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Joint retirement behaviour and pension reform in the Netherlands☆

Amparo Nagore García [a,*], Arthur van Soest [b]

[a] Department of Financial and Actuarial Economics, University of Valencia, Avda Tarongers s/n, Valencia, Spain
[b] Netspar & Department of Econometrics and Operations Research, Tilburg University, PO Box 90153, 5000 LE Tilburg, the Netherlands

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ABSTRACT

We examine the effects of a major pension reform in 2015 on the joint retirement decisions of working couples in the Netherlands. The reform abolished the partner allowance, a state pension supplement for a nonworking partner below the state pension age. At the same time, actuarially generous early retirement arrangements were made less attractive. Using rich administrative data, we estimate a multivariate mixed proportional hazards model that distinguishes between several sources of joint retirement: financial incentives, other causal mechanisms that make retirement of one spouse more likely when the other spouse retires (e.g., due to complementarities in leisure or social norms) and correlated preferences (observed and unobserved heterogeneity). We find that, conditional on observed and unobserved characteristics, the reform reduced the tendency to retire jointly and argue that this is not only due to a change in financial incentives but also to a change in the social norm.

Introduction

We analyse the consequences of a major policy reform in 2015 in the Netherlands for the joint retirement decisions of working couples and the mechanisms behind these decisions. The reform eliminated the partner allowance (PA). While pension systems are mostly designed at the individual level (Stancanelli, 2017), the PA in the Dutch system added a common feature. It was a supplementary allowance (up to 50 percent of the minimum wage)[1] to the state pension (SP), paid if the older partner already received the state pension[2] while the younger partner was still below their state pension age (SPA) and had low personal income from work or benefits. The PA created an incentive for the younger partner to stop working (just) before the older partner reached their SPA, implying that the younger partner's probability of retirement around that date should increase. Since older partners often retire when reaching the SPA, this already induces a source of joint retirement.

Earlier studies have concluded that retirement in couples is based on joint decision-making and have demonstrated the existence of spill over effects: Financial incentives targeted at one partner may also affect their spouse's retirement behaviour. This makes it worthwhile to analyse retirement decisions of individuals in couples at the level of the couple. It explains why there is an increasing number of studies that exploit changes in social security design to analyse joint-retirement patterns of couples. These studies come to contrasting findings on the direction of the interactions and asymmetric responses between wives and husbands.

To better understand the impact of policy reforms on joint retirement, it is necessary to account for the different mechanisms that can explain joint retirement, such as complementarities in leisure, assortative mating or convergence of preferences, and economic factors such as interdependencies in the consequences for the family budget constraint. An et al. (2004) introduced a reduced-form model for the joint distribution of the durations of paid work until retirement of the two spouses in a couple. They add a third – joint retirement - hazard to the standard bivariate model with two individual hazard rates. This third hazard explicitly incorporates the utility of retiring jointly in the model, in addition to the other sources of joint retirement that are already

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* Corresponding author.
E-mail addresses: amparo.nagore@uv.es (A. Nagore García), A.H.O.vanSoest@tilburguniversity.edu (A. van Soest).

[1] The partner allowance was introduced in 1985 and was discontinued on 1 April 2015 for new SP recipients. In the meantime, there were several small reforms in terms of the amount and the means testing.

[2] The full SP for married individuals is 50% of the minimum wage per person, and 70% of the minimum wage for a single living person.

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accounted for in a standard bivariate duration model.

In the current study, we follow the modelling strategy of An et al. (2004) to analyse joint retirement decisions and their sources for working couples in the Netherlands who are and are not subject to the 2015 reform. While existing studies often focus on the most common type of couples - those in which the husband is older than the wife, we also consider couples in which husbands are younger than their wives. Using administrative data on couples in which the older partner reached their SPA just before or just after the reform, we find that individual retirement hazards fell substantially due to the reform. This can largely be explained by the elimination of generous (actuarially very unfair) individual early retirement arrangements in occupational pensions, which coincided with the PA reform. For the younger partners, it is also a consequence of the fact that abolishing PA reduces the financial incentives to stop working. In addition, however, we find that the third "joint retirement" hazard fell significantly due to the reform, pointing at another structural mechanism leading to joint retirement.

The effect on the joint retirement hazard is larger for wealthy than for poorer households, whereas changes in the flat rate state pension play a much larger role for the latter. We therefore argue that the most plausible explanation for the fall in this third hazard rate is not financial incentives but the fact that abolishing the partner allowance affected the social norm concerning labour supply and retirement behaviour of older couples.

The remainder of this paper is organised as follows. The next section presents a brief review of the literature. Section "The Dutch pension system" explains the main characteristics of the Dutch pension system. Section "Data and descriptive statistics" describes the data. In the next section we present the econometric framework for the durations until retirement of both partners in the couple. Section "Estimation results" discusses the main results and the final section concludes.

Literature review and theoretical background

The literature has concluded that retirement in couples is often based on joint decision-making: Partners coordinate their exits from the labour market and often retire at approximately the same time, even if they differ in age. Most existing empirical studies relate to the US. See, e.g., Blau (1997, 1998) and Gustman and Steinmeier (2000, 2004). Evidence of joint retirement was also found for Canada (Baker, 2002), Denmark (An et al., 2004) and a large group of European countries (Hospido and Zamarro, 2014).

Ignoring the joint decision component and the spill-over effects may limit our understanding of retirement behaviour and may bias the estimates of the effects of retirement policies: Lalive and Parrotta (2017) quantified the difference in the effect of raising the full retirement age on the couple's labour supply using a joint model and a model ignoring partner's eligibility. They found that partners pension eligibility matters for women but not for men. Not accounting for this joint aspect of retirement behaviour leads to an estimated reform effect that is 10 % lower than in the joint model.

The literature suggests different mechanisms that may explain why spouses retire at approximately the same point in time. Several studies identify complementarities in leisure as an important factor: preferences to retire together with the partner rather than alone, for example because of the utility of joint leisure activities (e.g., Hurd, 1990; Gustman and Steinmeier, 2000, 2004; Coile, 2004). Stancanelli and van Soest (2016) quantified the leisure time couples spend together after retirement for French couples and concluded that the increase in joint leisure activities at retirement are statistically significant but not very large.

Other potential mechanisms driving joint retirement, explored less often, are assortative mating, poor health, and common economic factors. Assortative mating is based on the idea that individuals tend to choose a partner with similar preferences for leisure and work (e.g., Hurd, 1990; An et al., 2004). Poor health influences individual retirement decisions but may also increase the necessity of care giving by the spouse, thus influencing the spouse's retirement behaviour (Jiménez-Martín et al. 1999). Financial incentives to retire matter for the individual to which they apply but are also found to affect the spouse's retirement behaviour (Baker, 2002; Coile 2004; Lalive and Staubli, 2015). Moreover, in some systems, the structure of financial incentives for retirement may directly cause a positive correlation between retirement dates. An example is the US Old Age Social Security system (see, e.g., Hurd 1990).

The model of An et al. (2004) distinguishes complementarities in leisure time, modelled through a separate hazard for the couple's joint retirement, from assortative mating and correlation in preferences, modelled through the correlation between observed and unobserved heterogeneity terms in the two individual hazards.

Empirical evidence on the causal effect of financial incentives on joint retirement is limited, but useful to forecast the fiscal impact of future reforms. Recent studies exploiting changes in social security design found asymmetric responses between wives and husbands. Spouses may have conflicting interests over the timing of retirement because of age differences, gender differentials in life expectancy, or the design of social security regimes.

Few studies analyse the effects of financial incentives at the household level on the couplés labour supply, probably because most of the retirement policies are individually designed (Stancanelli, 2017). Baker (2002) examined how couplés labour supply responded to the introduction of the Spousés Allowance in Canada in 1975, an allowance for the younger spouse that is means-tested on family income. Individuals in eligible couples responded to the allowance incentives by showing a lower participation rate than their counterparts. This effect was stronger for men, usually the older partners in couples. Mastrogiacomo et al. (2004) investigated how the Dutch partner allowance, means tested on the younger partner's income, affects household participation decisions in the Netherlands. Their policy simulations suggest that when the state pension for the couple would be independent of the younger partner's income, younger partners would tend to continue working more often.

Some recent studies emphasize that retirement decisions are also influenced by behavioural factors such as social norms, an age anchor, peer effects or reference dependence. Behagel and Blau (2012) and Vermeer (2016) found that the manner of framing the standard retirement age influences the decision when to retire, by influencing the social norm or the reference point. Atalay and Barrett (2015) analysed a reform that changed the pension eligibility age for women in Australia and concluded that one reason this affected retirement decisions was that it changed the social norm. Similarly, Cribb et al. (2016) conclude that the early retirement age in the UK acts as a signal that sets the social norm for women's retirement. Bhatt (2017) concluded that the decreasing tendency to retire jointly in the US is partly due to changing social norms on work and gender.

