Sister competition and birth order effects among marriage-aged girls: Evidence from a field experiment in rural Bangladesh

Stephanie Zhong

Under supervision of:

Dr. Erica Field, *Faculty Advisor*

Dr. Michelle Connolly, *Seminar Advisor*

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Department of Economics, Duke University

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ABSTRACT

Early marriage before the age of 18 is prevalent among adolescent girls in Bangladesh, but the timing of marriage is not uniform across daughters within a household, with some sisters marrying earlier than others. Using survey data from a novel field experiment from rural Bangladesh, I find that girls ages 10-21 with lower birth order tend to be married at a younger age, even when controlling for confounding nature of household size on birth order. Additionally, girls with younger sisters are more likely to be married and at a younger age than girls with younger brothers. The findings on dowry are inclusive.

JEL classification codes: D13; J13; O15

Keywords: Birth order; Marriage; Household allocation

1. Introduction

In Bangladesh, the livelihood of girls is frequently characterized by onset of marriage before the age of 18 (UNICEF, 2014). Premature marriage is associated with lower levels of education, higher rates of domestic violence, and lower household bargaining power, making timing of marriage an important dimension for assessing the quality of life of adolescent girls in Bangladesh (Anukrit, 2017; Jensen, 2003). A randomized control trial field experiment in six sub-districts of rural Bangladesh offers novel evidence that financial incentives can induce households to delay the marriage of daughters ages 10-17 (Buchmann et al, 2017). However, timing of marriage is not uniform across daughters of the same household, with some sisters marrying earlier than others, thus no evaluation of marriage-delaying interventions is complete without considering household heterogeneity.

Previous literature suggests that older children receive less parental investment compared to their younger siblings; however, these findings mainly focus on educational attainment as the dependent variable or are limited to using proxies for marriage as the dependent variable (Vogl, 2013; Bratti, Fiore, and Mendola, 2017; Emerson and Souza, 2008). Using survey data from the Bangladesh field experiment, I am able to directly measure the impact sister competition and birth order on marriage age and other marriage-related outcomes. I find that girls ages 10-21 with lower birth order tend to be married at a younger age, even when controlling for the confounding nature of household size on birth order.

Additionally, girls with younger sisters are more likely to be married and at a younger age than girls with younger brothers. The results on dowry are inclusive.

2. **Background**

2.1 Review of literature

The current economic understanding of how household demographics and fertility decisions influence child outcomes derives from the seminal work of Becker (1960) and Becker and Lewis (1973). Their quantity-quality model predicts a within-household tradeoff between child quantity and child quality because the larger the family, the less resources available per child. In order words, children are modeled as identical, normal goods for which the marginal cost of improving the quality of a child increases with each additional child that is born into the family (Doepke, 2015). As an extension to the quantity-quality model, Becker and Tomes (1976) relax the assumption that all children are identical and consider how inter-household allocation of resources changes according the inherent differences in endowment. Becker and Tomes (1976) conclude that a more well-endowed child will produce a higher return to parental investment and therefore receive more net investment than a less well-endowed child of the same family. Becker and Tomes do not attempt to model why these differences in returns on parental investment occur among siblings; instead, they assume the differences in each child's

endowment may arise for many reasons, such as variation in inherited ability or environmental factors, to name a few.

Perhaps what is absent from the Becker and Tomes (1976) paper is the notion that social institutions and customs may also dictate or alter how returns to investment vary between siblings. In particular, the Bangladeshi marriage market is characterized by arranged marriages, dowry-giving, and preferences for young brides. Dowry is a payment in the form of cash or other valuable goods from the bride's family to the groom's family as a part of the arranged marriage agreement. The necessity of dowry in arranging marriages for girls lowers the return on investment of girls, whom require dowry to be married, while it raises the return on investment of boys, whom receive dowry when they are married. Thus, dowry can contribute to explicit parental preference for sons and gender-selective fertility behavior (Alfano, 2017; Bhalotra, Chakravarty, and Gulesci, 2016). Additionally, financially constrained households have been shown to take advantage of the higher return that boys command by substituting human capital investment towards boys and away from girls. In Nepal, a recent change to the conscription policies of the British Army improved the oversees jobs prospects of Nepali men (but not women), inducing households to investment more in the education of sons at the expense of lowering the education of daughters (Srestha and Palaniswamy, 2017). There is also evidence from a study of changes to inheritance laws in India suggesting that when low-income households allocate resources between sons and daughters, they view increases in dowry bequests and increases in human capital investment as equivalent means for compensating daughters (Roy, 2015).

Secondly, young brides are relatively more desirable than older ones, causing dowry levels to monotonically increases with the age of the girl (Field and Ambrus, 2008). Additionally, it is customary in Bangladesh for households with multiple girls to arrange each girl's marriage in sequence of birth order (Vogl, 2013). Vogl demonstrates that these cultural customs have the potential to create sister competition in households with multiples daughters because parents have pressure to marry-off older daughters quickly in order to leave time and dowry funds for younger daughters. This suggests a Beckerian quantity-quality tradeoff specific to daughters, since increasing the number of girls in the household increases the cost of improving each individual girl's "quality" as measured through age of marriage. By pooling Demographic Health Survey (DHS) data from four countries in South Asia (Bangladesh, India, Nepal, Pakistan), all with high rates of early marriage and varying degrees of dowry-practice, Vogl finds that conditional on having x -number of younger siblings, girls with next-younger sisters are more likely to migrate out of their natal household than girls with next-younger brothers. Vogl does not measure marriage rates directly, rather he uses migration out of the natal household as a proxy for onset of marriage, with the rationale being that married girls in these South Asian countries overwhelmingly reside with their in-laws.

