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Abstract:
While 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. Using the sex composition of the two first-born children as an instrumental variable, we estimate the effect of sibship size on adult fertility. Estimations are done on high-quality data from Norwegian administrative registers. Our study sample is all first- 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, both by shifting some men into fatherhood and increasing family size. For women, a negative quantum effect emerges, driven by a preference for two rather than three children among women from three-child families. Studying mediators we show 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

JEL classification: C26, J13, J22

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Sammendrag

Barn som vokser opp i store familier får i gjennomsnitt flere barn selv. Dette kan skyldes at foreldre og barn deler mange karakteristika - miljø, preferanser og genetikk - eller at det å få et ekstra søsken i seg selv påvirker sannsynligheten for å få flere barn i voksen alder. I denne artikkelen undersøker vi den siste forklaringen. Vi bruker en instrumentvariabel for å estimere effekten av antall søsken på fruktbarhet i voksen alder. Datasettet er hentet fra norske administrative registre og inkluderer menn og kvinner som er født på 1960-tallet i norske familier med minst to barn (omtrent 110 000 menn og 104 000 kvinner).

Et ekstra søsken har en positiv effekt på menns fruktbarhet, blant annet ved at noen menn som ellers ville forblitt barnløse, blir fedre. For kvinner finner vi en negativ effekt, drevet av en preferanse for å få to heller enn tre barn blant kvinner med to søsken.

Når vi undersøker mulige mellomliggende variable, finner vi at mødre jobber mindre hvis de får et tredje barn - men at mødre med to førstefødte sønner jobber betydelig mindre enn mødre med to førstefødte døtre. En mulig forklaring på funnene våre er dermed at knapphet på foreldres tid i oppveksten gjør jenter oppmerksomme på ulemper ved å vokse opp i store familier -- slik at de selv velger å få færre barn i voksen alder.

1 Introduction

Most important life outcomes – such as health, education, and income – are positively correlated across generations. This positive relationship is in part due to potential causation from one generation's achievements in these fields to that of the next generation, and in part due to the shared genetic and social circumstances of parents and children. Studies of the intergenerational correlation in fertility across the developed world consistently find that children tend to replicate also 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 2014b). The remaining correlation, however, is still somewhat of a black box. In this paper, we aim to estimate the causal link running from children's experience with their parents' fertility choices to their own fertility behavior in adulthood. In other words, how do parents' family size decisions directly affect fertility choices in the next generation? Though the correlation in fertility across generations is positive – across countries and irrespective of sex – growing up with an additional sibling could also be straining, possibly leading to a negative effect of sibship size on own fertility. Moreover, as fertility choices affect the other life outcomes of women and men in fundamentally different ways, there are reasons to expect different cross-generational causal effects across sex.

To this end, we apply the "same sex instrumental variable". The instrument utilizes the long-standing 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). Using data from Norwegian administrative registers, we

study the fertility behavior of Norwegian men and women born in the 1960s.[1] In this cohort, the modal number of siblings is one, closely followed by two (Rønsen 2004, p. 276). Our estimates thus capture the effect of growing up in a typical larger family, relative to a typical smaller family. We estimate effects on completed fertility (measured at age 40), as well as the likelihood of specific parity transitions.

Our main results are twofold: First, the increase in sibship size causes some men – who would otherwise have remained childless – to have children in adulthood. Second, the additional sibling causes some women to refrain from having a third child themselves. We investigate the role of several potential mediators, in order to understand the mechanisms behind these heterogeneous effects. Most importantly, we find that in the family of origin, the additional sibling significantly causes mothers to reduces their labor supply if the older children are sons, but not if they are daughters. A likely explanation seems to be that daughters help out more at home than sons do – as is consistently found both in international research (Raley and Bianchi 2006) and in Norwegian time use data – thereby enabling their mothers to work longer hours in paid work.[2] As a likely consequence, girls who grow up in three-child families are more familiar with the work load and time squeeze associated with having more children.

Although sibling sex composition is a much used instrumental variable for sibship size, the existence of direct effects (i.e. effects through channels other than sibship size) may be of particular concern when the outcome considered is fertility in the next generation. For this reason, we test extensively for direct effects of siblings' sex on adult fertility, and on all the other outcomes considered in this paper. In sibships with three children, whereof the two first borns are of opposite sex, the sex of the third sibling is unrelated to the parents' propensity of having a fourth or higher order birth in our data. This sample can therefore be used to test for the

[1]The reason for choosing exactly the 1960s cohort is balancing the need for full background information with the observation of completed fertility.

[2]Hege Kitterød, personal communitaction.

presence of direct effects of sibling sex composition. We find no evidence of there being direct effects of siblings' sex on any of the outcomes we consider.

The findings in this paper have broader implications for the understanding of fertility contagion. As fertility contagion is mainly found to be positive, it is commonly thought of as an effect multiplier – allowing relatively small changes in the cost of childbearing to be inflated into large fertility responses. Our findings, on the other hand, suggest that high fertility in one generation may or may not cause high fertility in the next generation, depending on the children's experience of life in larger families. Policies that make life in large families less straining – particularly for women – may thus contribute to maintaining high birth rates in the next generation.

2 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) find a 5.3% reduction on average in US families' total income as a result of the transition from two to three or more children, and similar findings have been made also in other countries (see e.g. Cools (2013) for Norway). Similarly, parents may shift time from (pure) leisure (such as time for hobbies and friends) to childrearing 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. In the same vein, theories of adaptive preferences suggest that parents are led to prefer larger families more strongly once they have an additional child (Hayford 2009) – and that they in turn transmit these preferences to their children (Barber 2000). The imitation hypothesis suggests that children model their fertility behavior

upon that of their parents, so that children who grow up with two siblings would be disproportionately more likely to have a completed family size of three (Starrels and Holm 2000).[3]

As information about the consequences of childbearing is imperfect, beliefs about the consequences of childbearing may significantly influence fertility behavior (Bernardi and Klaerner 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 may 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 would be more pronounced for women than for men: Girls increase their time spent on housework more than boys do when an additional sibling is born (Evertsson 2006; Gager et al. 1999), and will thus be more aware of the work required to raise a relatively large family. Additionally, the increase in sibship size impedes mainly 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.