The Dutch pension system

Since the late nineteen forties, the Dutch pension system consists essentially of three pillars: a state pension, (mandatory) occupational pensions, and individual private pensions. There have been many smaller and larger reforms in the state pension and rules for occupational pensions. In the past decades, reforms focused on making people work longer (see Visser et al., 2016, and Riekhoff, 2019 for recent overviews), but the three pillars have remained intact.

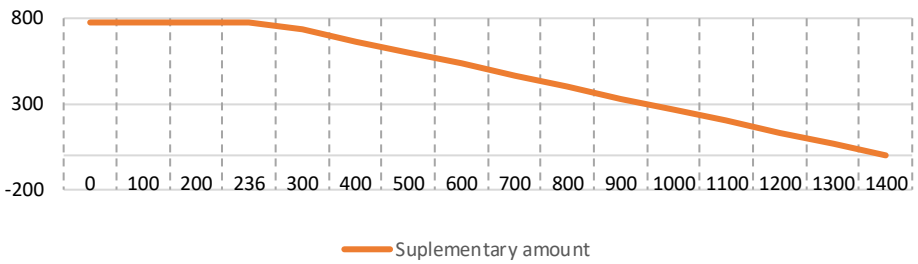

Fig. 1. Supplementary AOW amount (€ per month) by income of the younger partner (€ per month). *Source: Own elaboration.*

First pillar: State pension (SP)

The state pension (AOW, *Algemene Ouderdoms Wet*) provides a basic income (linked to the minimum wage) for every-one who has reached the state pension age (SPA) and has been a resident in the Netherlands from age SPA-50 to the SPA[3] (each year, 2 % of the full public pension benefit is accumulated). The rules for eligibility and the amounts for individuals and couples are simple and published widely. Thus, every Dutch resident who makes a small effort to collect the information can fully anticipate receiving a given amount from a specific age.

The amount depends on partnership status but not on earnings or employment history. It provides Dutch residents with a benefit that in principle guarantees approximately 70 % (in gross terms) of the minimum wage for a person living alone (€1111.55 per month in 2015) and 50 % (in gross terms) for each partner in a couple (married or living together, €765.95 in 2015).

Partner allowance

The Partner Allowance (PA) was linked to the AOW until its elimination in 2015. It was an extra allowance paid to the spouse who reached the SPA as long as the other spouse was younger than SPA and had low income from work and benefits. The full PA amount was independent of previous earnings – 50 percent of the minimum wage, €741 per month before tax. Since August 2011, the amount could be reduced by up to 10 % if the joint monthly income of both spouses was €2,714 or more.

Fig. 1 shows the PA amount in 2015 by the younger partnerś gross monthly income. The first €236.70 of partner's gross monthly salary was disregarded; Two thirds of the salary above €236.70 was deducted from the allowance; if the salary exceeded €1,411.13 gross per month, no PA allowance was paid. If the younger partner received a pension, it was deducted from the PA in full. If it was more than €782.95 gross per month, no PA was paid.

The PA existed due to the traditional social norm of a one earner family. This social norm gradually changed over the years, and many policy measures were taken that reflected the new norm of increasing labour force participation of women, with more individual tax and benefit policies. In 2015, PA was abolished for new cases. It is not paid to couples in which the older partner starts receiving a state pension on or after April 1st 2015 (born after December 31st 1949), who form a couple on or after January 1st 2015, or who were not entitled to PA before April 1st 2015 (due to too high income of the younger partner).

Second Pillar: Occupational Pension

Since the same birth cohort that faced the removal of PA (older partners born just after January 1, 1949) also faced a reform in occupational pensions, we have to consider the occupational pension system in some detail as well. The occupational pension system helps employees to maintain their standard of living after retirement. Participation is mandatory for more than 90 % of employees and for some independent professionals. This pillar is organised through pension funds at the level of a company or sector. In most arrangements, individuals can choose when they want to start receiving their annuity, with a minimum age before and a maximum age after their SPA. The amount is actuarially adjusted to the chosen starting age. Pension funds typically use a default age in the communication with their participants, often the SPA.

Early retirement schemes[4]

Actuarially generous early retirement arrangements became common in the last decades of the 20th century but were slowly phased out in the 21st century when population ageing increased the costs of pensions. As a final step of this transition process, the Dutch government adopted a new law on early retirement in 2006, the *Early Retirement and Life-Course Saving Arrangement Act* ("Wet VPL"), making it much less attractive to stop working before SPA for cohorts born after 1949, precisely the cohorts of older partners affected by the PA removal.

The new law on early retirement abolished the fiscal advantages for early retirement and transformed existing actuarially attractive prepension schemes into actuarially fair schemes. This implied a substantial drop in pension benefits for people born after 1949 who planned to retire early (van Ooijen et al., 2010). For example, the replacement rate for public sector workers dropped from 70 to 64 percent of average yearly earnings (de Grip et al., 2012).

Third Pillar: Private pensions

The (third) private pension pillar is voluntary and offers tax benefits for individuals who build up no or a limited occupational pension. This is mainly relevant for the self-employed and a small group of employees without occupational pension. Most private pensions are used to buy an annuity after a given age. This age can be chosen and postponed freely (within a wide range imposed by the tax rules) and is not linked to the SPA.

Expected effects of the reforms

The removal of actuarially unfair early retirement arrangements changes the financial incentives to retire for individuals, stimulating working longer and reducing individual retirement hazards. This is also what was found in existing studies (Visser et al. 2016; Nagore García and van Soest, 2021). It did not directly affect financial incentives for joint retirement. The PA removal strongly increased younger partner's incentives to remain in employment between their spouse's and their own

[3] Until 2012 the SPA was 65 years old; since then it is increasing, first, by one month and since 2015 by three months per year, reaching 67 years old in 2024. Each year of residency, 2% of the full benefit is accumulated so that individuals who spent part of their lives abroad receive proportionally less. We do not take account of this in our empirical analysis.

[4] For a detailed description of the Dutch early retirement system, see van Ooijen et al. (2010).

Table 1
Descriptive statistics of dual working couples 20 quarters before older partnerś SPA by the gender of the older partner. Pre-reform and post-reform groups.

	Older partner is the husband					Older partner is the wife				
	Pre-reform		Post-reform		*t*-test	Pre-reform		Post-reform		*t*-test
	mean	sd	mean	sd		mean	sd	mean	sd	
Individual characteristics										
Age-husband (months)	722.48	0.55	720.52	0.54	127.17	696.65	27.88	694.49	29.24	1.22
Age-wife (moths)	674.72	34.80	674.28	34.10	0.44	722.51	0.58	720.52	0.59	55.03
Age difference	47.77	34.79	46.23	34.11	1.57	25.87	27.89	26.03	29.24	−0.09
Partnership_duration at SPA	442.28	99.13	447.02	95.16	−1.72	427.34	118.17	434.65	106.53	−1.05
Children (dummy)	0.905	0.29	0.904	0.29	0.17	0.81	0.39	0.85	0.35	−1.96
Household Characteristics										
Financial wealth net of debt	53,578	175,517	55,091	186,717	−0.30	53,683	165,642	47,413	194,805	0.56
Regional unemployment rate										
Regional unemp_rate men	4.4 %	0.006	4.4 %	0.0061	2.58	4.3 %	0.006	4.4 %	0.006	−1.52
Regional unemp_rate women	4.5 %	0.005	4.5 %	0.005	2.80	4.5 %	0.005	4.5 %	0.005	−1.28
Observations	2,305		2,720			494		552		

Note: *t*-test refers to the test statistic for the null hypothesis of equal means for pre- and post-reform couples.
Source: Own elaboration from administrative data from Statistics Netherlands.

SPA. As emphasized in Nagore García and van Soest (2021), this explains why the individual hazard for younger partners is lower if the older partner is born after January 1, 1949. The PA removal, however, changes the incentives for the younger partner to retire. The PA increased the younger partner's retirement hazard just before the older partner reached their SPA. Since the older partner often retires at SPA, this was a source of joint retirement – which was removed when the PA was removed. Removing the PA might also have a (negative) income effect on the older partner's individual retirement hazard. The PA only depended on individual income of the younger partner, and therefore had no other (direct) effect on joint retirement through financial incentives. From a financial incentives point of view, we therefore expect that the reforms affect the individual retirement hazards but not the specific joint retirement hazard.