Besides marriage outcomes, education and labor participation are other means through which parents can invest or divest in the human-capital of each of their children. Holding household size and other family-specific characteristics constant, first-born children tend to receive less education, are more likely to migrate abroad, and are more likely to work or participate in domestic chores (Bratti, Fiore, and Mendola, 2017; Tenikue and Verheyden, 2010;

Baez, 2008; Emerson and Souza, 2008; Ejrnæs and Pörtner, 2004). These results are robust across a variety of different developing country settings. [1]

2.2 The Kinshoree Kontha (KK) Girls' Empowerment Field Experiment & Survey

From January 2007 to January 2018, researchers affiliated with Duke University, the Abdul Latif Jameel Poverty Action Lab (J-PAL), and Save the Children USA, conducted a clustered, randomized control trial in southeast Bangladesh. The goal of the field experiment was to evaluate the impact of alternative interventions in delaying marriage and increasing school attendance among adolescent girls ages 10-17. Researchers selected village communities with 40-490 marriage-aged girls per village in six rural sub-districts (Daulatkhan, Bubanganj, Muladi, Patuakhalui Sadar, Bauphal, and Bhola Sadar) to participate in the field experiment. Households were randomized at the village-level into four treatment arms: (1) control, (2) empowerment, (3) financial incentive, and (4) empowerment plus financial incentive. Three rounds of surveys were implemented at 1 year, 3 years, and 4.5 years after the start of the interventions to track the marriage and education outcomes of girls as well as collect information on girl's family conditions, behavioral patterns, and beliefs. Within each round of surveying, several different questionnaires were administered, each targeting a different member of the community, such as the girls themselves, heads of households, in-laws of married girls, village leaders, school teachers, matchmakers, and marriage registrars.

[1] Interestingly enough, a common theme in literature on birth order effects is that results from developed countries are reversed and cannot be replicated in developing country settings. Studies conducted in the United Kingdom, Norway, and the United States find strong *negative* associations between birth order and educational attainment, meaning levels of human capital investment are higher for first-born children holding household size and other characteristics constant. (Booth and Kee, 2009; Kantarevic and Mechoulan, 2006; Black, Deveraux, and Salvanes, 2005).

Villages designated to receive the empowerment treatment were mobilized through awareness campaigns aimed at informing parents, teachers, and influential village leaders of the importance of delaying marriage and increasing education for adolescent girls. Each community designed a "safe-space" in which all girls ages 10-19 were eligible to enroll in one of four cycles of peer-led, after-school empowerment sessions. Girls were taught a curriculum of basic literacy, numeracy, and oral communication skills as well as nutritional and reproductive knowledge for anywhere between 16 to 40 hours a week. Though the program was designed to reach 90% of all girls in the empowerment arm, self-reported enrollment rates from the survey estimate that 84% of eligible girls reported being a member of the KK empowerment groups (Buchmann et al., 2017).

In villages designated to receive the financial incentive, a ration card redeemable for four-liters of cooking oil was distributed to girls ages 15-17 conditional on the girl remained unmarried before the legal age of consent (age 18). The oil incentive was designed so that girls were able to receive a maximum of three four-liter distributions of cooking oil per year, equivalent to USD $16 per year in transfers. This amount was intended to be enough to compensate the girl's family for the increase in dowry that arises with delaying marriage by an additional year. [2] Bangladesh's GDP per capita in current USD is $1,359 and dowry payments can be upwards of $241, increasing by $12 for every year that a girl is unmarried (World Bank, 2018; Davis, 2011; Bruce and Lloyd, 2004)[3]; hence, the value of oil transfers was not negligible.

[3] All USD values are reported at the exchange rate as of April 15, 2018.

Oil distributions could only be collected by the girls themselves (not the parents) and in order to collect oil, girls had to present the ration card to administrators who then compared the girl's identification card to a list of unmarried girls before handing out the oil. According to self-reported data, 71% of surveyed girls ages 10-17 and unmarried at the start of interventions reported receiving at least one oil distribution (Buchmann et al., 2017).

The evaluation of the girls' empowerment field experiment found that oil incentive reduced the likelihood of being married under the age of 18 by 23% ($p < 0.01$) for all girls age 15-17 at start of intervention. Additionally, marriage age was reduced by 3.4 months ($p <0 .01$) for girls age 15-17 at the start of intervention and 5.0 months ($p < 0.01$) years for a subset of girls age 15 at the start of intervention. The empowerment program had no statistically significant effects on the main outcomes and there was no significant difference between the standalone oil incentive arm and the incentive plus empowerment arm. For further discussion see the working paper by Buchmann et al. (2017).

3. Empirical strategy and hypotheses

The path to establishing a causal relationship between gender-specific birth order and marriage outcomes is riddled with concerns of confounding variables and omitted variable bias. To start, birth order is correlated with household size (see Section 4.2 for further discussion). That is, children with lower birth orders are more likely to come from smaller households and children with higher birth orders are more likely to come from larger households, thus not only

is there a need to disentangle the family size effect from birth order, but also from any other unobserved household characteristics that might be correlated with family size and affecting child outcomes, such as household income, parental age, to name a few. This paper summarizes and implements multiple empirical methods suggested by the existing literature for dealing with the aforementioned issues in establishing causality.

