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The Effect of Childhood Family Size on Fertility in Adulthood: New Evidence From IV Estimation

Sara Cools[1] · **Rannveig Kaldager Hart**[2,3]

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Abstract Although fertility is positively correlated across generations, the causal effect of children's experience with larger sibships on their own fertility in adulthood is poorly understood. With the sex composition of the two firstborn children as an instrumental variable, we estimate the effect of sibship size on adult fertility using high-quality data from Norwegian administrative registers. Our study sample is all firstborns or second-borns during the 1960s in Norwegian families with at least two children (approximately 110,000 men and 104,000 women). An additional sibling has a positive effect on male fertility, mainly causing them to have three children themselves, but has a negative effect on female fertility at the same margin. Investigation into mediators reveals that mothers of girls shift relatively less time from market to family work when an additional child is born. We speculate that this scarcity in parents' time makes girls aware of the strains of life in large families, leading them to limit their own number of children in adulthood.

Keywords Fertility · Intergenerational transmission · Instrumental variables · Family size

Introduction

Most important life outcomes—such as health, education, and income—are positively correlated across generations. This positive relationship is partly due to potential causation

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✉ Rannveig Kaldager Hart
r.k.hart@sosiologi.uio.no

Sara Cools
sara.cools@socialresearch.no

1 Institute for Social Research, Oslo, Norway

2 Department of Sociology and Human Geography, University of Oslo, Oslo, Norway

3 Research Department, Statistics Norway, Oslo, Norway

from one generation's achievements in these fields to that of the next generation and partly due to the shared genetic and social circumstances of parents and children. Studies of the intergenerational correlation in fertility across the developed world have consistently found that children also tend to replicate their parents' family size (Murphy 2013).

The fact that this relationship resists the inclusion of detailed controls for socioeconomic status suggests that the transmission of fertility across generations is not merely a by-product of shared social circumstances (Kolk 2014). The remaining correlation, however, is still somewhat of a black box. The fact that parents' preferences for their children's fertility behavior is positively correlated with the next generation's preferences (Axinn et al. 1994; Starrels and Holm 2000) and behavior (Barber 2000) indicates some transmission of family culture across generations. However, the origin of this family culture could lie in shared environment (beyond socioeconomic position) as well as in genetic similarity (Kohler et al. 1999). Despite demographers' interest in intergenerational transmission of fertility, surprisingly little attention has been devoted to netting out the similarity across generations and obtaining causal estimates of the effect of an additional sibling on own fertility in adulthood.

In this article, we seek to answer two closely related research questions. First, what is the causal effect of having an additional sibling on fertility in adulthood? Second, which social mechanisms would mediate such an effect?

Answering these questions requires estimates that can plausibly be interpreted as capturing a causal effect. We therefore use the same-sex instrumental variable (IV), which exploits the demographic finding that having children of the same sex increases the probability of further childbearing (Andersson et al. 2006; Ben-Porath and Welch 1976; Gini 1951). This increase in sibship size is uncorrelated with all background factors of parents, such as their (initial) preference for family size (Angrist and Evans 1998).

To the best of our knowledge, the only other researcher applying IV estimation to this end is Kolk (2015), who found no clear effects of sibship size on adult fertility using the birth of younger twin siblings as an IV. We use the twin instrument in a robustness check in this study, although we believe that it has some invalidating features when applied to the intergenerational transmission of fertility. By applying what we consider a more credible instrument and by supplying extensive robustness checks and a thorough investigation into the mechanisms explaining our findings, our study offers a significant contribution to the causal understanding of fertility transmission across generations.

Using data from Norwegian administrative registers, we study the fertility behavior of Norwegian men and women born in the 1960s. We estimate effects on completed fertility (measured at age 43) as well as on the likelihood of making specific parity transitions. The 1960s cohort balances the need for full background information with that of observing completed fertility (see the upcoming section, "Study Sample"). In this cohort, the modal number of siblings is one, closely followed by two (Rønsen 2004). Our estimates thus capture the effect of growing up in a typical larger family, relative to a typical smaller family in a dual-earner society. With high female labor force participation but rudimentary public support for working mothers, Norway in the 1960s has striking similarities with today's lowest-low fertility context in southern and central Europe (McDonald 2000b).

Our main finding is that the increase in sibship size increases men's fertility in adulthood, while it decreases women's fertility. For both, the effect is concentrated in the decision to have a third child. To understand the mechanisms behind these heterogeneous effects, we investigate the role of several potential mediators. Most importantly, we find that the additional sibling causes mothers (in the family of origin) to reduce their labor supply significantly more in the male than in the female sample. As a potential consequence, girls who grow up with more than one sibling are more familiar with the workload and time squeeze associated with having more children.

Although sibling sex composition is a much used IV for sibship size, the possibility that sex composition affects more than just sibship size is of particular concern when the outcome considered is fertility in the next generation. We test extensively for such direct effects of sibling sex on all outcomes considered in this article, and we find no evidence for them. Our results are also corroborated by similar (albeit insignificant) point estimates when we apply the twin instrument.

Our findings cast new light on fertility contagion. Fertility contagion is commonly thought of as an effect multiplier, magnifying small changes in the cost of childbearing into large fertility responses. Our findings, on the other hand, suggest that large families in one generation may also cause lower fertility in the next generation. Whether contagion is positive or negative depends on the children's experiences in larger families. Policies that make life in large families less straining, particularly for women, may hinder negative contagion across generations and hence may contribute to maintaining high birth rates.

Sibship Size and Fertility in the Next Generation

The birth of an additional sibling influences the time and money available to each child and likely also the preferences and beliefs about life in large families. Moving from a sibship of two to three increases the workload at home, often pushing a household's established work–family balance in the direction of family life. Angrist and Evans (1998) found a 5.3 % reduction in U.S. families' total income as a result of the increase in sibship size, and similar findings have been documented in other countries (see, e.g., Cruces and Galiani 2007 for Latin America; Daouli et al. 2009 for Greece; Hirvonen 2009 for Sweden; Cools 2013 for Norway). In the upcoming section, "Parents' Labor Supply and Children's Housework," we estimate the effect of sibship size on parents' labor supply.

