# THE CAUSAL EFFECT OF FERTILITY ON COGNITIVE FUNCTIONING IN LATER LIFE

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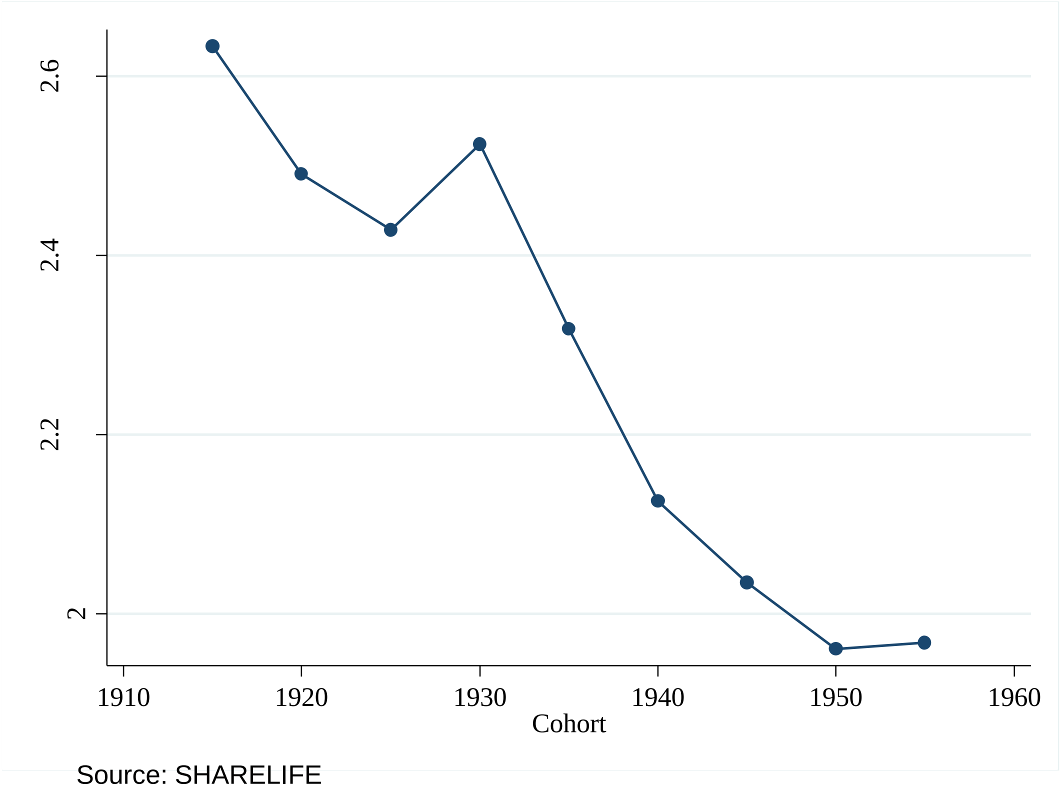
# Introduction

- Ongoing demographic change implies an ageing of the population
- Childbearing patterns have changed dramatically over the last few decades
- What are the consequences of fertility changes on the health of older individuals?