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 less direct transfers from parents to their adult children, there is scope for a negative effect on fertility in the next generation due to lower overall income. On the other hand, lower human capital implies lower alternative cost in caring for children, which, all else equal, suggests increased fertility in the next generation. However, Waynforth (2011) finds no significant correlation between

[3]In a less literal interpretation, the imitation hypothesis suggests that children from larger families prefer larger families themselves, yielding predictions identical to the preference transmission hypothesis.

fertility behavior and economic support from (grand)parents, and empirical studies systematically fail to find a deterring effect on human capital from sibship size at this margin (Black et al. 2005; Mogstad and Wiswall 2009).

The extraordinarily rich data set employed in this paper allows us to explore to what extent several of the mechanisms suggested in previous work are at work in our sample. In Section 7, we first explore how the availability of time and money in the family of origin is affected by an additional sibling, by looking at how an additional child affects parents' labor supply. We further check whether an additional sibling strengthens "family orientedness", proxied by parents' marital stability and the index person's propensity to marry and stay married. Finally, we explore the plausibility of effects running through the substitution mechanism by estimating the effect of an additional sibling on the index persons' human capital.

3 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 (as estimated by OLS regression) is likely to be severely biased, due to the shared biological, social and economic circumstances of parents and children. We therefore use whether the two first born children in the family of origin are of the same sex as an instrumental variable for sibship size.[4] An extensive demographic literature has shown that when the two first 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). As children's sex composition is uncorrelated with background characteristics of parents (such as fertility preferences), the *same sex* instrument is a much used instrumental variable for sibship or family size (see for instance Angrist and Evans (1998); Black et al. (2010); De Haan (2010)).[5]

[4]Throughout the paper, we refer to the individuals whose family *outcomes* we study as "index persons". The index persons' sibling(s) and parents constitute their "family of origin".

[5]A third requirement for instrument validity is *monotonicity*; "while all the instrument may have no effect on some people, all of those who are affected are affected in the same way" (Angrist and Pischke 2009, p. 154). In our application, this implies that having two children of the same sex never

Hence, the validity of siblings' sex composition as an instrumental variable in our setting hinges on there being no effect of its own of sibling sex on fertility choices made in adulthood, i.e., that there are no "direct effects" and that the instrumental variable is correctly excluded as a control variable in the estimations. The possibility that sibling sex composition has direct effects on fertility in the next generation cannot be ruled out a priori: Some studies suggest that family support structures affect fertility decisions (Aassve et al. 2012), and 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. 2013; Spitze and Trent 2006). While some qualitative studies suggest that having a sister in itself increases fertility (Bernardi 2003), quantitative studies suggests that brothers influence fertility timing slightly more than sisters (Lyngstad and Prskawetz 2010). As fertility timing is more easily influenced by context than completed fertility (Gauthier 2007), the observed timing correlations need not imply that siblings affect each others' completed fertility, which is the main subject of our study.

However, in all these studies, the effect may of course be channeled exactly through sibship size – in which case it does not pose a problem to our identification strategy. In order to estimate only the direct effect of sibship sex composition on fertility in adulthood, i.e., net of effects running through sibship size, one needs to look at a situation or sample where sex composition does not influence sibship size (as is done for instance by Angrist et al. (2010); Peter et al. (2014)). In Section 6 we provide an empirical investigation of direct effects of sibling sex composition, utilizing that the sex of the third child does not affect the propensity of further childbearing when the two first born children are of the opposite sex. Our findings show no evidence of direct effects of sibling sex on any of the outcomes considered

reduces the propensity of further childbearing. Couples induced to having further childbearing by the instrument are termed compliers, while couples induced to reduce their family size by the instrument are defiers in our application. de Chaisemartin (2014) shows that in presence of defiers, the IV estimates are to be interpreted as the treatment effect for the group of compliers who outnumber the defiers (de Chaisemartin 2014).

in this paper. This inspires confidence in the validity of our IV estimates.

4 Data and study sample

4.1 Study sample

Our point of departure is data from Norwegian administrative registers on all Norwegian residents. Personal identifiers link individuals to their parents and children. For registering to be complete, we restrict mothers of index persons to be born no earlier than 1935.[6] The need for reliable data on both family background and on own completed fertility makes individuals born during the 1960s particularly suited, hence we focus on the sample of individuals born between 1960 and 1969.

As the sex composition instrumental variable 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 where either parent is unknown to the registers. The study sample does not include individuals who are themselves twins, but they may have twin siblings.[7]

4.2 Family background characteristics

Since the individuals under study are born during the 1960s, background characteristics that are exogenous to the instrument must be observed further back than most of the important Norwegian registers go. Parents' income could be observed from 1967 onwards, and their education from 1970 onwards, both of which are too

[6]Information on birth year, gender, and an identifier linking the individual to information in other registers, exists for every person who has resided (legally) in Norway since 1968. Starting in 1965, all children born were registered and linked to their parents. In 1970, children younger than 17 but born before 1965 were registered to their mothers (and to some extent their fathers). Data on number of children born to an individual are therefore complete for women born around 1935 (if they started having children no sooner than at 18, their oldest child would be maximum 17 in 1970), and for men born somewhere between 1935 and 1947 (insofar as they are publicly registered as fathers). Thanks to Øystein Kravdal for this information.

[7]Results are not sensitive to these further restrictions.

Table 1: Family background variables by 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)
- 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)
- age at first birth	25.62	(4.38)	25.62	(4.39)	-0.00	(0.03)
N	53431		53814		107245	

Note: The samples are all couples with at least two children, where the two first children are both born in Norway in the period 1960-1969 and are registered with the same mother and father. For the means, standard deviations are reported in parentheses, for the estimated differences, standard errors are in parentheses. $^{\dagger} < 0.10$.

late for our purpose. The only background variables for our study sample that are realized prior to the instrument, are parents' year of birth, their age at first birth and the distance (in years) between the births of the first two children.

The means of these variables are reported in Table 1. We have split the sample into families with two children of the same sex (first column) and 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 we include background variables as controls in the estimations of how fertility in adulthood is affected, they enter as a set of dummy variables capturing the distance in years between the birth of the first and the second sibling (censored at six years), and dummies for parents' age at first birth (by age brackets of five years each). 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 paper, in addition to t-tests of the difference by instrument status, is given in Supplementary Material (Table S.1). 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 2: Mean values in outcome variables, by index person's sex

	Men		Women	
	Mean	SD	Mean	SD
N. children at 40	1.65	(1.22)	1.99	(1.14)
Has children at 40	0.75	(0.43)	0.86	(0.34)
Has >1 child at 40	0.59	(0.49)	0.72	(0.45)
Has >2 children at 40	0.24	(0.43)	0.32	(0.46)
Has >3 children at 40	0.05	(0.22)	0.07	(0.25)
N	111151		104719	

Note: The samples consist of all first and second born men and women born in Norway between 1960 and 1969 in families with at least two children, where the two first children are registered with the same mother and father. Standard deviations in parentheses.