Similarly, parents may shift time from (pure) leisure, such as time for hobbies and friends, to child-rearing upon the birth of an additional child. To the extent that parents of larger sibships place relatively more weight on family life, the value of family life as perceived by older siblings in the household may increase with additional siblings. This result could lead to more family-oriented behavior in the next generation, which could be reflected in higher probabilities of marrying and having a first child, more stable marriages, and larger families. To test this hypothesis, we use union stability (of both the index generation and their parents) as a proxy for being family-oriented (see upcoming "Union Stability of Parents and Index Persons" section).

Through adaptive preferences, a third child may give parents a preference for three-child families (for a more general example, see Hayford 2009). Furthermore, parents' preferences for their children's fertility behavior are positively correlated both with their children's fertility preferences (Axinn et al. 1994; Starrels and Holm 2000) and their fertility behavior (Barber 2000). In a similar vein, the *imitation hypothesis* suggests that children model their fertility behavior on that of their parents, such that those who grow up with two siblings would be disproportionately more likely to have a completed family size of three (Starrels and Holm 2000).

Given that information about the consequences of childbearing is imperfect, beliefs about these consequences may significantly influence fertility behavior (Bernardi and Klärner 2014). Individuals who grow up with an additional sibling may be more familiar with the strains of raising a relatively large family: children in larger families, on average, receive less care and attention from their parents and spend more time taking care of their (younger) siblings (Evertsson 2006). Presumably, such experiences are more pronounced for women than for men because girls increase their time spent on housework more than boys do when an additional sibling is born (Evertsson 2006; Gager et al. 1999), and are thus made more directly aware of the work required to raise a relatively large family. Additionally, the increase in sibship size mainly impedes women's careers (Cools 2013; Hardoy and Schøne 2008). To the extent that children use the parent of their own sex as a role model, awareness that a large family may limit career opportunities may lead women to limit their family size. Hence, girls from larger sibships may be more aware of the adverse consequences of larger families, both relative to boys from families of the same size and relative to children with fewer siblings. We describe differences in the housework efforts of teenage boys and girls in the upcoming section on "Parents' Labor Supply and Children's Housework" to better understand whether they contribute to any effects that we see in our sample.

An additional sibling may also affect fertility in adulthood through other causal channels. If less time and money available per child translates into lower human capital investment or into fewer direct transfers from parents to their adult children, there is scope for a negative effect on fertility in the next generation because of lower overall income. On the other hand, lower human capital implies lower alternative cost in caring for children, which (all else being equal) suggests increased fertility in the next generation. However, Waynforth (2011) found no significant correlation between fertility behavior and economic support from (grand)parents, and empirical studies have systematically failed to find a deterring effect on human capital from sibship size at this margin (Black et al. 2005; Mogstad and Wiswall 2009). In the upcoming section on "Index Person's Educational Attainment," we test for effects of sibship size on educational attainment, assessing whether this is a potential mediator of effects on family size.

Sibling Sex: IV Properties and Direct Effects

As an estimate of the effect of sibship size on fertility in the next generation, the intergenerational correlation in fertility is likely to be severely biased because of the shared biological, social, and economic circumstances of parents and children. Hence, estimating the effect of an additional sibling on fertility in the next generation requires a different empirical strategy. We use whether the firstborn and second-born children in the family of origin are of the same sex as an IV for sibship size. An extensive demographic literature has shown that when the firstborn and second-born children are of the same sex, parents are more likely to have a third child (Andersson et al. 2006; Hank 2007; Kippen et al. 2007). Because children's sex composition is uncorrelated with background characteristics of parents (such as fertility preferences), the same-sex instrument is a much-used IV for sibship or family size (see, e.g., Angrist and Evans 1998; Black et al. 2010; De Haan 2010).

The validity of using siblings' sex composition as an IV in our setting hinges on the sex composition having no effects of its own on fertility choices made in adulthood—that is, that it has no direct effects. Some studies have suggested that family support structures affect fertility decisions (Aassve et al. 2012) and that individuals who have a sister will on average receive less practical help from their parents in adulthood but more help from their sibling (Goodsell et al. 2015; Spitze and Trent 2006). Although some qualitative studies have suggested that having a sister in itself increases fertility (Bernardi 2003), quantitative studies have suggested that brothers influence fertility timing slightly more than sisters (Lyngstad and Prskawetz 2010). Because fertility timing is more easily influenced than completed fertility by context (Gauthier 2007), the observed correlations in timing need not imply that siblings affect each other's completed fertility. Importantly, in all these studies, the effect may be channeled exactly through sibship size—in which case, it does not pose a problem to our identification strategy.

To estimate only the direct effect of sibship sex composition on fertility in adulthood—that is, net of effects running through sibship size—one needs to look at a situation or sample in which sex composition does not influence sibship size (as is done, for instance, by Angrist et al. 2010; Peter et al. 2015). In the upcoming section, "Internal and External Validity," we provide an empirical investigation of direct effects of sibling sex composition, using the fact that the third child's sex does not affect the probability of further childbearing in families where the first two children are of opposite sex. We find no evidence of direct effects of sibling sex on any of the outcomes considered in this article. The empirical distribution across outcomes and sibship size, conditional on instrument status, satisfies the testable implication for instrument validity outlined by Kitagawa (2015). Taken together, these findings inspire confidence in the validity of our IV estimates.

Data and Study Sample

Study Sample

We use data from Norwegian administrative registers on all Norwegian residents. Personal identifiers link individuals to their parents and children. For registering to be as complete as possible, we restrict mothers of index persons to be born no earlier than 1935. The need for reliable data on both family background and on own completed fertility makes individuals born during the 1960s particularly suitable.

Because the sex composition IV is defined only for families with at least two children, our sample is limited to families whose first two children were both born between 1960 and 1969. We further exclude families in which the first two children do not share both parents or in which either parent is unknown to the registers. The mechanisms that we explore in the upcoming section "Empirical Tests of Mechanisms" may play out differently in intact and nonintact families. By this restriction, we exclude families that were "complex"—that is, families with stepchildren or single parents—before the realization of the instrument. The restriction also strengthens the first stage, improving the precision of the two-stage least squares (2SLS) estimates. The study sample does not include individuals who are themselves twins, but they may have twin siblings. Results are not sensitive to these further restrictions.

