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Family Size and Educational Attainment: Cousins, Contexts and Compensation

Ea Hoppe Blaabæk*, Mads Meier Jæger** and Joseph Molitoris***

* Department of Sociology, University of Copenhagen, Øster Farimagsgade 5, Building 16, 1014 Copenhagen K. E-mail: ebl@soc.ku.dk

** Department of Sociology, University of Copenhagen, E-mail: mmj@soc.ku.dk (Corresponding author)

*** Centre for Economic Demography, Lund University, Scheelevägen 15B, 223 63 Lund. E-mail: joseph.molitoris@ekh.lu.se.

Abstract: This paper analyses the effect of family size on children’s educational attainment using a new research design that combines fixed effects and instrumental variable (IV) approaches. We use (a) data on first cousins who belong to the same extended family but to different nuclear families to control for extended family fixed effects and (b) variation in in-married spouses’ number of siblings (a proxy for their fecundity and preferences) as an IV for variation in family size within extended families. We find that family size has a negative causal effect on educational attainment, and moreover that the negative effect is smaller in families with stronger social ties. Our results suggest that contextual characteristics outside the nuclear family moderate the negative effect of family size on children’s educational attainment.

Keywords: Family size, resource dilution, educational attainment, fixed effects, instrumental variables, contexts

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1 Introduction

Theories of intergenerational transmissions in demography and economics suggest that a trade-off exists between family size and the amount of resources parents invest in each of their children. In particular, it has been argued that parental investments which influence human capital accumulation are particularly vulnerable to this trade-off. As such, family size is expected to have a negative effect on children's long-term educational outcomes (Becker 1960; Blake 1981; Downey 1995; Gibbs et al. 2016).

There is abundant empirical evidence of a negative association between family size and children's educational outcomes, such as test scores, grades, and final educational attainment (this literature is reviewed in Steelman et al. 2002 and Öberg 2017). These results are consistent with the idea that more children dilute the available resources in a family (Becker 1960; Blake 1981; Gibbs et al. 2016). However, in recent years the empirical credibility of existing research, as well as its conceptual adequacy, has been called into question. First, research has challenged the interpretation that the negative association between family size and children's educational outcomes reflects a causal relationship (Angrist et al. 2010; Bougma et al. 2015; Sandberg and Rafail 2014). Second, some have argued that existing theories focus too narrowly on the nuclear family and that factors outside the nuclear family, for example extended family ties or religious communities, might offset (or even reverse) the negative consequences of growing up in a large family (Gibbs et al. 2016; Kalmijn and van de Werfhorst 2016; Shavit and Pierce 2001).

In this paper, we contribute to existing research by addressing both the empirical challenge associated with identifying the causal effect of family size on children's educational outcomes and the importance of contextual factors that might moderate the effect of family size. The main threat to a causal interpretation of the negative association between family size and children's educational outcomes arises from endogeneity; i.e., that omitted aspects of family background jointly affect family size and children's educational outcomes. Existing research (which we review in detail below) uses one of two research designs to address endogeneity. The first design uses longitudinal data and fixed effects (FE) models to control for time-invariant omitted aspects of families that affect both family size and children's educational outcomes (for example, socioeconomic status, abilities, and health; Guo and VanWey 1999; Rodgers et al. 2000; Sandberg and Rafail 2014). The second design relies on exogenous shocks to family size, for example due to a twin birth or the sex composition of the sibship, to isolate variation in family size that is unrelated to other factors that affect children's educational outcomes (Angrist et al. 2010). If these shocks are truly exogenous, they can be used in combination with instrumental variable (IV) methods to estimate the causal effect of family size on children's educational outcomes. As we show below, results from research that uses FE and IV designs are mixed, but most studies of wealthy countries suggest that family size has no causal effect on children's educational outcomes.

In this paper we combine the FE and IV designs. We analyse data on the educational attainment of first cousins from Wisconsin and exploit the fact that these first cousins belong to the same extended family, but to different nuclear families. We use variation in family size across nuclear families to control for extended family fixed effects (EFFEs). Moreover, we augment the EFFE design with an IV design that uses in-married spouses' number of siblings (which we argue is a proxy for fecundity and family size preferences; Jæger 2008; Silles 2010) as an IV for variation in family size *within* the extended family. We motivate this IV by a body of research showing that fertility is positively correlated across generations (Murphy 1999) due to an intergenerational transmission of fecundity and family size preferences (Axinn et al. 1994; Kosova et al. 2010; Rodgers et al. 2001) and, for these reasons, the number of siblings that in-married spouses have should be predictive of how many children they eventually have. We also argue that differences in in-married spouses' number of siblings do not have any direct effect on children's educational outcomes net of EFFEs and a rich set of observed family characteristics. We make the case that our research design has stronger *internal* validity than previous research that uses IVs since twin births may not be random due to, for example, improvements in reproductive technologies (Bhalotra and Clarke 2016; Kissin et al. 2005; Smith 2011; Vohr et al. 2009) and because the preference for sons and mixed-sex sibships has been shown to vary by culture (Andersson et al. 2006; Arnold and Zhaoxiang 1986; Clark 2000; Freedman et al. 1960). We also argue that our design has stronger *external* validity than previous research because, rather than relying on select sub-populations such as parents of twins and those increasingly few in Western countries that have a third child, our IV relies on the variation in in-married spouses' number of siblings that exists across the entire population of in-married spouses.

In addition to addressing empirical challenges, we also analyse heterogeneity in the effect of family size on children's educational outcomes arising from contextual factors. We build on the Conditional Resource Dilution (CRD) model to argue that investments in children from outside the nuclear family may moderate the negative consequences of growing up in a large family (Gibbs et al. 2016; Kalmijn and van de Werfhorst 2016; Shavit and Pierce 2001). Specifically, we analyse if the causal effect of family size on children’s educational outcomes depends on the strength of social relationships within the extended family. We hypothesize that the negative effect of family size is weaker in extended families with strong social ties than in families with weak ties (measured by how often family members meet, whether the family receives help with childcare from the extended family, and the subjective quality of their social relationships). These analyses go beyond the traditional focus on the nuclear family and shed new light on how factors outside the nuclear family moderate the effect of family size on children’s educational outcomes.

