EFFECTS OF SIBSHIP STRUCTURE REVISITED:

EVIDENCE FROM INTRA-FAMILY RESOURCE TRANSFER IN TAIWAN[1]

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Abstract

Numerous studies have consistently found negative effects of sibship size on educational outcomes. Three main explanations of these effects have been offered in the literature: (1) dilution of family resources, (2) a changing intellectual environment in the family for each succeeding sibling, and (3) unobserved selectivity at the family level. In this paper, we propose a fourth explanation as an extension of the resource dilution hypothesis: in a traditional or transitional society where resources from all family members are pooled together, families may sacrifice the educational opportunities of older (female) siblings and use their remittance to compensate the family expenses, particularly when there are younger siblings. With analyses of data from the Panel Study of Family Dynamics (PSFD), we find empirical evidence in support of this explanation. In particular, we find that the negative effects of sibship size are the strongest for girls with younger brothers and sisters *spaced apart* from them. We interpret this unusual high-order interaction involving sibship size, gender, density, and seniority within the context of Taiwan's patriarchal culture, in which families typically favor boys over girls.

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A large body of literature has been devoted to the study of the relationship between the number of siblings—"sibship size"—and educational attainment (e.g., Blau and Duncan 1967; Blake 1989; Steelman et al. 2002). A well-accepted finding in the literature is that, at least for the United States and Western Europe, sibship size has been consistently found to be negatively associated with educational attainment. This negative relationship between sibship size and educational attainment is so strong that it has been called "inarguable" (Kuo and Hauser 1997, p.73) and "virtually unequivocal" (Steelman et al. 2002, p.248).

Interpretation of causal mechanisms underlying this empirical pattern, however, is still subject to debate. The current literature contains three main explanations: (1) dilution of family resources (e.g., Blake 1981, 1989); (2) a changing intellectual environment for each succeeding sibling (Zajonc and Markus 1975); and (3) unobserved selectivity at the family level (e.g., Guo and VanWey 1999). While the first and third explanations only postulate sibship size effects but not birth order effects, the second explanation implies a particular pattern by birth order. All three explanations are silent on the issue of a potential gender asymmetry. The first explanation also suggests that the negative effects of sibship size are particularly acute when siblings are spaced *closely* because resource pressure is more severe when several siblings enter schools at about the same time.

In this paper, we propose a fourth explanation as an extension of the resource dilution hypothesis: in a traditional or a transitional society where resources from all family members are typically pooled together, families may sacrifice the educational outcomes of older, usually female, siblings. These older children join the labor market earlier and remit some of their resources to relax the family budget constraint, which in turn may improve the educational outcomes of younger siblings. Our explanation is based on a combination of three observations. First, family resources are not necessarily fixed and exogenous to the education of children. That is, family resources may include contributions of unmarried children in young adulthood. Second, in some Asian countries with a strong patriarchal culture, family resources may be directed disproportionately towards the education of boys rather than that of girls. Third, for intra-family transfer of resources to impact the educational outcomes of children in a family, it is necessary that children be spaced *apart* rather than following one another in close succession. Thus, contrary to the common wisdom in the literature based on the United States and Western Europe, which describes virtually no birth order or sex composition effects (Ernst and Angst 1983; Hauser and Kuo 1998), we postulate high-order interaction effects of number, gender, density, and seniority of siblings.

The context of our empirical work is post-war Taiwan. By analyzing recent data from the Panel Study of Family Dynamics (PSFD), which includes roughly 4,000 respondents from cohorts born between 1934 and 1976 (inclusive), we find empirical evidence in support of our proposed explanation. In particular, we find that the negative effects of sibship size are the strongest for girls who are spaced apart from their younger siblings, to whom the former could provide potential support. We interpret this unusual high-order interaction involving sibship size, gender, density, and seniority in the context of Taiwan's patriarchal culture, in which families favor boys over girls.

Theoretical Issues

Prevailing Explanations for Sibship Size Effects

The current literature contains three prevailing explanations for the negative association between sibship size and educational outcomes. The dominant explanation is the resource dilution hypothesis (Blake 1981, 1989). This explanation assumes a fixed total amount of family resources, both emotional and material. Thus, the family resources allocated to each child necessarily decrease as an inverse function of the number of children in the family. Only sibship size, not birth order, is assumed to matter.

Downey's (1995) work shows that some family resources, such as economic resources set aside for children's education, follow this predictable decreasing pattern of 1/x, where x is the number of children. However, other resources, such as computer availability, follow a threshold pattern in which the number of children no longer has a negative effect beyond a certain threshold. If a family's economic resources are diluted due to the need to support multiple children, it follows that the dilution constraint is greater when children are spaced closely than when they are further apart, as those children spaced closely enter college and need economic support from parents at about the same time. This is exactly what Powell and Steelman's (1990, 1993) research has found. Their work on the particularly acute negative effects of sibship size when siblings are closely spaced lends strong empirical credence to the resource dilution hypothesis.

Zajonc and Markus (1975) offer a competing hypothesis which they call "confluence" theory. According to this theory, the intellectual environment of the family for a particular child is construed as the averaged combination of parents and all siblings. Parents are assumed to be intellectually superior; the addition of children serves to lower the average intellectual quality, which explains the negative association between sibship size and educational outcomes. This theoretical model is dynamic in that a family's intellectual environment changes when new children are born into the family. As a result, early-born children are less affected by the total sibship size than late-born children, as the former have lived in a family environment with fewer children, which means a higher average intellectual environment, before the later children were born. Clearly, this theory predicts not only sibship size effects but also birth order effects. Finally, Zajonc and Markus (1975) also hypothesize that older children benefit from teaching younger children. This teaching function seems to account for two specific findings in their data: (1) singletons do worse than first-born children in sibship size two; and (2) last-born children seem to be particularly handicapped.

Despite the apparent elegance of the confluence theory, it has faced some serious criticisms (e.g., Retherford and Sewell 1991). The most serious problem with the theory is that decades of empirical research do not seem to support the notion that birth order, net of sibship size, affects education outcomes (Ernst and Angst 1983; Hauser and Sewell 1985). However, it is possible that Zajonc and Markus's (1975) confluence model is too narrowly focused on intellectual environment. In a traditional or transitional society, such as Taiwan, where children's *economic* resources are pooled together, we may find that older siblings do influence the educational outcomes of younger siblings. We will turn to the possibility of this type of "confluence" below.

The third prevailing explanation in the literature is simply the possibility that both sibship size and educational outcomes result from unobserved factors at the family level. If this is true, the negative association between sibship size and educational outcomes are spurious but not causal. One possibility, for example, is that parents who do not place a high value on the "quality" of their children's lives may end up having many children *and* not investing much in their education. In this hypothetical scenario, the parents would not necessarily improve the educational outcomes of their children even if they were to have fewer children and thus have extra resources (say through an extraneous shock such as infertility). This view is well represented by Guo and VanWey's (1999) study, which tests the hypothesis of family-level unobserved heterogeneity by constructing a fixed-effects model in which the addition of new children is found not to affect the cognitive skills of other children. Critics of Guo and VanWey's study point out (1) its narrow focus on cognitive skills, whereas the literature on sibship size is concerned with the whole range of educational outcomes; and (2) its research design that necessarily excludes children who are spaced closely -- those children who would suffer most according to the resource dilution model (Downey et al. 1999; Steelman et al. 2002).