We study the fertility outcomes in adulthood of both firstborns and second-borns in the families included in our sample, and we estimate these outcomes separately by the index person's sex. In order for the same-sex instrument to be internally valid for the second-borns, sample entry cannot be influenced by the firstborn's sex, and no systematic differences can exist within the sample between parents who have firstborns and second-borns of different sexes. We find no effect of firstborn's sex on the probability of entering our sample, nor do we find any statistically significant difference within the sample in parents' background characteristics according to firstborn's sex (results available upon request).

Family Background Characteristics

Because the individuals under study were born during the 1960s, background characteristics that are exogenous to the instrument must be observed further back than is recorded in most of the important Norwegian registers. Parents' income and education could be observed, respectively, from 1967 onward and from 1970 onward, both of which are too late for our purpose. The only available background variables that are realized prior to the instrument for the whole sample are parents' year of birth, their age at first birth, and the amount of time (in years) between the births of the first two children.

The means of these variables are reported in Table 1. We split the sample into families with two children of the same sex (first column) and those with two children of different sex (second column). The last column in Table 1 reports simple *t* tests of whether the background characteristics vary with the sex composition of the first children.

When included as controls, background variables enter as a set of dummy variables capturing the time in years between the birth of the first and the second sibling (censored at six years), and dummy variables for parents' age at first birth (by five-year age brackets). All models include birth year and birth order fixed effects (FE) in the form of a set of dummy variables for birth year and birth order. The full set of dummy variables to be used as controls throughout the article, in addition to *t* tests of the difference by instrument status, is given in Online Resource 1 (Table S1). Systematic differences in means by instrument status would indicate that the instrument is not randomly assigned. Some of the estimated differences according to same-sex sibship are statistically significant, but they are not significant in size.

Table 1 Mean values in family background variables by sibling sex composition

	Same Sex		Different Sex		Difference	
	Mean	SD	Mean	SD	Est.	SE
Distance Two First Children (years)	2.45	1.31	2.46	1.33	–0.01	0.01
Mother's Year of Birth	1941.47	3.45	1941.48	3.47	–0.01	0.02
Mother's Age at First Birth	22.13	2.81	22.16	2.84	–0.03†	0.02
Father's Year of Birth	1937.99	4.95	1938.02	4.96	–0.04	0.03
Father's Age at First Birth	25.62	4.38	25.62	4.39	–0.00	0.03
N	53,431		53,813		107,244	

Notes: The samples are all couples with at least two children, in which the first two children were both born in Norway in the period 1960–1969 and are registered with the same mother and father.

$^{\dagger}p < .10$

Table 2 Mean values in outcome variables, by index person's sex

	Men		Women	
	Mean	SD	Mean	SD
Number of Children at 43	1.75	1.24	2.03	1.14
Has Children at 43	0.78	0.42	0.87	0.33
Has >1 Child at 43	0.63	0.48	0.74	0.44
Has >2 Children at 43	0.27	0.44	0.33	0.47
Has >3 Children at 43	0.06	0.24	0.07	0.26
N	110,225		103,760	

Notes: The samples consist of all firstborn and second-born men and women born in Norway between 1960 and 1969 in families with at least two children, in which the first two children are registered with the same mother and father.

Fertility Outcome Variables

The main outcome variable considered in this article is the total number of children registered to the individual at the age of 43. The whole sample can be followed until age 43, after which we lose more than 10 % of the original sample with each yearly increment in age. We therefore present completed fertility at age 43 in our main results. As a robustness check, we estimated effects on fertility up to age 45 (Online Resource 1, Fig. S1). The point estimates are in line with the main findings, although precision decreases with sample size. Using the same age of observation for men and women and moving the female (male) estimates down (up) by a few years do not affect the difference in estimates across sex.

We also evaluate parity-specific outcomes by considering separately the probability of having more than zero, one, two, and three children at this age. Descriptive statistics for these outcomes are given in Table 2.

Additional Outcome Variables

In the investigation into mechanisms (upcoming "Empirical Tests of Mechanisms" section), we study three sets of additional outcome variables: parents' labor supply, the union stability of index persons and their parents, and the educational attainment of index persons.

The descriptive statistics for these outcomes are given in Table 8 in the appendix. Information on yearly personal income (wages, pensions, and entrepreneurial income) goes back to 1967 and covers the population residing in Norway each year.

Labor supply at the extensive margin (employment) is defined as having a yearly income above 1 BA.[1] We proxy labor supply at the intensive margin (i.e., working hours conditional on employment) by taking the log of income above 1 BA. This is a

[1] A yearly adjusted base amount, BA, is used in the Norwegian social insurance system to calculate various benefits. In 2014, 1 BA = NOK 88,370, about 18 % of the median household income, and approximately $14,000 USD at the 2014 NOK-USD exchange rate.

valid approximation in our case if a third child has no effect or only a negligible effect on hourly wages, as Cools (2013) documented. Because we find no effects on fathers' labor supply at either margin, these results are not displayed.

Education data come from Statistics Norway's education registers, which record all changes (and their dates) in individuals' highest educational attainment from 1970 onward. Finally, we have data on parents' marital status from 1992 onward: that is, from when the youngest individuals in our sample were aged 23, and the oldest were 32 years. Parents' marital status when the second child was aged 28 (when approximately one-half of the sample can be observed) therefore serves as a proxy for their marital status when the children still lived at home.

The same registers are used for the index persons' own marital status in adulthood (married, divorced, or neither). To capture family stability regardless of marital status (more than one-half of first births to Norwegian coresidental couples are currently to cohabiters), we estimate the effect of an additional sibling on the probability of having (at least) two children with the same partner. Having two children is itself an outcome affected by sibship size; hence, we present an unconditional measure equal to 1 if the individual, at age 43, has at least two children and these two share both parents, and 0 otherwise.

