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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, and introduced a law that made actuarially generous early retirement arrangements much less attractive. Using rich administrative data, we estimate a multivariate mixed proportional hazards model that distinguishes between two sources of joint retirement: causal mechanisms that make retirement of one spouse more likely when the other spouse retires ("state dependence", e.g. due to complementarities in leisure or social norms) and correlated preferences (observed and unobserved heterogeneity). We find that the reform weakened state dependence in joint retirement.

Keywords: Household labour supply, ageing, partner allowance, early retirement

JEL: D91, D31, J26

[1] This paper uses non-public microdata provided by Statistics Netherlands, made available for scientific research under certain conditions (contact microdata@cbs.nl for further information).

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1. 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 simultaneously eliminated the partner allowance and generous early retirement arrangements, increasing the incentives to work longer for specific cohorts.

Pension systems are mostly designed at the individual level (Stancanelli, 2017), but the partner allowance (PA) in the Dutch system added a common feature. It was a supplementary allowance (up to 50 percent of the minimum wage)[4] to the state pension (SP), paid if the older partner already received the state pension[5] as long as the younger partner had not yet reached their state pension age (SPA) and had low personal income from work or benefits. This created an incentive for the younger partner to stop working before the older partner reached their SPA, probably increasing the probability of retirement around that date.

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 evidence makes it worthwhile to analyse retirement decisions of individuals in couples at the level of the couple.

Our study contributes to the growing recent literature exploiting changes in social security design to estimate joint-retirement patterns of married couples. These studies come to contrasting findings on the direction of the interactions and asymmetric responses between wives and husbands. While these studies tend to 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.

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.

[4] 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.

[5] 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.

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. By adding a third – joint retirement - hazard to the standard bivariate model with two individual hazard rates, they explicitly accounted for the utility of retiring jointly, in addition to the other sources of joint retirement. In this study, we follow the modelling strategy of An et al. (2004) to investigate joint retirement decisions of working couples in the Netherlands who are and are not subject to the 2015 reform. 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 fall substantially due to the reform, which can largely be explained by the disappearance of generous (actuarially very unfair) early retirement occupational pensions. In addition, we find that the joint retirement hazard falls significantly due to the reform. We argue that the most plausible explanation is 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. Section 2 presents a brief review of the literature. Section 3 explains the main characteristics of the Dutch pension system. Section 4 describes the data. In section 5 we present the econometric framework for the durations until retirement of both partners in the couple. Section 6 discusses the main results. Conclusions are drawn in section 7.

2. 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 tend to retire at approximately the same time, even if they differ in age. Most existing studies relate to the United States. 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 the effect is 10% larger 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 - preferences to retire with the partner rather than alone, for example because of the utility of joint leisure activities - as an important factor (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 leisure complementarities in retirement are 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 (e.g., Hurd, 1990; An et al., 2004) is based on the idea that individuals tend to choose a partner with similar preferences for leisure and work. Poor health influences the individual retirement decision and may increase the necessity of care giving by the spouse, thus influencing the spouse's retirement behaviour (Jiménez-Martín et al. 1999). Financial incentives for retirement may also affect the spouse's retirement behaviour (Baker, 2002; Coile 2004;Lalive and Staubli, 2015). The structure of financial incentives for retirement may directly cause a positive correlation between retirement dates. An example where the rules immediately provide an incentive for joint retirement is the spouse allowance in 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 magnitude of the causal effect of financial incentives on joint retirement is very 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 couple´s labour supply, probably because most of the retirement policies are individually designed (Stancanelli, 2017). Baker (2002) examined how couples´ labour supply responded to the introduction of the Spouse´s 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 showing a lower participation rates 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 benefit would be independent of the younger partner's income, younger partners would tend to continue working more often.

Retirement decisions are also influenced by behavioural factors such as social norms, an age anchor, peer effects and reference dependence. For instance, 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.

3. The Dutch Pension system

As in many European countries, the Dutch pension system consists of three pillars: a state pension, (mandatory) occupational pensions, and individual private pensions.