3.1 Girl-specific birth order index

A number of studies of effects of a child's birth order on educational attainment have constructed birth order indices, which are variables that preserve to ordinality of siblings but are orthogonal to household size (Booth and Kee, 2009; Erjnæs and Pörtner, 2004; Tenikue, 2010). I construct a girl-specific birth order index using the method proposed by Booth and Kee [BK]. Let n be the i-th girl's birth rank among all the daughters in the household, and N be the total number of daughters in the household. The average birth order for girls in the household is $(N+1)/2$ and the birth order index $n/\left[\frac{N+1}{2}\right]$ is orthogonal to family size. As demonstration, the sample correlation between the BK birth order index and household size, measured as the number of girls in the household, is nearly zero in my dataset. This is an improvement from a sample correlation of 0.36 between absolute birth order and household size. This result is consistent with previous results, as BK found that sample correlation was reduced from 0.705 to 0.066 when using the birth order index instead of absolute birth order in their analysis.

Table 3.1: Sample correlation coefficients between birth order measures and household size

	Household size: number of girls	Household size: number of children
Absolute birth order	0.36	0.45
BK's birth order index,)	-0.02	-0.02
EP's relative birth order index[4]	-0.14	0.15

Equation [1] measures the effect of birth order for the i-th girl in the j-th household. The dependent variable y_{ij} corresponds to one of the main outcome variables of interest: marriage age or dowry-level. Dowry is the cost reported by the household of all of mediums of gifts including cash, land, livestock, gold, and other homestead items given by the girl or her family to the groom's family at time of marriage.

$$y_{ij} = \beta_0 + \beta_1 birthorder_{ij} + \boldsymbol{\beta}_2 \boldsymbol{X}_{ij} + \boldsymbol{\beta}_3 \boldsymbol{Y}_j + \epsilon_{ij} \qquad [1]$$

The $birthorder_{ij}$ variable is a measure of sibling ordinality, either BK's birth order index or a pair of indicator variables for first-born and last-born daughter, depending on the specification. For $y_{ij} = marriage\_age_{ij}$, a coefficient of $\widehat{\beta_1} > 0$ supports our hypothesis that first-born daughters marry at a younger age earlier relative to their younger sisters. For $y_{ij} = dowry_{ij}$, since dowries are monotonically increasing in age one could assume that so long as the coefficient on marriage age is positive the coefficient on dowry should also be positive. One could also imagine that the larger the age gap between a girl and her next-youngest sister, the

[4] In a similar fashion, Erjnæs and Pörtner use another birth order index referred to as the "relative birth order". It is calculated as $(n-1)/(N-1)$. BK's birth order index has the advantage because it is defined of the entire space $\{N = 1, 2, \ldots\}$, while Erjnæs and Pörtner's would be undefined for single-girl households ($N = 1$).

less of a financial constraint exists on the household because there is more time to accumulate dowry for next daughter. Thus, I include a variable for age gap between a girl and her next-younger sibling, and *a priori* we expect the coefficient on the age gap variable to be positive. However, it is also important to acknowledge that the relationship between dowry and birth order is less clear cut, since dowry is also thought to internalize the marriage market value of girls' physical attractiveness and capabilities and her family's wealth and status. Additionally, Field, Ambrus, and Torero (2010) suggest that dowry can be broken into two components, one that captures the attractiveness of a girl and her family and another that compensates the groom for the risk of a divorce settlement, hence it is possible that not all of the variation in dowry may not be explained by girl- and household-level characteristics.

The vector $\boldsymbol{X}_{ij}$ consists of girl-specific control variables, including the age gap between the *i*-th girl and her next-youngest sibling, indicator for has older brother, indicator for has older sister, indicator for has older step-sibling, age at start of surveying, age-squared, and years of incomplete education. To construct the years of incomplete education, I assume that a girl begins her primary education at age 7 and should graduate to the next grade on a yearly basis, completing secondary education (grade 12) by the age 18.[5] I then subtract the girl's actual reported grade from her expected grade, resulting in a control variable that mitigates the issue of a girl's age being highly collinear with her educational attainment. The household-specific control variables ($\boldsymbol{Y}_{\boldsymbol{ij}}$) are number of girls in household attending KK girls' empowerment

[5] For discussion of educational norms in Bangladesh, see Al-Samarrai (2007) and Bangladesh country report by UNESCO Institute of Statistics (2013).

sessions, number of girls in household receiving oil incentive to delay marriage, a continuous variable for number of girls in household, the gender ratio of children, parent's age and education at start of surveying, indicator for older step-siblings, indicator for grandparents, indicator for the belief that girl should wear veils as a proxy for religious conservatism, indictor for household has electricity, and indictor of village has a main road as a proxy for household remoteness.

3.2 Next-youngest brother and sister comparison

The next-youngest sibling method follows the work of Vogl (2013). Conditional on a girl having *x*-number of younger siblings, the gender of the girl's next-youngest sibling is independent of a girl's marriage age and dowry (assuming parents do not pursue abortions and other gender-selective reproductive behavior). Equation [2] therefore captures the causal effect of the gender of the next-youngest sibling on the *i*-th girl in the *j*-th household, where $\boldsymbol{y_{ij}}$ is once again one of the main outcomes of interest, (1) marriage age or (2) dowry-level. Additionally, I run this model for (3) likelihood of ever being married at the end of surveying and (4) likelihood of migration out of natal household by the end of surveying in order to assess how well migration serves as a proxy for onset of marriage.

$$y_{ij} = \boldsymbol{\alpha}_{0,ij} + \alpha_1 next\_sex_{ij} + \boldsymbol{\alpha}_2 \boldsymbol{X}_{ij} + \boldsymbol{\alpha}_3 \boldsymbol{Y}_j + \omega_{ij} \qquad [2]$$

The vector $\boldsymbol{\alpha_0}$ is a set of indicator variables for the number of younger siblings. The variable $next\_sex$ is equal to 1 if the girl's next-youngest sibling is female and equal to 0 if male. For marriage age and dowry, if the estimated coefficient on $next\_sex$ ($\widehat{\alpha_1}$) is less than zero, then this result supports the hypothesis that the presence of a younger sister causes the older sister to be

married at an earlier age and with lower dowry than if her next-youngest sibling was a brother. If a girl's migration status is truly a good proxy of the onset of marriage as Vogl (2013) asserts, then the coefficient ($\widehat{\alpha_1}$) from the regression on the migration indicator should be positive and close in magnitude to that of the regression on the ever-married indicator.

