ADBI Working Paper Series

THE EFFECT OF OPPOSITE SEX SIBLINGS ON COGNITIVE AND NONCOGNITIVE SKILLS IN EARLY CHILDHOOD

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No. 627
December 2016

Asian Development Bank Institute

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Suggested citation:

Cyron, L., G. Schwerdt, and M. Viarengo. 2016. The Effect of Opposite Sex Siblings on Cognitive and Noncognitive Skills in Early Childhood. ADBI Working Paper 627. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/effect-opposite-sex-siblings-cognitive-and-noncognitive-skills-early-childhood

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Abstract

We investigate the effect of having opposite sex siblings on cognitive and noncognitive skills of children in the United States at the onset of formal education. Our identification strategy rests on the assumption that, conditional on covariates, the sibling sex composition of the two firstborn children in a family is arguably exogenous. With regard to cognitive skills, learning skills, and self-control measured in kindergarten, we find that boys benefit from having a sister, while there is no effect for girls. We also find evidence for the effect fading out as early as first grade.

JEL Classification: I2, J13, J16

Contents

1. INTRODUCTION

While coeducation is the standard practice in schools in the United States (US) since the 19th century, academic interest is once again renewed on the debated issue of gender composition in learning environments. Several recent studies have shown more generally that gender peer effects in schools affect educational outcomes (Hill 2015; Hoxby 2000; Lavy and Schlosser 2011).[1] Direct evidence on single-sex education also largely confirms the benefits of homogeneous gender peer settings (Eisenkopf et al. 2015; Jackson 2012; Lee et al. 2014). Moreover, several studies have found that the gender composition of siblings also affects educational outcomes, but the evidence on gender peer effects of siblings is more mixed (Anelli and Peri 2015; Brunello and De Paola 2013; Butcher and Case 1994; Hauser and Kuo 1998; Parish and Willis 1993). However, most of the economic literature on sibling effects focuses on outcomes at later stages in life, while gender peer effects of siblings may arguably be most pronounced before children make regular contact with other peer groups.

This paper studies the effect of opposite sex siblings on cognitive and noncognitive skills of children in the US at the onset of formal education. More specifically, we use data on skills of kindergarten and first grade students from the Kindergarten Class of 1998–1999 of the Early Childhood Longitudinal Study (ECLS-K). Our empirical strategy rests on the assumption that the sex composition of the two firstborns in families with at least two children is exogenous, conditional on other covariates including the total number of siblings in a family.

We find that boys with a sister exhibit significantly higher math and reading skills in kindergarten, and better learning skills and self-control, than boys with a brother. The overall effect on girls is insignificant, which is in line with evidence from other studies on gender peer effects (e.g., Lee et al. 2014). We also find some indication for a fade-out of the effect for boys. The effects on reading skills, learning skills, and self-control at the end of first grade are significantly below the effects in kindergarten and not significantly different from zero. This quick fade-out might be explained by the gain in importance of other peer groups during formal education such as friends or classmates.

2. EMPIRICAL STRATEGY

We use data from the ECLS-K, which was administered by the National Center for Education Statistics (Tourangeau et al. 2002). The study is representative of the kindergarten population in 1998–1999 and follows children from kindergarten to eighth grade. Children are repeatedly given reading and math tests, and assessments of their noncognitive abilities are made. We analyze the public-use data from the first three waves—fall kindergarten, spring kindergarten, and first grade.[2] We restrict our sample to the first two children of a family with at least two children. Our final estimation sample comprises 9,402 children first surveyed in the fall of their kindergarten year.

[1] The evidence on gender peer effects is, however, largely confined to primary and secondary education and cannot necessarily be extrapolated to higher education (Oosterbeek and van Ewijk 2014).

[2] We focus on the early waves because subsequent attrition leads to a sizable reduction in the sample size, and a shift toward children of higher socioeconomic status.

We estimate the effect of having a sibling of the opposite sex based on the following augmented educational production function:

$$y_{it} = \alpha + opposite_i'\beta_{1t} + (opposite_i \times female_i)'\beta_{2t} + female_i'\beta_{3t} + X_{it}'\gamma + \delta_t + \varepsilon_{it}, \quad (1)$$

where y_{it} is the standardized level of reading scores, math scores, the self-control score, or the approaches to learning score of student *i* in wave *t*.[3] The dummy variable $female_i$ indicates the gender of the child, while *opposite* indicates whether a child has a sibling of the opposite sex.[4] The other right-hand-side variables are child characteristics and wave indicators.[5]

The effects of interest are the parameter vectors β_{1t} and β_{2t}. Parameters in β_{1t} capture a wave-specific intention-to-treat effect of having an opposite sex sibling for boys, while the elements of β_{2t} measure the difference in the effects for girls. We use the first wave as baseline category and estimate Equation (1) by weighted least squares using sampling weights provided in the ECLS-K data. Standard errors are clustered at the child level.