4.3 Fertility outcome variables

The main outcome variable considered in this paper is the total number of children registered to the individual at the age of 40.[8] 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 separately for men and women in Table 2.

4.4 Additional outcome variables

In the investigation into mechanisms, analyzed in Section 7, we study three sets of additional outcome variables. First, we study potential mediators of fertility effects measured in the index person's childhood, such as parents' income and marital stability. Second, we study educational outcomes of the index person. Finally, we study the effect on partnership behavior in adulthood, potentially mixed up with the effect on fertility, such as marital stability and assortative mating.

Education data come from Statistics Norway's education registers, which record all changes (and their dates) in individuals' highest educational attainment from

[8]The whole sample can only be followed until they are 42 years old, from which point on we lose 10% of the original sample with each yearly increment in age. We have therefore chosen to present completed fertility at 40 in our main results. As a robustness check, we have also estimated the effects on fertility up to age 47. Though the precision of the estimates decreases with sample size, the point estimates are in line with the findings of the paper (available upon request).

1970 onwards. Information on yearly personal income (consisting of wages, pensions and entrepreneurial income) goes back to 1967 and covers the population residing in Norway each year. We have data on marital status from 1992 onwards, that is, from when the youngest individuals in our sample are aged 23 and the oldest 32 years. Parents' marital status when the second child is aged 28 therefore serves as a proxy for their marital status when the children still live at home (this implies an underreporting of marriages that were still intact in earlier years and gives a conservative estimate of the effect of sibship size on family stability). The descriptive statistics for these outcomes are given in Table 8 in the Appendix.

5 Effects on fertility in adulthood

IV estimation is done in two steps, using *two stage least squares* (2SLS) regression. We first estimate the effect of sibship sex composition on sibship size, giving the *first stage estimates*. IV estimates are then obtained by regressing the index persons' fertility in adulthood on the part of the variation in the sibship size tied to the 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).[9] Since the instrument variable is the same for siblings within one family, and only varies across family of origin, the standard errors in the 2SLS regressions are clustered at the family of origin. We also present estimates of the effect of sibship sex composition on fertility in adulthood, using *ordinary least squares* (OLS) regression (these are *reduced form estimates* in the IV terminology).

[9]To be precise, the estimates capture a *local average treatment effect* (LATE) for the group of compliers who outnumber potential defiers (de Chaisemartin 2014).

Table 3: The effect of sibling sex composition and sibship size on fertility in adulthood

	First stage		*Red. form*		*IV estimate*	
	(1)	(2)	(3)	(4)	(5)	(6)
MEN	>1 sibling		N. of children		N. of children	
	OLS	OLS	OLS	OLS	2SLS	2SLS
Same sex	0.059**	0.057**	0.019*	0.019*		
	(0.003)	(0.003)	(0.008)	(0.008)		
>1 sibling					0.321*	0.325*
					(0.129)	(0.132)
Birth year FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth order FE	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes	No	Yes
R2	0.018	0.106	0.002	0.006	.	0.002
N	110226	110225	110226	110225	110226	110225
WOMEN	>1 sibling		N. of children		N. of children	
	OLS	OLS	OLS	OLS	2SLS	2SLS
Same sex	0.063**	0.061**	-0.012†	-0.014†		
	(0.004)	(0.003)	(0.007)	(0.007)		
>1 sibling					-0.195	-0.220†
					(0.119)	(0.121)
Birth year FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth order FE	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes	No	Yes
R2	0.019	0.108	0.002	0.007	.	.
N	103761	103760	103761	103760	103761	103760

Note: The sample is first and second borns in Norwegian families with at least two children (where the two first children are registered with the same mother and father), who are born between 1960 and 1969. Standard errors are clustered at the family of origin. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

5.1 Main results

The main results of this paper are presented in Table 3. Columns (1) and (2) give first stage estimates, columns (3) and (4) the reduced form estimates, and columns (5) and (6) the IV estimates. The upper panel gives estimation results for men, the lower for women. In all the specifications estimated in Table 3, we include birth year and birth order fixed effects. The even-numbered columns also include a set of exogenous control variables: Parents' year of birth, their age at first birth and the distance in age between the first two siblings.[10]

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 percent. The first stage estimates are comparable in size to other applications of this instrument. With t-statistics above 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 40 years old. Having a brother causes the men in our sample to have 0.019 more children on average ($p < 0.05$). On the other hand, having a sister causes the women in our sample to have 0.014 *fewer* children on average ($p < 0.10$).

For both men and women, the estimates in columns (3) and (4) show a negative effect on own fertility of having a sister rather than a brother. The estimates in columns (1) and (2) show that having a sibling of the same sex gives a 6 percentage points higher probability of having yet another, younger, sibling. This effect on sibship size is likely to play a major role in the estimated effect of same sex sibship on individuals' own fertility (columns (3) and (4)). 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

[10]The outcome and the control variables are described in Section 4 and in Appendix Table S.1.

(6) are unbiased estimates of the causal effect of sibship size on individuals' total number of children at age 40. According to these estimates, having an additional sibling as a child causes men to have 0.3 more children and women to have 0.2 fewer children on average in adulthood.

The different directions of the effects by the index person's sex are consistent with the argument about belief formation put forth in Section 2: Girls are more likely than boys to observe the strains of childrearing when having an additional sibling – potentially causing them to limit their own family size in adulthood. In absence of this negative belief formation, men seem to behave in a way more consistent with explanations extensively employed in the literature on intergenerational transmission, such as transmission of adaptive preferences or imitation.

5.2 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 0, 1, 2 and 3 children. If the negative effects among women are indeed mediated by belief formation, we expect women from larger sibships to avoid forming large families themselves – leading to more marked negative effects on higher parities. Among men, parity specific results can help evaluate the explanatory power of two of the suggested causal mechanisms: The imitation hypothesis suggests that men who grow up in three-child families prefer to have three children themselves in adulthood, thus predicting particularly strong effects at parity three (Starrels and Holm 2000). If, on the other hand, the results are driven by transmission of a more general family orientedness, we would expect to observe effects on all parities.