Effects on Fertility in Adulthood

We perform IV estimation in two steps, using 2SLS regression. We first estimate the effect of sibship sex composition on sibship size—captured by the probability of having more than one sibling—giving the first-stage estimates. We then obtain IV estimates by regressing the index persons' fertility in adulthood on the part of the variation in the sibship size tied to sex composition. The IV estimate captures the average treatment effect among those moved by the instrument—that is, those parents who will have a third child if and only if their two first children are of the same sex (Imbens and Angrist 1994). Because the IV always takes the same value for siblings, treating siblings as independent observations would underestimate standard errors. We avoid this by clustering at the family of origin.

We also present reduced-form estimates of the effect of sibship sex composition on fertility in adulthood (by ordinary least squares (OLS)). The reduced-form estimate gives the impact of sibling sex on the outcome in question, making no assumption that the effect is channeled through sibship size. Last, we obtain the intergenerational correlation using OLS regression of fertility in adulthood on sibship size.

Main Results

The main results of this article are presented in Table 3. Columns 1 and 2 give first-stage estimates, columns 3 and 4 show the reduced-form estimates, and columns 5 and 6 show the IV estimates. The OLS estimates of the intergenerational correlation in fertility are given in columns 7 and 8. The upper and lower panels give estimation results for men and women, respectively. All the specifications in Table 3 include birth year and birth order FE. The even-numbered columns also include a set of exogenous control variables (see the section, "Data and Study Sample" and Online Resource 1, Table S1): parents' year of birth, their age at first birth, and the time in age between the first two siblings.

Columns 1 and 2 in Table 3 give the OLS estimates of how being in a same-sex sibship affects the likelihood that individuals in our sample will have an additional sibling. These first-stage estimates are slightly larger for women than for men, but they are all very close to 6 percentage points and comparable in size to other applications of this instrument. With t statistics greater than 20, they satisfy the criterion of instrument relevance.

Columns 3 and 4 give the OLS estimates of how being in a same-sex sibship affects individuals' own number of children when they are 43 years old. Having a brother causes the men in our sample to have 0.015 more children, on average ($p < .05$). On the other hand, having a sister causes the women in our sample to have 0.014 fewer children, on average ($p < .10$). The effect on sibship size (columns 1 and 2) is likely to play a major role in the estimated effect of same-sex sibship on individuals' own fertility. Under the assumption that it is in fact the only causal channel from sex mix to fertility in adulthood (i.e., the exclusion restriction for instrument validity), the 2SLS estimates in columns 5 and 6 are consistent estimates of the causal effect of sibship size on individuals' total number of children at age 43. According to these estimates, having an additional (a second) sibling as a child causes men to have 0.26 more children and women to have 0.23 fewer children, on average, in adulthood.

Consistent with previous research, the intergenerational correlations shown in columns 7 and 8 are positive, and slightly stronger for women than for men. Compared with the causal effects documented in columns 5 and 6, the OLS estimates are thus substantially more positive for women but are slightly less positive for men. This outcome suggests that the unobserved variables netted out in our IV analysis—such as shared environment, preferences, and genetics—transmit fertility across generations more strongly for women than for men.

We further split the sample according to birth order. The estimates are statistically significant only in the samples of firstborn men and second-born women (Online Resource 1, Table S2).

Parity-Specific Effects

In order to know which fertility margins are affected by sibship size, we evaluate the effects of same-sex sibship and sibship size on the likelihood of having more than zero, one, two, and three children. If the negative effects among women are mediated by belief formation, we expect women from larger sibships to avoid forming large families. The imitation hypothesis suggests that growing up with two siblings leads to a preference for three children, predicting particularly strong positive effects at a parity of three (Starrels and Holm 2000). If, instead, results were driven by transmission of a more general sense of being family-oriented, we would expect effects on all parities among men.

The reduced-form (odd-numbered columns) and IV estimates (even-numbered columns) are given in Table 4. For men, the point estimates are positive at all margins but are significant only for the likelihood of having a third child. However, the parity-specific estimates do not differ significantly. An additional sibling makes men 10.9 percentage points ($p < .05$) more likely, on average, to have three or more children, indicating a male pattern of fertility imitation or adaptive preferences in which growing up with two siblings fosters a preference for a three-child family in adulthood.

For women, point estimates are negative at all margins above the first child. Here, too, the only significant estimate regards the likelihood of having a third child, which decreases by 15.6 percentage points ($p < .01$) due to the increase in sibship size.

Table 3 Effects of sibling sex composition and sibship size on fertility in adulthood

	First Stage >1 Sibling		Reduced Form Number of Children		IV Estimate Number of Children		OLS Estimate Number of Children	
	OLS	OLS	OLS	OLS	2SLS	2SLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Men								
Same sex	0.059**	0.057**	0.015*	0.015†				
	(0.003)	(0.003)	(0.008)	(0.008)				
>1 sibling					0.256*	0.258†	0.138**	0.123**
					(0.130)	(0.134)	(0.008)	(0.008)
Other controls	No	Yes	No	Yes	No	Yes	No	Yes
Adjusted R^2	.018	.106	.002	.005	.003	.005	.005	.007
N	110,225	110,225	110,225	110,225	110,225	110,225	110,225	110,225
Women								
Same sex	0.063**	0.061**	–0.013†	–0.014†				
	(0.004)	(0.003)	(0.007)	(0.007)				
>1 sibling					–0.210†	–0.233†	0.205**	0.183**
					(0.119)	(0.121)	(0.008)	(0.008)
Other controls	No	Yes	No	Yes	No	Yes	No	Yes
Adjusted R^2	.019	.108	.002	.006	—	—	.009	.011
N	103,760	103,760	103,760	103,760	103,760	103,760	103,760	103,760

Notes: The sample is firstborns and second-borns in Norwegian families with at least two children, in which the two first children are of opposite sex and were born between 1960 and 1969. Standard errors (shown in parentheses) are clustered at the family of origin. Birth order and birth year fixed effects are included in all estimations.

