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EARLY RETIREMENT BEHAVIOUR IN THE NETHERLANDS: EVIDENCE FROM A POLICY REFORM

BY

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Summary

In the early 1990s the Dutch labour unions and employer organisations agreed to transform the generous and actuarially unfair early retirement (ER) schemes into less generous and actuarially fair schemes that reward individuals for postponing retirement. The starting dates of these new ER programs varied by industry sector. In this study, we exploit this variation in starting dates to estimate the causal impact of the policy reform on early retirement behaviour. We use a large administrative dataset, the Dutch Income Panel 1989–2000, to estimate hazard rate models for the retirement age. We conclude that the policy reform has indeed induced workers to postpone retirement. Both the wealth effect (lower ER wealth) and the substitution effect (lower implicit taxes on retirement postponement) are significant, the latter being more substantial.

Key words: early retirement, intertemporal choice, duration analysis

JEL Code(s): C41, D91, J26

1 INTRODUCTION

In this paper we estimate the change in labour force participation of individuals aged 55 to 64 following an unanticipated reform in Dutch early retirement schemes in the 1990s. Historically, the labour force participation rate of elderly in the Netherlands was low compared to other western countries: in 1990 the employment-to-population ratio for age 55 to 64 was only 29.7

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percent.[1] This rate increased to 46.6 % in 2004, but still remained below the OECD average (OECD 2005a). The relatively low participation rate before the age of 65 remains high on the policy agenda, as it is often advised to increase participation, and thus the tax base, in order to bear the financial burden of an expanding senior citizen population (see, e.g., OECD 2005b).

An important question is therefore to what extent the higher participation rate of the elderly was induced by the reform rather than the favourable economic circumstances at the end of the 1990s. Starting from the mid-1990s, several financial parameters of the early retirement schemes were affected by the reform. In this study, we are able to provide explicit estimates of labour force participation effects resulting from (i) a change in the opportunity to take up benefits at an earlier age, (ii) a change in the implicit tax rate, and (iii) a change in pension wealth. Empirical evidence on how financial incentives provided by the schemes often encourage early retirement is available for several countries, such as Germany (Börsch-Supan 2000), the United Kingdom (Blundell et al. 2004) and the Netherlands (De Vos and Kapteyn 2004).[2] The result for the Netherlands is further reiterated by Kerkhofs et al. (1999), using a different data set, the Dutch Retirement Survey (CERRA). However, on the basis of the same data, Heyma (2004) reaches a conflicting conclusion that the importance of monetary enticements is limited. In an overview article that is mostly based on US evidence, Lumsdaine and Mitchell (1999) conclude that the impact of financial incentives on early retirement is important, and that it can explain about half of the observed variation in retirement patterns in the US. Several earlier studies were able to exploit an unanticipated reform in order to estimate the financial incentive effects of (early) retirement schemes: Krueger and Pischke (1992) identify the impact of a change in Social Security wealth on the labour supply of older men in the US; Baker and Benjamin (1999) use the fact that a Canadian pension reform was introduced at different speeds in Quebec and the rest of Canada; and Røed and Haugen (2003) make use of the introduction of a new early retirement scheme among a "quasi-random" group of Norwegian workers.

Our paper contributes to this literature by examining the Dutch policy reform. In the early 1990s, both labour unions and employer organisations in the Netherlands recognised the adverse incentive effects of the prevailing early retirement programs, and jointly decided to gradually transform them into less generous and more actuarially fair schemes. Until then, the early retirement schemes were highly actuarially unfair, leading to high implicit tax

1 Dutch citizens are entitled to a state pension starting at the age of 65.

2 These references appear in a compilation of articles, edited by Gruber and Wise (2004) (follow-up of Gruber and Wise (1999)). The German study is based on the German Socio-Economic Panel, the UK study on the UK Retirement Survey, and the Dutch study on the Dutch Socio-Economic Panel.

rates on the labour income of older workers. The decision implied a series of changes in the early retirement schemes. The starting dates of the new early retirement programs varied by industry sector. In this study, we exploit this variation in starting dates to estimate to which extent financial incentives affect the (early) retirement decision.

The reforms affected the (early) retirement decision of individuals in total in three different ways. First, employees were allowed to take up early retirement benefits at a much younger age than before. Typically, the eligibility age was 60 or 61 in the old schemes, while it became 55 in the new schemes. An important aspect of the early retirement schemes is that workers only qualify for early retirement benefits if they have paid work right before the eligibility age. Thus, the initial early retirement schemes contained an incentive to continue working right until the higher eligibility ages. This incentive was removed in the new schemes. A second 'price effect' consisted of the introduction of actuarial adjustments of early retirement benefits. This implied a huge shift compared to the previous early retirement scheme, where after becoming eligible for early retirement the price of leisure was virtually zero. In other words, the high implicit tax rates on labour income were removed for an important part under the new schemes. Finally, the new schemes affected 'early retirement wealth', so that less financial resources were available for the purchase of leisure. This 'income effect' or 'wealth effect' potentially leads to a postponement of early retirement. In this study we disentangle the estimated behavioural effects into these three components.

The causal impact of the early retirement reform can be estimated by exploiting the variation in starting dates of the new early retirement programs. It is important to note that although the reform could be foreseen, it could not be evaded by the individual worker. Therefore so-called anticipation effects do not hamper our analysis. Every age-cohort faced a pre-determined retirement program and no worker had the possibility to retire with the old scheme prior to the introduction of the new regime in anticipation of lower early retirement benefits. Furthermore, it is also important to note that the timing of the introduction of the new schemes is exogenous with respect to worker preferences and with respect to the demand for labour. In particular, the reason for the accelerated introduction of the new early retirement program for civil servants was that the government had decided to cut back expenditures, and the new retirement regime offered an opportunity to do so. The early retirement arrangements for civil servants will be our main source of variation over time, and individuals in a selection of other sectors will principally serve as control groups.

The dataset we use, the Dutch Income Panel 1989–2000, is based on administrative records of the Dutch National Tax Office. Estimating hazard rate models for the duration until retirement we find that the policy reform induced workers to postpone early retirement. In particular, we find that (i) removing the incentive to wait for the early retirement eligibility age has not led to increased retirement at younger ages, (ii) introducing actuarial adjustments in early retirement schemes importantly increased labour supply by the elderly, and (iii) reducing early retirement wealth has generated a positive labour supply effect, although smaller in magnitude than the former effect.

The organisation of this paper is as follows. In Section 2 we describe the early retirement schemes in the Netherlands, and we explain how the reforms have affected workers' incentives. The data used in our analysis are discussed in Section 3. Section 4 discusses the empirical strategy, and in Section 5 the estimation results are presented. Finally, Section 6 concludes.

2 THE REFORM OF THE DUTCH EARLY RETIREMENT SCHEMES

The Dutch pension system consists of both old-age pension provisions and early retirement schemes. The statutory old-age pension age is 65. From that age on, Dutch inhabitants are entitled to a state pension. In addition, most employees are entitled to a supplementary occupational pension.[3] Before the age of 65 early retirement schemes apply. The precise retirement rules are determined by negotiations between unions and employer organisations at the sectoral level of industry and are administered by pension funds, special 'early retirement funds', or insurance companies. Together with the other terms of employment, these rules are laid down in collective labour agreements. This means that participation in the early retirement scheme is mandatory for employees (that is, paying the premiums; the (early) retirement decision is out of free will).