We report two key findings. The first is that, after controlling for EFFEs, family size has a negative causal effect on children’s educational outcomes. We estimate that each additional child in the family reduces completed education by 0.034 years of schooling on average. This negative effect remains when, in addition to EFFEs, we also instrument differences in nuclear family size with in-married spouses’ number of siblings. Second, we find that the negative effect of family size on children’s educational outcomes is weaker in extended families in which family members meet more often and provide help with childcare. Consistent with the CRD model, our results suggest that family size has a negative causal effect on children’s educational outcomes, but also that the magnitude of this negative effect depends on contextual factors outside the nuclear family.

2 Theoretical Background

We now present the main theoretical arguments in demography and economics which motivate why family size should have a negative causal effect on children’s educational outcomes. We also discuss potential explanations of why this negative effect might vary across family contexts.

2.1 The Resource Dilution Model

The *Resource Dilution Model* (RDM) argues that parents have a finite pool of resources, some of which will be divided equally among their children, some of which will be reserved for the parents themselves, and some that will be shared by all members of the family (Downey 1995; Gibbs et al. 2016). These resources take the form of income, time, and social capital, all of which can be used to influence children's environments (e.g., quality of housing), opportunities (e.g., going to private versus public schools), and the amount of personal attention they receive from their parents (Blake 1981). Parental resources may be used to benefit children's development in several ways. On the one hand, they may be used to purchase "public goods" (i.e., items or experiences that can be shared by all), such as housing, books, or a computer, that can benefit the entire family. On the other hand, they may also be used to invest in children's well-being in ways that can only benefit specific individuals within the household, such as by paying for college tuition or music lessons (Sandberg and Rafail 2014; Workman 2017). As such, the RDM leads one to expect that each additional child in a family will necessarily lead to a reduction in the per capita investments children will receive from their parents, which, *ceteris paribus*, should lead to worse later-life outcomes among children with more siblings.

2.2 The Quantity-Quality Trade-Off

Although the RDM predicts that family size will be associated with lower per capita investments, it does not include a behavioural framework for analysing how parents decide on how many children to have and how they will invest in each child. The decision process of parents is crucial to understand, as it underlies the fundamental challenge associated with addressing the endogeneity of family size in a model of parental investments in their children. The “Quantity-Quantity Trade-Off” model (QQM) ultimately leads to similar predictions as the RDM regarding the relationship between family size and children’s outcomes. However, it differs in that it argues that couples make fertility decisions much as they make decisions about their consumption of market goods (Becker 1960; Becker and Lewis 1973; Becker and Tomes 1976). That is, given a fixed household budget, couples jointly decide on both how many children they will have and what “quality” (i.e., level of investment) those children will be. The optimal number of children is the one that reconciles couples’ preferences for market consumption and a certain level of “quality” in their children (Becker 1993). This means that, holding other factors constant, a higher number of children should lead to worse educational outcomes in children.

2.3 Contextual Moderators

The RDM and QQM focus on resources and investments within the nuclear family. Gibbs et al. (2016) propose a modified version of the RDM, called the Conditional Resource Dilution (CRD) model, in which contextual (state- and community-level) factors moderate the negative causal effect of family size on children’s educational outcomes. The CRD model is intended to account for the fact that the association between family size and children’s educational outcomes has been found to vary over time and across contexts. For example, Gibbs et al. (2016) find that the negative association between family size and children's educational outcomes is weaker in families belonging to religious groups (for example, Catholics and Mormons) whose social organisation provides access to a pool of extrafamilial resources. These findings are in line with theoretical arguments that public policies may substitute parental investments in children (Durlauf 1996; Solon 2009) and with empirical evidence that resources in the extended family may compensate for a lack of resources in the nuclear family (Jæger 2012; Shavit and Pierce 2001).

Inspired by the CRD model, this study tests if the causal effect of family size on educational attainment depends on the strength of social ties within extended families (measured by how often family members meet, how close they feel and whether they provide help with childcare). We argue that these contextual characteristics may lead to heterogeneity in the causal effect of family size because families that have access to extra-familial resources are better able to offset the resource constraints associated with having a larger family, which in turn benefit children. It is important to note here that our empirical strategy cannot test if the strength of social ties *causes* individuals to be more willing to give and receive extra-familial resources. We can only test whether or not the causal effect of family size on educational attainment differs along this dimension.

3 Literature Review

Previous research has addressed the negative effect of family size on outcomes such as education, IQ, grades, health, cash transfers to children, and wealth (Black, Devereux and Salvanes 2010; Downey 1995; Haider and McGarry 2018; Keister 2003; Lindahl

2008; Mosli et al.2016; Ochiai et al. 2012; Åslund and Grönqvist 2010). We focus on educational outcomes in this paper because this is the outcome that has received the most attention. An early descriptive literature documents that a negative association exists between family size and children's educational outcomes (Steelman et al. 2002 review this literature). A more recent literature has sought to identify the causal effect of family size on children's educational outcomes. This literature, which we review here and on which we build, typically uses one of two research designs: fixed effects (FE) or instrumental variables (IV). Table 1 summarises the research designs and main findings from this literature.

– TABLE 1 HERE –

The first line of research uses variation in family size within nuclear families to identify the effect of family size on children's educational outcomes (Guo and VanWey 1999; Rodgers et al. 2000; Sandberg and Rafail 2014). It employs a FE design to control for omitted aspects of family background that jointly affect family size and children's educational outcomes (for example, socioeconomic status, abilities, and health). The identifying assumption is that – conditional on FEs and observed family characteristics – the estimated effect of family size on children's educational outcomes is causal. As shown in Table 1, results from this line of research are mixed, but most studies, and particularly those focusing on wealthy countries, report no causal effect of family size on children's educational outcomes.

