All for One? Family Size and Children's Educational Distribution Under Credit Constraints

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Economists have been examining parents' decisions about their offspring's education in the context of "quantity-quality tradeoff" (e.g., Angrist, Lavy and Schlosser 2010) or "birth order effects" (e.g., Black, Devereux and Salvanes 2007). This paper contributes to both literatures by examining the possibility that a child's schooling can be increased by having more siblings, instead of being diminished by competition for parents' resources, as has been suggested in most of the literature. Specifically, parents unable to borrow or self-finance their children's education may rely on some of their older children's labor income as a source of funding. Then the child(ren) selected for education will benefit from having more siblings who support him/her (them). This implies that the relationship between family size and education, and the relationship between birth order and years of schooling may be systematically different across families depending on their access to assets and borrowing resources.

We first examine these relationships in a model combining convex returns to education and credit constraints. Our model predicts correlations among family size, years of schooling and birth order, which would not exist when either of these two elements is absent. In particular, for credit constrained parents, our model predicts a positive correlation between family size and educational level of the most educated child. It also predicts that the schooling of a child will be positively correlated with his/her birth order as well as with the fraction of female siblings (for males) when gender-biased norms exist. However, we show that these relationships weaken or disappear for parents with larger assets.

Second, we examine the model implications using datasets from the U.S., Mexico, and South Korea (herein Korea). These countries are chosen not only because they have data on educational attainment of all adult children in a family but also because they are at

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different stages of development and have different cultural norms. We expect that the model implications generated by credit constraints will be more pronounced among low income families within a country and also more pronounced in low income countries (Mexico and Korea) than in more developed ones (the U.S.). Gender-related predictions will also be more pronounced in Korea, which is known for its son preferences. We find the empirical results to be consistent with our model predictions. Although we do not rule out the possibility that an alternative model may generate some of the empirical patterns this paper documents, it would be challenging to account for all systematic relationships between parents' income and intra-family educational allocation using alternative hypotheses.

Apart from those cited above, our paper is related to various existing studies. Tenikue and Verheyden (2010) examine cross-sibling transfers to understand children's schooling in Sub-Saharan Africa. Our paper is different from theirs in that we examine the role of family size and birth order in schooling, while they focus on birth order effects within a family. Furthermore, we allow for gender-based schooling choice, and test the model implications in the samples of those who completed their schooling decisions and from countries that have very different socioeconomic settings. Murdoch (2000) presents evidence that having more sisters can increase men's years of schooling in Africa, which can be explained by our model and empirical evidence. Behrman, Pollak and Taubman (1989) examine the possibility that a large family may face lower costs of education because of sibling-based policies. Their mechanism is distinct from ours because the former does not explain the differential impact we observe by father's education nor by birth order. Finally, our paper contributes to the studies exploring intrafamily distribution of resources to support elderly parents (e.g., Raut and Tran 2005), in that this paper suggests the same kind of intrafamily decisions could be made at an early stage when families decide children's schooling.

1 Model

Assume parents j with n_j number of children value their children's schooling using:

$$W = \sum_{k=1}^{n_j} \left(h(S_{kj}) - (1 + c_{kj}) S_{kj} \right),$$

where k denotes birth order (that is 1 for the eldest child, and n_j for the youngest), S_{kj} denotes years of schooling of the kth, c_{kj} is an idiosyncratic utility cost of schooling that is assumed independent of birth order.[2] Function h governs the returns to schooling, assumed such that $h(0) = 1$, $h' > 0$ and $h''(S) > 0$ for any $0 \leq S < a$ and $h'' < 0$ for any $S \geq a$. Define b as the point where $\frac{h(b)-1}{b} = h'(b)$. This altogether implies that for any $S \leq b$, the elasticity of the function $h()$ is greater than 1 while for any point such that $S > b$, the elasticity is less than 1.