In the Netherlands, early retirement schemes were first introduced in the 1970s in the form of the so-called 'VUT schemes'.[4] These schemes operated as pay-as-you-go (PAYG) systems in which the working population pays for the retirement of early retirees. The arrangement was favourable for older workers, and eligibility conditions were relatively mild. In the 1990s concerns arose about the adverse incentive effects and the long run financial sustainability of these retirement schemes. A general agreement was reached between labour unions, employer organisations, and the government to reform the system. Initially, some small changes were made to the system, such as increasing the eligibility age or lowering the replacement rate. Thereafter, the PAYG-based VUT schemes were gradually replaced by capital funded 'prepension' (PP) schemes. These new early retirement programs introduced actuarial adjustments for different retirement ages, so as to create more neutral labour supply incentives. In addition to that, the individuals' early retirement

3 See Bovenberg and Meijdam (2001) for details on the Dutch old-age pension system.

4 In Dutch, the acronym 'VUT' stands for 'early retirement'.

wealth was typically lower in the new programs. In this section, we discuss the original early retirement schemes and their successors.

2.1 *Flat-Rate Early Retirement Schemes*

From the late 1970s on, early retirement schemes were agreed upon in many collective agreements and consequently put in place in many sectors of industry. A typical feature of these VUT schemes was that the replacement rate did not depend on retirement age. The eligibility age was decreased several times in most sectors and at the end of the 1980s it was age 60 or 61 for a majority of employees. The schemes were a shared responsibility of the social partners, and were facilitated by the government through a favourable tax treatment: pension premiums were deductible from the worker's gross salary, while early retirement benefits were being taxed as if they were a regular source of income. Due to the progressive tax system the tax advantage was considerable (see Kooiman et al. 2004).

The financial conditions of these flat-rate early retirement schemes were favourable for older workers: gross benefits equalled up to 80% of the last earned gross wage, and old-age pension entitlements continued to grow as if retirees kept on working. To qualify for early retirement through this scheme, a worker needed to reach the eligibility age and needed to be working in a sector or firm for at least 10 years. The benefits were not means tested. As these schemes did not contain any actuarial adjustments, there was clearly a great incentive to retire at exactly the eligibility age. This is well documented in, e.g., Lindeboom (1998) and Kapteyn and de Vos (1999). During the period that VUT schemes were being shaped, the employment-to-population ratio for men between the ages of 55 and 64 dropped from to 63.2 to 44.2% (1979–1990; based on OECD (1996)).

2.2 *Actuarially Adjusted Early Retirement Schemes*

In the 1990s labour unions, employer organisations and the government decided to transform the early retirement programs. The reforms initially comprised of small changes in the conditions of the flat-rate VUT schemes. The eligibility age was increased and the replacement rate was lowered in several sectors, including the government and the educational sector.

A couple of years later, a more fundamental reform was agreed upon: all existing VUT schemes would in the long run be replaced by 'pre-pension' (PP) schemes. These schemes differ from the VUT schemes in several ways. First of all, the PP schemes would be capital funded, unlike the VUT which was a PAYG system.[5] In fact, PP schemes are collective (mandatory) savings arrangements in which workers save for their own early retirement. From the viewpoint of the individual older worker, the source of funding of his early retirement benefits is however hardly relevant, as he is mainly interested in the financial consequences of the personal choices he is able to make.

A more important difference is that the early retirement wealth was often lower in the new scheme. In a sample of 105 collective labour agreements, the Labour Inspectorate (2004) finds for a majority of cases that the gross replacement rate at a given retirement age was decreased by at least 10%-points. Moreover, the old age pension rights no longer continued to increase during early retirement, as was the case under the VUT schemes.

A second important difference is that the price of leisure was altered in two different ways. In the first place, the introduction of actuarial adjustments into the PP schemes implied an important price effect. Most PP schemes would be actuarially fair, so that the price of leisure would rise substantially after the original eligibility age (see Euwals et al. (2005) for a formal characterization). However, in the PP scheme it is allowed to take up early retirement benefits from the age of 55 on, which may have induced employees to retire earlier than under a VUT scheme. The reason is that only individuals with paid work would qualify for early retirement benefits under the VUT scheme, implying an incentive to continue working until the eligibility age.

A last difference concerned the eligibility criteria. Since the PP schemes were individual savings arrangements, an employee would be eligible to receiving the maximum benefit only if he had contributed to a PP scheme for 35 or 40 years, depending on the exact regulations of the early retirement scheme. If the employee has a shorter employment history, then early retirement benefits are lower *pro rata*. This feature of the PP schemes implies that immediate introduction was not possible. Therefore, long-lasting transitional arrangements were introduced.

2.3 *Transitional Arrangements*

Transitional arrangements were introduced in order to smooth the transition from the flat-rate VUT schemes to actuarially adjusted schemes. In practice, however, it turned out that most older workers continued to face early retirement arrangements that were close to the old schemes. An exception was ABP, the pension fund of civil servants and individuals working in the education sector. This pension fund started reforming its early retirement schemes relatively early, and introduced some actuarial adjustments into its schemes

5 The reform did not affect the funding of the normal retirement schemes (after age 65). The state pension and the occupational pension continued to be financed by PAYG and capital funding respectively.

from 1997 on. The accelerated introduction of the transitional scheme was a consequence of the government's retrenchment policy at the time.

Table 1 shows the early retirement schemes for eight selected industry sectors for the period 1989–2000. For each sector of industry the replacement rate is shown for each possible retirement date and age. These replacement rates determine the level of the benefits that an employee receives from the moment of early retirement until age 65. For example, an individual born in 1944 and working in the health care sector would receive a replacement rate of 75% given retirement at age 60, while an individual in the 1939 cohort would receive 80% at this same age. Note that in some instances, employees may be subject to a combination of different transitional schemes. Consider for instance a civil servant employed by the national government who was born in January 1932. For this individual, retirement at age 61 (i.e. in 1993) implies a replacement rate of 80%, while early retirement at later ages implies a replacement rate of 75% (see the second and third row of the concerning early retirement scheme in Table 1). In the next subsection we will provide a detailed example of an individual worker being subject to different regimes.

In four sectors (post/telecom, agriculture, catering industry, and cleaning industry), the early retirement replacement rates have not changed during the period 1989–2000. The pension funds in these sectors decided to wait with the introduction of actuarial adjustments until after 2000. Some small changes took place in the level of the replacement rates in the health care sector, but the scheme was highly actuarially unfair during the entire time period considered in this paper. The three remaining sectors (national and local government and the education sector) all have their early retirement schemes administered by the pension fund ABP. The workers in these sectors initially also faced a flat-rate VUT scheme, but starting from April 1997, ABP introduced actuarial adjustments in its schemes, so that a worker who postpones retirement is rewarded with higher benefits.

