Parental Decision on Additional Birth and Burden on Child Quality *

Ahram Moon[1], Ahyoung Song †[2], and Yusun Cho[3]

[1] *International Academy of Business and Economics, Tianjin University of Finance and Economics, China*
[2] *Department of Social Welfare, Gachon University, Republic of Korea*
[3] *Sol Price School of Public Policy, University of Southern California, U.S.*

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Abstract

Since parents' desire for child quality increases the costs of raising a child due to the required educational investment, the pecuniary and non-pecuniary burdens of childrearing on parents can compel them to abandon the hope of additional births, or even to remain childless. Using 2015 Korea National Survey on Fertility, Family Health & Welfare, we estimate the interrelationship between birth behavior and educational expenses as the direct investment in child quality. Compared to total child-rearing expenses, per-child educational expenditure has smaller elasticity. Parents' investment on educational aspects is less responsive to the number of children. Households with two children spend 78% of educational investment per child compared to families with only child and it is larger marginal effect on total child-rearing cost per child. This also supports that educational expenditure is less shrinkable with the number of children.

Keywords: fertility, child quality, educational investment, South Korea

JEL Codes: D13, J13

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†Corresponding author (*Email address*: ahyoung.song80@gmail.com)

1 Introduction

In many of the East Asian countries that have experienced rapid economic and social development over the last three decades, education has been widely considered a key asset for securing economic prosperity or social mobility. Parents in such context dominated by Confucian ideals that emphasize accomplishment thorough training and learning have paid meticulous attention to children's education (Anderson and Kohler, 2013). In a highly stratified society, parents' anxiety over their children arouses an obsession with education that is sometimes called 'education fever'. This phenomenon aggravates performance competition among students, a hierarchical ranking structure for universities, academic factionalism, wealth transfer between generations, and other social concerns (Bray, 2003).

Not only are conventional issues impacted by this, but it can also affect fertility decisions. Since parents' desire for child quality increases the costs of raising a child due to the required educational investment, the pecuniary and non-pecuniary burdens of childrearing on parents can compel them to abandon the hope of additional births, or even to remain childless. Furthermore, the most popular response to a question on the ideal social conditions for having children in South Korea from the 2015 Korea National Survey on Fertility, Family Health and Welfare (KNSFFHW), was 17.9% of married women indicating the reduction of private outside-of-school education. Therefore, unlike in western countries, a discussion of parents' educational burden is required for a fuller understanding of the lowest-lower fertility being experienced in East Asia.

As an ultra-low fertility country where the Total Fertility Rate (TFR) has remained under 1.3 since 2001, the South Korean government has launched public policies designed to raise the fertility rate to the replacement level of 2.1.[1] Despite such efforts such as family policies targeting relief for households' childcare difficulties or labor policy designed to reduce women's opportunity costs, any recovery in the TFR appears distant. Due to the ineffectiveness and short-term nature of related policy, other perspectives unique to Korea are being pursued, such as addressing gender equity or social gender-role norms. Under these circumstances, this paper investigates the expansion of the cost of child quality provoked by the competitive education system that has come to dominate South Korea.

In the field of family economics pioneered by Gary Becker, relationships between income and number of children have been studied by regarding child quality as a consumption good in the household utility function. The child quality-quantity (QQ) trade-off explains the quality of children and the number of children as normal goods and child quality is represented as investment in children (Becker, 1981; Willis, 1973). As income rises, the number of children can increase due to an income effect. On the other hand, as income rises, demand for child quality is also increased and a rise in the shadow price of child quantity is induced (substitution effect). The child quality and quantity trade-off approach argues that the effect on fertility

[1] As concerns over ultra-low fertility rates in South Korea grow, substantial research has been published to explain the associated mechanisms. It is commonly labelled "lowest-low fertilit" when total fertility rates fall below 1.3 (Kohler and Ortega, 2002). However, considering the unique fertility trends in East Asia, "ultra-low fertilit" is commonly used to describe the characteristics of fertility rates in the region (Jones et al., 2008; Yoo and Sobotka, 2017).

depends on the combination of both income and substitution effects, and presents a possible negative association between income and fertility.

A large body of empirical research has estimated the association between fertility behavior and children's academic outcome as an indicator of child quality, and the results have varied by country or type of outcome. Although only weak causality between family size and child scholastic outcome has been found in the literatures (Black et al., 2005; Angrist et al., 2010), Hanushek (1992) and Mogstad and Wiswall (2016) conclude that larger family size is indeed negatively correlated to child educational achievement.[2] Unlike other studies, Lee and Mason (2010)'s macro perspective on this trade-off stresses the negative effects of human capital investment on the fertility rate by applying an overlapping generations model.