# INTRODUCTION: EVOLUTION OF PARITY ACROSS COHORT




Source: SHARELIFE

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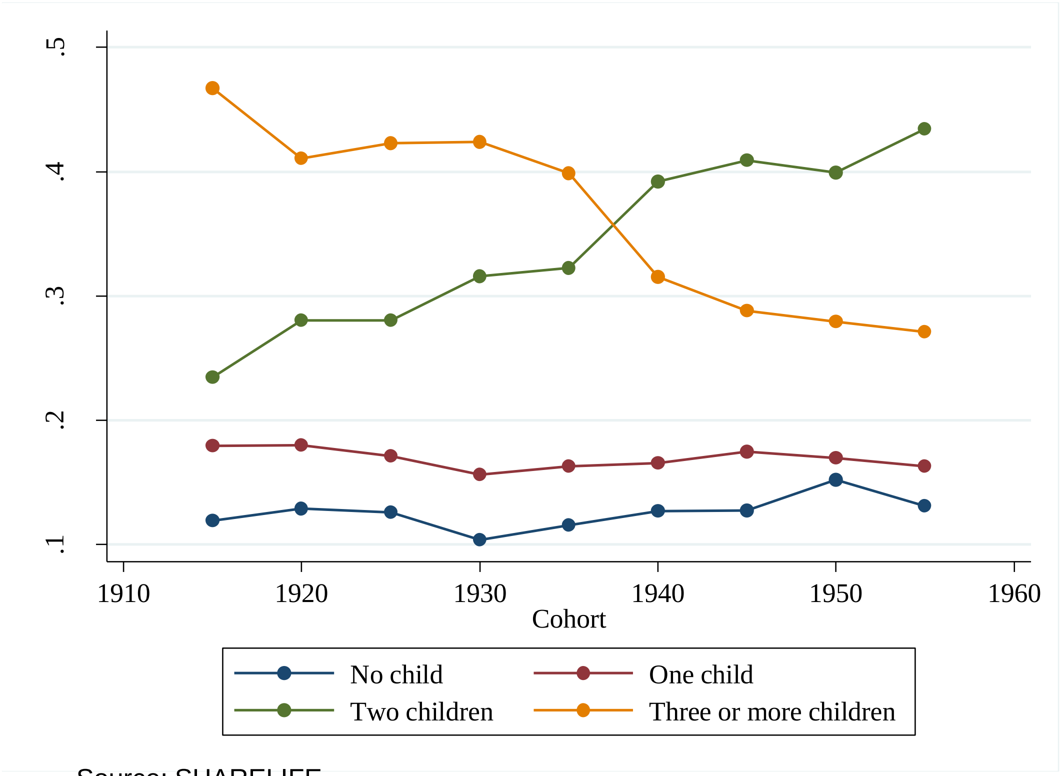


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# Introduction

- Older individuals face a variety of health challenges. Age-related decline in cognitive functioning is well documented (Baltes, Lindenberger, & Staudinger, 2006; Small, 2001)

- Cognitive impairments are associated with:
  - Loss of productivity
  - Decreased quality of life
  - Increased disability
  - Higher health-related expenditures

# INTRODUCTION

- However this decline is not homogenous across the population, with some people maintaining cognitive vitality even into extreme old age (Berkman et al., 1993, Silver et al., 1998)

- This cognitive heterogeneity in ageing has been attributed by Stern and others (Stern, 2002, 2003; Scarmeas & Stern, 2003) to the concept of “cognitive reserve”

- The degree of resilience to biological changes has been found to depend on several factors, including socioeconomic dimensions such as education (Le Carret et al., 2003), occupation, leisure activities, or life style (see for a review: Fillit et al., 2002; and Fratiglioni et al., 2004)

# Introduction

- The number of children may affect cognitive performance at older ages through several mechanisms:
  - Social:
    - Social contacts/support (Ertel et al 2008; Zunzunegui et al 2003; Vlachantoni et al 2015)
  - Economic:
    - Living standard (Mani et al. 2013; Caceres-Delpiano and Simonsen 2012)
    - Labour market participation (Rohwedder and Willis 2010; Bonsang et al 2012; Angrist and Evans 1998)
  - Health :
    - Lower estrogen exposure (Heys et al. 2011)
    - Higher risk of obesity (Caceres-Delpiano and Simonsen 2012)
    - Sleep deprivation (Ritcher et al. 2019; Virta et al. 2013)

# This Study

- We contribute to the existing descriptive literature (e.g. Grundy and Read, 2017; Keenman and Grundy, 2018) by investigating the causal effect of fertility on cognitive functioning in later life
- We use an instrumental variable approach by exploiting a source of exogenous variation in the number of children
- The sex composition of the first two children is used as an instrument to study the marginal effect of additional children, conditional on having at least two children. There is a strong parental preference for a mixed sibling-sex composition (e.g. Ben-Porath and Welch, 1976)
- The use of this approach as an instrument was first proposed by Angrist and Evans (1998)

