Can Longevity Risk Alleviate the Annuitization Puzzle?

Empirical Evidence from Survey Data

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1. Introduction and Motivation

- Life expectancy has improved substantially since the past decades and it has accelerated in the recent years in all developed countries.

    1. World Health Statistics (2013): global LE at birth between 1990 and 2011 has increased from 62 to 68 years for males, and from 67 to 72 years for females.
    2. In Europe: LE at birth between 1990 and 2011 from 68 to 72 years for males, and from 76 to 79 years for females.
    3. In NL: LE at birth: from 74 to 79 years for males, and from 80 to 82 years for females.

- In an increasingly ageing society: trade off between financial sustainability of retirement system and the need to provide with adequate insurance for late-life consumption
- Pension reforms in the past few years in most OECD countries, leading to higher retirement ages and different ways to compute pension entitlements

1. Introduction and Motivation

- As the only contract that acts as insurance against longevity risk, the annuity should always be chosen by risky individuals, even in presence of bequest motives (Yaari 1965; Davidoff *et al.* 2005)
- Yet the empirical evidence from several countries shows that only a minor fraction of individuals voluntarily buys annuities (James and Song 2001; Johnson *et al.* 2004; Beatrice and Drinkwater 2004)
- The combination of these two facts is known as the "*annuitization puzzle*".

1. Introduction and Motivation

1. Supply side motives
   - highly priced annuities due to adverse selection and administrative costs (Brown *et al.* 1999, 2001 for the USA; Cannon and Tonks 2004, Finkelstein and Poterba 2004 for the UK),
2. Demand side motives
   - intra-family risk sharing (Kotlikoff and Spivak 1981)
   - liquidity constraints and large out-of-pocket health expenditures (Palumbo 1999; De Nardi *et al.* 2010)
   - preference for bequests (Friedman and Warshawsky 1990; Vidal-Melia and Lejarraga-Garcia 2006)
3. Behavioural reasons
   - default effects (Bütler and Teppa 2007)
   - framing effects (Brown *et al.* 2008)

1. Introduction and Motivation

- In NL: Both old age state benefits and supplementary pensions are received in the form of an annuity.
- In a recent study, Brown and Nijman (2011) argue that, contrary to all other developed countries, pension income might be overannuitized in the Netherlands. Accordingly, allowing individuals some discretion over the disposition of the assets in their individual accounts could be welfare improving, as liquidity needs, precautionary motives, and bequests could be better addressed by a greater degree of flexibility.
- This paper contributes to the literature and to the debate about how to cash out pension rights upon retirement, as it focuses on the role of longevity risk in the annuitization decision.

1. Research questions

1. Does the annuity demand respond to longevity risk?
2. Do different time horizons in measuring longevity risk matter?
3. Are actuarial survival probabilities superior predictors of the annuity demand?

1. This paper

1. Methodology
    - utility-based measure of annuity value for singles and couples in a slightly different model than Brown and Poterba (2000) as we take into account explicitly the uncertainty of the time horizons agents face in this decision
    - subjective survival probabilities (SSPs) as measures of perceived longevity risk
2. Main findings
    - people expecting to live longer claim to prefer the annuity
    - individual preferences are consistent with SSPs and not with actuarial ones.
3. Relevance and policy implications
    - delivers important empirical results on the role of the SSPs and their use in the theoretical model for annuitization choices
    - combined with the empirical evidence that on average individuals tend to systematically underestimate their life expectancy, the annuitization puzzle may be alleviated by helping individuals in better assessing their longevity risk
    - relevant findings in a context of overannuitized retirement system

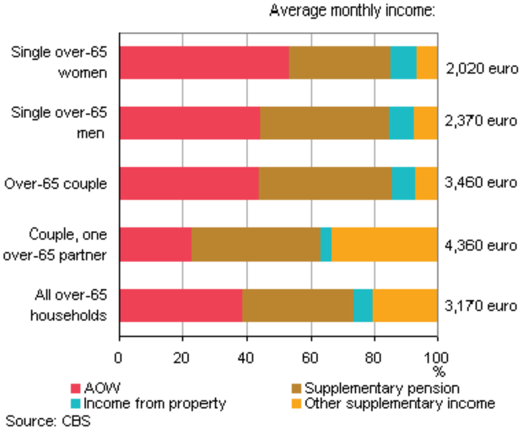
Outline

1. Introduction and Motivation
2. Pension system in NL
3. SSP and theoretical model for annuitization choices
4. Data
5. Results
6. Concluding remarks

2. Pension system in NL

1. PAYG old age state pension
   - unrelated to labour history and to other income sources
   - depends on having lived in the Netherlands and on household composition
   - 40% of the gross incomes of over-65 hhs (CBS, 2012)
2. DC mandatory (between employer and employees) occupational career-average pension
   - pension fund and superannuation payments
   - 35% of the gross incomes of over-65 hhs (CBS, 2012)
3. individual retirement savings schemes held on a purely voluntary basis

All pension income as annuity!


