Optimal annuitization with background risk and equity exposure during retirement

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Annuity products

- Nominal annuity:
  - Contract that pays a specified amount until death.
- Real annuity:
  - Contract that provides a specified purchasing power until death
- Variable annuity:
  - Participation in mutual fund with cash flows until deal

- Annuities are often imposed by social security systems (often PAYG) and / or Defined Benefit pensioen plans. Sometimes also required in DC plans
- Annuities partly insure the risk of outliving your assets

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Annuities and the crisis

- Funded annuity provision has become more important because of
  - Discussion on sustainability and reduction of generosity of current PAYG systems (increase in dependency ratios)
  - Assumed better risk return trade off in funded systems
- Annuity provision can be complemented by investment and contribution policies to reduce conversion risk, e.g. life cycle investing

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Institutional differences

In virtually all countries:

- Annuities imposed by social security system (usually PAYG; sometimes means tested)

US

- Annuitization is mandatory in DB schemes (nominal)
- Annuitization is voluntary in individual DC schemes and hardly chosen

UK

- Annuitization is mandatory in DB schemes (“real”)
- Annuitization is voluntary in individual DC schemes and hardly chosen but mandatory at some age

Germany

- Large PAYG annuity component
- New funded products (Riester plans) require annuitization at later age

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Institutional differences

Switzerland, Australia:

- At retirement individuals can choose to take an annuity or a lump-sum. Many people choose the (recommended) annuity

Netherlands

- In insurance products and DC schemes nominal annuities are mandatory
- In DB schemes the annuities are usually based on conditional indexation, a mix of nominal, real and variable annuities

France

- Not unlike Germany ?

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Academic literature

Welfare impact of access to annuities

- Insurance against longevity risk
- Return enhanced by mortality credit

- Illiquidity of annuities because of adverse selection
- Incompleteness of many annuity markets (e.g. lack of equity exposure or real annuities)
- Load factors; heterogeneity in survival rates
- Absence of bequests

Behavioral literature:

- Financial illiteracy
- Importance of adequate defaults

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This presentation

- Survey of the existing literature
  - Classical results that full annuitization would be optimal
  - Literature on relative impact of deviations from these assumptions

- Analysis of the impact of
  - background risk and
  - lack of indexed and variable annuities

  on welfare implications of access to annuity markets and on annuity demand in setting with optimal savings and investment behavior after retirement

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The Yaari(1965) result and extension by Davidoff, Brown, Diamond (2005)

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Optimality conditions

- Davidoff-Brown-Diamond provide a set of conditions for optimality of full annuitization
- Central assumptions:
  - Actuarially sufficiently fair annuities (mortality credit positive)
  - Absence of bequest motive
  - Complete annuity markets (e.g. indexed linked, equity linked)
- Market completeness implies that annuity version of every possible investment opportunity available: periodically accounts of investor who die are distributed across accounts of surviving investors

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Example: case of time separable CRRA utility

- Utility specification:

$$U(C_1,\ldots,C_T) = \Sigma_t \, (1+\delta)^{-(t-1)} \, p_t \, u(C_t)$$

s.t.