Since academic outcome, the output of child quality, attributes from the cumulative effects of various determinants along with family size, Cáceres-Delpiano (2006) focuses on parental investment as an input of child quality. Mother's labor force participation and marital status, as measures of parental time inputs or a dummy of attending private school are used to indicate direct child investment in their study. The results show no impact on family size from parents' non-monetary investment. Although they conducted tests of the QQ trade-off model using inputs of child quality, the variables still only indirectly reflect the costs of child quality identified in Becker's theory. The costs of childrearing can serve as a representative of a household's concern for child quality.[3] In terms of the expenditure question of Browning (1992), the U.S. Department of Agriculture annually announces the estimated costs of childrearing using multivariate regression on spending on common and child-exclusive goods based on a consumer expenditure survey (Lino, 2011). We have adopted this straightforward method to estimate the interrelationship between birth behavior and educational expenses as the direct investment in child quality.

Among previous research on fertility rates in South Korea, a significant amount of research focuses on factors associated with changes in fertility rates over time using population-based

[2] Both Black et al. (2005) and Mogstad and Wiswall (2016) use the same data (Norwegian data) and empirical methodology. Both consider the OLS method to be able to control the compounding effect of household characteristics and the instrument variable (IV) method to address the endogeneity of family size. Twin birth is an instrument for family size which is common in demography (Rosenzweig and Wolpin, 1980; Rosenzweig and Schultz, 1987). However, Mogstad and Wiswall (2016) relaxes the linearity assumption of the effect of family size on child quality (the marginal effect is constant). Considering years of children's educational attainments as a dependent variable, they find an inverse U-shape between quantity and quality. Larger family size shows a strong negative relation, but smaller family size shows complementarity between the number of children and educational attainment.

[3] Chapter 5 of Rosenzweig and Stark (1997) points out the difficulty in defining the cost of children and Browning (1992) suggests four types of question to define it. (i) The positive question: how do children affect the expenditure patterns of a household? (ii) The needs question: how much income does a family with children need compared to a childless family? (iii) The expenditure question: how much do parents spend on their children? (iv) The iso-welfare question: how much income does a family with children require to be as well off as a family with no children? Because the range of costs of children in this paper implies investment in child quality, we limit this to the third question, 'the expenditure question'. This is because the second type of question, 'the needs question,' represents the cost of maintaining children (necessary for nutritional or physiological demands) and the iso-welfare question is related to adult welfare. The positive question focuses on the impact of children on parents' expenditure, so it is also excluded.

data such as the Korea Population Census. Women's educational achievement level, for example, is examined as a factor related to fertility rate changes in Korea. Yoo (2014) investigates the role of women's education in the fertility transition in South Korea with results that indicate that women's education level plays different roles in fertility rates by birth cohort. While completed birth rate is strongly associated with women's education level for women in past birth cohorts, the role of the education level of women in understanding birth rates in Korea deteriorates among women in more recent birth cohorts. Choe and Retherford (2009) examines the association between education level and fertility decline for the period of 1995-2005 and finds that the direct effects of education on fertility decline were not significant. Despite the weak direct effects, they suggest that the rapid increase in education level may have resulted in postponement of first marriage and first birth and a focusing of more time on employment, which are factors related with low birth rates in South Korea.

Other previous studies have examined the link between women's labor force participation and fertility rates in South Korea (Kim, 2014; Ma, 2016). Studies consistently show that for first childbirth, women's labor participation is not associated. It does rather strongly negatively predict second childbirth, however. Ma (2016) longitudinally examines the causality between women's childbirth and labor force participation. The results indicate that women who participated in the labor force after their first childbirth were less likely to have a second child. Similar results are also found in other cultural contexts, such as in European countries (Gustafsson et al., 1996).

There are studies that investigate fertility rates with factors other than women-related factors such as women's education level or labor force participation as above. Considering the unique cultural context of South Korea, an increasing number of studies has examined education cost for children as a barrier to improving fertility rates in the country (Lee, 2008; Anderson and Kohler, 2013; Tan et al., 2016). In their case study, Anderson and Kohler (2013) indicate that education fever in South Korea, including spending a significant amount of money on children's education should be taken into account when attempting to understand the rapid decline in fertility rates. Tan et al. (2016) argues that the link between educational expenses for children and fertility rates needs to be understood by considering institutional factors such as the higher education system and labor market.

In this line of research, Lee (2008) successfully estimates the negative elasticity of child quality and quantity and suggests the existence of a QQ trade-off using 1993-1999 data. To address unobserved heterogeneity, the gender of the first child is applied as the instrumental variable for the number of children. Although son preference and gender role equity still exists, this may not be enough to account for recent trends. Hence, we choose 2015 data that includes a younger cohort and add one more instrument variable, an indicator of difficulty in conceiving. This variable is drawn from the question "Have you as a couple experienced difficulty in becoming pregnant for over a year after stopping contraception?" Since a conception issue affects the tempo effect of birth, it is highly correlated with the eventual number of children. Similarly to son preference, this experience may be not be related to postnatal investment in a Korean context imbued with an unusual enthusiasm for education. We apply the estimation strategy of Lee (2008) to observe the trade-off between educational investment in children and fertility using two instruments.