The actuarial adjustments in the early retirement schemes may affect the retirement decision of individual workers. For example, before 1995 civil servants of the local government had a large incentive to retire at age 59. This provided them with a pension benefit equal to 80% of their last earned wage for the next six years (up to age 65). Postponing retirement did not increase the level of the benefits: retiring one year later still resulted in a replacement rate of 80%, but now for five years rather than six. After April 1997, the incentive to retire at age 59 did not exist anymore. Retiring at age 59 resulted in a benefit of 45 or 48% (depending on the year of birth) and postponing retirement until age 60 increased the replacement rate to 55 or 59%. Given an interest rate of 4% and taking into account the mortality rate of 59-year old individuals, the expected discounted values of the two income streams are the same. Note that the early retirement schemes of ABP after 1997 only

TABLE 1 – EARLY RETIREMENT REPLACEMENT RATES FOR 8 SELECTED SECTORS, 1989–2000[a]

Date of retirement	Date of birth	Retirement age									
		55 (%)	56 (%)	57 (%)	58 (%)	59 (%)	60 (%)	61 (%)	62 (%)	63 (%)	64 (%)
National government, education (ABP)											
< April 1, 1992		0	0	0	0	0	80	80	80	80	80
April 1992–April 1993		0	0	0	0	0	0	80	80	80	80
May 1993–March 1997		0	0	0	0	0	0	75	75	75	75
≥ April 1, 1997	< April 1, 1942	27	30	35	40	48	59	75	75	75	75
	≥ April 1, 1942	25	28	32	38	45	55	70	70	70	70
Local government (ABP)											
< June 1, 1993		0	0	0	0	80	80	80	80	80	80
June 1993–Dec. 1994		0	0	0	0	75	75	75	75	75	75
Jan. 1995–March 1997		0	0	0	0	0	75	75	75	75	75
≥ April 1, 1997	< April 1, 1942	27	30	35	40	48	59	75	75	75	75
	≥ April, 1 1942	25	28	32	38	45	55	70	70	70	70
Health care (PGGM)											
< January 1, 1999		0	0	0	0	0	80	80	80	80	80
≥ January 1, 1999	in 1939	–	–	–	–	40	80	80	80	80	80
	in 1940	–	–	–	40	40	79	79	79	79	79
	in 1941	–	–	0	39	39	78	78	78	78	78
	in 1942	–	0	0	39	39	77	77	77	77	77
	in 1943	0	0	0	38	38	76	76	76	76	76
	in 1944	0	0	0	38	38	75	75	75	75	75
Post/telecom (TPG/KPN)											
Full period		0	0	0	0	0	0	80	80	80	80
Agriculture (BPL)											
Full period[b]		0	0	0	0	80	80	80	80	80	80
Catering industry (PHC)											
Full period		0	0	0	80	80	80	80	80	80	80
Cleaning industry (BPSG)											
Full period[b]		0	0	0	0	0	80	80	80	80	80

[a] We select industry sectors for which (i) workers can be identified on the basis of their industrial sector code (SBI) in the dataset that we will use, and (ii) for which we are able to construct the early retirement replacement rates. Arrangements for workers born after 1945 are not reported, as these are irrelevant for our analysis. Replacement rates are constant over time from the moment of early retirement until age 65. Names of pension funds are reported between parentheses. Note that only seven early retirement schemes are presented, as the national government and education sectors share the same scheme.

[b] Although not reported in this table, both the Agriculture and Cleaning industries changed their early retirement schemes between 1989 and 2000. However, these changes did not affect any person in the dataset that we will use, and are therefore omitted.

contain actuarial adjustments until the age of 61.[6] For higher ages the scheme was similar to a flat-rate scheme again. Thus, during the period 1989–2000 postponement of retirement until the statutory old-age pension age of 65 was always discouraged in all included sectors.

After age 65, workers do not receive an early retirement benefit anymore, but social security (state pension called 'AOW' in Dutch) and an old-age pension benefit. Pension funds take the social security benefits into account in the calculation of the supplementary old-age pension benefits by the use of a threshold, the so-called 'franchise'. Individuals only build up old-age pension rights over the part of the wage that exceeds this threshold (see Table 2 for more information). In order to receive a full old-age pension, a worker has to contribute to a pension fund for 35 or 40 years. Under the flat-rate VUT schemes, early retirees would continue to build old-age pension rights. Under the new PP schemes this is no longer the case, implying that not every early retiree will be able to build up a complete old-age pension. Table 2 reports old-age pension replacement rates for a worker that would receive a complete old-age pension in case he works until age 65. The old-age pension replacement rates are relevant for constructing the financial incentive measures that we will use in the empirical analysis. Note that old-age pension replacement rates can both be higher or lower than the early retirement replacement rates, implying that retirees may experience an income change at age 65. For instance, a civil servant employed by the national government before April 1992 receives 80% of his last income in early retirement from age 60, and 70% after the age of 65. Furthermore, note that the low replacement rates for the catering and cleaning industries do not necessarily imply lower pension benefits as the franchise equals zero (i.e. the pension funds in this sector do not take the state pension into account, while they do in the other sectors). As the tables show, civil servants and some workers of the health care sector face different incentives at different moments in time. In the empirical analysis we take this in to account by modelling the hazard rate of exiting into retirement as a function of the incentives at the individual's age. More details are given in Section 4.

3 DATA

The data for this study are drawn from the Dutch Income Panel (*Inkomens Panel Onderzoek*, IPO) 1989–2000, which is a one percent sample of income histories of registered citizens of the Netherlands with at least one registration during the 12-year period. Our selected sub-sample consists of observations on 2,937 individuals who are employed at their 55th birthday in one of eight

6 This changed in 2003 (not shown in the table). In that year the pension fund ABP finished the transition by introducing a scheme that was actuarially fair at all possible retirement ages.

TABLE 2 – OLD-AGE PENSION REPLACEMENT RATES FOR 8 SELECTED SECTORS, 1989–2000[a]

Date of retirement	Franchise[b]	Retirement age										
		55 (%)	56 (%)	57 (%)	58 (%)	59 (%)	60 (%)	61 (%)	62 (%)	63 (%)	64 (%)	65 (%)
National government, education (ABP)												
<April 1, 1992	15 250[c]	53	54	56	58	60	70	70	70	70	70	70
April 1992–March 1997	15 250[c]	53	54	56	58	60	61	70	70	70	70	70
≥April 1, 1997	15 250[c]	53	54	56	58	60	61	63	65	67	68	70
Local government (ABP)												
<January 1, 1995	15 250[c]	53	54	56	58	70	70	70	70	70	70	70
January 1995–March 1997	15 250[c]	53	54	56	58	60	70	70	70	70	70	70
≥April 1, 1997	15 250[c]	53	54	56	58	60	61	63	65	67	68	70
Health care (PGGM)												
Full period	13 580[d]	53	54	56	58	60	70	70	70	70	70	70
Post/telecom (TPG/KPN)												
Full period	15 881[e]	53	54	56	58	60	61	70	70	70	70	70
Agriculture (BPL)												
Full period	13 739[e]	53	54	56	58	70	70	70	70	70	70	70
Catering industry (PHC)												
Full period	0[e]	14	15	15	19	19	19	19	19	19	19	19
Cleaning industry (BPSG)												
Full period	0[e]	9	9	10	10	10	12	12	12	12	12	12

[a] See note a in Table 1.

[b] The franchise serves as a threshold in the calculation of the supplementary occupational pension benefits. Individuals only build up old-age pension if their wage exceeds the franchise. In this way pension funds take into account the state pension that individuals receive.

[c] In 2004.

[d] In 2003.