$$W_{t+1} = (1+R)\,(W_t - C_t);\; W_{t+1} > 0$$

with

$$u(x_t) = x_t^{1-\gamma}$$

and

p_t	probability to be alive in t
δ	(inverted) discount factor future consumption

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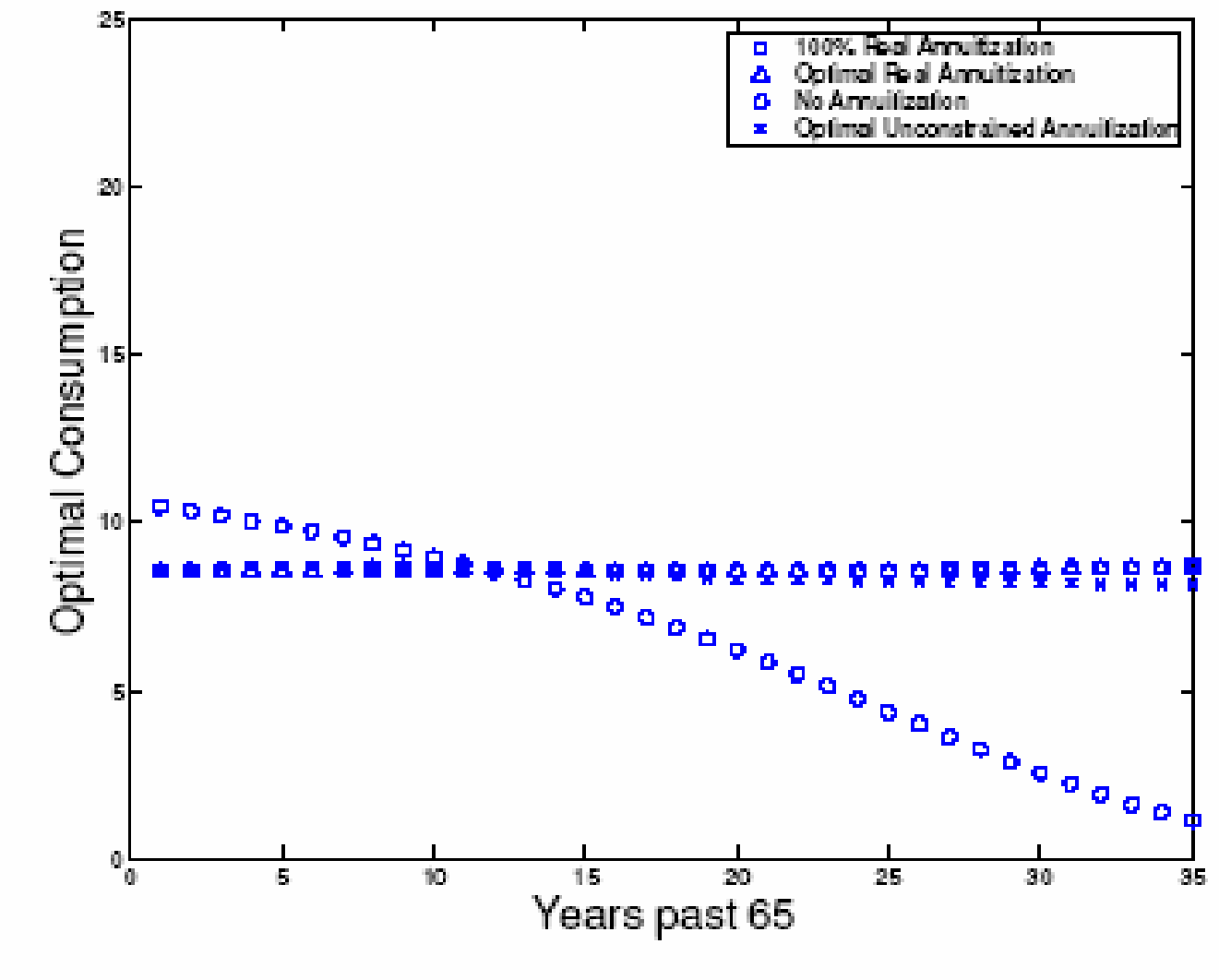
Optimal Consumption; CRRA; $\gamma = 2$; $\delta = 3\%$



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The optimal consumption path

- If there is no mortality risk the optimal consumption pattern is upward sloping if $R > \delta$, downward sloping if $R < \delta$ and flat if it is the case that $R = \delta$.
- With fair annuities this carries over to the annuities case: the decrease in survival probability cancels against the fact that state consumption is cheap.
- With discount rate equal to interest rate: the optimal consumption path is constant and a real annuity delivers just that.
- If agents can not insure longevity risk they will consume more initially and less later, because they might no longer around to enjoy later consumption
  - The divergence between optimal consumption path with and without annuities is illustrated in the figure. Gives rise to substantial increase in certainty equivalent wealth

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Equivalent of wealth effect of access to annuities in base case

Equivalent wealth variation for access to annuity markets					
Time separable power utility					
Real interest rate = 3%					
Gamma risk aversion	inverted disc fact delta	EV full real annuity	Optimal fraction annuitized	EV optimal fract real annuity	EV optima ann. pattern
1	1,03	44	100%	44	44
1	1,1	15	72%	19	24
2	1,03	56	100%	56	56

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The impact of background risk and lack of variable annuities

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Introduction

- Background risk refers to unexpected expenditures that do not contribute to utility per se
  - Health care costs
  - Cost of failure of durables
  - Cost of unexpected life course events
- Paying for background risk requires liquidity. Annuities are illiquid because of adverse selection

- In this paper (unlike many others) we do not assume that consumption (incl impact of background risk) in retirement equals annuity income but derive optimal consumption and investment strategies using the simulation methodology developed in Brandt el al (2005, JF) and Koijen, Nijman and Werker (2009, RFS)

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The preferences and constraints

Utility specification:

$$U(C_1,\ldots,C_T) = \Sigma_t \, (1+\delta)^{-(t-1)} \, p_t \, C_t^{1-\gamma}$$

Find optimal consumption and investment strategy s.t.

$$W_{t+1} = (W_t + Y_t - B_t - \Pi_t C_t)(1+R_t + w_t \, r_{t+1}) \; ; \; W_{t+1} > 0$$

where

Y_t	annuity income
B_t	background risk
Π_t	price index
w_t	equity exposure
r_{t+1}	return on equities
p_t	probability to be alive in t
δ	(inverted) discount factor

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The financial market

Let $x_t' = (X_{1t} , X_{2t}, \log \Pi_t, \log S_t)$ with

- X_{1t} instantaneous real rate
- X_{2t} instantaneous expected inflation
- Π_t price index
- S_t stock price

We assume a VAR model for the states and consistent factor models for the nominal and real term structure (see Koije, Nijman and Werker (2009))

$x_t = \mu + \Gamma (x_{t-1} - \mu) + \varepsilon_t$ $\qquad$ $\varepsilon_t \sim$ i.i.d. $N(0, \Sigma)$.