The parameters are identified under the assumption that the sibling sex composition of the two firstborns in families with at least two children is exogenous, conditional on other covariates including the total number of siblings in a family.[6] Arguably, sex at birth is a random outcome and, overall, it is indeed almost evenly distributed, with a slightly larger, naturally occurring, chance of having a boy than a girl. For the cohort of children being considered in this study, the sex-at-birth ratio lies within the standard range for industrialized countries of 1.03 to 1.07 boys for every girl (Citro et al. 2014).

However, some endogeneity concerns remain. In particular, one key concern is that modern diagnostics allow the early determination of a child's sex before birth, which could lead to sex-selective abortions. However, existing studies provide little evidence of significant sex selection in the US that could confound our estimates. Citro et al. (2014) present difference-in-difference results for Illinois and Pennsylvania, where sex-selective abortions were banned in the 1980s. They find that the reforms had no effect on sex ratios. The sex ratios at birth were within the biological norm 5 years before and after the ban. Overall, Rodgers and Doughty (2001) confirm that the model that best describes the birth data in the US is one that is unconditional on the sex of previous siblings. Finally, Almond and Edlund (2007) find that certain maternal characteristics are indeed associated with more sons who are young, married, and well-educated. Nevertheless, the resulting difference in sex ratio remains minor for very large differences in parental characteristics, all within the norm of the sex ratios.

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[3] All outcome variables are standardized to mean 0 and standard deviation 1.

[4] *opposite* is defined so that the variable takes into account only siblings ±4 years of the sample child. This was chosen so that when the cohort child enters kindergarten the sibling is past baby age where he/she would require a lot of parental attention, but also so that the sibling is not too far away in age such that interactions are rare. The effect remains significant as the age gap between siblings increases, but becomes smaller in magnitude.

[5] Covariates are reported in detail in the notes of Table 1.

[6] We emphasize that our identification assumption holds conditional on the total number of children in a family, because the sex composition of the first-borns may have an impact on family size (cf. Ichino et al. 2014) and families may face a trade-off in terms of child quantity and quality (cf. Black et al. 2005). Note, however, that our results remain virtually unchanged if we do not condition on family size or other family characteristics (see columns 1 and 4 of Table 1).

3. RESULTS

Table 1 shows our main estimation results based on Equation (1). The results for all four outcomes are presented in two panels, which present the effects on cognitive skills (panel A) and noncognitive skills (panel B). For each outcome, we report three specifications with different sets of covariates to show the stability of results to adding controls.

Table 1: The Effect of an Opposite Sex Sibling on Skills in Early Childhood

Panel A: Cognitive Outcomes						
	Math			**Reading**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Opposite	0.087**	0.064**	0.057*	0.101***	0.080**	0.080***
	(0.035)	(0.031)	(0.031)	(0.033)	(0.031)	(0.031)
Opposite×Spring-KG	–0.013	-0.017	-0.016	–0.011	-0.014	-0.013
	(0.024)	(0.023)	(0.023)	(0.022)	(0.021)	(0.021)
Opposite×1st Grade	–0.017	-0.013	-0.016	–0.066*	-0.062*	-0.063*
	(0.035)	(0.034)	(0.034)	(0.034)	(0.033)	(0.033)
Opposite×Female	–0.035	-0.049	-0.043	–0.071	-0.084**	-0.083**
	(0.046)	(0.041)	(0.041)	(0.045)	(0.042)	(0.042)
Opposite×Female×Spring-KG	–0.022	-0.022	-0.023	0.011	0.011	0.011
	(0.032)	(0.031)	(0.031)	(0.030)	(0.029)	(0.029)
Opposite×Female×1st Grade	0.040	0.038	0.042	0.062	0.061	0.062
	(0.047)	(0.045)	(0.045)	(0.047)	(0.046)	(0.046)
School Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Parental Background	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
R^2	0.002	0.165	0.178	0.005	0.136	0.143
Panel B: Noncognitive Outcomes						
	Approaches to Learning			**Self-Control**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Opposite	0.133***	0.120***	0.118***	0.084**	0.075**	0.071**
	(0.033)	(0.032)	(0.032)	(0.034)	(0.033)	(0.033)
Opposite×Spring-KG	–0.053*	–0.057**	–0.057*	–0.072**	–0.077**	–0.076**
	(0.029)	(0.029)	(0.029)	(0.032)	(0.032)	(0.032)
Opposite×1st Grade	–0.096**	–0.092**	–0.093**	–0.116***	–0.114***	–0.115***
	(0.041)	(0.041)	(0.041)	(0.043)	(0.043)	(0.043)
Opposite×Female	–0.071	–0.081*	–0.079*	–0.020	–0.027	–0.024
	(0.045)	(0.044)	(0.044)	(0.045)	(0.045)	(0.044)
Opposite×Female×Spring-KG	0.042	0.045	0.044	0.028	0.032	0.031
	(0.039)	(0.039)	(0.039)	(0.043)	(0.043)	(0.043)
Opposite×Female×1st Grade	0.033	0.029	0.031	0.038	0.035	0.037
	(0.056)	(0.056)	(0.056)	(0.059)	(0.058)	(0.058)
School Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Parental Background	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
R^2	0.043	0.097	0.100	0.028	0.060	0.065
Child-Cluster	9,402	9,402	9,402	9,402	9,402	9,402
Observations	24,325	24,325	24,325	24,325	24,325	24,325