First pillar: State pension (SP)

The state pension (AOW, *Algemene Ouderdoms Wet*) provides a basic income (linked to the minimum wage) for everyone who has reached the state pension age (SPA) and has been a

resident in the Netherlands from age 15 to age 65 (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 pension benefit that in principle guarantees 70% of the minimum wage for a person living alone and 50% for each partner in a couple (married or living together). The Partner Allowance was linked to the AOW until its elimination in 2015. Table A2 in the Appendix shows the AOW pension amounts by partnership status.

Partner allowance

The partner allowance (PA) is an extra allowance paid to the spouse who reached the SPA if the other spouse is younger than SPA and has low income from work and benefits. The amount of the partner allowance is independent of previous earnings (50 percent of the minimum wage). Since August 2011, the amount could be reduced by up to 10% if the joint monthly income is €2,714 gross or more.

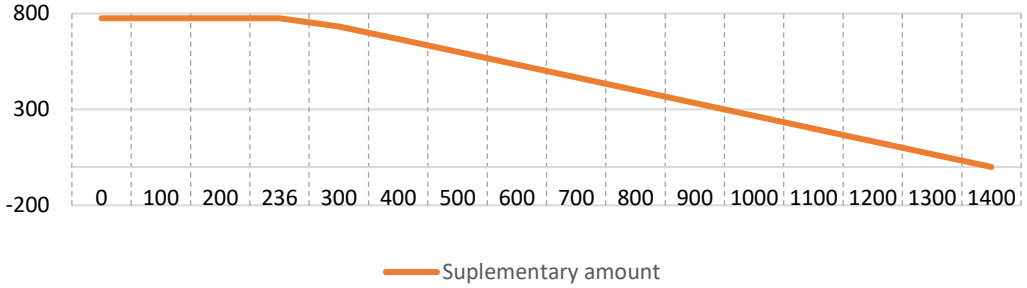
Figure 1 shows the PA amount by the younger partner´s gross monthly income. The first €236.70 of partner's gross monthly salary are disregarded; Two thirds of the salary above €236.70 are deducted from the allowance; if the salary exceeds €1,411.13 gross per month, no supplementary allowance is payable. If the younger partner receives a pension, it is deducted in full from the allowance. If it is more than €782.95 gross per month, no PA is payable.

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 the younger partner's income.

Second Pillar: Occupational Pension

The second pillar, the occupational pension system, helps employees to maintain their standard of living after retirement. Participation is mandatory for most 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.

Figure 1 Supplementary AOW amount (€ per month) by income of the younger partner (€ per month)



Source: Own elaboration

***Early retirement schemes*[6]**

As of January 1, 2006, the Dutch government adopted a new law on early retirement, the *Early Retirement and Life-Course Saving Arrangement Act* ("Wet VPL"), making it less attractive to stop working before SPA for cohorts born after 1949, precisely the cohorts of older partners affected by the PA abolishment.

The new law on early retirement abolished the fiscal advantages for early retirement and transformed existing actuarially attractive pre-pension 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).

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

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.

4. Data and Descriptive statistics

Dataset

Our empirical analysis is based on several Dutch administrative datasets provided by Statistics Netherlands that can be matched through anonymized identification codes. 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) use the same source of data to analyze the effect of PA on individual retirement decisions; they do not consider joint retirement.

To construct the individual´s labour market state in a given time period, we link the employment dataset that includes information on paid work on a monthly basis and we aggregate it at a quarterly basis. Moreover, we merge other datasets containing individual characteristics. Table A1 in the appendix shows a detailed description of the variables included in our panel and the source of information.

We define two labour market states: employment and retirement. An individual is employed if he or she works more than 60 hours per quarter[7] 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 less than 60 hours, or earns less than €711. We identify joint retirement when both partners retire in the same quarter. Retirement is considered an absorbing state, i.e., we do not consider

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

transitions out of retirement. Other exits or no exit (keep 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 2016. We only use couples where both partners do paid work five years before the older partner´s SPA[8] and where the age difference between partners exceeds two months. We follow both partners until they stop working or until the end of the observation period (end of 2016). In addition, we exclude individuals who were self-employed[9] at any time from 2010 until 2016, since information on self-employment is on an annual basis and we cannot identify the quarter in which a self-employed individual stops working.