The vector $\boldsymbol{X}_{ij}$ consists of girl-specific control variables, including the age gap between the i-th girl and her next-youngest sibling, an interaction between sex and age gap of next-youngest sibling, indicator for has older brother, indicator for has younger brother, indicator for has older step-sibling, age at start of surveying, age-squared, and years of incomplete education. Since $\boldsymbol{\alpha_0}$, the set of indicators for number of younger siblings, is included in this specification, I exclude the continuous variable for number of the girls from the vector of household controls, but the rest of the variables in vector $\boldsymbol{Y}_j$ are the same as listed in the previous sub-section 3.1.

4. Data and variables

4.1 Analysis dataset

The data for the empirical analysis comes from three surveys administrated as a part of the KK girls' empowerment field experiment:

- A census survey of randomly-selected households within the six targeted sub-districts, implemented at the start of the interventions
- A survey of all households with at least one adolescent girl eligible for participation in either KK treatment arms, implemented at the start of the interventions

- A follow-up census that asked all households surveyed during the beginning census to update the status of girls in the household, implemented 5 years after start of interventions

Merging these three datasets results in a roster of household members with information about each member's age, sex, education, marriage status, employment at the start of surveying and interventions. From there, I exclude grandparents, uncles and aunts, in-laws, and other relatives, confining the analysis to the nuclear family (parents and children). From the roster and reported age variable, I am able to calculate the number of girls in each household, each girl's birth order, and indicator variables for various different family structures. Girls listed as domestic servants are dropped due to the difficulty in assigning parental and household attributes to these situations.[6] Additionally, 586 households, or 10% of the analysis dataset, list older step-children or children born to only one parent who have migrated out of the household. In these cases, the older step-children are not included in the construction of household size and birth order variables and instead denoted with an indicator variable equal to 1 if the household reports having these older step-children.

The resulting data set contains 5,807 households with at least one girl between the ages of 10 and 21 and with complete data on marriage age and dowry-levels. Beyond the initial round of surveying, the KK researchers only collected follow-up data from girls who were ages 10 to 17 at the start of intervention. However, this surveying constraint should not impede my analysis

[6] Cases of girls listed as domestic servants are few. A total of 283 domestic servants are dropped, compromising less than 3% of girls in analysis sample.

as 74% of Bangladeshi women report being married before the age of 18 and marriage outcomes for boys are outside the scope of the research question at hand (UNICEF, 2014).

4.2 Summary statistics

Table 4.1 below summarizes the average marriage age by girl-specific birth order and number of girls in household for the analysis sample. Generally speaking, the column totals are decreasing with number of girls, indicating preliminary evidence of the quantity-quality tradeoff. Additionally, increasing row total suggests there are positive birth order effects on average marriage age, although there are too few observations for higher birth orders to make conclusive statements. Additionally, Table 4.1 demonstrates the important probabilistic observation that girls with lower birth order are more likely to come from households with fewer girls highlighting the confounding nature of household size on birth order.

Table 4.1. Average marriage age by birth order and number of girls for households with at least one girl ages 10 to 21 at start of KK interventions.

	Number of girls										
Birth order, girl specific	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**	**N**
1	17.2	16.8	16.7	16.5	16.5	16.7	16.2	16.3	16.7	16.7	4,837
2		17.1	16.6	16.9	16.8	16.8	16.7	15.6	16.8	16.8	2,299
3			16.8	16.6	16.7	17.2	16.9	17.1	16.7	16.7	9,933
4				17.6	16.6	16.7	17.2	19.1	17.1	17.1	411
5					16.8	16.9	16.7	18.8	16.7	16.7	142
6						16.3	16.9	16.9	16.9	16.9	44
7							16.3	17.2	16.6	16.6	10
8								17.9	17.3	17.6	3
9									20.5	20.5	2
Total	17.2	16.9	16.7	16.7	16.7	16.7	16.7	17.2	16.9	16.8	-
N	670	2,029	2,446	1,857	1,039	454	170	55	21	-	8,741

Girl- and household-level characteristics are summarized in Table 4.2 and Table 4.3. The average age of marriage for girl ages 10 to 21 in the analysis sample is 16.8 and the median is 17.2 (not reported in Table 4.2). This statistic is consistent with the 2014 Bangladesh DHS which reports the median age of first marriage for women ages 20-24 to be 17.2 (NIPORT, et al., 2016). The sample proportion of girls who have ever been married is 0.79 and is closely approximated by the proportion of girls who have migrated out of her natal households, suggesting that a girl's migration status may be a viable proxy for onset of marriage. Since the average age in the sample is close to 18, most girls should be close to completing secondary education. However, summary statistics suggests most girls only have a primary-level education and most school-aged girls are below their expected grade level.

The average number of children per household in the analysis set is 5.34, higher than the national average among rural households of 4.46 (Khan, 2015). The ratio of boys to girls within households is less than 1 and the likelihood that a girl's next-youngest sibling is female is greater than 0.5, indicating households in our sample tend to report having more girls than boys. This may be a result of the nature of the survey framework since the explicit goal of the KK field experiment was to targeted households with adolescent girls. Average age at start of intervention is 50 and 40 years for father and mothers, respectively, and the majority of both fathers and mothers tend to have no education or primary-level education. Twenty-one percent of households have grandparents living alongside the nuclear family, and 8% list older step-siblings who have migrated out of the household. An overwhelming majority (92%) of head of households answered "yes" to the question, "Do you think a veil in need for girl leaving the

household?", an indication of religious conservatism exhibited through the Islamic observance of *purdah*. Twenty-eight percent of households have electricity and 35% are located in villages with access to a central, paved road.

