Son Preference, Sex-Selective Abortion, and Parental Investment in Girls in Korea: Evidence from the Year of the White Horse[1]

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March 2015

Abstract

We investigate how the selection of offspring gender in the presence of son preference affects the parental investments in girls and boys in South Korea. To identify the magnitude of parental son preference, we exploit two types of variations in the extent of sex selections, namely, (1) the provincial variations in the sex ratio at birth that result from regional differences in cultural norms and religious beliefs, and (2) the temporary increase in the sex ratio at birth in 1990 (the year of the White Horse), which has been driven by zodiacal preference. We conduct triple difference estimations to examine how the gender differences in parental investment in the health and education of children change across regions and cohorts. We find that the relative parental investments in girls in the forms of prenatal care, breast feeding and private out-of-school education are significantly larger for cohorts born in 1990 and that the effect of the year of the White Horse is more strongly observed in regions with higher sex ratios at birth. A higher prevalence of sex-selective abortions led to greater parental investments in girls than in boys. The rise of sex-selective abortions in Korea from the early 1980s to the early 2000s unintendedly improved the human capital development of females who were selectively born to parents with weaker bias against daughters.

[1] We benefited from helpful comments and suggestions of Eleanor Jawon Choi, Ryuichi Tanaka and participants of the 2014 SNU–Tokyo University Joint Conference, the 2015 APEBH Conference, and the 2015 Korean Allied Economics Conference.

1. Introduction

Parental differential investment in boys and girls has been studied extensively by analyzing some Asian countries where son preference is strongly observed (Gupta 1987; Sen 1992; 2003; Qian 2008; Rosenzweig and Zhang 2009). These studies have shown that parental son preference is associated with asymmetric intra-household resource allocation, such as health and education investments between boys and girls. They also find that the gender-differential parental investments result in gender inequalities in the outcomes of children, such as their mortality, nutritional status, and school enrollment rates (Oster 2009; Pande 2003; Parish 1993; Schultz 1993).

The introduction of prenatal sex determination technologies has enabled parents to know the gender of their children prior to delivery. The availability of ultrasound under the culture of son preference can generate a twofold effect on girls. First, ultrasound makes prenatal sex selection viable, which increases the chance for girls to be aborted. Second, if parents with son preference are carrying a female fetus, ultrasound can negatively affect their prenatal investments in their future children.

Several studies have explored the effect of prenatal sex determination technologies on the male-to-female ratio at birth. The improved local access to ultrasonic tests have significantly increased the number of sex-selection abortion incidents (Kim 2005; Chen, Li, and Meng 2013). By exploiting the different timing of diagnostic ultrasound introduction in China during the 1980s, Chen et al. (2013) investigated the relationship between prenatal sex selection and high sex ratio at birth and found that improving the local access to ultrasound technology significantly increased the sex ratio at birth.[2]

The gender-differential investments of parents in their children have also attracted research attention. Several researchers have investigated the effects of fetal gender knowledge on gender-differential prenatal investments and on the subsequent child outcomes. By using data on first-generation parents who immigrated from India and China to the United States, Lhila and Simon (2008) found that prenatal screening of offspring gender did not lead to discriminative behaviors of mothers against female fetuses. By contrast, using micro health data from India, Bharadwaj and Lakdawala (2013) reported that pregnant mothers with male

[2] Sex ratio at birth is generally defined as the ratio of boys to 100 girls. The natural level of sex ratio at birth without intervention is approximately 105 (between 103 and 107).

fetuses visited antenatal clinics and received tetanus shots more frequently than those mothers with female fetuses. Almond et al. (2010) also reported that the early neonatal mortality of girls rose with increased access to ultrasonic tests.

The effects of sex selection on postnatal gender discrimination have also been studied. Valente (2014) found that the proximity to a legal abortion center neither led to more sex selections nor gender-differential investments in neonatal health by Nepalese parents. Dasgupta (2011) determined that households with a higher sex ratio imbalance exhibited a longer duration of breastfeeding girls than households with a more balanced sex ratio at birth.

In this study, we investigate how the selection of offspring gender in the presence of son preference affects parental investments in girls and boys in South Korea. To identify the magnitude of parental son preference, we exploit two types of variations in the extent of sex selections, namely, (1) the provincial variations in the sex ratio at birth that result from regional differences in cultural norms and religious beliefs, and (2) the temporary increase in sex ratio at birth in 1990 (the year of the White Horse), which has been driven by zodiacal preferences. We conduct triple difference estimations to examine how gender differences in parental investments in the health (measured by the prevalence of breastfeeding) and education (measured by expenditure on private tutoring) of children change across regions and birth cohorts.

The relative parental investments in girls in the form of prenatal care, breastfeeding and private education are significantly larger for cohorts born in 1990, and the effect of the year of the White Horse is more strongly observed in regions with higher sex ratios at birth. Therefore, a higher prevalence of sex-selective abortions leads to greater parental investments in girls than in boys. This finding can be attributed to the fact that only those parents with relatively weak son preference selectively choose to carry female fetuses when a large fraction of girls are prenatally aborted. This paper suggests that the rise of sex-selective abortions in Korea from the early 1980s to the early 2000s have unintendedly improved the human capital development of females who are selectively born to parents with weaker bias against daughters.

This study contributes to the literature in several aspects. We add to the limited number of studies on the effects of prenatal sex selection by exploiting the unique demographic variations in Korea. To our knowledge, our analysis is the first to draw evidence from Korea, thereby widening our understanding of the possible differences among various

countries. This paper also has implications for long-term relative improvements in the educational and labor market performances of females in Korea. We speculate that the accelerating progress of females over the recent years can be attributed to the reduced parental prejudice against girls, which helps increase investments in the human capital development of females.

2. Backgrounds

2.1. Son preference and sex selection in Korea

Similar to those in many other Asian countries, parents in Korea traditionally prefer having sons than daughters. Influenced by the Confucian tradition, a son (especially the eldest son) is expected to inherit the family tradition and serve his ancestors. The lower labor market status of females has also made daughters less attractive to parents, especially those who are poor and have to depend on their offspring for old-age support. Given the prevalence of son preference in Korea, the sex ratios at birth in the country began to increase after the ultrasound technology was introduced in the early 1980s (Figure 1). After reaching its highest level in 1990, the boy-to-girl ratio declined to a normal level of 106 by 2007. The rapid rebalancing of the sex ratio is attributed to the changes in social norms, the development of the Korean economy, the increasing disadvantage of males in the marriage market, and the relative improvements in the social and economic status of females (Chung and Das Gupta 2007; Edlund and Lee 2013; Lee 2013).

Aside from the dramatic changes in Korea over the last three decades, the sex ratios at birth greatly vary across all Korean provinces for a given year. Figure 2 presents the sex ratios at birth from 1988 to 2000 in four selected Korean provinces. The ratio is remarkably higher in southeastern regions, such as in the metropolitan city of Daegu and the province of Kyung-buk, which remain dominated by Confucian teachings. Although these inter-province differences in sex ratios at birth have diminished over time, the boy-to-girl ratios in the southeast region remained high in the early 2000s.