$R_t^{(n)} = a_n + b_n' x_t$

$R_t^{R(n)} = a_n^R + b_n^{R'} x_t$

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The benchmark parameters

Roughly calibrated to US data:

- Expected return equities 8%; st.dev. of 20%
- Mean short rate 4%
- Mean inflation 3.5%; st.dev. 1.4%, etc.

- Risk aversion coefficient $\gamma = 5$
- Survival probabilities US males

- All results are normalized relative to real annuity income of one (Full Real Annuity Income)
- Background risk has mean of 10% of FRAI with standard deviation 7% of FRAI

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The solution method

- Euler conditions for optimal asset weights and consumption level take form of conditional expectations
- Approximate the conditional expectation by regressing realizations of the random variables in the Euler condition on the state variables.
- Use resulting regression coefficients to determine optimal asset weights are a smooth function of the asset weights.

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Results for benchmark case

- We consider four cases: either nominal or real annuities are available and with or without background risk
- Full annuitization is not a priori optimal for the benchmark case because of
  - Lack of equity exposure in annuity menu
  - Presence of background risk
- If optimal savings and investment trajectory implemented nevertheless full annuitization turns out to be almost optimal.

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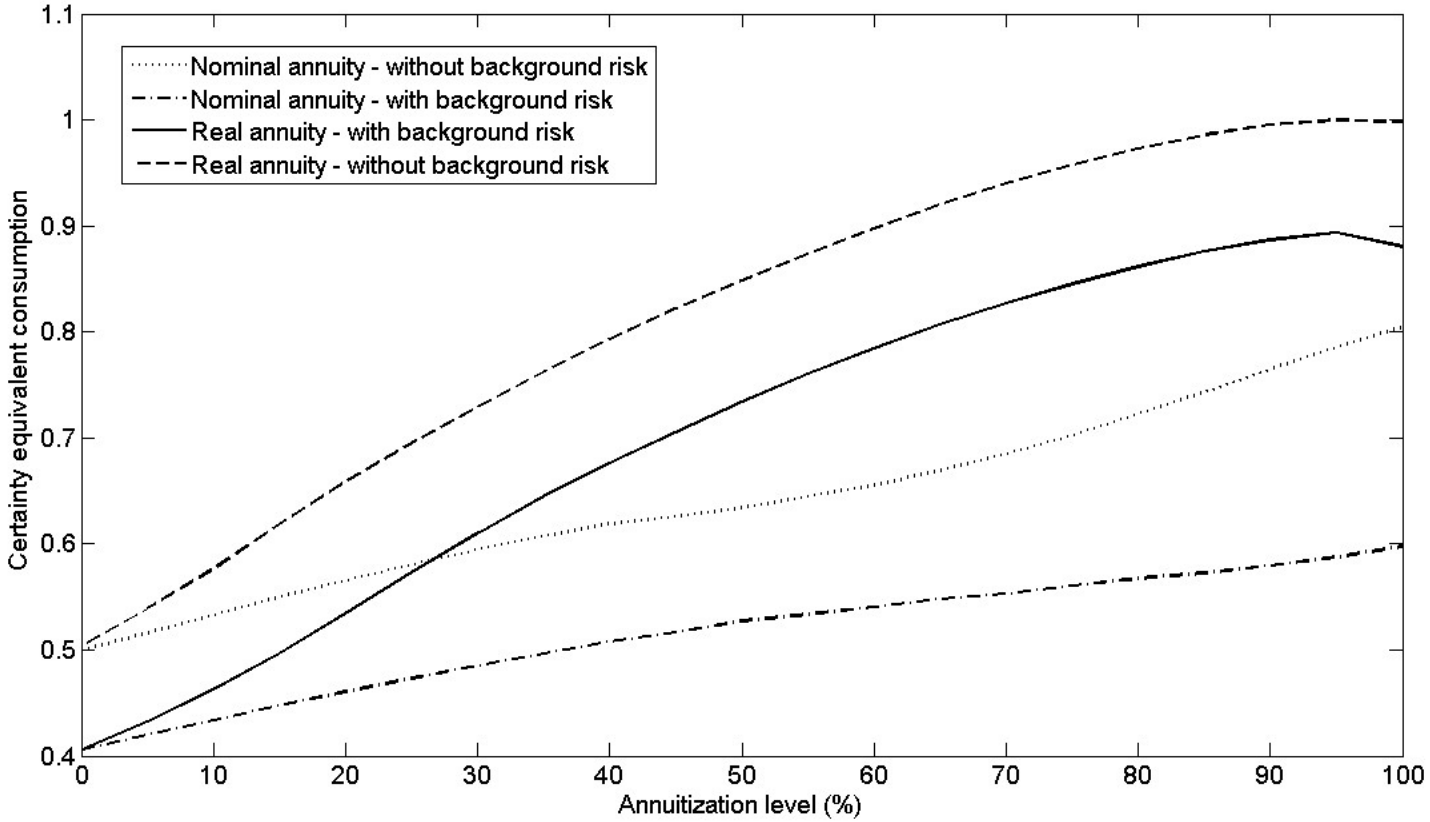
Welfare implications of the annuity level