Table 4.2. Summary statistics for girls ages 10 to 21 at start of surveying.

	Mean	**SD**
Age of first marriage	16.75	3.29
Dowry (USD)	371.43	648.09
Ever married, 1=yes	0.77	0.42
Moved out of natal household, 1=yes	0.77	0.42
Birth order, girl-specific	1.72	0.99
Birth order index, girl-specific	0.83	0.36
Age at start of surveying	17.69	6.10
Gender of next youngest sibling, 1=female	0.57	0.50
Age gap to next youngest sibling, years	3.65	1.88
Girl no education, 1=yes	0.07	0.26
Girl primary (grades 1-8), 1=yes	0.72	0.45
Girl secondary (grades 9-12), 1=yes	0.21	0.40
Girl postsecondary, 1=yes	0.00	0.70
Girl's education, number of years incomplete	3.86	3.52
Has older brother, 1=yes	1.00	0.04
Has younger brother, 1=yes	0.85	0.36
N		**9,829**

Table 4.3. Summary statistics for households with at least one girl ages 10 to 21 at start of surveying.

	Mean	SD
Num. children in hh.	7.47	1.94
Gender ratio, boys/girls	0.90	0.81
Father age at start of surveying	50.0	9.94
Father no education, 1=yes	0.42	0.49
Father primary (grades 1-8), 1=yes	0.41	0.49
Father secondary (grades 9-12), 1=yes	0.14	0.35
Father postsecondary, 1=yes	0.03	0.17
Mother age at start of surveying	40.01	8.04
Mother no education, 1=yes	0.49	0.50
Mother primary (grades 1-8), 1=yes	0.47	0.50
Mother secondary (grades 9-12), 1=yes	0.03	0.17
Mother postsecondary, 1=yes	0.00	0.04
Num. girls in hh. attending KK empowerment	0.67	0.70
Num. girls in hh. receiving oil incentive	0.14	0.37
Hh. has older step-siblings, 1=yes	0.08	0.28
Hh. has grandparents living-in,, 1=yes	0.21	0.41
Hh. believes girl should wear veil. , 1=yes	0.92	0.27
Hh. has electricity, 1=yes	0.27	0.45
Village has a main road, 1=yes	0.35	0.48
N		**5,807**

5. Results and discussion

5.1 Girl-specific birth order index

5.1.1 Marriage age

Column (1) of Table 5.1 shows the OLS estimates of the girl-specific BK birth order index on marriage age. The estimate on the birth order index is positive, suggesting that marriage age tends to increase with to birth order, even when controlling for household size and other girl- and household-specific characteristics. A marginal increase in the birth order index increases a girl's marriage age by 0.91 years, or 11 months ($p < 0.001$), representing roughly a one-third standard deviation increase from the average marriage age of 16.8 among girls in the sample. Additionally, the effect of the age gap between a girl and her next-youngest sibling is small but highly statistically significant (0.17 years, $p < 0.001$), offering evidence that a girl's marriage timing is affected by how soon-after the household must marry the subsequent daughter.

Table 5.1. OLS and FE estimates of birth order effects on marriage age for households with at least one girl ages 10-21 at start of surveying, measured in years. Standard errors shown in parenthesis.

	(1) OLS, girl-specific birth order index		(2) OLS, first & last-born indicators		(3) FE, girl-specific birth order index	
Birth order index, girl-specific	0.907***	(0.156)			2.189***	(0.292)
Is first born daughter, 1=yes			-0.519***	(0.101)		
Is last born daughter, 1=yes			-0.523	(0.772)		
Age gap to next youngest sibling	0.166***	(0.0210)	0.170***	(0.0210)	0.143***	(0.0323)
Age at start of surveying	0.239***	(0.0340)	0.231***	(0.0339)	0.308***	(0.0683)
Age squared	-0.00216**	(0.000693)	-0.00220**	(0.000693)	-0.00229*	(0.00111)
Girl's education, years incomplete	-0.181***	(0.0142)	-0.181***	(0.0143)	-0.159***	(0.0264)
Num. children in hh.	-0.0529	(0.0296)	-0.0902**	(0.0317)		
Has older brother, 1=yes	-3.873***	(1.012)	-4.025***	(1.011)	-5.542***	(1.513)
Has younger brother, 1=yes	-0.158	(0.153)	-0.890	(0.766)	-0.297	(0.204)
Has older step-sibling, 1=yes	-0.0237	(0.178)	0.0445	(0.180)		
Gender ratio, boys/girls	0.334***	(0.0719)	0.286***	(0.0698)		
Num. girls attending empowerment	0.198***	(0.0548)	0.190***	(0.0548)		
Num. girls receiving oil incentive	0.213*	(0.101)	0.217*	(0.101)		
Father age at start of surveying	-0.0320***	(0.00745)	-0.0308***	(0.00744)		
Father primary (grades 1-8), 1=yes	-0.0405	(0.0877)	-0.0293	(0.0877)		
Father secondary (grades 9-12), 1=yes	0.158	(0.133)	0.169	(0.133)		
Father postsecondary, 1=yes	0.421	(0.253)	0.416	(0.253)		
Mother age at start of surveying	0.0247*	(0.0101)	0.0296**	(0.0100)		
Mother primary (grades 1-8), 1=yes	0.287***	(0.0861)	0.287***	(0.0862)		
Mother secondary (grades 9-12), 1=yes	1.046***	(0.258)	1.043***	(0.259)		
Mother postsecondary, 1=yes	-0.825	(0.950)	-0.868	(0.951)		
Hh. has grandparents living-in, 1=yes	-0.0312	(0.0900)	-0.0232	(0.0901)		
Hh. believes girl should wear veil, 1=yes	-0.241	(0.140)	-0.242	(0.140)		
Hh. has electricity, 1=yes	0.288***	(0.0870)	0.297***	(0.0871)		
Village has a main road, 1=yes	-0.0982	(0.0779)	-0.0897	(0.0780)		
Constant	17.16***	(1.074)	19.23***	(1.312)		
Household fixed effects?	**No**		**No**		**Yes**	
N	**7,175**		**7,175**		**7,175**	
Adjusted R-squared	**0.0996**		**0.0985**		**--**	