On the other hand, we know that retirement decisions can also be driven by behavioural factors (see the references in Section "Literature review and theoretical background"). In the context of the reform, social norms seem particularly relevant. PA was based upon the idea of a one earner family – the traditional view that the husband (usually the older partner) working for pay and the wife doing the housework. Abolishing the PA signalled that this view was no longer true for generations with older partner born as of 1949, at least according to the government. This may have led to an immediate further change in the social norm towards more individualistic retirement decisions (on top of the ongoing trend), possibly reducing joint retirement. Such a reduction would apply for high earners and low earners alike, while financial incentives will be relevant mainly for low income earners, since they only concern the state pension – a modest part of total income for high income earners.

Data and descriptive statistics

Dataset

Our empirical analysis is based on administrative data provided by Statistics Netherlands. In this study, it is crucial to identify couples. We use a dataset that contains the link between all persons registered in the Municipal Basis Administration who ever have (had) a relationship (marriage or registered partnership). Nagore García and van Soest (2021) used the same source of data to analyze the effect of PA on individual retirement decisions; they do not consider joint retirement.

To construct the individuaĺs labour market at a given point in time, we aggregate the monthly information on paid work to quarterly data. Moreover, we merge with data containing individual characteristics. Table A1 in the appendix shows a detailed description of the variables included in our panel and the original data source.

We define two labour market states: employment and retirement. An individual is employed if he or she works more than 60 h per quarter[5] and has a gross quarterly wage higher than €711 (three times the monthly threshold above which PA is reduced). A transition into retirement occurs in the quarter in which the individual stops working, works<60 h, or earns less than €711. Joint retirement is defined as both partners retiring in the same quarter.[6] Retirement is considered an absorbing state, i.e., we do not consider transitions out of retirement. Other exits or no exit (working until the end of the observation window) are treated as right censored cases.

We selected stable couples, starting their relationship before 2009 and not ending it (and both surviving) until end of 2017. We only use couples where both partners did paid work five years before the older partnerś SPA[7] and where the age difference between partners exceeds two months.[8] We follow both partners until they stop working or until the end of the observation period (end of 2017). In addition, we exclude individuals who were self-employed at any time from 2010 until 2017, since we cannot identify the quarter in which a self-employed individual stops working.

Moreover, we focus on couples with older partners born in a narrow time window, so that they are born just in time not to be affected by the reform or just late enough to be affected by the reform. In other words, the older partner reaches the SPA[9] just before or just after the time of elimination of the partner allowance: in February, March, April or May 2015. Couples in which the older partner reaches the SPA before April 1st, 2015, are eligible for the partner allowance. In the data we selected, these are the couples with older partner born in November or December 1949. In the other part of our dataset, the older partner is born in January or February 1950 and the couple is not eligible for PA. The same

[5] An et al. (2004) consider anyone working less than five hours per week as retired.

[6] Admittedly this is somewhat arbitrary. An et al. (2004) only have annual data and define joint retirement as retiring in the same year. We perform a sensitivity check with this definition in Section "Estimation results".

[7] Since data are quarterly, couples whose older partner reaches the SPA in February-March (April-May) 2015 must be working in the 1st (2nd) quarter of 2010 to be included in the sample.

[8] PA is provided as long as one partner has reached the SPA and the other one has not. Since we do not know the exact birthday (only the month of birth) we select couples with an age difference of at least two months.

[9] The SPA of the older partners in our sample is always 65 years old and three months.

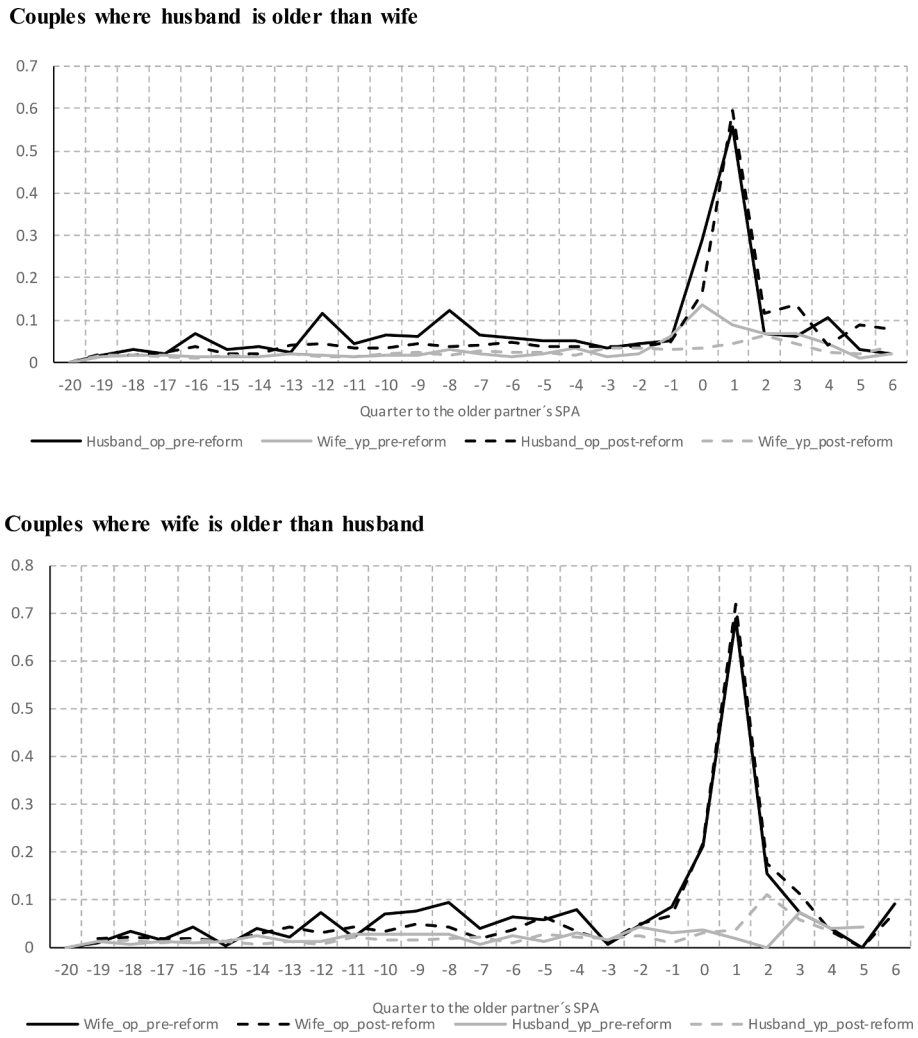

Fig. 2. Hazard estimates; exits from work to retirement. Pre- and post-reform groups. *Source: Own elaboration from administrative data from Statistics Netherlands.*

threshold date (January 1st 1950) also determines whether the older partner is affected by the early retirement reform or not.

Our sample contains 5025 couples (2305 pre-reform and 2720 post-reform) with husbands older than wives and 1046 (494 pre-reform 552 post-reform) with younger husbands, giving a much larger dataset than the 243 couples used by An et al. (2004).

Descriptive statistics

Table 1 shows the descriptive statistics for pre- and post-reform couples in the first quarter of 2010 by gender of the older partner. By construction, the groups differ in age. As expected, in most couples (83 %), the older partner is the husband. The age difference between spouses is larger if the older partner is the husband (almost four years) than if the older partner is the wife (around two years). Average partnership duration is around 445 (430) months for couples with male (female) older partners. The proportion of couples with children is slightly larger for those where the husband is the older partner (90 % versus 81 %). Average household financial wealth net of debt is between 53,000 and 55,000 euros for pre-reform and post-reform groups except in non-typical couples (husband younger than wife), where it is lower after the reform. These differences are not significant, however.

Retirement exits

Fig. 2 shows the estimated quarterly hazard rates from work to retirement from 20 quarters before until 6 quarters after the older partner reaches the SPA.[10] Separate hazard rates are presented for typical couples (in which the husband is the older partner) and for less common couples (in which the wife is the older partner), and for the pre-reform (PA eligible) and post-reform (not PA-eligible) groups. Focusing on the typical couples in the top panel, hazard rates are stable and below 0.1 before the quarter in which the older partner reaches the SPA for all groups except for husbands in the pre-reform cohorts, who have higher hazard rates at the typical peaks of early retirement. These older husbands could often benefit from generous early retirement arrangements. Both groups of husbands have the largest hazard rate shortly after reaching the SPA. Wives show a small peak at the husbands SPA for the PA-eligible group but not for the group that is no longer PA-eligible.

The pattern is less clear for the couples where the wife is older than the husband (bottom panel). Differences between pre- and post-reform are smaller for wives than for husbands who are the older partner in the couple. There are no clear differences between younger husbands in pre- and post-reform groups around the wife's (the older partners) SPA.

In total, the dataset has 4009 couples for which both durations are

[10] In spite of the fact that the observation period of the analysis ends in the last quarter of 2017, hazard rates are shown until six quarters after the older partner reaches the SPA because since then the estimates were less precise given the small number of individual that remain employed, specially cases with two partners employed.

Table 2
Estimation results for several model specifications: Hazard older partner.

