement to some later age and the utility derived through immediate retirement at planning age. The introduction of a utility framework thus allows not only for the consideration of retirement benefits, but also of the stream of net labor income until retirement as well as the utility gain associated with the increase in leisure time while retired.

To derive a definition of the option value from the life-cycle model some simplifying assumptions have to be made (cf. Cahuc and Zylberberg (2004) p.19-27 for a general definition of the intertemporal maximisation problem). First, it is assumed that the utility function of the individuals is temporally separable so that the utility gathered in each time period is described by an instantaneous utility function[7]. Second, instantaneous utility depends only

[7]Note that this representation of utility is restrictive only in the sense that it does

on after-tax income thus implying a direct link[8] between after-tax income and consumption: $u(Y_t) = Y_t^\gamma$ where γ measures the marginal utility of consumption. Third, it is assumed that the labor-leisure trade-off can be represented by the weighting parameter α, where $\alpha > 1$ implies a relative utility increase in retirement due to additional leisure time. Correspondingly, $1/\alpha$ can be interpreted as the marginal disutility of work.

The expected present discounted utility at age S if retirement occurs at age R can thus be formulated as follows:

$$V_S(R) = \sum_{t=S}^{R-1} u(YLAB_t^{NET}) \cdot \nu_t \cdot \delta^{t-S} + \alpha \cdot \sum_{t=R}^{\infty} u\left(YRET_t^{NET}(R)\right) \cdot \nu_t \cdot \delta^{t-S} \quad (6)$$

Where $YLAB_t^{NET}$ is after-tax labor income at age t, $YRET_t^{NET}(R)$ after-tax retirement benefits at age t given retirement at R; ν_t is, as before, the probability to survive at least until age t given survival until age S; δ is the discount rate. The utility parameters α and γ measure the relative utility increase from leisure and the marginal utility from consumption respectively.

The option value at planning age S of continuing work beyond retirement age R is denoted as follows:

$$OV_S(R) = \max_{T>R} [V_S(T)] - V_S(R) \quad (7)$$

Where T varies between planning age S and age 100. Given the utility parameters α and γ (see section 4 for a description of the econometric approach), the OV can thus be computed for every planning age S within the time period of interest.

Within this framework postponing retirement has three effects on utility: First, later retirement is associated with additional labor income, which increases utility for all those individuals who are still well integrated in the labor market. Second, it decreases the time spent in retirement and, consequently, the amount of retirement benefits received, thus decreasing utility. And, third, additional periods of contribution to social security lead to a higher per-year retirement benefit when retired, which again has a positive effect on utility. The latter two effects have additional weight due to the consideration of α, the relative utility of leisure. In general, current retirement

not allow for an influence of past on current decisions. However, one can argue that this assumption is appropriate in this case since retirement is defined as an absorbing state.

[8] Although consumption and saving dynamics are not modelled, the econometric specifications control for the stock of individual wealth, see section 4.

probabilities should depend negatively on the option value up to the point where no utility gains can be achieved through further employment. Once this point is reached, the option value turns negative and the individual is expected to retire with certainty.

3 Microsimulations

In order to implement the option value framework it is necessary to calculate individual net retirement benefits for each year in the planning period 2002-2014 contingent on the individually relevant retirement plans. Table 1 shows descriptive statistics by gender and retirement plan. In the basic datatset each individual is observed from the beginning of his or her employment career until retirement which takes place in any year within the window period 2002 to 2009. Although the data includes all relevant information necessary to compute gross retirement benefits in the year of actual retirement, further assumptions are needed to derive counterfactual retirement benefits and eligibility conditions.

These issues are apporached in the following way. First, annualised gross incomes are projected beyond the actual retirement year, e.g. for $t \geq R$, based on the individual income time series. Second, individual assessment bases are calculated based on contribution and substitution periods, including childcare. Third, gross retirement benefits as defined by the assessment base, retirement plan and insurance record are calculated and eligibility for all relevant retirement plans as implicated by the individual insurance record is defined. However, since in the Austrian context it is essential to account for different forms of disability pensions, probabilities to obtain disability status are estimated on individual level and used to define expected eligibility. Fourth, the Austrian income tax and social security legislation of the corresponding planning year is applied (as modelled in the tax-benefit microsimulation model ITABENA, Hofer et al. (2003)) in order to obtain net retirement benefits as well as net labor income.

Table 1: Descriptive Statistics

	women				men			
retirement plan	obs.	mean age	mean benefit	assessment base	obs.	mean age	mean benefit	assessment base
old age	56,007	60.1 (0.6)	741 (503)	1,221 (601)	8,748	65.1 (0.6)	1,503 (911)	2,164 (951)
disability	29,690	55.2 (2.5)	681 (349)	1,234 (521)	65,209	56.7 (2.7)	1,980 (658)	1,854 (618)
corridor	0	-	-	-	5,242	62.0 (0.0)	1,752 (537)	2,253 (698)
long insurance	75,709	56,3 (1,1)	1,350 (536)	1,830 (716)	74,200	60.7 (0.9)	1,996 (500)	2,649 (638)
total	161,406	57.4 (2.4)	1,015 (597)	1,509 (712)	153,399	59.2 (3.0)	1723 (679)	2,325 (744)

	contribution years	insurance years	child-rearing years	contribution years	insurance years	child-rearing years
old age	22.6 (8.0)	30.1 (7.2)	6.6 (3.8)	32.6 (12.3)	35.9 (11.4)	0.0 (0.3)
disability	22.9 (7.6)	31.4 (6.1)	6.9 (4.2)	33.5 (8.2)	37.8 (7.2)	0.0 (0.2)
corridor	-	-	-	37.8 (5.6)	44.8 (2.7)	0.0 (0.3)
long insurance	35.7 (4.6)	40.3 (1.6)	5.3 (3.6)	43.4 (3.2)	45.5 (1.8)	0.0 (0.1)
total	28.8 (9.2)	35.1 (7.1)	6.1 (3.9)	38.4 (8.2)	41.6 (6.9)	0.0 (0.2)

Sample of new pension accruals 2002-2009, samplesize: 314,805, standard deviations in parenthesis. Disability pensions include white-collar, blue-collar and the self employed. All monetary values inflated to base year 2009. Source: AMDB and VVP, IHS 2012

Income Projections

The definition of the incentive measures suggests that future labor income influences retirement behaviour in two major ways: First, it can alter the assessment base through affecting the average lifetime income (or the average income of e.g. the best 15 years). Second, receiving labor income, which is usually higher than retirement benefits, acts as an incentive to stay in the labor market in its own right. However, due to the highly fragmented retirement legislation in Austria the calculation of the incentive measures is based on a consistent planning horizon of 5 years. To predict future labor income in this time period it is assumed that income dynamics are rather minimal towards the end of the employment career. Individual average real growth rates are constructed on the basis of the annualised gross income of the previous 5 years and used to project the income trajectory 5 years into the future.

This approach corresponds to the empirical observation that Austrian labor markets are, in general, not among the most flexible compared to other European (or OECD) countries (Kiander and Viren, 2001; OECD, 2004). Research on specific aspects of old-age labor market outcomes confirms this result. Ichino et al. (2007) show that although displaced workers in the age group 45-55 face reduced re-employment probabilities compared to prime-age workers, their employment prospects catch up over a consecutive period of 2 years. However, displacement of older workers is hindered by employment protection legislation like, for instance, the layoff tax which has been shown to reduce displacement probabilities of older workers (Schnalzenberger and Winter-Ebmer, 2009). Winter-Ebmer et al. (2011) analyse the relationship between job quality and retirement for several European countries, arguing that job dissatisfaction induces early labor market exit, with job insecurity being a major predictor of early retirement. Although subsidisation of part-time employment of older workers yields modest increases in employment probabilities, Hofer et al. (2011) find that this policy has negative overall effects on labor supply, as most older workers simply substitute part-time for full-time work.

In order to account for the limited reemployment possibilities of elder unemployed, individuals that are without labor income for a period of 2 or more years up to their observed retirement date are considered to be basically out of the labor force[9]. For these individuals a postponement of retirement

[9]Note that other specifications have been applied in order to check the sensitivity of the

is associated only with an increase in insurance periods (due to the receipt of unemployment or social benefits), but not with any additional labor income. On the other hand, individuals who obtain labor income up to the year before their observed retirement date are assumed to continue their employment career thus being able to collect not only further insurance periods, but also additional labor income based on their individual real income growth rates. The results from the projection are depicted in table 2.