In 1990, Korea recorded a sharp, temporary increase in its sex ratios at birth, which was attributed to the zodiacal preference of parents. Similar to other Asians, Koreans have a long tradition of following the oriental calendar system, in which the years are typified by zodiacal signs according to a rotating cycle of 12 animals, namely, rat, ox, tiger, rabbit,

dragon, snake, horse, sheep, monkey, rooster, dog, and pig. Many people believe that the personality and characteristics of an individual are defined based on his/her zodiac sign. Koreans have a unique belief that girls who are born in the year of the Horse have undesirable characteristics as wives, which is regarded unfortunate for women in a traditional society.

The years of the Horse that come every 12 years are not identical to one another. A 60-year cycle is completely formed when the 12 animal years are combined with the five major elements (i.e., metal, water, wood, fire, and soil) that compose the earth. Based on these elements, the years of the Horse are distinguished from one another by five colors (i.e., blue, red, yellow, white, and black). Therefore, a specific year of the Horse is recorded every 60 years. Although all years of the Horse are believed to bring misfortune to girls, those girls who are born in the year of the White Horse are believed to be the most inauspicious.[3] The mythical faith of Koreans regarding the year of the White Horse is demonstrated by the lower fertility rates and higher sex ratios at birth in Korea during this year (Lee and Paik 2006). In 1990, Korea recorded the highest sex ratio at birth following the advent of sex selection technologies.

2.2. Investments in Children in Korea

2.2.1. Prenatal care

Prenatal care for pregnant women usually includes measurement of vital signs, blood test for determining anemia and hepatitis, and urine test for checking diabetes or other infections. In addition, education programs on healthy lifestyle and habits are provided. Prenatal care can be helpful for improving the birth outcomes of the newly-born as well as the health of the mothers, especially those with serious health problems. For example, Kogan et al. (1994) find that receiving sufficient advice on health behavior diminishes the probability of low birth weight among children born to high-risk women. It is widely accepted that the condition while in utero that prenatal care can affect is an important determent of health and human capital development (Barker 1992, 1994; Currie and Hyson 1999; Behrman and Rosenzweig 2004; Black, Devereux, and Salvanes 2007; Currie and

[3] A newspaper article states: "Women born in Horse Years are said to be smart, active, impatient and argumentative, that is to say, unmarriageable in this patriarchal society… Women born in the Year of the White Horse, which comes every 60 years, are said to be even worse, bringing disaster and even death to the men around them" (*Chicago Tribune*, March 9, 1990).

Moretti 2007).

In South Korea, prenatal care was not so costly during the period under study. A large fraction of the population had been covered by the National Health Insurance (NHI) by the late 1980s. In addition, under the Mother and Child Health Act that was fully amended in 1986, pregnant women could receive basic checkups for free of charge at public health centers once they registered pregnancy or delivery. The percentage of pregnant women who received prenatal care was already high by the mid 1980s (82.4% in 1985), and continuously increased over time (88.5% in 1988, 94.4% in 1991, and 99.2% in 1994).[4]

The high rate of coverage during the period does not necessarily imply that prenatal visit did not incur any cost for pregnant women. Because of the shortage of and poor accessibility to high-quality public medical facilities, the vast majority of pregnant women visited private hospitals for prenatal care.[5] The requirement of pregnancy registration could play a role of non-monetary barrier to the benefit.[6] Although the medical cost for basic care covered by the NHI is generally low, the ratio of out-of-pocket payments to the total expenses is relatively high in Korea. For the five years covered by this study (1988 to 1992), a non-trivial proportion of pregnant women (3.7%) did not receive prenatal care at all. Under the circumstance, it may not be unreasonable to use prenatal care as a measure of parental investment in children following previous studies on the topic (Bharadwaj and Lakdawala 2012; Lhila and Simon 2008).

2.2.2. Breastfeeding

Studies on medical and public health have suggested that breastfeeding affects the short- and long-term infant and maternal health outcomes in developed and developing countries. By reviewing the effects of breastfeeding in developed countries,[7] Chung et al. (2007) revealed that a history of breastfeeding was associated with various health benefits for infants—even after early childhood—and their mothers.[8]

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[4] National Survey on Fertility, Family Health, and Welfare in Korea

[5] Only 126 out of 1,000 pregnant women visited a public medical center in 1990.

[6] Currie and Grogger (2002) introduce the literature suggesting that non-monetary barriers might be one of factors that explain why some eligible people do not participate in the Medicaid programs.

[7] Plenty of evidence has also been collected from developing countries (Isaacs 2005; Betran et al. 2001; Chen, Yu, and Li 1988; Retherford et al. 1989).

[8] The following benefits have been identified: reduction in the risk of acute otitis media, non-specific gastroenteritis, severe lower respiratory tract infections, atopic dermatitis, obesity, types 1 and 2 diabetes, sudden infant death syndrome, childhood leukemia, necrotizing enterocolitis, and asthma

Although many studies have established the benefits of breast milk, actual breastfeeding practices have been discouraged in many parts of the world during the 1970s. Other than the socioeconomic factors that affect the prevalence of breastfeeding, the decrease in the breastfeeding practices is partly attributed to the promotion of manufactured breast milk substitutes. In response to the promotion of these alternatives, WHO adopted the "International Code of Marketing of Breast Milk Substitutes" in 1981 to regulate the inappropriate sales promotion of infant food substitutes as well as introduce appropriate remedial measures. The Korean government also took few legal actions to implement the recommendations of WHO despite not fully enforcing this code in the country (Chung et al. 2008).[9]

A more effective breast milk promotion campaign was initiated by a civic organization, Consumers Korea, in 1983 with support from WHO, UNICEF, and International Organization of Consumers Unions. The organization publicly distributed pamphlets containing information on the advantages of breast milk over infant formulas, held an international seminar on the benefits of breast milk, and submitted a bill for controlling the production and sales of artificial baby food, such as infant formula.

However, both the public and private breast milk campaigns in Korea failed to increase the prevalence of breastfeeding practices in the country. The percentage of mothers who breastfed their babies declined in the late 1980s and the early 1990s.[10] However, the overall decline in breastfeeding cannot be solely attributed to the ignorance of mothers regarding the benefits of such practice. According to a 1990 survey by Consumers Korea on infant feeding practices, more than 85% of mothers responded that exclusive or partial breastfeeding was better than bottle feeding.[11] The decrease in breastfeeding practices may be attributed to other factors that influence the decisions of mothers regarding the type of

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(for young children). In terms of maternal benefits, a history of nursing was associated with a reduced risk of type 2 diabetes, breast cancer, and ovarian cancer.

[9] The promotion of infant formula to the general public and the provision of free or low-cost supplies to health workers and healthcare facilities were prohibited in 1991, while the advertising of bottle-fed complementary food, which are difficult to distinguish from formula food, was prohibited in 2002 (Chung et al. 2007).