Methodologically, we address endogeneity by introducing the new instrument of fertility to analyze recent patterns of birth behavior. In addition, our results evidence that monetary educational investment in children is a burden on parents and hinders additional childbirth. Compared to Lee's previous estimation, we find that the trade-off between child quality and quantity has weakened since the late 1990s, and that parents may not reduce their spending per child even in response to having another child. To raise the fertility rate, we emphasize the importance of relieving parents' concerns over their children's education. Along with labor or family policies, the improvement of public education and alleviation of parents' dependence on private outside-of-school education is a necessity condition to increase the birth rate in South Korea.

2 Data and descriptive statistics

The data used in this study was obtained from the 2015 Korea National Survey on Fertility, Family Health & Welfare (KNSFFHW). This survey has been conducted by the Korea Institute for Health and Social Affairs (KIHASA) every three years since the 1970s. After stratified two-stage cluster sampling, 11,000 ever-married women of childbearing age (15-49) and never-married men and women aged 20-44 who reside in households were selected. This paper chooses its samples from the ever-married women. Questionnaires include lifetime event information in terms of women's behavior and attitudes towards marriage and fertility, as well as their demographic characteristics.

This paper limits the sample to married women who have remained stably within their first marriage since fertility can be interrelated with marital disruption. For example, since marital disruption reduces the period of exposure to child-bearing, remarrying females can have lower family size, but family size may be affected by the duration between disruption and remarriage (Cohen and Sweet, 1974; Thornton, 1978). Observations with missing values for fertility variables were eliminated. The final number of observations used in this paper contains 9,379 women.

Table 1 describes summary statistics for socio-economic variables. Although the average number of children is 1.71, women over 45 years of age have 1.98 children on average. Fifty-one percent of the households have a son as the first child. About 13% have experience with difficulty conceiving for over one year. The average ages of a mother at marriage and first birth are 26.53 and 27.78, respectively. The periods for giving birth increase with birth order. On average, 36 and 49 months are the periods for birthing the second and third child after the previous birth.

While 41% of women held a four-year university degree, more than half of the sample had a husband who had graduated from a four-year university. Women had a higher proportion of high- school or two-year college graduation than did men. Almost 40% lived in a large urban area, including in the capital city of Seoul and six other designated metropolitan cities. The average monthly household income for 2015 was equivalent to about 4,500 US dollars ($) (4,981,020 Korean won (KRW)) at the rate of 1,100 KRW/$. Additionally, if the household had school-aged or younger children or younger, they spent 273 US dollars

monthly in total educational expenditures per child, including childcare services and private supplementary tutoring. It is notable that educational expenditure per child accounts for about 6% of household income.[4]

3 First-child gender and difficulty conceiving

3.1 Weak instrument variables

Korean fertility studies have investigated the association between son preference and fertility (Arnold, 1985; Larsen et al., 1998). Assuming that couples prefer to bear a son, the gender of the first child may affect their consecutive birth behavior. Even if the desired number of children is one, a couple who has a daughter as their first child many choose to have and additional child and conceive the subsequent child quickly. Hence, Lee (2008) considers first-child gender to be an instrument for the number of children. Although son preference reflecting the social norms of Korea can be a good predictor, a couple's experience of difficulty conceiving a child can represent individual traits and then provide a good predictor of fertility behavior. This kind of experience may delay birth timing and eventually affect family size. The NSFFHW includes a question on self-reported difficulty with conceiving a child that we take as a predictor of fertility: "After you and your husband attempted conception, did you experience difficulty with becoming pregnant for more than a year?" In this paper, both son preference and difficulty with conception are considered instrument variables (IV) for the number of children.

This subsection demonstrates the explanatory power of two IVs related to fertility *quantum* (number of children) and *tempo* (timing of birth). First, a parity progression model is performed to show that having a girl first is likely to lead to having more children under the influence of son preference, and a couple with experience of conception difficulty ends up with a smaller family size. With regards to the parity progression model, we limit it to women over 40 who have completed reproduction behavior and are not considering further childbearing. Although women over 40 considering themselves part of the no longer fertile group can be a conventional assumption, we also restrict the age range to women over age 45 and prove the relation with fertility as a robustness check. Table 2 shows ordinary least square (OLS) regression results in which the dependent variable is the number of children and a logit model where the dependent variable is the binary indicator of whether a household has more than one child or no child. When adding the first child's gender to the estimation, the sample is restricted to mothers who have at least one child, so the sample size becomes smaller.

The OLS results present a negative association between quantum and instrument variables:

[4] To whom may have suspicious with large amount of spending on children education in Korea, the Survey of Private Education Expenditure conducted by Statistics Korea and the Ministry of Education reports that each 77.2 and 73.1 percent of middle school students participated in small-group or large-scale classes of private tutoring in 2007 and 2014. In 2014, 56.4% of Korean students either attended large-scale classes or hired a private tutor for academic subjects as supplementary tutoring (73.1% those in middle school and 55.7% those in general high school students). Households spent US$174 per child for private tutoring on average monthly (about US$225 of middle school students and US$209 of general high school students).