†$p < .10$; *$p < .05$; **$p < .01$

Internal and External Validity

Direct Effects of Sibling Sex

Although sibling sex composition is a much-used instrumental variable for sibship size, the potential existence of direct effects, which would compromise the instrument's internal validity, cannot be dismissed a priori. To assess the likelihood of bias in the IV estimates presented in Tables 3 and 4, we study how individuals' fertility decisions in adulthood are affected by sibling sex mix in the particular case in which sibling sex mix does not affect sibship size. Among the families in our sample with at least three children and in which the two first children are of opposite sex, parents are not, on average, influenced by the sex of the third child in their decision to have a fourth child.

This sample can therefore be used to investigate direct effects of sibship sex composition, rid of any effect going through sibship size.

Columns 1 and 2 in Table 5 show how a second sibling (i.e., the family's third-born) being of the same sex as the index person affects parents' further childbearing in this sample. For both men and women, the effect is quite precisely estimated to be 0; the sex of the third child does not influence parents' propensity to have a fourth child. In columns 3 and 4, we estimate whether having a same-sex second sibling impacts fertility at age 43. The estimates show no significant effect of having a sibling of the same sex on individuals' own fertility in adulthood for either men or women. The point estimates are small and in the opposite direction of the reduced-form estimates in Table 3, and we therefore find it unlikely that the IV estimates in Table 3 are severely biased. If anything, the bias indicated by the estimates in Table 5 would push the IV estimates toward 0.

We also estimated direct effects for each parity transition, as in Table 4, and we found no evidence of direct effects for any of the outcomes, further strengthening the case for internal validity (available upon request).

Table 4 Effects of sibling sex composition and sibship size on different parity transitions in adulthood

	>0 Children		>1 Child		>2 Children		>3 Children	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Men								
Same sex	0.003		0.003		0.006*		0.002	
	(0.003)		(0.003)		(0.003)		(0.001)	
>1 sibling		0.056		0.059		0.109*		0.035
		(0.045)		(0.052)		(0.047)		(0.026)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	.005	.002	.003	.003	.003	.005	.003	.004
N	110,225	110,225	110,225	110,225	110,225	110,225	110,225	110,225
Women								
Same sex	0.001		–0.002		–0.010**		–0.003†	
	(0.002)		(0.003)		(0.003)		(0.002)	
>1 sibling		0.014		–0.025		–0.156**		–0.045
		(0.034)		(0.046)		(0.051)		(0.027)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	.005	.006	.002	—	.005	—	.003	—
N	103,760	103,760	103,760	103,760	103,760	103,760	103,760	103,760

Notes: The sample is firstborns and second-borns in Norwegian families with at least two children, in which the two first children are of opposite sex and were born between 1960 and 1969. Standard errors (shown in parentheses) are clustered at the family of origin. Birth order and birth year fixed effects are included in all estimations.

$^{\dagger}p < .10$; $*p < .05$; $**p < .01$

Table 5 Testing for direct effects of sibling sex composition on fertility in adulthood

	First Stage >2 Siblings		Direct Effects Number of Children	
	OLS (1)	OLS (2)	OLS (3)	OLS (4)
Men				
Same sex	–0.001	0.000	–0.002	–0.002
	(0.005)	(0.005)	(0.014)	(0.014)
Other controls	No	Yes	No	Yes
Adjusted R^2	.015	.058	.001	.003
N	32,273	32,273	32,273	32,273
Women				
Same sex	0.001	–0.001	0.015	0.015
	(0.005)	(0.005)	(0.013)	(0.013)
Other controls	No	Yes	No	Yes
Adjusted R^2	.015	.059	.001	.003
N	32,274	32,274	32,274	32,274

Notes: The sample is firstborns and second-borns in Norwegian families with at least three children, in which the two first children are of opposite sex and were born between 1960 and 1969. Standard errors (shown in parentheses) are clustered at the family of origin. Birth order and birth year fixed effects are included in all estimations.

Alternative IV: Twins

Twinning may be used as an alternative instrument for family size (Angrist and Evans 1998; Black et al. 2005). The twin instrument captures the effect of an unintended third birth, with zero spacing to the second birth, and it might therefore differ from the one captured by the same-sex IV.

In Table 6, we show the estimates of the effect of an additional sibling on fertility in adulthood using the twin IV. The first-stage estimates are given in columns 1 and 2, and the IV estimates are shown in columns 3 and 4. Again, the estimated effect of sibship size on fertility is positive for men and negative for women, comparable in size with the same-sex IV estimates but not statistically significant at conventional levels. The estimates are also comparable with those Kolk (2015) found when applying the twin instrument to Swedish data.

Applying the twin instrument to fertility outcomes raises some concerns regarding both internal and external validity. For women, the genetic heritability of (monozygotic) twinning could bias the estimates in either direction: women whose mothers had twins may have more children after a twin birth, or have fewer children if their heightened risk of twinning keeps them from having additional children. Because

Table 6 First- and second-stage estimates using twin instrument

	>1 Sibling		Number of Children	
	OLS (1)	OLS (2)	2SLS (3)	2SLS (4)
Men				
Twin 2nd	0.363**	0.373**		
	(0.003)	(0.010)		
>1 sibling			0.082	0.085
			(0.206)	(0.201)
Other controls	No	Yes	No	Yes
R^2	.005	.105	.004	.007
N	55,195	55,195	55,195	55,195
Women				
Twin 2nd	0.366**	0.380**		
	(0.003)	(0.011)		
>1 sibling			–0.210	–0.178
			(0.195)	(0.187)
Other controls	No	Yes	No	Yes
R^2	.006	.109	—	—
N	52,049	52,049	52,049	52,049

Notes: The sample is firstborns and second-borns in Norwegian families with at least two children, in which the two first children are of opposite sex and were born between 1960 and 1969. Standard errors (shown in parentheses) are clustered at the family of origin. Birth year fixed effects are included in all estimations.

$^{**}p < .01$

twinning is a shock not only to the number of siblings but also to the spacing between them, growing up with younger twin siblings is possibly a different experience from growing up with two younger singleton siblings. Using exogenous variation in spacing from miscarriages, Buckles and Munnich (2012) showed that spacing in its own right affects outcomes of both children and parents. Although the validity of the same-sex instrument is corroborated in our setting by tests for direct effects, we do not have similar tests for the twin instrument.