Table 2: Distribution of Real Growth Rates in Gross Income

	mean	std.dev.	skew	kurt	p25	**p50**	p75	**N**
women	**0.0046**	0.1036	-3.286	34.05	-0.0022	**0.0129**	0.0271	**128,929**
men	**-0.0015**	0.1071	-3.292	33.61	-0.0034	**0.0117**	0.0211	**136,099**

According to this definition approximately 11% of males and 20% of females are already out of the labor force when they retire. For the remainder of the individuals the table shows that real income growth is very close to zero for both genders. Although the median is in the same region for both (somewhat above 1%), the female average is only slightly above zero (0.46%) while the male[10] average is negative (-0.15%).

Retirement Benefits

Since the administrative dataset comprises the actual assessment base and actual gross pension benefits on individual level, calculation results (for the real retirement age) can be compared with the actual pension as calculated by the pension insurance office. Table 3 shows the ratio of simulated to actual assessment bases. Looking at the mean the simulated assessment base exceeds the actual one by 2 % for women and 1 % for men. The range of deviation is quite low, with 0.99 at the border of the first decile and 1.01 between ninth and tenth decile for women and 0.97 and 1.01 for men, respectively. Looking at the pension calculation as a whole (table 4) the medium deviation is +1 % for women and +2 % for men. Although both simulation outputs, assessment bases and pensions, are slightly higher than

results with regard to these assumptions. However, shortening the required unemployment spell to 1 year did not affect the results qualitatively. The same is true for a change in the averaging period to either 3 or 10 years.

[10]Since working hours are not observed decreases in income due to a reduction in labor supply can not be identified, thus potentially leading to a downward bias in real income growth for some of the individuals.

the actual values, these results confirm that these calculation procedures yield results that are very close to the actually observed values[11].

Table 3: Distribution of Simulated/Actual Assessment Base

	mean	sd	p10	p25	**p50**	p75	p90	N
women	**1.020**	0.356	0.994	1.000	**1.003**	1.003	1.011	**161,330**
men	**1.009**	0.412	0.965	0.987	**1.000**	1.002	1.014	**153,388**

Table 4: Distribution of Simulated/Actual Gross Retirement Benefits

	mean	sd	p10	p25	**p50**	p75	p90	N
women	**1.010**	0.461	0.927	0.980	**1.054**	1.125	1.164	**161,351**
men	**1.018**	0.499	0.944	1.001	**1.042**	1.122	1.140	**153,393**

Table 5: Probability of Obtaining Disability Pension at Pre-Retirement Ages

	mean	sd	**skew**	**kurt**	min	max	**N**
women: all ages	0.042	0.060	3.67	24.32	0.0001	0.9850	1,134,662
age 56	0.060	0.072	3.02	17.12	0.0007	0.9850	143,167
men: all ages	0.083	0.097	2.18	9.06	0.0000	0.9543	1,466,506
age 57	0.120	0.115	1.78	6.67	0.0000	0.9543	120,754

Eligibility Conditions

The interpretation of the individual decision problem underlying the option value framework basically views retirement as a dichotomous choice. This perspective entails specific assumptions with regard to the eligibility conditions for different retirement plans. On the one hand, gradual retreat from the labor market (e.g. through subsidised part-time employment scheme for the elderly) is not considered. On the other hand, the multiple pathways into retirement as defined by Austrian pension law have to be accounted for.

Six different retirement plans are accounted for (cf. 1). This includes old-age retirement (AP), pre-retirement due to long insurance records (VAPL),

[11]Reasons for the deviations might lie in missing information in the data, such as the exact date of birth or the number of children. The database might also lack the last update of some variables.

pre-retirement through the corridor option (KOP) as well as retirement due to disability (BU, EU and IP). While the former three retirement plans will be summarised as regular retirement schemes, the latter three are referred to as disability pensions. Old-age retirement (AP) as well as the two pre-retirement schemes (VAPL and KOP) are *regular* in the sense that there exists a set of deterministic rules that governs eligibility based on age, cohort, gender and individual insurance records. As long as only regular retirement plans are considered, it is therefore possible to compute incentive measures based on equations 1, 3, 5 and 7.

However, eligibility to any of the three disability pensions is not conditional on insurance records, but only on the individual health status. Accidents or diseases causing lifelong disability can, of course, occur without preannouncement and these retirement plans were initially created with the intention to insure the working population against such events. In Austria workers are thus eligible for disability pension if their ability to work is reduced by 50% due to any kind of accident or illness. In case of application physicians judge whether this requirement is met in a specific screening process, which necessarily involves a certain degree of subjective evaluation.

In addition to the subjectivity of such decisions, further complications arise from the fact that applications for disability pension are potentially endogenous. Boersch-Supan (2001) argues that employers as well as employees might make strategic use of the disability option. Employers, on the one hand, have an incentive to restructure the labor force at the charge of the social security system. Likewise, employees have an incentive to claim disability pension for their own personal benefit in a misuse of the pension system. As a result, it has to be expected that eligibility for disability pension is, at least to some extent, manipulated, as the incentives to do so are often quite high.

However, as each of the three disability options is associated with a different occupational group, it can be ruled out that any person is eligible for two (or more) of these retirement plans at the same time. As in the German context, it is expected that applications for any of these disability options will reflect strategic behaviour by employers as well as employees. The fact that almost 30% of the individuals in the data retire via one of the disability options underscores the relevance of this issue. As shown in table 1 the mean retirement ages associated with these retirement plans are between 54-56 for women and 56-57 for men. It is thus not implausible, at least in the Austrian context, to speak of these disability options as a form of (very) early retirement.

To approach this issue in a comprehensive way, the uncertain disability options are dealt with by interpreting the incentive measures as expected values. Therefore two complementary event-paths are defined and weighted by their respective probabilities. Taking the SSW from equation 1 as an example the expected social security wealth is defined as follows:

$$E[SSW_S(R)] = p \cdot SSW_S^{DIS}(R) + (1-p) \cdot SSW_S^{DIS}(\hat{R}) \tag{8}$$

As the superscript DIS denotes the SSW associated with being eligible for any of the three disability options, the expected SSW of retirement at age R (at planning age S) is a weighted sum of the SSW associated with retirement at age R or at a later age $\hat{R}$. Since $\hat{R}$ is defined as the earliest possible date at which the individual is eligible for any regular retirement plan, this formulation implies that an early exit from the labor force (even before pre-retirement age) is allowed for on voluntary basis. However, due to the probability weights associated with either of the two event-paths, the expected SSW will reflect (i) how likely it is that the application receives a positive evaluation and (ii) how long it might otherwise take to become eligible for any possible pre-retirement plan (in case the initial application was turned down).

This approach thus captures the two essential features of the Austrian system. On the one hand, individuals start retiring on the basis of the disability options already at a very early age and, on the other hand, applications can basically be repeated several times until early exit is finally granted[12]. Although it has been layed out only in case of the SSW, exactly the same approach is applied to all other incentive measures.

To preserve as much individual heterogeneity as possible, a binary probit model estimates the individual probabilities to apply for and obtain disability pension. Therefore, observed (successfull) applications are taken as dependend variable and linked to an age-cubicle, migrational background, year indicators, average lifetime income as well as cumulative daily information

[12]Note that due to the comparatively young retirement ages associated with the disability options, later switches towards regular retirement plans are not allowed for. This would be rather speculative, as specific assumptions would have to be taken with regard to the employment options of individuals who have already opted out of the labor market. The present approach, however, avoids this since disability pensions are rather insensitive with regard to further employment spells and the accumulation of further contribution periods due to the receipt of social benefits is allowed for.