Gender Symmetry versus Asymmetry

With only a few exceptions (e.g., Powell and Steelman 1989), previous studies exploring the three prevailing explanations have assumed gender symmetry in their discussions of sibship effects on males and females. The main reason for this practice, of course, is that the existing literature is largely based on data from the United States and Western Europe. In these areas, although women's educational attainment historically lagged behind that of men, this gender gap has now disappeared or even been reversed (Shavit and Blossfeld 1993). Even when women were disadvantaged educationally, this disparity at the societal level did not translate into a sex composition effect of sibship on one's educational attainment at the family level (Hauser and Kuo 1998). In other words, girls in families with no brothers or with many brothers fared similarly—attaining less education than boys overall. However, in a paper written specifically to dispel the notion that sex composition of siblings may affect education attainment, Hauser and Kuo (1998, p.645) explicitly allow for an exception in East Asian countries, "where there is a strong preference for sons."

How does son preference translate into family practices that generate gender inequality in educational outcomes in East Asia? It is *not* merely a matter of parents spending more material resources on sons' than on daughters' education. As Greenhalgh (1985) forcefully argues, and Parish and Willis (1993) convincingly demonstrate, the key to understanding the implications of son preference for gender inequality in a Confucian culture such as Taiwan lies in intra-family resource transfers.

At the risk of oversimplification, let us give a stylized description of the patriarchal family that is typical in East Asian countries under Confucian influence, drawing on the work of Greenhalgh (1985) and Parish and Willis (1993). We realize that a great deal of variability exists in the applicability of this description across individual families and over time (Thornton and Lin 1994). In the traditional Taiwanese family system, sons are permanent members of their natal family and retain life-time contractual relationships with their parents. They are expected to contribute to their parents' economic well-being throughout their adult lives. Thus, it is "rational," or in their self-interest, for parents to invest in sons because they can reap the benefits of the investment over a long period of time. In contrast, daughters are only transitory members of their natal families before their marriage, upon which they move to and contribute to the families of parents-in-laws, though daughters are expected to contribute to their natal family before marriage. Thus, the time during which daughters contribute to their natal family is limited, and education, as human capital, takes time both to occur and to yield a return (Mincer 1974). As a result, parents mobilize resources from daughters, particularly unmarried older daughters, to improve the family budget in general, and sometimes to benefit the educational outcomes of sons. The resources in question are primarily remittances from daughters' market labor but can also be household work, which frees up parents to work longer hours. In Greenhalgh's (1985, p.276) words, "Put baldly, parents' *key strategy* was to take more from daughters to give more to sons and thus get more for themselves."

Close Spacing versus Distant Spacing

The family system depicted above for Taiwanese society and other East Asian countries undermines a basic assumption in the classical resource dilution model, which assumes that family resources available to facilitate children's education are entirely downward, from parents to children, and thus exogenous and fixed with respect to children's educational outcomes. As we described earlier, in a traditional Taiwanese family, unmarried children can directly contribute economic resources to the family by working and thus help fund their family expenses. Although theoretically both daughters and sons could help their siblings' education, daughters' education is usually sacrificed to help their brothers' education.

In the classical resource dilution model, which assumes only downward resource flow, resources are highly constrained when children are spaced closely. Indeed, the finding of Powell and Steelman (1990, 1993) that the negative sibship size effects are most pronounced for closely spaced siblings provides strong support for the resource dilution explanation. However, in the Taiwanese context, we can observe the negative effect of having younger brothers on an older sister's educational attainment only if there is sufficient spacing between her and her younger brothers. That is, economic resources of older daughters can only be diverted to help fund the education of their *much* younger brothers. Thus, contrary to Powell and Steelman's (1990, 1993) claim, we may observe a stronger effect of sibship size when spacing is *far apart* rather than when it is close. Consideration of spacing represents an important improvement of our study over prior work by Greenhalgh (1985) and Parish and Willis (1993).

Seniority Symmetry versus Asymmetry

Given the normative path of education-then-work, resource transfer among siblings usually flows from older siblings to younger siblings. This seniority asymmetry implies a birth order effect: early-born children, particularly daughters, may discontinue education early to work and to fund the education of their younger siblings. There is a large literature based on data from the United States and Western Europe refuting the claim that educational outcomes differ by birth order given sibship size (Blake 1989;

Ernst and Angst 1983; Hauser and Sewell 1985; Steelman et al. 2002). It may seem odd that we are reintroducing a birth order effect for the case of Taiwan.

Our reason for reintroducing a birth order effect is the argument that there is intra-family resource transfer across siblings in Taiwan, in the form of an older sibling supporting a younger sibling. As Parish and Willis (1993) point out, such seniority-based transfers among siblings are particularly sensible when there is no external credit market for investment in education against future earnings. One can view this type of intra-family transfer as a mirror analog of the teaching effect in the confluence model (Zajonc and Markus 1975), which hypothesizes that older siblings benefit from an opportunity to teach younger siblings. However, whereas the teaching effect is assumed to be positive so that the last-born is assumed to be the most disadvantaged by the confluence model, our intra-family transfer model recognizes the disadvantage of the early-born in bearing the burden of supporting younger siblings, and thus the relatively favorable position of the last-born child.

The preceding discussions concerning gender, spacing, and seniority are all intricately and intrinsically interrelated. They are all based on a special feature of the Chinese family. As Parish and Willis (1993, p.866) observe, “One of the best things that can happen to a male, besides being born to rich, well-educated parents, is to have an older sister.” In our model, we suggest that the worse scenario that can happen to a female is “to have much younger siblings.” Thus, in our paper we treat the influences of gender, spacing, and seniority in sibship as *interactive*, rather than additive, effects on educational outcomes.

The Taiwanese Context

Our empirical research is situated in contemporary Taiwan. Let us provide a brief description of the education system in Taiwan before proceeding to data analysis. The Taiwanese education system consists of five main tiers of regular schools: elementary (6 years), junior high (3 years), high school (3 years), college (4 years), and graduate schools, with some supplementary vocational schools. Although various schools used to screen their own students, since 1950 most schools in Taiwan have participated in the

Joint Entrance Examinations (JEE) to select them. Nearly all our sampled respondents are subject to the JEE screening. Before 1968, for the entrance from elementary to junior high, from junior high to high school, or from high school to college, each person needed to go through a respective JEE. The high school to college JEE was nationwide, whereas the others were held in separate districts, within which thousands of students would join the competition. After 1968, mandatory education was extended from six to nine years, and as a result the JEE from elementary school to junior high school was abolished.

In Taiwan, because (a) the training of teachers of all school tiers was monopolized by national normal colleges, (b) the salary scales of teachers and professors were seniority-based, and (c) the university professor licensure was uniformly regulated by the Ministry of Education during most relevant periods of our study; there are not many a *priori* reasons to expect quality differences among school teachers.[2] Moreover, the tuition upper bound of private schools regulated by the government also limits quality improvement. Thus, most parents and students in Taiwan prefer less-expensive public schools and universities over private institutions. The JEE ranks all examinees according to their JEE scores, and higher-scoring examinees are allowed to choose schools (or departments) to enter before lower-scoring examinees do.[3]

The JEE in Taiwan is basically a written exam and thus the criterion for moving up the educational ladder is uniform. Given the above-mentioned rigid JEE system, whether a given student can

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[2] The monopoly of teacher training was finally abolished in 1997 and the uniform professor licensure system was decentralized in 1991, but these recent changes could not have affected the previous decisions of the respondents.