# EMPIRICAL STRATEGY

- The equation to be estimated is the following:

$$cognition_{ict} = \beta_0 + \beta_1 children_{ict} + X'_{ict}\beta_2 + \alpha_c + \tau_t + \varepsilon_{ict}$$

- This equation can be estimated by OLS under the assumption that:

$$E(\varepsilon | children, X) = 0$$

- Unlikely to be the case due to selection, confounding factors or measurement error

# EMPIRICAL STRATEGY

- Instrumental variables approach:

$$children_{ict} = \gamma_0 + \gamma_1 same\_sex_{ict} + X'_{ict}\gamma_2 + \gamma_c + \delta_t + \omega_{ict}$$

$$cognition_{ict} = \beta_0 + \beta_1 chil\widehat{dren}_{ict} + X'_{ict}\beta_2 + \alpha_c + \tau_t + \varepsilon_{ict}$$

- Hypotheses:

  Instrument relevance

  Instrument as good as random

  Exclusion restriction

  Monotonicity (in case of heterogeneous effects)

- Specification checks:
  - Control for the sex of the first two children to discard any confounding bias to the potential effect of sex of children on cognitive functioning (Angrist and Evans, 1998)
  - Alternative instrument using the fact of having two boys and the fact of having two girls. Allow to perform an overidentification test in order to see whether the sex of the children might bias the results (Angrist and Evans, 1998)

# DATA: THE SAMPLE

- Pooled data from waves 1, 2, 4, 5 and 6 of the Survey of Health, Ageing and Retirement in Europe (SHARE)

- 19 European countries and Israel: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Ireland, Israel, Italy, Luxembourg, the Netherlands, Poland, Portugal, Slovenia, Spain, Sweden, and Switzerland

- Sample selection:
  - Individuals aged 65 year-old or more
  - Individuals with only biological children
  - Individuals with at least two children

- The final analytical sample includes 75,233 observations

# DATA: THE MEASURES OF COGNITIVE FUNCTIONING

- The survey assesses cognitive functioning by using short and simple tests of episodic memory and executive functioning
- In the episodic memory task, participants were asked to memorize ten common words, and to list as many of these words as they could remember in one minute. There are an immediate and a delayed word recall task
- For the fluency task, respondents had to name as many different animals as possible in one minute
- We combine the score from each test using principal component analysis
- Results hold for each test separately

# DATA: THE MEASURE OF PARITY

- The main independent variable is the number of biological children alive
- The instrument is based on a dummy variable equal to one when the two oldest children have the same sex