[10] The percentages of mothers who practiced exclusive breastfeeding were 49.6% in 1983 and 43.7% in 1988, while the percentages of mothers who bottle-fed their infants (entirely depending on manufactured baby food) were 16.7% in 1983 and 25.9% in 1988 (Park and Hwang 1993).

[11] Approximately 27.2% of mothers chose exclusive breastfeeding as an ideal feeding method, 55.3% said that the combination of breastfeeding and bottle feeding with more weight on the former was ideal, and only 15.8% thought that placing more weight on bottle feeding was ideal (Kyukyung Lee, "Breastfeeding Hospital 0.9%," *The Kyunghyang Daily News*, 5 November 1990. 19 print).

baby food, such as the secular increase in the employment rates among women.[12]

Breastfeeding entails non-trivial costs for mothers. First, such practice requires much time, which is particularly costly for working women. Second, breastfeeding incurs physical and psychic costs, which are especially severe in societies that are not supportive of breastfeeding. For instance, breastfeeding in public places is inconvenient in the absence of nursing rooms.[13] Third, mothers must maintain their health while nursing their infants.

In sum, the majority of the mothers in Korea began to perceive the advantages of breast milk over substitute food, such as infant formulas, by the late 1980s. Breastfeeding requires a substantial amount of time as well as physical and psychic costs to mothers. Therefore, breastfeeding can be considered a form of parental investment in their children during the study period (from the late 1980s to the early 1990s).

2.2.3. Competition in education and private tutoring

Korean parents are highly concerned about the education of their children. Entering an excellent college is considered a key success factor in the labor and marriage markets. The demand for excellent education has been intensified as the extent of wage inequality and the disparities between high-paying and low-paying jobs continued to increase since 2000. The wage differences between higher- and lower-university graduates in Korea widened between 1999 and 2008 (Ko 2011).[14] Under a highly competitive environment, parents become willing to allot much of their money and time for enhancing the academic performance of their children.

Given that the Korean secondary education system has been equalized, only few differences can be observed across the schools in the country in terms of the quality of education that they offer and the amount of tuition that they require.[15] Under this condition, parents who want to spend most of their finances for paying tuition cannot make additional

[12] The employment rate of females aged 15 and above in Korea increased from 39.6% in 1985 to 46.2% in 1990. Such increase was particularly evident for younger women who would have experienced marriage and delivery (Park and Hwang 1994).

[13] As another example of psychic disutility among mothers, only few mothers avoid breastfeeding their infants because they believe that such practice would negatively affect their physical shape.

[14] The wage premium of elite (top 10) college graduates over non-elite college graduates increased from 4.6% in 1999 to 28.9% in 2008 (Ko 2011).

[15] Expensive international schools have been established in some metropolitan cities of Korea, such as Seoul and Busan. However, the number of students that are accepted into these schools is extremely limited that those who aspire to enter these schools heavily depend on private tutoring.

investments in their children. Therefore, the differences in parental investments in the education of their children cannot be easily distinguished based on the amount of money that parents spend on formal education.

This feature of the Korean education system, combined with the intensified competition for higher education, increased the demand for private tutoring (Lee 2008). According to the Survey of Private Education Expenditure by the Korean National Statistical Office, over 75% of school-age children received some form of private tutoring in 2009. The average amount of money that was spent on private tutoring accounted for 6% of the total household expenditures in 2010.[16] In Korea, where parents believe that private tutoring increases the likelihood for their children to enter excellent universities, the expenditure on private education is a primary form of parental investment in the human capital of children.

3. Conceptual Framework

This study focuses on parental investments in children who were born in the late 1980s and the early 1990s. The diffusion of sex selection technologies (e.g., ultrasonic tests) was assumed to be completed by the late 1980s. Although abortion has been prohibited by South Korean law except under special circumstances, such law was not effectively enforced and abortion clinics in the country remained accessible and inexpensive. This assumption is consistent with the generally high sex ratio at birth in 1988, which has reached over 112 in the entire country and over 109 in 12 of its 15 provinces.

Under these circumstances, the substantial variations in the sex ratio at birth across Korean provinces capture the varying preferences of parents for the gender of their offspring rather than the differences in the availability of sex selection technologies. Cultural differences can result in regional variations in son preference. For instance, son preference is particularly strong in some provinces, such as the city of Daegu and the province of Kyung-buk, where the Confucian tradition remains influential. Edlund and Lee (2013) found a negative correlation between the proportion of Christian residents and sex ratio at birth by investigating county-level data.

The inter-provincial differences in the sex ratio at birth can also be attributed to the regional disparities in the economic and psychic benefits of having a son instead of a

[16] Korean Statistical Office, 2010 Household Income and Expenditure Survey

daughter. Parents prefer having sons because they expect to receive greater economic support from them than from daughters. Edlund (1999) also found that the chances of having grandchildren could affect the offspring gender selection of parents. Edlund and Lee (2013) reported that the sex ratio at birth in Korea was negatively related to the average earnings (a proxy for the size of marginal utility from the additional income of children) and the marriage market conditions of sons. Lee (2013) found that the improvement in the relative labor market status of females was associated with the decreasing boys-to-girls ratio in each county from 2001 to 2010.

The son preferences of individuals, which are rooted in their cultural norms or religious beliefs, cannot change rapidly over time. Therefore, when mass migrations across regions are barred, one can safely assume that each region has a quasi-fixed distribution of son preference that remains stable over time. The economic or psychic benefits from children of a particular gender can also be influenced by the changing conditions in the labor and marriage markets. Therefore, the sex ratio at birth in a given region can fluctuate along with the changing economic or demographic environments of the region even if the region-specific distribution of son preference remains unchanged. However, the inter-province differences in the economic and demographic factors of offspring sex selection remained stable in Korea during the study period. As suggested by the strong positive correlation between the sex ratios at birth in 1989 and 1995 (presented in Figure 3), few changes were observed in the variance pattern of son preferences across regions.

Figure 4 illustrates the circumstances that are described in this paper. The two graphs in panels A and B present the distributions of the expecting parents in two regions, A and B, who know that the gender of their child is female. Each individual has a particular value of son preference. On average, the residents in region B have a stronger son preference than those in region A ($\mu_A < \mu_B$). When the son preference value of parents exceeds a certain threshold, which is denoted by *d*, they will choose to abort their children. The threshold value for abortion depends on the financial, psychological, and social costs of sex-selective abortion and the region-specific factors that determine the economic advantages of sons over daughters. For simplicity, consider a case in which regions A and B have the same cutoff value (d_0) as presented in Figure 4. Under this condition, a larger fraction of girls are aborted in region B than in region A; thus, the sex ratio at birth is higher in region B than in region A. If the threshold value differs across regions, the variance pattern in the sex ratios at birth

across regions can be determined based on the differences in the shape of the preference distribution and on the size of the cutoff value.

Basing on evidence on gender bias in parental investments in children, we assume that parents with a stronger son preference discriminate more actively against girls when investing in the human capital of their offspring. If we suppose that the relative investments of parents in their sons are proportional to the strength of their son preference, then the magnitude of gender bias in investments in children becomes greater in a region with a higher average value of son preference than in a region with a lower value of son preference. If sex-selective abortion is unavailable, then the girls in region A will fare better than those in region B because the unconditional mean of son preference is greater in region A than in region B ($\mu_A < \mu_B$).