The reduced form (odd-numbered columns) and IV estimates (even-numbered columns) are given in Table 4. For men, fertility at all margins except the highest (the likelihood of having more than three children) is affected. The effects are not significantly different from each other, but the greatest effect regards the likelihood

Table 4: Parity-specific effects of sibling sex composition and sibship size on fertility in adulthood

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MEN	>0 children		>1 child		>2 children		>3 children	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
Same sex	0.005†		0.006†		0.007**		0.001	
	(0.003)		(0.003)		(0.003)		(0.001)	
>1 sibling		0.080†		0.103†		0.123**		0.026
		(0.046)		(0.053)		(0.046)		(0.023)
Birth year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth order FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.006	.	0.004	.	0.004	0.002	0.003	0.004
N	110225	110225	110225	110225	110225	110225	110225	110225
WOMEN	>0 children		>1 child		>2 children		>3 children	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
Same sex	0.001		-0.002		-0.009**		-0.002	
	(0.002)		(0.003)		(0.003)		(0.002)	
>1 sibling		0.024		-0.038		-0.148**		-0.039
		(0.035)		(0.046)		(0.050)		(0.026)
Birth year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth order FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.006	0.006	0.003	.	0.006	.	0.003	.
N	103760	103760	103760	103760	103760	103760	103760	103760

Note: The sample is first and second borns in Norwegian families with at least two children (where the two first children are registered with the same mother and father), who are born between 1960 and 1969. Standard errors are clustered at the family of origin. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

of having more than two children. Interpreted as the effect of sibship size, men are on average 12.4 percentage points more likely to be fathers of at least three children if they have a second sibling. There are thus some indications that men do imitate the fertility pattern from their family of origin, but as the parity specific results do not differ significantly, evidence is not firm. The presence of effects on parities other than the third indicates that transmission of a "general family oriented behavior" contributes to the effects observed among men.

For women, the only margin that is significantly affected is the likelihood of having three or more children. Again interpreted as the effect of sibship size, the additional sibling makes women 14.8 percentage points less likely on average to have three or more children. This supports the notion that women who grow up in large sibships are reluctant to form large families themselves in adulthood. As there is no particular reason why sisterhood should have direct effects on this particular parity, this finding corroborates the instrument's validity. This is discussed more thoroughly below.

5.3 Result by index persons' birth order

We have further split the sample according to birth order, and though the estimates do not differ significantly by birth order, they are statistically significant only in the samples of first born men and second born women (Appendix Table 9). Relative to first borns, second borns of both sex are less positively affected by the birth of a second sibling. Regarding educational attainment, Conley and Glauber (2006) find that second borns are more negatively affected by the birth of an additional sibling than are first borns. While first borns retain their position as the oldest child when a third child is born, second born children are shifted from being the youngest to being middle born.[11] The shift to a less advantageous position within the sibship

[11]Middle born children do worse with respect to several non-academic outcomes, such as self-esteem (Kidwell 1982) and a vast number of risky behaviors in adolescence (Argys et al. 2007) – a finding that might be explained by parents being more likely to favour first- or last borns than middle borns (Salmon et al. 2012; Suitor and Pillemer 2007).

Table 5: The (direct) effect of sibling sex composition on sibship size and fertility in adulthood in the reduced sample

	First stage		*Dir. Effects*	
	(1)	(2)	(3)	(4)
MEN	>2 siblings		N. of children	
	OLS	OLS	OLS	OLS
Same sex	-0.001	0.000	-0.004	-0.004
	(0.005)	(0.005)	(0.014)	(0.014)
Birth year FE	Yes	Yes	Yes	Yes
Birth order FE	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes
R2	0.015	0.058	0.002	0.004
N	32274	32273	32274	32273
WOMEN	>2 siblings		N. of children	
	OLS	OLS	OLS	OLS
Same sex	0.000	-0.001	0.012	0.012
	(0.005)	(0.005)	(0.013)	(0.013)
Birth year FE	Yes	Yes	Yes	Yes
Birth order FE	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes
R2	0.015	0.059	0.001	0.003
N	32275	32274	32275	32274

Note: The sample is first and second borns in Norwegian families with at least three children, where the two first children are of opposite sex, born between 1960 and 1969. Standard errors are clustered at the family of origin. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

upon the birth of a second sibling may explain why the causal effect of sibship size is consistently less positive for second borns, even turning negative for second born women, than it is for first borns.

6 Assessing instrument validity

Direct effects of sibling sex

Although sibling sex composition is a much used instrumental variable for sibship size, the existence of direct effects from having a sibling of the same sex cannot be a priori dismissed (as is discussed in Section 3). In order 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 where sibling sex mix does not affect sibship size. Among the families in our sample

with at least three children, where 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 is therefore suitable for the investigation of 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 zero; 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 40. The estimates show no significant effect of having a sibling of the same sex on individuals' own fertility in adulthood, for neither men nor women. The point estimates are both smaller and go 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 4 would push the IV estimates towards zero.

We have also estimated direct effects for each fertility outcome, as in Table 4, and reassuringly, there is no evidence of direct effects for any of the outcomes. These results are available from the authors upon request.

Alternative IV: Twins

There is also the possibility of using twinning 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 one might therefore expect the effect to be different to the one captured by the same sex IV.[12] In Appendix Table 10, we show the estimates of the effect of an additional sibling on fertility in adulthood using the twin IV. Again we find positive effects of an

[12]The absence of spacing could in itself affect the childhood conditions of the index person, making for potential direct effects on fertility in adulthood, as would the concern with inheritability of twin births.

additional sibling for men and negative effects for women, comparable in size to the same sex IV estimates, but not statistically significant at conventional levels. Kolk (2014a) finds comparable results applying the twin instrument to Swedish data.

7 Understanding the heterogeneous effects on fertility in adulthood

In order to gain insight into what might yield opposing effects of family size on women and men, we estimate how several other outcomes are affected by sibship size: Potential mediators in the family environment during the index person's childhood and youth, and outcomes related to family formation.[13] As shown in the following, our findings regarding these other outcomes support the idea that having an extra sibling may constitute a more straining experience for girls than for boys: Mothers' income upon the birth of a third child is reduced by much more in the men's (boys') sample than in the women's (girls') sample, and parents' marital stability is relatively more positively affected by the increase in family size in the men's/boys' sample. We also find that an increased propensity to marry might to some extent explain the positive effect on men's fertility, while marital instability does not seem to explain the negative effect of sibship size on women's fertility.

