We are not all equal: impact of socioeconomic status on old age dependence

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Introduction and Literature

Introduction (1/3)

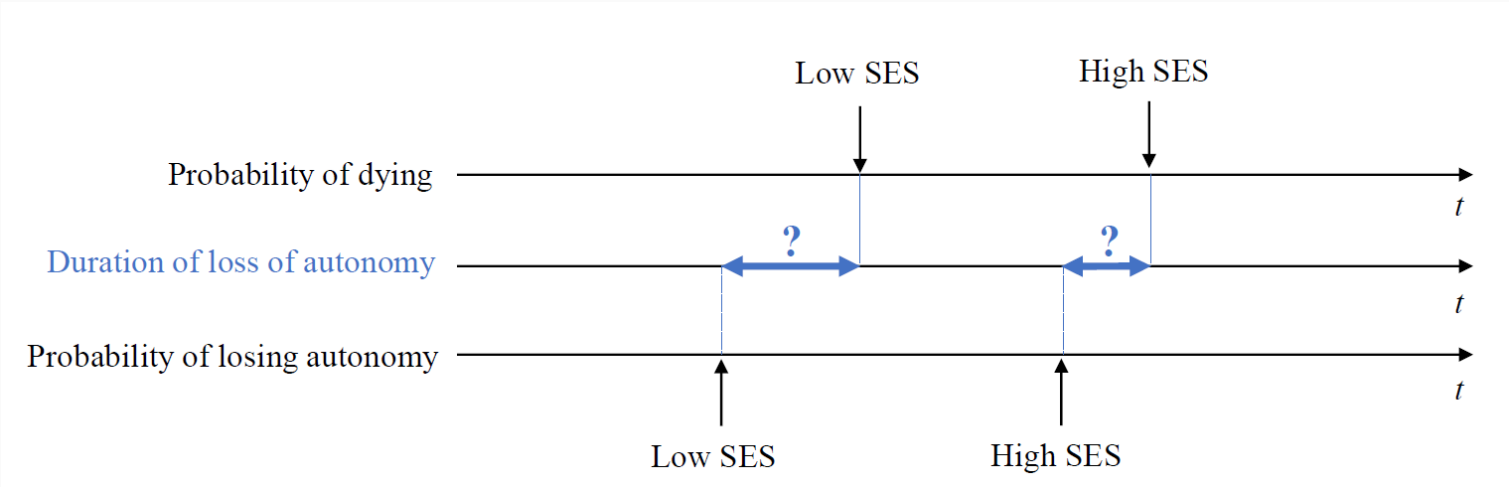
- In the last decades, life expectancy at birth has sharply risen in all developed countries (OECD average: 83 and 78 years for women and men respectively)
- Heterogeneity: differences in mortality by socio-economic status continue (see Cutler et al. (2011) for an overview)
- Beyond these health inequalities, the increasing life expectancy leads to an increase in the number of dependent people
- The question of life expectancy in *good health* is therefore relevant and it is essential to understand how the loss of autonomy evolves at the end of life $\Rightarrow$ Living longer $\neq$ living longer in good health !
  - In OECD countries: 50% of the 65 years old and older report daily limitations (ADL) (OECD, 2021)
  - Number of dependent people is expected to increase (Canta, 2020)

Introduction (2/3)

- Dependent people generally turn to family and friends to get the necessary help
  - Preferences
  - Cost of formal care
  - Low development of long-term care insurance contracts
- As informal family help could decrease, the poorest people will finally rely on public subsidies to finance the substantial care they will need
- Current budgetary tensions to be accentuated in the face of papy-boom (combination of extension of life and arrival at advanced ages of the baby-boomers generation) $\rightarrow$ Long-term care (LTC) needs will increase $\rightarrow$ costly for the individuals and the State.
  - LTC needs: the day-to-day help with activities of daily living and additional types of medical support
- Aim: how the loss of autonomy evolves at the end of life and which individuals are more likely to suffer from dependency.

Introduction (3/3)

- **Research question:** what is the causal impact of wealth on
  - the probability of losing autonomy ?
  - the duration of the loss of autonomy ?
  - mortality?



- **Data:** use 2 datasets: HRS (from the US) and SHARE (from Europe).
- **Methods:**
  - Probability of losing autonomy: Cox models + IV
    - using inheritance/large gifts as an instrument for wealth
  - Duration of the loss of autonomy: Cox models + IV

Literature & Contributions (1/2)

About mortality?