The second line of research uses an IV design to provide exogenous or "quasi-experimental" variation in family size and twin births and sibship sex composition have been the preferred instruments. In addition to these, some research has used policy reforms and difference-in-difference (DID) designs to the same end. Examples of policy reforms include: changes in China's family planning policy (Argys and Averett 2015; Liu 2014; Qian 2009), municipal contraceptive bans in the Philippines (Dumas and Lefranc 2016), physical distance to family planning centres (Dang and Rogers 2016), variation in reproductive capacity as measured by, for example, (sub)fecundity (Bougma et al. 2015; Jæger 2008; Silles 2010) and miscarriages (Maralani 2008), and variation in contraceptive technologies (Rosenzweig and Schultz 1987). Table 1 shows that research focusing on wealthy countries mostly reports no causal effect of family size on children's educational outcomes.

4 Research Design

In this paper we use a design that combines the FE and IV designs. We begin by illustrating this design in Fig. 1 by means of the data structure in the Wisconsin Longitudinal Study (WLS), the dataset we use in the empirical analysis (Herd et al. 2014). We then formalise the design within a regression framework.

In Fig. 1 the focal respondent (and generation), the WLS Graduate, is labelled A. The WLS also includes a randomly selected (older or younger) sibling of A, labelled B (the sibling respondent). Moreover, it includes the spouses of A and B, labelled A' and B'. Nuclear families AA' and BB' are the second generation (G2) in the WLS, which also includes the parents of sibling pair A and B, labelled AB_{-1} (where $_{-1}$ refers to the previous generation), and the parents of A and B's spouses, labelled A'_{-1} and B'_{-1}, respectively (G1). Finally, the WLS includes information on all children of A and B, i.e., the third generation (G3) and labelled $A_{+1,n}$ and $B_{+1,n}$, respectively (where subscript *n* refers to child number). The data structure in the WLS means that the children of A and B are first cousins who belong to the same extended family (linked via A and B) but to separate nuclear families (AA' and BB'). We observe these first cousins' educational attainment (years of completed schooling), total number of siblings, and many characteristics of the nuclear family in which they grew up.

– FIG. 1 HERE –

4.1 Extended Family Fixed Effects Design

Fig. 1 summarises the generations and family relationships in our data. Our outcome of interest is educational attainment in the third generation ($A_{+1,n}$ and $B_{+1,n}$), and we model educational attainment as a function of family size and other factors using the following linear model:

$$y_{ijk} = \alpha + \beta_1 f_{jk} + \beta_2 \mathbf{z}_{jk} + \beta_3 \mathbf{x}_{ijk} + e_k + c_{jk} + \varepsilon_{ijk}. \quad (1)$$

In this model y_{ijk} is the educational attainment of child *i* ($i = 1,\ldots,n$) belonging to nuclear family *j* ($j = 1,\ldots,n$) and to extended family *k* ($k = 1,\ldots,n$). The observed explanatory variables include family size *f* (our main explanatory variable), other nuclear family characteristics captured in the vector **z**, and individual child characteristics captured in the vector **x**. The model also includes a time-invariant fixed effect (FE) specific to each extended family, e_k, a FE specific to each nuclear family c_{jk} and a random error term ε_{ijk}. In this model, e_k captures fixed unobserved differences between extended families (with regard to, for example, socioeconomic status, abilities, and health) that jointly affect family size in the second generation and educational attainment in the third generation. Likewise, c_{jk} captures unobserved differences between nuclear families that jointly affect family size and educational attainment in the third generation. We now rearrange Eq. 1 to obtain an EFFE model. Specifically, we subtract extended family means for all variables and, using the difference operator Δ , we arrive at:

$$\Delta y_{ijk} = \beta_1 \Delta f_{jk} + \beta_2 \Delta \mathbf{z}_{jk} + \beta_3 \Delta \mathbf{x}_{ijk} + c_{jk} + \Delta \varepsilon_{ijk}. \quad (2)$$

Eq. 2 shows an EFFE model in which the FE specific to each extended family (e_k) has been differenced out. Conceptually, this EFFE model identifies the effect of family size on children's educational attainment from differences in family size between families from the same extended family. In this model, β_1 may be interpreted as the Average Treatment Effect (ATE), i.e., as the average difference in years of completed schooling between children in the population who have one more/less sibling. In addition to estimating this baseline EFFE model, in the analyses of contextual moderation presented below we also include indicators the strength of social ties between A and B, as well as interaction effects between these variables and family size.

4.2 Adding IV to the EFFE Design

The EFFE design controls out the EFFE, but not the family FE, c_{jk} . Generally, it is not possible to control for c_{jk} in Eq. 2 since in that case the effect of family size is indistinguishable from the family FE.[1] Instead, we propose to extend the EFFE design with an IV component that allows us to identify the causal effect of family size net of the family FE (under a set of assumptions which we describe below).

We now illustrate the idea behind our IV design. Assume we have an extended family with two sisters (A and B in Fig. 1) who marry different men (A' and B') and eventually become mothers. Differences in family size between the families to which these sisters belong may arise from differences in their (and their husbands') fecundity, family size preferences, and from random factors. We propose that the in-married spouses' number of siblings can be used as an empirical proxy for variation in fecundity and preferences that originates from outside the extended family to which A and B belong. We also hypothesize that in-married spouses who have more siblings have higher fecundity and a stronger preference for a large family than in-married spouses who have fewer siblings. We motivate this hypothesis based on several pieces of research. Studies have documented a positive correlation in completed fertility across generations (Dahlberg 2013; Murphy 1999); individuals who grew up with more siblings tend to have more children. This intergenerational correlation in completed fertility is known to be due to a combination of genetic and environmental factors. Genetic factors may influence, for example, fecundity that is transmitted from parents to children (Kosova et al. 2010; Rodgers et al. 2001). Environmental factors include family socialisation and being exposed to a larger family (Axinn et al. 1994; Duncan et al. 1965; Lyngstad and Prskawetz 2010; Régnier-Loilier 2006). Together, these factors

[1] Family size varies across (but not within) nuclear families. If we include c_{jk} in Eq. 2 we would only be able to identify the effect of explanatory variables that vary both within extended and nuclear families, i.e., the **x** variables.