Households who experienced difficulty with conception and bear a son first end up with a smaller number of children. The first column of the logit model shows that the occurrence of conception problems makes it three times more difficult to have a child. In addition, households with this experience have 1.5 times lower probability of having two or more children than do households without conception issues. Having a boy first also decreases by about 25% the probability of having an additional birth. In the last part of Table 2, similar estimation results are found when narrowing the age group from 40-49 to 45-49. As a result, two IVs are strongly correlated with the fertility quantum.

Second, the predictability of the two IVs for fertility tempo is observed using survival analysis. Because fecundity varies with parents' age, having a girl first moves up the timing of second birth. Also, biologically, a difficult experience in conceiving delays birth timing. Since the period from the prior to the subsequent birth is regarded as a dependent variable, we perform a hazard model which enables the inclusion of all age groups of women. A Weibull hazard model takes into account the time intervals between marriage and first birth, as well as between first and second birth, respectively. One concern is that consecutive births are ordered events, and a later birth cannot take place until the previous birth has occurred. In order to account for this additional correlation, the results using the Prentice et al. (1981) method (PWP) are added to Table 3.[5]

The left portion of Table 3 presents the hazard ratio for each IV for birth timing. In the first column, experience of difficulty in conceiving significantly decreases the hazard rate of having a first child by about 67%. Difficulty in conception or the birth of a son at first also significantly decrease the hazard ratio of having a second child, by 54% and 13%, respectively, for women who have one child. Similar to the results of the parity progression model, the biological event (experience of conception difficulty) has a stronger effect on the fertility decision than does son preference. The PWP estimation represents a smaller hazard rate (28% and 11%, respectively). This points out the possibility of over-estimations without conditioning the occurrence of prior events. It is notable that the timing of second birth can be related with the time period between marriage and first birth. Despite a difference in the magnitudes of estimates, the hazard analysis suggests that the two IVs can explain the difference in fertility tempo.

Finally, both the indicator of having a son as the first child and the indicator of having experience with conception difficulty show strong predictability of child quantity and the estimation results relieve the concern of the weak IVs.

3.2 Validity of instrument variables

Instrument variables should be satisfied by the validity condition. In our analysis, IVs should be related to the number of children but not affect monetary investment in childcare. We may suspect that parents who prefer a son would also tend to spend more on a son's education than on a daughter's. Although son preference has long been reflected in parents' monetary and

[5] Mario Cleves summarizes how multiple failure-time data using Stata in http://www.stata.com/support/faqs/statistics/multiplefailuretimedata/. Stata code for PWP method are obtained by the instruction of this web source using Stata.

time inputs for boys in East Asian countries, gender differences in postnatal investment have been reduced with the decline in family size in South Korea Chung and Gupta (2007). The Survey of Private Education Expenditure conducted by Statistics Korea and the Ministry of Education reports no difference in participation and expenditure in private tutoring between boys and girls. While 77.1% and 68.1% of school-aged boys participated in private tutoring in 2007 and 2015, respectively, 76.9% and 69.5% of girls took part in the same years. In terms of monthly education expenditure per child, parents spent 223,000 KRW and 239,000 KRW for boys and 227,000 KRW and 250,000 KRW for girls in 2007 and 2015. As the 2015 KNSFFHW was used for this study, we examine a younger cohort of children (born between 1996 and 2015) than does previous research. These data support the recent trend of decline in gender differences in educational expenditure.

To check our samples, Table 4 summarizes total investment in child education, including pre-school and school-aged children, by child's gender and experience of difficulty conceiving. Since the existence of children who finished public education affects resource allocation for child input in households, this table exclusively considers household with only pre-school or school-aged children. In one-child families, 233,000 KRW was spent on boys and 228,000 KRW on girls per month, and the mean comparison test shows no significant difference between boys and girls. Even households with two children demonstrate no significant difference between a first boy and a first girl (T-statistics and p-value are 0.91 and 0.36). In terms of the sample with experience of difficulty conceiving, the total educational expenditures per child are similar between the two groups. Although the summary statistics do not deal with unobserved heterogeneity, the figures intuitively show that there is no difference in terms of costs for child quality for gender and difficulty conceiving.

4 Estimation and results

As an empirical strategy to test the existence of a child quality-quantity trade-off, we begin with the linear regression for the logarithm of total investment in children (lnI) as a function of demographic variables, as well as the number of children and the error term. For household i,

$$lnI_i = \alpha n_i + X_i\beta + u_i^0, \tag{4.1}$$

$$\text{where } n_i = X_i\gamma + Z_i\delta + u_i^1. \tag{4.2}$$

X_i is a vector of observations' characteristics, such as dummies for mother's and father's educational attainment, father's age, mother's age and age squared, dummies for location, and the logarithm of total household income. Because the costs of child-caring depend on the age of children, dummies for three age group of first child (pre-school, primary education, and lower and upper secondary education stage) are included. To deal with endogeneity of fertility, (4.2) serves as the first stage regression of instrument method, and then contains IVs in Z and other control variables X. The excluded instrument Z set includes dummy for

gender of first child and dummy for experience on difficulty of conception over a year.