Table 6: Disability

#	MALE ESTIMATES	coeff. estimate	std. error	t-stat	p-value
1	age	-8.9229960	2.8170100	-3.17	0.002
2	age^2	0.1757204	0.0508968	3.45	0.001
3	age^3	-0.0011420	0.0003059	-3.73	0.000
4	migration	0.1208689	0.0371022	3.26	0.001
5	avg. monthly income	-0.0000846	0.0000248	-3.41	0.001
6	sick leave	0.0015879	0.0001532	10.36	0.000
7	regular employment	0.0000979	0.0000311	3.15	0.002
8	self-employment	0.0002069	0.0000178	11.65	0.000
9	fragmented employment	0.0001773	0.0001056	1.68	0.093
10	unemployment	0.0002806	0.0000261	10.77	0.000
11	NACE A	0.0432546	0.0154226	2.80	0.005
12	NACE B	-0.0042950	0.0267653	-0.16	0.873
13	NACE C	0.0317609	0.0106440	2.98	0.003
14	NACE D	0.0176789	0.0140274	1.26	0.208
15	NACE E	0.0357124	0.0195022	1.83	0.067
16	NACE F	0.045759	0.0102780	4.45	0.000
17	NACE G	0.0241075	0.0107396	2.24	0.025
18	NACE H	0.0321721	0.0112446	2.86	0.004
19	NACE I	0.0451574	0.0112343	4.02	0.000
20	NACE J	0.0134792	0.0153328	0.88	0.379
21	NACE K	0.0137407	0.0123669	1.11	0.267
22	NACE L	0.0412128	0.0135569	3.04	0.002
23	NACE M	0.0186414	0.0128761	1.45	0.148
24	NACE N	0.0470014	0.0126390	3.72	0.000
25	NACE O	0.0216844	0.0110532	1.96	0.050
26	NACE P	0.0360243	0.0198986	1.81	0.070
27	NACE Q	0.0391706	0.0138466	2.83	0.005
28	NACE R	0.0454607	0.0155593	2.92	0.003
29	NACE S	0.0158934	0.0142941	1.11	0.266
30	NACE T	0.1537665	0.0661521	2.32	0.020
31	NACE U	0.0085322	0.0392446	0.22	0.828
32	YEAR 2002	-1.0211470	0.1378691	-7.41	0.000
33	YEAR 2003	-1.1390660	0.1352163	-8.42	0.000
34	YEAR 2004	-1.4999060	0.1436022	-10.44	0.000
35	YEAR 2005	-1.7224880	0.1341509	-12.84	0.000
36	YEAR 2006	-1.8357530	0.1336559	-13.73	0.000
37	YEAR 2007	-2.0029500	0.1367518	-14.65	0.000
38	YEAR 2008	-2.0487630	0.1347887	-15.20	0.000
39	YEAR 2009	-2.2701420	0.1364330	-16.64	0.000
40	Constant	148.2981000	51.8631800	2.86	0.004
Summary Statistics:			number of observations	13616	
			log-likelihood $\mathcal{L}\ (\widehat{\beta})$	-3127.9204	
			likelihood ratio index ρ^2	1290.19	
			likelihood ratio index ρ^2	0.1710	

on employment, industrial sector, unemployment and sick leave. Regressions are run for men and women separately and are depicted in tables 6 and 7.

The predicted individual probabilities to obtain disability pension at ages 50 to either 60 or 65 for females or males, respectively, are shown in table 3.

Table 7: Disability

#	FEMALE ESTIMATES	coeff. estimate	std. error	t-stat	p-value
1	age	-40.3380400	5.3817150	-7.50	0.000
2	age^2	0.7615687	0.1003164	7.59	0.000
3	age^3	-0.0047784	0.0006221	-7.68	0.000
4	migration	0.1802927	0.0458683	3.93	0.000
5	avg. monthly income	-0.0002371	0.0000617	-3.85	0.000
6	sick leave	0.0009780	0.0001613	6.06	0.000
7	regular employment	-0.0000702	0.0000407	-1.72	0.085
8	self-employment	0.0001089	0.0000138	7.89	0.000
9	fragmented employment	0.0000213	0.0000604	0.35	0.724
10	unemployment	0.0001217	0.0000323	3.77	0.000
11	NACE A	0.0274589	0.0285609	0.96	0.336
12	NACE B	(reference)			
13	NACE C	0.0412519	0.0150957	2.73	0.006
14	NACE D	(reference)			
15	NACE E	0.0933529	0.0619484	1.51	0.132
16	NACE F	0.0357456	0.0183218	1.95	0.051
17	NACE G	0.0238352	0.0151875	1.57	0.117
18	NACE H	0.0324083	0.0171512	1.89	0.059
19	NACE I	0.0437480	0.0144386	3.03	0.002
20	NACE J	-0.0774121	0.0930992	-0.83	0.406
21	NACE K	0.0210659	0.0175852	1.20	0.231
22	NACE L	0.0269948	0.0181060	1.49	0.136
23	NACE M	0.0135092	0.0183571	0.74	0.462
24	NACE N	0.0554348	0.0165710	3.35	0.001
25	NACE O	0.0357680	0.0151686	2.36	0.018
26	NACE P	0.0200142	0.0244480	0.82	0.413
27	NACE Q	0.0402572	0.0163325	2.46	0.014
28	NACE R	0.0210766	0.0254283	0.83	0.407
29	NACE S	0.0422131	0.0168633	2.50	0.012
30	NACE T	-0.1612355	0.1274692	-1.26	0.206
31	NACE U	(reference)			
32	YEAR 2002	-1.245375	0.1870122	-6.66	0.000
33	YEAR 2003	-1.541068	0.1830589	-8.42	0.000
34	YEAR 2004	-1.705531	0.1885476	-9.05	0.000
35	YEAR 2005	-1.984252	0.1831530	-10.83	0.000
36	YEAR 2006	-2.181083	0.1820537	-11.98	0.000
37	YEAR 2007	-2.188116	0.1847223	-11.85	0.000
38	YEAR 2008	-2.371205	0.1827918	-12.97	0.000
39	YEAR 2009	-2.458082	0.1841069	-13.35	0.000
40	Constant	709.991003	96.0413000	7.39	0.000
Summary Statistics:			number of observations	14408	
			log-likelihood $\mathcal{L}(\widehat{\beta})$	-1748.6792	
			likelihood ratio index ρ^2	0.1822	

The mean probability over all possible pre-retirement ages is around 4.6% for females and 8.3% for males. Although individual results range from zero to more than 95%, most probabilities are close to zero, resulting in a rightward skewed distribution. For both genders, the mean (per age group) is rising from age 50 until 56 and 57 for females and males respectively. At the latter age the probabilities reach their maximum, which is about 6% for females and 12% for males. For older age groups the individual probabilities are declining rapidly, reaching zero at regular retirement ages.

Empirical Patterns of the Incentive Structure

The procedures laid out in the previous sections enable the calculation of the incentive measures as discussed in section 2 for each planning year in the period 2002-2009. Specifically, one-year accruals, one-year accrual rates, tax rates, peak values and option values are computed. While the SSW measures an individuals current accounting balance versus the pension insurance office, the accruals consider changes in this balance from the planning year to the next. The two forward-looking variables, the peak and option values, are each calculated based on a 5-year planning horizon. Taken together, these variables therefore summarise the incentive structure of the Austrian pension system as faced by each individual in the data.

Table 8 summarises the distribution of the expected SSW by age and gender. For both genders eligibility effects are clearly visible. While for females a jump in SSW can be observed at age 55, a related increase is observed for men just before age 60. As has been laid out in subsection 3, SSW at pre-retirement ages is defined as an expected value with a 5-year planning horizon. Females of age 55 will thus just be able to take their future eligiblity, at the statutory retirement age of 60, into account. As a result, their expected SSW shows a strong increase at this age, a phenomenon that is more pronounced for individuals at the lower end of the distribution. Since some of the individuals will be eligible for pre-retirement (or have a high probability of receiving a disability option), their SSW will already be higher at younger ages thus placing them in higher percentiles. A similar picture evolves for males, though the latter are more likely to receive disability options therefore resulting in a smoother increase of expected SSW around age 60. However, a considerable amount of males is eligible for pre-retirement plans that typically start at age 60, thus leading to large increases in SSW already at age 55 for individuals in higher percentiles.

A further empirical result emerges from table 8. For both genders it is striking that the SSW is basically stagnant as soon as pre-retirement ages, at 55 for females and 60 for males, are reached. This result is even more relevant as it is clearly visible for all parts of the distribution, and emerges from observations on the individual level as well as from aggregate figures.

Although the incentive measures are very dispersed and strongly dependent on individual characteristics, it is thus fair to say that (based on an analysis of the SSW as well as the option value) the incentive structure discourages individuals from continuing to work beyond the earliest possible retirement date.