Average monthly income:
Single over-65 women
2,020 euro
Single over-65 men
2,370 euro
Over-65 couple
3,460 euro
Couple, one over-65 partner
4,360 euro
All over-65 households
3,170 euro
0
20
40
60
80
100
%
AOW
Supplementary pension
Income from property
Other supplementary income
Source: CBS

3. SSP

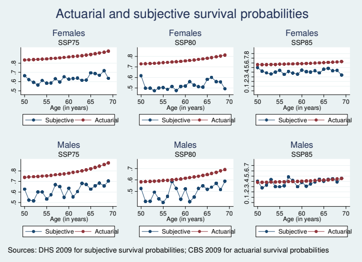
- parental longevity
- subjective survival probabilities (SSP)

Please indicate your answer on a scale of 0 to 10, where 0 means “no chance at all” and 10 means “absolutely certain” .
SSPXX : How likely is it that you will attain (at least) the age of XX?

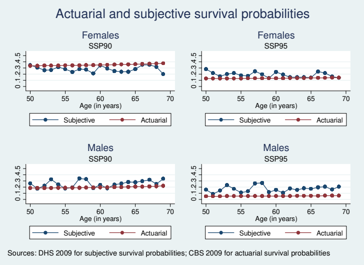
same as HRS, ELSA, SHIW

Table 2: SSPs and socio-economic factors (mean values)

Variable	**SSP75**	**SSP80**	**SSP85**	**SSP90**	**SSP95**	**SSP100**
GENDER						
Women	6.92	5.82	5.11	3.22	3.62	0.67
Men	6.87	5.56	5.31	3.77	2.52	0.56
Difference	*0.05*	*0.26 ** *	*-0.20*	*-0.55*	*1.10*	*0.11*
EDUCATION LEVEL						
Low level	6.60	5.50	5.01	3.34	3.34	0.83
Mid/high level	6.99	5.74	5.37	3.78	2.28	0.46
Difference	*-0.38 *** *	*-0.23 * *	*-0.36*	*-0.43*	*1.05 ** *	*0.37*
SAH						
Good/Very good	7.19	5.98	5.74	4.25	3.11	0.57
Fair/Bad/Very bad	5.78	4.58	3.91	1.86	1.79	0.58
Difference	*1.41 *** *	*1.40 *** *	*1.83 *** *	*2.39 *** *	*1.32 ** *	*-0.01*
LT ILLNESS						
Yes	6.36	5.17	4.90	3.08	2.37	0.60
No	7.08	5.86	5.47	4.01	2.84	0.56
Difference	*-0.72 *** *	*-0.69 *** *	*-0.57 ** *	*-0.92 ** *	*-0.46*	*0.04*
SMOKE						
Yes	6.48	5.24	5.08	3.72	4.00	0.00
No	7.05	5.82	5.26	3.61	2.53	0.64
Difference	*-0.56 *** *	*-0.58 *** *	*-0.17*	*0.10*	*1.46*	*-0.64*
DRINK						
Yes	6.24	4.93	5.11	2.16	1.75	0.00
No	6.94	5.73	5.24	3.69	2.70	0.64
Difference	*-0.69 *** *	*-0.79 *** *	*-0.13*	*-1.53 * *	*-0.95*	*-0.64*
HOUSEHOLD INCOME						
Larger than 40,000 euros	6.86	5.59	5.29	3.60	2.63	0.64
Lower than 40,000 euros	6.82	5.72	5.25	3.74	2.85	0.40
Difference	*0.32*	*-0.13*	*0.04*	*-0.14*	*-0.22*	*0.24*



Sources: DHS 2009 for subjective survival probabilities; CBS 2009 for actuarial survival probabilities