[e] In 2002. A zero franchise together with a replacement rate of 19% implies that an individual receives 19% of his last earned wage income plus a state pension. With a nonzero franchise, the individual only receives an 'additional' pension benefit if his (past) wage income exceeds a certain threshold level. 'Additional' here means 'supplementary to the state pension'. Thus, the first case in general leads to higher pension benefits for lower incomes.

selected sectors of industry, and not living on welfare, unemployment insurance or disability insurance at this initial age. We observe these individuals from their 55th birthday on.

The IPO dataset is drawn from registers made available by the Dutch National Tax Office and is administered by Statistics Netherlands (CBS). In total, the dataset contains about 75 thousand individuals per year. The dataset contains individuals that are included in the Dutch municipal registers. Attrition occurs only because of migration or death, or because of moving to an institution (like a nursing home or a prison). New individuals are added to the sample every year to compensate for the loss in numbers of observations because of attrition.

The IPO dataset is particularly suitable for studying early retirement behaviour. For every individual, we observe the level and the source of income at each moment in time. This allows us to measure the date of retirement very precisely, since at that moment the source of income changes from labour to a retirement fund. Besides its accuracy, a second important advantage of the dataset is the long time period over which we observe individuals. Furthermore, the dataset contains industry sector codes (SBI74, SBI93), which allows us to merge the individual data with information from collective labour agreements, including information on institutional early retirement ages and gross replacement rates. The dataset has some disadvantages as well, as the Dutch official registers lack information on education, health and pension wealth.

As the information on pension and early retirement arrangements is crucial for our study, we need to select sectors of industry that match to one and only one collective agreement on the four-digit level code for the industry sector. Each of these sectors has a pension fund which carries out the pension and early retirement regulations. The industry sectors and their respective pension funds that we selected for this study were shown in Table 1. Note that the selected pension funds cover about 40% of all employees in the Netherlands aged between 25 and 65. The resulting dataset contains 2,937 individuals, of which 1,232 are employed in the government sector, 741 in the education sector, 445 in the health care sector, 224 in the post/telecom sector and 295 in one of the other sectors. Unfortunately, we cannot use the exact classification of Tables 1 and 2 as the industry sector codes do not allow us to differentiate between national and local government. In the empirical analysis we will therefore assume that a civil servant works at the national government with a given probability (see Section 5).

Men are overrepresented in our sample of individuals who are employed at age 55; only 22% of the sample consists of women (Table 3). The low share of women is in line with the low employment rate of Dutch women in this cohort; later cohorts of women have substantially higher employment rates. The health care pension fund (PGGM) has by far the largest proportion of women. Only few individuals are single at age 55, while the individuals have on average 0.17 children under the age of 18.

As can be read from the table, the individuals in our sample have relatively high incomes and are relatively wealthy: about 71% earns more than the Dutch median income. This is in line with the prevailing system of seniority wages. In particular, employees in the government, education and post/telecom

TABLE 3 – SAMPLE STATISTICS OF WORKERS IN 7 SELECTED INDUSTRY SECTORS AT AGE 55, 1989–2000

	Government	Education	Health care	Post/ telecom	Agriculture	Catering	Cleaning	Total
Observations	1,232	741	445	224	172	71	52	2,937
Individual characteristics								
Female	0.13	0.26	0.50	0.12	0.10	0.24	0.31	0.22
Single	0.09	0.09	0.14	.04	0.07	0.10	0.12	0.09
Children (≤18y)	0.12	0.23	0.16	0.16	0.31	0.25	0.31	0.17
Financial characteristics								
Gross wage (× €1,000)	42.00	48.37	36.87	34.51	34.90	37.95	28.30	41.50
High income[a]	0.75	0.81	0.54	0.79	0.53	0.58	0.42	0.71
House value[b]	1.65	2.00	2.02	2.05	1.75	1.14	0.89	1.76
Mortgage[b]	1.06	1.28	0.94	0.97	0.58	0.68	0.27	1.02

[a] Dummy which equals 1 if income is higher than the Dutch median income.

[b] Relative to yearly income.

Source: Dutch Income Panel (Statistics Netherlands), 1989–2000, own calculations.

sectors have relatively high incomes. Despite the relatively small number of employees in the health care sector with a high income, the housing value and mortgage debt is relatively high. This may be due to the rather heterogeneous group of participants with nursing personnel on the one hand and medical personnel on the other hand.

For a proper measurement of the effect of the reform it is important to have a sufficient number of observations under the different early retirement schemes. Of the 1,232 observations in the government sector, 356 individuals retired before April 1997 (Table 4). Hence, these individuals were only subject to the old scheme. On the other hand, 312 employees in this sector reached the age of 55 after April 1997, implying that they only faced the new scheme. The remaining 564 observations have been subject to both schemes. They became 55 before April 1997, but only retired after that date. The ones who were aged between 55 and 61 suddenly became eligible for a benefit as a result of the reform. A comparable categorisation of the observations holds for the 741 observations in the education sector. Of the 445 observations in the health care sector, 298 observations became eligible for a benefit according to the transitional scheme on January 1, 1999. Note, however, that this scheme is highly actuarially unfair (see Table 1). A descriptive analysis on the basis of aggregated data is not straightforward, because the regulation of the different early retirement schemes changed at different points in time during our observational period. Hence, we turn to the empirical analysis.

TABLE 4 – NUMBER OF OBSERVATIONS PER REGIME, WORKERS IN 7 SELECTED INDUSTRY SECTORS, 1989–2000

Industry sector	Start of transition	VUT[a]	Both[b]	Transition[c]	Total
Government (ABP)	April 1997	356	564	312	1,232
Education (ABP)	April 1997	116	412	213	741
Health care (PGGM)[d]	January 1999	147	298	0	445
Post/telecom (TPG/KPN)	–	224			224
Agriculture (BPL)	–	172			172
Catering industry (PHC)	–	71			71
Cleaning industry (BPSG)	–	52			52
Total		1,138	976	525	2,937

[a] Generous flat-rate early retirement scheme (see Section 2.1).
[b] Individuals may first face a VUT scheme, but then from a certain day onwards a transitional arrangement.
[c] Transitional arrangement to less generous and actuarially fair early retirement scheme (see Section 2.3).
[d] Note that the transitional arrangement of the health care sector is highly actuarially unfair (Table 1).
Source Dutch Income Panel (Statistics Netherlands), 1989–2000, own calculations.

4 EMPIRICAL STRATEGY

4.1 *Incentive Measures*

Before specifying our empirical model, we first discuss some quantitative indicators for the financial incentives faced by individuals. Some of these indicators have been derived from the theoretical life-cycle model. As was mentioned in the introduction, we will not follow a structural approach in estimating the effects of the pension reform, but instead use these indicators in a reduced-form context.[7]

Stock and Wise (1990a,b) proposed the option value model, where an economic agent chooses the retirement date for which expected utility is at its maximum, i.e. immediate retirement is optimal iff

$$G(t) = \max_{R:R>t} \left\{ V_t(Y_t|R) + \sum_{s=t+1}^{\infty} \beta_{st} E_t V_s(Y_s|R) \right\} - \sum_{s=t}^{\infty} \beta_{st} E_t V_s(Y_s|t) < 0 \quad (4.1)$$

where $G(t)$ is the option value (OV) of continued work, i.e. a negative value corresponds to immediate retirement being the optimal decision of the indi-

7 For papers who did follow the structural life-cycle approach (typically under some set of simplifying assumptions), see a.o. Rust (1989), Rust (1997), Van der Klaauw and Wolpin (2003), Blau (2004), Heyma (2004), French (2005), Gustman and Steinmeier (2005).