Moreover, we focus on the narrow cohorts around the reform: the older partner reaches the SPA around the time of elimination of the partner allowance and the early retirement reform (February-May 2015). Only couples in which the older partner reaches the SPA before April 1st 2015 are eligible for the partner allowance. These are the older partners born in November or December 1949; if the older partner is born after 1949, the couple is not eligible. The same date (January 1st 1950) determines whether the individual 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 sample than used in An et al. (2004) (243 couples).

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

[8] Since data are quarterly, couples whose older partner reaches the SPA in February-March (April-May) 2015 must be working in 1st (2nd) quarter 2010 to be included in the sample.
[9] To identify individuals who worked as self-employed we use a dataset on incomes from self-employment. (*PINKZELFST*).

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%).

Table 1 Descriptive statistics of dual working couples 20 quarters before older partner´s 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 (months)	674.72	34.80	674.2827	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 dur. at SPA	442.28	99.13	447.02	95.16	-1.72	427.34	118.17	434.65	106.53	-1.05
Children	90.5%	0.29	90.4%	0.29	0.17	81.0%	0.39	85.5%	0.35	-1.96
Macroeconomic characteristics										
Husband unemp. rate	4.4%	0.006	4.4%	0.006	2.58	4.3%	0.006	4.4%	0.006	-1.52
Wife unemp. rate	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 gives the test statistic for the null of equal means pre- and post-reform.

Source: Own elaboration from administrative data from Statistics Netherlands

Exits to retirement

Figure 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. 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 pre-ER reform) and post-reform groups. Focusing on the typical couples (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 pre-reform husbands, who have higher hazard rates at the typical peaks of early retirement. Both groups of husbands have the largest hazard rate shortly after reaching the SPA. Only pre-reform wives (PA-eligible) show a small peak at the husband´s SPA.

The pattern is not so clear for less common couples (bottom panel). Differences between pre- and post-reform are smaller for wives than for husbands who are the older partner in the couple. Unlike the top panel in figure 2, there are no differences between younger husbands in pre- and post-reform groups around the older partner´s SPA.

Figure 2 Hazard estimates; exits from work to retirement. Pre- and post-reform groups
Couples where husband is older than wife