Table 8: Social Security Wealth by Age

	Women							Men						
Age	p10	p25	p50	p75	p90	mean	sd	p10	p25	p50	p75	p90	mean	sd
47	3,067	5,226	9,819	21,361	39,709	16,638	18,125	1,052	2,072	5,302	15,052	32,576	12,066	17,085
48	802	1,190	2,316	5,856	15,126	5,912	9,918	918	1,910	4,899	13,713	31,200	11,693	17,682
49	443	656	1,194	3,132	8,387	3,509	7,003	946	2,056	5,144	14,030	32,309	11,964	17,419
50	428	759	2,368	173,806	288,157	77,948	123,884	917	1,748	4,551	13,634	32,788	11,728	17,738
51	556	1,176	6,505	234,608	337,160	114,792	140,095	1,330	2,492	5,462	15,526	36,528	13,340	19,355
52	1,529	10,098	189,651	269,277	358,628	176,937	132,501	2,031	3,794	7,689	19,957	43,829	16,528	21,907
53	1,302	20,617	193,769	270,648	361,339	183,175	133,357	1,987	3,656	8,827	21,085	46,695	17,701	23,415
54	1,386	9,187	193,928	275,592	370,176	182,112	141,245	2,942	5,162	11,140	25,093	52,999	20,727	25,529
55	94,395	140,359	213,218	301,794	404,843	232,300	122,885	5,984	14,790	48,570	258,341	329,920	127,179	132,118
56	92,569	138,638	217,961	309,890	419,201	237,468	129,108	9,076	23,206	109,895	288,368	347,811	157,915	139,367
57	91,543	137,286	220,356	311,722	423,089	238,674	130,842	16,795	52,184	240,100	312,810	362,683	204,062	137,465
58	90,963	135,787	223,545	312,919	424,451	239,413	131,683	56,999	195,660	269,350	329,033	376,289	251,410	122,565
59	87,197	126,918	214,583	302,958	415,021	231,351	131,090	140,991	215,694	286,975	346,861	394,212	273,406	122,535
60	88,725	123,965	205,267	291,887	403,046	224,666	128,378	165,630	234,935	311,024	374,498	422,109	302,063	119,698
61	93,042	126,004	205,488	295,473	411,628	227,879	130,647	170,178	244,036	319,751	383,309	424,105	308,518	120,753
62	96,969	128,837	206,443	302,436	422,608	232,251	132,191	172,244	248,101	324,555	387,208	423,432	311,441	117,001
63	97,400	125,956	182,625	267,244	382,179	213,118	119,077	172,416	251,154	328,125	388,255	422,054	312,891	116,912
64	100,187	130,071	185,109	264,810	380,767	214,067	117,298	166,335	251,381	328,513	387,407	418,475	310,384	116,725
65	103,221	134,917	187,008	260,896	374,227	214,254	116,516	157,179	246,995	327,317	384,892	413,554	306,412	117,940
66	107,047	139,565	186,722	253,908	362,997	211,949	105,705	150,272	247,369	333,391	388,141	412,123	308,223	115,387
67	109,200	140,358	184,702	245,724	343,930	207,277	104,970	142,192	239,824	329,994	388,931	407,255	302,644	105,528
68								102,357	166,851	285,109	377,391	389,176	266,525	118,470
69								99,318	157,705	260,676	366,355	374,581	254,194	119,575
70								95,644	149,646	245,926	356,654	367,018	243,289	109,877
71								97,406	147,504	227,557	345,508	355,058	234,506	105,071
72								100,923	144,237	218,559	340,778	341,918	228,341	101,193
Total	26,090	116,478	199,848	289,861	395,235	211,291	136,169	9,011	71,807	261,676	346,516	397,504	227,775	153,756

4 Econometric Model

Data

Due to computational tractability the data is reduced in several ways. First, exit probabilities are to be estimated, so only observations from the beginning of the planning period, 2002, up to the actual retirement date, i.e. 2009 at the latest, are included. Second, corresponding to the definition of the forward-looking incentives, only observations up to 5 years prior to the actual retirement date are included. The resulting left-censored dataset thus contains between 1 and 6 observations per individual, depending on the actual retirement date. Third, 5,000 individuals are randomly drawn from the full dataset, thus resulting in an estimation sample of 14,301 person-years.

Specifications

In order to model retirement behaviour within the option value framework several cross-sectional probit models are estimated taking retirement in the planning year as dependent and SSW plus an additional incentive measure as the main independent variables. As discussed in section 1, the introduction of forward-looking variables like the option value in a cross-sectional model captures most of the intertemporal variation within a comparatively simple framework[13]. To capture the effects of aging on retirement age enters the model in two different ways, either linearly (LA) or through a full set of indicators (AD). In addition, seperate models are estimated for females and males, thus resulting in a total of 12 model specifications. The estimation results for the option value (OV) specifications are shown in tables 10 and 11, while the results from the accrual rate and peak value specifications (ACCRA, PEAK) are available on request.

While these specifications abstract from equilibrium effects on interest rate and discount factor[14] by assuming a constant $\delta = 0.97$, a grid search mechanism is implemented to find the optimal values for α and γ. Table 9 summarizes the favoured approach as well as the actual values used by the various country groups in Gruber and Wise (2002). The most general

[13]In order to better deal with unobserved heterogeneity among individuals several random-effects specifications have been estimated, however, none of these offered significant improvements over the original option value specification.

[14]Based on a corresponding discount rate of $r = 0.03$.

Table 9: Utility Parameters: Methods and Values

	BE	CA	DEN	FRA	GER	IT	JPN	NED	ESP	SWE	UK	US	**AUT**
α	1.36	1.36	1.36	1.12*	2.8*	1.25	1.36	1.36	1.25	(a)	1.36	1.36	**1.92***
γ	0.75	0.75	0.75	0.25*	1	1	0.75	0.75	1	0.75	0.75	0.75	**0.56***
δ	0.97	0.97	0.97	0.97	0.97	0.985	0.97	0.97	0.97	0.97	0.97	0.97	**0.97**

Note: Countries taking $\alpha = 1.36$ and $\gamma = 0.75$ are referring to the structural model developed by Stock and Wise (1990); * refers to values derived through a grid search; (a) The Swedish model differentiates α by gender, deriving 3.19 and 1.18 for males and females respectively (based on a grid searches). Source: All country groups refer to Gruber and Wise (2002)

approach to determine optimal values for α and γ would be to develop a full structural model that delivers estimates of the two utility parameters along with other parameters. This approach is described in more detail in the original contribution of Stock and Wise (1990). Though they succeed in determining structural utility parameters on the basis of the retirement behaviour of workers from one large firm, none of the authors in Gruber and Wise (2002) implement this approach on the basis of a more differentiated dataset.

In chosing the utility parameters for their models, the majority of the research teams thus simply refers to the results of Stock and Wise (1990), that is to say they assume $\alpha = 1.36$ and $\gamma = 0.75$. The results from the grid search, however, suggest that the likelihood of the econometric model increases as α increases and/or γ decreases. While the magnitude of the effect of the incentive measures increases along with the likelihood, the age-effect on retirement probabilities decreases until it eventually turns insignificant[15] (only for very low values of γ). To avoid this, a boundary solution, $\alpha = 1.92$ and $\gamma = 0.56$, is chosen such that the significance of all variables is preserved while the likelihood of the model is maximised.

Estimation Results

As shown in the estimation tables 10 and 11, the parameter estimates of the incentive measures have the expected sign and are highly significant through-

[15] The results from the grid search are available on request and they suggest that, although it keeps on increasing, the likelihood function does not reach a maximum within reasonably defined boundaries. In a first round the grid search includes values of $\alpha \in [1, 10]$ and $\gamma \in [0.25, 1]$ in order to check for an eventual maximum. However, based on the results from the first round, the grid has been narrowed to $\alpha \in [1.88, 2.07]$ and $\gamma \in [0.53, 0.57]$.

out the 12 specifications[16]. In general, the stock of social security wealth (SSW_S) increases, while additional incentive measures ($ACCRA_S$, $PEAK_S$ or OV_S) decrease the probability to retire at planning age S. Although the magnitude of the effects varies, this pattern is found in all specifications (including the grid search) thus pointing to a robust relationship between the incentive structure and retirement behaviour.