motivate why in-married spouses' number of siblings would be positively correlated with family size and why it is a candidate IV. Moreover, if in-married spouses' number of siblings only affects children's educational attainment via family size (net of EFFEs and observable controls), it is also a valid IV for family size. To formalise the IV component, we extend the EFFE model by treating family size as endogenous to children's educational attainment. Formally, we write:

$$\Delta f_{jk} = \delta_1 \Delta I_{jk} + \delta_2 \Delta \mathbf{z}_{jk} + \delta_3 \Delta \mathbf{x}_{ijk} + c_{jk} + \Delta \xi_{ijk}, \quad (3)$$

$$\Delta y_{ijk} = \beta_1 \Delta \hat{f}_{jk} + \beta_2 \Delta \mathbf{z} + \beta_3 \Delta \mathbf{x}_{ijk} + c_{jk} + \Delta \varepsilon_{ijk}. \quad (4)$$

In this two-stage EFFE-IV model, Eq. 3 (the model for differences in family size) is the *first stage regression*, while Eq. 4 (the model for differences in children's educational attainment) is the *second stage regression* (Angrist and Pischke 2009). In the first stage regression we regress differences in family size across families (denoted Δf) on differences in in-married spouses' number of siblings (denoted ΔI) and on the **z** and **x** variables. In the second stage regression we use predicted differences in family size, denoted $\Delta \hat{f}_{jk}$, to estimate the effect of family size on children's educational attainment, β_1.

It is important to clarify the interpretation of β_1 in Eq. 4, including how it differs from the interpretation in the EFFE in Eq. 2. The estimate of the EFFE-IV model identifies a Local Average Treatment Effect (LATE) of family size, i.e., the average effect for "complier families" who respond to the treatment of having one spouse who has more siblings by having more children (Angrist and Pischke 2009; Imbens and

Angrist 1994). This means that, in contrast to the EFFE model which identifies the ATE, the estimate of β_1 in the EFFE-IV should be interpreted as a local causal effect. Later, we will discuss possible interpretations of the LATE with respect to the composition of the complier group. The advantage of our IV, and unlike previous research that uses twin birth and sibling sex composition as IVs for family size, is that it relies on variation in in-married spouses' number of siblings across the entire population of WLS families.[2]

In order to be a valid IV, in-married spouses' number of siblings must not have any direct effect on children's educational attainment. We believe that this assumption is credible for two reasons. First, we control for a wide range of observable family characteristics in the **x** and **z** vectors that might be correlated both with in-married spouses' number of siblings and with their children's educational attainment (for example, IQ, educational attainment, and family income). Second, we also control for EFFEs which account for omitted factors that lead siblings A and B to have similar mating preferences (due to shared family socialisation) and similar socioeconomic characteristics (due to shared endowments and family resources). Consequently, although we cannot formally rule out that in-married spouses' number of siblings might have a direct effect on children's educational attainment, we argue that our research

[2] We have analysed if the variation that exists in in-married spouse's number of siblings is similar across the distribution of Wisconsin Longitudinal Study (WLS) families' socioeconomic characteristics (measured by A and B's income and education). For example, it might be that individuals from high-income families tend to marry partners with less variation in family size compared to individuals from low-income families. We find no evidence that differences in in-married spouses' number of siblings vary across the distribution of A and B's income and education (results available upon request).

design makes this unlikely. Since our IV model is based on nested data (first cousins are nested both within nuclear and extended families), the number of observations in the first stage regression is based on the number of G2 families in the WLS (subscript *j*), while the number of observations in the second stage regression is based on the total number of G3 children (subscript *i*). All test statistics and standard errors reported below adjust for clustering of respondents across different levels of nesting.

4.3 Hypotheses

Motivated by the RDM and the QQM, our first and main hypothesis is that family size has a negative causal effect on children's educational attainment (*H1*). Moreover, building on the CRD model and on the empirical results presented by Gibbs et al. (2016), we also hypothesise that contexts moderate the negative effect of family size. Specifically, our second hypothesis is that the negative effect of family size is smaller in extended families with strong social ties than in extended families with weak ties (*H2*). We motivate this hypothesis based on arguments that members of the extended family share financial, social and emotional resources in order to protect the family against risks (Altonji et al. 1992; Jæger 2012) and on empirical evidence that large kinship groups reduce the negative effect of family size on children's educational attainment (Shavit and Pierce 2001). Thus, the quality of social ties within the extended family should reflect the extent to which family members are willing to share resources that would offset the negative consequences of resource dilution. With respect to *H2,* it should be reiterated that our analysis cannot identify a causal effect of the strength of social ties on the relation between family size and education; it can only identify if the causal effect of family size on education is correlated with contextual factors.

5 Data and Variables

The WLS data are based on a random sample of 10,317 individuals who graduated from a Wisconsin High School in 1957 (Herd et al. 2014). The WLS graduates (A in Fig. 1) and a randomly selected sibling (B in Fig. 1) have been interviewed regularly since 1957. Moreover, the spouses of the WLS graduate and the sibling respondents (A' and B' in Fig. 1) have also been interviewed several times. Finally, WLS graduates and sibling respondents provide information on all of their children (i.e., $\mathrm{A}_{+1,n}, \mathrm{B}_{+1,n}$).

We focus on the educational attainment of the children of the WLS graduates and the sibling respondents, i.e., the third generation $\mathrm{A/B}_{+1}$. This sample consists of 34,290 individuals who are siblings (linked via nuclear families AA' and BB') and first cousins (linked via parents A and B who are siblings). We restrict the sample to only include children who were at least 25 years old when information on their educational attainment was collected to be reasonably sure that children have completed their education (Warren and Hauser 1997 and Jæger 2012 apply similar restrictions). We also restrict the sample to extended families with at least two children in the child generation. This restriction omits extended families with only one observation in the child generation since these families are uninformative in our EFFE design.[3] Our analytical sample then consists of 22,734 children (i.e., $\mathrm{A/B}_{+1}$) nested within 7,164 nuclear families (i.e., AA' and BB') and 5,888 extended families (i.e., AB_{-1}). Table 2 shows descriptive statistics for our analytical sample and for the

[3] This reduction does not affect our analytical sample much since more than 97 percent of all extended families in the WLS have more than one child.

total sample (which does not impose any restrictions on children’s age and on family size). The table shows that although differences in means between the two samples are statistically significant for most variables (given the large sample sizes), substantive differences are very small.

– TABLE 2 HERE –

5.1 Measures

5.1.1 Dependent Variable

Our dependent variable is children’s educational attainment, measured as years of completed schooling.