[3] For instance, in the year 2000, 125,498 students registered for the JEE of colleges. The overall entrance rate from high school to college was 59.98%. The most preferred college overall was National Taiwan University, which allowed only 3,244 students to enter. Students whose scores were lower than the rank criterion of the various departments at National Taiwan University had to choose other universities. In the same year, 22,115 students participated in the JEE from junior high to high school in the Taipei area; corresponding figures in other areas are omitted.

enter a higher tier school or college depends on his or her ability as well as the resources (e.g., after-school tutoring) that the student's parents are able to provide. The quantity of such resources depends on the parents' educational background, ethnicity, sex preferences, and budget constraints. For instance, if the parents can only afford to send one child to college, then a child's gender or birth order may play an important role. In short, the rigid structure of Taiwan's education system allows us to directly assess the impact of family inputs.

Data

For this study, we analyze data from the Panel Study of Family Dynamics (PSFD) in Taiwan, a large survey project that we conducted in collaboration with other researchers. This study consists of respondents who were randomly selected based on their birth years. Survey questionnaires were administered via face-to-face interviews. The main respondents were born into three birth cohorts: (1) cohort born within 1934-1954, (2) cohort born within 1953-1963, and (3) cohort born within 1964-1976. These samples were drawn by a stratified three-stage random sampling procedure. First, the 131 counties of Taiwan were stratified according to urbanization levels, and counties were then randomly selected within each stratum. In the second stage, smaller administrative districts (village or equivalent district in urban areas, called "li" in Taiwan) were randomly selected. Finally, in the third stage, individuals were randomly drawn.

The three cohorts of respondents mentioned above were interviewed through the same survey instrument respectively in 1999, 2000 and 2003. In this analysis, we use data from all three of these surveys. The original sample included roughly 4,000 respondents. The questionnaire covered detailed socio-economic information about family members of the interviewed individual as well as their relations with one another. In particular, for each randomly-sampled respondent, information concerning the educational background of almost all of the respondent's siblings was also collected. From the information of the respondent and his (her) siblings, we constructed a family-siblings data set in order to estimate the differential educational achievement among siblings. To analyze the completed education of children in families, the sample was confined to families with individual children aged 25 or above.[4] After deleting observations with missing variables, the final sample consisted of 10,764 children from 2,626 families.

The educational attainment of children was measured by the total number of years of completed education, regardless of type of schooling. For postgraduate schooling, a master's degree was coded as 18 years of education, and a doctoral degree as 22. The average education by sibling size is listed in Appendix Table 1. From this table, we can observe clear evidence that the average educational attainment of male respondents is negatively associated with the number of brothers, and the average educational attainment of female respondents is negatively associated with the number of sisters. However, the effects of cross-sex sibship sizes are much less clear-cut. These preliminary results reveal the complexity of cross-gender sibling effects.

Besides child's schooling, other variables used in the empirical analysis are listed in Appendix Table 2. For analytical purposes, sibship size is further distinguished by gender, seniority and spacing. The operational definition of sibling spacing is based on whether the age difference between siblings is greater than four years. Siblings "spaced closely" is measured by the number of siblings within four years of the subject's age. Otherwise, siblings are defined as "spaced apart."[5]

"Father's schooling" and "mother's schooling" are measured in years of completed schooling, just like "child's schooling." They are included as control variables in the regression models to reflect parents' socioeconomic status. To understand the effect of mother's working status on the children's educational attainment, we construct the variable "mother ever worked," defined as 1 if mother ever

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[4] Since mandatory military service is obligatory for males for at least two years, we choose 25 years of age as the cutoff point for completed education.

[5] The measure for sibling density is not the same as those adopted by Powell and Steelman (1990, 1993). Powell and Steelman define siblings to be closely spaced if the age difference is within two or three years. We also tried measures similar with Powell and Steelman (1990, 1993) and found similar results.

worked in the past, and 0 otherwise. The father's ethnicity is divided into four categories (Fukkien, Hakka, Mainlander and Aborigine), with Aborigine as the reference group. Fukkiens and Hakka are early immigrants from Mainland China, while "Mainlanders" mostly immigrated during the Chinese Civil War in 1945-1949.

The means and standard deviations of the above variables are summarized in Appendix Table 2. It can be found from the table that the average education of males is greater than that of females--11.20 and 10.08 years respectively. Among respondents' parents, father's average years of schooling exceeded those of mother by 2.2 years. Thus, the educational gap by gender had narrowed from the parents' generation to the respondents' generation. Concerning the sibship size, the average number of siblings is about 3.68 and the average number of closely-spaced siblings is comparable to that of apart-spaced ones.

To highlight our key argument, we provide descriptive statistics in Appendix Tables 3a-3c, modeled after Powell and Steelman (1993, Table 1). In this set of tables, we present mean levels of schooling completed (last panel), as well as proportions attaining specific levels of education (other panels), by the total number of siblings versus the number of closely-spaced siblings. Powell and Steelman (1993) use the format to clearly illustrate the point that for their U.S. data, it is primarily the number of closely-spaced siblings (row-wide variation) that exerts a negative impact on educational attainment. For our Taiwanese data, as the total number of siblings increases, the average educational attainment of subjects first increases, then decreases. The relationship between sibship size and mean education is thus not monotonic. When we further distinguish sibship size by density, we observe a clear pattern for female respondents, which also shows up for the total sample as a result of aggregation: as the number of closely spaced siblings increases, the mean education shows an increasing pattern. This pattern is very strong and robust across all panels. For example, female respondents with 5+ siblings, none of whom is closely spaced, had 6.9 years of schooling. This contrasts with 9.0 years of schooling for female respondents with 5+ siblings all of whom are closely spaced. This finding directly contradicts the pattern in Powell and Steelman's (1993) Table 1, highlighting differences in family culture between Taiwan and the U.S.

We believe that the increasing pattern of closely-spaced siblings within each row is due not to female respondents benefiting from having closely-spaced siblings but to their not suffering from having apart-spaced siblings. In other words, women's educational attainment is the lowest in the lower-left corner within each panel, as those entries represent women with numerous apart-spaced siblings. This pattern is consistent with our argument that parents sacrifice older daughters' education to relax the family budget constraint, and possibly benefit the education of much younger, particularly male, siblings. We will further explore the relationship between educational attainment and sibship by density in the next section.

Methods

Children from the same family may be subject to the influence of unobservable family-level characteristics. Analysis of family-siblings data thus should take family (siblings) structure into account. In the previous literature, either a sibling-fixed effects model or a variance-corrected ordinary least squares (OLS) model has been adopted to lessen such problems.[6] Both solutions have associated advantages and disadvantages, and the choice between them is not always clear-cut. As Griliches (1979) pointed out long ago, the use of sibling-fixed effects controls family characteristics but not necessarily all unobserved selectivity. Another potential problem with the fixed-effect approach is the presence of measurement error. If the fixed effect model is applied, the bias associated with measurement error may become larger by taking the differences of variables.[7] Furthermore, the fixed-effect approach puts a high demand on data that is not always met in practice.