	IPH Model	An et al. Model- two hazards		An et al. Model–no mixing	Complete An et al. Model	
		2 mass points	3 mass points		2 mass points	3 mass points
tp1	−4.21***	−4.24***	−4.24***	−4.31***	−4.29***	−4.37***
	(0.14)	(0.15)	(0.15)	(0.14)	(0.15)	(0.16)
tp2	−3.42***	−3.42***	−3.43***	−3.50***	−3.47***	−3.51***
	(0.13)	(0.14)	(0.14)	(0.14)	(0.15)	(0.15)
tp3	−2.84***	−2.81***	−2.82***	−2.94***	−2.86***	−2.85***
	(0.14)	(0.15)	(0.15)	(0.15)	(0.16)	(0.16)
tp4	−2.79***	−2.71***	−2.71***	−2.91***	−2.76***	−2.72***
	(0.16)	(0.18)	(0.18)	(0.17)	(0.18)	(0.18)
tp5	−3.06***	−2.95***	−2.95***	−3.20***	−3.00***	−2.94***
	(0.17)	(0.18)	(0.18)	(0.17)	(0.18)	(0.19)
tp6	−1.04***	−0.83***	−0.85***	−1.14***	−0.86***	−0.80***
	(0.15)	(0.17)	(0.17)	(0.16)	(0.17)	(0.18)
tp7	−2.48***	−1.91***	−1.98***	−2.75***	−2.03***	−1.97***
	(0.15)	(0.18)	(0.18)	(0.16)	(0.18)	(0.18)
tp8	−2.50***	−1.69***	−1.79***	−2.84***	−1.92***	−1.87***
	(0.15)	(0.20)	(0.20)	(0.17)	(0.20)	(0.20)
Male_older_partner	0.065	0.13*	0.13*	0.051	0.12	0.12
	(0.053)	(0.059)	(0.059)	(0.055)	(0.060)	(0.062)
Male_older_partner = 0#	−0.34***	−0.43***	−0.412***	−0.355***	−0.43***	−0.45***
Post-reform = 1	(0.063)	(0.069)	(0.069)	(0.055)	(0.071)	(0.073)
Male_older_partner = 1 #	−0.42***	−0.59***	−0.58***	−0.44***	−0.57***	−0.59***
Post-reform = 1	(0.030)	(0.037)	(0.038)	(0.031)	(0.037)	(0.039)
Age_difference	−0.0010*	−0.0012*	−0.0016**	0.00015	−0.00091	−0.00092
	(0.00048)	(0.00054)	(0.00054)	(0.00049)	(0.00055)	(0.00056)
Partnership_duration	0.00053**	0.00070***	0.00066***	0.00060***	0.00069***	0.00070***
at the older partner's SPA	(0.00017)	(0.00019)	(0.00018)	(0.00017)	(0.00019)	(0.00019)
Children (dummy)	−0.16***	−0.20***	−0.19***	−0.15**	−0.19***	−0.19***
	(0.044)	(0.050)	(0.050)	(0.046)	(0.051)	(0.052)
Unemployment rate	1.04	−0.90	−0.55	1.09	−0.17	−0.16
	(1.68)	(1.82)	(1.82)	(1.75)	(1.86)	(1.89)
V1		−2.54***	0.53***		0.19***	1.74***
		(0.45)	(0.12)		(0.014)	(0.20)
V2			0.076**			0.13***
			(0.026)			(0.022)
a1		−2.92***	1.05**		1.79***	−1.31***
		(0.21)	(0.35)		(0.11)	(0.29)
a2			3.13***			1.72***
			(0.26)			(0.11)
Observations	191,000	191,000	191,000	191,000	191,000	191,000
Log Likelihood	−36,338.47	−36,288.70	−36,264.90	−36,130.24	−35,897.95	−35,884.45

Note: Baseline hazard for the three hazards is a piece-wise constant with annual cut points: tp1 to tp8 (from 2010 to 2017, one dummy per year). See table A1 for the definition of the other variables. Standard errors in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

uncensored (2025 in the pre-reform group and 1984 in the post-reform group). The percentage where both partners retire in the same quarter is 7.73 % overall, 7.26 % in the PA-eligible group and 8.22 % in the not PA-eligible group. The 7.73 % is higher than what we would expect if retirement of the two partners was independent and uniformly distributed across quarters (31 quarters are considered), but this cannot be seen as evidence of joint retirement decisions since individual retirement rates peak in certain quarters (cf. Fig. 2 above and the discussion of Table 1 in An et al., 2004). Nor can we conclude that joint retirement is more common before the reform, since the post-reform distribution of the older partner's retirement quarter is clearly more peaked than the pre-reform distribution. We need a model to see whether joint retirement decisions play a role and whether this role changes due to the reform.

Empirical models

This section describes the model of An et al. (2004), which they refer to as BMPH (bivariate mixed proportional hazard) model. In addition, we also consider several simpler models that can be considered as special cases of the An et al. (2004) model. We introduce three latent durations, all starting at the time the oldest partner in the couple reaches age 60: Y^{op}, Y^{yp}, Y^{c}. This form of left censoring makes our results relevant for the population of couples where both partners did paid work at that point in time rather than for all couples (cf. Lancaster, 1990). The duration completions reflect individual retirement of the older and younger partner (*op* and *yp,* respectively) and joint retirement of the couple (*c*). Assuming no right censoring, each partner (*op* or *yp*) retires when either the corresponding individual duration ends (Y^{op} or Y^{yp}), or when the couple retires jointly and Y^{c} ends. The observed durations are therefore given by $T^{op} = \min(Y^{op}, Y^{c})$ and $T^{yp} = \min(Y^{yp}, Y^{c})$. The key feature and novelty of this model is the third duration Y^{c}, which can explain why, conditional on observed and unobserved heterogeneity, retirement decisions can still be (positively) correlated, due to, for example, complementarity in leisure or financial incentives that make retirement more attractive once the partner also retires.

The hazard rates for the three latent durations Y^{op}, Y^{yp}, Y^{c} are specified as mixed proportional hazards:

$$h^{j}\left(t|X_t, V^{j}\right) = \gamma^{j}(t)\exp\left(X_t\beta^{j} + V^{j}\right); j = op, yp, c \quad (1)$$

The baseline hazards $\gamma^{j}(t)$ are specified as piecewise constant.[11] The hazards depend on observed variables X_t, one of which varies over time (the gender specific regional unemployment rate), and on time invariant

[11] We estimated the same specifications using Weibull baseline hazards. According to the Akaike Information Criterion, the specifications with piecewise constant baseline hazards give a better fit to the data.

Table 3
Estimation results for several model specifications: Hazard younger partner.

	IPH Model	An et al. Model- two hazards		An et al. Model–no mixing	Complete An et al. Model	
		2 mass points	3 mass points		2 mass points	3 mass points
tp1	−3.48***	−3.49***	−3.84***	−3.88***	−3.95***	−4.02***
	(0.14)	(0.14)	(0.18)	(0.18)	(0.16)	(0.17)
tp2	−3.09***	−3.09***	−3.28***	−3.49***	−3.57***	−3.61***
	(0.15)	(0.15)	(0.17)	(0.19)	(0.17)	(0.17)
tp3	−2.79***	−2.79***	−2.78***	−3.26***	−3.31***	−3.32***
	(0.15)	(0.15)	(0.17)	(0.20)	(0.18)	(0.18)
tp4	−2.36***	−2.35***	−2.15***	−2.87***	−2.91***	−2.89***
	(0.17)	(0.17)	(0.19)	(0.22)	(0.19)	(0.20)
tp5	−2.05***	−2.04***	−1.72***	−2.53***	−2.59***	−2.54***
	(0.17)	(0.17)	(0.20)	(0.22)	(0.20)	(0.20)
tp6	−1.40***	−1.38***	−0.99***	−1.96***	−2.04***	−1.97***
	(0.16)	(0.16)	(0.19)	(0.21)	(0.19)	(0.20)
tp7	−1.53***	−1.51***	−1.10***	−2.66***	−2.55***	−2.47***
	(0.15)	(0.15)	(0.19)	(0.22)	(0.19)	(0.19)
tp8	−1.41***	−1.38***	−0.95***	−2.40***	−2.51***	−2.42***
	(0.14)	(0.14)	(0.18)	(0.21)	(0.18)	(0.18)
Male_older_partner	0.36***	0.36***	0.42***	0.44***	0.48***	0.49***
	(0.061)	(0.062)	(0.071)	(0.085)	(0.077)	(0.080)
Male_older_partner = 0#	−0.12	−0.13	−0.13	−0.157	−0.14	−0.152
Post-reform = 1	(0.072)	(0.072)	(0.08)	(0.107)	(0.095)	(0.098)
Male_older_partner = 1#	−0.31***	−0.32***	−0.36***	−0.34***	−0.32***	−0.33***
Post-reform = 1	(0.035)	(0.035)	(0.041)	(0.044)	(0.039)	(0.040)
Age_difference	−0.020***	−0.020***	−0.024***	−0.013***	−0.013***	−0.014***
	(0.00073)	(0.00074)	(0.0011)	(0.00086)	(0.00079)	(0.00082)
Partnership_duration_SPA	−0.000053	−0.0000092	−0.000071	0.000095	0.00017	0.00015
	(0.00020)	(0.00020)	(0.00023)	(0.00025)	(0.00023)	(0.00024)
Children (dummy)	−0.19***	−0.19***	−0.19**	−0.20**	−0.22***	−0.22***
	(0.054)	(0.054)	(0.061)	(0.066)	(0.060)	(0.062)
Unemployment rate	−6.82***	−7.17***	−7.68***	−6.17**	−5.31**	−5.18*
	(1.82)	(1.83)	(2.01)	(2.29)	(2.05)	(2.11)
V1		−0.77***	2.27***		0.055***	1.69***
		(0.12)	(0.19)		(0.011)	(0.24)
V2			−0.24***			−0.025
			(0.055)			(0.023)