5.1.2 Family Size

Family size is our main explanatory variable and measures the total number of children in each nuclear family AA' and BB', respectively (including biological, adopted, step, and foster children). Mean family size is 3.9 (SD = 1.7; the lowest value is 1 and the highest is 14).

5.1.3 Explanatory Variables

We control for a variety of family and individual characteristics (i.e., the **z** and **x** vectors discussed above). Family characteristics include mother and father’s education (years of completed schooling), total family income in 1976 in $1,000s[4], father’s socioeconomic

[4] We impute missing information on total family income using data on the WLS graduate and the sibling respondent’s personal income in 1974 and household income in 1992.

status (SES, measured by Duncan's Socioeconomic Indicator [SEI]), the WLS graduate or sibling respondent's birth order and their IQ at around age 18. This vector also includes three variables that capture the quality of social ties within the extended family: (1) frequency of contact between A and B over the past 12 months (mean number of contacts per month), (2) an indicator of whether A/B have received help with babysitting or childcare from any other family than their spouse and (3) an indicator of the extent to which A and B feel close to each other (1-4 scale with response categories: 1 = "Very close," 2 = "Somewhat close," 3 = Not very close," and 4 = "Not at all close"). Individual characteristics include sex (dummy for women), birth order, and age in 2004.[5]

5.1.4 Instrumental Variable

Our instrumental variable measures in-marrying spouse A' and B''s number of siblings (ever born), as reported by these spouses in separate spousal surveys.

6 Results

We present the empirical results in four subsections. First, we present results from baseline Ordinary Least Squares (OLS) regressions. Second, we present results from FE models in which we control for EFFEs and observed family and individual

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[5] The WLS includes some information on the socioeconomic characteristics of the first generation (i.e., AB_{-1}, A'_{-1} and B'_{-1}). Unfortunately, although there is considerable information on AB_{-1} (education, income, SES, etc.), and some information on A'_{-1}, the only available information on B'_{-1} is family size. Given that most of our substantive analyses rely on variation within the extended family, the only variable in the first generation that we can (and do) use is family size.

characteristics. Third, we present results from the EFFE-IV model in which, in addition to controlling for EFFEs, we use in-married spouses' number of siblings as an IV for differences in family size within extended families. Finally, we use the EFFE models to analyse if the negative effect of family size on educational outcomes varies by the strength of social ties within the extended family.

6.1 Baseline OLS Results

Models 1 and 2 in Table 3 summarise results from baseline OLS regressions of children's years of completed schooling on family size and individual and family controls (Table A1 and A2 in the appendix summarise all regression results). In the OLS model in which we do not include any controls we find a negative effect of family size on educational attainment, with each additional sibling estimated to reduce educational attainment by about 0.16 years of schooling ($p < 0.001$). This result is similar to those reported in previous descriptive studies (Steelman et al. 2002). In model 2, we add the control variables, which significantly reduces the estimated negative effect of family size ($\tilde{\beta}_1$ = -0.037, $p < 0.01$). This reduction (statistically significant at $p < 0.001$) suggests that much of the correlation between family size and educational attainment is due to family characteristics (education, income, etc.). Nevertheless, there remains a statistically significant negative association between family size and educational attainment.[6]

[6] *N* is slightly higher in the OLS models than in the EFFE models (which we discuss next) because in the former we also include extended families with only one observation in the child generation. OLS results are identical if we use the restricted sample in which we only include extended families with two or more children.

– TABLE 3 HERE –

6.2 EFFE Results

Models 3 and 4 summarise results from EFFE models. In the baseline EFFE model without controls (model 4) we find a statistically significant and negative effect of family size on educational attainment ($\tilde{\beta}_1$ = -0.100, $p < 0.001$). In this model the coefficient on family size is a little less than two thirds of the coefficient in the corresponding baseline OLS model, which suggests that omitted aspects of the extended family that are correlated with family size account for about one-third of the baseline negative association between family size and educational attainment (the two coefficients are statistically significantly different at $p < 0.001$). When we also include the control variables in model 4, the coefficient on family size reduces further to -0.034 but remains statistically significant ($p < 0.01$). This result suggests that adding a rich set of observed controls reduces the negative estimate of family size by two thirds (the coefficient on family size in model 4 is statistically significantly different from the one in model 3 at $p < .001$). Substantively, and consistent with RDM, the QQM and with *H1*, we find that family size has a negative causal effect on children's educational attainment. With regard to effect size, the negative effect of having three children (the median family size in our sample) amounts to about one-tenth of a year of education, which is equivalent to the effect of about one more year of parental education (See Table A1).[7]

[7] In addition to the results reported here, we have also run the EFFE model separately for all different gender combinations of the sibling pair A and B (i.e., two brothers, two sisters, and one brother and one sister). All combinations yield statistically significant and negative estimates of the effect of family size

6.3 Instrumenting Differences in Family Size

In order to further qualify our analysis, we extend the EFFE model and instrument differences in family size within extended families with differences in in-married spouses' number of siblings. As explained earlier, the motivation behind this analysis is to exploit variation in nuclear family size that arises from the in-married spouses' fecundity and family size preferences and that is unrelated to omitted characteristics of nuclear families that affect children's educational attainment.

Model 8 in Table 3 summarises results from our EFFE-IV model (we discuss results from models 5-7 below). The upper part of the table summarises results from the second stage IV regression, while the lower part summarises results from the first stage regression. We begin with the first stage regression. Here, and as hypothesized, we find that the in-married spouse's number of siblings has a highly significant positive effect on nuclear family size ($\tilde{\delta}_1 = 0.048$, $p < 0.001$) after we control for EFFEs and observed controls. Moreover, the test statistic on the *F*-test for the excluded instrument ($F = 27.09$) indicates that the IV is highly statistically relevant (Staiger and Stock 1997). The second-stage estimate of the effect of family size reported in the upper part of model 8 is negative and statistically significant ($\tilde{\beta}_1 = -0.584$, $p < 0.01$). This result suggests that when we isolate variation in nuclear family size that we argue is unrelated to omitted family characteristics that affect education, family size has

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on educational attainment (and all estimates are statistically indistinguishable from the one presented in model 4; results available upon request).

a negative causal effect on children's educational attainment. The result is consistent with *H1* and with our results from the EFFE.

