The causal effect of fertility history on cognitive functioning in later life

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Abstract

The impact of fertility on cognitive functioning among older individuals in Europe is not well understood. This is in spite of rapid changes in fertility patterns and widespread concerns for the negative effects of ageing on cognitive functioning. We use an instrumental variable (IV) based approach by exploiting a source of exogenous variation in the number of children. This allows us to assess the effect of number of children on cognitive outcomes among older adults in Europe. Our results indicate that having a third child negative affects later life cognition. Our IV results are larger than the OLS estimates, which could suggest a positive selection of those who decide to have a third child. We did identify regional heterogeneity: The effect is more salient in the Northern European countries (Sweden and Denmark), while no significant effect is found in the Southern European countries (Greece, Italy, Portugal and Spain).

Introduction

This study aims to analyse the consequences of fertility behaviour on cognitive functioning of older individuals in Europe.

Ageing European countries have seen changes in childbearing distributions, with a transition to below replacement fertility levels and rising childlessness as many forego childbearing altogether (Beaujouan and Sobotka 2017, Sobotka 2017). Childbearing has in many cases in Europe become more polarised (with rising shares having low fertility while many still have relatively high fertility) (Frejka 2017).

National fertility levels differ according to human capital and economic development (Myrskylä, Kohler et al. 2009). Moreover, the individual level relationship between fertility and education and/or income has changed over time, and for several countries it has reversed (Skirbekk 2008, Vogl 2015).

Particularly men have experienced a growth in childlessness -- e.g., in Finland in 2015 one in three men were childless at age 40, while Norway or the US saw about one in four men being childless at this age (Rotkirch and Miettinen 2017, Statistics Norway 2017, CDC 2018). This is a public health concern since men without children, particularly at later ages, often have a greater disease burden and exhibit higher mortality (Umberson 1987, Agerbo, Mortensen et al. 2012, Reczek, Pudrovska et al. 2016) – and often tend to be less socially integrated and have less economic resources (Jokela, Rotkirch et al. 2010, Rotkirch and Miettinen 2017). Fertility choices and family forms are related to health risk factors affecting mental and physiological health (Lim, Vos et al. 2013).

Population ageing is associated with large costs, particularly where ageing is associated with later life cognitive decline – which reduces the potential for maintaining productivity and increasing the retirement age at later ages – and raise the need for transfers, support and care at later ages (Wimo, Jönsson et al. 2013, Pratchett 2015). Age-related cognitive impairments, even those not reaching the threshold for dementia diagnosis, are associated with a loss of quality of life, increased disability, lower productivity, and higher health-related expenditures and care needs (Albert, Glied et al. 2002, Tabert, Albert et al. 2002). Cognitive abilities levels and trajectories at older ages differ across countries and cognitive decline below a given threshold take place earlier in some countries compared to others (Skirbekk, Loichinger et al. 2012, Chary, Amieva et al. 2013, Hessel, Kinge et al. 2018).

It is not well known whether the change in fertility interacts with cognitive ageing. There are several hypothesis that could explain why fertility might affect cognitive functioning at older ages. First, a large literature has investigate the effect of fertility children on labour supply of mothers. The common result is that parenthood and the number of children reduce labour force participation of women. This effect may translate into poorer cognitive functioning at older age as cognition has been shown to be positively related to labor-market participation and the age at retirement (Bonsang, Adam et al. 2012, Grotz, Letenneur et al. 2015), occupation and job-task content (Schooler, Mulatu et al. 1999, Altonji, Kahn et al. 2014). Second, higher fertility increases the likelihood of falling below the poverty line and facing a reduction in total family income (Cáceres-Delpiano and Simonsen 2012) and poverty has been shown to adversely affect cognition (Mani et al. 2013). Third, literature has shown that children are often the main source of support and social interactions for older individuals (e.g. (Vlachantoni, Shaw et al. 2015)). Children of dependent older adults provide a large amount of support and informal care across Europe, even in Nordic countries characterized by generous and universal welfare systems (Costa-Font, Karlsson et al. 2016). It is unclear whether changes in childbearing may lead to more interaction and stimulation of cognitive functioning among older adults.

The number of children may thus increase this source of support and improve cognitive functioning in later life as more social interactions have been suggested to be protective against cognitive decline through stimulating physical and mental activity (Zunzunegui, Alvarado et al. 2003, Ertel, Glymour et al. 2008)

There are only a few studies that have investigated the causal effects of fertility on health outcomes of women. Caceres-Delpiano and Simonsen (Cáceres-Delpiano and Simonsen 2012) used data form the US to analyse the impact of fertility on overall wellbeing of mothers. Using multiple birth as source of exogenous variation, they found that family size increases the likelihood of mothers suffering from high blood pressure and becoming obese. However, this analysis is based on mothers aged between 20 and 45 year-old. Kruk and Reinhold (Kruk and Reinhold 2014) used the first three waves of SHARE to investigate the effect of children on depression in old age using instrumental variables strategy based on multiple birth and sex composition of the first two children. They found no effect of additional children on mental health of men but a third child can be detrimental to women's mental health. However they did not investigate the heterogeneity of the effects of fertility on their outcomes.