Sample distribution according to the sex of the first two children

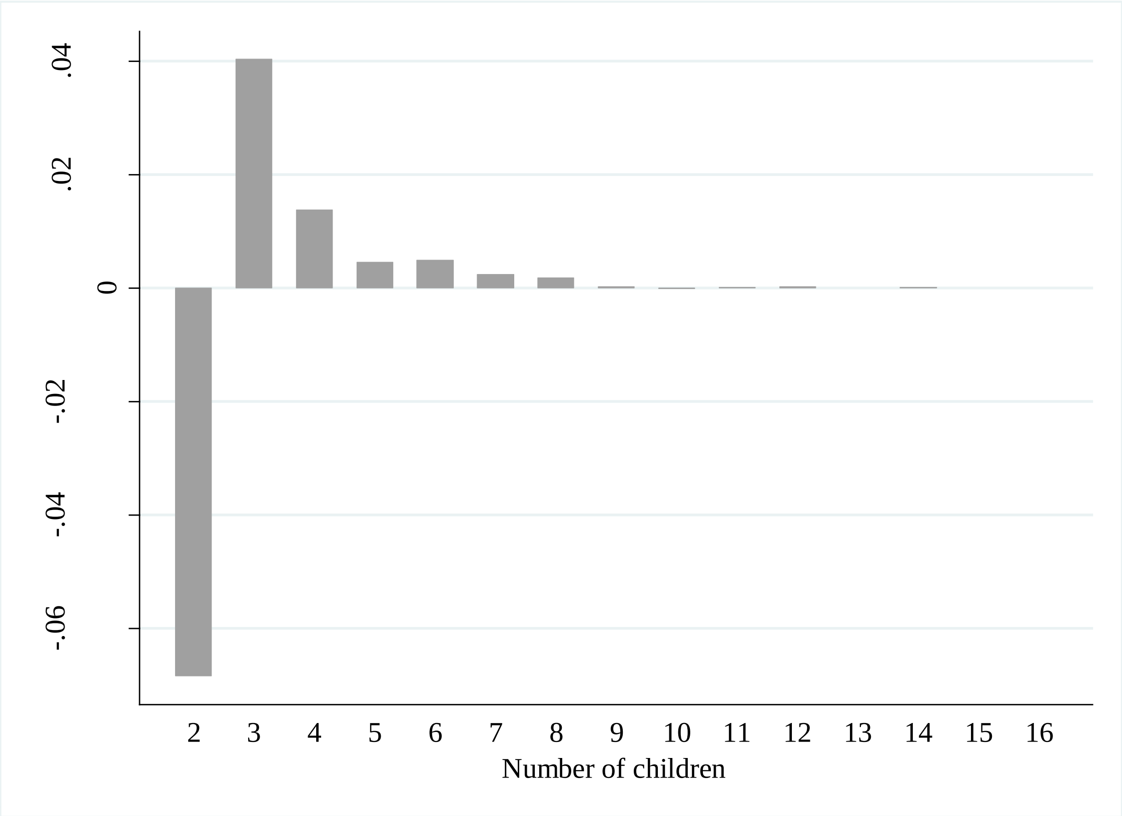
| | Boy at second birth | Girl at second birth | Total |
|---|---|---|---|
| Boy at first birth | 25.62% | 25.13% | 50.75% |
| Girl at first birth | 24.95% | 24.30% | 49.25% |
| Total | 50.57% | 49.43% | 100% |

Probability to have at least three children according to the sex of the first two children

| | Boy at second birth | Girl at second birth |
|---|---|---|
| Boy at first birth | 48.0% | 41.8% |
| Girl at first birth | 41.7% | 49.3% |

# DATA: THE MEASURE OF PARITY

- Difference in the distribution of the sample according to the sex composition of the first two children.



## Data: Other covariates

- We control for a number of exogenous variables:
    - Country fixed effects
    - Sex country-specific effects
    - Wave fixed effects
    - Education
    - Age of the parent at second birth
    - Third-order polynomial in age
    - Being born abroad
- Results similar with or without controls (but gain in efficiency)

# DESCRIPTIVE EVIDENCE

| | All | By sex composition of the first two children | | |
|---|---|---|---|---|
| | | Different sex | Same sex | P-value for difference |
| Sex of the respondent (1=woman) | 0.55 | 0.56 | 0.55 | 0.229 |
| Age of the respondent | 74.29 | 74.32 | 74.27 | 0.318 |
| Age at the birth of the second child | 29.44 | 29.46 | 29.42 | 0.205 |
| Respondent born abroad | 0.10 | 0.10 | 0.10 | 0.098 |
| Level of education : | | | | |
| Primary or less | 0.35 | 0.35 | 0.35 | 0.989 |
| Secondary | 0.44 | 0.44 | 0.44 | 0.310 |
| Tertiary | 0.20 | 0.20 | 0.20 | 0.196 |
| Education missing | 0.01 | 0.01 | 0.01 | 0.814 |
| Number of observations | 75,233 | 37,676 | 37,557 | |

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| Number of children | 2.78 | 2.71 | 2.84 | 0.000*** |
| Immediate word recall test | 4.65 | 4.67 | 4.63 | 0.002*** |
| Delayed word recall test | 3.16 | 3.18 | 3.15 | 0.065* |
| Word fluency test | 17.92 | 17.99 | 17.84 | 0.004*** |
| Number of observations | 75,233 | 37,676 | 37,557 | |