We should interpret the coefficient on family size in the EFFE-IV as a LATE, i.e., as applying to families that comply with the "treatment" of having an in-married spouse who has more siblings. We have argued previously that an advantage of our IV is that it uses variation in in-married spouses' number of siblings across the entire population of WLS families. This property means that our LATE estimate applies to a more general population than those estimated in previous research, which might help to explain why our LATE and ATE estimates (which we would argue pertain to partly overlapping populations) are both negative and statistically significant.[8] Still, the EFFE-IV estimate of the effect of family size is statistically significantly larger than the EFFE estimate ($p < 0.05$). This means that among compliers the negative effect of family size on children's educational attainment is stronger than in the general population. One interpretation of this result might be that "complier couples" are more likely to consist of one individual who has ambivalent family size preferences and one who has stronger preferences. We base this idea on findings from several studies which have shown that when one partner of either sex has preferences to limit family size, they often have veto power on fertility decisions (Thomson 1997; Thomson and Hoem 1998). On the other hand, when only one partner has a strong preference for more children and the other is ambivalent, couples are substantially more likely to have larger families (Schoen et al. 1999; Thomson, McDonald and Bumpass 1990). Moreover, one

[8] We have replicated the traditional twin birth and sex composition IVs in our WLS data and find that neither produces a statistically significant estimate of the effect of family size on educational attainment. Results are available upon request.

study has also shown that children born to women who had ambivalent fertility intentions tended to have more health and cognitive problems (Crissey 2005). Together, these pieces of research suggest that the larger negative impact of family size on educational attainment among compliers may be related to discordant fertility preferences between partners.

6.4 Contextual Moderation

In the last part of the empirical analysis we test whether the negative effect of family size on children's educational attainment is moderated by the strength of social ties within the extended family (*H2*). Models 5-7 in Table 3 summarise results from EFFE models in which, in addition to the main effect of family size, we also include interaction effects between family size and (1) the frequency of meetings between A and B in the past 12 months, and (2) the indicator of whether A/B have received help with babysitting or childcare from the extended family and (3) the indicator of how close A and B feel to each other.

In the EFFE model in which we include an interaction effect between family size and the indicator of how often parents A and B meet, we find a positive and statistically significant ($p < 0.01$) estimate on the interaction term. This result suggests that the negative effect of family size is smaller in extended families that meet more often than in extended families that meet less often. We also find a statistically significant ($p < 0.001$) estimate on the interaction term between family size and whether A/B has received help with childcare. This result suggests that the negative effect of family size is smaller in extended families that help each other with childcare. These results are consistent with the CRD model claiming that investments in children from outside the nuclear family, in this case investments by members of the extended family, moderate the negative effect of coming from a large family. We also find that the interaction effect between family size and the indicator of how close A and B feel to each other is not significant. This result might suggest that physical and social contact (for example, when members of the extended family help each other out or provide social support), rather than purely emotional connection, moderates the negative effect of family size on educational attainment. Overall, the results from the interaction models suggest that characteristics indicating worse access to extra-familial resources were correlated with a stronger negative causal effect of family size on education.

7 Conclusion

Does family size have a negative causal effect on children's educational outcomes? And if so, do family contexts moderate this negative effect? We address these questions by proposing a new research design that combines extended family fixed effects (EFFEs) with arguably exogenous variation in family size to improve causal interpretations and by analysing if access to extra-familial resources via the extended family moderates the negative effect of family size.

Empirical analyses of first cousins from Wisconsin show that, after controlling for EFFEs and a rich set of observable controls, family size has a negative causal effect on educational attainment. This negative effect, which we interpret as the Average Treatment Effect (ATE) of family size, persists when, in addition to EFFEs, we also instrument differences in nuclear family size with differences in in-married spouses' number of siblings (a proxy for their fecundity and family size preferences). We also find that the negative effect of family size is smaller in extended families in which family members meet more often and help each other with childcare, while the strength of emotional ties does not matter. Together, these results suggest that resources outside the nuclear family might reduce the negative impact of resource dilution as emphasised in the CRD model. Based on our design and results, we now provide some input for future research and address some limitations and opportunities in our research design.

First, our research illustrates the inherent difficulties in identifying the causal effect of family size on children's outcomes. Objections can be raised against the validity of previous (and of our) research, and we address the identification challenge by combining the FE and IV designs and by proposing a new source of variation in family size, in-married spouses' fecundity and family size preferences, which we argue is not directly related to children's educational outcomes. Although our approach rests on the same sets of assumptions as previous research, we believe that combining two complimentary research designs (which yield the same substantive results) improves the robustness and overall credibility of our results.

Second, our approach underscores the difficulties in interpreting for whom the (or: a) causal effect of family size applies. Findings from research that has used sibling sex composition as an IV for family size illustrate this point. This research reports no consistent findings, probably due to differences across studies in the underlying (and often unknown) subpopulations who comply with the "treatment" implied by the IV. In this paper, we also identify a LATE, but we argue that because the variation induced by our IV comes from the entire population of in-married spouses, this LATE applies to a larger population. We also find that our LATE estimate was larger than the ATE estimate, which suggests that, among compliers, there is a stronger negative effect of family size on children's educational attainment. We speculate that complier couples might have more discordant fertility preferences than the general population, which leads them to be more strongly exposed to the negative consequences of having a larger family.

Third, we could expand the EFFE design to control in a more comprehensive way for omitted family characteristics. In particular, we could exploit information about the genetic relatedness between the WLS graduate and the sibling respondent to accomplish this goal. For example, in some families the WLS graduate and sibling respondent are monozygotic (MZ) twins, while in others one sibling is adopted and the other is a full sibling. If A and B are MZ twins, the EFFE model would control for a more comprehensive range of omitted family background characteristics than is currently the case (since MZ twins are genetic clones at birth and share the same family environment). There are too few MZ twins (N ~ 40) among the WLS graduates and sibling respondents for us to implement a genetically informed EFFE design, but our design would be feasible with a larger dataset or with one that oversamples MZ twins. In this regard, our paper showcases a research design that can be extended in future research.