Welfare gains of access to annuities

- Welfare gains in addition to pre-imposed annuities, e.g. originating in PAYG or DB schemes
- No background risk

Fraction of pre-imposed real annuities	Welfare gain of nominal annuities	Welfare gain of real annuities
0%	49.8%	68.6%
40%	23.1%	23.2%
60%	10.0%	10.8%
80%	3.1%	2.8%

- Lack of access to equity markets not too important
- Welfare gain of annuity markets in many countries income dependent as pre-imposed schemes focus more on poverty protection

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Welfare gains of access to annuities

- Welfare gains in addition to pre-imposed annuities, e.g. originating in PAYG or DB schemes
- With background risk

Fraction of pre-imposed real annuities	Welfare gain of nominal annuities	Welfare gain of real annuities
0%	38.8%	78.9%
40%	23.7%	27.9%
60%	11.6%	12.9%
80%	3.4%	3.6%

- Lack of access to equity markets not too important
- Even with sizable background risk high level of annuitization (100% / 96%) remains optimal

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Consumption adjustments: the real annuity case

- Background risk has very limited impact on welfare impact of annuities because a level of liquid wealth enables smoothing of the shock
- At age 70 e.g. shock of 20% FRAI smoothed out to have impact of less than 5% on optimal consumption
- With real annuities wealth level of 1 adequate to smooth majority of shocks