Note: * $p < 0.05$ ** $p < 0.01$ ***$p < 0.001$

The results in column (1) highlight notable associations between marriage age and other girl- or household-level characteristics. The number of girls in the household receiving oil incentive is positively related to marriage age (0.21 years, $p < 0.05$), which is consistent with the working paper evaluation of the marriage-delay interventions (Buchmann, et al., 2017). Interestingly enough, the coefficient on number of girls attending empowerment sessions is similar in magnitude and statistically significant (0.20 years, $p < 0.001$) which is not observed in the working paper results. The coefficient on years of incomplete education is negative and statistically significant (-0.181 years, $p < 0.001$), meaning a girl in a grade level below her expected grade of attainment tends to marry earlier than a girl at or above her expected grade. Mother's education level also appears to play a role in determining a girl's marriage age. All else equal, having a mother with primary level education (grades 1-8) increases a girl's marriage age by 3.4 months (0.29 years, $p < 0.01$) compared to having a mother with no education, and having a mother with secondary school-level education (grades 9-12) increases marriage age by 1.05 years ($p < 0.01$). Having an older brother tends to decrease a girl's marriage age by more-than-one sample standard deviation, ceteris paribus (-3.87 years, $p < 0.001$). There are a few rationales for this observation. For one, households may transfer resources away from girls towards boys in the household as discussed in Section 2.1, but the empirical results do not seem consistent with this hypothesis since we would expect to see a negative coefficient on the gender ratio variable too if this explanation were valid. It is also possible that older brothers get married and bring their respective wives into the household, whom assist with domestic chores and childrearing, thereby allowing parents to marry their own daughter off sooner than if there were no daughter-in-law present. Further research would be necessary to confirm or reject

either of these explanations for the observed large, negative effect of an older brother on a girl's marriage age.

The results of column (2), which uses an indicator variable for first-born daughter and an indicator for last-born daughter instead of BK's continuous birth order index, mainly serve to confirm the results from column (1). Holding girl- and household-characteristics constant, first-born daughters tend to marry 0.52 years (6.2 months) earlier than their middle-born sisters. There is no evidence that last-born sisters marry any earlier or later than middle-born sisters. Interestingly enough, the coefficient on the continuous variable for number of girls in households is negative and statistically significant in column (2), which tends to support the hypothesis that there is a quantity-quality tradeoff among girls in the same household. However, this same coefficient was not significant in the previous specification using the birth order index, adding to the on-going debate in existing literature of whether the quantity-quality tradeoff persists once controlling for birth order of children within the family (see Booth and Kee, 2009; Black, Deveraux, and Salvanes, 2005). Other control variables coefficients are robust across the two specifications in columns (1) and (2).

Column (3) includes household fixed effects in lieu of the vector $\boldsymbol{Y_j}$ of household-specific controls. The magnitude of the coefficient on the birth order index is much higher yet still statistically significant compared to the coefficient in the model without fixed effects (2.19 years, $p < 0.001$). This indicates that the model in column (1) may exhibit omitted variable bias that is causing an underestimate of the marginal effect of an increase in birth order on marriage age. Indeed, the Hausman test rejects the null that that the non-fixed effects model is preferable.

5.1.2 Dowry-level

The birth order effect on dowry-levels are less conclusive compared to those seen in the marriage age results. Table 5.2 shows the OLS and FE estimates of the effect of birth order on dowry-levels converted to current USD. Dowry is measured as the cost of all cash and non-cash gifts exchanged from the girl's family to the groom's family at time of marriage. The birth order index suggests that a marginal increase in a girl's birth order increases her dowry, however this effect is not statistically significant (47.57 USD, $p > 0.05$). Including indicators for first- and last-born daughter in column (2) or fixed effects as shown in column (3) reverse the apparent relationship between birth order and dowry, suggesting omitted variable bias or measurement error in dowry data.

Table 5.2. OLS and FE estimates of birth order effects on reported dowry-levels for household with at least one girl ages 10-21 at start of surveying, measured in USD. Standard errors show in parenthesis.