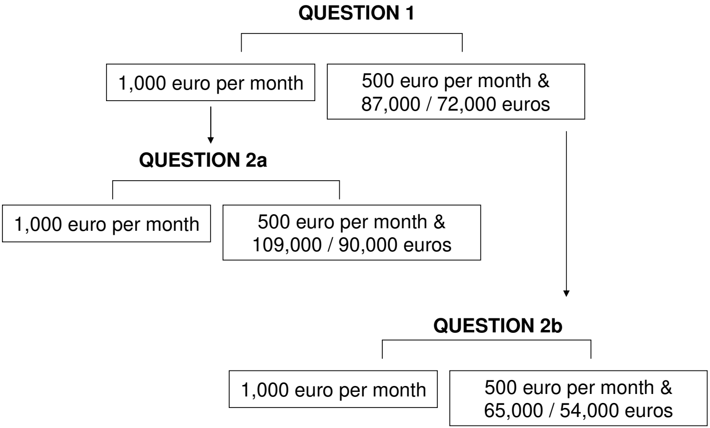


Sources: DHS 2009 for subjective survival probabilities; CBS 2009 for actuarial survival probabilities

3. The dependent variable

Imagine you are 65 years old, and you are receiving 1,000 euro per month in state pension. Suppose you were given the choice to lower that benefit by half, to 500 euro per month. This one-half benefit reduction would continue for as long as you live. In return you would be given a one-time, lump sum payment of [87,000 euro (for females) / 72,000 euro (for males)].

Would you take the 1,000 euro monthly benefit for life, or the lower monthly benefit combined with the lump sum payment?


QUESTION 1
1,000 euro per month
500 euro per month & 87,000 / 72,000 euros
QUESTION 2a
1,000 euro per month
500 euro per month & 109,000 / 90,000 euros
QUESTION 2b
1,000 euro per month
500 euro per month & 65,000 / 54,000 euros

Suppose two periods. Compare value functions

$$\max_s V_2^N(w,p) = pu(w-s) + (1-p)\,v(Rs)$$

with

$$\max_s V_2^A(w,p) = pu(\gamma w - s) + (1-p)\,v(\gamma w + Rs)$$

Calling $q = R\frac{1-p}{p}$

$$\frac{u'(w-s_N)}{v'(Rs_N)} = q = \frac{u'(\gamma w - s_A)}{v'(\gamma w + Rs_A)}$$

Annuity-equivalent wealth α defined as

$$V_2^N(\alpha w, p) = V_2^A(w, p)$$

or

$$\begin{aligned} & pu\left(u'^{-1}\left[qv'\left(Rs_N(\alpha w)\right)\right]\right) && + \quad (1-p)\,v\left(Rs_N(\alpha w)\right) \\ = \quad & pu\left(u'^{-1}\left[qv'\left(\gamma w + Rs_A(w)\right)\right]\right) && + \quad (1-p)\,v\left(\gamma w + Rs_A(w)\right) \end{aligned}$$

Same functional form on both sides, implying

$$Rs_N(\alpha w) = \gamma w + Rs_A(w)$$

replacing in Euler equations yields

$$\alpha = \gamma\left(1 + \frac{1}{R}\right)$$

independent of p and u (risk aversion).

Our model

Suppose no annuities. One-period value function

$$\tilde{V}_1^N(w) = u(w)$$

Two-period value function

$$\tilde{V}_2^N(w) = u(w - s_N(w)) + v(Rs_N(w))$$

Suppose annuities. One-period value function

$$\tilde{V}_1^A(w) = u(\gamma w)$$

Two-period value function

$$\tilde{V}_2^A(w) = u(\gamma w - s_A(w)) + v(\gamma w + Rs_A(w))$$

Define lotteries

$$\begin{aligned} L^A &= p\tilde{V}_1^A + (1-p)\,\tilde{V}_2^A \\ L^N &= p\tilde{V}_1^N + (1-p)\,\tilde{V}_2^N \end{aligned}$$

Prefer annuitization if $L^A > L^N$. Consider α such that

$$L^N(\alpha w, p) = L^A(w, p)$$

or

$$pu(\alpha w) + (1-p)\,\tilde{V}_2^N(\alpha w) = pu(\gamma w) + (1-p)\,\tilde{V}_2^A(w)$$

Compare with Brown and Poterba

$$V_2^N(\alpha w, p) = V_2^A(w, p)$$

Functional form does not net out as in BP, so role for u and p restored.