With regard to the control variables the estimation results are also as expected. All other things held constant, an additional year of age increases the probability to retire, where the age indicators show that men and women are most likely to retire at ages 65 and 60 respectively. Additional peaks in the age indicators are observed at 50, 60 and 62 for men and at 57 for women, however, year and industry indicators display no particular pattern. Migrational background as well as days in sick leave (per year) both have a positive effect on retirement at planning age.

However, as no educational information is included in the administrative dataset, averages of monthly income over the entire employment record are included to approximate educational attainments. As expected, a higher income potential corresponds to a lower probability of leaving the labor market. Regarding employment four different variables that are all measured on a days per year basis are included: regular employment, self-employment, fragmented employment and unemployment. While regular employment has a positive effect on retirement for males, the parameter turns insignificant in the female models, which fits well with the fact that a considerable part of the female entitlements in the observed age cohorts are due to childcare periods. Self-employment turns out to be insignificant in most specifications, however, time spent in fragmented employment or unemployment has a significantly negative effect on retirement probabilities.

Although these results are qualitatively the same for different values of the two utility parameters, α and γ, the quantitative effects of the respective incentive measure increase as α increases and/or γ decreases. In general, the incentive effects are stronger in the specifications with age indicators, where the option value models reach the highest log-likelihood values thus resulting in likelihood ratio indices ρ^2 of 0.46 and 0.34 for females and males, respectively.

[16]The results from the accrual rate and peak value specifications (ACCRA, PEAK) are available on request.

Table 10: Option Value Specification with Linear Age (OV-LA-MEN)

#	MALE ESTIMATES	coeff. estimate	std. error	t-stat	p-value
1	**social security wealth**	3.10e-06	3.42e-07	9.06	0.000
2	**option value**	-0.000788	0.0000441	-17.86	0.000
3	age	0.0490289	0.0088135	5.56	0.000
4	migration	0.1464948	0.0365513	4.01	0.000
5	sick leave	0.0006478	0.0001536	4.22	0.000
6	regular employment	0.0000237	0.0000173	1.37	0.171
7	self-employment	0.0000273	0.0000174	1.57	0.117
8	fragmented employment	-9.50e-06	0.0000850	-0.11	0.911
9	unemployment	-0.0000712	0.0000245	-2.91	0.004
10	avg. monthly income	-0.0004606	0.0000466	-9.89	0.000
11	NACE A	0.2309181	0.1848995	1.25	0.212
12	NACE B	-0.3338738	0.2823768	-1.18	0.237
13	NACE C	0.0820796	0.1001994	0.82	0.413
14	NACE D	-0.0739154	0.1474779	-0.50	0.616
15	NACE E	0.6126561	0.4596404	1.33	0.183
16	NACE F	0.3319055	0.1034424	3.21	0.001
17	NACE G	0.0238435	0.1001503	0.24	0.812
18	NACE H	-0.0386803	0.1137415	-0.34	0.734
19	NACE I	0.2267986	0.1405453	1.61	0.107
20	NACE J	-0.1725319	0.1603280	-1.08	0.282
21	NACE K	-0.1830038	0.1206741	-1.52	0.129
22	NACE L	-0.0016103	0.2115430	-0.01	0.994
23	NACE M	-0.0918498	0.1271987	-0.72	0.470
24	NACE N	0.1998773	0.1451288	1.38	0.168
25	NACE O	0.0751489	0.1120666	0.67	0..502
26	NACE P	-0.2915570	0.2974188	-0.98	0.327
27	NACE Q	-0.1512520	0.1752370	-0.86	0.388
28	NACE R	-0.1189379	0.2224540	-0.53	0.593
29	NACE S	-0.0695682	0.1760470	-0.40	0.693
30	NACE T	-0.2590911	0.5140223	-0.50	0.614
31	NACE U	(referrence)			
32	YEAR 2002	-1.0713500	0.0701397	-15.27	0.000
33	YEAR 2003	-1.0352270	0.0681197	-15.20	0.000
34	YEAR 2004	-1.3838770	0.0703666	-19.67	0.000
35	YEAR 2005	-1.0934620	0.0653927	-16.72	0.000
36	YEAR 2006	-0.8323986	0.0641612	-12.97	0.000
37	YEAR 2007	-0.9224212	0.0680696	-13.55	0.000
38	YEAR 2008	(referrence)			
39	YEAR 2009	(referrence)			
38	Constant	-2.5604260	0.5772210	-4.44	0.000
Summary Statistics:		number of observations		8867	
		log-likelihood $\mathcal{L}$ $(\widehat{\beta})$		-3632.4976	
		likelihood ratio index ρ^2		0.2580	

Discussion

Comparing parameter estimates across the different countries collected in Gruber and Wise (2004) suggests that the Austrian model compares quite favourably to the others. As incentives are significant and behave as expected

Table 11: Option Value Specification with Linear Age (OV-LA-WOMEN)

#	**FEMALE ESTIMATES**	coeff. estimate	std. error	t-stat	p-value
1	**social security wealth**	8.47e-06	3.92e-07	21.63	0.000
2	**option value**	-0.0003609	0.0000332	-10.86	0.000
3	age	0.1999934	0.0081175	24.64	0.000
4	migration	0.1543268	0.0333787	4.62	0.000
5	sick leave	0.0006876	0.0001425	4.83	0.000
6	regular employment	-2.86e-06	0.0000113	-0.25	0.801
7	self-employment	-1.46e-06	0.0000124	-0.12	0.906
8	fragmented employment	-0.0000848	0.0000390	-2.17	0.030
9	unemployment	-0.0000622	0.0000243	-2.56	0.010
10	avg. monthly income	-0.0014097	0.0000765	-18.44	0.000
11	NACE A	-0.071935	0.2168824	-0.33	0.740
12	NACE B	(reference)			
13	NACE C	-0.0721004	0.8871410	-0.81	0.416
14	NACE D	0.2461368	0.3155584	0.78	0.435
15	NACE E	-0.2019777	0.3638039	-0.56	0.579
16	NACE F	-0.1577642	0.1237474	-1.27	0.202
17	NACE G	-0.1950140	0.0836146	-2.33	0.020
18	NACE H	-0.1883729	0.1248225	-1.51	0.131
19	NACE I	-0.1010081	0.0969629	-1.04	0.298
20	NACE J	-0.0737845	0.1826955	-0.40	0.686
21	NACE K	-0.1327506	0.1203130	-1.10	0.270
22	NACE L	-0.2696328	0.1213721	-2.22	0.026
23	NACE M	-0.2294154	0.1140781	-2.01	0.044
24	NACE N	-0.0138500	0.1079309	-0.13	0.898
25	NACE O	-0.1510573	0.0907597	-1.66	0.096
26	NACE P	-0.1903601	0.1707463	-1.11	0.265
27	NACE Q	-0.2639135	0.1022324	-2.58	0.010
28	NACE R	0.3685364	0.3759394	0.98	0.327
29	NACE S	-0.0843404	0.1102427	-0.77	0.444
30	NACE T	0.1979234	0.1910086	1.04	0.300
31	NACE U	(reference)			
32	YEAR 2002	-0.8845741	0.0648686	-13.64	0.000
33	YEAR 2003	-0.7891009	0.0624716	-12.63	0.000
34	YEAR 2004	-1.3395620	0.0674459	-19.86	0.000
35	YEAR 2005	-1.1091810	0.0601959	-18.43	0.000
36	YEAR 2006	-0.9180255	0.0586510	-15.65	0.000
37	YEAR 2007	-0.9559141	0.0613606	-15.58	0.000
38	YEAR 2008	(reference)			
39	YEAR 2009	(reference)			
40	Constant	-11.1362100	0.4995615	-22.29	0.000
Summary Statistics:			number of observations	10405	
			log-likelihood $\mathcal{L}\ (\widehat{\beta})$	-3877.4475	
			likelihood ratio index ρ^2	0.3152	

throughout all specifications, the model offers robust evidence of the effect of the incentive structure on retirement behaviour in Austria.