- Negative link between mortality and socio-economic status (SES) highlighted (Kitagawa et al. (1973), Duleep (1986, 1989), Deaton et al. (1998) or Cristia (2009) for the United States, Jusot (2006) for France, Hupfeld (2011) for Germany, Kalwij et al. (2013) for the Netherlands or Attanasio et al. (2003) for the United Kingdom)
- Difficult to conclude about the causal nature of this relationship (see for instance Lleras-Muney (2005); Lindhal (2005); Balia et al. (2008); Van Kippersluis et al. (2011)) but... mortality inequalities are undeniable

About probability of losing autonomy?

- Negative correlation between education or income/wealth and functional limitations (Freedman and Martin, 1999; Kim and Rhum, 2012; Lefebvre et al., 2018; Connolly et al., 2025)
- Literature more about determinants of long-term care spending (De Meijer et al., 2011; Wu et al., 2014; Abbing et al., 2021)

Literature & Contributions (2/2)

About duration of loss of autonomy?

- Cambois et al. (2011) with French data showed that manual workers have a double disadvantage: shorter life expectancy and more years in poor health and with disabilities
- Friedberg et al. (2014) with HRS data showed that the state of dependence is not an absorbing state for the wealthiest classes, but only for the less wealthy
- Lefebvre et al. (2018): 1st paper looking at the duration aspect in Europe by using mainly end-of-life interviews

Our contributions:

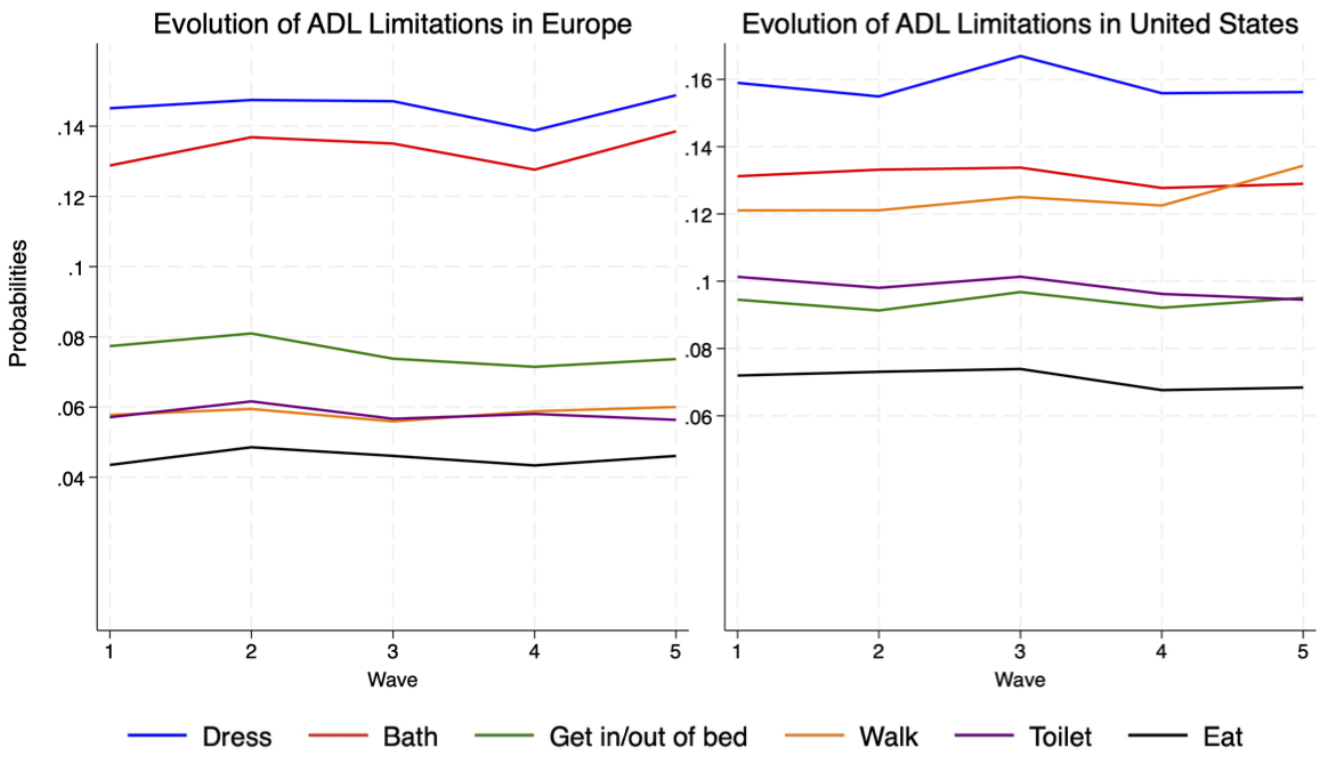
- *Method:* provide a stronger identification strategy
- *Thematic:* duration of loss of autonomy in Europe and US