KG = kindergarten.

Notes: Weighted least squares regressions using sampling weights. Dependent variables are reported in the column headings. All outcomes are standardized to standard deviation 1 and mean 0. *Opposite*: Child has an opposite sex sibling of similar age (within ±4 years). The regressions control for female, female-time interactions, parental background, and ethnicity. *Parental Background:* contains *parental education*, a categorical variable for highest parental education level in 9 levels from 9th grade to PhD; *sibship size*, the number of siblings a child has; *food stamp* receipt within the last 12 months; *home language,* a dummy if English is the family language as the closest proxy for immigration status; *family type* equals 1 if the child is living in a two-parent family. *African-American, Hispanic, Asian*: dummies for self-declared ethnicity. Clustered standard errors in parentheses. Sample: children with birth order 1 or 2, and with a sibling within ±4 years.

*** p <0.01, ** p <0.05, * p <0.1.

Data Source: Early Childhood Longitudinal Study – Kindergarten Class.

The results of the impact to boys of having a sister at kindergarten entry, depicted in the first row of panels A and B, carry a clear message: in all four domains, effects are positive and significant. Effects sizes range from an increase of 6% of a standard deviation in math to 12% in approaches to learning.[7] Overall, the coefficients of interest are very stable to the inclusion of observable covariates—compare columns (1) to (3), and (4) to (6) in panels A and B—which is in line with the assumption that the composition of sibling sex of the two firstborns in a family is exogenous.

Over time, however, the effects appear to fade out. The wave interactions in rows 2 and 3 of panels A and B show that the initially positive effect reverts to the opposite direction over time, despite not always being significant. By the end of first grade, the linear combinations of *opposite* and the wave interactions become insignificant for all outcomes.[8] A potential explanation for this finding may be that the initial effect fades out quickly as children integrate into school and other peer groups, such as friends or classmates, gain in importance.

We complement the picture by showing that no effects exist for girls. In fall-kindergarten, the coefficients on the interaction terms in the fourth row of panels A and B in Table 1 measure this difference in the effect size on girls from having a sibling of the opposite sex. Despite not always being statistically significant, all coefficients are negative and sizable, which indicates that the effects are substantially lower for girls. Combined with the baseline effect reported in the first row, the effect on girls of having a sibling of the opposite sex is not significantly different from zero in all four domains. The estimates of the interaction terms reported in rows 5 and 6 of panels A and B in Table 1 show that this result does not change over time. While it is difficult to pin down a definite explanation for this effect heterogeneity across gender, the finding that girls are less likely to be affected by the gender of their peers is in line with other findings in the literature (e.g., Lee et al. 2014).

4. CONCLUSION

The economic literature on sibling gender effects in education has focused exclusively on outcomes measured during secondary education and beyond. We contribute to this literature by providing a first analysis of gender peer effects of siblings on cognitive and noncognitive skills at the entry to education. Our identification strategy rests on the assumption that the composition of sibling sex of the two firstborns in a family is arguably exogenous while we also account for total family size. We find that having a sister has a positive impact on the initial achievement levels in math, reading, learning

[7] Measured by six items: attentiveness, organization, flexibility, persistence in a task, eagerness to learn, and independence in learning (Tourangeau et al. 2002).

[8] Additional analyses, available upon request, show that all estimates of sibling effects are insignificant in higher grades, but these estimates are highly imprecise.

skills, and self-control of boys at kindergarten entry. In contrast, educational outcomes of girls are not affected by the gender of their siblings. Furthermore, while having a sister is beneficial for the school readiness of boys, the effect fades out quickly and disappears by the end of first grade. We hypothesize that this fade-out might be explained by classmates and friends quickly replacing siblings as the dominant peer group after school entry.

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