We use data from the Survey of Health Ageing and Retirement in Europe that includes, among others, extensive information about family structure and health of older individuals (50+) from 19 Europeans countries and Israel. Akin to previous studies, we will use exogenous variation in fertility in order to identify the effect of number of children on cognitive functioning in later life. We use the sex composition of the first two children based on the empirical regularity that parents having the first two kids with the same sex have a higher probability of having a third child (e.g. (Ben-Porath 1967)).

Data

The sample

The empirical analysis is based on the pooled data from waves 1, 2, 4, 5 and 6 of the *Survey of Health, Ageing and Retirement in Europe* (SHARE).[1] Wave 3 is not used because this wave was devoted to a retrospective survey that does not include the information that is necessary for our analysis. SHARE includes extensive information on health, employment, financial situation, family and activities of a representative sample of the 50+ population in 19 European countries (Börsch-Supan, Brugiavini et al. 2005, Börsch-Supan, Brugiavini et al. 2008).[2] The interviewed persons being 50 year old or older come from the following countries: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Luxembourg, the Netherlands, Poland, Portugal, Slovenia, Spain, Sweden, and Switzerland. Data were collected using a computer assisted personal interviewing (CAPI) program, supplemented by a self-completion paper and pencil questionnaire. For more details on the sampling procedure, questionnaire content and fieldwork methodology, we refer readers to (Börsch-Supan, Brugiavini et al. 2008). [3]

For the following analysis, we restrict the sample to individuals aged between 50 and 85 (121,804 observations) who have only biological children (97,472 observations). Given our identification strategy, we only keep individuals with at least two children (77,955 observations). Finally, we discard observations with missing values for the variables of interest or the controls. The final analytical sample includes 71,328 observations.

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[1] Since we pool the waves of SHARE, we have more than one observations for many individuals observed in the sample. In the empirical analysis we thus present the standard error clustered at the individual level.

[2] Israel is also part of SHARE but we discard this country for our analysis. Nevertheless, a sensitivity check show that the inclusion of Israel in our analysis does not affect our results.

[3] More information can be found on the SHARE website: http://www.share-project.org/.

The measures of cognitive functioning

SHARE measures cognitive functioning of all respondents by using short and simple tests of episodic memory (learning and recall), executive functioning (verbal fluency), numeracy (arithmetical calculations), and orientation in time. However, the numeracy and the orientation in time tests were administered for individuals who were interviewed for the first time from the fourth wave onwards. We thus focus on 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. The immediate recall phase took place just after the interviewer had read out the ten words, while the delayed recall phase occurred after completing the fluency and the numeracy tests. For the fluency task, respondents had to name as many different animals as possible in one minute.

We use principal component analysis in order to combine the scores from these three cognitive tests (immediate recall, delayed recall and fluency) into a more general index of cognitive functioning, defined as the first principal component. We obtain an indicator that we normalize with a mean zero and unit variance.

Control variables

The equations to be estimated also include a limited number of control variables. We include age and age squared to take into account cognitive ageing. The level of education is included as an additional control variable and classified according to the ISED-1997 classification. We also control for the fact that the respondent is born out of the country and for the age of the respondent when the first child is born. All model also control for country fixed-effects and wave fixed effects.

Empirical strategy

The aim of the empirical analysis is to measure the effect of the number of children ($children_{it}$) on the cognitive functioning of the parents (C_{ict}). The equation to be estimated is the following:

$$C_{ict} = \beta_0 + \beta_1 children_{ict} + \boldsymbol{X'}_{\boldsymbol{ict}}\boldsymbol{\beta_2} + \alpha_c + \tau_t + \varepsilon_{ict}, \quad (1)$$

where $\boldsymbol{X'}_{\boldsymbol{ict}}$ is a vector of control variables that are likely to be related to cognitive functioning, β_0, β_1 and $\boldsymbol{\beta_2}$ are parameters to be estimated, α_c and τ_t are country and wave fixed effects, and ε_{ict} is the error term. Under the assumption that the error term is uncorrelated to $children_{it}$ and $\boldsymbol{X'}_{\boldsymbol{ict}}$, the parameter of interest β_1 can be estimated by Ordinary Least Squares. This assumption is unlikely to hold in the present context. The decision of having more children is clearly non-random and depends on a large number of observed and unobserved characteristics that are likely to be correlated with cognitive functioning.