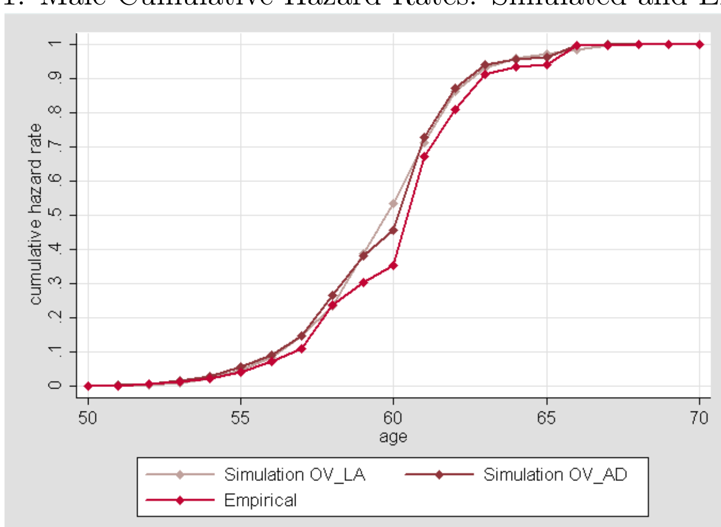
Since the effect of a given change in the pension system is determined by changes in the wealth level as well as in the forward-looking incentive measure, the quantitative relevance of the estimation results is best judged through simulations. While the latter will be discussed in depth in chapter 5, the following section evaluates the performance of the estimates with regard to several (internal) dimensions. First, expected retirement ages by retirement plan and gender are calculated on the basis of the option value model and compared these to the average retirement ages in the data. The results are summarised in table 12, where it has been distinguished between option value specifications with linear age (OV-LA) and age indicators (OV-AD).

Table 12: Retirement Ages: Simulated and Empirical

	males			**females**		
ret. plan	empirical	OV-LA	OV-AD	empirical	OV-LA	OV-AD
AP	65.08	64.03	63.86	60.08	59.31	59.45
VAPL	60.67	60.01	60.08	56.27	56.02	56.05
KOP	62	60.15	60.23	-	-	-
BU	56.70	56.96	56.85	54.33	54.81	54.66
EU	57.17	57.13	57.02	56.38	56.35	56.41
IP	56.58	56.75	56.61	54.86	55.26	55.16

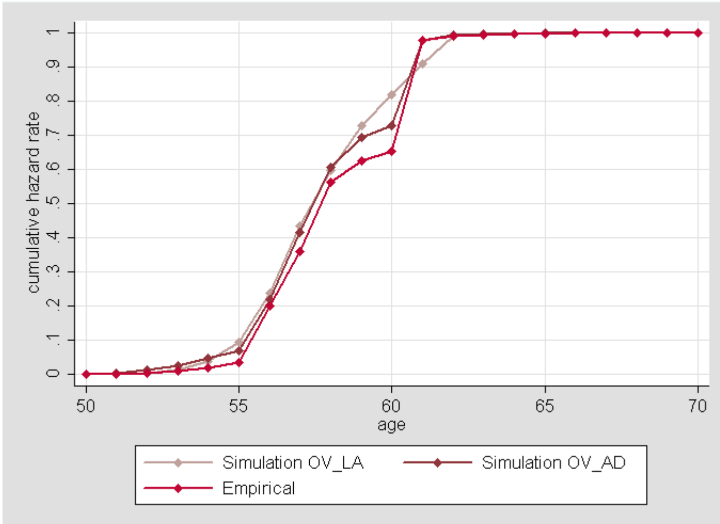
Note: OV-LA and OV-AD refer to the option value specification with linear age and age indicators, respectively.

Figure 1: Male Cumulative Hazard Rates: Simulated and Empirical



Notes: OV-LA and OV-AD refer to the option value specification with linear age and age indicators respectively. Empirical hazard rates are computed on the basis of the estimation subsample, see section 4.

Figure 2: Female Cumulative Hazard Rates: Simulated and Empirical



Notes: OV-LA and OV-AD refer to the option value specification with linear age and age indicators respectively. Empirical hazard rates are computed on the basis of the estimation subsample, see section 4.

The table shows that the simulations typically underestimate retirement ages for regular retirement plans (AP, VAPL, KOP) while slightly overestimating them for the disability options (BU, EU, IP). In case of the old-age retirement plan (AP) male estimates are about one year below the observed average, though female estimates are closer. Simulated retirement ages in the pre-retirement plan due to long insurance history (VAPL), which is by far the most common pathway to retirement (cf. table 1), are generally very close to the observed values. The characteristics of the other pre-retirement plan (KOP), however, are harder to account for, thereby resulting in comparatively large differences. Regarding the disability options, on the other hand, the model appears to capture observed behaviour quite well, as the results for all three options (BU, EU, IP) are very close to empirical averages.

In addition, empirical cumulative hazard rates are computed and plotted against the simulation results in figures 1 and 2. For both genders, it is apparent that the simulations fit the observed retirement data very well. Though the specifications with linear age are not capable of reproducing the observed kinks at 60 (for males and females) and 65 (males only), the inclusion of age indicators yields almost exactly the same structure.

A range of further empirical results emerge from these two figures. Both show that until the age of 55 only less than 10% of the individuals in the data have already left the labor market. Starting at that age, however, females begin to drop out very rapidly, so that female retirees account for around 35% at age 57 and 60% at ages 58 and 59. At statutory retirement age, 60, 65% of the female work force in the data is already retired. After a further shift into retirement at 60, almost none of the females remains employed. For males, the picture shifts somewhat to the right. Although 90% are still working at age 57, a considerable amount drops out in the next 3 years, resulting in 35% already being retired at age 60. As for the females, many leave the labor market at this age so that only 10% of the male labor force remains at ages 61-63. Only a fraction of these workers continues to be employed until the statutory retirement age, 65, is reached. After that age the amount of individuals who are still in the labor market is negligible.

5 Simulations

Scenario Definitions

This section presents a range of simulations that have been run on the basis of the estimation results (cf. section 4). The simulations serve two main purposes. First, the estimated parameters from the full set of specifications are applied so as to check external validity and make sure that no unexpected results arise. Second, having discussed signs and significance of the estimated parameters, simulations have to be considered in order to assess the full quantitative impact of a given change in the incentive structure on retirement behaviour.

To this end two standard reforms are implemented as laid out in Gruber and Wise (2004). The first reform evaluates the effect of an increase in the statutory retirement age by three years (3Y), while the second common reform scenario pronounces financial incentives through additional bonuses and deductions (CR).

For the simulations the full dataset is used, including every individual not only until observed retirement date, but until the end of the observational period in 2009[17]. The option value model is taken as basis for the simula-

[17]Note that individuals who are either below 50 at the beginning, or above 70 at the end of the observational period are excluded.

tions because, on the one hand, its representation of individual behaviour is more in line with economic theory and, on the other hand, due to its advantage in terms of explanatory power (cf. section 4). However, to abstract from idiosyncratic temporal effects simulations are based on the linear age specification (OV-LA).

The baseline scenario is defined such that it represents the Austrian pension system exactly as it has been faced by the individual decision makers in the corresponding year of the observational period 2002-2009[18]. To evaluate counterfactuals against this baseline each of the reform scenarios is implemented on the basis of exactly the same time period.

However, since amendments of the retirement legislation are typically implemented over a medium to long term horizon, a comprehensive prediction of future retirement behaviour would entail a careful representation of the implementation process, depending not only on the reform scenarios but also on expected changes in future regulations as formulated by current law. Although such predictions of future scenarios are perfectly feasible on the basis of this model, the simulations presented in this section serve to evaluate what would have been the case if reforms were enacted within the baseline period.

The first reform scenario postpones statutory retirement ages for all regular retirement plans by three years, while leaving disability options unchanged. Since the availability of the latter mainly depends on the individual health status, eligibility regulations for these retirement plans remain as described in 3. This, however, does not imply that the reform fails to affect the incentive structure at earlier ages. Since expected incentive measures, as defined in equation 8, depend also on future eligibility for regular retirement plans, changes in the statutory retirement ages will affect incentives also through this channel.