Note: Baseline hazard for the three hazards is a piece-wise constant with annual cut points: tp1 to tp8 (from 2010 to 2017, one dummy per year). Standard errors in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

unobserved heterogeneity terms $(V^j, j = op,\ yp,\ c)$ that are assumed to be independent of all X_t (the standard assumption in this kind of models; see van den Berg, 2001), but may be correlated among each other. We will assume that they follow a discrete distribution with two or three mass points (cf. Heckman and Singer, 1984). This splits the population into several groups with different exit rates, but which group a couple belongs to is not observed. The population fractions of the groups are unknown parameters p_k. We do not impose any normalization on the baseline hazard, but instead assume.

$$E(V^j) = 0 : \sum_{k=1}^{K} p_k \bullet V_k^j = 0, j = op, yp, c$$

Conditional on the $(V^j, j = op, yp, c)$, the three durations Y^{op}, Y^{yo}, Y^c are assumed to be mutually independent.

As explained in Section "Data and Descriptive statistics", we grouped durations into quarters and define joint retirement as retiring in the same quarter. The covariates X_t can vary across quarters but not within quarter, and the piecewise constant baseline hazards remain constant within each quarter. (In fact, we will assume they are constant over each full year.) This implies that it is straightforward to compute the three integrated hazards and corresponding survival functions $S^{op}(t, V)$, $S^{yp}(t, V), S^c(t, V)$ conditional on $V = (V^{op}, V^{yp},\ V^c)$ (for details, see An et al., 2004).

The model is estimated with maximum likelihood. Likelihood contributions can be written as the expected value over the unobserved heterogeneity terms of the conditional likelihood given V. The conditional likelihood contribution is a straightforward expression in terms of survival functions and hazard rates. If the older partner in couple n retires in an earlier quarter than the younger partner does ($t_n^{op} < t_n^{yp}$), then the conditional likelihood contribution is given by:

$$S_n^{op}(t^{op}, V)\ S_n^{yp}(t^{yp}, V) S_n^c(t^{yp}, V) h^{op}(t^{op}, V) h^{yp}(t^{yp}, V), \tag{2}$$

where the survival functions depend on n through X_t. A similar expression can be given for the case $t_n^{yp} < t_n^{op}$. If both retire in the same quarter ($t_n^{op} = t_n^{yp} = t$), then the conditional likelihood contribution is given by:

$$S_n^{op}(t, V)\, S_n^{yp}(t, V) S_n^c(t, V) [h^{op}(t, V) h^{yp}(t, V) + h^c(t, V)\,] \tag{3}$$

Here the first part of the total hazard reflects 'coincidental' joint retirement while the second part reflects 'structural' joint retirement due to, e.g., complementarities in leisure or joint features of financial incentives. In case of right-censoring (e.g., keep working until the end of the observation window), one or more of the hazards are dropped. See An et al. (2004) for more explanation.

The observed covariates in X_{it} include:

- The "Post-reform" or "not PA-eligible" dummy $T_i = 1\{birthday_i > Dec1949\}$ (1 if the individual is born in January or February 1950, 0 if born in November or December 1949)
- The interaction of male older partner and post-reform, to capture the difference in retirement between the more common couples with husband older than wife, and the less common couples with wife older than husband
- The age difference between partners
- The partnership duration
- A dummy for the presence of children
- The gender specific quarterly regional unemployment rate (*u_rate*)

Table 4
Estimation results for several model specifications: Couple's hazard.

	IPH Model	An et al. Model- two hazards		An et al. Model–no mixing	Complete An et al. Model	
		2 mass points	3 mass points		2 mass points	3 mass points
tp1				−6.06***	−5.80***	−5.98***
				(0.60)	(0.77)	(0.83)
tp2				−5.69***	−5.21***	−5.42***
				(0.61)	(0.72)	(0.79)
tp3				−4.58***	−4.06***	−4.19***
				(0.58)	(0.62)	(0.68)
tp4				−4.12***	−3.53***	−3.59***
				(0.64)	(0.66)	(0.72)
tp5				−4.15***	−3.87***	−3.91***
				(0.64)	(0.72)	(0.78)
tp6				−2.77***	−1.27*	−1.29*
				(0.60)	(0.60)	(0.66)
tp7				−1.48**	1.76**	1.76**
				(0.51)	(0.58)	(0.63)
tp8				−1.32**	4.14***	4.15***
				(0.50)	(0.65)	(0.69)
Male_older_partner				0.15	0.11	0.095
				(0.19)	(0.17)	(0.17)
Male_older_partner = 0#				−0.076	−0.452**	−0.46**
Post-reform = 1				(0.128)	(0.165)	(0.165)
Male_older_partner = 1 #				−0.076	−0.64***	−0.64***
Post-reform = 1				(0.13)	(0.14)	(0.14)
Age_difference				−0.068***	−0.30***	−0.30***
				(0.0045)	(0.019)	(0.019)
Partnership_duration_SPA				−0.00048	−0.00026	−0.00025
				(0.00059)	(0.00062)	(0.00063)
Children (dummy)				−0.12	0.14	0.14
				(0.18)	(0.21)	(0.21)
Unemployment rate				5.29	−1.63	−1.74
				(6.13)	(6.01)	(6.04)
V1					1.05***	0.58
					(0.13)	(6.00)
V2						1.10***
						(0.29)

Note: Baseline hazard for the three hazards is a piece-wise constant with annual cut points: tp1 to tp8 (from 2010 to 2017, one dummy per year). Standard errors in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

In addition to the full An et al. (2004) model, we estimate several special cases for comparison:

i. The An et al. model which has three hazards but without mixing, so all heterogeneity is observed and $P(V^{op} = V^{yp} = V^{c} = 0) = 1$.
ii. The standard bivariate mixed proportional hazards model, where the third (couple's) hazard $h^{c}(t, V)$ is set to zero.
iii. An independent proportional hazards (IPH) model without mixing and without the couple's hazard.

We need the full model, An et al. (2004) model, to disentangle several mechanisms that can explain joint retirement in the data. Model (i) misses unobserved heterogeneity, which can be due to assortative matching or convergence in preference over the course of marriage and has been shown to explain part of joint retirement decisions in observed data. Like in the univariate case, omitting unobserved heterogeneity can lead to biased estimates of duration (in our case age) dependence (Lancaster, 1990). Moreover, allowing the unobserved heterogeneity terms in the two individual hazards to be correlated captures correlation in preferences that can be due to assortative matching in the marriage market or convergence in preferences over time, another potential source of joint retirement. Model (ii) on the other hand misses the structural component of joint retirement that we aim to identify, and which can be due to, e.g., complementarity in leisure. It explains all joint retirement decisions from observed and unobserved heterogeneity. Model (iii) has independent hazards conditional on covariates and can only explain joint retirement due to a common role for the covariates for both individual hazards.

Estimation results

Complete estimation results for the four different model specifications are presented in Tables 2–5. Table 2 shows the parameters of the older partner's hazard, Table 3 refers to the younger partner's hazard and Table 4 to the couple's hazard. Table 5 presents the estimated distribution of the unobserved heterogeneity terms.

The first column of Tables 2 and 3 shows the estimates of the IPH model. In the next two columns, we add correlated unobserved heterogeneity with two and three mass points, respectively. The fourth column adds the hazard for the couple, but without mixing. Finally, Columns 5 and 6 use the full An et al. model, with two and three mass points for the unobserved heterogeneity terms. The couple's hazard in Table 5 only has the final three models.