Total expenditure for childrearing includes the costs for childcare facilities, hiring a personal nanny for preschoolers, tuition and other expenses for public education, private tutoring expenses, miscellaneous goods and services for children (toys, nursery products, and so on). Costs for consumption goods shared with adults, such as food or housing, are excluded from this study. Since we focus on educational expenses as an important indicator of parents' preference regarding child quality, required goods such as food or housing, fall beyond our scope. Indirect costs involved in childrearing by parents (childcare time or the career opportunity costs of having children) are also disregarded. In addition, total child-rearing expenses still include the goods and services for maintaining children, so we also consider the additional dependent variable of educational expenses only, including tuition and expenses for public education, childcare service for preschool children, and private tutoring.

The main analysis accounts for households which have school-age or younger children. If households have a child who has completed public education, that household is eliminated from the sample. Although parents may financially support their children even after they graduate from high school, higher education tuition and other expenses vary with students' career choices. Therefore, we only consider children within the public education system before high school graduation.

Table 5 presents the OLS and IV coefficients of fertility in the logarithm of household expenditures in children. The left portion of table is the results of the regression on total child-rearing and the right 3 columns result from the estimation when educational expense is dependent variable. In terms of total child-rearing costs, the OLS estimates of α are similar to IV results (about 34%). But, OLS and IV regressions on educational spending are different after addressing the unobserved heterogeneity. OLS and IV results are interpreted as having one more child will expand parental investment in education by 28.2% and 44.8%, and OLS estimate is under-estimated by 17%. Since those having a son first or difficulty with conception are less likely to have a larger number of children, addressing unobserved heterogeneity accounts for the observed relationship between child quantity and quality.

Lee (2008) explains that the elasticity of quality-quantity trade off is calculated using α. According to Becker and Lewis (1973), investment in children I is equal to $p_q nq$, where p_q is the unit price of child quality and q is the average quality of child. Following the derived equation by Lee (2008), α represents:

$$\alpha = plim \frac{\ln p_q nq}{n} = plim(\frac{1}{n} + \frac{\partial q}{\partial n}\frac{1}{q}) = \frac{1}{E(n)}(1 + \varepsilon_{qn}) \tag{4.3}$$

Hence, the elasticity of child quality with respect to quantity ε_{qn} is constructed from the coefficient α. $E(n)$ can be replaced with the sample average of n. Since the sample has 1.80 and 1.89, respectively, both elasticities of total and educational expenses per child with respect to the number of children are calculated as negative (-0.40 and -0.15, respectively). This negative elasticity implies indicates a trade-off between child quality and quantity. However, the magnitudes are different and the size of per-child educational expenditure elasticity is

smaller. Parents' investment on educational aspects is less responsive to the number of children. This is interpreted as parents in South Korea being less likely to reduce educational expenditure per child even when they have additional child. Parents expect that having an additional child can almost double the burden of their children's educational costs. It is also smaller than Lee (2008)'s finding using late 1990s data. This result using recent data supports the conception that households are indeed choosing not to have more children due to the resulting increase in educational cost, and trade-off is weaken between quality and quantity.

For a robustness check, another specification was also performed using the dichotomy variables for fertility instead of number of children (Table 6). Non-linear regression also has the merit of identifying whether the magnitude of the effect depends on a different number of children. When D_{2i} and D_{3i} stand for the indicators of having two children and three children, the equation is as follows.

$$lnI_i = \alpha_2 D_{2i} + \alpha_3 D_{3i} + X_i\beta + u_i^0, \tag{4.4}$$

$$\text{where } D_{2i} = X_i\gamma_2 + Z_i\delta_2 + u_{2i}^1, \tag{4.5}$$

$$D_{3i} = X_i\gamma_3 + Z_i\delta_3 + u_{3i}^1. \tag{4.6}$$

Unlike in the linear specification, the coefficient α_n presents the marginal effect of a second or third child on the expenditure per child using $(1 + \alpha_n)/n$ (Lee, 2008). OLS and IV results of total child-rearing costs are similar, while those of educational expense have difference. After instrumental estimation, households with two and with three children respectively spend 68% and 60% of total childrearing investment per child compared to families with only child. Children with more siblings tend to be the recipients of less individual parental expenditure. On the other hand, in terms of educational expenditures, only α_2 is statistically significant. The marginal effect of the second child on educational expenditure per child can be calculated as 78% and it is larger effect on total child-rearing cost per child. The results of non-linear specification also support that educational expenditure is less shrinkable with the number of children than childrearing expenditure. The interpretation of insignificance of α_3 should be careful. This is because the sample size with three children is much smaller than that of two children family. D_2 indicates 4165 household but D_3 has 776. Thus, insignificant estimates can be induced by relatively smaller size of sample.