vidual. Income at age s, including the amount of cash flow to or from the pension fund, is denoted by Y_s, and the indirect utility function is denoted by V. Thus, $E_t V_s(Y_s|R)$ denotes the expected indirect utility at age s given retirement at age R. Cash flows at a future age s are discounted with a factor β_{st} at present age t, and this discount factor includes the mortality rate. In words, the option value gives the difference between the utility enjoyed by retirement at the optimal age of retirement and that obtained by immediate retirement. This option value model is in fact a simplification of the life-cycle model, and is obtained by interchanging the maximum and expectation-operators in the dynamic programming rule of the life-cycle model. As Stock and Wise note, the expected value of the maximum of a set of random variables is larger than the maximum of their expected values, so that the option value of continued work is necessarily smaller than would be implied by the dynamic programming rule based on the life-cycle model. Several authors have questioned whether going from the full DP model to the OV model in (4.1) should be regarded as a simplification, as the latter might as well be a more 'realistic' alternative to describe the individual's retirement behaviour. Lumsdaine et al. (1992) conclude that the DP model and the OV model perform equally well in explaining and predicting the retirement behaviour of individuals. In a different context (viz. the application for social security disability insurance benefits in the United States), Burkhauser et al. (2003) even conclude that the OV model outperforms the DP model.

In their econometric specification, Stock and Wise (1990a,b) allow for individual specific random effects in both wage and retirement income. However, only very few authors have succeeded in estimating the full-fledged option value model as originally specified by Stock and Wise. Instead, most applications based on (4.1) use the variable $G(t)$ in a reduced form context. The most common application is to fix the parameters γ, k, and the discount factor (denoted by β in the above specification) at some given values, and let $G(t)$ enter as a linear regressor in a probit model (e.g., Samwick 1998; Börsch-Supan 2000; Berkel and Börsch-Supan 2003; Asch et al. 2005).[8] This is equivalent to estimating the full option value model with fixed parameters, and deterministic wages and retirement income (Lumsdaine et al. 1992). A common specification for the expected indirect utility function is

$$E_t V_s(Y_s|R) = \begin{cases} [w_s]^\gamma & \text{if } s < R \\ [kB_s(R)]^\gamma & \text{if } s \geq R \end{cases} \tag{4.2}$$

8 The values at which the parameters are fixed in the mentioned references are between 0.75 and 1.00 for γ (risk aversion up to risk neutrality); between 0.03 and 0.05 for the discount rate (excluding the mortality rate); and between 1.5 and 3.1 for k. Note that none of these ranges is in accordance with the 'original' estimates ($\gamma = 0.63$; $\rho = 0.22$; $k = 1.25$) of the full option value model obtained by Stock and Wise (1990a).

where w_s is the wage at age s, $B_s(R)$ is the amount of cash flow to or from the pension fund at age s given retirement age R, and γ is the risk aversion parameter and k represents the relative valuation of leisure. We will employ this specification in our empirical model.

Coile and Gruber (2000) note that a potential drawback of the option value measure is that it is a function of future wages, and the latter may be a major source of variation across individuals. This implies that the researcher who is interested in identifying the behavioural effects induced by the early retirement scheme may find that the OV is for a large part measuring the effects of income dispersion rather than the effects he is interested in. Furthermore, this approach does not allow for estimating the separate effects of different (complementary) pension schemes. As an alternative the authors propose making use of the 'peak value', which is defined as

$$H(t) = \max_{R:R>t} \left\{ \sum_{s=t}^{\infty} \beta_{st} E_t B_s(R) \right\} - \sum_{s=t}^{\infty} \beta_{st} E_t B_s(t) \tag{4.3}$$

In words, the peak value is the difference between total discounted pension wealth at its maximum expected value and its value if retirement occurs immediately. As discussed in Samwick (2001), the peak value is the same as the option value under the assumptions that future wages do not affect the optimal retirement age, workers are not risk averse ($\gamma = 1$), and income in retirement has the same utility value as income before retirement ($k = 1$). The peak value (with fixed discount rate) is mostly used as an explanatory variable in a reduced form probit model, just like the option value (with fixed parameters). Applications are found in Coile and Gruber (2000) and Asch et al. (2005).

In addition to the OV and PV measures, we also use a financial incentive measure for the wealth effect. Total pension wealth at age t is computed as:

$$PW(t) = \sum_{s=t}^{\infty} \beta_{st} E_t B_s(t) \tag{4.4}$$

Using this incentive measure we may estimate the size of the income effect, that is, the extent to which pension wealth is used to finance retirement (at the margin).

4.2 *Mixed Proportional Hazard Rate Model*

We use a mixed proportional hazard rate model to describe the time spent in employment since the age of 55. The advantage of a hazard rate model over probit estimations for every age from 55 to 64 (which are often used in the literature) is that hazard rate models account for the endogenous selection of those still working at older ages. A probit regression at, e.g., age 63 gives the probability of early retirement at this age conditional on working at the birthday of age 63. This model is suitable for policy simulations with changing incentives at this particular age. The model is however not suitable for policy simulations with changing incentives over the whole range from age 55 to 64, as the model does not account for the endogenous change of the population that still works at the birthday of age 63. Hazard rate models are designed to take this selection into account. Having estimated such a model, both the conditional and unconditional retirement probabilities can be predicted given some set of financial parameters.

We model the duration T_i of an individual i as the time that elapses between his 55th birthday and the moment of (early) retirement. Although the data allow us to measure T_i in days, we round this duration to *years* for two reasons. First, data are to a large extent clustered around (especially *right after*) birthdays so that measuring T_i in days would not add much variation. Second, closer inspection of the data reveals that measurement in days may be not very precise, as the tax authorities are not so much interested in daily information but rather in information on a yearly basis. Since retirement is mandatory at the age of 65, this implies that T_i will not exceed the value of ten. Retirement is supposed to be an absorbing state: an individual who is retired will not start working again.[9] The hazard rate (or instantaneous exit rate) $\lambda_i\,(t|x_{it}, \varepsilon_i)$ for individual i at time t is defined as the marginal probability of immediate retirement, conditional on not having retired yet before time t. Define a vector of time-dependent individual characteristics x_{it}, a conformable parameter vector β, and an unobserved individual heterogeneity term ε_i and let

$$\lambda_i\,(t\,|x_{it}, \varepsilon_i\,) = \lambda_0\,(t) \exp\,(x_{it}{\prime}\beta + \varepsilon_i)\,. \tag{4.5}$$

In this equation $\lambda_0(t)$ is the baseline hazard, and ε_i is a random term representing unobserved heterogeneity between individuals. We specify the baseline hazard semi-parametrically, such that the age effect follows a step function with one parameter for each age (cf. Meyer 1990). The probability that a spell lasts until time $t + 1$ given that it has lasted until t then reads as:

$$h(t, x_{it}, \varepsilon_i) = P\,(T_i \geq t+1\,|T_i \geq t, x_{it},\, \varepsilon_i) = \exp\left[-\bar{\lambda}_0(t) \exp\,(x_{it}{\prime}\beta + \varepsilon_i)\right], \tag{4.6}$$

where

$$\bar{\lambda}_0(t) = \int_t^{t+1} \lambda_0\,(u)\,du. \tag{4.7}$$

9 This is however not a heavy constraint in our analysis. First, practice shows that the early retirement event is indeed absorbing in the overwhelming majority of cases. Second, even if it would not be absorbing, then we could simply redefine the duration to be equal to the moment of *first* (early) retirement.