	(1)		(2)		(3)	
	OLS, girl-specific birth order index		OLS, first & last-born indicators		FE, girl-specific birth order index	
Birth order index, girl-specific	47.57	(35.23)			-33.23	(63.88)
Is first born daughter, 1=yes			-8.333	(23.26)		
Is last born daughter, 1=yes			-338.6*	(151.9)		
Age gap to next youngest sibling	8.381	(4.682)	9.077	(4.676)	16.56*	(6.988)
Age at start of surveying	-69.62***	(7.635)	-70.58***	(7.620)	-65.08***	(14.34)
Age squared	1.086***	(0.157)	1.079***	(0.157)	0.981***	(0.229)
Girl's education, years incomplete	-11.44***	(3.307)	-11.31***	(3.306)	-14.72*	(5.807)
Num. children in hh.	-19.97**	(6.852)	-19.85**	(7.353)		
Has older brother, 1=yes	234.6	(307.9)	221.5	(307.6)	217.2	(409.1)
Has younger brother, 1=yes	-96.78**	(32.34)	-448.7**	(150.5)	-94.59*	(41.66)
Has older step-sibling, 1=yes	38.81	(40.36)	29.61	(40.99)		
Gender ratio, boys/girls	30.86	(15.93)	23.35	(15.10)		
Num. girls attending empowerment	57.40***	(12.23)	57.33***	(12.24)		
Num. girls receiving oil incentive	51.87*	(22.95)	52.60*	(22.93)		
Father age at start of surveying	-2.004	(1.747)	-1.772	(1.745)		
Father primary (grades 1-8), 1=yes	109.7***	(19.79)	111.0***	(19.78)		
Father secondary (grades 9-12), 1=yes	127.2***	(30.02)	129.1***	(30.02)		
Father postsecondary, 1=yes	273.0***	(54.98)	275.0***	(54.98)		
Mother age at start of surveying	0.218	(2.326)	0.812	(2.302)		
Mother primary (grades 1-8), 1=yes	38.47*	(19.29)	37.68	(19.29)		
Mother secondary (grades 9-12), 1=yes	217.6***	(55.03)	213.0***	(55.04)		
Mother postsecondary, 1=yes	-62.23	(212.1)	-67.07	(212.1)		
Hh. has grandparents living-in, 1=yes	54.55**	(21.02)	53.36*	(21.03)		
Hh. believes girl should wear veil, 1=yes	-100.3**	(32.63)	-100.3**	(32.63)		
Hh. has electricity, 1=yes	60.69**	(19.96)	61.68**	(19.95)		
Village has a main road, 1=yes	55.63**	(17.65)	56.61**	(17.65)		
Constant	1,118.8***	(313.6)	1,509.9***	(345.6)	1,037.3*	(439.8)
Household fixed effects?	**No**		**No**		**Yes**	
N	**5,106**		**5,106**		**5,106**	
Adjusted R-squared	**0.170**		**0.170**		**--**	

Note: * $p < 0.05$ ** $p < 0.01$ ***$p < 0.001$

5.2 Next-youngest brother and sister comparison

Columns (1) and (2) of Table 5.2 show the OLS estimates of the effect of having a younger sister on a girl's marriage age and dowry level, and columns (3) and (4) show logistic regression odds-ratio estimates of the effect of younger sister on a girl's likelihood of ever being married and likelihood of migration out of her natal household.

Holding girl- and household-specific characteristics constant, having a younger sister reduces a girl's marriage age by 0.54 years or approximately 6 months ($p < 0.01$) compared to having a younger brother. The sample average among girls in with younger brothers is 16.76 years with a standard deviation of 3.2 years, thus having a younger sister would on average reduce a girl's marriage age to 16.22, a less-than-one standard deviation decreases. The coefficient on the age gap variable is also positive and significant (0.108 year, $p < 0.01$), as predicted in Section 3. This result suggests increasing the age distance between siblings allows parents to incur costs more smoothly over time and keep an older daughter in the household longer. The interaction term between gender and age of next-youngest sibling is not significant, meaning there is not marginal effect of having a younger sister versus a younger brother of an increase in the age gap on marriage age.

All else equal, younger sisters reduce a girl's dowry-level by 147 USD ($p < 0.01$), compared to young brothers, a relatively small magnitude compared to mean dowry-level of $509 and standard deviation of $716 for girls with younger brothers. Girls with younger sisters are 1.129 ($p > 0.05$) and 1.319 ($p < 0.05$) times more likely to be ever-married and to migrate out of the natal household, respectively. My results confirm that likelihood of migration is a decent

proxy for onset of marriage for adolescent girls; however, future research should bear in mind that the likelihood of migration may overestimate likelihood of marriage, as seen in columns (3) and (4) of Table 6.2. This overestimate is likely to persist as opportunity for jobs and education in urban areas continue to become more accessible for girls in Bangladesh (Kabeer, 2007). Although the gender of a younger sibling plays a role in determining a girl's marriage age, the demographics of a girl's *older* siblings does not appear to matter as the coefficients on the indicators for has older brother, has older sister, and has older step-sibling are not statistically different from zero.

Table 5.3. Younger sister effects on marriage age, dowry, ever-married likelihood, and migration likelihood for girls ages 10 to 21 at start of surveying. Standard errors shown in parenthesis. Odds ratios reported for logistic regression estimates.