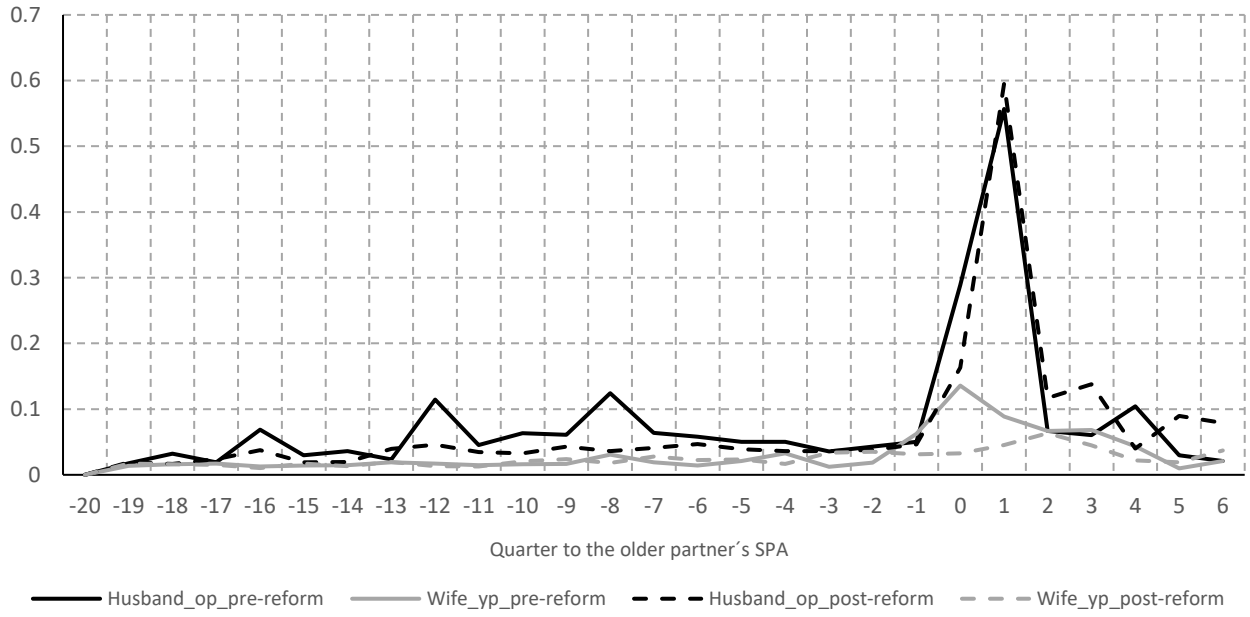
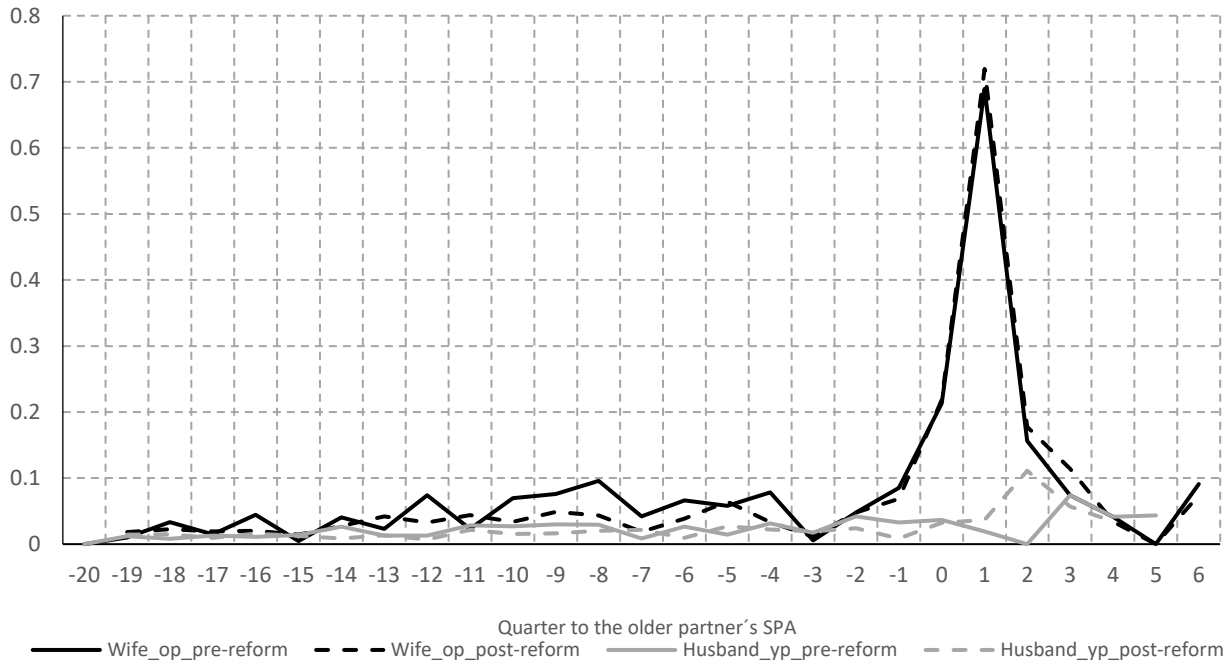


Figure 2, continued. Couples where wife is older than husband



Source: Own elaboration of administrative data from Statistics Netherlands.

In total, the dataset has 4009 couples for which both durations are 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 pre-reform group and 8.22% in the post-reform 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. Figure 2 above and the discussion of Table 1 in An et al., 2004). Nor can we conclude that joint retirement is more common after the reform, since the post-reform distribution of the older partner's retirement quarter 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.