7.1 Childhood conditions and educational attainment

Parents' income

Sibship size is likely to affect especially the material conditions in which individuals grow up.[14] 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. The first six rows of Table 6 give the estimates of how parents' income was

[13] The outcome variables are described in Section 4.4.

[14] Bütikofer (2011) tests whether child costs depend on sibling sex composition in a wide range of countries, and finds no evidence of economies of scale in consumption for families with same sex children in richer countries.

Table 6: The effect of sibship size on childhood circumstances and educational achievement

	Men	Women	Diff
	(1)	(2)	(3)
Outcome:	IV est.	IV est.	IV est.
Parents' income during childhood			
Father's income at child age 1-5	-0.030	-0.038	0.004
	(0.036)	(0.035)	(0.039)
Father's income at child age 6-10	0.009	-0.036	0.040
	(0.048)	(0.047)	(0.052)
Father's income at child age 11-15	-0.049	-0.024	-0.026
	(0.050)	(0.048)	(0.054)
Mother's income at child age 1-5	0.065	0.073	-0.007
	(0.085)	(0.082)	(0.095)
Mother's income at child age 6-10	-0.136*	-0.053	-0.081
	(0.063)	(0.060)	(0.069)
Mother's income at child age 11-15	-0.475**	-0.094	-0.363**
	(0.070)	(0.066)	(0.076)
Parents' marital stability			
Parents married at age 28	0.122*	0.044	0.075
	(0.057)	(0.056)	(0.063)
Index person's educational achievement			
Index person's sec. educ. at age 19	0.061	-0.015	0.076
	(0.051)	(0.052)	(0.066)
Secondary educ. at age 40	0.010	0.027	-0.007
	(0.050)	(0.049)	(0.064)
Lower tert. educ. at age 40	0.079	0.021	0.061
	(0.050)	(0.051)	(0.064)
Higher tert. educ. at age 40	0.021	-0.012	0.033
	(0.031)	(0.025)	(0.037)

Note: The samples are mothers and fathers (first 6 rows), parental couples (7. row) and children (last 4 rows) in Norwegian families with at least two children, where the two first children are registered with the same mother and father and are born between 1960 and 1969.† < 0.10,* $p < 0.05$, ** $p < 0.01$.

affected by additional children during the childhood years of the individuals (the index persons) in our sample. Income is measured in standard deviations, and then averages are taken over the years when the second born child is aged 1-5, 6-10 and 11-15 years.

Fathers' income is not moved by sibship size in our sample. Mothers' income, on the other hand, is lowered in the years when the second child is aged 6-10 years and 11-15 years, but not during the first 1-5 years. This may reflect that mothers of two and three children alike reduce their working hours to take care of the second child in its early years (under the age of five), while those who have a third child are relatively more likely to remain at home after this age.[15]

There is a substantial difference in the point estimates for the effect of another child on mothers' income in the men's and the women's samples. When the second child is 6-10 years old (and a third child on average 3-7 years old), the effect in the men's sample is a reduction in mothers' income of 13.6% of a standard deviation, while the reduction is 5.3% of a standard deviation – not statistically significant – in the women's sample. Later, when the second child is aged 11-15, the reduction in mothers' income is about half a standard deviation in the men's sample, and only one tenth of a standard deviation in the women's sample.

Tests for direct effects equivalent to those presented in Table 5 show no evidence of a direct effect of sex mix on mothers' earnings (Supplementary Material, S.2). A violation of instrument validity thus seems an unlikely explanation of these findings. Rather, it seems likely that the effect of having a third child on mothers' labor supply is mediated by whether they have daughters to help out with caring for the younger sibling. When the second child is 11-15 years old, the oldest child would be about 13-18 years old, and both children would be expected to help out at home – especially if they are girls.[16] Thus, mothers of girls may indeed choose to reduce

[15]The estimates are done by age of the second child, since this measure is defined for the whole sample. The third child, if born, will on average be about three years younger than the second child.

[16]Data from Norwegian time use surveys indicate that as teenagers, the girls in our index co-

hours worked less than mothers of boys upon the birth of a third child, exactly because a "team" of two girls at home is of more help than a "team" of two boys. Compared to boys who have a second sibling, girls who have a second sibling would either have to help out more at home, and/or make do with less parental time.[17] This supports the explanation that the negative effects on fertility among women are being (partly) mediated by belief formation. If depletion of family income were driving the negative effects found on women's fertility through the income effect, as suggested in Section 2, we would expect to find a relatively stronger negative effect of sibship size on mothers' income in the women's sample. As the results reveal the opposite pattern, lower family income seems an unlikely mediator of the negative effects found among women. Rather, the depletion of another resource – mothers' time – may seem to have a stronger impact in the intergenerational transmission.

Parents' marital stability

The last row in Table 6 presents estimates of the effect of sibship size on the marital stability of the parents in the family of origin.[18] For both men and women, the estimated effect of sibship size on their parents' likelihood of remaining married is positive. The estimate is however only statistically significant in the men's sample. Again, robustness checks show no evidence of direct effects of sex mix (Supplementary Material, Table S.2).[19] 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). Also, intact grandparental couples will on

horts contribute substantially more to household work than do boys. The time use data that come closest to covering our cohorts includes men and women born 1956-1964, and are collected in 1980, when these men and women are aged 16-24 years old. While male respondents on average spends 1,35 hours daily on housework, the time spent on housework is about 50% higher among female respondents (2,41 hours)`https://www.ssb.no/a/kortnavn/tidsbruk/tab-2002-05-13-03.html`)

[17]Gauthier et al. (2004) find that mothers increased working hours hardly reduce time spent on active child rearing, thus strengthening explanations linked to children's participation in housework.

[18]Parents' marital status can only be observed from 1992 onwards, hence the observation at age 28 of the second child is only a proxy for marital status in the childhood home (see Section 4.4).