Full model for couples without annuities

Suppose known time of death of couple, with $T_f < T_m$.
Objective function without access to annuity:

$$V(w_0, T_m, T_f) = \sum_{t=0}^{T_f} \beta^t \left(u(c_{mt} + \lambda c_{ft}) + u(\lambda c_{mt} + c_{ft}) \right) + \sum_{t=T_f+1}^{T_m} \beta^t u(c_{mt})$$

subject to

$$\begin{aligned} w_{t+1} &= R\left(w_t + y_t - c_{mt} - c_{ft}\right) \\ w_{T_m+1} &= 0 \end{aligned}$$

Assume $\beta R = 1$.

Optimal intra-temporal consumption sharing

$$c_{mt} = c_{ft}$$

Optimal inter-temporal allocation for $t \neq T_f$

$$c_t = c_{t+1}$$

Optimal inter-temporal allocation for $t = T_f$,

$$(1+\lambda)\, u'\left(\frac{1+\lambda}{2} c_t\right) = u'\left(c_{t+1}\right)$$

implying

$$c_{t+1} = \varphi c_t$$

Consumption path is a step function with step φ when wife dies.

Inter-temporal budget constraint

$$w_0 + \sum_{t=0}^{T_m} \beta^t \left(y_t^m + y_t^f \right) = \sum_{t=0}^{T_m} \beta^t c_t$$

Substitute the optimal consumption path

$$w_0 + \left\{ \sum_{t=0}^{T_f} \beta^t \left(y_t^m + y_t^f \right) + \sum_{t=T_f+1}^{T_m} \beta^t y_t^m \right\} = c_0 \left\{ \sum_{t=0}^{T_f} \beta^t + \sum_{t=T_f+1}^{T_m} \beta^t \varphi \right\}$$

Using indicator functions, write as

$$w_0 + \tilde{y} B = c_0 \tilde{\varphi} B$$

Full model for couples with annuities

Annuity payment is

$$b_t = \gamma w_0$$

if either the couple or the annuity owner alone is alive at t, and

$$b_t = \tau \gamma w_0$$

if the survivor is not the policy owner.
Period budget constraints are

$$\begin{aligned} w_1 &= R\left(b_0 + y_0 - c_{m0} - c_{f0}\right) \\ w_{t+1} &= R\left(w_t + b_t + y_t - c_{mt} - c_{ft}\right), \qquad t \geq 2 \\ w_{T_m+1} &= 0, \end{aligned}$$

Euler equations as above, so consumption is a step function.
However, inter-temporal budget constraint is different

$$\sum_{t=0}^{T_m} \beta^t \left(b_t + y_t^m + y_t^f \right) = \sum_{t=0}^{T_m} \beta^t c_t$$

Substitute optimal consumption

$$\gamma w_0 \tilde{\tau} B + \tilde{y} B = c_0 \tilde{\varphi} B$$

Compare with lump-sum case

$$w_0 + \tilde{y} B = c_0 \tilde{\varphi} B$$

Value function

$$V(w_0) = \sum_{t=0}^{T_f} \beta^t 2u\left(\frac{1+\lambda}{2}c_0\right) + \sum_{t=T_f+1}^{T_m} \beta^t u(\varphi c_0)$$

Assume CRRA utility

$$u(c) = \frac{c^{1-\rho}}{1-\rho} \Longrightarrow \varphi = \frac{1}{2}(1+\lambda)^{1-\frac{1}{\rho}}$$

implies in matrix form

$$V(w_0) = \frac{1}{\varphi} u(\varphi c_0)\tilde{\varphi} B$$

$\Longrightarrow$ Evaluate V for all configurations of $B = B(T_m, T_f)$.