The second scenario aims at an unification of various retirement plans and a stronger pronounciation of the financial incentives delivered by the pension system. It is based on the common reform proposed by Gruber and Wise (2004), p.30-35, and includes (i) unique statutory retirement at 65 (for men and women), (ii) pre-retirement at 60 (both genders), (iii) retirement benefits at statutory retirement age comprise 60% of labor income at age 59 (with a minimum of 300 euros/month), (iv) benefits are reduced/increased

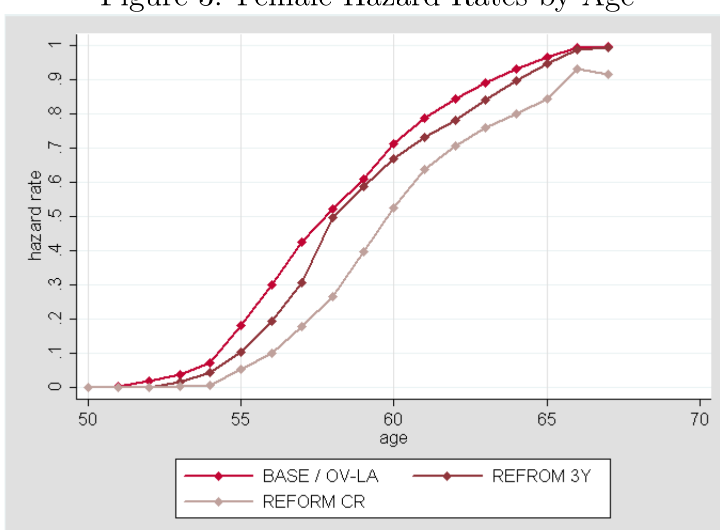
[18]Note that there existed considerable diversity with regard to retirement regulations within this time period.

by 6% p.a. for each year before/after age 65. Again, in this case disability options are modelled as before. However, as the pre-retirement character of the disability options is in conflict with the spirit of this reform scenario, it is necessary to make some further specifications: Although access to the disability options are kept open also in this scenario, the same deductions as for regular pre-retirement ages (i.e. 6% p.a. for each year prior to 65) are applied.

Discussion

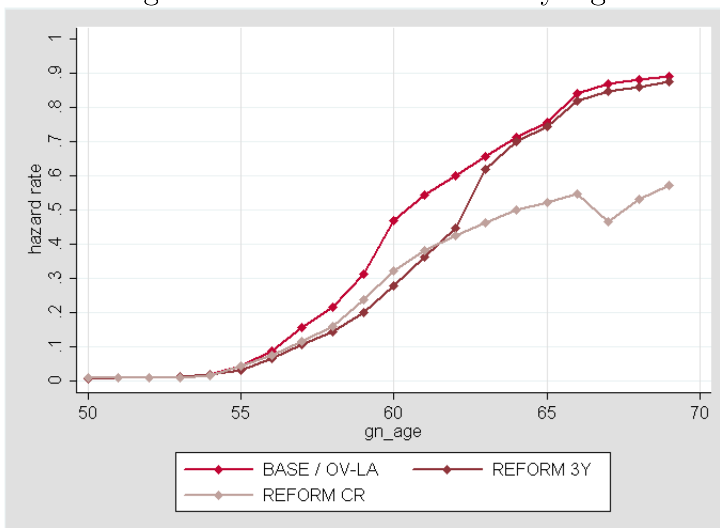
To discuss simulation results individual retirement probabilities are aggregated by age and gender and compared between base and reform scenarios. Specifically, mean hazard rates as well as cumulative hazards are computed for all age groups between 50 and 68 for females and 69 for males. In addition, expected retirement ages at the beginning of the observational period, i.e. in 2002, are computed and the proportion of individuals aged 56 to 65 that is out of the labor force (OLF) is examined.

Figure 3: Female Hazard Rates by Age



Notes: This figure shows mean individual hazard rates by age in three different scenarios. OV-LA refers to the option value specification with linear age; 3Y refers to the plus-three-years scenario and CR to the common reform as discussed in subsection 5.

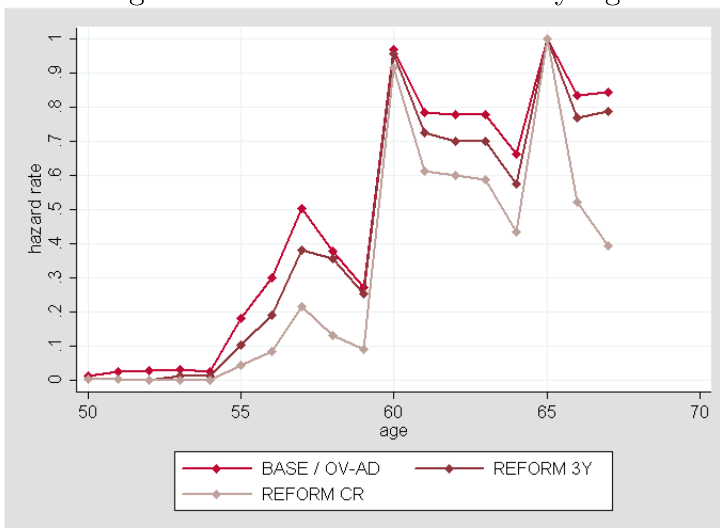
Figure 4: Male Hazard Rates by Age



Notes: This figure shows mean individual hazard rates by age in three different scenarios. OV-LA refers to the option value specification with linear age; 3Y refers to the plus-three-years scenario and CR to the common reform as discussed in subsection 5.

Figure 3 shows female hazard rates in the baseline simulation with linear age (OV-LA) as well as in the reform scenarios 3Y (+3 years) and CR (common reform). Figure 5 has corresponding results from the model with age indicators (OV-AD). While in the former model hazard rates are smoothly increasing with age, the latter allows for fixed age effects which contribute to the observed peaks at 57, 60 and 65. Though the peak at age 60 is due to eligibility age effects alone, the increase in mean hazards in the age group 55-57 is likely to be related to the increased probability of obtaining disability pension. The peak at 65, however, might either correspond to interrelations with male eligibility or else be due to some social norm about the accepted (female) retirement age. Both specifications show that the reform scenarios reduce the average exit probability, though in the female case the decrease in the hazard rates due to the common reform is stronger throughout all age groups. As discussed in Gruber and Wise (2004), this is due to the fact that the common reform represents a rather harsh regime as compared to the current Austrian regulations (especially for women). The main driving forces are: (i) the common reform introduces a unique statutory retirement age of 65 for both genders, which is higher than the female retirement age in

Figure 5: Female Hazard Rates by Age

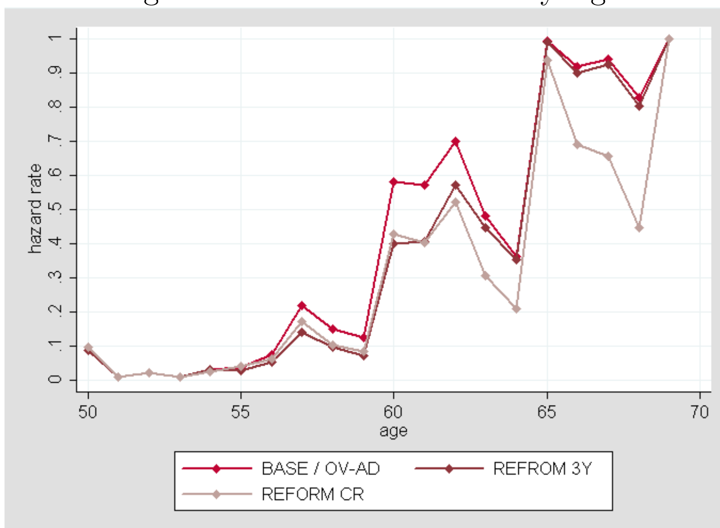


Notes: This figure shows mean individual hazard rates by age in three different scenarios. OV-LA refers to the option value specification with linear age; 3Y refers to the plus-three-years scenario and CR to the common reform as discussed in subsection 5.

the base (60) as well as in the 3Y scenario (63); (ii) pre-retirement begins at age 60, which is again higher than in the other two scenarios (55-60 in the base and 58-63 in the 3Y scenario); and (iii) access to disability options is allowed only under considerable deductions and without the imposition of a maximum loss.