The distribution $\bar{\lambda}_0 = \left[\bar{\lambda}_0(t)\right]_{t=0}^{9}$ can be estimated along with the parameters in β. Note that the baseline hazard function in (4.7) carries a bar to indicate that this concerns the average age effect over one year.

Next, we assume that unobserved heterogeneity can be characterised by a mixture of two mass points:

$$P(\varepsilon_i = \eta) = \alpha, \tag{4.8}$$

with the second mass point chosen such that $E[\exp(\varepsilon_i)] = 1$, $P(\varepsilon_i = \eta_2) = 1 - \alpha$, $\eta_2 = \log((1 - \alpha\exp(\eta))/(1 - \alpha))$.[10]

On the basis of the information in our dataset we cannot differentiate between workers of the national and the local governments. We assume workers of the government to be part of the national government with a given probability 0.39. This probability is based on the proportion of civil servants which is working for the national government. Further, the transition from employment to retirement is not observed for all individuals, either because it occurred after the end of the sample period, or because the individual exited employment via a different route (e.g. unemployment or disability). We treat these individuals as right-censored.[11]

The likelihood of observing a particular retirement date follows from (4.6), after taking the expectation with respect to the unobserved heterogeneity term using (4.8). Thus, summing over individual workers indexed by i, the likelihood function reads as:

$$\begin{aligned} L = \sum_i \log\Bigg(\alpha \Bigg((1 - h(t_i, x_{it}, \eta))^{\delta_i} \prod_{s=0}^{t_i - \delta_i} h(s, x_{is}, \eta) \Bigg) \\ + (1-\alpha)\Bigg((1 - h(t_i, x_{it}, \eta_2))^{\delta_i} \prod_{s=0}^{t_i - \delta_i} h(s, x_{is}, \eta_2) \Bigg)\Bigg), \end{aligned} \tag{4.9}$$

where δ_i equals one if individual i is observed until the age of (early) retirement, and zero otherwise, and t_i is the length of the observed (either completed or uncompleted) spell. Maximisation of this likelihood function with respect to $\theta = (\beta, \bar{\lambda}_0, \alpha, \eta)$ yields consistent and asymptotically efficient parameter estimates.

10 Heckman and Singer (1984) argued that results may be very sensitive to the choice of a particular functional form for the distribution of ε_i, and therefore, the authors proposed using a non-parametric characterisation of ε_i by means of a finite set of points of support, whose number, locations, and weights are empirically determined. Guo and Rodriguez (1994) have found that, in practice, two or three points of support often suffice.

11 Right-censoring due to other exit routes applies to roughly 10% of the still employed workers at each age between 55 and 65. We choose to abstract from unemployment and disability as these exit routes are measured with measurement error in the data, and so they would need a special modelling treatment (see, for example, Van Vuren and van Vuuren (2007)).

5 ESTIMATION RESULTS

5.1 *Specification with Dummy Indicator Variables*

Our first specification makes a distinction between actuarially unfair and actuarially fair schemes using dummy variables. We estimate the impact of the reforms on the basis of these dummy variables for the different relevant early retirement schemes. The results should be interpreted as an *average* effect of the reform from a generous actuarially unfair to a less generous actuarially fair scheme. However, what exactly drives the change in early retirement behaviour remains unclear. For this reason, the next subsection will implement a specification with the measures for the financial incentives discussed in Section 2, the peak value and the option value.

A worker may be subject to either one of the following three cases: (1) a worker may be *not yet eligible* for an early retirement benefit. In this case, early retirement is unattractive as the worker will loose all his early retirement rights; (2) A worker may be *eligible to a flat-rate early retirement benefit*. In that case, early retirement is attractive as continuing to work hardly leads to a higher life-time income (see Euwals et al. 2005); (3) A worker may be *eligible to an actuarially fair early retirement scheme*. To allow for the three different regimes in the empirical hazard rate model, we define two dummy variables: one dummy variable *incentive to retire* and one dummy variable *incentive to wait* (see note c in Table 5 for exact definitions). The latter dummy variable equals unity if the worker will become eligible for early retirement benefits at some moment in the future, leading to an incentive to wait (i.e. case (1)). The dummy variable 'incentive to retire' equals one for individuals who are subject to a flat-rate early retirement scheme (i.e. case (2)), and zero for others. Thus, the reference case is an actuarially fair early retirement scheme which can be taken up at any age starting at the age of 55. Because of the reforms, the values of these two dummy variables change over time for civil servants and workers in the education sector (participants of the pension fund ABP). The dummy variables for the other industry sectors do not change over time, which makes an interpretation as 'control group' possible.

The estimation results show that the baseline hazard is upward sloping until age 61 and downward sloping after that age (Table 5). The null hypothesis that the baseline hazard is constant is strongly rejected by a likelihood ratio or a Wald test. We take this as evidence for the presence of age dependence. On the basis of deteriorating health conditions and a possibly increasing preference for leisure with age we could expect a monotonically increasing baseline hazard. An explanation for the peak at age 61 may be interdependence of preferences, but measurement error may play a role as well. This last argument is a consequence of the fact that the dummy variables can take only two values, while there may be much more variation in

TABLE 5 – ESTIMATION RESULTS, MODEL SPECIFICATION WITH DUMMY VARIABLES

Variable	Estimate[a]	Std. error[b]	Variable	Estimate[a]	Std. error[b]
Baseline hazard			*Industry sectors*		
Age 55	−4.87*	(0.58)	Gov/Edu (ABP)	1.02*	(0.29)
Age 56	−4.84*	(0.62)	Post/telecom	2.19*	(0.34)
Age 57	−4.29*	(0.61)	Agriculture (BPL)	1.24*	(0.35)
Age 58	−4.63*	(0.62)	Catering (PHC)	0.01	(0.42)
Age 59	−4.08*	(0.62)	Cleaning (BPSG)	−0.98	(0.70)
Age 60	−2.85*	(0.60)			
Age 61	−1.95*	(0.90)	*Indiv. charact.*		
Age 62	−2.42*	(1.02)	Single woman	−0.09	(0.28)
Age 63 and 64	−2.70*	(1.07)	Single man	0.16	(0.24)
			Non-single woman	−0.27	(0.20)
Year dummies			Children	−0.28*	(0.13)
1990	0.20	(0.50)	High income	0.60*	(0.15)
1991	−0.36	(0.49)	Mortgage debt	0.01	(0.03)
1992	0.50	(0.45)	House value	−0.07*	(0.03)
1993	0.26	(0.45)			
1994	0.10	(0.45)	*Incentive variables*[c]		
1995	0.22	(0.45)	Incentive to retire	2.28*	(0.29)
1996	−0.27	(0.45)	Incentive to wait	−0.08	(0.21)
1997	0.01	(0.47)			
1998	−0.31	(0.48)	*Heterogeneity*		
1999	−0.07	(0.48)	α	0.46*	(0.05)
			η	−2.56*	(0.68)
Statistics					
Number of observations		2,937			
Log-likelihood		−1924.86			

[a] Reference groups: health care (PGGM), 1989, pre-pension scheme, non-single man, no high income.

[b] Variables marked with * are significant at the 5% significance level.