Sex-selective abortions diminish the average son preference value of parents who actually give birth to a girl because a fraction of the right tail of the distribution is censored. In other words, girls who may have been born to parents with the strongest son preference in the region are selectively aborted. However, the average son preference of parents who choose to bear the child (the conditional mean of son preference) is determined by the shape of the distribution (e.g., the unconditional mean of son preference) as well as the proportion of aborted girls rather than inferred directly from the sex ratio at birth in a particular region. If the distribution of son preference is identical across regions, then the conditional mean of son preference becomes lower in a region with a higher boy-to-girl ratio. However, if the distribution of son preference differs across regions, the regional variations in sex ratio at birth cannot be easily attributed to the differences in sex selections (e.g., similar distributions of son preference and different thresholds for abortion) or to the differences in inherent son preferences (e.g., different distributions of son preference and similar thresholds for abortion).

The year of the White Horse (1990) produced an exogenously driven variation in parental selections of offspring gender, which offeres a unique opportunity to explore the effects of changing son preference on parental investment in girls. Given that the marriage-market prospect for females born in this year would be worse than for females who were born in other years, some parents who would have carried the female fetus into term in an ordinary year would choose to abort their child instead. The sex ratio at birth in Korea increased from 111.8 in 1989 to 116.5 in 1990 and then fell to 112.4 in 1991. Given that the behavioral changes of parents could partly be attributed to their concerns about the attitudes of other

people (including potential male partners and their parents) toward their would-be daughters, a wider population in Korea can be affected regardless of their own preference for offspring gender. The sharp increase in the sex ratio at birth between 1989 and 1990 is observed in virtually every Korean province (Table 1).

Figure 4 presents the effect of the year of the White Horse as a movement of the threshold value for abortion to the left (from d_0 to d_1).[17] The figure suggests that the effect of the year of the White Horse becomes stronger in a province with a higher sex ratio at birth than in a province with a more balanced sex ratio at birth. Even if the magnitude of the change in threshold (d_1–d_0) remains the same, the additional number of sex-selective abortions (represented by the shaded areas) is larger in region B than in region A. In support of this hypothesis, the effect of the year of the White Horse, which is measured by the magnitude of the increase in the sex ratio at birth between 1989 and 1990, is positively related to the sex ratio at birth in 1989 (Figure 5). The application of an identification strategy (triple difference analysis) in this study is motivated by these circumstances.

4. Data and Measures of Parental Investment

The data for this study are collected from several sources. The first data set contains the sex ratios at birth by administrative division, which is obtained from the "Annual Report on Live Births and Deaths Statistics" that is published by the Korean Statistical Office. This survey is designed for documenting demographic changes in Korea, such as live births, deaths, marriages, and divorces. These statistics are based on the vital registrations of all Koreans who live in Korea and in other countries. The vital statistics in Korea, especially those published after the late 1980s, are widely regarded as highly comprehensive and accurate.[18] The information gathered throughout a specific year is published in the next year in the form of an annual report, which includes the total number of boys and girls that are

[17] The primary implications remain the same if the effect of the year of the White Horse is characterized by a temporary horizontal shift of the preference distribution.

[18] Incomplete birth registration data are collected prior the late 1980s (Choi 1991) as parents have failed to register their births on time. However, the improvement in the registration system, the introduction of the social security system, and the implementation of stronger laws have increased the rate of birth registrations to more than 90% in the late 1980s (N. Kim 1997). Given that the delayed birth registrations have been continuously updated in the Annual Report in the following 10 years, we use the most recent information for each cohort that is given in the report.

born in each administrative region (metropolitan cities and provinces).[19] We restrict the sample to sons and daughters who are born between 1988 and 1992 to construct a balanced data set with two cohorts who are each born before and after 1990. The sex ratio at birth for a particular year and administrative region is calculated based on the number of births by gender. Table 1 shows the sex ratios at birth for each province from 1988 to 1992.

The second data source is a micro dataset from the "National Survey on Fertility, Family Health, and Welfare in Korea," which is provided by the Ministry of Health and Welfare in cooperation with the Korea Institute for Health and Social Affairs. This survey, which has been conducted triennially since 1991, provides a nationally representative sample of households. Women in the sample households who are aged between 15 and 49 years are asked about the demographic characteristics of their household members. The modules of this dataset are designed to investigate the birth history, value for children, and attitude toward family planning of the surveyed women. The initial sample size is approximately 7,000 women for one year. The variables related to health investment, such as prenatal care and breastfeeding, are provided only for the youngest child who is aged below three years of ever-married women. Therefore, we select only households with ever-married mothers whose youngest child is born between 1988 and 1992 from the pooled sample of surveys for 1991 and 1994. Table 2 shows the summary statistics of this dataset.

The dataset for our empirical analysis on parental educational investment is drawn from the Youth Panel (YP) surveys, which are annual longitudinal surveys on the school life, social and economic activity, and family background of Korean youth. YP comprises two different waves. The first wave began in 2001 and followed up the sample individuals for six years under the Phase 1 Youth Panel Survey Project (YP2001). A new sample composed of individuals who were aged between 15 and 29 years was constructed to perform the Phase 2 Project in 2007 (YP2007), which included cohorts who were born from 1979 to 1993. We utilize YP2007 because this project includes the five birth cohorts of our interest (cohorts born from 1988 to 1992).

The initial survey of YP2007 provides detailed information on the private out-of

[19] Korea had six metropolitan cities and nine provinces from 1988 to 1990. The city of Ulsan belonged to the province of Kyung-buk and did not publish separate statistical data on its population. Therefore, the sex ratio data in Ulsan prior its independence from Kyung-buk could not be calculated. Given that the patterns of the sex ratios at birth in Ulsan closely follow those of Kyung-buk, the changes in administrative classifications do not significantly affect the results.

school education history of the respondents, including their educational types, frequencies, and expenditures, regardless of their status. For example, the private education section contains the following questions: “Have you received any private education while in middle or high school? What are the subjects on which you have received private education? How much have you paid for tutoring every month?”

Questions on private education expenditure are separately given for each subject, such as Korean, essay writing, English, mathematics, social studies, science, technical course, music, fine arts, or physical education (these three are classified under the same category), non-English foreign language, and full-package educational program. Parents in South Korea narrowly focus their investments on private education to prepare their children for their Korean Scholastic Ability Test, which includes questions on Korean language, mathematics, English, social studies, and science. Technical courses are designed only for students in technical schools, and the expenditure patterns on the music, fine arts, or physical education subject are qualitatively different from those on other subjects. Therefore, the expenditures on the five main subjects are employed to construct a variable for private education expenditure.