In the second and fifth column of Table 5, both IVs have significant and negative association with the number of children. The partial R-squared in the second and fifth columns is 0.021 and 0.026, which is 10% and 18% of total R-squared. Since the F statistics are 75.8 and 84.4, this proves the explanatory power of two IVs. Also, we can test for the validity using Sargan-Hansen J statistics. Both columns presents that Sargan statistics accepts the validity condition of IVs since p-values are 0.92 and 0.25, respectively. Some coefficients from the first stage regression are interesting to point out. Mothers' traits are more critical than father's in terms of fertility. Higher educated female or order cohort mother tends to have smaller number of children. Since children whose age is older have more chance to have younger siblings, the first child whose are in higher grade in school is more likely to have more siblings. Households who reside in urban area are incline to have smaller children than in rural.

Estimates on other variables from the second stage regression are noteworthy as well. In general, parents with more education tend to invest more in children's quality. However, the difference between the two-year college and four-university groups among fathers is not significant. The more-educated mother group spends significantly more on children's education, including school tuition and private tutoring, but the significance disappears within educational costs. More highly educated mothers are more likely to invest in child quality but have a smaller number of children. The estimates on the natural logarithm of income convey child-rearing elasticity with respect to household income. Since income elasticity is positive and smaller than one, child-rearing or educational goods consumption is a normal good. However, elasticity with respect to educational expenses is about 5% more elastic than that for childrearing costs. This supports the possible educational inequality induced by household's wealth. When a first child is in lower or upper secondary education, households spend more on childcare expenses since private tutoring costs and other expenses increase with a child's age. Families which reside in cities have smaller family sizes and spend more on children.

5 Conclusion

The effects of the number of children on investment in child quality were investigated by addressing unobserved heterogeneity. Not only the gender of the first child, the conventional instrument for fertility, but experience of difficulty with conception for over one year is added to the instrument set. Since experience with difficulty in conception for over a year affects the tempo effect, this variable has a predictive power for the number of children. A prenatal preference for son still exists in South Korea, so first-child sex is good instrument of fertility. However, as society has developed and social norms have changed, son preference has also been eroded. Hence, one more additional instrument which is representative of individual traits relieves the concern over the weak IV problem. From the first-stage regression results, difficulty in conception shows significantly larger magnitudes of coefficients than does the first-child gender variable.

Following Lee (2008), the elasticities between child quality and quantity is constructed from the estimation results. Using a relatively recent cohort compared to the previous literature, our results show households' birth behavior can be attributed to deepening educational competition in South Korea. Particularly, total childrearing expenditure shows a clear negative association with fertility, so children with more siblings obtain less in terms of parents' expenditures than do those with no siblings. However, the educational expenditure result indicates that parents do not reduce their educational investment per child due to the size of the family. Based on the belief that greater spending on education guarantees children's future outcomes, it is considered inevitable these days to sustain a consistent per-child educational expenditure level.

Most public policy designed to promote the fertility rate has focused on family or labor policy to mitigate mothers' opportunity costs when having an additional child. As many policies achieve only short-term results, our findings evidence that the normalization of

competitive education is a necessity condition. Particularly, education fever has already been a subject of government attention because of intergenerational inequality through educational investment. Based on rigorous analysis, we also support the understanding that mitigating education fever may help alleviate the lowest-lower fertility currently experienced by South Korea.

Although this paper reveals that parents' burden of educational investment can encumber family size, the estimated elasticity in this paper explains parents' preferences after birth behavior. This result only explains the indirect comprehension of the interrelationship between quality and quantity and cannot address the true effect of the expected educational investment on fertility. As an extension of this work, predicted educational expenditure can be calculated using the IV estimates, and such an approach would shed light on whether expected investment in child quality determines the number of children.

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Table 1: Summary Statistics

	N	Mean	S.D	Min	Max		N	Percent
Father's age	9,379	41.39	6.65	20	65	Father's education		
Mother's age	9,379	38.72	6.10	18	50	High-school or less	2,814	30
Mother's age at marriage	9,379	26.53	3.64	15	44	2-year college	1,614	17.21
Mother's age at 1st birth	8,576	27.78	3.71	17	44	4-year university or more	4,951	52.79
Month between 1st and 2nd birth	6,276	35.53	21.19	0	211			
Month between 2nd and 3rd birth	1,095	48.74	31.42	0	191	Mother's education		
						High-school or less	3,488	37.19
Number of children	9,379	1.71	0.80	0	5	2-year college	1,992	21.24
when mother's age over 45	1,945	1.98	0.65	0	5	4-year university or more	3,899	41.57
First boy	8,576	0.51	0.50	0	1			
Difficulty conceiving over a year	9,379	0.13	0.34	0	1			
						Location		
2015 Household income	9,376	4981.02	2964.38	0	130000	Large cities	3,702	39.47
House owned when married	9,379	0.34	0.47	0	1	Medium or small size cities	3,662	39.04
Total education cost per child	8,576	300.83	291.64	0	3420	Rural are	2,015	21.48

Note: 2015 household income indicates the monthly income in household. Monthly total education cost includes costs for childcaring service for pre-school child, public education expense, and private out-of-school education (private tutoring) expense. The units of income and education costs are 1,000KRW.