[c] The dummy variable *incentive to retire* is defined as being eligible for a flat-rate early retirement benefit, while the dummy variable *incentive to wait* is defined as not yet being eligible for an early retirement benefit.

Source: Dutch Income Panel (Statistics Netherlands), 1989–2000, own calculations.

incentives to wait and to retire. In the next subsection we will further exploit this variation.

The early retirement behaviour differs significantly between participants of different industry sectors. Even after correction for individual characteristics, the government employees and the workers in the education, post, telecom and agriculture sectors retire significantly earlier than the workers in the other sectors. Individuals with children have a lower propensity to retire than those without. The dummy variable *high income* has a positive sign, while the variable *house value* has a significantly negative sign. Neither the other individual characteristics nor the year dummies have a significant effect on the hazard rate. On the other hand, unobserved heterogeneity turns out to be important.

The estimate of the dummy variable *incentive to retire* is significantly positive. Thus, the old flat-rate early retirement schemes indeed resulted in a higher propensity to withdraw from the labour market than an actuarially fair scheme. The dummy variable *incentive to wait* has the theoretically correct sign but is not significantly different from zero. One would expect that a worker who has not yet reached the eligibility age would have a strong incentive to postpone retirement. But after April 1, 1997 only few workers decided to retire at the ages of 55–59 anyhow. These results show that the policy reform is effective in the sense that it induced workers to postpone early retirement. The major cause of this result is that the high implicit tax at the eligibility age was removed.

5.2 *Specification with Financial Variables*

Our second specification attempts to capture the impact of financial incentives more precisely by making use of measures for the price effect by both the peak value and the option value, respectively, and the wealth effect by the pension wealth variable. Compared to the earlier specification, the current setting offers the advantage that we can now make use of different sources of variation in financial incentives in order to identify the effects separately. Clearly, we need to make some assumptions in order to be able to compute the incentive measures. First, we assume that real wages of workers between 55 and 65 years remain constant. This assumption is in line with computational procedures followed by pension funds and with empirical evidence on the wage growth of older Dutch workers by Borghans et al. (2007). Second, it should be noted that both early retirement and old-age pension benefits are *conditionally indexed*, that is, these benefits are adjusted annually in order to account for the inflation rate and the development of contractual wages, conditional on the pension fund's financial status. While computing financial incentive measures we assume full indexation of early retirement benefits, which is a realistic assumption for the period under consideration (1989–2000). Third, we assume that workers have worked sufficient number of years making them eligible for the full benefits as specified in Tables 1 and 2. This assumption becomes essential in the absence of detailed employment histories of individuals.

TABLE 6 – ESTIMATION RESULTS, MODEL SPECIFICATION WITH PEAK VALUE

Variable	Estimate[a]	Std. error[b]	Variable	Estimate[a]	Std. error[b]
Baseline hazard			*Industry sectors*		
Age 55	−3.91*	(0.50)	Gov/Edu (ABP)	0.13	(0.22)
Age 56	−3.90*	(0.54)	Post/telecom	1.22*	(0.27)
Age 57	−3.40*	(0.55)	Agriculture (BPL)	0.73*	(0.31)
Age 58	−3.69*	(0.56)	Catering (PHC)	0.21	(0.36)
Age 59	−2.96*	(0.56)	Cleaning (BPSG)	−1.16*	(0.60)
Age 60	−1.83*	(0.54)			
Age 61	−0.19	(0.57)	*Indiv. charact.*		
Age 62	0.60	(1.20)	Single woman	−0.15	(0.27)
Age 63 and 64	1.39	(1.29)	Single man	0.03	(0.22)
			Non-single woman	−0.53*	(0.16)
Year dummies			Children	−0.17	(0.12)
1990	0.31	(0.50)	Mortgage debt	0.02	(0.02)
1991	−0.24	(0.49)	House value	−0.07*	(0.03)
1992	0.59	(0.45)			
1993	0.45	(0.45)	*Financial variables*		
1994	0.25	(0.45)	Pension wealth[c]	3.27*	(0.76)
1995	0.35	(0.44)	Peak value[d]	−5.66*	(1.35)
1996	−0.10	(0.45)			
1997	−0.20	(0.46)	*Heterogeneity*		
1998	−0.65	(0.46)	α	0.27*	(0.03)
1999	−0.45	(0.46)	η	−4.14*	(1.06)
Statistics					
Number of observations		2,937			
Log-likelihood		−1974.37			

[a] Reference groups: health care (PGGM), 1989, pre-pension scheme, non-single man.
[b] Variables marked with * are significant at the 5% significance level.
[c] Pension wealth is the discounted value of future pension benefits (Section 2.2). We assume an individual discount rate of 4%.
[d] Peak value is the difference between total discounted pension wealth at its maximum expected value and its value if retirement occurs immediately (4.3).
Source: Dutch Income Panel (Statistics Netherlands), 1989–2000, own calculations.

Tables 6 and 7 present the results with the peak value (4.3) and the option value measures (4.1), respectively. For the latter measure we assume the marginal utility of income to fall with consumption; to be precise $\gamma = 0.75$ (see (4.2). The relative valuation of leisure parameter (k) is set equal to 1.7, and

TABLE 7 – ESTIMATION RESULTS, MODEL SPECIFICATION WITH OPTION VALUE

Variable	Estimate[a]	Std. error[b]	Variable	Estimate[a]	Std. error[b]
Baseline hazard			*Industry sectors*		
Age 55	−3.77*	(0.54)	Gov/Edu (ABP)	0.23	(0.22)
Age 56	−3.84*	(0.58)	Post/telecom	1.34*	(0.27)
Age 57	−3.44*	(0.57)	Agriculture (BPL)	0.76	(0.31)
Age 58	−3.81*	(0.58)	Catering (PHC)	0.23*	(0.37)
Age 59	−3.14*	(0.56)	Cleaning (BPSG)	−1.06*	(0.61)
Age 60	−2.04*	(0.54)			
Age 61	−0.37	(0.57)	*Indiv. charact.*		
Age 62	0.31	(1.09)	Single woman	−0.09	(0.27)
Age 63 and 64	1.04	(1.16)	Single man	0.01	(0.22)
			Non-single woman	−0.46*	(0.16)
Year dummies			Children	−0.18	(0.12)
1990	0.32	(0.51)	Mortgage debt	0.02	(0.02)
1991	−0.19	(0.50)	House value	−0.07*	(0.03)
1992	0.63	(0.46)			
1993	0.49	(0.46)	*Financial variables*		
1994	0.28	(0.45)	Pension wealth[c]	3.96*	(0.75)
1995	0.37	(0.45)	Option value[d]	−0.35*	(0.09)
1996	−0.08	(0.45)			
1997	−0.18	(0.47)	*Heterogeneity*		
1998	−0.63	(0.47)	α	0.27*	(0.03)
1999	−0.43	(0.47)	η	−3.95*	(0.90)
Statistics					
Number of observations		2,937			
Log-likelihood		−1975.79			

[a] Reference groups: health care (PGGM), 1989, pre-pension scheme, non-single man.
[b] Variables marked with * are significant at the 5% significance level.
[c] Pension wealth is the discounted value of future pension benefits (Section 2.2). We assume an individual discount rate of 4%.
[d] Option value is the difference between utility from delayed optimal retirement and immediate retirement (4.1). We assume $k = 1.7$ and $\gamma = 0.75$.
Source: Dutch Income Panel (Statistics Netherlands), 1989–2000, own calculations.

the individual discount rate (ρ) equals 4%.[12] The same discount rate is used for the calculation of pension wealth, and mortality rates are obtained from the life table that is used by all large insurance companies in the Netherlands.