	(1) Marriage Age		(2) Dowry-level (USD)		(3) Ever Married		(4) Migrated Out of Household	
Mean among girls with next-younger brother	**16.759**	**(3.243)**	**508.5**	**(716.0)**	**0.726**	**(0.446)**	**0.698**	**(0.459)**
Gender of next youngest sibling, 1=female	-0.543**	(0.190)	-146.6**	(44.83)	1.129	(0.136)	1.319*	(0.161)
Age gap to next youngest sibling	0.108**	(0.0376)	-4.491	(8.396)	0.959	(0.0229)	0.955*	(0.0222)
Interaction sex and age of next youngest sibling	0.0430	(0.0477)	25.38*	(10.99)	0.974	(0.0288)	0.965	(0.0283)
Age at start of surveying	1.667***	(0.129)	171.5***	(31.99)	1.797***	(0.141)	2.334***	(0.186)
Age squared	-0.0486***	(0.00413)	-6.707***	(1.055)	0.983***	(0.00249)	0.975***	(0.00251)
Girl's education, years incomplete	-0.143***	(0.0167)	-15.19***	(4.087)	1.008	(0.0105)	1.014	(0.0109)
Has older sister, 1=yes	4.140	(3.023)			5.294	(7.509)	4.028	(5.719)
Has older brother, 1=yes	1.178	(2.132)	-49.44	(649.6)	5.148	(4.749)	4.128	(3.827)
Has older step-sibling, 1=yes	0.252	(0.211)	68.68	(51.11)	1.171	(0.162)	0.820	(0.115)
Gender ratio, boys/girls	0.103	(0.0624)	29.90*	(14.32)	1.204***	(0.0526)	0.948	(0.0385)
Num. girls attending KK empowerment	0.320***	(0.0590)	55.17***	(14.12)	1.016	(0.0373)	0.869***	(0.0325)
Num. girls receiving oil incentive	0.189	(0.112)	54.42*	(26.81)	1.041	(0.0758)	0.986	(0.0714)
Father age at start of surveying	-0.0222**	(0.00837)	-3.967	(2.055)	0.986**	(0.00508)	1.004	(0.00538)
Father primary (grades 1-8), 1=yes	0.152	(0.0952)	116.5***	(22.96)	0.970	(0.0603)	0.854*	(0.0544)
Father secondary (grades 9-12), 1=yes	0.199	(0.150)	167.8***	(36.16)	0.778**	(0.0701)	0.581***	(0.0527)
Father postsecondary, 1=yes	0.137	(0.290)	316.8***	(66.74)	0.750	(0.118)	0.688*	(0.111)
Mother age at start of surveying	0.0164	(0.0111)	-2.949	(2.686)	0.988	(0.00667)	0.991	(0.00691)
Mother primary (grades 1-8), 1=yes	0.328***	(0.0935)	49.27*	(22.50)	0.757***	(0.0458)	0.762***	(0.0470)
Mother secondary (grades 9-12), 1=yes	1.000***	(0.279)	238.2***	(63.90)	0.499***	(0.0723)	0.631**	(0.0923)
Mother postsecondary, 1=yes	-2.496*	(1.074)	-140.8	(246.4)	0.255**	(0.120)	1.043	(0.533)
Hh. has grandparents living-in, 1=yes	-0.0424	(0.105)	63.69*	(25.93)	1.092	(0.0727)	0.948	(0.0631)
Hh. believes girl should wear veil, 1=yes	-0.0815	(0.148)	-115.5**	(35.86)	1.054	(0.0957)	0.901	(0.0853)
Hh. has electricity, 1=yes	0.391***	(0.0987)	76.91**	(23.91)	0.842**	(0.0509)	0.727***	(0.0439)
Village has a main road, 1=yes	-0.158	(0.0858)	61.04**	(20.68)	1.094	(0.0600)	0.938	(0.0518)
Constant	-2.108	(3.805)	-197.1	(688.1)	0.00298	(0.00533)	0.000476	(0.000855)
N	**5,497**		**4,381**		**7,773**		**7,773**	
Adjusted or pseudo R-squared	**0.104**		**0.129**		**0.0293**		**0.0515**	

Note: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$. Adjusted R-squared reported for OLS estimates in columns (1) and (2) and pseudo R-squared reported for logistic regression odds-ratio estimates in columns (3) and (4).

6. Conclusions

I use survey data from a girl's empowerment field experiment conducted in six-subdistricts of Bangladesh to assess the effect of birth order and younger sisters on marriage age for girls ages 10-21 at start of surveying. Existing literature on sibling competition is largely limited to studying the effects on a child's educational or labor market outcomes. However, for adolescent girls in Bangladesh and other of parts of the developing world, onset of marriage is arguably an equally important aspect of a girl's well-being and her future welfare (UNICEF, 2014). Furthermore, certain cultural practices in marriage market of Bangladesh, such as dowry-giving and the tradition of marry daughters in sequence of birth, cause differences in returns to investment between boys and girl and also among sisters. Thus, marriage age and marriage-related outcomes should not be neglected in studies of the inter-household allocation decisions.

In cases where marriage outcomes have been the focus of birth order studies, the empirical analysis has been limited to dependent variables that approximate onset of marriage, for instance since the majority of married women in Bangladesh reside with their in-laws, a girl's likelihood of migrating out of her natal household is used as a proxy for likelihood of marriage (Vogl, 2013). The nature of the girl's empowerment field experiment allows me to specify a model using a continuous marriage age variable as the dependent variable, thereby contributing to the body of existing literature in a novel and meaningful manner. Results are consistent with existing literature: girls with younger sisters are married-off sooner than girls with younger brothers and an increase in girl's birth order tends to increase marriage age, all

else equal. Effects are robust across a number of different specifications. However, the inconclusive results from the analysis of dowry-levels highlight the need for accurately-reported and representative data on dowry-levels in order to minimize measurement bias and further understand patterns in household resource allocation and their relationship to the well-being of adolescent girls.

My results strengthen the body of evidence that differences in children can cause parents to invest or allocate resources unequally among children, which is important to keep in mind for the purposes of future economic research and policymaking. For instance, though the oil incentive arm of the girls' empowerment field experiment was shown on average to delay onset of marriage among girls ages 10-17, it is unknown how the oil incentive differentially impacted girls within the same household. In order words, the results presented in this paper suggest that the income elasticity of marriage age might be different across sisters of the same household. To the extent that interventions and policies aimed at lowering household fertility rates, curbing the practice of dowry, and increasing marriage age and inheritance rights of girls are increasingly common in Bangladesh and other countries in the developing world, understanding these sources of household heterogeneity will be important for determining the marginal effectiveness of these policies.

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