External Validity

The estimates obtained using the same-sex, or twin, instrument capture the effect of an additional sibling for individuals whose parents have a third child if and only if the first two children are of the same sex, or if and only if the second birth is a twin birth (local average treatment effect, or LATE). The similarity of the effects as estimated by the two instruments indicates that the effects are not specific to increases in family size driven by twinning or preferences for sex mix. Starting then from the assumption that we seem to capture the general effect of sibship size on fertility for men and women in our index cohort, we discuss the relevance of our findings to other contexts and birth cohorts in the upcoming “Discussion” section.

Empirical Tests of Mechanisms

To gain insight into social mechanisms that could mediate the different effects of sibship size on men’s and women’s family formation in adulthood—thus answering our second research question—we investigate how several other outcomes (described in the earlier section, “Additional Outcome Variables”) are affected by sibship size. Any such mediator must itself be causally affected by sibship size; hence, we continue to present IV estimates to handle bias from unobservable confounders.

Parents’ Labor Supply and Children’s Housework

If the addition to the family reduces parents’ total labor supply, this will result in lower family income and in more time spent by at least one parent at home (see the earlier section, “Sibship Size and Fertility in the Next Generation”). The upper panel of Table 7 gives the estimates of how mothers’ labor supply was affected by additional children during the childhood years of the index persons in our sample. (Fathers’ labor supply is not moved by family size in our sample; results are available upon request.)

Labor supply is measured at the extensive margin (employment) and at the intensive margin (log earnings conditional on employment), with averages taken over the years when the second-born child is aged 6–10 and 11–15 years. The estimates are done by age of the second child because this measure is defined for the whole sample. The third child, if born, will be approximately three years younger, on average, than the second child.

We find a substantial difference in how mothers’ labor supply is affected by sibship size in the men’s and in the women’s sample. When the second child is 6–10 years old (and a third child is, on average, 3–7 years old), the effect is a 17.6 percentage point reduction in mothers’ employment in the men’s sample ($p < .01$), whereas no reduction in mothers’ employment is evident in the women’s sample. When the second child is aged 11–15, mothers’ employment is reduced by 33 percentage points in the men’s sample ($p < .01$), and still an effect is not evident in the women’s sample. The differences by gender are highly statistically significant. At the intensive margin, labor supply is significantly reduced when the second child is aged 11–15 in both samples, by about 38 % in the men’s sample and 12 % the women’s sample. Again, the estimated difference in the pooled model is substantial and statistically significant ($p < .01$).

Tests equivalent to those presented in Table 5 show no evidence of a direct effect of sex mix on mothers’ labor supply (Online Resource 1, Table S3). Also, the conditional distributions across mothers’ income and sibship size satisfy the requirement in Kitagawa (2015) (available upon request). A violation of instrument validity thus seems an unlikely explanation of these findings.

Table 7 IV estimates for the effects of sibship size on childhood circumstances, union stability, and educational achievement

Outcome	Men (1)	Women (2)	Difference (3)
Mothers' Labor Supply During Childhood			
Employment, 2nd child aged 6–10	–0.176**	–0.008	–0.164*
	(0.057)	(0.056)	(0.064)
Employment, 2nd child aged 11–15	–0.330**	–0.015	–0.300**
	(0.052)	(0.050)	(0.058)
Log earnings, 2nd child aged 6–10	–0.053	–0.065	0.014
	(0.073)	(0.073)	(0.082)
Log earnings, 2nd child aged 11–15	–0.324**	–0.119*	–0.193**
	(0.063)	(0.059)	(0.068)
Parents' Marital Stability			
Parents married, 2nd child aged 28	0.122*	0.044	0.075
	(0.057)	(0.056)	(0.063)
Index Person's Union Stability			
Married at age 43	0.111*	0.097[†]	0.012
	(0.054)	(0.052)	(0.071)
Divorced at age 43	0.032	–0.105**	0.130*
	(0.037)	(0.040)	(0.052)
>1 child same partner at 43	0.125*	0.011	0.108
	(0.054)	(0.050)	(0.069)
Index Person's Educational Achievement			
Secondary education at age 19	0.061	–0.015	0.076
	(0.051)	(0.052)	(0.066)
Secondary education at age 43	0.009	–0.030	0.042
	(0.063)	(0.061)	(0.081)
Lower tertiary education at age 43	0.071	0.012	0.058
	(0.062)	(0.062)	(0.080)
Higher tertiary education at age 43	0.007	–0.020	0.026
	(0.039)	(0.030)	(0.046)

Notes: In columns 1 and 2, each cell gives the 2SLS estimate of the effect of sibship size on the outcome given by the row heading. In column 3, each cell gives the corresponding 2SLS estimate of the difference in the effect of sibship size by index person's sex, estimated in the pooled sample. The samples are mothers (upper panel), parental couples (middle panel), and children (lower panels) in Norwegian families with at least two children, in which the two first children are of opposite sex and were born between 1960 and 1969. The number of observations for each estimate is given in the corresponding cells in Tables S3 and S4. Standard errors (shown in parentheses) are clustered at the family of origin.

$^*p < .05$; $^{**}p < .01$

Rather, it seems likely that the effect of having a third child on mothers' labor supply is mediated by whether they have a daughter to help out at home. The largest differences by sex are found when the second child is 11–15 years old and the oldest about 13–18 years, when both are old enough to participate in household work if required.

A daughter in the household may enable mothers to work longer hours in paid work upon the birth of a third child. We have checked survey data on Norwegian teenagers' time use in our index cohorts, collected in 1980 (see Online Resource 1 for more details). A simple OLS regression shows that girls spend 32 minutes more on housework per day than boys do ($p < .001$, see Table 9 in the appendix). The difference increases by about 10 minutes with an additional sibling (not statistically significant). Because of the relatively small sample size ($N = 415$), we cannot instrument for family size, and the estimates do not have a causal interpretation.

Being more involved in housework, teenage girls may have been more aware of the work required to raise a family than their male peers were. Hence, a more negative effect for women than for men could be linked to the possibility that a second sibling was more of a learning experience for teenage girls than for teenage boys.