In this paper, we considered--but were not able to implement--the fixed-effects model because the effects of the individual sibship size variable could not be distinguished from the family-specific constant

[6] See Behrman et al. (2005) and Sanbonmatsu et al. (2004) for examples.

[7] Griliches (1979) gives a detailed discussion on the problems of fixed effects model.

terms, as the two are collinear with each other. We use our regression model below to illustrate this point. For the *j*th sibling in the *i*th family, consider the following model:

$$y_{ij} = \alpha + X'_{ij}\beta + Z'_{ij}\gamma + u_{ij}, \quad i = 1, \ldots, n,\ j = 1, \ldots, n_i, \tag{1}$$

where y is a measure for education, *X* is a set of sibship size variables, *Z* contains other explanatory variables, and *u* denotes the error term. In our analysis, the *X* variable takes alternative forms. In the simplest form, only the total sibship size is included. In the more complex models, gender, spacing, and seniority of sibship structure are considered sequentially and interactively.

The fixed-effects model allows family-specific intercept terms, changing equation (1) into:

$$y_{ij} = \alpha_i + X'_{ij}\beta + Z'_{ij}\gamma + u_{ij}, \quad i = 1, \ldots, n,\ j = 1, \ldots, n_i, \tag{2}$$

For the simplest model (*X* containing total sibship size only), it could be easily seen that the fixed-effect model is under-identified due to the perfect collinearity between the family-specific constant terms (α_i 's) and the *X* variable. This situation is not improved with more refined operationalizations of the *X* variables, as long as the sum of the sibship size variables is constant within family. While identification of the fixed-effects model can be achieved by arbitrarily deleting one of the sibship variables in a complex operationalization of *X*, interpretation of the remaining variables would be difficult.

For the aforementioned reasons, we choose ordinary least squares (OLS) with Huber-White adjustment. In our data, it is reasonable to assume that correlations across different individuals are due to within-family resemblance. We further assume that across-family differences (represented by α_i 's in equation 2) generate within-family clustering but do not systematically correlate with *X*, our key independent variables. Under this condition, OLS estimation of equation (2) yields consistent point estimates but wrong standard errors. The Huber-White procedure calculates the correct standard errors that adjust for correlations between siblings.[8]

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[8] Since the estimator of the standard errors is robust to the deviation from the standard assumption of i.i.d. (independent and identically distributed) sample, the Huber-White adjusted estimator of variance is also known as

Results

Preliminary Findings: The Effects of Sibship Size

In our empirical analysis, we first follow the literatures and estimate the effects of overall sibship size on educational attainment. Then we distinguish sibship size sequentially by gender, spacing, and seniority to further explore the influence of sibship structure on education. In our regression models, we use years of schooling as the dependent variable.

In the regression model, we account for the secular improvement in educational opportunity with birth cohort dummies as explanatory variables. The birth cohort dummies contain eleven groups, the range for each group being five years and the youngest cohort (birth year $\geq$ 1980) being the reference group. The results presented in Table 1 show that, overall, the birth cohort dummies are highly significant at the 1% level. For persons born before 1965, an earlier date of birth is associated with a severe disadvantage in terms of educational attainment.[9] For later cohorts, cohort differences are small.

Table 1 about Here

In Table 1, two models (Model A and Model A') are distinguished. The difference is that Model A estimates the overall effect of sibship size, while Model A' estimates the effect of sibship size separately for males and females (which is tantamount to interacting gender dummies and sibship size). The results of Model A show that sibship size has a negative effect on educational outcomes, which is consistent with the previous literature. However, the results of Model A' show that the number of siblings has asymmetric effects on males and females. The effect remains negative for females but turns out to be insignificant for males. These preliminary findings offer some weak evidence for our prior

the robust estimator of variance. Further information about this correction procedure can be found in Huber (1967) or White (1980).

[9] Since the estimates of the birth cohort dummies in the other regression models are similar to those presented in Table 1, they are not listed in the other tables for brevity of presentation. Detailed results are available from the authors upon request.

conjecture that additional siblings may provide help to males in addition to diluting the resources in the family. We will return to this topic later in the paper.

As to other explanatory variables, one could observe from Model A that males attain higher levels of schooling than females. Other regressors show consistent signs and magnitudes of coefficients in Models A and A'. Both father's schooling and mother's schooling have positive effects on educational achievement. The effect of father's schooling is greater than mother's, probably because, with father being the primary bread winner, father's education may better reflect the economic situation of the family. Relative to those subjects with mothers who never worked, the ones with mothers who have worked attained lower education. Mother's work may affect the educational attainment of children in opposing ways. A working mother could bring more economic resources to her family, which may help her children to attain higher education. However, since childcare and work compete for a mother's time, a working mother could be restrained in the time and energy that she devotes to her children. In addition, a mother may work out of economic necessity so that her work status may reflect an underlying economic condition. In any event, mother's work status is associated with a lower level of education in our results.[10]

With respect to ethnicity dummies, relative to Aborigines, subjects of other ethnic backgrounds tend to have higher education. Among all groups, the educational attainment of Mainlanders is the highest. As post-war immigrants, Mainlanders are more likely to live in urban areas and hold non-farming jobs but are less likely to own land than early immigrants and Aborigines. On average, Mainlanders have higher levels of educational attainment than other ethnic groups.

Main Findings: The Effects of Sibship Size by Gender, Seniority and Density

[10] Due to our concern that mother's work status might be contaminated by measurement error, we also experimented with specifications that removed the variable from the models. However, the main results remained unchanged. The results from alternative specifications are available from the authors upon request.

To analyze the effects of sibship size by gender, we rerun the regressions and present the results in Table 2.[11] In this table, Model B shows that both brothers and sisters have detrimental effects on the subject's educational attainment, and the magnitudes of these two coefficients are similar in size. The results of Model B' resemble those of Model A' (Table 1), with siblings of both genders showing negative effects on females and no effects on males. Since other findings are similar to those on Table 1, we do not repeat the interpretation here.

Table 2 about Here

Now we further divide siblings into two groups—those spaced closely and those spaced apart – and present the results in Table 3. From Model C of Table 3, we find that siblings (brothers or sisters) spaced apart have negative effects on education, yet the effects of siblings spaced closely are not significant. Again, this surprising finding directly contradicts the conventional resource theory as formulated by Powell and Steelman (1990, 1993). Model C' of the same table shows more interesting patterns: while siblings (brothers or sisters) spaced apart are detrimental to females, they have no influence on males.

Table 3 about Here

Finally, to examine whether younger or elder spaced-apart siblings are detrimental to the subject's educational attainment, we further divided sibship size by seniority for the analyses reported in Table 4. The results of Model D are straightforward: only younger siblings spaced apart show negative effects. From Model D', we further confirm that only females are influenced by siblings spaced apart, such effects being more pronounced for females with younger siblings spaced apart than for those with older siblings spaced apart. The finding that the number of older siblings spaced apart has a weak negative effect on females' educational attainment seems to be a puzzle. One possible interpretation is

[11] The models in Tables 2, 3, and 4 are also estimated by OLS with Huber-White adjustment (as in Table 1). The birth cohort dummies are also controlled in these models.

that a younger sister may not gain from the resources the elder siblings bring into the family or that families of such sibling configurations somehow have poor economic resources. As long as she has to compete with her siblings for the family resources, siblings spaced apart, either younger or older, are associated with a lower level of educational attainment.