Data

Data

- **HRS:** Health and Retirement Study (US)
- **SHARE:** Survey of Health, Ageing, and Retirement in Europe
- Biennial and longitudinal surveys that follow people over 50 years old
- Access to the evolutions of:
  - The individual health status and characteristics
  - Time at which the person becomes dependent/dies
  - Household/individual socioeconomic situation
- Highly harmonized: be used for pooled or comparative analyses
- Waves 10 to 14 for HRS; 4 to 8 for SHARE
  $\rightarrow$ time period: 2010/2011 - 2019/2020
- Focus on **65y and more**

Data: ADL Limitations



Data: Household Wealth

Household Wealth

- Net sum of all assets = estimated value of real estate, amounts on bank accounts, value of shares and bonds, etc. to which any debts are subtracted
- Terciles and percentiles by country

Control for demographic (gender, age), health (mental and physical conditions) and family (partner and children) variables

Data: Alive individuals descriptive statistics

	T=1		T=2		T=3		T=4		T=5	
	SHARE	US	SHARE	US	SHARE	US	SHARE	US	SHARE	US
N	11,046 (27.0%)	7,249 (26.1%)	9,038 (22.1%)	6,291 (22.6%)	7,969 (19.5%)	5,466 (19.7%)	6,935 (17.0%)	4,697 (16.9%)	5,907 (14.4%)	4,075 (14.7%)
HH Wealth (thousands)	**246.0 (496.0)**	**497.8 (989.7)**							294.2 (580.9)	734.4 (2548.6)
Women	0.543 (0.498)	0.555 (0.497)	0.552 (0.497)	0.559 (0.497)	0.561 (0.496)	0.568 (0.495)	0.576 (0.494)	0.579 (0.494)	0.591 (0.492)	0.585 (0.493)
Age	74.768 (6.763)	75.244 (6.956)	75.744 (6.218)	76.258 (6.461)	77.186 (5.919)	77.512 (6.121)	78.622 (5.521)	78.961 (5.666)	80.464 (5.054)	80.435 (5.345)
Being single	0.384 (0.486)	0.388 (0.487)	0.393 (0.488)	0.395 (0.489)	0.410 (0.492)	0.426 (0.495)	0.430 (0.495)	0.446 (0.497)	0.459 (0.498)	0.467 (0.499)
Having child(ren)	0.907 (0.291)	0.947 (0.225)	0.905 (0.293)	0.950 (0.218)	0.907 (0.291)	0.950 (0.218)	0.912 (0.283)	0.951 (0.217)	0.914 (0.280)	0.953 (0.212)
Having mental health	0.285 (0.452)	0.156 (0.363)	0.268 (0.443)	0.154 (0.361)	0.259 (0.438)	0.153 (0.360)	0.255 (0.436)	0.148 (0.355)	0.282 (0.450)	0.141 (0.348)
Having health conditions	0.582 (0.493)	0.728 (0.445)	0.573 (0.495)	0.751 (0.432)	0.600 (0.490)	0.779 (0.415)	0.623 (0.485)	0.803 (0.398)	0.625 (0.484)	0.828 (0.378)

Figure 1: Sample of alive individuals by regions overtime

Data: Dependent individuals descriptive statistics

	T=2		T=3		T=4		T=5	
	SHARE	US	SHARE	US	SHARE	US	SHARE	US
N	733 (25.7%)	461 (21.1%)	758 (26.5%)	587 (26.8%)	686 (24.0%)	560 (25.6%)	680 (23.8%)	582 (26.6%)
HH Wealth (thousands)	162.8 (466.8)	253.3 (523.4)					129.8 (216.7)	375.1 (723.2)
Women	0.604 (0.489)	0.603 (0.490)	0.609 (0.488)	0.598 (0.491)	0.596 (0.491)	0.616 (0.487)	0.612 (0.488)	0.658 (0.475)
Age	81.003 (7.212)	81.310 (7.677)	82.178 (6.685)	81.981 (7.304)	83.479 (6.539)	83.289 (6.727)	84.938 (5.982)	83.546 (6.289)
Being single	0.523 (0.500)	0.633 (0.482)	0.545 (0.498)	0.598 (0.491)	0.540 (0.499)	0.639 (0.481)	0.541 (0.499)	0.640 (0.480)
Having child(ren)	0.907 (0.290)	0.939 (0.239)	0.893 (0.309)	0.954 (0.211)	0.878 (0.327)	0.941 (0.236)	0.891 (0.312)	0.929 (0.257)
Having mental health	0.693 (0.462)	0.514 (0.501)	0.633 (0.482)	0.473 (0.500)	0.638 (0.482)	0.421 (0.494)	0.622 (0.485)	0.473 (0.500)
Having health conditions	0.839 (0.368)	0.924 (0.265)	0.844 (0.363)	0.918 (0.274)	0.827 (0.378)	0.943 (0.232)	0.836 (0.370)	0.943 (0.231)