Table 2 also compares the log likelihoods of the six models and thus helps to select the model that gives the best fit to the data. According to Likelihood Ratio tests, the more restrictive model is always rejected against the more general model. In other words, the complete An et al. model (2004) in the final column, with three hazards and unobserved heterogeneity captured by three mass points is the preferred specification. Using three mass points rather than two or zero mass points improves the likelihood substantially and significantly, and so does allowing for the third (couple's) hazard rather compared to the more standard bivariate duration model with the two individual hazards.

As in An et al. (2004), the importance of the couple's hazard shows that there are factors driving joint retirement that go beyond correlation in individual preferences of the two partners, in line with the evidence of joint retirement in earlier studies, such as Lalive and Parrotta (2017) and other studies mentioned in Section "Literature review and theoretical

Table 5
Estimation results for several model specifications: Unobserved heterogeneity.

An et al. Model- two hazards- 2 mass points					
Mass points	Probability	Older partner		Younger partner	
		V	exp(v)	V	exp(v)
1	5.12 %	−2.54	0.08	−0.77	0.46
2	94.88 %	0.14	1.15	0.04	1.04

Complete An et al. Model- 2 mass points							
Mass points	Probability	Older partner		Younger partner		Couple	
		V	exp (v)	V	exp (v)	V	exp (v)
1	85.69%	0.19	1.21	0.055	1.06	1.05	2.86
2	14.31%	−1.14	0.32	−0.33	0.72	−6.29	0.002

An et al. Model- two hazards- 3 mass points					
Mass points	Probability	Older partner		Younger partner	
		V	exp(v)	V	exp(v)
1	10.69%	0.53	1.70	2.27	9.68
2	85.57%	0.07	1.07	−0.24	0.79
3	3.74%	−3.12	0.04	−1.00	0.37

Complete An et al. Model- 3 mass points							
Mass points	Probability	Older partner		Younger partner		Couple	
		V	exp (v)	V	exp (v)	V	exp (v)
1	3.97%	1.74	5.70	1.69	5.42	0.58	1.79
2	81.44%	0.13	1.14	−0.025	0.98	1.10	3.00
3	14.58%	−1.20	0.30	−0.32	0.73	−6.30	0.002

Note: ρ(younger partner, older partner) = 0.46;
Note: ρ(younger partner, older partner) = 0.81; ρ (couple, older partner) = 0.82; ρ (younger partner, couple) = 0.33.

Table 6
Reform effects for extended model allowing for separate effects for wealthier and less wealthy households.

	Older partner	Younger partner	Couple
male_older_partner=1 # Post-reform=1 # rich=1	-0.52***	-0.36***	-0.69***
	(0.052)	(0.054)	(0.18)
male_older_partner=1 # Post-reform=1 # rich=0	-0.649***	-0.31***	-0.626***
	(0.05)	(0.057)	(0.177)
male_older_partner=0 # Post-reform=1 # rich=1	-0.51***	-0.091	-0.56**
	(0.09)	(0.11)	(0.21)
male_older_partner=0 # Post-reform=1 # rich=0	-0.38***	-0.24	-0.39
	(0.091)	(0.13)	(0.21)
Observations	191,000	191,000	191,000
Log Likelihood	-35,865.562	-35,865.562	-35,865.562

Note: The model extends the final model in Section "Empirical Models" (last column in Tables 2, 3 and 4). Standard errors in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

background". These factors reflect some structural mechanism leading to coordinated decisions of the two spouses. Complementarities in leisure is the most obvious of such mechanisms, but financial incentives or social norms could also play a role. The reform effects on the couple's hazard aim to shed more light on this.

The estimates in the first columns of Tables 2 and 3 are largely in line with the estimates for individual retirement in Nagore García and van Soest (2021). The baseline hazards reflect the empirical hazards in Fig. 2, with, for older partners, a large peak in the year they reach the state pension age. Having children reduces the retirement hazard for both younger and older partners. A larger age difference between partners means that the younger partner is younger,[12] so it is not surprising that this implies a lower retirement hazard in Table 3. This effect of the age difference might also be explained by the gradual increasing of the SPA that affects younger partners, especially those in the post-reform group (not eligible for the PA). Having a young younger partner also reduces the retirement rate of the older partner, though this effect is not significant in the models incorporating a couple's hazard. A higher regional unemployment rate significantly reduces the hazard for younger partners but does not have a significant effect for older partners.

The 2015 reform had a strong negative effect on the retirement rates of older partners: In Table 2, the post-reform dummy is negative and significant for male older partners in all specifications. According to our preferred model, male older partners affected by the reform are almost 45 % less likely to exit to retirement in each quarter before reaching SPA than those not affected by the reforms ($(e^{-0.59}-1) \times 100$ %). If the older partner is a woman, the effect is −36 %. These effects are qualitatively in line with the results of Nagore García and van Soest (2021) who study both individuals' hazards separately. According to their comparison with retirement of singles who reach their SPA just before and just after the reform, they are largely due to the removal of generous early retirement arrangements and to a much lesser extent to the removal of the partner allowance.

For female younger partners (Table 3), the reform also had a strong and significant negative effect on retirement. According to our favourite model (final column), wives younger than their husbands who are in the post-reform group are 28 % less likely to retire than those in the pre-reform group. Nagore García and van Soest (2021) argue that this is due to the removal of the partner allowance, since the allowance created a strong financial incentive for younger partners to retire early, just before their partner reaches his or her SPA. Since older partners often also retired themselves when reaching their SPA, it implies that financial incentives of the PA were a source of joint retirement, captured by the individual hazards. Specifically allowing for a third (couple) hazard hardly changes the estimated effects of the reform on the individual retirement hazards. For the much smaller group of male younger partners (*male_op = 0*), we also find a negative effect, but this is not significant.

The main novelty of the current study compared to Nagore García and van Soest (2021) is the third (couple's) hazard, which explicitly accounts for structural mechanisms leading to joint retirement (Table 4). Our main parameter of interest is the effect of the reform on the couple's hazard. We find a strong negative effect of the reform, both for couples where the older partner is male and for couples where the older partner is female. While much of the reform effects on the individual hazards is probably due to the removal of actuarially unfair early retirement benefits, this is unlikely for the couple's hazard, since the early retirement benefits were purely individual-based, independent of the labour market position of the spouse. In contrast, it seems plausible that the change in the couple's hazard is due to the removal of the PA. First, the PA made it financially more attractive for younger partners to retire early, creating a negative effect of the PA removal on the individual hazard of the younger partner. The fact that, in addition, the couple's hazard changes suggests that removing PA also induced another negative structural effect on joint retirement, not operating through the financial incentives. One possible explanation is a sudden change in social norm due to removing PA (Behagel and Blau, 2012; Atalay and Barrett, 2015; Cribb et al., 2016; Bhatt, 2017): PA acted as a signal that the younger partner (usually the wife) should be able to retire when the older partner (the husband) retired. This signal disappeared with the reform, resulting in different behaviour after the reform. Below we will give more evidence in favour of this explanation vis a vis a change in

[12] Since all older partners are born at approximately the same time, age of the younger partner is almost perfectly correlated with the age difference between partners and not included as a separate regressor.

financial incentives.

The other variable that significantly affects the couple's hazard is the age difference between spouses: the larger the age difference, the smaller the couple's hazard. This result seems intuitive, since a large age difference means that when older partners reach an age at which they typically retire (SPA), their younger partners will often be too young to be able to afford retirement (or consider themselves too young to retire for other reasons).

A final remark on Table 4 concerns the large differences between the models without and with unobserved heterogeneity ("no mixing" versus "2 mass points" and "3 mass points"). This applies in particular to the reform effects (which are small and insignificant in the no mixing model) and the effect of the age difference (which is still significant by much smaller in the no mixing model), in line with the argument of Lancaster (1990) that ignoring unobserved heterogeneity biases the duration dependence estimates (cf. Section "Empirical Models"). It implies that accounting for unobserved heterogeneity makes a substantial difference, confirming that we should not use a simplified model.

Table 5 presents the estimated joint distribution of the unobserved heterogeneity terms in the models that account for unobserved heterogeneity. The estimated correlation coefficient between the frailty components of the two individual hazards is always positive (0.81 in the most general model), suggesting that assortative matching or convergence of preferences for leisure versus consumption often implies that the two partners either both want to retire early, or both want to retire late. This contributes to explaining why couples are often observed retiring jointly, particularly if they have the same age (Michaud et al., 2020). The positive correlations with the frailty component in the couple's hazard suggest that preferences for early retirement go together with a larger tendency to retire jointly.