Finally, in terms of theory development our results highlight the need to look beyond the nuclear family if we want to understand contextual differences in the ways in which family size affects children's outcomes. Nuclear families belong to larger kin groups and communities that seem to moderate the effects of family size on educational outcomes, and this ought to be taken into account in future studies, as is done in the CRD model (Gibbs et al. 2016). We therefore encourage future research that explores if other types of communities to which families belong, for example religious, ethnic, national, or social, or other aspects of physical communities such as neighbourhoods, might have similar protective (or hurtful) properties with regard to children's outcomes, and whether or not the role of these moderating factors have varied over time.

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Table 1. Summary of Results from Research on Family Size and Children's Educational Outcomes

Study	Outcome	Effect of Family Size	Identification Strategy	Country
FAMILY FIXED EFFECTS				
Guo and VanWey (1999)	Cognitive ability (test scores)	No effect	Within-child and within-family FE	US
Rodgers et al. (2000)	IQ	No effect	Within-family FE	US
Sandberg and Rafail (2014)	Cognitive ability (test scores)	No effect	Within-child FE	US
INSTRUMENTAL VARIABLES				
Rosenzweig and Schultz (1987)	Years of schooling	Negative	IV (contraceptive use)	Malaysia
Black et al. (2005)	Years of schooling	No effect	IV (Twin births, sex composition)	Norway
Cáceres-Delpiano (2006)	Educational attainment	No effect	IV (Twin births)	US
Conley and Glauber (2006)	Grade repetition	Firstborns: No effect; Second borns: Positive	IV (Sex composition)	US
Baez (2008)	Years of schooling	Negative	IV (Sex composition)	Colombia
Jæger (2008)	Years of schooling	Negative	IV (mothers' and fathers' family size and age at first birth)	US
Lee (2008)	Household expenditure on education	Negative (non-linear)	IV (Sex composition)[a]	South Korea
Li et al. (2008)	Educational level	Rural: Negative Urban: No effect	IV (Twin births)	China

Maralani (2008)	Years of schooling	No effect	IV (Women's reports of miscarriages)	Indonesia
Dayioglu et al. (2009)	School enrollment	No effect	IV (Twin births)	Turkey
Rosenzweig and Zhang (2009)	Years of schooling	Negative	IV (Twin births) and FE	China
Qian (2009)	School enrollment	Positive	IV (China's family planning policy)	China
Angrist et al. (2010)	Years of schooling	No effect	IV (Sex composition and twin births)	Israel
Black et al. (2010)	IQ	Sex composition: No effect; Twin births: Negative	IV (Sex composition and twin births)	Norway
De Haan (2010)	Years of schooling	No effect	IV (Sex composition and twin births)	US
Ferrari and Zuanna (2010)	Attainment of university degree	Italy: No effect; France: Positive	IV (Sex composition)	France and Italy
Silles (2010)	Cognitive ability (test scores)	Negative	IV (mothers' family size, time between marriage and first birth and sex composition)	Great Britain
Åslund and Grönqvist (2010)	Grade Point Average, years of schooling, university enrollment	No effect	IV (Twin births)	Sweden
Frenette (2011)	Reading score and school attendance	Reading score: No effect School attendance: Negative	IV (Twin births)	Canada
Kang (2011)	Private tutoring expenses	Boys: No effect Girls: Negative	IV(Sex composition)[a]	South Korea
Marteleto and de Souza (2012)	Years of schooling	2+ children: No effect; 3+ children: Positive. Change over time: 1977-1990 positive, later: no effect	IV (Twin births)	Brazil

Ponczek and Souza (2012)	Years of schooling, school progression	Boys: No effect Girls: Negative	IV (Twin births)	Brazil
Bagger et al. (2013)	Years of schooling	Negative	IV (Twin births) + family FE	Denmark
Fitzsimons and Malde (2014)	Years of schooling	No effect	IV (Sex composition)[a]	Mexico
Liu (2014)	Years of schooling	No effect	IV (China's family planning policy)	China
Argys and Averett (2015)	Years of schooling	Negative	DID (migrants flows + China's family planning policy)	China
Bougma et al. (2015)	Years of schooling	Negative	IV (sub fecundity)	Burkina Faso
Dang and Rogers (2016)	Years of schooling, tutoring	Years of schooling: No effect Tutoring: negative	IV (distance to family planning centre)	Vietnam
Dumas and Lefranc (2016)	Grade repetition	Negative	DID (municipal contraceptive ban)	Philippines
Kugler and Kumar (2017)	Years of schooling	Negative	IV (Sex composition)[a]	India

Notes: FE = Fixed effect; DID = Difference in Difference; IV = Instrumental Variable; [a] Sex composition = Preference for boys (rather than preference for mixed-sex sibships)

Table 2. Descriptive Statistics

	Analytical Sample			Total Sample		
	Mean	SD	*N*	Mean	SD	*N*
Years of education	14.19	2.10	22,544	14.04	2.17	31,911
Family size*	3.91	1.74	22,544	3.92	1.83	34,290
Controls:						
Birth order	2.46	1.49	22,544	2.51	1.55	34,290
Sex (woman)	0.50	0.50	22,544	0.51	0.50	34,286
Age (in 2004)	38.21	5.05	22,544	37.66	6.73	33,846
Father’s education	13.59	2.68	22,544	13.64	2.71	29,738
Mother’s education	12.95	1.79	22,544	12.99	1.87	31,253
Father SES	49.46	25.29	22,544	49.02	25.29	32,332
Family income	19.34	12.35	22,544	18.52	11.68	32,632
IQ of WLS graduate/sibling	101.88	14.54	22,544	102.13	14.74	32,258
Birth order of graduate/sibling	2.44	1.79	22,544	2.48	1.78	32,099
Frequency of meetings	28.81	59.16	19,793	25.64	56.59	33,233
Help with childcare*	0.01	0.10	18,114	0.01	0.11	24,293
Closeness	1.91	0.80	19,798	1.58	1.36	33,233
Instrumental variables:						
Spouse’s number of siblings*	4.39	2.70	21,582	4.38	2.68	26,187

Note: * Difference in means between analytical and total sample is *not* statistically significant at $p < 0.05$.