Figure 2: Sample of dependent individuals by regions overtime

Data: probability of dependency w.r.t. wealth terciles

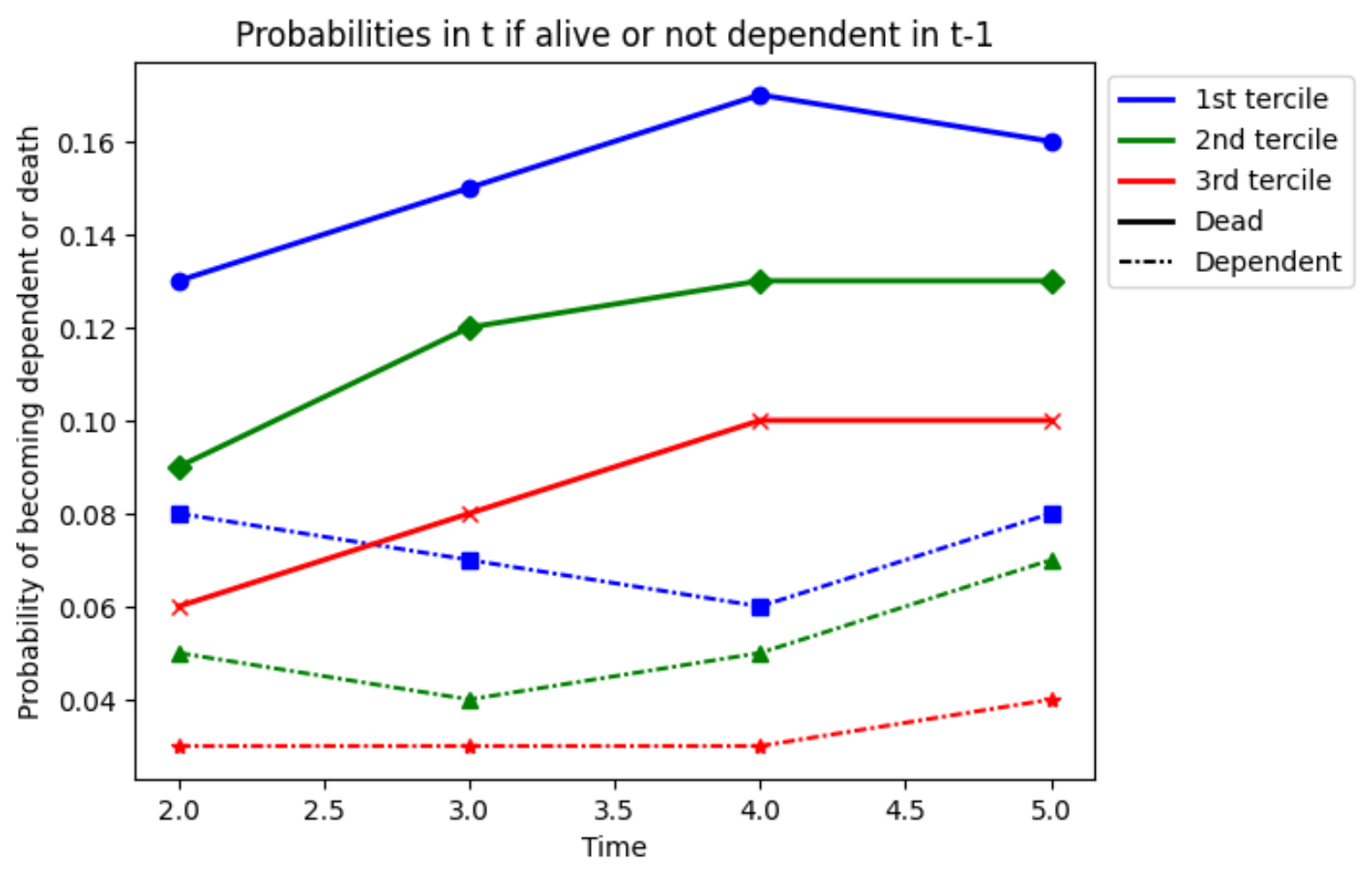


Figure 3: Probability of the event (death/loss of autonomy) in *t* if not dependent in *t-1* w.r.t wealth terciles

Dependency

Empirical Strategy - Cox Model (1/5)