Parents cannot borrow to finance the education of their children. The monetary cost of schooling, normalized as 1 per unit, must be financed out of parental assets A_j and labor earnings of siblings working as youth at a wage rate of w_k when they are not attaining the maximum education level $\bar{S}$. The wage rate is assumed to decrease in birth order.[3] Then the budget set is:

$$\sum_{k=1}^{n_j} S_{kj} \leq A_j + \sum_{k=1}^{n_j} w_k (\bar{S} - S_{kj}).$$

Unconstrained parents will select S^*_{kj} such that $h'(S^*_{kj}) = 1 + c_{kj}$. When parents are credit constrained, the first- and second-order conditions ensure that for any two children k and k', receiving a positive education, we must have $h''(S_{kj}), h''(S_{k'j}) < 0$,

$$\frac{h'(S_{kj}) - (1 + c_{kj})}{1 + w_k} = \frac{h'(S_{k'j}) - (1 + c_{k'j})}{1 + w_{k'}}, \tag{1}$$

[2] While there is evidence that IQ and birth order are positively correlated, this does not appear to be linked to innate ability but more to posterior investments made by parents. See Black, Devereux and Salvanes 2007.

[3] We consider this assumption justifiable in the cases where older children are more productive at work due to physical strength than their younger siblings.

and that the monetary cost of their education is equal to resources:

$$\sum_{k=n_j}^{n_j} S_{kj}(1+w_k) = A_j + \bar{S}\sum_{k=1}^{n_j} w_k.$$

Proposition 1 *Depending on asset level, parents' schooling decision follows one of the three regimes: (1) For assets above $A^*(n_j)$, parents are unconstrained and select S^*_{kj} such that $h'(S^*_{kj}) = 1 + c_{kj}$. (2) For parents with assets below $A^*(n_j)$ but above $\tilde{A}(n_j)$, all children receive a positive investment driven by the first-order conditions* (1)*(3) For parents with assets below $\tilde{A}(n_j)$, at least one child acquires no schooling.*

Proof. This first regime occurs when the restriction is not binding, which occurs when assets are at least as large as $A^*(n_j) = \sum_{k=1}^{n_j} S^*_{kj} - w_k(\bar{S} - S^*_{kj})$. Define $\tilde{A}(n_j)$ as being the asset level at which parents are indifferent between educating all children or spending all their resources on a $n-1$ of them. Consider family j who is indifferent between educating $n_j - 1$ or n_j children when it has asset $\tilde{A}(n_j)$. A slightly higher level of assets will enable them to increase the schooling investments of their children and given that all children who receive positive education level must, by the second order condition, fall into the range where the returns to schooling are concave, it will always be optimal to continue educating all children. For parental assets below $\tilde{A}(n_j)$, it can also be easily shown that even pooling all resources into a subset of children may not be sufficient to offer $S > b$ to these children, thus making it clearly optimal to invest in fewer children as assets decrease. ■

Now we examine the role of family size, birth order, and gender in our model.

Family size: In families with assets lower than $\tilde{A}(n_j)$, the most educated child in a family will benefit from having more siblings since their labor earnings will finance her schooling. However, for parents with assets between $\tilde{A}(n_j)$ and $A^*(n_j)$, having an additional sibling will penalize the most educated child as more siblings imply more competition for scarce resources. Finally, family size will be irrelevant for non-credit constrained parents.

Birth order: In wealthy families, investment is independent of birth order since it depends only on the idiosyncratic cost of education. However, for credit-constrained parents, higher birth order children (i.e., younger ones) will be favored for schooling because wages are assumed to decrease in birth order (see eq. (1) for the relationship between schooling and wage).

Gender: Suppose that the opportunity cost of educating a girl is higher than that of a boy. For example, this condition would be satisfied in our model if females can earn a sufficiently higher wage when young or have to pay a higher utility cost to attend school ($w_{kj=girl} > w_{kj=boy}, c_{kj=girl} > c_{kj=boy}$). If parents are unconstrained, having an additional female sibling instead of a male sibling will have no impact on that child's educational investment. In the case where parents are borrowing constrained but still are able to offer a positive educational investment in all children, having a female sibling will relax the parental borrowing constraint and offer male siblings more resources for their education. This pattern will be even more marked at lower levels of parental assets.

2 Empirical Strategy and Data

We empirically test the relationship between family size (n_j) and the years of schooling of the most educated child in a family (y_j) as follows:

$$y_j = \alpha n_j + \beta A_j + \gamma n_j * A_j + \rho X_j + \varepsilon_j,$$

where A_j is proxied with the father's educational attainment. Our model suggests that $\alpha > 0$ but $\gamma < 0$; that is, for low income families, family size has positive impact on the most educated child's schooling but that impact decreases as A_j increases. Additional control variables (X_j) include the cohort of the first child born interacted with A_j to capture differential schooling trends over time by father's educational level.