Table 2: Parity progression model for the completed fertility

	Panel A. Mother over 40						
	OLS			Logit			
Dependent Variable	n			1[n>0]	1[n>1]	1[n>1]	1[n>1]
Difficulty of conceiving	-0.478***		-0.287***	-3.165***	-1.498***		-1.494***
	(0.04)		(0.03)	(0.26)	(0.11)		(0.11)
First boy		-0.124***	-0.120***		-0.262***	-0.251***	
		(0.02)	(0.02)			(0.09)	(0.09)
R2	0.185	0.090	0.112				
Psuedo-R2				0.440	0.137	0.096	0.139
N	4372	4267	4267	4372	4267	4267	4267
	Panel B. Mother over 45						
Difficulty of conceiving	-0.515***		-0.356***	-3.052***	-1.865***		-1.878***
	(0.05)		(0.05)	(0.41)	(0.17)		(0.17)
First boy		-0.151***	-0.150***			-0.470***	-0.504***
		(0.03)	(0.03)			(0.14)	(0.14)
R2	0.186	0.088	0.119				
Psuedo-R2				0.464	0.154	0.095	0.162
N	1945	1906	1906	1945	1906	1906	1906

Note: n indicates the number of children. Equations include father and mother's age, mother age squared, dummies for mother and father's three education categories (high school graduates or less, 2-year college, and 4-year university or more), location, and housing status at marriage. Robust standard errors are shown in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Table 3: Hazard ratio model for birth timing

	Weibull				PWP		
Dependent Variable	[Mar-1st]	[1st-2nd]	[1st-2nd]	[1st-2nd]		Both	
Difficulty of conceiving	0.322***	0.458***		0.459***	0.723***		0.724***
	(0.02)	(0.03)		(0.03)	(0.02)		(0.02)
First boy			0.863***	0.868***		0.894***	0.896***
			(0.03)	(0.03)		(0.01)	(0.01)
N	9348	8465	8465	8465	8465	8465	8465

Note: Dependent variables are months between subsequent birth events. [Mar-1st] and [1st-2nd] indicate months between marriage and the first birth, and the first and second birth, respectively. In PWP methods, subsequent events from marriage to 2nd birth are considered, simultaneously. Equations include father and mother's age, mother age squared, dummies for mother and father's three education categories (high school graduates or less, 2-year college, and 4-year university or more), mother age at the first birth, location, and housing status at marriage. Robust standard errors are shown in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Table 4: Educational expenses by first child gender and difficulty in conceiving

		Panel A. Gender difference		
n	Gender	Obs	Mean	S.D
1	First boy (1)	1,227	233.7	331.5
1	First girl (2)	1,058	228.0	327.7
Mean test	(1)-(2)		5.7	
	T-stat *(p-value)*		0.4	*(0.7)*
2	First boy (3)	2,202	382.5	314.4
2	First girl (4)	1,963	373.6	313.7
Mean test	(3)-(4)		8.89	
	T-stat *(p-value)*		0.91	*(0.36)*
		Panel B. Conception difficulty		
Difficulty	Yes (5)	912	287.5	301.0
	No (6)	6,304	273.2	273.4
Mean test	(5)-(6)		14.3	
	T-stat *(p-value)*		1.36	*(0.17)*

Note: n indicates the number of children. Educational investment per child indicates household monthly educational cost per child including costs for childcaring service for pre-school child, public education expense, and private out-of-school education (private tutoring) expense.

Table 5: Parents' expenses in children

Dep. Variable	Total child-rearing expense			Educational expense		
	OLS	IV		OLS	IV	
		First	Second		First	Second
n	0.354***		0.334***	0.282***		0.448***
	(0.01)		(0.07)	(0.02)		(0.10)
1[First boy]		-0.065***			-0.072***	
		(0.01)			(0.01)	
1[Difficulty in conceiving]		-0.232***			-0.262***	
		(0.02)			(0.02)	
Father's education						
2-year college	0.063***	-0.007	0.069***	0.087***	-0.022	0.091***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
4-year university or more	0.058***	-0.018	0.060***	0.073***	-0.017	0.076***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Mother's education						
2-year college	0.044***	-0.006	0.040**	0.032	0.002	0.032
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
4-year university or more	0.058***	-0.055***	0.057***	0.017	-0.043**	0.023
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Father's age	0.001	-0.002	0.000	0.013***	-0.007***	0.015***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Mother's age	0.022*	0.224***	0.019	0.139***	0.179***	0.109***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)
Mother's age squared	-0.000	-0.003***	-0.000	-0.002***	-0.003***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
First child age group						
Primary school	0.238***	0.479***	0.250***	0.747***	0.379***	0.681***
	(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.05)
Secondary school	0.485***	0.679***	0.504***	1.031***	0.603***	0.923***
	(0.02)	(0.03)	(0.05)	(0.04)	(0.03)	(0.07)
Large cities	0.115***	-0.063***	0.116***	0.269***	-0.073***	0.281***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Small or medium size cities	0.063***	-0.015	0.065***	0.171***	-0.029	0.176***
	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)
ln(HH Income)	0.460***	-0.017	0.459***	0.542***	-0.021	0.546***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Constant	1.199***	-2.049***	1.294***	-3.536***	-0.824**	-3.393***
	(0.24)	(0.29)	(0.27)	(0.48)	(0.37)	(0.49)
R-squared	0.502	0.213	0.502	0.479	0.146	0.470
Partial R-squared		0.021			0.026	
F test		75.761			84.410	
(p-value)		*(p<0.00)*			*(p<0.00)*	
Sargan test			0.004			1.330
(p-value)			*(p=0.95)*			*(p=0.25)*
N	7258	7258	7258	6387	6387	6387