We use the average private education expenditure for all school years available in the dataset. The amount of private education expenditure may vary across each grade. The first-year survey of YP2007 provides retrospective answers for a particular question at the time of the survey. For example, for those cohorts who had already graduated from high school by 2007, YP2007 records only the monthly expenditure of these students during their entire secondary school years. In the subsequent surveys, the respondents are required to provide their private tutoring expenditures for the previous year after the previous survey was conducted. Therefore, for the majority of the cohorts in our sample, the retrospective average for early school years (obtained from the first wave) and the average values for the later years are mixed to compute the variable on private education.

For these reasons, the variable on monthly private education expenditure is subject to measurement errors. Although we cannot fully resolve this problem, the following justifications may be suggested. First, the retrospective answer in the first survey provides the average for all school years up to the time of the survey. Therefore, mixing the retrospective answer for the previous years and that for the current year will not lead to a bias. Second, if the relationship between grade and magnitude of private tutoring expenditure is similar across the five cohorts, adding cohort dummy variables can mitigate the potential bias problem.

5. Empirical Strategy and Results

5.1. Prenatal Health Investment

As explained in the conceptual framework section, we exploit the variations in the incidence of prenatal sex selections across regions and birth cohorts to examine the relationship between son preference and parental investments in children. Although the local prevalence of sex-selective abortions cannot be directly observed, such prevalence can be inferred from the sex ratios at birth in each province.[20] We expect that the subjects of the 1990 female birth cohort are born to parents with weaker son preference and receive relatively greater parental investments as compared to the neighboring birth cohorts. We also anticipate that the effect of the year of the White Horse is stronger in places with an initially higher sex ratio at birth.

To investigate how the average strength of parental son preference can affect the prenatal health investments in children, which are measured by prenatal care or incidence of low birth weight, we estimate the following triple-difference equation:

$$y_{ist} = \beta_0 + \beta_1 girl_i + \beta_2 sexratio_s + \beta_3 1990_t + \beta_4 girl_i \times sexratio_s + \beta_5 girl_i \times 1990_t + \beta_6 1990_t \times sexratio_s + \beta_7 girl_i \times sexratio_s \times 1990_t + X_i'\beta + \gamma_s + \delta_t + \mu_{st} + \varepsilon_{ist} \quad (1)$$

where subscripts *s* and *t* denote the province and year of birth, respectively; y_{ist} denotes a dummy variable that indicates whether the mother received prenatal care during pregnancy of her child *i* in province *s* born in year *t* or whether the child born with low birth weight (a birth weight less than 2,500g); $girl_i$ is a dummy variable for daughters, which is equal to 1 if child *i* is a girl and 0 otherwise; $sexratio_s$ denotes a time-invariant variable on sex ratio at birth in the birthplace *s* of a child; 1990_t is a dummy variable for the year of the White Horse, which is equal 1to 1 if child *i* is born in 1990 and 0 otherwise; X_i is a vector of individual characteristics that include parental education, age of mother during birth,

[20] If girls have a higher infant mortality rate than boys, sex ratios that exceed the natural level may not represent the effect of prenatal sex selection. However, in 1989, the actual mortality rate at age 0 is higher in boys than in girls. Out of 100,000 births, 313.9 boys and 288.3 girls were dead upon birth, while 112.7 boys and 98.6 girls were dead between 1 year and 4 years. Given the pervasiveness of son preference during this period, the high sex ratios at birth in 1989 can be explained by the incidence of prenatal sex selection.

variables indicating whether child *i* is born naturally or by caesarean operation, and variables indicating whether the child is the first born in a family; γ_s is a province fixed effect, δ_t is a year-of-birth fixed effect, and μ_{st} is a province-year fixed effect.

We use the following two variables for the time-invariant sex ratio at birth in each province. First, we include in baseline regressions dummy variable indicating if the child was born in one of the four provinces where the sex ratios at birth have been remarkably higher than the rest of the country, including Daegu, Kyung-buk, Ulsan, and Kyung-nam (referred to as "High4" in the balance of the paper).[21] Second, we use continuous variable on the province-specific sex ratio at birth in 1989 (denoted "Sexratio"). The baseline regressions are based on a pooled sample of the 1991 and 1994 surveys that includes the children born between 1988 and 1992.

Table 4 presents the results of logistic model estimations for prenatal care based on three different specifications. The dependent variable is a dummy indicating whether the mother received at least one prenatal checkup.[22] Model 1 (column 1) includes dummy for girl, the 1990 birth cohort dummy and the provincial sex ratio at birth in 1989, a full set of double differences (girl*high4, girl*1990, high4*1990), and the triple differences among them (girl*high4*1990) with no covariates. In model 2 (column 2), parental education, age of mother at the time of delivery, and basic features of birth are controlled. Model 3 (column 3) additionally includes variables on province-specific year effects as well as year and province dummy variables.

The estimated coefficient for the triple interaction term, *high4*girl*1990 birth cohort*, is positive and statistically significant.[23] Controlling the province-specific time fixed effects does not change the results, although it decreases the statistical significance of the coefficient to a small degree. The estimated coefficients for the triple difference terms suggest that in the four provinces with higher sex ratios at birth, the year of the White Horse brought an effect of increasing the advantage of girls over boys in the probability of receiving prenatal care by 8 to 9 percentage points. The results suggest that the subjects of the 1990 female birth

[21] The average sex ratio at birth from 1988 to 1992 was 123.84 in the "high4" provinces, and 112.28 in the other regions.

[22] Whereas the information of whether mother attends prenatal checkup is surveyed in the 1991 and 1994 data, the number of prenatal checkups is reported only in the 1994 survey.

[23] This result corresponds well with the patterns of the effect of the year of White Horse displayed by Figure A1. For the subjects of the 1990 birth cohort born in high sex-ratio provinces, the rate of prenatal care is much higher for girls than for boys.

cohort have received relatively greater parental investments in the form of prenatal care compared to those of the neighboring birth cohorts, and that the effect of the year of the White Horse is stronger among offspring born in places with an initially higher sex ratio.

We conduct several robustness checks with the same dependent variable on prenatal care. The results are reported in Table 5. First, we use the continuous variable on the sex ratio at birth instead of the dummy variable on "high4" provinces (Panel A). Second, we use the full sample of children included in the pooled sample of the 1991 and 1994 surveys, adding those born in 1993 and 1994 while disregarding the balance between the years before and after 1990 (Panel B). Third, we estimate a linear probability model instead of logistic model (Panel C). The results provide practically the same implications as the baseline results. We also conduct a falsification test by replacing the dummy variable for the 1990 birth cohort by a dummy for the 1989 birth cohort (Panel D).[24] The estimated coefficient for the new triple interaction term is statistically insignificant.

We also employ an alternative proxy variable for prenatal investment, namely, the probability of having a low birth weight (LBW). Only the 1994 survey provides the information on birth weight for the children born between 1990 and 1994. We conduct regressions for LBW based on two samples: the cohorts born between 1990 and 1992, a subset of the baseline sample (Panel E) and the full sample of children born between 1990 and 1994 (Panel F). The results show that the incidence of LBW among girls relative to that among boys is significantly lower for the subjects of the 1990 birth cohort born in provinces with higher sex ratios, which is consistent with the results pertaining to prenatal care.