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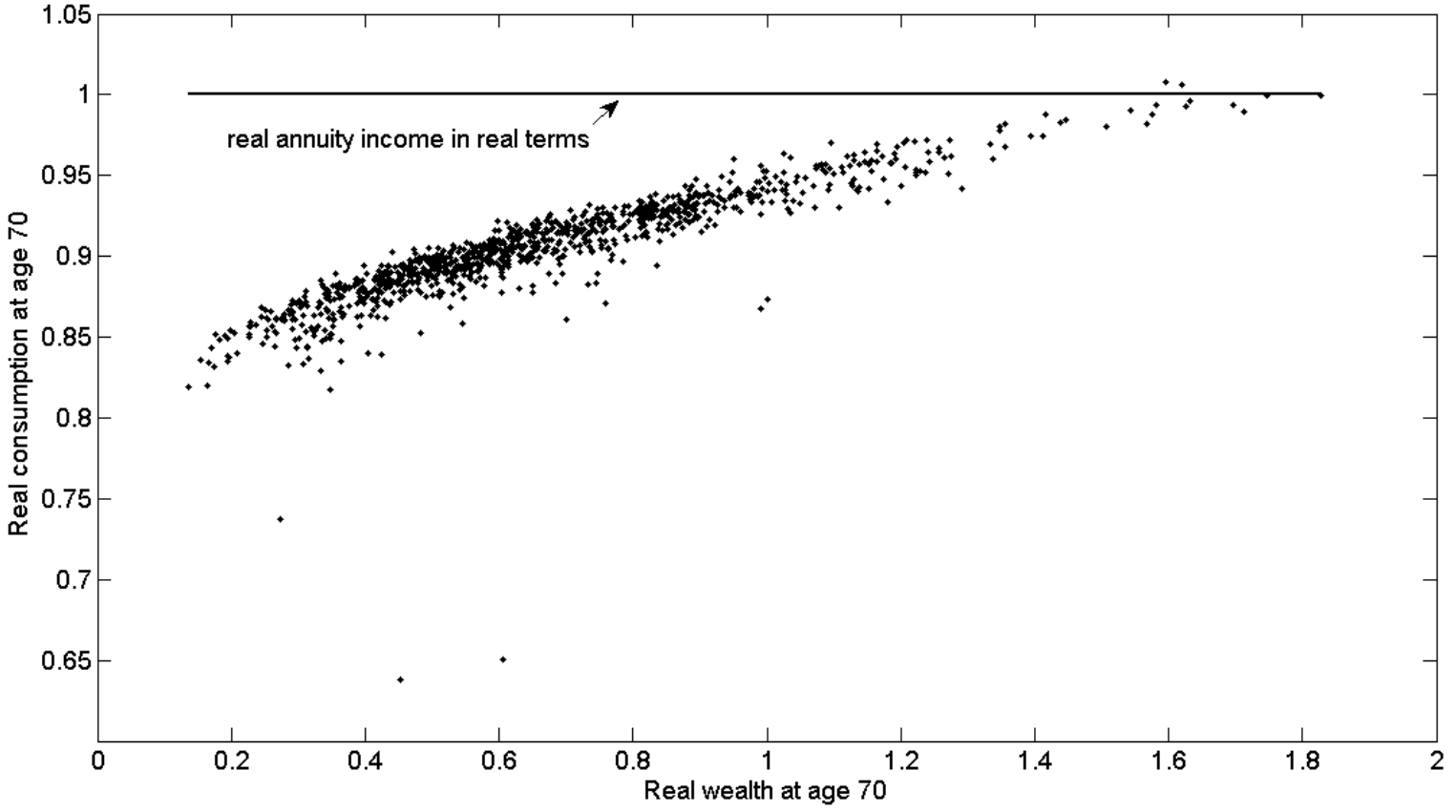
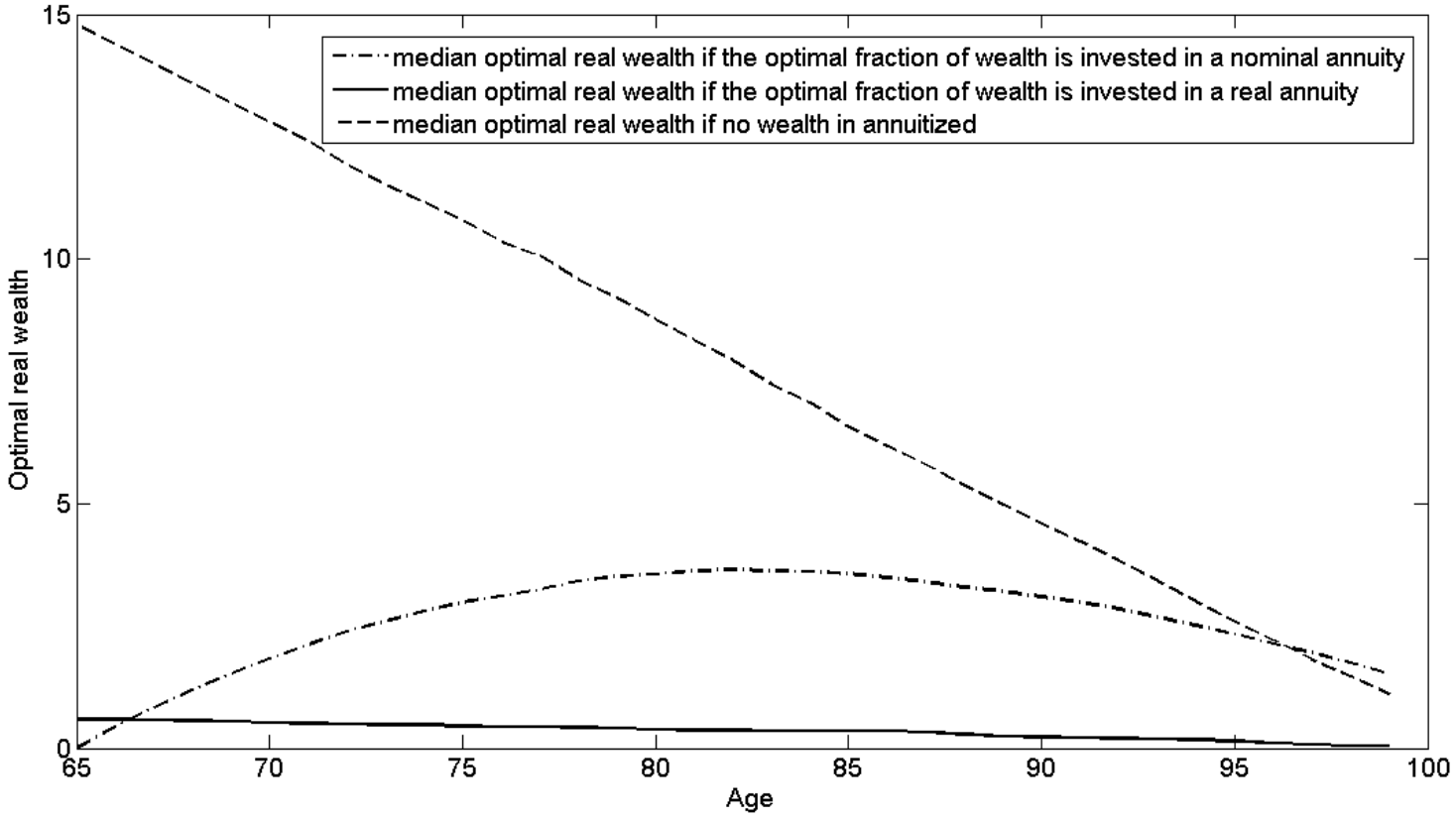
Consumption adjustment due to shocks in wealth at age 70 (real annuity case)