Note: Robust standard errors are shown in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Table 6: Nonlinear specification of parents' expenses

Dep. Variable	Total child-caring expense		Educational expense	
	OLS	IV	OLS	IV
D_2	0.476***	0.360***	0.469***	0.568***
	(0.01)	(0.11)	(0.02)	(0.14)
D_3	0.669***	0.813***	0.559***	0.610
	(0.02)	(0.29)	(0.03)	(0.39)
Father's education				
2-year college	0.065***	0.062***	0.086***	0.086***
	(0.02)	(0.02)	(0.03)	(0.03)
4-year university or more	0.060***	0.059***	0.079***	0.079***
	(0.02)	(0.02)	(0.03)	(0.03)
Mother's education				
2-year college	0.033**	0.043**	0.019	0.016
	(0.02)	(0.02)	(0.03)	(0.03)
4-year university or more	0.054***	0.058***	0.005	0.005
	(0.02)	(0.02)	(0.03)	(0.03)
Father's age	0.000	0.001	0.015***	0.015***
	(0.00)	(0.00)	(0.00)	(0.00)
Mother's age	0.003	0.017	0.119***	0.107***
	(0.01)	(0.02)	(0.02)	(0.03)
Mother's age squared	0.000	-0.000	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
First child age group				
Primary school	0.226***	0.228***	0.736***	0.718***
	(0.02)	(0.04)	(0.03)	(0.05)
Secondary school	0.471***	0.468***	1.009***	0.978***
	(0.02)	(0.06)	(0.04)	(0.08)
Large cities	0.118***	0.119***	0.269***	0.270***
	(0.01)	(0.02)	(0.02)	(0.03)
Small or medium size cities	0.065***	0.067***	0.171***	0.170***
	(0.01)	(0.02)	(0.02)	(0.03)
ln(HH Income)	0.454***	0.458***	0.534***	0.533***
	(0.01)	(0.01)	(0.02)	(0.02)
Constant	1.917***	1.633***	-2.924***	-2.791***
	(0.24)	(0.32)	(0.48)	(0.51)
R-squared	0.514	0.487	0.492	0.490
N	7211	7211	6341	6341

Note: Robust standard errors are shown in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Table 7: First-stage results of nonlinear specification

Dep. Variable	Total child-caring expense		Educational expense	
	D_2	D_3	D_2	D_3
1[First boy]	0.015	-0.037***	0.022*	-0.045***
	(0.01)	(0.01)	(0.01)	(0.01)
1[Difficulty in conceiving]	-0.173***	-0.030***	-0.199***	-0.032***
	(0.02)	(0.01)	(0.02)	(0.01)
Father's education				
2-year college	0.015	-0.003	0.001	-0.003
	(0.02)	(0.01)	(0.02)	(0.01)
4-year university or more	0.002	-0.004	-0.001	-0.002
	(0.02)	(0.01)	(0.02)	(0.01)
Mother's education				
2-year college	0.034**	-0.017	0.037**	-0.015
	(0.02)	(0.01)	(0.02)	(0.01)
4-year university or more	-0.002	-0.026**	0.007	-0.025**
	(0.02)	(0.01)	(0.02)	(0.01)
Father's age	-0.000	-0.001	-0.004**	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)
Mother's age	0.122***	0.049***	0.090***	0.043***
	(0.01)	(0.01)	(0.02)	(0.01)
Mother's age squared	-0.002***	-0.001***	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
First child age group				
Primary school	0.193***	0.132***	0.106***	0.126***
	(0.02)	(0.01)	(0.02)	(0.01)
Secondary school	0.249***	0.199***	0.174***	0.198***
	(0.02)	(0.01)	(0.02)	(0.01)
Large cities	-0.002	-0.030***	0.003	-0.037***
	(0.02)	(0.01)	(0.02)	(0.01)
Small or medium size cities	0.020	-0.017*	0.020	-0.023**
	(0.01)	(0.01)	(0.02)	(0.01)
ln(HH income)	0.017	-0.014*	0.018	-0.016*
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	-1.989***	-0.529***	-1.152***	-0.346*
	(0.24)	(0.15)	(0.31)	(0.21)
R-squared	0.098	0.059	0.048	0.050
Partial R-squared	0.017	0.006	0.025	0.008
F test	52.87	17.87	62.36	19.28
(p-value)	*(p<0.00)*	*(p<0.00)*	*(p<0.00)*	*(p<0.00)*
N	7211	7211	6341	6341

Note: Robust standard errors are shown in parentheses. * p<0.1, ** p<0.05, *** p<0.01