- We analyse how socioeconomic status, proxied by household wealth, affects two distinct but related outcomes: the onset and the duration of dependency.
  - First = transition from autonomy to dependence
    - Start with fully independent at first observation and for whom wealth is measured at the same initial period
    - Follow them until they first report a loss of autonomy (ADLs)
    - Duration variable = time spent in an independent state (right censoring - drop out/die before becoming dependent/reach last observation without period of dependency)
    - Goal: Estimate the hazard of becoming dependent (instantaneous risk of losing autonomy conditional on having remained independent up to time t)
  - Second = the time spent in a dependent state before death
    - Same modeling approach but to the subsample of individuals who become dependent during the observation period
    - Here, the duration variable measures the time from the onset of dependency until death (or until the last observation if still alive)
    - This be interpreted as an estimate of survival once dependent

Empirical Strategy - Cox Model (2/5)

- In both cases, we model the duration, i.e. the time until the onset of dependency or until death once dependent, as a function of initial wealth and a set of individual characteristics using a Cox proportional hazards model.
  - Formally, for individual i:

$$\lambda(i, t \mid W_{i,t_0} X_i) = \lambda_0(t) \exp(W_{i,t_0}\beta_1 + X'_{i,t}\beta_2)$$

    where $\lambda_0(t)$ is the unspecified baseline hazard common to all individuals, W_{i,t_0} denotes the level of wealth at baseline, and $X_{i,t}$ the vector of time-varying and individual characteristics (gender, quadratic age, marital status, presence of children, chronic conditions, and mental health).
  - Estimation of Hazard ratios $\exp(\beta_1)$ where values below one indicate a lower instantaneous risk associated with higher wealth.
  - Remark: we use the wealth percentile at baseline rather than contemporaneous wealth, since current wealth may be affected by health shocks, consumption in retirement, or care expenditures once dependency arises (comparability).

Empirical Strategy - Cox Model (3/5)

- Causal interpretation of β_1 may be challenged by endogeneity:
  - Unobserved factors (latent health status, risk preferences, or access to informal care) may influence both wealth and health
  - Moreover, poor health may reduce wealth through medical expenses or early retirement, generating reverse causality
  - Finally, measurement error in self-reported wealth may lead to attenuation bias
- Solution?
  - Cox model is nonlinear and semi-parametric: 2SLS inconsistent (Terza et al., 2008; Tchetgen Tchetgen et al., 2015)
  - $\rightarrow$ control function approach by applying the two-stage residual inclusion (2SRI) method
  - Estimate first-stage regression:

$$W_{i,t_0} = \gamma_0 + I_{i,t_0}\gamma_1 + X'_{i,t}\gamma_2 + \nu_{i,t}$$

Empirical Strategy - Cox Model (4/5)

- Include both the wealth variable and the first-stage residuals in the Cox model:

$$\lambda(i, t \mid W_{i,t_0}, \hat{\nu}_i, X_i) = \lambda_0(t) \exp(\beta_1 W_{i,t_0} + X'_{i,t}\beta_2 + \beta_3 \hat{\nu}_{i,t})$$

  with β_1: 1) the hazard of dependency with respect to wealth, conditional on being not dependent; 2) the hazard of death with respect to wealth, conditional on entering dependence.

- Instrument? **having inherited or received large gifts in $t = 1$ (or before)**
- **Relevance:**
  - First stage estimations confirm the predictive power
  - Inheritance/large gifts receipt have been used as an instrument for wealth in studies investigating the effect of wealth on health behaviors (Kim et al., 2012; Kippersluis et al., 2014) and health outcomes (Meer et al., 2003; Carman, 2013)

Empirical Strategy - Cox Model (5/5)

- **Exclusion Restriction:**
  - inheritance receipt reflects the poor state of health in the family (Apouey et al., 2015) $\rightarrow$ **inheritance excluding close family members**
  - Wealthy or "priviledged" backgrounds are particularly likely to receive inheritance and benefited from the childhood care that leads to good health as adults (Meer et al., 2003)

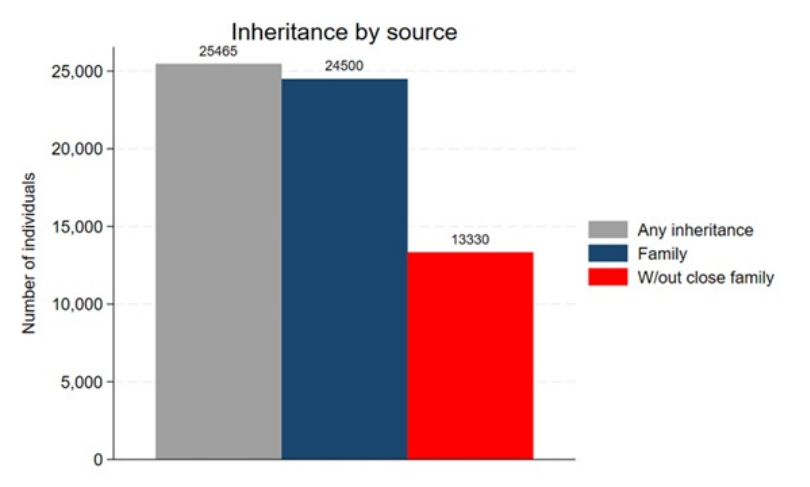


Figure 4: Absolute numbers

	SHARE	US
Any inheritance	27.2	29.3
Family	26.4	27.4
Without close family	13.1	16.8