# RESULTS: INSTRUMENT RELEVANCE, FIRST STAGE ESTIMATES:OLS

| Dependent variable : | Number of children | | |
|---|---|---|---|
| | All | Men | Women |
| Same sex | 0.129*** | 0.128*** | 0.128*** |
| | (0.012) | (0.018) | (0.017) |
| Control variables included | yes | yes | yes |
| F-test of the excluded instrument | 112.17 | 52.02 | 58.98 |
| Two boys | 0.113*** | 0.119*** | 0.106*** |
| | (0.015) | (0.021) | (0.021) |
| Two girls | 0.145*** | 0.138*** | 0.151*** |
| | (0.016) | (0.023) | (0.021) |
| Control variables included | yes | yes | yes |
| F-test of the excluded instrument | 57.19 | 26.02 | 31.24 |
| P-value for difference between “Two boys” and “Two girls” | 0.075 | 0.466 | 0.065 |
| N | 75,233 | 33,485 | 41,748 |

*Note*. Clustered (at the individual level) standard errors are in parentheses. *p < .1. **p < .05. ***p < .01.

# RESULTS: REDUCED FORM ESTIMATES, OLS

| Dependent variable : | Cognitive test score | | |
|---|---|---|---|
| | All | Men | Women |
| Same sex | -0.025*** | -0.029** | -0.021** |
| | (0.008) | (0.011) | (0.011) |
| Control variables included | yes | yes | yes |
| Two boys | -0.029*** | -0.031** | -0.028** |
| | (0.010) | (0.014) | (0.013) |
| Two girls | -0.021** | -0.027* | -0.015 |
| | (0.010) | (0.014) | (0.013) |
| Control variables included | yes | yes | yes |
| P-value for difference between "Two boys" and "Two girls" | 0.459 | 0.814 | 0.419 |
| N | 75,233 | 33,485 | 41,748 |

*Note*. Clustered (at the individual level) standard errors are in parentheses. *p < .1. **p < .05. ***p < .01.

# RESULTS: 2SLS ESTIMATES

| Dependent variable : | Cognitive test score index | | |
|---|---|---|---|
| | All | Men | Women |
| Instrument used : | Same sex | | |
| Number of children | -0.190*** | -0.224** | -0.164** |
| | (0.062) | (0.093) | (0.084) |
| Control variables included | yes | yes | yes |
| Endogeneity test (p-value) | 0.006 | 0.023 | 0.101 |
| Instruments used : | Two boys, two girls | | |
| Number of children | -0.177*** | -0.219** | -0.139* |
| | (0.060) | (0.092) | (0.080) |
| Control variables included | yes | yes | yes |
| Endogeneity test (p-value) | 0.011 | 0.025 | 0.176 |
| Overidentification test (p-value) | 0.200 | 0.611 | 0.207 |
| N | 75,233 | 33,485 | 41,748 |

*Note*. Clustered (at the individual level) standard errors are in parentheses. *p < .1. **p < .05. ***p < .01.

# RESULTS: INTERPRETATION

- The effect of having one additional child is equivalent to a cognitive ageing of about 4 years of age.

- The IV results are larger than OLS estimates. It suggests positive selection into those who decide to have more than two children.*

- Does not estimate an average effect of the population. The 2SLS results estimate a Local Average Treatment Effect (LATE).
- Compliers are more likely to be:
  - Less educated
  - Had their second child at younger age

- But no difference across:
  - countries/regions
  - age
  - sex
  - immigrant status

# Results: 2SLS estimates by level of education of the parents

| Dependent variable : | Cognitive test score index | | |
|---|---|---|---|
| | Primary education | Secondary education | Tertiary education |
| Instrument used : | Same sex | | |
| Number of children | -0.187** | -0.198* | -0.131 |
| | (0.077) | (0.113) | (0.170) |
| Control variables included | yes | yes | yes |
| F-test of excluded instruments | 45.3 | 47.1 | 21.4 |
| N | 26,476 | 33,197 | 15,066 |

*Note*. Clustered (at the individual level) standard errors are in parentheses. *p < .1. **p < .05. ***p < .01.