Union Stability of Parents and Index Persons

Previous research has suggested that a larger sibship may lead to a stronger family orientation and hence mediate a positive effect of sibship size on fertility in the next generation (see the earlier section, "Sibship Size and Fertility in the Next Generation"). We explore this mechanism by looking at how sibship size affects union stability—both for index persons in adulthood and for their parents—as a proxy for being family-oriented.

The second panel in Table 7 presents estimates of the effect of sibship size on the marital stability of the parents in the family of origin. For both men and women, the estimated effect of sibship size on their parents' likelihood of remaining married is positive. The estimate is, however, statistically significant only in the men's sample. Again, we find no evidence of direct effects of sex mix on parents' marital stability (Online Resource 1, Table S3).

Children from intact homes may have a more positive experience of family life in their childhood, leading to increased fertility in the next generation (Axinn and Thornton 1996). The positive effect on parents' marital stability found in the men's sample could contribute to increased family-orientedness—thus resulting in higher fertility—among men.

The third panel of Table 7 shows the estimated effect of sibship size on the index person's likelihood of being married and divorced at the age of 43. For men, having an additional younger sibling increases the likelihood of being married at age 43 by 11 percentage points, and it does not affect the likelihood of divorce. This finding indicates that growing up in a relatively large sibship increases men's family-orientedness more generally, shifting some men who would otherwise have remained unmarried into marrying and having more children. For women, the effect on marriage is about the same as for men, and there is a negative effect of 10.5 percentage points on the likelihood of being divorced ($p < .01$). Hence, the negative effect on women's fertility is not a result of lower union stability.

This interpretation is corroborated in the last row of Table 7, which gives the estimates of the effect of sibship size on the likelihood of having had two first children with the same partner. Relative to the effect on the overall probability of having two children (Table 4), having an additional sibling makes it relatively (but statistically insignificantly) more likely for both men and women to have two first children with the same partner.

Index Person's Educational Attainment

A much-hypothesized effect of increased sibship size is that parents will invest less in each child and thus that children from larger sibships will have lower educational attainment (Becker 1960). Educational attainment is again a well-known fertility predictor (see the earlier section, "Sibship Size and Fertility in the Next Generation"). The lower panel of Table 7 displays no significant effect of sibship size on the likelihood of completing high school by age 19. Also, we find no evidence of effects of sibship size on educational attainment when measured at age 43. We find no consistent effects of an additional sibling on the duration of educational enrollment (available upon request). Hence, educational attainment is an unlikely mediator of the effects on fertility behavior.

Discussion

Although fertility is consistently positively correlated across generations, the findings presented in this article suggest that the causal effect of sibship size on adult fertility follows a more complex pattern. A second sibling induces some men to have a third child themselves, but it keeps some women from making the same parity transition. Based on the evidence about various mechanisms that could potentially channel the effect of sibship size on adult fertility, a picture emerges of two processes taking place as a family increases in size.

First, an additional child shifts time and attention to family life from other activities. In the study of mediators, we observe a shift away from mothers' labor supply, easily interpreted as an increase in family time. Evidence of increased union stability both for index persons in adulthood and for their parents further supports a shift toward family values. From this process alone, we would expect a positive impact of sibship size on fertility in adulthood.

Second, the additional child takes up resources in terms of time, income, or both. Presumably, other siblings will to some extent receive less time and monetary input from their parents and will be expected to provide some of their own time to the care of their younger sibling. Resources also become scarcer for parents, and mothers' time in particular will be visibly more constrained. Because knowledge about the consequences of fertility decisions is often obtained through own experience (Bernardi and Klärner 2014), an additional sibling might therefore make children more conscious of the costs of raising a larger family, potentially causing a negative impact of sibship size on fertility in adulthood.

The findings in the preceding section indicate that the relative impact of these two processes varies with gender. Evidence of the first process is found mainly in the male sample, where mothers' labor supply is much more reduced than in the female sample and where the additional sibling significantly increases parents' marital stability. One interpretation of these findings is that parents in the male sample adapt their preferences and values to the increase in family size (cf. Hayford 2009) and then transmit these (adaptive) preferences to their children (Axinn et al. 1994; Barber 2000).

In the female sample, the evidence of such a shift toward family values is weaker: mothers' labor supply and parents' marital stability is less affected. Insofar as parents' time concerns are felt more keenly by children than their money concerns, the second process will be of relatively greater importance in the female sample. Our female index persons will have witnessed mothers who were far more time-constrained or will have had to provide much more for their younger siblings—or both—than their male counterparts.

Conley (2004) suggested that families are much more likely to use girls as a "labor reserve" when parental time is scarce. The fact that daughters help out more at home than sons (see the earlier sections "Sibship Size and Fertility in the Next Generation" and "Parents' Labor Supply and Children's Housework") could in part explain why mothers of girls and boys respond so differently to the birth of an additional sibling. However, by sharing in the family workload, their daughters may in turn become reluctant to have many children in adulthood. The fact that the women in our study who have an additional sibling refrain from having a larger family—and not from marriage and parenthood in general—further supports the interpretation that the birth of an additional sibling reveals specific information of the strains associated with life in larger families.

The negative effect of an additional sibling is concentrated among second-born women ("Main Results" section). When a third child is born, the second-born is moved to the comparatively less favorable position of middle-born in the sibship (Argys et al. 2007; Kidwell 1982; Salmon et al. 2012). Because middle-borns, on average, receive less time and attention from their parents, they may also be more aware of the disadvantages of a larger sibship. Regarding educational attainment, Conley and Glauber (2006) found that second-borns are more negatively affected than firstborns by the birth of an additional sibling. This pattern suggests that our findings likely are driven by an interplay of different social mechanisms, which together create the mix of effects that emerges.

In the literature on fertility contagion, fertility is expected to be contagious through social networks largely because of imperfect information of its consequences, and individuals drawing on their own experiences and network as information sources (Bernardi and Klärner 2014). Although most studies of fertility contagion have consistently found positive effects, our study presents new evidence of belief-mediated negative contagion on female fertility. Because controlling for unobserved heterogeneity in the OLS framework is usually only partial, estimates of social contagion are likely to be biased upward because of similarity within networks and families.