Next we use the following equation to examine the birth order effect:

$$y_{kj} = \alpha k + \beta A_j + \gamma k * A_j + \rho X_{kj} + \varepsilon_{kj}, \tag{2}$$

where y_{kj} measures the educational attainment of the k^{th} birth order child in family j, and X_{kj} includes a gender dummy in addition to the controls mentioned previously. Our model suggests that $\alpha > 0$ but $\gamma < 0$. Note that standard errors are clustered at family level. Finally, to study the gender effect, we examine not only birth order but also siblings' gender composition within a similar framework.

We empirically test our model implications using the national surveys of the elderly in the U.S., Korea, and Mexico. We use the "1993 Asset and Health Dynamics Among the Oldest Old (AHEAD)" for the U.S., the "2006 Korean Longitudinal Study of Aging" for Korea, and the "2001 Mexican Health and Aging Study" for Mexico, as they provide detailed information of the elderly respondents and their adult children. We use a subsample of families with more than or equal to two children to focus on educational choices across multiple children. We also restrict the sample to fathers aged over 50 or more in the case of Korea and Mexico so that the children are likely to have completed their education (the U.S. data included only fathers aged 70 and over).

Sample statistics show that the U.S. has the most educated fathers (11 years of schooling), followed by Korea (8 years), and then Mexico (5 years). However, in terms of children's education and family size, the U.S. and Korea are comparable to each other (13.5 years and 3.5 children), but Mexico on average has 9.5 years of schooling for children and 6 children per household. Using the difference between the average educational attainment of girls versus boys as an indication of gender-specific opportunity cost, we find that parents face higher costs of educating girls in Korea, followed by Mexico and then the U.S.

3 Results

Table 1 shows the relationship between family size and the maximum educational attainment of the children within a family. For our analysis, we classify fathers into four categories based on their highest degree: no degree from formal schooling (baseline group), primary, secondary (middle or high school), and tertiary. In Mexico and Korea, having more siblings is positively correlated with the years of schooling of the most educated child when their fathers have no formal degree, but that relationship weakens as the father's education increases. The U.S. data shows no significant relationship, which is to be expected because it is more developed than the other two countries and thus credit constraints are less marked. Note that a positive correlation between family size and maximum years of schooling within a family can be the product of a simple statistical property where outliers are more likely in larger samples. However, this alternative explanation cannot justify the difference across fathers' educational attainments that we document, nor why we do not observe this pattern in the U.S.

Table 2 presents the correlation between birth order and a child's years of schooling (columns labelled as "Yrs. ed.") and the likelihood of a child to get the highest schooling in his/her family (columns labelled as "Most ed."). In all countries, fathers with no formal education educate a child more than his/her adjacent older sibling by 0.2 to 0.7 years. This birth order effect is reduced for fathers with more education. For fathers with tertiary education, the effect remains negative only in the case of Korea, while in Mexico and the U.S., it becomes positive as has been shown for Nordic countries (Black, Devereux and Salvanes, 2005). A similar pattern is observed in terms of whether a child is the most educated in their family.

Next, we test whether in contexts where the opportunity cost of educating a girl is higher than that of a boy, a male from a poor family will benefit from having more sisters than brothers since these sisters would be likely to contribute to their education. We use a strategy similar to Vogl (2013): conditional on the number of younger siblings an individual has, the gender composition of the younger siblings is close to being random.[4] Table 3 presents the results for males and females separately. We find evidence that men benefit from having a higher fraction of younger female siblings in Korea, and that this benefit decreases as fathers are more educated. Females do not appear to suffer or benefit from having a different gender

[4]Our model would also suggest that the gender composition of older siblings would matter, but we do not use this variation in our regression analysis since that measure is likely to be biased in front of any gender-related stopping rule or sex-selective abortion.

composition among their younger siblings. We find no pattern in either Mexico or the U.S., although the signs in the U.S. are consistent with the Korean example but much noisier.