12 We experimented with different parameter values. Within the ranges mentioned in footnote 5 there was not much variation in the results.

Both specifications of the model yield a clear wealth effect as the coefficient of the variable *pension wealth* is significantly larger than zero. So, a larger pension wealth induces workers to retire at a younger age. Furthermore, both specifications yield a clear price effect as well. The parameters for both the *option value* and the *peak value,* are significantly negative, which is consistent with theory. A financial reward to delay early retirement, in the form of a higher benefit level in case of postponement, induces workers to continue working. Most parameters continue to be similar to the estimates of the preceding section. A remarkable change however is that the baseline hazard now continues to increase after age 61. The propensity to retire increases with age, which is in line with, for example, decreasing health with age.[13]

In order to interpret the estimated coefficients we may translate these into marginal effects ξ_k as follows (for variable x_k):

$$\xi_k = \frac{\partial \xi}{\partial x_k} = \frac{\partial(10 - E[T])}{\partial x_k} = -\frac{\partial E[T]}{\partial x_k}, \tag{6.1}$$

where ξ denotes the individual's expected time spent in early retirement (measured in years). Details on the exact computation of ξ_k are provided in appendix A. Measuring x_k in 100,000 s of euro, we compute marginal effects at sample average values for the *peak value* and *option value* at 0.67 and 0.62, respectively. Thus, increasing the *peak value* with 100,000 euros[14] would induce the average worker to extend his career by about 8 months ($\approx 0,67 \cdot 12$). The marginal effect of an increase in *pension wealth* with 100,000 euros is estimated at -0.39 and -0.47, respectively, depending on which specification is used. Decreasing *pension wealth* with 100,000 euros would induce the average worker to extend his career by 5–6 months. Stated differently, the average worker would extend his working life by one year either if he receives about 150,000 euros extra paid out in wages (price effect), or if his pension wealth is decreased by about 250,000 euros (wealth effect). Thus, the early retirement decision is more sensitive to changes in the price of leisure than to changes in an individual's pension wealth.

13 According to the testing procedure for non-nested models proposed by Vuong (1989), the peak value and the option value model perform about equally well: the concerning test statistic is not statistically significant at a five percent significance level. The two models with financial variables are however outperformed by the model with the dummy indicator variables as the test statistic gives a highly statistically significant outcome in favour of the latter model. A possible explanation for this result is that the option value and the peak value might be imperfect measures of how people make retirement decisions.

14 Note that the peak value is measured in terms of net future cash flows, viz. (6.2). An additional incentive of 100,000 euros thus equals about 3 to 4 net year salaries of the average worker (compare Table 3 which reports average gross salaries).

6 CONCLUSION

In this study, we estimate the causal impact of financial incentives on early retirement behaviour in the Netherlands. We exploit the variation in the starting dates of the transitional arrangements from actuarially unfair schemes to more actuarially fair schemes. It is important to note that the reforms could not be evaded by the individual worker so that the so-called anticipation effects do not hamper our analysis: Every age-cohort faced a pre-determined retirement program and no worker had the possibility to retire with the old scheme prior to the introduction of the new regime in anticipation of harsher retirement benefits. Second, the reforms, which took place earlier in the government and education sectors than in other sectors, can be considered as an exogenous shock. The reason is that it was driven by the government's policy to cut back expenditures, and not by worker preferences. The dataset we use for this purpose, the Dutch Income Panel 1989–2000, is based on administrative records of the Dutch National Tax Office. Estimating hazard rate models for early retirement, we find that the policy reforms have induced workers to postpone early retirement.

The reform of the Dutch early retirement system causes major changes in the individual early retirement rights. First, the actuarial adjustments in the new schemes introduce a price effect as the price for leisure becomes 'more fair'. Second, the new schemes entail lower early retirement wealth which potentially leads to a wealth effect, i.e. less resources to purchase leisure time. By modelling the exact financial incentives and using them in our empirical model specification, we try to disentangle the empirical relevance of these two effects. According to our estimates, an increase in the peak value of 100,000 euros would make the average worker extend his career by 8 months,[15] while a decrease in his early retirement wealth by the same amount would induce a career extension of 5 months. A third change in the early retirement schemes was the possibility to retire at an earlier age than under the old scheme. That is, an incentive to continue working until the eligibility age was removed. We however did not find any evidence that this has led to an increased use of the early retirement scheme at younger ages. All in all, we conclude that the policy reform was effective in increasing the labour supply of the elderly.

As early retirement will retain its place of importance on the policy agenda, more research to answer some open questions is needed. First of all, better data obtained by merging information on individual early retirement and pension rights with administrative data from the Dutch National Tax Office will largely rule out possible problems due to measurement error. This will help to get a better identification of the price and wealth effects in early retirement

15 The peak value is defined as a worker's increase in lifetime wealth if he decides to continue working until this lifetime wealth attains its maximum value (see Section 4).

behaviour. Second, behavioural aspects are likely to be important. Therefore, the incorporation of behavioural elements into the empirical analysis of early retirement is still a major challenge for the future.

APPENDIX A: COMPUTATION OF MARGINAL EFFECTS

In this appendix we show how the estimated coefficients of the hazard model can be translated into marginal effects. The coefficients of the hazard model are gathered in the vector β (see (4.5)) and may contain financial incentive measures such as the peak value, option value, and pension wealth.

Given some early retirement hazard rate $\lambda(t)$, it is standard to show that the corresponding probability for retirement at time t is given by[16]

$$f_0(t) = \lambda(t) \prod_{s=0}^{t-1} (1 - \lambda(s)). \tag{6.2}$$

It is however possible that workers make use of alternative exit routes, such as Disability Insurance (DI). Denote the DI hazard rate at time t by $\mu(t)$. Equation (6.2) then generalises to

$$f(t) = \lambda(t) \prod_{s=0}^{t-1} (1 - \lambda(s) - \mu(s)). \tag{6.3}$$

Now, the probability that the individual retires at time t conditional on retirement through the official early retirement scheme equals

$$g(t) = \frac{f(t)}{\sum_{s=0}^{10} f(s)}, \tag{6.4}$$

so that the expected period spent in early retirement equals

$$\xi = 10 - \frac{\sum_{t=0}^{10} t f(t)}{\sum_{t=0}^{10} f(t)}. \tag{6.5}$$

Although not shown explicitly in the current notation, λ and f are still conditional on a vector of exogenous variables x (compare (4.5)). Hence, the change in ξ resulting from a marginal change in the variable x_k equals

$$\xi_k = \frac{\partial \xi}{\partial x_k} = -\frac{\partial}{\partial x_k} \left(\frac{\sum_{t=0}^{10} t f(t)}{\sum_{t=0}^{10} f(t)} \right). \tag{6.6}$$

16 This is the discrete time analogue of Equation (2.4) on p. 9 in Lancaster (1990).

Using (6.3), this quantity can be computed for each individual using numerical differentiation. A straightforward estimator of ξ_k is then simply the average of all individual values for ξ_k. The DI hazard rates used in (6.3) are obtained from aggregate statistics.

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