5.2. Postnatal Health Investment

We investigate parents' postnatal health investments in children using the same data (the National Surveys on Fertility, Family Health, and Welfare in Korea) and similar triple-difference models (equation 1) used in the preceding subsection for analyzing prenatal health investments. The dependent variable (index of postnatal health investment) is a dummy indicating if the mother breastfed the child. The baseline regressions are based on a pooled sample of the 1991 and 1994 surveys that include the children born between 1988 and 1992.

Table 6 presents the regression results for three specifications. The coefficient for the

[24] The year 1989 was chosen for the falsification test, because it is the only year other than 1990 when girls were more likely to receive prenatal care than boys in provinces with higher sex ratios (see Appendix Figure A1).

triple interaction term, *high4*girl*1990 birth cohort*, is positive and statistically significant for all specifications.[25] The estimated coefficients for the triple difference terms suggest that in the provinces with higher sex ratios at birth, the coming of the year of the White Horse had a consequence of increasing the probability of breastfeeding of girls relative to that of boys by 19 to 20 percentage points, nearly 40% of the sample mean. The results suggest that girls' relative advantages (disadvantages) over boys in receiving postnatal health investment are greater (smaller) for the cohorts born in the year and place where sex-selective abortions were pervasive.[26]

We perform additional regressions to see if the results are robust to changes in specification or sample. The results are reported in Table 7. First, we include the continuous variable on the sex ratio at birth instead of the dummy variable for birth in one of the four provinces with higher sex ratios at birth (Panel A). Second, we use the full sample of children adding those born between 1993 and 1994 to the baseline sample (Panel B). Third, we add the variable on the working status of the mother (if the mother of the child worked in the year of the delivery) to the set of independent variables (Panel C).[27] Fourth, we estimate a linear probability model (Panel D). Fifth, we perform a falsification test by including the 1992 year dummy in the regressions instead of the 1990 dummy (Panel E).[28] Finally, we consider the duration of breastfeeding by including dummy variable indicating if the child was breastfed for at least three or six months (Panels F and G, respectively).[29] The results of all these additional regressions confirm the primary conclusion drawn from the baseline regressions.

5.3 Educational investment during adolescence

We investigate whether girls who were born in the year and place in which sex-

[25] Figures A2 and A3 graphically display the effect of the year of the White Horse. Substantial advantage of girls over boys in breastfeeding is observed for the 1990 birth cohort born in the provinces with higher sex ratios at birth.

[26] The results for the other variables are largely consistent with those obtained from previous studies. However, the negative sign of the schooling years of the father does not correspond to the prediction, which may be explained by the fact that richer families have recently developed a stronger son preference. Edlund and Lee (2013) found that the sex ratio at birth was higher among affluent parents (with higher education and better occupation) since 1990.

[27] Since the variable is available only from the 1991 survey, this analysis is based on a subsample of children born from 1988 to 1991.

[28] Only in 1990 and 1992, girls were more likely to be breastfed than boys in the provinces with higher sex ratios at birth (Appendix Figure A2)

[29] The children who were at least 3 months or 6 months old, respectively, are included in the sample used in the analysis.

selective abortions were widely performed had relative advantages in receiving parental investments in education by using the empirical strategy similar to that in the analysis of health investment. As explained, private out-of-school education is one of the most important types of parental investment in adolescent children in Korea. The log value of the average monthly private tutoring expenditure on five major subjects is employed as the dependent variable.

For the local sex ratio at birth, YP2007 does not provide information on the place of birth, but provides only the place where the respondent has lived at the age of 14 and the place of residence at the time of the survey.[30] Therefore, we use the place of residence of the respondents at age 14 to calculate the provincial sex ratio at birth. This method is subject to measurement errors arising from geographic mobility.[31] However, this problem might be mitigated to some extent by using the dummy variable for residing at age 14 in one of the four provinces with higher sex ratios at birth as the dependent variable. The "high 4" provinces are all located in the same "Youngnam" region in the southeast part of Korea, and geographic migrations among primary and secondary school students are predominantly within-region transfers.[32]

The regression model for the triple-difference estimation is basically the same as equation (1), but the following variables are defined differently: y_{ist} denotes the variable on private education expenditures for child *i* in province *s* born in year *t*, $high\ 4_s$ is a dummy variable that indicates that the child lived at age 14 in one of the four regions with higher sex ratios at birth, X_i denotes a vector of individual characteristics that include parental education, log of household monthly income, sibling size, birth order of child *i*, and the

[30] The information on sex ratios at birth is provided by regions, which indicates how many girls and boys are born in a specific year and region. If the information on the place of birth is available, we can perfectly match the place of birth with the sex ratios at birth in a particular region.

[31] Families may migrate to a place that can provide a better educational environment for their children. Geographic movements can also be caused by economic, vocational, and housing issues. A limitation of this study is that it uses the information on the place of school as proxy for the place of birth. If the factors associated with migration affect the private education expenditures of households, then our estimate becomes biased. However, the factors associated with migration may not be significantly different across regions. Given that the discrepancy between the place of birth and the location of the school likely increases along with age, we attempt to mitigate the potential bias arising from migrations by looking into the middle-school cohorts.

[32] Using the micro sample of the 2000 census, we analyze the geographic mobility patterns of cohorts who are born in the late 1980s and find that the vast majority of individuals who have moved to a different province between 0 and 15 years have moved within the two larger geographic divisions, the "high 4" provinces and the rest.

dummy variable for the types of high school (equal to 1 if child *i* attends a general high school, and 0 if child *i* attends a vocational or other type of high school). All other notations are the same as those in equation (1).

Approximately 17% of the sample households report that they do not spend anything on the private education of their children. We adopt Heckman's two-step estimation method to prevent the potential bias that may arise from censoring the independent variable. In the first stage, we conduct probit regressions by including all independent variables in equation 1 and a dummy variable that indicates if child *i* participates in private education as y_i (see Appendix Table A1 for the results). In the second stage, we perform OLS regressions by employing the log value of private education expenditure as y_i and adding the inverse Mills ratio that is computed from the first-step regressions. The variable on birth order is omitted from the regressions to satisfy the exclusion restrictions.[33]

The results of the second-stage regressions reported in Table 8 confirm that parental investments in girls relative to those in boys are greater in the cohort that is born in the year of the White Horse, and that the cohort effect is stronger for those who are born in regions with higher sex ratios at birth. Those who are born in "high 4" regions and who are included in the 1990 birth cohort have received significantly more private education than those from the neighboring cohorts (1988, 1989, 1991, and 1992 birth cohorts) and those from regions with a relatively balanced sex ratio at birth. The results are similar across the three specifications. The estimated coefficients for the other variables have the expected signs.[34] Parental education, household incomes, attending general high school, and smaller sibling size are positively related to the size of private education expenditures.

The results suggest that the magnitude of the 1990 cohort effect is substantial. The coefficient for the triple difference term estimated from model 3 indicates that, in the "high 4" provinces, the coming of the year of the White Horse increased the amount of spending on girls' private education relative to boys' by 0.328 in log value. If evaluated at the sample mean of private education expenditure (about 353,000 Won), this is an increase by about

[33] The results of the first-stage regressions (Appendix Table A1) show that children of higher-parity birth are significantly less likely to participate in private education (Models 2 and 3). Birth order has no significant effect on the amount that is spent on private tutoring when this variable is included in the second-stage regressions.