Figure 5: Inheritance prevalence in SHARE and the US

Results - Become Dependent (1/6)

	Baseline			*2SRI*		
	All	**US**	**SHARE**	**All**	**US**	**SHARE**
Wealth percentiles	0.991*** (0.000)	0.989*** (0.001)	0.993*** (0.001)	0.986*** (0.005)	0.985** (0.006)	0.989 (0.008)
Women	0.837*** (0.000)	0.897 (0.066)	0.802*** (0.053)	0.829*** (0.042)	0.894 (0.061)	0.794*** (0.056)
Being single	0.991 (0.051)	0.999 (0.078)	0.977 (0.068)	0.912 (0.082)	0.932 (0.111)	0.924 (0.128)
Having child(ren)	0.918 (0.298)	0.814 (0.117)	0.974 (0.098)	0.911 (0.073)	0.799 (0.113)	0.974 (0.092)
Having mental health	3.549*** (0.169)	3.407*** (0.236)	3.640*** (0.241)	3.442*** (0.193)	3.294*** (0.263)	3.583*** (0.266)
Having health conditions	2.397*** (0.166)	2.272*** (0.280)	2.453*** (0.207)	2.234*** (0.168)	2.208*** (0.275)	2.427*** (0.218)
N	54639	23604	31035	54639	23604	31035
	Controlled for age and country fixed effects					

Figure 6: Cox models: baseline & 2SRI

Example: HR = 0.991* (All, baseline)

- Interpretation: For each additional percentile of wealth, the hazard of the event decreases by about 0.9% (1 0.991).
- Wealthier individuals experience the event more slowly / are less likely to experience it at any time.
- US slightly stronger (0.989); SHARE slightly weaker (0.993).
- 2SRI estimates are similar but slightly farther from 1 (likely correcting endogeneity).

Results - Become Dependent (2/6)

- Display the coefficients (β) instead of hazard ratios (HR $=$ exp(β0)).
- Remark: that does not turn them into marginal effects. It only changes the scale of the output.

Probability of loss of autonomy (2SRI)	By regions					
	US	*North*	*Center*	*South*	*East*	*SHARE*
Wealth percentiles (2nd stage)	-0.015** (0.006)	-0.015 (0.025)	-0.003 (0.011)	-0.036 (0.026)	-0.017 (0.027)	-0.011 (0.009)
Inheritance (1st stage)	16.9*** (0.414)	11.4*** (0.821)	13.6*** (0.570)	10.7*** (1.315)	8.1*** (0.563)	12.0*** (0.409)
F-Stat (1st stage)	662.8	108.8	184.0	37.2	142.9	248.7
N	23604	4228	12004	4993	9810	31035
	By sex		**By partnership status**		**By age**	
	Women	*Men*	*Single*	*Couple*	*< 80*	*> 80*
Wealth percentiles (2nd stage)	-0.022*** (0.008)	-0.004 (0.006)	-0.023*** (0.006)	-0.001 (0.007)	-0.015** (0.007)	-0.012* (0.006)
Inheritance (1st stage)	14.6*** (0.395)	14.1*** (0.437)	15.8*** (0.503)	13.5*** (0.360)	14.5*** (0.347)	13.8*** (0.540)
F-Stat (1st stage)	297.1	137.5	76.9	115.6	322.8	146.9
N	30649	23990	22111	32528	38877	15762

Figure 7: Cox models: Heterogeneity for 2SRI

Results - Become Dependent (3/6)

	By regions			
	US		*SHARE*	
	Women	*Men*	*Women*	*Men*
Wealth percentiles (2nd stage)	-0.015* (0.008)	-0.014* (0.007)	-0.028** (0.012)	0.010 (0.013)
Inheritance (1st stage)	17.2*** (0.556)	16.7*** (0.622)	12.3*** (0.553)	11.7*** (0.608)
F-Stat (1st stage)	480.6	234.4	158.2	72.6
N	13456	10148	17193	13842
	Single	*Couple*	*Single*	*Couple*
Wealth percentiles (2nd stage)	-0.029*** (0.008)	0.001 (0.008)	-0.014 (0.011)	-0.003 (0.012)
Inheritance (1st stage)	19.6*** (0.725)	15.6*** (0.501)	12.6*** (0.689)	11.6*** (0.509)
F-Stat (1st stage)	167.2	226.2	40.6	57.4
N	9809	13795	12302	18733
	< 80	*> 80*	*< 80*	*> 80*
Wealth percentiles (2nd stage)	-0.012 (0.009)	-0.018** (0.009)	-0.018 (0.012)	-0.001 (0.012)
Inheritance (1st stage)	17.2*** (0.500)	16.1*** (0.741)	12.1*** (0.479)	11.6*** (0.787)
F-Stat (1st stage)	486.7	182.9	151.5	67.9
N	16166	7438	22711	8324