# RESULTS: 2SLS ESTIMATES BY AGE AT SECOND BIRTH

| Dependent variable : | Cognitive test score index | | |
|---|---|---|---|
| | All | Men | Women |
| Number of children | -0.212*** | -0.240** | -0.271** |
| | (0.072) | (0.095) | (0.126) |
| Number of children x Age at second birth | -0.017 | 0.022 | -0.039* |
| | (0.017) | (0.036) | (0.022) |
| Control variables included | yes | yes | yes |
| N | 75,233 | 33,485 | 41,748 |

*Note*. Clustered (at the individual level) standard errors are in parentheses. *p < .1. **p < .05. ***p < .01.

# RESULTS: HETEROGENEITY

| | Cognitive test score index | | | |
|---|---|---|---|---|
| | Northern Europe | Western Europe | Eastern Europe | Southern Europe |
| Number of children | -0.535** | -0.150 | -0.142 | -0.097 |
| | (0.244) | (0.123) | (0.120) | (0.095) |
| Control variables included | yes | yes | yes | yes |
| Endogeneity test (p-value) | 0.006 | 0.308 | 0.402 | 0.638 |
| | First stage estimates: Number of children | | | |
| Same sex | 0.118*** | 0.109*** | 0.134*** | 0.149*** |
| | (0.029) | (0.021) | (0.018) | (0.028) |
| Control variables included | yes | yes | yes | yes |
| F-test of the excluded instruments | 16.269 | 26.943 | 54.829 | 27.807 |
| N | 9,326 | 29,443 | 16,945 | 17,189 |

*Note.* Clustered (at the individual level) standard errors are in parentheses. *p < .1. **p < .05. ***p < .01.

# RESULTS: HETEROGENEITY

| | Cognitive test score index | | | | |
|---|---|---|---|---|---|
| | Northern Europe | Western Europe | Eastern Europe | Southern Europe | All but not Northern countries |
| Number of children | -0.535** | -0.150 | -0.142 | -0.097 | -0.132** |
| | (0.244) | (0.123) | (0.120) | (0.095) | (0.067) |
| Control variables included | yes | yes | yes | yes | yes |
| Endogeneity test (p-value) | 0.006 | 0.308 | 0.402 | 0.638 | 0.147 |
| | First stage estimates: Number of children | | | | |
| Same sex | 0.118*** | 0.109*** | 0.134*** | 0.149*** | 0.127*** |
| | (0.029) | (0.021) | (0.018) | (0.028) | (0.013) |
| Control variables included | yes | yes | yes | yes | yes |
| F-test of the excluded instruments | 16.269 | 26.943 | 54.829 | 27.807 | 91.465 |
| N | 9,326 | 29,443 | 16,945 | 17,189 | 63,577 |

*Note*. Clustered (at the individual level) standard errors are in parentheses. *p < .1. **p < .05. ***p < .01.

# Results: Mechanisms

- Social support/contacts:
    - Positive with the frequency of contacts (smaller effect in the North, larger in the South )*
    - Not significant with informal care (no difference across regions)*
    - Positive with the number of grandchildren (larger in the North, smaller effect in the South)*
    - Not significant with caring for grandchildren (no difference across regions)*
- Labour market experience:
    - Not significant regarding the age they quitted their last job (no difference across regions) *
    - Not significant regarding the type of profession (difference across regions)*
- Standard of living:
    - Negative for wealth (Larger in Northern and Western Europe)*
    - Not significant for income (Negative for Northern Europe)*
- Health:
    - Positive for BMI and the risk of being overweight*

## Interpretations and Limitations

- Given the nature of the instruments, it only identifies the effect of having a third child.
- LATE
- Loss of precision due to the use of 2SLS. Difficulties in exploring the heterogeneity of the effects.

# CONCLUSIONS

- Using an instrumental variable approach, we estimated the causal effect of having a third child on cognitive functioning in later life in Europe
- We find that it has large negative effect on the level of cognitive performance in later life for both men and women
- This result suggests that the trend toward having less children could have unexpected benefits for cognition in later life
- More research is warranted in order to better understand the mechanisms linking childbearing history and cognitive functioning in later life