Table 3. Summary of Results from OLS, EFFE, and EFFE-IV Regressions of Children's Educational Attainment

Research Design	OLS		EFFE					EFFE-IV
Model	1	2	3	4	5	6	7	8
	Baseline	W. Controls	Baseline	W. Controls	Freq. Meeting	Help w. Childcare	Closeness	Spouse: No. sibs
Family size	-0.160***	-0.037**	-0.100***	-0.034**	-0.047**	-0.047**	-0.074*	-0.584**
	(0.012)	(0.012)	(0.013)	(0.013)	(0.014)	(0.014)	(0.030)	(0.214)
Family size × Freq. meeting					0.005**			
					(0.002)			
Family size × Childcare						0.488***		
						(0.142)		
Family size × closeness							0.021	
							(0.014)	
N	22,734	22,734	22,544	22,544	19,793	18,114	19,798	21,582
R^2	0.018	0.192	0.003	0.034	0.037	0.036	0.037	0.034
Controls[a]	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Extended family FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
First stage IV:								
Spouse's no. sibs								0.048***
								(0.009)
F-test for excluded instruments								27.09
N (first stage)								6,836

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, [a] Controls: *Child*: Birth order, sex, and age. *Parents*: Father's education, mother's education, father's SES, family income, and IQ. Table A1 and A2 summarise all regression results. Standard errors in OLS and IV models are adjusted for clustering of children within nuclear and extended families.

Fig. 1. Family Structure in the WLS

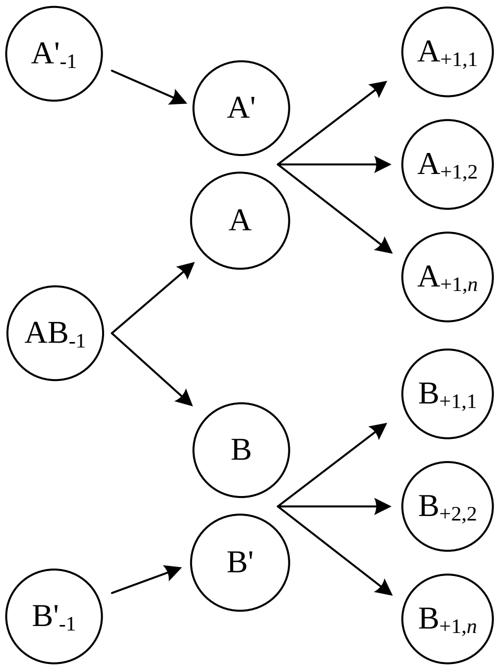

Table A1. Regressions of Family Size on Children's Educational Attainment

Research Design	OLS		EFFE				
Model	1	2	3	4	5	6	7
	Baseline	W. Controls	Baseline	W. Controls	Freq. meeting	Help w. Childcare	Closeness
Family size	-0.160***	-0.037**	-0.100***	-0.034**	-0.047**	-0.046**	-0.074*
	(0.012)	(0.012)	(0.013)	(0.013)	(0.014)	(0.014)	(0.030)
Family size × Freq. meeting					0.005**		
					(0.002)		
Family size × Childcare						0.488***	
						(0.142)	
Family size × closeness							0.021
							(0.014)
Controls							
Birth order		-0.109***		-0.099**	-0.097***	-0.097***	-0.098***
		(0.013)		(0.013)	(0.014)	(0.015)	(0.014)
Sex (woman)		-0.160***		-0.186***	-0.184***	0.179***	- 0.184***
		(0.025)		(0.025)	(0.026)	(0.028)	(0.026)
Age		-0.019***		-0.017***	-0.017***	-0.015)**	-0.018***
		(0.004)		(0.004)	(0.004)	(0.005)	(0.005)
Father's education		0.161***		0.108***	0.105***	0.095***	0.106***
		(0.009)		(0.013)	(0.013)	(0.013)	(0.013)
Mother's education		0.136***		0.099***	0.100***	0.085***	0.099***
		(0.011)		(0.015)	(0.015)	(0.017)	(0.015)
Father's SES		0.009***		0.010***	0.009***	0.011***	0.009***
		(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
Family Income		0.007***		0.007**	0.007**	0.007**	0.007**
		(0.001)		(0.002)	(0.002)	(0.002)	(0.002)
IQ of graduate/sib		0.009***		0.005**	0.006**	0.007***	0.006**
		(0.001)		(0.002)	(0.002)	(0.002)	(0.002)
Birth order of graduate/sib		0.010		0.001	0.005	0.008	0.001
		(0.009)		(0.017)	(0.018)	(0.019)	(0.018)
Childcare						-2.100***	
						(0.603)	
Constant	14.814***	9.732***	0.040***	0.033***	0.037***	0.037***	0.035***
	(0.048)	(0.241)	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)
N	22,734	22,734	22,544	22,544	19,793	18,114	19,798
Extended family FE	No	No	Yes	Yes	Yes	Yes	Yes

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ Standard errors in OLS and IV models are adjusted for clustering within nuclear and extended families.

Table A2. Results from EFFE-IV Regressions of Children's Educational Attainment (model 8)

	Second stage	First stage
Family size	-0.584**	
	(0.226)	
Instruments		
Spouse's no. sibs		0.048***
		(0.009)
F-test for excluded instruments		27.09
Controls		
Birth order	-0.114***	
	(0.013)	
Sex (woman)	-0.181***	
	(0.026)	
Age	-0.022***	
	(0.004)	
Father's education	0.106***	-0.009
	(0.013)	(0.011)
Mother's education	0.061**	-0.068***
	(0.023)	(0.012)
Father's SES	0.008***	-0.004***
	(0.001)	(0.001)
Family Income	0.007**	0.001
	(0.002)	(0.002)
IQ of WLS graduate/sibling	0.006**	0.002
	(0.002)	(0.001)
Birth order of WLS graduate/sibling	-0.131*	-0.225***
	(0.051)	(0.013)
Constant	0.035***	-0.004
	(0.008)	(0.009)
N	21,582	6,836
Extended family FE	Yes	Yes

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ Standard errors in OLS and IV models are adjusted for clustering within nuclear and extended families.