Responses of richer and poorer couples

To check the plausibility of our interpretation of the effects of the PA removal on the couple's hazard using social norms rather than financial incentives, we estimated an extended version of the most general model in the previous section in which the effects of the reform can be different for the wealthier and less wealthy households in the sample, interacting the reform effects with dummies indicating whether initial household financial wealth net of household debt is below or above the median (using dummies *rich* and *poor*).[13] The results are summarized in Table 6.[14]

The extension outperforms the model in Section "Empirical Models" according to a likelihood ratio test,[15] although most of the reform effects are qualitatively similar for the richer and poorer households. The main conclusion from Table 6 is that most reform effects are larger for the richer than for the poorer households. This certainly applies to all couple's hazards, although the differences are not individually significant. If the reform effect were due to the changes in financial incentives, we would expect the reduction of the couple's hazard to be larger for poorer households, for whom the state pension plays a much larger role in relation to their total income and pension entitlements. This is the opposite of what we find. Our findings therefore suggest that financial incentives are not the main story, backing up the interpretation for the change in the couple's hazard that we already gave above: the reform weakened the social norm that couples are expected to retire when the oldest partner retires. This confirms findings of Atalay and Barrett (2015), Cribb et al. (2016), and Bhatt (2017), who all emphasize the role of institutional arrangements setting a social norm. It is also in line with Nagore García et al. (2021), who find that richer self-employed respond more to the anticipated wealth shock of receiving the State Pension than poorer self-employed and attribute this to social norm of retiring at the SPA.

Robustness check

Admittedly, defining joint retirement as retiring in the same quarter is somewhat arbitrary (cf. Section "Data and Descriptive statistics"). Since many other studies use data at an annual aggregation level and define joint retirement as retirement in the same calendar year instead of the same quarter, we have also estimated the same model at an annual level of aggregation. The results can be found in the appendix. Due to the coarser nature of the data used for these estimations, there are some issues with estimating the couple's hazard. For example, the estimated baseline hazard is zero in some years and in the model with three mass points, there is a substantial fraction of couples (35.8 %) for which the third hazard is always zero (Table A5).

Still, the main results are qualitatively in line with those of the model using quarterly data: there is significant evidence of a nonzero couple's hazard, and the reform has a significant negative effect not only on individual retirement hazards but also on the couple's hazard.

Conclusions

We have analysed the retirement decisions of couples in the Netherlands around the time of a major reform of public and occupational pensions in 2015. Exploiting a rich administrative dataset on couples falling under the old and the new regime, we estimated a model introduced by An et al. (2004) with two individual retirement hazards and a couple's retirement hazard, also accounting for correlated observed and unobserved heterogeneity. Our first main finding is that the couple's hazard improves the goodness of fit of the model substantially and significantly. This gives evidence of joint retirement that is due to some structural mechanism leading to coordinated decisions of the two spouses. Complementarities in leisure is one of such mechanisms, but financial incentives or non-economic factors such as social norms may also play a role.

Our main findings concern the reform. It removed the partner allowance (PA), previously given to couples where the older partner reached the state pension age, but the younger partner did not, and means tested on the younger partner's income. This removal contributed to a reduction in individual retirement hazards, particularly for the (female) younger partner, since it substantially increased the rewards for the younger partner to work longer and not retire at the time the older partner reaches SPA, an age at which the older partner is likely to retire. Thus the removal of PA reduced one financial incentive to retire jointly, captured by the individual hazard of the younger spouse.

The main finding in our paper is that the reform also lowered the third hazard: the couple's retirement hazard, capturing retirement of both partners in the same quarter. This is true for couples where the husband and for couples where the wife is the older partner, though the effect is stronger for couples where the husband is older than the wife. Since we do not expect the reform to change preferences for joint leisure activities and since the reform does change individual financial incentives but not the incentives for retiring jointly, we argue that this effect must reflect a different structural mechanism. We propose a change in social norm, which seems plausible because it was public knowledge that the partner allowance was based upon the traditional one earner family model and its removal was motivated by the fact that this model no longer applied for the new generations. Moreover, our finding in an extended model that the reform effects on the couple's hazard is at least as large for the richer half of the households in the sample as for the poorer half further justifies this interpretation rather than an interpretation related to financial incentives.

[13] We estimated a model adding some initial conditions, such as household wealth net of debt, to the general model and the main results were similar to those presented in the paper.

[14] Complete estimation results are available upon request from the authors.

[15] Test statistic 37.78, exceeding the 5% critical value of the chi squared distribution with six degrees of freedom (12.66).

Future research could focus on structural dynamic models that can help to identify the role of financial incentives and complementarities in leisure for individual and joint retirement more precisely. On the other hand, if our interpretation is correct, such a structural model should also account for behavioural phenomena such as changing social norms, as is also suggested by the recent literature on explaining the stylized facts in individual retirement decisions.

CRediT authorship contribution statement

Amparo Nagore García: Data curation, Methodology, Software, Visualization, Writing – original draft. **Arthur van Soest:** Conceptualization, Validation, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Table A1
Definition of the explanatory variables.

Variables	Description	Source
Personal Characteristics		
Male_younger_partner	1 if the younger partner is male	GBAPERSOONTAB
Male_older_partner	1 if the older partner is male	GBAPERSOONTAB
Age_younger_partner_m	Age of the younger partners (in months). Time-varying variable.	GBAPERSOONTAB
Difference in age (months)	Age difference between partners in months	GBAPERSOONTAB
Partnership_duration at the SPA (months)	Partnership duration (in months) in the month the older partner reaches the SPA	GBAVERBINTENISPARTNERBUS
Children	1 if the younger partner has children	KINDOUDER
Household Variables		
Financial wealth net of debt	Financial wealth net of financial debts (except mortgage for home owners) at the beginning of 2010	INTEGRAAL VERMOGENSBESTAND
Rich	1 if household financial wealth net of debt at the beginning of 2010 is above the median	INTEGRAAL VERMOGENSBESTAND
Macroeconomic variable		
Regional Unemployment rate (men and women)		
	Yearly regional (at province level) unemployment rate by gender for the older (younger) partner. (units: percentage: 0.04)	Eurostat

Table A2
Estimation results for several model specifications: Hazard older partner with annual observations.

	IPH Model	An et al. Model- two hazards		An et al. Model–no mixing	Complete An et al. Model	
		2 mass points	3 mass points		2 mass points	3 mass points
tp1	−2.97***	−3.00***	−3.33***	−3.12***	−3.05***	−3.09***
	(0.14)	(0.17)	(0.24)	(0.15)	(0.17)	(0.17)
tp2	−2.08***	−2.08***	−2.38***	−2.25***	−2.14***	−2.17***
	(0.14)	(0.17)	(0.24)	(0.15)	(0.16)	(0.17)
tp3	−1.51***	−1.43***	−1.67***	−1.70***	−1.51***	−1.51***
	(0.15)	(0.18)	(0.25)	(0.16)	(0.18)	(0.19)
tp4	−1.47***	−1.26***	−1.39***	−1.69***	−1.38***	−1.33***
	(0.17)	(0.21)	(0.28)	(0.18)	(0.20)	(0.21)
tp5	−1.73***	−1.46***	−1.45***	−1.94***	−1.57***	−1.49***
	(0.17)	(0.21)	(0.27)	(0.18)	(0.21)	(0.22)
tp6	0.35*	1.13***	1.81***	0.17	0.82***	1.03***
	(0.16)	(0.21)	(0.40)	(0.17)	(0.20)	(0.21)
tp7	−1.16***	0.53*	1.48**	−1.54***	−0.25	0.14
	(0.15)	(0.25)	(0.49)	(0.17)	(0.21)	(0.23)
tp8	−1.18***	0.97**	2.18***	−1.66***	−0.057	0.46
	(0.16)	(0.32)	(0.63)	(0.18)	(0.22)	(0.26)
Male_older_partner	0.046	0.23***	0.27**	0.040	0.16*	0.22**
	(0.055)	(0.069)	(0.084)	(0.059)	(0.068)	(0.074)
Male_older_partner = 0#	−0.252***	−0.3688***	−0.46***	−0.27***	−0.36***	−0.35***
Post-reform = 1	(0.06577)	(0,08)	(0.103)	(0.071)	(0.08)	(0.087)
Male_older_partnerp = 1 #	−0.33***	−0.59***	−0.69***	−0.35***	−0.54***	−0.60***
Post-reform = 1	(0.030)	(0.041)	(0.053)	(0.032)	(0.042)	(0.044)
Age_difference	−0.0011*	−0.0023***	−0.0023**	0.00079	−0.0012*	−0.0017**
	(0.00049)	(0.00065)	(0.00079)	(0.00052)	(0.00062)	(0.00066)
Partnership_duration_SPA	0.00055**	0.00071**	0.00085**	0.00068***	0.00078***	0.00074**
	(0.00017)	(0.00022)	(0.00028)	(0.00018)	(0.00021)	(0.00023)
Children (dummy)	−0.16***	−0.22***	−0.29***	−0.15**	−0.23***	−0.23***
	(0.046)	(0.060)	(0.075)	(0.049)	(0.058)	(0.062)
Unemployment rate	1.33	−2.97	−2.53	1.21	−1.12	−1.72
	(1.74)	(2.23)	(2.54)	(1.86)	(2.11)	(2.22)
V1		−2.18***	−0.74		0.29***	0.83***
		(0.22)	(0.47)		(0.020)	(0.12)