Figure 8: Cox models: Heterogeneity for 2SRI by region

Results - Become Dependent (4/6)

- By dealing with endogeneity, the effect of wealth on dependency event is driven by:
  - American people, women and singles
  - In US: by singles and oldest people
  - In Europe: significant effect of wealth for women

Results - Become Dependent (5/6)

Robustness test:

- Accelerated Failure Time (AFT) models quantify time directly by estimating how covariates stretch or compress the time to the event, whereas Cox models focus on the instantaneous risk (hazard).
- AFT provides Time Ratios, offering an intuitive interpretation of how long individuals remain in a given state, complementing the Hazard Ratios from Cox.

	Hazard Ratio			Time Ratio		
	Baseline			Baseline		
	All	US	SHARE	All	US	SHARE
Wealth percentiles	-0.009*** (0.001)	-0.010*** (0.001)	-0.007*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.013*** (0.001)
	2SRI			2SRI		
	All	US	SHARE	All	US	SHARE
Wealth percentiles	-0.014*** (0.005)	-0.015** (0.006)	-0.011 (0.009)	0.020*** (0.004)	0.017*** (0.005)	0.022*** (0.008)

Figure 9: Hazard Ratio (Cox) and Time Ratio (AFT) models

Results - Become Dependent (6/6)

What can we observe?

- Hazard Ratios (risk of dependency) $\rightarrow$ Slightly stronger in US (wealth reduces risk more)
- Time Ratios (delay of dependency) $\rightarrow$ Slightly stronger in SHARE (wealth extends autonomy more)

Interpretation of results?

- US: Wealth plays a stronger role in avoiding dependency transitions (risk-based interpretation), consistent with a market-driven long-term care system.
- Europe (SHARE): Wealth translates into a longer delay before dependency, likely reflecting better ability to purchase home care, accessible medical services, and healthier living environments.

Results - Duration of Dependency (1/4)

	Baseline			*2SRI*		
	All	**US**	**SHARE**	**All**	**US**	**SHARE**
Wealth percentiles	1.001 (0.001)	1.001 (0.001)	1.000 (0.002)	1.008 (0.006)	1.017** (0.008)	0.994 (0.012)
Women	0.606*** (0.041)	0.709*** (0.068)	0.521*** (0.050)	0.614*** (0.042)	0.713*** (0.071)	0.510*** (0.057)
Being single	1.020 (0.074)	1.027 (0.108)	1.036 (0.105)	1.131 (0.141)	1.343* (0.230)	0.948 (0.174)
Having child(ren)	1.002 (0.110)	0.959 (0.174)	1.003 (0.138)	1.016 (0.109)	1.055 (0.191)	1.001 (0.143)
Having mental health	1.236*** (0.078)	1.158* (0.104)	1.322*** (0.120)	1.282*** (0.089)	1.300*** (0.129)	1.289** (0.142)
Having health conditions	1.015 (0.106)	1.464** (0.279)	0.992 (0.112)	1.131 (0.111)	1.593** (0.341)	0.978 (0.122)
N	3220	1486	1734	3220	1486	1734
	Controlled for age and country fixed effects					

Figure 10: Cox models: baseline & 2SRI

Results - Duration of Dependency (2/4)

Duration of dependence (2SRI)	By regions					
	US	*North*	*Center*	*South*	*East*	*SHARE*
Wealth percentiles (2nd stage)	0.017** (0.007)	0.049 (0.033)	0.003 (0.015)	-0.070 (0.173)	-0.074 (0.059)	-0.006 (0.011)
Inheritance (1st stage)	16.9*** (0.414)	11.4*** (0.820)	13.6*** (0.569)	10.7*** (1.314)	8.1*** (1.040)	12.0*** (0.409)
F-Stat (1st stage)	662.8	108.8	183.9	37.2	142.8	248.7
N	1486	152	530	402	650	1734
	By sex		**By partnership status**		**By age**	
	Women	*Men*	*Single*	*Couple*	*< 80*	*> 80*
Wealth percentiles (2nd stage)	0.014 (0.010)	0.001 (0.009)	0.007 (0.008)	0.007 (0.010)	0.011 (0.012)	0.007 (0.009)
Inheritance (1st stage)	14.6*** (0.395)	14.1*** (0.437)	15.8*** (0.503)	13.5*** (0.359)	14.5*** (0.347)	13.8*** (0.541)
F-Stat (1st stage)	297.1	137.5	76.9	115.6	322.8	146.9
N	1941	1279	1769	1451	1391	1829