In order to identify the causal effect of the number of children on cognitive functioning of the parents, we therefore use an IV approach. The instrument, to be valid, should be related to the number of children and should not be correlated with the error term of the structural equation (ε_{ict}). The candidate chosen as a valid instrument for the number of children is the gender composition of the first two children. A large literature documented that parents have generally a preference for a mixed-sibling sex composition (e.g. Ben-Porath (1967)). Moreover, the event of having two children of the same sex is random and provides a source of exogenous variation in fertility behavior that is unrelated to any observed and unobserved characteristics of the parents. This instrument has been extensively used to identify the causal effect of fertility in different contexts (Angrist, Lavy et al. 2006). In order to test the validity of the instrument, we perform some sensitivity checks. First, we include the sex of the two first children as additional control to discard any confounding bias to the potential effect of sex of children on cognitive functioning. Second, instead of using the fact that the two first children have the same sex as the instrument, we will use two instruments: a dummy variable that is equal to one when the first two children are girls and another dummy variable that is equal to one when the first two children are boys. This alternative identification strategy allows us to perform an overidentification test in order to check whether the sex of the children might bias the results.

Results

Descriptive statistics

Table. Descriptive statistics

	All	By sex composition of the first two children	
		Different sex	Same sex
Number of observations	71,328	35,411	35,917
Immediate word recall test	4.74	4.76	4.73
Delayed word recall test	3.26	3.27	3.25
Word fluency test	18.29	18.32	18.26
Number of children	2.73	2.67	2.80
Age of the respondent	0.55	0.55	0.55
Age at the birth of first child	72.91	72.95	72.88
Sex of the respondent (1=woman)	25.75	25.77	25.72
Respondent born abroad	8.2%	8.1%	8.3%
ISCED-0	6.0%	5.8%	6.2%
ISCED-1	28.0%	28.4%	27.7%
ISCED-2	18.0%	18.5%	17.4%
ISCED-3	27.2%	26.8%	27.6%
ISCED-4	3.5%	3.6%	3.5%
ISCED-5	16.1%	15.8%	16.4%
ISCED-6	0.6%	0.6%	0.7%
ISCED missing	0.6%	0.5%	0.6%
The two first children have the same sex	50.4%	0.0%	100.0%
The two first children are men	25.9%	0.0%	51.4%
The two first children are women	24.5%	0.0%	48.6%

First stage results

Table. First stage estimates: The effect of sex composition of the first two children on the total number of children.

Dependent variable :	Number of children		
	All	Men	Women
Same sex	0.126***	0.122***	0.129***
	(0.012)	(0.017)	(0.017)
Control variables included	yes	yes	yes
F-test of the excluded instrument	111.64	51.55	59.83
Two boys	0.106***	0.105***	0.106***
	(0.014)	(0.020)	(0.020)
Two girls	0.148***	0.141***	0.154***
	(0.015)	(0.022)	(0.021)
Control variables included	yes	yes	yes
F-test of the excluded instrument	57.84	26.41	31.51
N	71,328	31,952	39,376

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

Results from the two-stage least squares.

Table. 2SLS estimates: The effect of number of children on cognitive functioning.

Dependent variable :	Cognitive test score index		
	All	Men	Women
Instrument used :	Same sex		
Number of children	-0.174***	-0.175*	-0.177**
	(0.064)	(0.097)	(0.085)
Control variables included	yes	yes	yes
Endogeneity test (p-value)	0.021	0.138	0.072
Instruments used :	Two boys, two girls		

Number of children	-0.165***	-0.175*	-0.157*
	(0.062)	(0.095)	(0.081)
Control variables included	yes	yes	yes
Endogeneity test (p-value)	0.026	0.131	0.108
Overidentification test (p-value)	0.526	0.993	0.367
N	71,328	31,952	39,376

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

Findings

We find that having a third child negative affects later life cognition.

We use an instrumental variable based approach by exploiting a source of exogenous variation in the number of children. This allows us to assess the effect of number of children on cognitive outcomes among older adults in Europe. Our IV results are larger than the OLS estimates, which could suggest a positive selection of those who decide to have a third child. Additional results do indeed suggest that individuals who grew up in a household where there were many books at home are more likely to have more than two children. Moreover, our results hold true for both men and women, and could therefore be less likely to be driven by labour market participation. We did identify regional heterogeneity: The effect is more salient in the Northern European countries (Sweden and Denmark), while no significant effect is found in the Southern European countries (Greece, Italy, Portugal and Spain).

Our results are robust to : a) Using individuals whose no child died and using the information about the sex composition of the children obtained from SHARELIFE. b) The use of an individual random effects IV model taking into account the panel dimension of the data. c) Taking into account only observations for when the individual participates to the survey for the first time. d) Including individuals older than 85 years.

Conclusion

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 this parity progression negatively affect cognitive performance in later life among both men and women. This result suggests that the trend toward having less children could have unexpected implications for cognition in later life.

Population ageing and changes in fertility distributions imply that more research is needed in order to better understand the mechanisms linking childbearing history and cognitive functioning in later life. We need further studies to better understand the mediating mechanisms linking changes in family size with cognitive performance later in life. Subsequent work should also include more information on other fertility transitions than that we study (progressing from the second to the third birth). This includes studying how childlessness, the transition to a second child and higher order births (the transition to the fourth and fifth child) affect later life cognition.

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