[19]In the European context, no consistent relationship between child sex and divorce risk is found (Diekmann and Schmidheiny 2004).

average have more time and money, potentially giving more support to their (adult) children. However, neither Kreyenfeld (2004) nor Rijken and Liefbroer (2009) find any correlation between parent's divorce and fertility behavior in adulthood (though the latter measures divorce net of conflict level).

Educational attainment

A much hypothesized effect of increased sibship size is that parents will invest less in each child, and that as a result, children from larger sibships will have lower educational attainment. As shown in Table 6, we find no significant effect of sibship size (or sex mix) on the likelihood of completing high school by the age of 19.[20] Also when measured at age 40, there is no firm evidence of effects of sibship size on educational attainment.

If sibship size reduces educational attainment, this could be expected to contribute to lower fertility among men (as lower education reduces income), whereas for women, the effect would be a composite of the same negative "income effect" on the one hand, and a positive effect on fertility due to how lower wages caused by less education reduce the alternative cost of time spent on childcare, on the other.[21] As our results reveal the opposite pattern – positive effects among men and negative effects among women – educational attainment is an unlikely mediator, and the absence of effects on educational attainment thus falls well in line with the findings in Section 5.

7.2 Outcomes related to family formation

Table 7 show the estimated effect on the index person's likelihood of being married and divorced at the age of 40, respectively. For men, an additional younger sibling

[20] The finding that education of Norwegian children is not affected by sibship size is in line with the finding in Black et al. (2005).

[21] In addition, knowledge and skills developed through education may enable individuals to better asses the costs and benefits of parenthood, and to plan fertility more efficiently (Kravdal and Rindfuss 2008). It is, however, not obvious how this will affect completed fertility.

Table 7: The effect of sibship size on outcomes related to family formation

	Men	Women	Diff
	(1)	(2)	(3)
Outcome:	IV est.	IV est.	IV est.
Marital status of index person			
Married at age 40	0.152**	0.070	0.077
	(0.055)	(0.052)	(0.071)
Divorced at age 40	0.022	-0.084*	0.098*
	(0.034)	(0.038)	(0.048)
Sibship characteristics of index person's spouse			
Sibship size	0.148	0.065	0.095
	(0.161)	(0.159)	(0.212)
N. of sisters	0.150	0.128	0.030
	(0.122)	(0.113)	(0.157)
N. of brothers	-0.002	-0.063	0.065
	(0.120)	(0.120)	(0.161)
Mixed sex sibship	-0.034	0.098†	-0.122†
	(0.057)	(0.053)	(0.073)
Birth rank	0.003	0.091	-0.064
	(0.150)	(0.136)	(0.192)

Note: The sample is first and second borns in Norwegian families with at least two children (where the two first children are registered with the same mother and father), who are born between 1960 and 1969. Standard errors are clustered at the family of origin. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

increases the likelihood of being married at age 40 by 15 percentage points, and it does not affect the likelihood of divorce, indicating that growing up in a relatively large sibship increases men's "family orientedness" more generally – shifting some men who would otherwise have remain unmarried into marrying and having children.

For women, there is no significant effect on the likelihood of being married at age 40 (though the point estimates are also positive). As marriage is strongly linked to the *transition* to parenthood – not affected in the female sample – this is not very surprising. Interestingly, Table 7 shows a statistically significant negative effect of sibship size on the likelihood of being divorced among women, indicating that the negative effect of sibship size on women's fertility is not driven by union instability.

Experiences in the family of origin may affect preferences in the partner market, which may in turn influence fertility. Particularly, if men who have an additional sibling tend to find partners from large families (who share the preference for large families), this may contribute to the positive effects in the male sample (Murphy 2006). We have therefore investigated whether sibship size affect the likelihood of

having a partner from a particular sibship size or sex mix, or with a specific birth rank.

We find no evidence that assortative mating is affected by sibship size for our index persons, neither in terms of partners' sibship size, sex mix or birth rank. The estimates are reported in Table 7. As close to every second first birth in Norway currently is to cohabiting parents, we look at assortative mating with respect to the other parent of the index person's first child.[22] This outcome is obviously endogenous with respect to ever having a child, which is clearly affected by sibship size among the men in our sample. With this in mind, our findings suggest that assortative mating is unlikely to contribute to the positive effects among men at higher parities. Furthermore, these results suggest that previous findings of assortative mating on family size is not an effect of sibship size.

8 Concluding discussion

While fertility is consistently positively correlated across generations, the findings of this paper suggest that the causal effect of an additional sibling on adult fertility follows a more complex pattern. Under the assumption that the effect of sibship sex composition is fully channeled through sibship size, our results show that a second sibling causes some men who would have otherwise remained childless to enter fatherhood, while it keeps some women from proceeding to have a third child.

Based on the evidence about various mechanisms that could potentially channel the effect of sibship size on adult fertility (as presented in Section 7), there emerges a picture 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. (Similarly, but not observable in

[22] `https://www.ssb.no/en/statistikkbanken`, Table 08451: Live births, by parity, cohabitation status of mother.

our data, parents may shift time to childrearing from (other) leisure activities when an additional sibling is born.) To the extent that this shift changes children's perceptions of the relative values of work vs. family life, given their parents' function as role models, we would expect a positive impact of sibship size on fertility in adulthood.

Second, the additional child takes up some resources – in terms of time, income, or both. Expectedly, resources are shifted away from other siblings, who receive less time and monetary input from their parents, and who will, in addition, to some extent be expected to provide some of their own time to the care of their younger sibling. Resources also become more scarce to parents, and mothers' time in particular will be visibly more scarce. As knowledge about the consequences of fertility decisions is imperfect and often obtained through own experience (Bernardi and Klaerner 2014), an additional sibling might in this way 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 two processes may very well take place at the same time, and their relative impact would then decide the size and direction of the effect we aim to estimate in this paper. As the findings in Section 7 indicate, however, their relative impact seems to vary with gender, giving rise to different effects for men and women. Evidence of the first process is found mainly in the male sample. Here, mothers significantly reduce their labor supply upon the birth of their third child. This could be interpreted as a shift away from work related concerns to family values. In the male sample, an additional sibling also significantly increases marital stability.[23] This increased marital stability could reflect a more "general" family orientation, – going beyond changes in parental labor supply – but also simply be driven by the changes in labor supply: As the birth of an additional sibling increases specialization, the

[23]To the extent that intact parental couples have more time and money for each of their children, the increase in marital stability could compensate partly for the resource dilution an additional sibling implies.

microeconomic theory of the family would predict that increased family stability follows (Becker 1991). In the female sample, there is much less evidence of such a shift: Here, the labor supply of mothers with three children stays much closer to the level of two child mothers than in the male sample. No evidence is found here that the parents' likelihood of remaining married is significantly affected by having a third child. Based on this process alone, we would therefore expect men's fertility in adulthood to be positively affected by sibship size, but not women's.