Table 4 about Here

We now proceed to find evidence that directly bears on the conjecture that an elder sister may start working earlier under the presence of a much younger brother. For this, we utilize responses to a question on the PSFD questionnaire pertaining to the year when the respondent started a formal job. The survey defined a formal job as a full-time paid job that lasted for more than one month. We used the age at first job as the dependent variable and estimated regression models with similar specifications to those in Table 4. The results were presented in Table 5. We observe that the numbers of younger brothers spaced apart have a significantly negative effect on the age of first job for females. The point estimate reveals that an elder sister would start working 0.4 year earlier for each additional younger brother. There is no other sibling effect on age of first job. Although preliminary, this finding is consistent with what we hypothesized in this paper.

Table 5 about Here

The main findings of Tables 1-4 are summarized in the first two columns of Table 6a. From these two columns, we may conclude that sibship size does not matter for males, while the educational attainment of females is affected by the composition of sibling structure. Siblings spaced apart, regardless of gender or seniority, have negative effects on the educational attainment of females. To further explore whether the coefficients of individual sibship size variables are equivalent between males and females, we conducted a t test, the results of which we present in the third column of Table 6a. An F test was also performed to examine the overall difference between genders, with the results listed in the final column of the same table. The F test statistics show that the differences in sibship effects between gender are significant in all cases (i.e., Models A', B', C', and D').

To examine whether sibship density matters given the same gender and seniority, we performed t and F tests and display the results in Table 6b. From the first two columns of Table 6b, we find that sibship density has asymmetric effects on males and females. Even though sibship density does not make any difference for males, it matters for females. Siblings spaced apart, especially younger siblings, are more detrimental to the educational opportunities of females than their male counterparts. These results are consistent with our prior conjecture that females may sacrifice their own educational opportunities and act as resource providers for their spaced-apart siblings.

Tables 6a and 6b about Here

In summary, our study explores the effects of sibship on education in the Taiwanese context by refining sibship configuration, and in doing so questions the conventional wisdom based on American and Western European experiences. The key hypothesis we suggest is a modified resource-dilution model with son preference under the Chinese family tradition, where family resources are composed of both parental earnings and sibling remittances. The son preference culture suggests the likelihood of sacrificing the educational opportunity of older girls, who enter the labor market earlier and contribute to the family income pool. This is more likely to happen when the girl in question has more younger siblings spaced apart, who increase the burden on the family budget. Thus, the younger siblings indeed dilute parental resources, whereas the older sisters expand such resources by stopping schooling and devoting themselves to the job market. This is a complicated scenario and can be identified only when the sibling structure is refined according to the sex-seniority-space dimensions.

Discussion and Conclusion

In this paper, we propose an extension of the resource dilution hypothesis for the Taiwanese context: if resources from all family members are pooled together, families may sacrifice the educational opportunities of older (female) siblings and transfer their resources to improve the educational outcomes of younger, especially male, siblings. With analyses of data from the Panel Study of Family Dynamics (PSFD), we find empirical evidence in support of this explanation. In particular, we find that the negative effects of sibship size are the strongest for girls who have younger brothers and sisters *spaced apart*. We interpret this unusual high-order interaction involving sibship size, gender, density, and seniority in the context of Taiwan's patriarchal culture, in which families often favor boys over girls.

While our work is motivated by Greenhalgh's (1985) insight that Taiwanese parents mobilize resources from older daughters to benefit younger sons, the full story seems more complicated. Despite there being a son preference culture, there was virtually no sex-selective abortion, as the requisite technology was not available in Taiwan during this period. There is, however, some evidence of sex-preference in fertility behavior. In our data, the correlation coefficient between the proportion of female children in the family and sibship size is positive (0.1802, significant under 1%), indicating that parents continued their fertility so as to have a son if they were not satisfied with the number of sons.

The sex of each child was thus a random event. In families where sons were born ahead of daughters, parents did not have easy mechanisms with which to sacrifice the education of later-born daughters for the benefit of sons. Only when daughters were born first and much younger siblings were on the horizon did parents discontinue the education of older sisters and transfer their resources to benefit the family in general, possibly their much younger siblings in particular. Interestingly, it seems that older sisters' education is sacrificed to benefit both younger brothers and younger sisters. While there is gender asymmetry in terms of which older siblings were sacrificed, there is no gender asymmetry in terms of which young siblings benefited from the intra-family transfer. In light of these findings, Parish and Willis's (1993) interpretation is appealing: parents may extract resources from their older daughters because they lack economic resources due to the lack of a credit market. Once they have resources (say from older daughters), they no longer discriminate against younger daughters. This interpretation suggests that parents' differential treatment of sons and daughters is an extreme measure under severe resource constraint. Once they have adequate resources, parents' treatment of daughters is not too dissimilar to their treatment of sons.

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Table 1: Estimated Effects of Sibship Size on Educational Attainment

Explanatory Variables	Model A		Model A′	
	Coefficient	| *t* | value	Coefficient	| *t* | value
Constant	7.471***	15.73	7.944***	16.73
Year at birth (≥1980 as ref.)				
≤1934	-6.004***	9.55	-5.997***	9.62
1935-39	-5.513***	13.98	-5.557***	14.13
1940-44	-4.438***	13.22	-4.455***	13.31
1945-49	-3.257***	10.06	-3.277***	10.15
1950-54	-2.359***	7.60	-2.385***	7.71
1955-59	-1.574***	5.13	-1.594***	5.21
1960-64	-0.859***	2.85	-0.878***	2.92
1965-69	-0.396	1.32	-0.412	1.37
1970-74	-0.121	0.41	-0.142	0.49
1975-79	-0.106	0.36	-0.136	0.47
Male	1.051***	15.85	0.133	0.72
Father's schooling	0.284***	18.34	0.285***	18.35
Mother's schooling	0.198***	11.78	0.199***	11.83
Mother ever worked	-0.361***	3.29	-0.351***	3.20
Father's ethnicity				
Fukkien	2.240***	6.65	2.271***	6.85
Hakka	2.669***	7.47	2.696***	7.65
Mainlander	3.052***	8.44	3.072***	8.61
Sibship size	-0.089**	2.51		
Male × Sibship size			0.032	0.75
Female × Sibship size			-0.217***	4.91
Joint F test for birth cohort dummies d.f.= (10, 2,590)	82.41***		82.42***	
R-squared	0.452		0.453	
Number of families	2,591		2,591	
Number of observations	10,654		10,654	

Note: Coefficients are OLS estimates, and t values refer to the null hypothesis of the true coefficient being zero, with robust standard errors. Model A pools the model by gender. Model A' separates the model by gender. ***, **, * denote significance at 1%, 5%, 10% levels respectively.