5 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}. Their completion reflects individual retirement of the older and younger partner (*op* and *yp,* respectively) and joint retirement of the couple (*c*). Assuming no censoring, each individual (*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 $T_n^{op} = \min(Y^{op}, Y^{c})$ and $T_n^{yp} = \min(Y^{yp}, Y^{c})$. The novelty of the 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 is also retiring.

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

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

The baseline hazards $\gamma^j(t)$ are specified as piecewise constant.[10] The hazards depend on observed variables X_t, one of which is varying across years (regional unemployment rate), and on time invariant 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. Since we do not impose a normalization on the baseline hazard, we impose

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

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

We grouped durations into quarters, and joint retirement is defined as retiring in the same quarter (see Section 4). The covariates X_t can vary across quarters but not within quarter, and the piecewise constant 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 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 is given by:

[10] 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.

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

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 is given by:

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

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" 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
- Age difference between partners
- Partnership duration
- Presence of children
- The regional unemployment rate (*u_rate*)

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.

6. 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 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 second and third column, we add correlated unobserved heterogeneity with two and three mass points of support respectively, but we set the couple's hazard to 0. The fourth column adds the hazard for the couple to the IPH model, but without mixing. Finally, in columns 5 and 6, the full An et al. model is used, with two and three points of support for the unobserved heterogeneity terms. Table 5 for the couple's hazard only has the final three models.

Table 2 also compares the log likelihoods of the six models. According to Likelihood Ratio tests, the richer model always outperforms the more restrictive model. In other words, the An et al. model with three mass points in the final column is the preferred specification. As in An et al. (2004), the importance of the couple's hazard provides evidence of preferences (or financial incentives) for joint retirement.

The estimates in the first columns of Table 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 Figure 2, with a large peak in the year they reach the state pension age for the older partners. 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, so it is not surprising that this implies a lower retirement hazard. 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. The regional unemployment rate significantly reduces the hazard for younger partners but does not have a significant effect for older partners.

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

	IPH	An et al.- two hazards		An et al.- no mixing	Complete An et al.	
		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_op	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_op=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_op=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)
Partner_dur_SPA	0.00053**	0.00070***	0.00066***	0.00060***	0.00069***	0.00070***
	(0.00017)	(0.00019)	(0.00018)	(0.00017)	(0.00019)	(0.00019)
Children	-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	191000	191000	191000	191000	191000	191000
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). Standard errors in parentheses. * p<0.05; ** p<0.01; *** p<0.001*

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

	IPH	An et al.- two hazards		An et al.-no mixing	Complete An et al.	
		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_op	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_op=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_op=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)
Partner_dur_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	-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*

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

	IPH	An et al.- two hazards		An et al.-no mixing	Complete An et al.	
		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_op				0.15	0.11	0.095
				(0.19)	(0.17)	(0.17)
Male_op=0# Post-reform=1				-0.076	-0.452**	-0.46**
				(0.128)	(0.165)	(0.165)
Male_op=1 # Post-reform=1				-0.076	-0.64***	-0.64***
				(0.13)	(0.14)	(0.14)
Age_difference				-0.068***	-0.30***	-0.30***
				(0.0045)	(0.019)	(0.019)
Partner_dur_SPA				-0.00048	-0.00026	-0.00025
				(0.00059)	(0.00062)	(0.00063)
Children				-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*

Table 5 Estimation results for several model specifications: Unobserved heterogeneity

An et al.- 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.- 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.- 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

Note: Rho(younger partner, older partner)=0.46;

Complete An et al.- 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: Rho(younger partner, older partner)=0.81; Rho (couple, older partner)= 0.82; Rho (younger partner, couple)= 0.33

The 2015 reform has 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 reforms 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 lesser extent to the removal of the partner allowance.

For female younger partners (Table 3), the reform also has a strong and significant negative effect on retirement. According to our favourite model (final column), wives 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 this allowance created a strong financial incentive for younger partners to retire early. 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 younger male partners (*male_op=0*), we also find a negative effect, but this is not significant.