The cumulative hazards in figure 7 confirm these results. While, in the baseline scenario about 18% of females are already out of the labor force at age 56, reform 3Y decreases this number to 10%, and the common reform reduces it even further, i.e. to 4%. Although the gap between the reform scenarios and the baseline increases with age for women in their 50s, it begins to narrow again at 60, so that (even in the common reform scenario) only very few females remain in the labor market after that age. Table 13 shows that these effects correspond to a reduction of the OLF proportion of females between 56 and 65 from 72.4% in the base to 67.7% and 60.6% in the 3Y and CR scenarios. Comparing these results to those in Gruber and Wise (2004) indicates that Austrian women in this age group have the second highest OLF proportion among all countries included in this volume. Although the abovementioned summary argues that Dutch workers display a similar OLF

Figure 6: Male Hazard Rates by Age

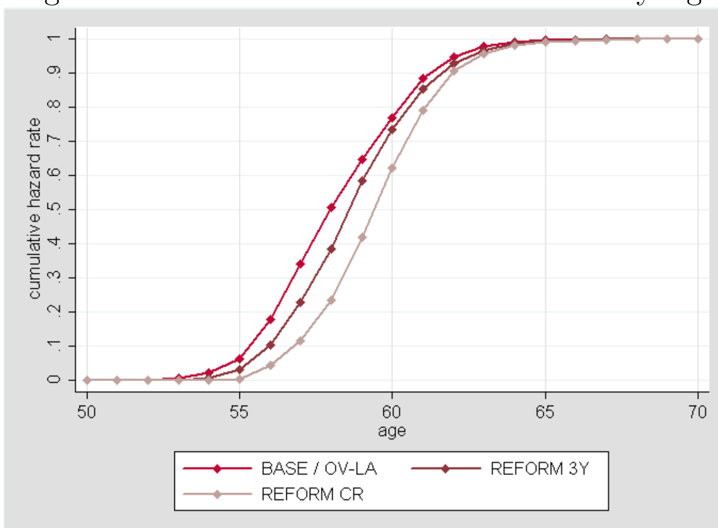


Notes: This figure shows mean individual hazard rates by age in three different scenarios. OV-LA refers to the option value specification with linear age; 3Y refers to the plus-three-years scenario and CR to the common reform as discussed in subsection 5.

proportion, it is shown that the common reform is likely to reduce it to less than 30%. However, the results imply that, although retirement behaviour of Austrian women is driven by incentives, the reduction due to an implementation of the common reform would be much lower (thus placing them closer to the Italian case).

Although both reform scenarios decrease the hazard rates considerably, the two reform scenarios have more distinguished effects in the male case, see 4 and 6 for the model with linear age and age indicators, respectively. Results from the model with age indicators shows similar, though somewhat less pronounced, peaks at ages 57, 62 and 65. While the first of these is again related to the disability options, the second peak relates to pre-retirement eligibility (either through VAPL or KOP retirement plans) and the third to old-age eligibility. Comparing the relative impact of the two reforms, however, indicates that the 3Y scenario implies lower hazard rates only for males between 55 and 61. This picture changes drastically as the hazard rates for males older than 61 show only a marginal decrease in the 3Y scenario relative to the base scenario. Since every retirement plan is adjusted by 3 years and the disability options are not subjected to increased deductions,

Figure 7: Female Cumulative Hazard Rates by Age

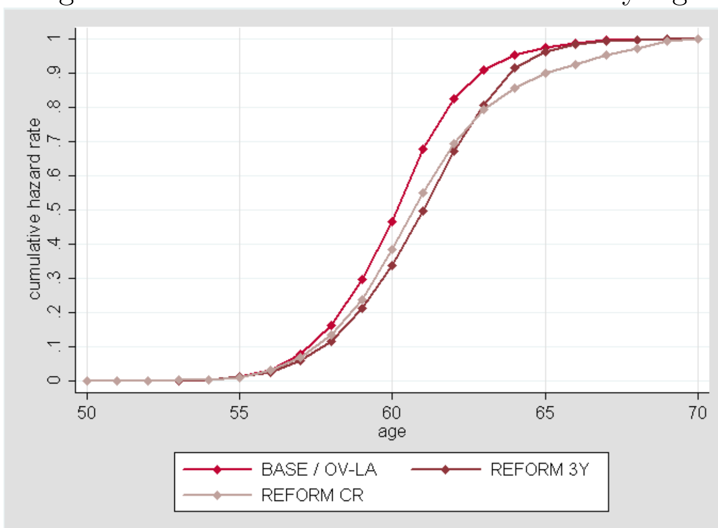


Notes: This figure shows mean cumulative hazard rates by age in three different scenarios. OV-LA refers to the option value specification with linear age; 3Y refers to the plus-three-years scenario and CR to the common reform as discussed in subsection 5.

the impact of the 3Y scenario peters out as soon as pre-retirement again becomes accessible starting at age 63. The common reform, on the other hand, has stronger effects for males in the age group 60-69. This result is in line with the fact that men, relative to women, show a much stronger response to incentive measures as indicated by the estimated parameters. Although the statutory retirement age is the same for men in the base scenario as compared to the common reform, the incentives introduced by the latter appear to yield strong impacts on male retirement behaviour well beyond pre-retirement ages.

These results are again reflected in the cumulative hazards in figure 8. In the baseline scenario 47% are out of the labor force at age 60, a number that is decreased to 38% and 34% in the common reform and 3Y scenarios respectively. While some positive difference between base and reform remains until age 65 in the 3Y scenario, the common reform scenario succeeds in extending male employment careers up until age 68. A comparison of these results with discussions in the previous paragraphs demonstrates large differences between Austrian men and women. On the one hand, males have a lower OLF proportion due to the current difference in statutory retirement ages, as

Figure 8: Male Cumulative Hazard Rates by Age



Notes: This figure shows mean cumulative hazard rates by age in three different scenarios. OV-LA refers to the option value specification with linear age; 3Y refers to the plus-three-years scenario and CR to the common reform as discussed in subsection 5.

depicted in table 13. On the other hand, they also show a stronger response to financial incentives, what gives rise to an increased scope for policy makers to influence male retirement behaviour. Although the common reform basically introduces the same incentive structure for both genders, it does therefore not fully succeed in bringing the female OLF proportion to about the same range as the male. As for international comparisons, Austrian men are in the middle ranges with regard to their OLF proportions. Although they are more responsive than their female counterparts, the impact of the reform scenarios is still not as high as for countries like Germany or the Netherlands.

Table 13: Out of labor Force Proportions

	BASE	3Y	CR
females	0.724	0.677	0.606
males	0.538	0.461	0.466

The same picture emerges from the consideration of expected retirement ages, see table 14. While the general performance of the simulations in terms of this number has been discussed in section 4, evaluation of the reform scenarios indicates that both have the potential to increase male expected retirement ages by approximately 0.8-0.9 years on average. For females the corresponding increase in the 3Y scenario would be around 0.5 years, while reaching 1.4 years in the common reform scenario.

Table 14: Expected Retirement Ages

	exp. retirement		**difference**	
	females	males	females	males
BASE	**57.6**	**59.7**	-	-
3Y: plus 3 years	58.1	60.4	+ 0.5	+ 0.8
CR: common reform	59.0	60.6	+ 1.4	+ 0.9

6 Conclusion

Although international comparison on the basis of the results in Gruber and Wise (2004) is hindered by the fact that current legislation differs substantially among countries, it is apparent from the results discussed in the previous section that the Austrian case is characterised by several features. Although the estimation results show a robust relationship between incentive measures and retirement behaviour, the overall quantitative impact appears to be somewhat lower than in other countries, especially when combined with the fact that actual retirement ages are among the lowest. This feature is highlighted through a comparison e.g. with the Danish case, where the common reform yields an increase of 1.4 years for women and men alike. Germany, which is typically assumed to share some similarities in the institutional setting with Austria, also reports a stronger impact related to both reform scenarios, thus ranging up to 2.3 years for both genders. Another characteristic feature, which is of course related to the low actual retirement ages, is the existence of several disability options. Although the presented approach captures this feature quite well, a more comprehensive approach might be warranted, especially with regard to the transition from these forms of early retirement to regular retirement. A third relevant aspect might be hidden in the fact that the Austrian retirement regulations are characterised by a considerable degree of diversity, especially for individuals retiring within the time frame of this observational period. Due to this complexity (as well as the uncertainty related to potential future reforms), it is not entirely clear to what extend Austrian individuals are in fact capable of forming rational expectations about their future entitlements. However, as this situation will give way to more transparent regulations in the near future, it is to be expected that the observed incentive effects are strengthened along with this development.

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