Table 2: Estimated Effects of Sibship Size by Gender on Educational Attainment

Explanatory Variables	Model B		Model B′	
	Coefficient	| *t* | value	Coefficient	| *t* | value
Constant	7.472***	15.73	7.924***	16.62
Male	1.052***	15.76	0.167	0.90
Father's schooling	0.284***	18.34	0.285***	18.33
Mother's schooling	0.198***	11.78	0.199***	11.85
Mother ever worked	-0.362***	3.30	-0.353***	3.21
Father's ethnicity				
Fukkien	2.237***	6.63	2.271***	6.82
Hakka	2.666***	7.44	2.690***	7.60
Mainlander	3.047***	8.40	3.070***	8.56
Brothers	-0.081*	1.72		
Male × Brothers			0.007	0.12
Female × Brothers			-0.182***	3.13
Sisters	-0.093**	2.33		
Male × Sisters			0.051	1.06
Female × Sisters			-0.237***	4.58
Joint F test for birth cohort dummies d.f.= (10, 2,590)	81.97***		81.94***	
R-squared	0.452		0.453	
Number of families	2,591		2,591	
Number of observations	10,654		10,654	

Note: Coefficients are OLS estimates, and t values refer to the null hypothesis of the true coefficient being zero, with robust standard errors. Model B pools the model by gender. Model B' separates model by gender. ***, **, * denote significance at 1%, 5%, 10% levels respectively.

Table 3: Estimated Effects of Sibship Size by Gender and Density on Educational Attainment

Explanatory Variables	Model C		Model C′	
	Coefficient	| t | value	Coefficient	| t | value
Constant	7.477***	15.69	7.805***	16.14
Male	1.055***	15.81	0.413**	2.09
Father's schooling	0.284***	18.34	0.284***	18.33
Mother's schooling	0.196***	11.66	0.198***	11.77
Mother ever worked	-0.358***	3.27	-0.347***	3.16
Father's ethnicity				
Fukkien	2.235***	6.60	2.269***	6.71
Hakka	2.661***	7.40	2.683***	7.47
Mainlander	3.051***	8.38	3.072***	8.46
Brothers spaced closely	-0.028	0.49		
Male × Brothers spaced closely			-0.060	0.78
Female × Brothers spaced closely			-0.022	0.31
Brothers spaced apart	-0.103*	1.94		
Male × Brothers spaced apart			0.036	0.52
Female × Brothers spaced apart			-0.250***	3.94
Sisters spaced closely	-0.025	0.49		
Male × Sisters spaced closely			0.034	0.53
Female × Sisters spaced closely			-0.078	1.15
Sisters spaced apart	-0.129***	2.79		
Male × Sisters spaced apart			0.035	0.64
Female × Sisters spaced apart			-0.309***	4.81
Joint F test for birth cohort dummies d.f.= (10, 2,590)	78.08***		77.00***	
R-squared	0.452		0.455	
Number of families	2,591		2,591	
Number of observations	10,654		10,654	

Note: Coefficients are OLS estimates, and t values refer to the null hypothesis of the true coefficient being zero, with robust standard errors. Model C pools the model by gender. Model C' separates the model by gender. ***, **, * denote significance at 1%, 5%, 10% levels respectively.

Table 4: Estimated Effects of Sibship Size by Gender, Seniority, and Spacing on Educational Attainment

Explanatory Variables	Model D Coefficient	Model D $\lvert t \rvert$ value	Model D′ Coefficient	Model D′ $\lvert t \rvert$ value
Constant	7.369***	15.39	7.673***	16.02
Male	1.043***	15.62	0.423**	2.14
Father's schooling	0.285***	18.40	0.285***	18.36
Mother's schooling	0.198***	11.80	0.200***	11.85
Mother ever worked	-0.352***	3.20	-0.340***	3.10
Father's ethnicity				
Fukkien	2.229***	6.55	2.273***	6.70
Hakka	2.651***	7.34	2.683***	7.45
Mainlander	3.045***	8.33	3.077***	8.45
Elder brothers spaced closely	-0.066	1.04		
Male × Elder brothers spaced closely			-0.117	1.38
Female × Elder brothers spaced closely			-0.031	0.36
Elder brothers spaced apart	-0.088	1.46		
Male × Elder brothers spaced apart			-0.025	0.34
Female × Elder brothers spaced apart			-0.161**	2.05
Younger brothers spaced closely	0.004	0.07		
Male × Younger brothers spaced closely			-0.015	0.17
Female × Younger brothers spaced closely			-0.024	0.29
Younger brothers spaced apart	-0.136**	1.99		
Male × Younger brothers spaced apart			0.080	0.93
Female × Younger brothers spaced apart			-0.327***	3.86
Elder sisters spaced closely	-0.018	0.31		
Male × Elder sisters spaced closely			-0.005	0.07
Female × Elder sisters spaced closely			-0.025	0.33
Elder sisters spaced apart	-0.053	1.03		
Male × Elder sisters spaced apart			0.027	0.44
Female × Elder sisters spaced apart			-0.150**	2.15
Younger sisters spaced closely	-0.025	0.40		
Male × Younger sisters spaced closely			0.064	0.73
Female × Younger sisters spaced closely			-0.112	1.48
Younger sisters spaced apart	-0.242***	3.86		
Male × Younger sisters spaced apart			0.046	0.58
Female × Younger sisters spaced apart			-0.491***	6.28
Joint F test for birth cohort dummies d.f.= (10, 2,590)	51.56***		52.24***	
R-squared	0.453		0.457	
Number of families	2,591		2,591	
Number of observations	10,654		10,654	

Note: Coefficients are OLS estimates, and t values refer to the null hypothesis of the true coefficient being zero, with robust standard errors. Model D pools the model by gender. Model D' separates the model by gender. ***, **, * denote significance at 1%, 5%, 10% levels respectively.

Table 5: Estimated Effects of Sibship Size by Gender, Seniority, and Spacing on Age at First Job

	Model D		Model D′	
Explanatory Variables	Coefficient	| t | value	Coefficient	| t | value
Constant	16.233***	18.02	16.202***	17.52
Male	1.125***	5.72	1.240***	2.61
Father's schooling	0.155***	4.96	0.155***	4.96
Mother's schooling	0.179***	5.17	0.182***	5.24
Father's ethnicity				
Fukkien	1.532*	1.90	1.488*	1.85
Hakka	1.096	1.29	1.093	1.29
Mainlander	2.223***	2.60	2.183**	2.55
Elder brothers spaced closely	-0.022	0.12		
Male × Elder brothers spaced closely			-0.061	0.24
Female × Elder brothers spaced closely			-0.003	0.01
Elder brothers spaced apart	-0.134	0.85		
Male × Elder brothers spaced apart			-0.330	1.57
Female × Elder brothers spaced apart			0.108	0.46
Younger brothers spaced closely	-0.086	0.50		
Male × Younger brothers spaced closely			-0.131	0.53
Female × Younger brothers spaced closely			-0.033	0.14
Younger brothers spaced apart	-0.255	1.62		
Male × Younger brothers spaced apart			-0.097	0.45
Female × Younger brothers spaced apart			-0.409*	1.85
Elder sisters spaced closely	0.116	0.69		
Male × Elder sisters spaced closely			0.084	0.37
Female × Elder sisters spaced closely			0.153	0.62
Elder sisters spaced apart	-0.014	0.10		
Male × Elder sisters spaced apart			0.165	0.92
Female × Elder sisters spaced apart			-0.242	1.22
Younger sisters spaced closely	0.007	0.04		
Male × Younger sisters spaced closely			0.075	0.31
Female × Younger sisters spaced closely			-0.043	0.19
Younger sisters spaced apart	0.011	0.07		
Male × Younger sisters spaced apart			-0.315	1.37
Female × Younger sisters spaced apart			0.275	1.32
Joint F test for birth cohort dummies	2.40** d.f.= (7, 2,445)		2.49** d.f.= (7, 2,437)	
R-squared	0.085		0.088	
Number of observations	2,467		2,467	

Note: The sample is confined to the respondents since information on the time of first job is only available for the respondents. Coefficients are OLS estimates, and t values refer to the null hypothesis of the true coefficient being zero. Model D pools the model by gender. Model D' separates the model by gender. ***, **, * denote significance at 1%, 5%, 10% levels respectively.