Finally, while our model assumes that parents make all schooling decisions, it is likely that children will eventually also participate in this decision. Adding this to our model requires that children who sacrifice their education for the benefit of their siblings be compensated accordingly. While we do not observe transfers between siblings, we do measure transfers made from children to their elderly parents. Children who benefited from the investment of their siblings could thus compensate them by contributing more heavily to the care of their parents once they require assistance. We have explored this possibility in the case of Korea and find that a child who is from a poor family and receives the most education within his/her family has a much higher probability of making transfers to the parents and the transfers are likely to be larger. Children from wealthy families do not appear to display this pattern.

4 Conclusions

This paper develops a simple model where convex returns to education and credit constraints make siblings potential allies to obtain higher returns instead of competing for parent's investments. We also show that in a context where gender discrimination is high, female siblings may be particularly helpful to boys. The model implications are consistent with empirical patterns observed in the U.S., Mexico, and Korea.

Our model has an important policy implication: in an environment where returns to education are sufficiently convex, a policy that restricts family size may lead to unintended adverse consequences. Suppose that the children selected for schooling compensate their siblings for their sacrifice through transfers when they are grown up. Then a fertility restriction policy may impede this type of intra-sibling arrangement among poor families and potentially harm all children, including those who would have worked for their siblings' schooling but get paid back later in life.

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Table 1: Family size and education level of the most educated child

	Korea	Mexico	U.S.
n_j	0.372***	0.239***	-0.033
	(0.050)	(0.042)	(0.168)
n_j*Primary	-0.190***	-0.316***	0.052
	(0.069)	(0.052)	(0.174)
n_j*Secondary	-0.262***	-0.382***	0.046
	(0.072)	(0.092)	(0.171)
n_j*Tertiary	-0.347***	-0.228*	0.142
	(0.123)	(0.131)	(0.175)
N	4,494	4,894	2,218

All regressions include dummies for father's educational attainment and the year the first child was born interacted with the educational category of the father.*: 10% significance, **: 5% significance, ***: 1% significance

Table 2: Birth order(k) and educational attainment

	Korea (N=15,778)		Mexico (N=26,861)		US (N=7,926)	
	Yrs. ed.	Most ed.	Yrs. ed.	Most ed.	Yrs. ed.	Most ed.
k	0.741***	0.106***	0.293***	0.024***	0.186**	0.039***
	(0.032)	(0.005)	(0.019)	(0.003)	(0.078)	(0.012)
k*Primary	-0.265***	-0.028***	-0.235***	-0.014***	-0.142	-0.031**
	(0.043)	(0.007)	(0.026)	(0.003)	(0.090)	(0.014)
k*Secondary	-0.456***	-0.062***	-0.525***	-0.051***	-0.231***	-0.060***
	(0.044)	(0.007)	(0.044)	(0.005)	(0.082)	(0.013)
k*Tertiary	-0.519***	-0.074***	-0.767***	-0.096***	-0.294***	-0.092***
	(0.053)	(0.011)	(0.068)	(0.009)	(0.083)	(0.014)

All regressions include dummies for father's educational attainment and the year the first child was born interacted with the educational category of the father. Standard errors clustered at the level of the family. *: 10% significance, **: 5% significance, ***: 1% significance

Table 3: Siblings' gender and education

	Korea		Mexico		U.S.	
	Males	Females	Males	Females	Males	Females
% females	0.646**	0.020	-0.358	-0.072	1.502	0.466
	(0.295)	(0.286)	(0.294)	(0.299)	(1.027)	(1.196)
% females*Primary	-0.465	-0.104	0.623*	0.072	-0.991	-0.894
	(0.354)	(0.342)	(0.346)	(0.351)	(1.112)	(1.263)
% females*Secondary	-0.740**	-0.002	0.577	-0.002	-1.550	-0.542
	(0.324)	(0.317)	(0.448)	(0.449)	(1.041)	(1.206)
% females*Tertiary	-0.467	0.063	0.649	0.456	-1.425	-0.636
	(0.331)	(0.361)	(0.459)	(0.519)	(1.049)	(1.212)
N	5,558	5,726	8,741	8,616	2,891	2,905

All regressions include dummies for father's educational attainment and the year the first child was born interacted with the educational category of the father. Standard errors clustered at the level of the family. *: 10% significance, **: 5% significance, ***: 1% significance