In the male sample, the IV estimates are not significantly different from the OLS estimates, suggesting that the intergenerational correlation in fertility could be largely driven by the causal effect of an additional sibling. In the female sample, on the other hand, our causal estimates suggest that the intergenerational correlation in fertility is substantially and significantly biased upward compared with the effect of an additional sibling. This difference suggests that exactly those mechanisms that are netted out in our IV design—similarities in both observable and unobservable characteristics between parents and children—drive the positive intergenerational correlation in fertility among women. This includes shared social background, heritability of fertility preferences (Rodgers et al. 2001), and transmission of parents' initial fertility preferences (Starrels and Holm 2000).

The IV estimates of sibship size presented in this article pertain, in the strictest sense, to the margin between one and two siblings in the family of origin and to individuals whose parents are moved to have a third child by the sex mix of the two first children. Because the alternative twin instrument also yields a more negative effect of sibship size on women's fertility in adulthood than on men's, we believe that the results are not specific to children of parents with exactly these sex-mix preferences. Throughout the period of study, the most common number of (maternal) siblings in Norway is one, closely followed by two (Rønsen 2004). In our index cohorts, our estimates thus capture the effect of moving from a typical small to a typical larger sibship. The margin from two to three children is important: the decreasing proportion of families with more than two children has been pinpointed as an important driver of lowest-low fertility (Morgan 2003). One might speculate that having a first sibling is perceived as more of a clear gain, potentially producing a more positive effect on fertility in the next generation than indicated by our findings.

Furthermore, the external validity of our findings depends on whether the mechanisms identified in the preceding section are also plausible in social contexts other than the egalitarian Nordic welfare state. The positive effect found among men seems driven by larger sibships strengthening family orientation in the next generation. This mechanism is found in other Western contexts in the literature on intergenerational transmission (Axinn et al. 1994; Barber 2000; Starrels and Holm 2000), backing up the external validity of the positive causal effect found for men.

Our analysis of mechanisms suggest that the increase in family size intensifies the conflict between work and family life for mothers, translating into lower fertility for women in the next generation. Norway in the 1960s and 1970s was in transition from a traditional to a more gender egalitarian society. While female labor supply increased, state-provided childcare was only partial (Havnes and Mogstad 2011), and fathers' active involvement in childcare and housework was marginal (Kitterød and Rønsen 2013; Statistics Norway 1983). Several studies linked such partial gender equality—potentially leaving mothers with a "double burden" (Sieber 1974)—to low fertility (Becker 1991; Esping-Andersen and Billari 2015; Goldscheider et al. 2015; McDonald 2000a). This environment resembles that of lowest-low fertility regions in today's Europe, where increased female labor supply has not been paralleled with institutions that support working mothers or increased father involvement (Goldscheider et al. 2015; McDonald 2000a). Our findings for women are of particular relevance for these contexts and are perhaps less important for contexts where high female labor supply and relatively high fertility coexist. Furthermore, our results are relevant to any parity transition that intensifies the conflict between paid work and motherhood, be it the third or fourth, or maybe fifth, child. At very high parity transitions, couples may already practice full gender specialization, and the mechanisms that we detect here may be of less relevance. Notably, our results indicate that negative cross-generational effects pertain even when the younger generation faces vastly improved institutional support (Rønsen and Skrede 2010).

For countries seeking to maintain both high fertility rates and high female labor force participation, our results underline the significance of facilitating the combination of family life and market work throughout active parenthood. It is well established that the lack of such support structures have an immediate negative effect on fertility. The novelty of our findings lies in that this negative effect on fertility may be even more severe than previously assumed, given that it can persist across generations.

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Appendix

Table 8 Mean values in additional outcome variables, by index person's sex

	Men			Women		
	Mean	SD	*N*	Mean	SD	*N*
Mother's Labor Supply						
Income, 2nd child aged 6–10	1.47	1.38	82,809	1.48	1.37	78,647
Income, 2nd child aged 11–15	2.02	1.60	106,314	2.05	1.60	100,291
Employment, 2nd child aged 6–10	0.50	0.42	82,809	0.50	0.42	78,647
Employment, 2nd child aged 11–15	0.65	0.41	106,314	0.66	0.40	100,291
Father's Labor Supply						
Income, 2nd child aged 6–10	5.80	2.08	109,110	5.80	2.08	102,711
Income, 2nd child aged 11–15	6.10	2.43	108,466	6.11	2.44	102,063
Employment, 2nd child aged 6–10	0.98	0.11	109,110	0.98	0.11	102,711
Employment, 2nd child aged 11–15	0.97	0.14	108,466	0.97	0.14	102,063
Parents' Marital Stability						
Parents married, 2nd child aged 28	0.74	0.44	90,080	0.73	0.44	84,709
Index Person's Union Stability						
Married at age 43	0.52	0.50	102,376	0.55	0.50	98,417
Divorced at age 43	0.14	0.34	102,376	0.18	0.39	98,417
Has >1 child with one partner at 43	0.55	0.50	110,225	0.64	0.48	103,760
Index Person's Educational Attainment						
Secondary education at age 19	0.32	0.47	108,016	0.41	0.49	102,112
Secondary education at age 43	0.69	0.46	76,463	0.67	0.47	72,084
Lower tertiary education at age 43	0.28	0.45	76,463	0.36	0.48	72,084
Higher tertiary education at age 43	0.09	0.28	76,463	0.06	0.23	72,084

Notes: The samples consist of all firstborn and second-born men and women born in Norway between 1960 and 1969 in families with at least two children, in which the first two children are registered with the same mother and father. Parents' income is measured in base amounts (BA), and employment is defined as having income.

Table 9 Time spent on housework by child sex and family size: OLS regression results

	Estimate	SE
AddSib	0.9	6.2
Girl	32.4**	7.4
Girl × AddSib	10.9	12.9
Adjusted R^2	.107	
Number of Observations (unique individuals)	415	208

Notes: The sample consists of 415 days of time use entries (208 unique individuals).

**$p < .01$

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