The pattern in mothers' labor supply suggests that the second process will be of greater importance in the female sample than in the male sample, insofar as parents time concerns are felt more keenly by children than their money concerns. As mothers' labor supply is far less reduced in this sample, our female index persons will either have witnessed mothers who were far more time constrained, or they will have had to provide much more for their younger siblings – or both – than their male counterparts. Supporting the latter explanation, a qualitative study by Conley (2004) suggests that families are much more likely to use girls as a "labor reserve" when parental time is scarce. From this process we would therefore expect women's fertility in adulthood to be more negatively effected by sibship size than that of men.

This cluster of effects is further corroborated by the finding that men have a higher tendency to be married in adult life if they have an additional sibling. Growing up in a larger family does not cause women to remain unmarried and childless – but rather to limit their family size. This further supports that the birth of an additional sibling reveals specific information of the strains associated with life in larger families.

The mechanisms drawn upon in this paper bear resemblance to the mechanisms elaborated on in the literature on fertility contagion (Bernardi and Klaerner 2014). In this literature, it is emphasized that fertility is contagious through social networks largely because information of the consequences of fertility choices is imperfect –

and individuals draw upon their own experiences and network as a source of such information. Furthermore, it is underlined that fertility contagion can be positive or negative – depending on the character of the information transmitted.

While we draw upon the literature of fertility contagion for explanations, our study also has important implications for this strain of demographic research. Though opening up for the theoretical possibility of negative effects, most studies of fertility contagion consistently find effects to be positive. However, as controlling for unobserved heterogeneity is usually only partial, estimates may be biased upwards due to similarity within networks and families. This is clearly the case for the intergenerational correlation in fertility, which is likely *more positive* than the effect of an additional sibling on fertility, due to similarity between parents and children in unobservable characteristics. This study provides an empirical example of negative fertility contagion between generations. Our findings indicate that if the goal is to ensure lasting high levels of fertility, policies ought to facilitate the living conditions for children and adults in large families.

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Appendix

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

	Men		Women	
	Mean	SD	Mean	SD
Mediating outcomes				
Mother's income at child age 1-5	54.88	(51.22)	54.98	(51.03)
Mother's income at child age 6-10	59.24	(55.91)	59.63	(55.56)
Mother's income at child age 11-15	83.35	(65.94)	84.66	(65.97)
Father's income at child age 1-5	196.09	(64.81)	196.00	(64.46)
Father's income at child age 6-10	232.01	(84.29)	231.72	(83.99)
Father's income at child age 11-15	251.53	(100.10)	251.71	(100.63)
Secondary educ. at age 19	0.32	(0.47)	0.41	(0.49)
Income at age 18-20	72.17	(49.88)	55.53	(37.70)
Parents married at age 28	0.74	(0.44)	0.73	(0.44)
Joint outcomes				
Secondary educ. at age 40	0.70	(0.46)	0.68	(0.47)
Lower tert. educ. at age 40	0.29	(0.45)	0.36	(0.48)
Higher tert. educ. at age 40	0.09	(0.29)	0.06	(0.24)
Income 36-40	335.75	(228.57)	208.47	(127.62)
Married at age 40	0.50	(0.50)	0.56	(0.50)
Divorced at age 40	0.11	(0.32)	0.16	(0.37)
Partner's family characteristics				
Birth rank	2.11	(1.22)	2.12	(1.21)
Sibship size	3.09	(1.30)	3.21	(1.40)
N. of sisters	1.02	(0.99)	1.06	(1.00)
N. of brothers	1.07	(0.97)	1.14	(1.06)
Mixed sex sibship	0.70	(0.46)	0.68	(0.47)
Same sex sibship	0.30	(0.46)	0.32	(0.47)
N	111110		104687	

Note: The samples consist of all first and second born men and women born in Norway between 1960 and 1969 in families with at least two children, where the two first children are registered with the same mother and father. Income is measured in 1000 CPI-adjusted (1998) NOK. Standard deviations in parentheses.

Table 9: The effect of sibling sex composition and sibship size on number of children at age 40, effects by index person's birth order

MEN	First borns		Second borns	
	2SLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)
>1 sibling	0.450**	0.463**	0.145	0.168
	(0.172)	(0.179)	(0.178)	(0.183)
Birth year FE	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes
R2	.	.	0.005	0.007
N	55537	55537	55614	55613
WOMEN	First borns		Second borns	
	2SLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)
>1 sibling	0.027	0.024	-0.455**	-0.469**
	(0.161)	(0.170)	(0.164)	(0.164)
Birth year FE	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes
R2	0.002	0.006	.	.
N	52398	52397	52321	52321

Note: The sample is first and second borns in Norwegian families with at least two children (where the two first children are registered with the same mother and father), who are born between 1960 and 1969. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

Table 10: First and second stage effects using twins at 2nd birth as IV

MEN	>1 sibling		N. of children	
	(1)	(2)	(3)	(4)
	OLS	OLS	2SLS	2SLS
Twin 2nd	0.363**	0.373**		
	(0.030)	(0.029)		
>1 sibling			0.049	0.055
			(0.211)	(0.205)
Birth year FE	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes
R2	0.005	0.105	0.003	0.007
N	55195	55195	55195	55195
WOMEN	>1 sibling		N. of children	
	(1)	(2)	(3)	(4)
	OLS	OLS	2SLS	2SLS
Twin 2nd	0.366**	0.380**		
	(0.030)	(0.029)		
>1 sibling			-0.128	-0.098
			(0.202)	(0.194)
Birth year FE	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes
R2	0.006	0.109	.	.
N	52050	52049	52050	52049

Note: The sample is first borns in Norwegian families with at least two children (where the two first children are registered with the same mother and father), who are born between 1960 and 1969. Standard errors are clustered at the family of origin. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