Define lotteries for couples as

$$
\begin{aligned}
L_L(w_0) &= \sum_{t_m=0}^{T_m} \sum_{t_f=0}^{T_f} p(t_m, t_f)\, V_L(w_0, t_m, t_f) \\
L_A(w_0) &= \sum_{t_m=0}^{T_m} \sum_{t_f=0}^{T_f} p(t_m, t_f)\, V_A(w_0, t_m, t_f),
\end{aligned}
$$

AEW defined over lotteries satisfies

$$0 = \sum_{t_m=0}^{T_m} \sum_{t_f=0}^{T_f} p(t_m, t_f) \left(\tilde{\varphi} B(t_m, t_f)\right)^{\rho}$$
$$\left[((1+x) + z(t_m, t_f))^{1-\rho} - (\gamma \tilde{\tau} B(t_m, t_f) + z(t_m, t_f))^{1-\rho} \right]$$

where lifetime income to wealth ratio

$$z\left(t_m, t_f\right) = \frac{\tilde{y} B\left(t_m, t_f\right)}{w_0}$$

Intuitive comparative statics:

$$\frac{dx}{d\rho} > 0, \frac{dx}{d\beta} < 0, \frac{dx}{dp} < 0.$$

$\Longrightarrow$ preference for annuitization increases with risk aversion and decreases with discounting and expected shorter life spans.

Taking the model to the data

We parameterize γ, β, and τ.
We have y and w_0 for singles and couples.
We have actuarial and subjective duration

$$p_{mt} = p\,(T_m \geq t)$$

We require instead hazard rates, obtained from

$$\begin{aligned} p\,(T_m = t) &= p\,(t \leq T_m < t+1) \\ &= p\,(T_m \geq t)\,p\,(T_m < t+1) \\ &= p_{mt}\,(1 - p_{mt+1}) \end{aligned}$$

Duration data at 5-year frequency $\Longrightarrow$ interpolate or 2nd-order fit for annual frequency.

Variable	I Coefficient [Marg.eff.] (Std. Err.)	II Coefficient [Marg.eff.] (Std. Err.)	IIa Coefficient [Marg.eff.] (Std. Err.)	IIb Coefficient [Marg.eff.] (Std. Err.)	III Coefficient [Marg.eff.] (Std. Err.)
SSP75	0.116 *** [0.041] (0.019)	0.132 *** [0.045] (0.021)	0.128 *** [0.043] (0.031)	0.117 *** [0.041] (0.026)	0.134 *** [0.045] (0.022)
Age 17-30 years		-0.493 *** [-0.170] (0.164)	-0.942 ** [-0.315] (0.429)	-0.741 *** [-0.258] (0.272)	-0.735 *** [-0.250] (0.254)
Age 31-40 years		-0.470 *** [-0.162] (0.130)	-0.492 *** [-0.164] (0.176)	-0.476 *** [-0.165] (0.156)	-0.482 *** [-0.164] (0.131)
Age 41-50 years		-0.339 *** [-0.117] (0.121)	-0.381 ** [0.127] (0.170)	-0.406 *** [-0.141] (0.145)	-0.365 *** [-0.124] (0.122)
Age 51-60 years		-0.284 ** [-0.098] (0.115)	-0.190 [-0.063] (0.161)	-0.392 *** [-0.136] (0.138)	-0.307 *** [-0.104] (0.115)
Female indicator		-0.226 *** [-0.077] (0.086)	-0.265 ** [-0.088] (0.128)	-0.266 ** [-0.092] (0.104)	-0.273 *** [0.093] (0.092)
HH gross income (categories)		-0.022 [-0.007] (0.015)	-0.036 * [-0.012] (0.022)	-0.021 [-0.007] (0.018)	-0.030 * [-0.010] (0.016)
Chances of bequest (in %)		-0.019 * [-0.006] (0.010)	-0.034 ** [-0.011] (0.015)	-0.013 [-0.004] (0.012)	-0.012 [-0.004] (0.011)
Chances of bequest* *Importance of bequest					-0.024 * [-0.008] (0.013)
Log-likelihood	-1327.029	-1142.190	-533.684	-783.121	-1054.773
Pseudo R^2	0.013	0.024	0.032	0.024	0.030
N.Obs.	1000	871	411	596	808

For any additional 10 percent-point increase in the SSP75 the probability to annuitize increases by 4.1 percent on average

4. Model - Three specifications

- Chance of Bequest - *What is the chance that you will leave an inheritance (including possessions and valuable items) of more than 10,000 euro?*

We then split the sample of respondents between those who answered that for them it is important or very important any of the following statements (Regression IIa), and those who answered that for them it is not important or not very important any of the following statements (Regression IIb):

(-) *To save so that I can help my children if they have financial difficulties*
(-) *To save so that I can give money or presents to my children and/or grandchildren*