Median wealth path for the annuity strategies



Consumption adjustments: the nominal annuity case

- Background risk has similar impact on consumption and welfare as in case of real annuities
- Full annuitization is optimally combined with sizable wealth accumulation because of
  - Frontloading of the annuity
  - Lack of equity exposure

- Initial background risk dominated by mortality credit in case of one time decision
- Gradual increase of annuity portfolio must be even better

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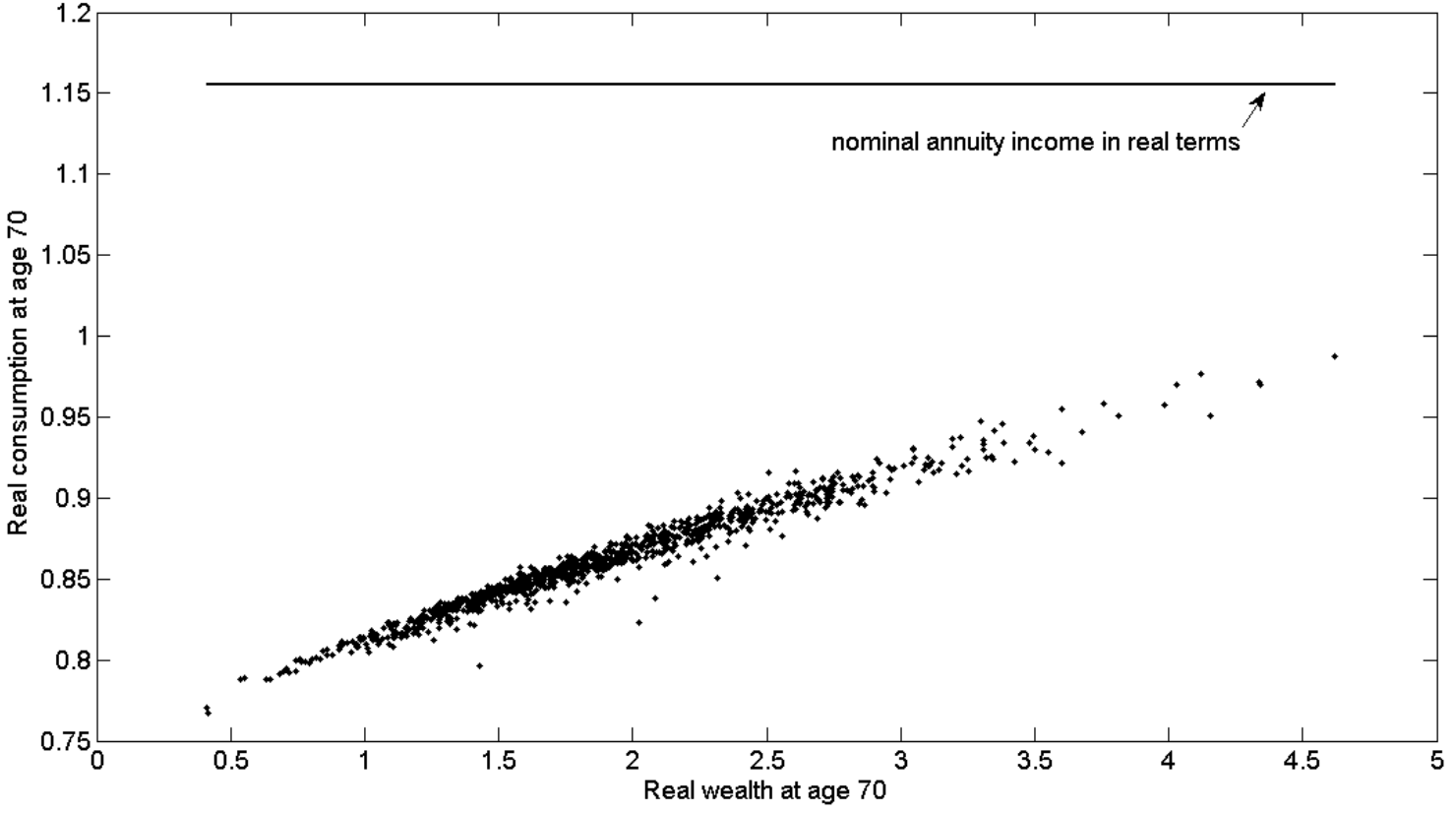
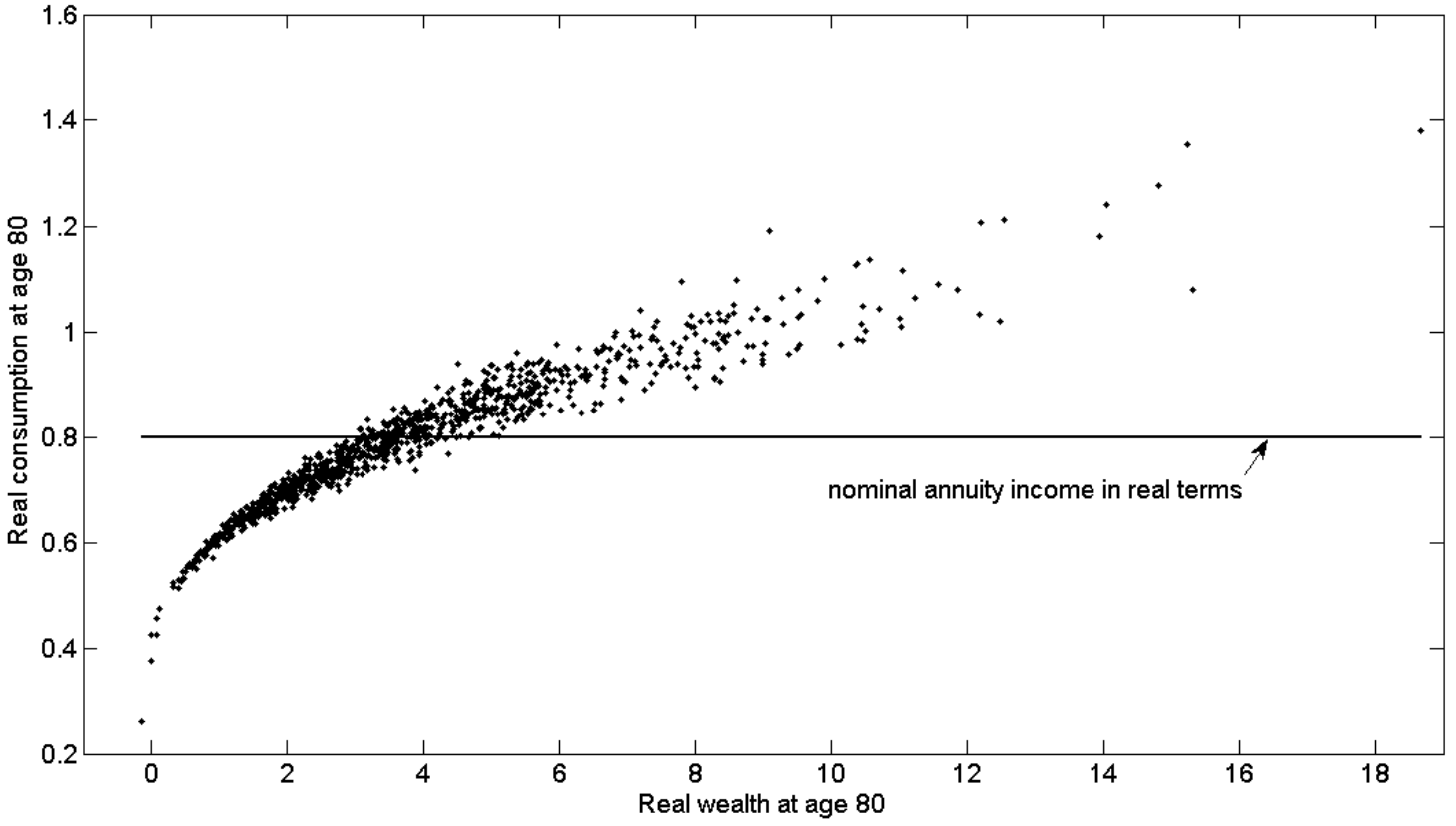
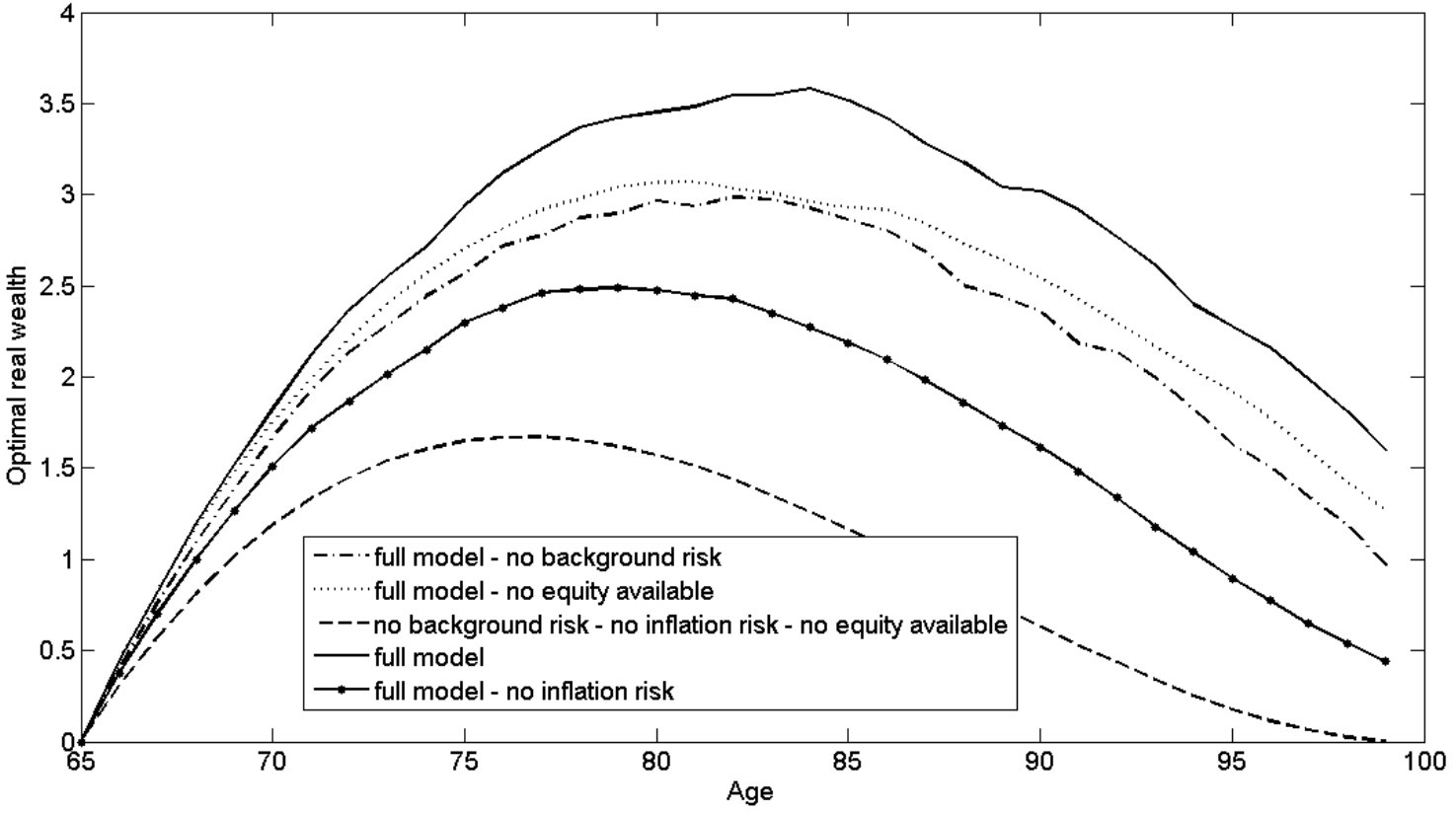
Consumption adjustment due to shocks in wealth at age 70