Table 6a: Summary Results for Estimated Coefficients

Model/Variables	Coefficients: Male	Coefficients: Female	|t| statistic for difference between gender	F statistic for overall difference between gender
Model A′				
Sibship size	0.032	-0.217***	4.99***	
Model B′				
Brothers	0.007	-0.182***	2.76***	13.24*** d.f.=(2, 2,590)
Sisters	0.051	-0.237***	4.81***	
Model C′				
Brothers spaced closely	-0.060	-0.022	0.39	10.99*** d.f.=(4, 2,590)
Brothers spaced apart	0.036	-0.250***	3.54***	
Sisters spaced closely	0.034	-0.078	1.33	
Sisters spaced apart	0.035	-0.309***	4.65***	
Model D′ (Table 4-1)				
Elder brothers spaced closely	-0.117	-0.031	0.75	8.80*** d.f.=(8, 2,590)
Elder brothers spaced apart	-0.025	-0.161**	1.45	
Younger brothers spaced closely	-0.015	-0.024	0.10	
Younger brothers spaced apart	0.080	-0.327***	3.93***	
Elder sisters spaced closely	-0.005	-0.025	0.20	
Elder sisters spaced apart	0.027	-0.150**	2.20**	
Younger sisters spaced closely	0.064	-0.112	1.66*	
Younger sisters spaced apart	0.046	-0.491***	5.65***	

***, **, * denote significance at 1%, 5%, 10% levels respectively.

Table 6b: Tests for the Equivalence of Coefficients of Sibship Size

Model/Tests	Male: |t| statistic for ind. test	Male: F statistic for joint test	Female: |t| statistic for ind. test	Female: F statistic for joint test
Model B′				
Brothers = Sisters	0.51		0.72	
Model C′				
Brothers spaced closely = Brothers spaced apart	1.22	0.61 d.f.=(2, 2,590)	3.30***	8.63*** d.f.=(2, 2,590)
Sisters spaced closely = Sisters spaced apart	0.00		2.92***	
Model D′ (Table 4-1)				
Elder brothers spaced closely = Elder brothers spaced apart	0.90	0.34 d.f.=(4, 2,590)	1.40	5.39*** d.f.=(4, 2,590)
Younger brothers spaced closely = Younger brothers spaced apart	0.73		2.97***	
Elder sisters spaced closely = Elder sisters spaced apart	0.15		1.38	
Younger sisters spaced closely = Younger sisters spaced apart	0.03		3.80***	

***, **, * denote significance at 1%, 5%, 10% levels respectively.

Appendix Table 1: Average Year of Schooling by Sibling Size

	All	Male	Female
Sibship size			
0	9.012	10.408	7.793
1	11.460	12.163	10.403
2	12.270	12.405	12.076
3	11.849	12.019	11.664
4	10.645	11.160	10.205
5+	9.186	9.886	8.593
Number of brothers			
0	10.992	11.991	9.631
1	11.455	11.847	11.035
2	10.529	10.889	10.214
3	9.632	10.386	8.951
4	9.234	9.952	8.542
5+	9.317	9.542	9.019
Number of sisters			
0	11.341	11.573	11.093
1	11.116	11.619	10.523
2	10.512	11.046	10.009
3	10.104	10.802	9.452
4	9.888	10.524	9.396
5+	10.000	11.039	9.108

Appendix Table 2: Summary of Means and Standard Deviations

Variables/Observations	All(10,654)	Male(5,317)	Female(5,337)
Child's schooling	10.640	11.200	10.083
	(4.189)	(3.899)	(4.389)
Father's schooling	5.849	5.849	5.849
	(4.323)	(4.350)	(4.296)
Mother's schooling	3.597	3.585	3.609
	(3.822)	(3.835)	(3.809)
Mother ever worked	0.263	0.271	0.256
	(0.440)	(0.444)	(0.436)
Father Fukkien	0.779	0.777	0.780
	(0.415)	(0.416)	(0.414)
Father Hakka	0.116	0.115	0.117
	(0.320)	(0.319)	(0.322)
Father Mainlander	0.089	0.095	0.083
	(0.285)	(0.293)	(0.276)
Sibship size	3.676	3.558	3.793
	(1.331)	(1.353)	(1.299)
Brothers	1.776	1.724	1.827
	(1.102)	(1.127)	(1.074)
Sisters	1.900	1.833	1.966
	(1.256)	(1.239)	(1.269)
Brothers spaced closely (age difference $\leq$ 4)	0.913	0.900	0.926
	(0.817)	(0.813)	(0.822)
Brothers spaced apart (age difference > 4)	0.863	0.825	0.902
	(0.916)	(0.915)	(0.916)
Sisters spaced closely	0.970	0.929	1.011
	(0.889)	(0.857)	(0.920)
Sisters spaced apart	0.930	0.904	0.955
	(0.996)	(1.007)	(0.985)
Elder brothers spaced closely	0.437	0.450	0.424
	(0.603)	(0.607)	(0.599)
Elder brothers spaced apart	0.401	0.412	0.390
	(0.731)	(0.746)	(0.715)
Younger brothers spaced closely	0.476	0.450	0.502
	(0.620)	(0.607)	(0.631)
Younger brothers spaced apart	0.462	0.412	0.511
	(0.753)	(0.727)	(0.774)
Elder sisters spaced closely	0.505	0.504	0.506
	(0.655)	(0.652)	(0.657)
Elder sisters spaced apart	0.495	0.512	0.477
	(0.841)	(0.870)	(0.812)
Younger sisters spaced closely	0.466	0.425	0.506
	(0.634)	(0.607)	(0.657)
Younger sisters spaced apart	0.435	0.392	0.478
	(0.774)	(0.743)	(0.801)

Appendix Table 3a: Mean Education by Number of Closely Spaced Sibling and Total Number of Siblings: All Sample