Figure 11: Cox models: Heterogeneity for 2SRI

Results - Duration of Dependency (3/4)

	By regions			
	US		*SHARE*	
	Women	*Men*	*Women*	*Men*
Wealth percentiles (2nd stage)	0.020* (0.012)	0.011 (0.010)	0.001 (0.020)	-0.015 (0.018)
Inheritance (1st stage)	17.2*** (0.556)	16.7*** (0.622)	12.3*** (0.552)	11.7*** (0.608)
F-Stat (1st stage)	480.6	234.4	158.2	72.6
N	892	594	1049	685
	Single	*Couple*	*Single*	*Couple*
Wealth percentiles (2nd stage)	0.019** (0.009)	0.015 (0.012)	-0.013 (0.018)	-0.006 (0.020)
Inheritance (1st stage)	19.6*** (0.724)	15.6*** (0.501)	12.6*** (0.689)	11.6*** (0.509)
F-Stat (1st stage)	167.2	226.2	40.6	57.4
N	857	629	912	822
	< 80	*> 80*	*< 80*	*> 80*
Wealth percentiles (2nd stage)	0.024* (0.013)	0.014 (0.010)	-0.019 (0.026)	-0.002 (0.016)
Inheritance (1st stage)	17.2*** (0.500)	16.1*** (0.741)	12.1*** (0.479)	11.6*** (0.787)
F-Stat (1st stage)	486.7	182.9	151.5	67.9
N	641	845	750	984

Figure 12: Cox models: Heterogeneity for 2SRI by region

Results - Duration of Dependency (4/4)

Results

- No effect in Europe of wealth on the duration of dependence
- Effect in the US, driven by women, single and youngest ones (Among dependent individuals, higher wealth slightly increases the hazard of death for women in the US)

Interpretation:

- Among dependent individuals, richer Americans actually tend to die slightly earlier than poorer Americans...
- ... while in Europe wealth does not seem to influence mortality once people are already dependent.

Conclusion - Discussion

Conclusion/Discussion (1/2)

- Our results:
  - EU: negative effect of wealth on dependency of women but not on duration
  - US: negative effect of wealth on dependency and duration (double penalty)
- Next steps:
  - Add some robustness (interval-censored, for instance) and heterogeneity analysis
  - Investigate mechanisms:
    - Better access to continuous care in Europe extends survival in dependency
    - Informal + formal care are complementary and increase longevity in dependency
    - Institutional environments in Europe prolong life even in severe dependency
    - Social protection and poverty alleviation

Conclusion/Discussion (2/2)

- Better access to continuous care in Europe extends survival in dependency
  - Europe: universal or heavily subsidized LTC
    - Public systems (e.g., Germany, France, Netherlands, Scandinavia) cover most care costs.
    - Dependent individuals receive professional home care, institutional care, and cash benefits, which help them survive longer even with severe dependency.
  - vs. US: more market-driven
    - LTC largely financed out-of-pocket until assets are depleted $\rightarrow$ delayed or suboptimal care.
    - Medicaid only steps in once people are poor enough.
- Informal + formal care are complementary and increase longevity in dependency
  - In many European countries, family structures and social norms support intensive informal care (adult children, extended family)
  - This help stabilizes dependent individuals, delays deterioration, and increases survival duration
- Other mechanisms to investigate...

Thanks! Questions?

Empirical Strategy (former one)

- Baseline regressions

$$D_{it+1} = \beta W_i + X_{it}^{'}\gamma + \alpha_i + \varepsilon_{it} | D_{it} = 0$$

$$ADL_{it+1} = \beta W_i + X_{it}^{'}\gamma + \alpha_i + \varepsilon_{it} | D_{it} = 0$$

- W_{it} is the indicator of the percentile of wealth in which the individual belongs in $t = 1$
- **Correlated Random Effects model** (Mundlak, 1978): individual specific effect is expressed as a linear function of average time-varying explanatory variables and random individual specific effect that is assumed to be independent of the explanatory variables:

$$\alpha_i = \bar{X}_i\zeta + \xi_i$$

- Baseline equation can be rewritten as

$$D_{it+1} = \beta W_i + X_{it}^{'}\gamma + \bar{X}_i\zeta + \xi_i + \varepsilon_{it} | D_{it} = 0$$