(*continued on next page*)

Table A2 (*continued*)

	IPH Model	An et al. Model- two hazards		An et al. Model–no mixing	Complete An et al. Model	
		2 mass points	3 mass points		2 mass points	3 mass points
V2			0.92***			0.12***
			(0.10)			(0.035)
a1		−1.90***	1.11***		1.58***	0.49*
		(0.12)	(0.27)		(0.084)	(0.19)
a2			1.85***			1.55***
			(0.25)			(0.098)
Observations	48,568	48,568	48,568	48,568	48,568	48,568
Log Likelihood	–22,884.98	–22,787.28	–22,776.03	–22,682.78	–22,380.378	–22,343.63

Note: Baseline hazard for the three hazards is a piece-wise constant with annual cut points: tp1 to tp8 (from 2010 to 2017, one dummy per year). Standard errors in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table A3
Estimation results for several model specifications: Hazard younger partner with annual observations.

	IPH Model	An et al. Model- two hazards		An et al. Model–no mixing	Complete An et al. Model	
		2 mass points	3 mass points		2 mass points	3 mass points
tp1	−2.16***	−2.16***	−2.16***	−2.67***	−2.60***	−2.68***
	(0.14)	(0.14)	(0.15)	(0.19)	(0.16)	(0.17)
tp2	−1.64***	−1.64***	−1.64***	−2.21***	−2.11***	−2.17***
	(0.15)	(0.15)	(0.15)	(0.20)	(0.17)	(0.17)
tp3	−1.34***	−1.33***	−1.34***	−2.04***	−1.83***	−1.87***
	(0.15)	(0.15)	(0.16)	(0.21)	(0.17)	(0.18)
tp4	−0.91***	−0.89***	−0.90***	−1.64***	−1.42***	−1.44***
	(0.17)	(0.17)	(0.17)	(0.23)	(0.19)	(0.20)
tp5	−0.60***	−0.58***	−0.58***	−1.24***	−1.09***	−1.09***
	(0.17)	(0.17)	(0.17)	(0.24)	(0.19)	(0.20)
tp6	0.059	0.090	0.091	−0.76***	−0.59**	−0.56**
	(0.16)	(0.16)	(0.17)	(0.23)	(0.19)	(0.19)
tp7	−0.081	−0.042	−0.039	−1.41***	−0.99***	−0.94***
	(0.15)	(0.15)	(0.15)	(0.24)	(0.18)	(0.19)
tp8	0.050	0.097	0.10	−1.22***	−0.96***	−0.92***
	(0.14)	(0.15)	(0.15)	(0.23)	(0.17)	(0.18)
Male_older_partner	0.34***	0.36***	0.35***	0.46***	0.45***	0.52***
	(0.062)	(0.062)	(0.063)	(0.094)	(0.075)	(0.081)
Male_older_partnerp = 0#	−0.1358383	−0.142*	−0.14*	−0.18	−0.17***	−0.12
Post-reform = 1	(0.071948)	(0 0.0726)	(0.073)	(0.119)	(0.091)	(0.094)
Male_older_partner = 1 #	−0.31***	−0.32***	−0.32***	−0.37***	−0.33***	−0.34***
Post-reform = 1	(0.035)	(0.035)	(0.036)	(0.047)	(0.038)	(0.041)
Age_difference	−0.021***	−0.021***	−0.021***	−0.012***	−0.014***	−0.015***
	(0.00074)	(0.00075)	(0.00075)	(0.00091)	(0.00078)	(0.00083)
Partnership_duration_SPA	−0.00011	−0.000093	−0.000096	0.00016	0.00014	0.000020
	(0.00020)	(0.00020)	(0.00020)	(0.00027)	(0.00022)	(0.00023)
Children (dummy)	−0.19***	−0.19***	−0.20***	−0.20**	−0.23***	−0.23***
	(0.054)	(0.054)	(0.055)	(0.070)	(0.059)	(0.063)
Unemployment rate	−6.90***	−7.35***	−7.13***	−6.22*	−5.27**	−4.91*
	(1.83)	(1.84)	(1.84)	(2.44)	(2.02)	(2.10)
V1		−0.48***	−0.16*		0.070***	0.76***
		(0.056)	(0.063)		(0.012)	(0.085)
V2			0.15***			−0.20**
			(0.038)			(0.063)

Note: Baseline hazard for the three hazards is a piece-wise constant with annual cut points: tp1 to tp8 (from 2010 to 2017, one dummy per year). Standard errors in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table A4
Estimation results for several model specifications: Hazard couple with annual observations.

	IPH Model	An et al. Model- two hazards		An et al. Model–no mixing	Complete An et al. Model	
		2 mass points	3 mass points		2 mass points	3 mass points
tp1				−4.90***	−4.34***	−6.56***
				(0.70)	(1.25)	(1.71)
tp2				−3.46***	−3.08**	−5.30***
				(0.50)	(1.07)	(1.42)
tp3				−2.38***	−2.57*	−4.79***
				(0.48)	(1.09)	(1.44)
tp4				−2.01***	−2.23	−4.60**
				(0.54)	(1.21)	(1.54)
tp5				−2.27***	−20.8	−21.3
				(0.56)	(2526.4)	(2332.6)
tp6				−0.68	2.49*	0.70
				(0.51)	(1.16)	(1.34)

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Table A4 (*continued*)

IPH Model	An et al. Model- two hazards		An et al. Model–no mixing	Complete An et al. Model	
	2 mass points	3 mass points		2 mass points	3 mass points
tp7			0.18	8.53***	7.55***
			(0.44)	(1.55)	(1.92)
tp8			0.41	14.6***	14.5***
			(0.43)	(2.38)	(3.28)
Male_older_partner			0.10	0.28	0.21
			(0.17)	(0.32)	(0.36)
Male_older_partner = 0# Post-reform = 1			−0.081	−0.95**	−1.32**
			(0.16)	(0.32)	(0.45)
Male_older_partner = 1# Post-reform = 1			−0.051	−1.13***	−1.32**
			(0.12)	(0.30)	(0.47)
Age_difference			−0.065***	−0.69***	−0.78***
			(0.0042)	(0.10)	(0.15)
Partnership_duration_SPA			−0.00070	−0.0021	−0.0024
			(0.00052)	(0.0014)	(0.0016)
Children (dummy)			−0.15	−0.12	−0.081
			(0.16)	(0.39)	(0.45)
Unemployment rate			3.34	3.48	7.85
			(5.28)	(10.4)	(11.7)
V1				2.77***	−5.80***
				(0.50)	(1.30)
V2					5.14***
					(1.23)

Note: Baseline hazard for the three hazards is a piece-wise constant with annual cut points: tp1 to tp8 (from 2010 to 2017, one dummy per year). Standard errors in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table A5
Estimation results for several model specifications: Unobserved heterogeneity. Annual observations.

An et al. Model- two hazards- 2mass points

Mass points	Probability	Older partner		Younger partner	
		V	exp(V)	V	exp(V)
1	1.95 %	2.18	8.85	−0.48	0.62
2	98.05 %	−0.04327	0.96	0.009526	1.01

An et al. Model- two hazards- 3mass points

Mass points	Probability	Older partner		Younger partner	
		V	exp(V)	V	exp(V)
1	29.00%	−0.74	0.48	−0.16	0.85
2	61.00%	0.92	2.51	0.15	1.16
3	10%	−3.606	0.03	−0.468	0.63

Complete An et al. Model- 2 mass points

Mass points	Probability	Older partner		Younger partner		Couple	
		V	exp(V)	V	exp(V)	V	exp(V)
1	82.9%	0.29	1.34	0.07	1.07	2.77	15.96
2	17.1%	−1.41	0.24	−0.34	0.71	−13.45	0.00

Complete An et al. Model- 3 mass points

Mass points	Probability	Older partner		Younger partner		Couple	
		V	exp(V)	V	exp(V)	V	exp(V)
1	22.2%	0.83	2.29	0.76	2.14	−5.8	0.00
2	64.2%	0.12	1.13	−0.2	0.82	5.14	170.72
3	13.6%	−1.92	0.15	−0.29827	0.74	−14.75	0.00

Note: Rho (older partner, younger partner) = 0.98.
Note: Rho (older partner, younger partner) = 0.61; Rho(couple; older partner) = 0.53; Rho (younger partner, couple) = -0.35.

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