Total Number of Siblings	Number of Closely Spaced Siblings (age difference ≤ 4) 0	1	2	3	4	5+	Total	Number of Sample
Junior High School Graduation								
0	0.540	—	—	—	—	—	0.540	163
1	0.696	0.801	—	—	—	—	0.774	398
2	0.765	0.852	0.919	—	—	—	0.886	1,725
3	0.719	0.833	0.900	0.930	—	—	0.879	2,228
4	0.774	0.700	0.770	0.809	0.832	—	0.766	2,196
5+	0.554	0.558	0.579	0.641	0.628	0.833	0.597	3,884
Total	0.661	0.726	0.769	0.765	0.686	0.833	0.745	
Number of Sample	818	2,846	4,362	2,074	506	48		10,654
Senior High School Graduation								
0	0.387	—	—	—	—	—	0.387	163
1	0.569	0.699	—	—	—	—	0.666	398
2	0.597	0.708	0.795	—	—	—	0.752	1,725
3	0.556	0.624	0.733	0.822	—	—	0.717	2,228
4	0.626	0.509	0.563	0.645	0.685	—	0.580	2,196
5+	0.422	0.376	0.415	0.470	0.466	0.521	0.426	3,884
Total	0.512	0.553	0.605	0.614	0.528	0.521	0.582	
Number of Sample	818	2,846	4,362	2,074	506	48		10,654
College Graduation								
0	0.104	—	—	—	—	—	0.104	163
1	0.137	0.250	—	—	—	—	0.221	398
2	0.176	0.245	0.247	—	—	—	0.241	1,725
3	0.150	0.153	0.204	0.228	—	—	0.194	2,228
4	0.104	0.108	0.134	0.168	0.203	—	0.138	2,196
5+	0.072	0.073	0.078	0.096	0.088	0.021	0.081	3,884
Total	0.121	0.149	0.157	0.151	0.121	0.021	0.149	
Number of Sample	818	2,846	4,362	2,074	506	48		10,654
Years of Schooling								
0	9.012	—	—	—	—	—	9.012	163
1	10.500	11.791	—	—	—	—	11.460	398
2	11.000	11.950	12.596	—	—	—	12.270	1,725
3	10.268	11.172	12.031	12.619	—	—	11.849	2,228
4	10.643	9.970	10.558	11.206	11.741	—	10.645	2,196
5+	8.699	8.707	9.060	9.685	9.595	10.083	9.186	3,884
Total	9.888	10.427	10.854	10.898	10.202	10.083	10.640	
Number of Sample	818	2,846	4,362	2,074	506	48		10,654

Appendix Table 3b: Mean Education by Number of Closely Spaced Sibling and Total Number of Siblings: Male Sample

Total Number of Siblings	Number of Closely Spaced Siblings (age difference ≤ 4)							Number of Sample
	0	1	2	3	4	5+	Total	
Junior High School Graduation								
0	0.697	—	—	—	—	—	0.697	76
1	0.788	0.866	—	—	—	—	0.849	239
2	0.866	0.858	0.931	—	—	—	0.903	1,018
3	0.779	0.882	0.918	0.932	—	—	0.903	1,194
4	0.915	0.755	0.807	0.855	0.902	—	0.815	1,011
5+	0.729	0.659	0.651	0.691	0.669	0.926	0.672	1,779
Total	0.788	0.792	0.818	0.806	0.734	0.926	0.803	
Number of Sample	416	1,531	2,191	934	218	27		5,317
Senior High School Graduation								
0	0.474	—	—	—	—	—	0.474	76
1	0.635	0.743	—	—	—	—	0.720	239
2	0.612	0.695	0.791	—	—	—	0.748	1,018
3	0.636	0.619	0.731	0.797	—	—	0.711	1,194
4	0.729	0.560	0.575	0.682	0.754	—	0.614	1,011
5+	0.541	0.420	0.465	0.519	0.503	0.593	0.476	1,779
Total	0.596	0.587	0.637	0.646	0.573	0.593	0.618	
Number of Sample	416	1,531	2,191	934	218	27		5,317
College Graduation								
0	0.171	—	—	—	—	—	0.171	76
1	0.135	0.283	—	—	—	—	0.251	239
2	0.224	0.251	0.266	—	—	—	0.258	1,018
3	0.143	0.170	0.229	0.213	—	—	0.204	1,194
4	0.085	0.161	0.143	0.195	0.262	—	0.163	1,011
5+	0.118	0.073	0.098	0.100	0.115	0.037	0.094	1,779
Total	0.147	0.174	0.183	0.158	0.156	0.037	0.172	
Number of Sample	416	1,531	2,191	934	218	27		5,317
Years of Schooling								
0	10.408	—	—	—	—	—	10.408	76
1	11.077	12.465	—	—	—	—	12.163	239
2	11.567	11.965	12.739	—	—	—	12.405	1,018
3	10.922	11.505	12.245	12.486	—	—	12.019	1,194
4	11.678	10.722	10.912	11.655	12.459	—	11.160	1,011
5+	10.353	9.532	9.754	10.244	10.013	10.889	9.886	1,779
Total	10.942	11.056	11.366	11.287	10.697	10.889	11.200	
Number of Sample	416	1,531	2,191	934	218	27		5,317

Appendix Table 3c: Mean Education by Number of Closely Spaced Sibling and Total Number of Siblings: Female Sample

Total Number of Siblings	Number of Closely Spaced Siblings (age difference ≤ 4)							Number of Sample
	0	1	2	3	4	5+	Total	
Junior High School Graduation								
0	0.402	—	—	—	—	—	0.402	87
1	0.600	0.688	—	—	—	—	0.660	59
2	0.635	0.845	0.902	—	—	—	0.863	707
3	0.658	0.768	0.882	0.927	—	—	0.853	1,094
4	0.625	0.649	0.738	0.777	0.780	—	0.724	1,185
5+	0.370	0.462	0.520	0.602	0.597	0.714	0.533	2,105
Total	0.530	0.649	0.719	0.732	0.649	0.714	0.686	
Number of Sample	402	1,315	2,171	1,140	288	21		5,337
Senior High School Graduation								
0	0.310	—	—	—	—	—	0.310	87
1	0.500	0.624	—	—	—	—	0.585	59
2	0.577	0.727	0.801	—	—	—	0.760	707
3	0.474	0.630	0.736	0.847	—	—	0.723	1,094
4	0.518	0.460	0.552	0.619	0.634	—	0.551	1,185
5+	0.296	0.334	0.373	0.433	0.437	0.429	0.384	2,105
Total	0.425	0.513	0.573	0.588	0.493	0.429	0.545	
Number of Sample	402	1,315	2,171	1,140	288	21		5,337
College Graduation								
0	0.046	—	—	—	—	—	0.046	87
1	0.140	0.193	—	—	—	—	0.176	59
2	0.115	0.235	0.218	—	—	—	0.216	707
3	0.158	0.130	0.179	0.244	—	—	0.184	1,094
4	0.125	0.058	0.126	0.148	0.159	—	0.117	1,185
5+	0.025	0.072	0.062	0.092	0.068	0.000	0.070	2,105
Total	0.095	0.119	0.131	0.146	0.094	0.000	0.126	
Number of Sample	402	1,315	2,171	1,140	288	21		5,337
Years of Schooling								
0	7.793	—	—	—	—	—	7.793	87
1	9.900	10.633	—	—	—	—	10.403	59
2	10.269	11.929	12.386	—	—	—	12.076	707
3	9.605	10.736	11.810	12.756	—	—	11.664	1,094
4	9.554	9.265	10.242	10.887	11.207	—	10.205	1,185
5+	6.963	7.923	8.486	9.254	9.277	9.048	8.593	2,105
Total	8.796	9.696	10.339	10.580	9.826	9.048	10.083	
Number of Sample	402	1,315	2,171	1,140	288	21		5,337