Consumption adjustment due to shocks in wealth at age 80



Decomposition of drivers of the median optimal wealth trajectories



Concluding remarks

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Concluding remarks

- We show that even in case of
  - Pre-imposed real annuities
  - Substantial background risk
  - Lack of equity exposure in annuities
  - Lack of access to additional real annuities

  full annuitization is optimal and generates sizable welfare gains, provided the optimal savings and investment strategy is implemented
- Loads, heterogeneity in survival rates and bequest motives will only impact these conclusions if they are quite sizable.

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Deferred annuities and conversion at later stage

- Hu, Scott and Watson (2006) have shown that a large part of the welfare gains of annuities can be obtained by buying deferred annuities.
- As these will be cheap they require less liquidity and can be close to optimal with less sophisticated savings strategies
- Many other papers (e.g. Horneff et al (2007, 2008), Pang and Warshawky (2008) analyze partial conversion at a later stage. This is potentially even more attractive than the solutions offered here also suggests almost full annuitization eventually. Note that these paper ignore adverse selection risk which gets much more important at later ages. These papers ignore inflation risk

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Policy implications

- Within the model even actuarially unfair annuities are optimal unless the money's worth would be quite low

- It is well known that agents often choose lump-sums rather than annuities if they are free to do so at retirement.
- The model suggests that
  - Annuitization could be made mandatory to obtain tax credits
  - Annuity markets should be made transparent and efficient and pricing dependent on observable characteristics (to reduce adverse selection) to get optimal welfare gains
  - Annuity markets should be accessible especially for those with low survival rates (low educated men, elderly)

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