[34] Figure A4 demonstrates that girls born in 1990 in provinces with high sex ratios at birth received substantially larger parental investments in private education than boys, unlike the subjects of neighboring birth cohorts.

135,000 Won or 38% of the sample mean.

Table 9 reports the results of several sensitivity tests. To further minimize the potential bias due to geography mobility, we use the sex ratio at birth for an even larger geographic unit, namely, the entire southeast region by adding Busan into the group with higher sex ratios at birth (referred to as "high 5"). The results (Panel A) show that the coefficient for the triple differences term remains statistically significant in models 2 and 3. If the continuous variable on the sex ratio at birth is used instead of dummy variables, the effect of the triple difference term is no longer significant. Including the 1991 year dummy in the regressions, instead of the 1990 dummy, gives insignificant coefficients for triple difference terms (Panel C).[35]

6. Conclusion

This study has investigated how the selection of offspring gender in the presence of son preference affects the parental investments in girls and boys in South Korea. Although the prevalence of sex-selective abortions cannot be observed directly, this phenomenon can be inferred from the sex ratios at birth. To identify the magnitude of parental son preference, we exploit two types of variations in the extent of sex selections, namely, (1) the provincial variations in the sex ratio at birth that result from regional differences in cultural norms and religious beliefs, and (2) the temporary rise in the sex ratio at birth in 1990 (the year of the White Horse), which has been driven by zodiacal preference.

Following previous studies on the subject, we use prenatal visit and the incidence of low birth weight as measures of prenatal health investment in children. Moreover, we consider the breastfeeding practices of mothers as a measure of parental health investment in children. Given that the majority of the mothers in Korea began to perceive the advantages of breast milk in the late 1980s and that breastfeeding requires a substantial amount of time as well as physical and psychic costs from mothers, this measure can be considered a form of parental investment in children. We employ the average monthly private education expenditure as the index of parental educational investment in children. Expenditures on private tutoring is a primary form of parental investment in the human capital of children in

[35] In the "high4" provinces, girls received noticeably greater educational investments than boys only in 1990 and 1991 (Appendix Figure A4).

Korea where the competition for excellent colleges is fierce and the formal education system is highly equalized.

We conduct triple difference estimations to examine how gender differences in the parental investments in the health and education of children change across regions and cohorts. The relative parental investments in girls in the form of prenatal care, breastfeeding and private education are significantly larger for the cohorts that are born in 1990 than those for the adjacent cohorts. The effect of the year of the White Horse is stronger in those regions with sex ratios at birth that are higher. These results show that a higher prevalence of sex-selective abortions leads to greater parental investments in girls than in boys.

A possible mechanism behind these results is the selections of parents who carry the female fetus to term despite the availability of sex-selective abortions. Girls who are born when sex-selective abortions are widely conducted must be selectively born to parents with less prejudice against girls, thereby receiving relatively greater parental investments. Therefore, this paper suggests that the rise of sex-selective abortions in Korea from the early 1980s to the early 2000s have unintendedly improved the human capital development of females who are selectively born to parents with weaker bias against daughters.

This paper exploits a unique episode of exogenously driven changes in parental preference for offspring gender. The results of this study provide useful implications regarding the improving academic and professional performance of females in Korea. The socioeconomic status of females in Korea has improved over time as the country has experienced modernization and economic growth. The long-term trend of female progress became considerably steeper over the last 15 years, especially in the areas of competition between genders that were largely determined by the quality of individual performance (e.g., academic records and test scores) with little room for discrimination.

The increasing power of females in Korea is illustrated in the following examples. First, the college entrance rate of male high school graduates, which was approximately 8% higher than that of females in 2000, was overtaken by that of female high school graduates in 2009 (Appendix Figure A5). Girls are about 10% more likely to enter college than boys today. Second, the percentage of female students in the entering class of Seoul National University, which is widely regarded as the top college in Korea, increased from 23% in 1995 to 40% in 2005; the proportion of females in the economics department of the university also increased from 8% in 1995 to 43% in 2009 (Appendix Figure A6). Third, the proportion of females

among the successful applicants in the three major exams for prestigious public service positions (i.e., civil service, foreign affairs service, and legal service) increased rapidly in the late 1990s (Appendix Figure A7). Finally, only one out of the five newly appointed judges and prosecutors in Korea in 2000 was female, whereas at present, women account for more than two thirds of the entrants to these professions (Appendix Figure 8).

To our knowledge, the mechanism behind the accelerating progress of females over the recent years remains unclear. Although speculative, the results of this study suggest that these changes can be partly attributed to the reduced parental prejudice against girls, which helps increase the investments in the human capital development of females.[36] The secular decrease in the sex ratio at birth over the last two decades indicates that the son preference in Korea has been declining since the mid-1990s. However, the traditional gender bias in Korea was probably declining from an earlier period.[37] If the son preference in Korea had been stable or slowly declining before the mid-1990s, sex-selective abortions in the 1980s and 1990s could weaken the prejudice against girls among parents who gave birth to daughters. Under this circumstance, females who were born in the early 1980s are presumably the first birth cohorts who benefited from the decline in parental son preference. This conjecture is consistent with the recent examples of female progress that are presented in this paper.

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[36] We do not argue that girls are more favorably treated by parents than boys today in Korea. Choi and Hwang (2015) found that Korean parents still invest more in their sons than in their daughters even after the sex ratio at birth declined to a normal level. However, they suggested that the gender gap was narrowed over time, which was consistent with our primary claim.

[37] The increasing sex ratio at birth from the early 1980s to the mid-1990s does not necessarily indicate an increasingly stronger parental son preference. This increasing trend can better be explained as a process of approaching the actual parental demand for offspring gender that has been made possible by the introduction of new technologies.

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<Table 1>

Sex Ratios at Birth in 1988-1992 by Administrative Region

Region	1988	1989	1990	1991	1992
Seoul	110.82	109.59	113.27	110.76	111.27
Busan	111.95	111.15	118.42	116.33	117.3
Daeku	134.50	121.75	129.68	126.32	124.95
Incheon	110.01	106.88	111.95	108.7	108.1
Gwangju	107.20	108.15	113.27	111.85	112.9
Daejeon	NA	122.71	122.66	114.03	114.88
Ulsan	NA	NA	NA	119.4	125.19
Gyunggi	109.41	107.47	111.34	109.83	111.43
Gangwon	108.03	109.73	112.96	110.71	111.99
Chung-buk	112.71	111.65	117.03	113.09	117.38
Chung-nam	114.07	109.96	116.63	113.77	116.39
Jeon-buk	109.31	108.26	113.76	108.07	107.85
Jeon-nam	111.96	109.57	114.06	110.71	110.25
Kyung-buk	125.22	127.17	130.74	124.08	123.58
Kyung-nam	119.00	117.19	124.66	117.22	119.26
Jeju	109.74	112.66	118.80	105.5	118.04

Notes. *National Survey on Fertility, Family health and Welfare in Korea* is conducted annually and from 1991, cleaned datasets completed error correction are available via online. Information of previous years can be found in the print version of the annual reports. However, the number of births in Ulsan from 1988 to 1990 written in the report was so small (For example, 2 babies was born in Ulsan in 1989, and 18 babies in 1990) that the reporting number seems not reliable considering the size of population. Our guess for this misreporting is that there were frequently changes in the name of Ulsan cities and its neighboring districts, thereby generating confusion with division of the region.