Variable	I Coefficient [Marg.eff.] (Std. Err.)	II Coefficient [Marg.eff.] (Std. Err.)	IIa Coefficient [Marg.eff.] (Std. Err.)	IIb Coefficient [Marg.eff.] (Std. Err.)	III Coefficient [Marg.eff.] (Std. Err.)
SSP95	0.097 *** [0.034] (0.016)	0.109 *** [0.037] (0.018)	0.108 *** [0.036] (0.026)	0.084 *** [0.029] (0.022)	0.106 *** [0.036] (0.018)
Age 17-30 years		-0.478 *** [-0.164] (0.168)	-1.026 ** [-0.340] (0.430)	-0.771 *** [-0.269] (0.274)	-0.772 *** [-0.262] (0.255)
Age 31-40 years		-0.575 *** [-0.197] (0.132)	-0.623 *** [-0.206] (0.180)	-0.556 *** [-0.194] (0.160)	-0.591 *** [-0.201] (0.134)
Age 41-50 years		-0.415 *** [-0.142] (0.123)	-0.483 *** [0.160] (0.172)	-0.472 *** [-0.165] (0.149)	-0.443 *** [-0.150] (0.124)
Age 51-60 years		-0.307 *** [-0.105] (0.116)	-0.202 [-0.067] (0.163)	-0.417 *** [-0.145] (0.141)	-0.334 *** [-0.113] (0.117)
Female indicator		-0.214 ** [-0.073] (0.087)	-0.271 *** [-0.090] (0.130)	-0.241 ** [-0.084] (0.105)	-0.248 *** [0.084] (0.092)
HH gross income (categories)		-0.013 [-0.004] (0.015)	-0.029 [-0.009] (0.022)	-0.013 [-0.004] (0.018)	-0.019 [-0.006] (0.016)
Chances of bequest (in %)		-0.015 [-0.005] (0.010)	-0.040 *** [-0.013] (0.015)	-0.007 [-0.002] (0.012)	-0.008 [-0.002] (0.011)
Chances of bequest* *Importance of bequest					-0.027 ** [-0.009] (0.013)
Log-likelihood	-1298.135	-1115.798	-528.483	-767.741	-1035.474
Pseudo R^2	0.013	0.025	0.037	0.021	0.029
N.Obs.	978	851	407	583	793

Table 6: Annuity choice and AEW - ordered probit estimates

	(Ia) Coeff. [Marg.eff.] (Std.Err.)	(IIa) Coeff. [Marg.eff.] (Std.Err.)	(IIIa) Coeff. [Marg.eff.] (Std.Err.)	(Ib) Coeff. [Marg.eff.] (Std.Err.)	(IIb) Coeff. [Marg.eff.] (Std.Err.)	(IIIb) Coeff. [Marg.eff.] (Std.Err.)
AEW (actuarial)	0.508	0.618	0.634			
	[0.185]	[0.224]	[0.233]			
	(0.58)	(0.66)	(0.64)			
AEW (subj. interp.)				0.824*	0.983*	1.188**
				[0.300]	[0.356]	[0.436]
				(2.21)	(2.55)	(2.95)
N. children		-0.107	-0.110		-0.123*	-0.130*
		[-0.038]	[-0.040]		[-0.044]	[-0.047]
		(-1.95)	(-1.88)		(-2.21)	(-2.20)
Chances bequest (%)			-0.0249			-0.0306
			[-0.009]			[-0.011]
			(-1.48)			(-1.82)
Chances bequest*			0.008			0.007
*Import.bequest			[0.003]			[0.003]
			(0.41)			(0.39)
Log-likelihood	-558.516	-547.455	-504.949	-556.237	-544.414	-500.776
Pseudo R^2	0.0003	0.013	0.015	0.004	0.018	0.023
N.Obs.	418	415	386	418	415	386

6. Concluding remarks

1. SSPs convey reasonably meaningful information on individual longevity, and relate relatively well with a number of background and socio-economic characteristics, on average.
2. SSPs are systematically lower (esp. for females) than actuarial SP.
3. SSPs are consistent, significant and robust predictors of the individual annuity choice.
4. SSPs do not loose their predictive power when controlling for bequest motives, which is the other main determinant of the choice.
5. Individual preferences are consistent with SSPs and not with actuarial ones.
6. The annuitization puzzle may be alleviated by helping individuals in better assessing their longevity risk.
7. Findings support the possibility of relaxing annuitization constraint in NL, via welfare improving policies.