Supplementary material

Table S.1: Balancing test of family background variables

First born's birth year	
- 1961	-0.000
	(0.002)
- 1962	-0.002
	(0.002)
- 1963	-0.002
	(0.002)
- 1964	-0.004†
	(0.002)
- 1965	-0.004†
	(0.002)
- 1966	0.004†
	(0.002)
- 1967	0.002
	(0.002)
- 1968	0.005**
	(0.002)
- 1969	0.000
	(0.001)
- 19610	0.000
	(0.000)
Mother's age at first birth	
- <20 years	-0.001
	(0.002)
- 20-24 years	-0.005†
	(0.003)
- 25-29 years	0.006*
	(0.002)
- 30-34 years	0.001
	(0.001)
- ≥35 years	0.000
	(0.000)
Father's age at first birth	
- <20 years	0.001
	(0.001)
- 20-24 years	0.002
	(0.003)
- 25-29 years	-0.005†
	(0.003)
- 30-34 years	0.002
	(0.002)
- ≥35 years	0.001
	(0.001)
Distance first and second born	
- <1 year	-0.000*
	(0.000)
- 1-2 years	0.002
	(0.003)
- 2-3 years	-0.001
	(0.003)
- 3-4 years	-0.004
	(0.003)
- 4-5 years	0.001
	(0.002)
- 5-6 years	0.000
	(0.001)
- >6 years	0.003**
	(0.001)
Observations	107245

Note: The samples are all couples with at least two children, where the two first children are both born in Norway in the period 1960-1969 and are registered with the same mother and father. For the means, standard deviations are reported in parentheses, for the estimated differences, standard errors are in parentheses. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

Table S.2: The effect of sibship size and sex mix on childhood circumstances and educational achievement

	Men			Women			Diff
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome:	Red.form	IV est.	Dir.eff.	Red.form	IV est.	Dir.eff.	IV est.
Parents' income during childhood							
Father's income at child age 1-5	-0.002	-0.030	-0.003	-0.002	-0.038	0.003	0.004
	(0.002)	(0.036)	(0.003)	(0.002)	(0.035)	(0.003)	(0.039)
Father's income at child age 6-10	0.000	0.009	-0.000	-0.002	-0.036	-0.000	0.040
	(0.003)	(0.048)	(0.004)	(0.003)	(0.047)	(0.004)	(0.052)
Father's income at child age 11-15	-0.003	-0.049	0.001	-0.001	-0.024	-0.002	-0.026
	(0.003)	(0.050)	(0.004)	(0.003)	(0.048)	(0.004)	(0.054)
Mother's income at child age 1-5	0.004	0.065	-0.007	0.005	0.073	0.007	-0.007
	(0.005)	(0.085)	(0.008)	(0.005)	(0.082)	(0.008)	(0.095)
Mother's income at child age 6-10	-0.008*	-0.136*	-0.003	-0.003	-0.053	0.003	-0.081
	(0.004)	(0.063)	(0.006)	(0.004)	(0.060)	(0.006)	(0.069)
Mother's income at child age 11-15	-0.027**	-0.475**	-0.006	-0.006	-0.094	0.005	-0.363**
	(0.004)	(0.070)	(0.006)	(0.004)	(0.066)	(0.006)	(0.076)
Parents' marital stability							
Parents married at age 28	0.008*	0.122*	0.002	0.003	0.044	-0.001	0.075
	(0.004)	(0.057)	(0.005)	(0.004)	(0.056)	(0.005)	(0.063)
Index person's educational achievement							
Index person's sec. educ. at age 19	0.004	0.061	-0.004	-0.001	-0.015	0.007	0.076
	(0.003)	(0.051)	(0.005)	(0.003)	(0.052)	(0.005)	(0.066)
Secondary educ. at age 40	0.001	0.010	0.000	0.002	0.027	0.005	-0.007
	(0.003)	(0.050)	(0.005)	(0.003)	(0.049)	(0.005)	(0.064)
Lower tert. educ. at age 40	0.005	0.079	-0.006	0.001	0.021	-0.000	0.061
	(0.003)	(0.050)	(0.005)	(0.003)	(0.051)	(0.005)	(0.064)
Higher tert. educ. at age 40	0.001	0.021	-0.002	-0.001	-0.012	0.003	0.033
	(0.002)	(0.031)	(0.003)	(0.002)	(0.025)	(0.002)	(0.037)

Note: The sample is first and second borns in Norwegian families with at least two children (where the two first children are registered with the same mother and father), who are born between 1960 and 1969. Standard errors are clustered at the family of origin. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

Table S.3: The effect of sibship size and sex mix on outcomes related to family formation

	Men			Women			Diff
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome:	Red.form	IV est.	Dir.eff.	Red.form	IV est.	Dir.eff.	IV est.
Marital status of index person							
Married at age 40	0.009**	0.152**	0.003	0.004	0.070	-0.003	0.077
	(0.003)	(0.055)	(0.006)	(0.003)	(0.052)	(0.006)	(0.071)
Divorced at age 40	0.001	0.022	-0.003	-0.005*	-0.084*	0.000	0.098*
	(0.002)	(0.034)	(0.004)	(0.002)	(0.038)	(0.004)	(0.048)
Sibship characteristics of index person's spouse							
Sibship size	0.008	0.148	0.007	0.004	0.065	-0.000	0.095
	(0.009)	(0.161)	(0.017)	(0.010)	(0.159)	(0.018)	(0.212)
N. of sisters	0.008	0.150	0.006	0.008	0.128	0.004	0.030
	(0.007)	(0.122)	(0.013)	(0.007)	(0.113)	(0.013)	(0.157)
N. of brothers	-0.000	-0.002	0.001	-0.004	-0.063	-0.005	0.065
	(0.007)	(0.120)	(0.013)	(0.007)	(0.120)	(0.013)	(0.161)
Mixed sex sibship	-0.002	-0.034	0.006	0.006†	0.098†	0.000	-0.122†
	(0.003)	(0.057)	(0.006)	(0.003)	(0.053)	(0.006)	(0.073)
Birth rank	0.000	0.003	-0.007	0.006	0.091	-0.008	-0.064
	(0.009)	(0.150)	(0.016)	(0.008)	(0.136)	(0.015)	(0.192)

Note: The sample is first and second borns in Norwegian families with at least two children (where the two first children are registered with the same mother and father), who are born between 1960 and 1969. Standard errors are clustered at the family of origin. $^{\dagger} < 0.10$,* $p < 0.05$, ** $p < 0.01$.

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