Our main parameter of interest is the effect of the reform on the couple's hazard (Table 4). 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 the reform effects on the individual hazards are probably due to the removal of actuarially unfair early retirement benefits, there seems to be no reason why this should also affect the couple's hazard, since these early retirement benefits were purely individual based, not accounting for 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 partner allowance (PA). PA made it financially more attractive for younger partners to retire early, as already reflected in the younger partner's individual hazard. The fact that the couple's hazard changes suggests that before the reform, PA made early retirement of the younger partner particularly attractive if it coincided with the older partner's retirement. A possible explanation is a change in social norm induced by removing PA (Behagel and Blau, 2012; Atalay and Barrett, 2015; Vermeer, 2016; 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.

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 the older partner reaches an

age at which he or she typically retires (SPA), the younger partner will often consider him- or herself too young to retire.

Table 5 presents the estimated joint distribution of the unobserved heterogeneity terms in the models accounting 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.

Robustness check

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.

7. 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 that also accounts for correlated observed and unobserved heterogeneity. Our first finding is that the couple's hazard improves the goodness of fit of the model substantially. This gives evidence of joint retirement that is not due to correlated individual preferences, but due to some structural mechanism leading to coordinated decisions of the two spouses. Complementarities in leisure is the most obvious of such mechanisms.

Our main findings concern the reform. The main element of the reform was to stimulate individuals to work longer by essentially abolishing generous early retirement occupational pensions. As expected, this had substantial negative effects on the retirement hazard rates at all ages before the state pension age. This response is stronger for older partners in typical couples where the husband is older than the wife. The second element was the removal of the partner allowance, 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.

The main finding in our paper, however, 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 the two types of couples, though the effect is stronger for the typical ones. Since we do not expect the reform to change preferences for joint leisure activities and since the reform does changes individual financial incentives but not the incentives for retiring jointly, we argue that this effect must have a different interpretation. 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.

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.

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Appendix

Table A1 Definition of the explanatory variables

Variables	Description	Source
	Personal Characteristics	
Male_yp	1 if the younger partner is male	GBAPERSOONTAB
Male_op	1 if the older partner is male	GBAPERSOONTAB
Age_yp_m	Age of the younger partners (in months). Time-varying variable.	GBAPERSOONTAB
Difference in age (months)	Age difference between partners in months	GBAPERSOONTAB
Partner_duration (months)	Partnership duration (in months) as a time varying variable	GBAVERBINTENISPARTNERBUS
Partner_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
	Macroeconomic variable	
Unemployment rate (yp_u_rate; op_u_rate)	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	An et al.- two hazards		An et al.- no mixing	Complete An et al.	
		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_op	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_op=0#	-0.252***	-0.3688***	-0.46***	-0.27***	-0.36***	-0.35***
Post-reform=1	(.06577)	(0,08)	(0.103)	(0.071)	(0.08)	(0.087)
Male_op=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)
Partner_dur_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	-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)
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	48568	48568	48568	48568	48568	48568
Log Likelihood	-22,884.988	-22,787.28	-22,776.03	-22,682.784	-22,380.378	-22,343.638

*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	An et al.- two hazards		An et al.-no mixing	Complete An et al.	
		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_op	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_op=0#	-0.1358383	-0.142*	-0.14*	-0.18	-0.17***	-0.12
Post-reform=1	(0.071948)	(0 .0726)	(0.073)	(0.119)	(0.091)	(0.094)
Male_op=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)
Partner_dur_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	-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	An et al.- two hazards		An et al.-no mixing	Complete An et al.	
		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)
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_op				0.10	0.28	0.21
				(0.17)	(0.32)	(0.36)
Male_op=0# Post-reform=1				-0.081	-0.95**	-1.32**
				(0.16)	(0.32)	(0.45)
Male_op=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)
Partner_dur_SPA				-0.00070	-0.0021	-0.0024
				(0.00052)	(0.0014)	(0.0016)
Children				-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.- 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.- 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

Note : Rho (older partner, younger partner)=0.98

Complete An et al.- 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.- 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)= 0.61; Rho(couple; older partner)=0.53; Rho (younger partner, couple) = -0.35