<Table 2>
Summary Statistics of the Data from
National Survey on Fertility, Family Health and Welfare

Variable	Mean (SD)
Prenatal care	0.963
	(0.189)
Breast-feeding	0.713
	(0.453)
Girl	0.458
	(0.498)
Sex ratio	112.1
	(5.804)
1990 birth cohort	0.293
	(0.455)
Mother's years of schooling	11.74
	(2.441)
Father's years of schooling	12.61
	(2.620)
Mother's age at birth	28.00
	(3.397)
Natural birth	0.779
	(0.415)
First child	0.414
	(0.493)
1988 birth cohort	0.146
	(0.353)
1989 birth cohort	0.169
	(0.375)
1991 birth cohort	0.215
	(0.411)
1992 birth cohort	0.177
	(0.382)
Observations	2,738

Source: National Survey on Fertility, Family health and Welfare in Korea for 1991 and 1994.

<Table 3>
Summary Statistics of the YP 2007

Variable	Mean (SD)
Private education participation	0.829
	(0.376)
Log of private education expenditure	3.565
	(0.651)
Girl	0.475
	(0.499)
Sex ratio	113.9
	(6.017)
1990 birth cohort	0.211
	(0.408)
Father's years of schooling	13.22
	(2.641)
Mother's years of schooling	12.44
	(2.232)
Log of household income	8.208
	(0.520)
Sibling size	2.250
	(0.650)
Birth order	1.584
	(0.663)
General School	0.805
	(0.396)
High regions	0.289
	(0.453)
1988 birth cohort	0.167
	(0.373)
1989 birth cohort	0.189
	(0.392)
1991 birth cohort	0.223
	(0.416)
1992 birth cohort	0.210
	(0.407)
Observations	3,752

Source: Youth Panel Survey Project for the second phase (YP 2007)
Note. Log of private education expenditure (per month) statistics are based on 3,108 non-missing observations

<Table 4>

Triple-Difference Logistic Regressions for the Prenatal Investment (Marginal Effect)

	At least one prenatal visit		
	Model 1	Model 2	Model 3
Girl	-0.0128	-0.0176**	-0.0312**
	(0.00805)	(0.00817)	(0.0137)
High4	0.0160	0.0205	0.0132
	(0.0221)	(0.0212)	(0.0185)
Girl*High4	-0.0113	-0.00616	-0.00171
	(0.0187)	(0.0220)	(0.0296)
1990	0.0210	0.0223*	-0.00292
	(0.0149)	(0.0134)	(0.0137)
Girl*1990	-0.0301**	-0.0287**	-0.0311
	(0.0141)	(0.0146)	(0.0193)
High4*1990	-0.0614***	-0.0635***	-0.0764***
	(0.0227)	(0.0221)	(0.0169)
Girl*High4*1990	0.0870***	0.0820***	0.0947***
	(0.0279)	(0.0264)	(0.0300)
Mother's years of education		0.00629***	0.00914***
		(0.00169)	(0.00169)
Father's years of education		0.00544***	0.00484***
		(0.00109)	(0.00177)
Firstborn		0.0156*	0.0185*
		(0.00860)	(0.0107)
Mother's age at birth		-0.000983	-0.00103
		(0.000913)	(0.00132)
Province fixed effect	No	No	Yes
Year-of-birth fixed effect	No	No	Yes
Province x year-of-birth fixed effect	No	No	Yes
Observations	2,752	2,752	2,010

Source: National Survey on Fertility, Family health and Welfare in Korea for 1991 and 1994.
Note: The dependent mean is 0.963. Robust standard errors are in parentheses.
*** p<0.01, **p<0.05, *p<0.1

<Table 5>

Sensitivity Tests for the Results on Prenatal Investments

	Prenatal Investment			
	Sample size	Model 1	Model 2	Model 3
	Dependent variables: Mother Attends at Least One Prenatal Checkups (1=Yes, 0=No)			
A. Continuous Variable				
Girl*Sexratio*1990	2,750	0.00588**	0.00531**	0.00906***
		(0.00266)	(0.00227)	(0.00243)
B. Year of birth 1988-1994				
Girl*High4*1990	3,506	0.0733***	0.0709***	0.0866***
		(0.0234)	(0.0226)	(0.0267)
C. Linear Probability Model				
Girl*High4*1990	2,750	0.0825***	0.0795**	0.0713**
		(0.0260)	(0.0287)	(0.0311)
D. Falsification Test				
Girl*High4*1989	2,750	0.0223	0.0187	0.0243
		(0.0561)	(0.0546)	(0.0702)
	Dependent variables: Baby Born with Low Birth Weight (1=Yes, 0=No)			
E. LBW, 1990-1992				
Girl*Sexratio*1990	1,091	-0.00904**	-0.00949**	-0.00810**
		(0.00384)	(0.00393)	(0.00322)
F. LBW, 1990-1994				
Girl*Sexratio*1990	1,834	-0.00756**	-0.00755**	-0.00680**
		(0.00383)	(0.00379)	(0.00314)

Source: National Survey on Fertility, Family health and Welfare in Korea for 1991 and 1994.

Note: Results of logistic regressions except panel C. The dependent mean is 0.963 for panels A, C, and D, 0.969 for panel B, 0.035 for panel E and 0.031 for panel F, respectively. The information of birth weight of the most recent birth (within three years prior to the survey) is included only in the 1994 survey. In the 1994 survey, the years of the birth of the most recently born range from 1990 to 1994. Panel E is restricted to babies born between 1990 and 1992, which is a subsample of the balanced sample (1988-1992). Panel F uses all available information from the 1994 survey. Likewise, panel B uses the pooled sample for two years and is not restricted by the year of birth. For panel A, the sex ratio at birth in the province of birth is used instead of dummy that indicates the child was born in one of the four regions with higher sex ratio is used. Robust standard errors are in parentheses.

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

<Table 6>

Triple-Difference Logistic Regressions for the Postnatal Health Investment (Marginal Effect)

	Practice of breastfeeding		
	Model 1	Model 2	Model 3
Girl	0.00751	0.0110	0.00837
	(0.00959)	(0.00983)	(0.0112)
High4	0.0283	0.0128	0.208***
	(0.0310)	(0.0267)	(0.0164)
Girl*high4	-0.00257	0.00219	0.00261
	(0.0263)	(0.0286)	(0.0295)
1990	-0.00344	-0.00520	-0.0220*
	(0.0139)	(0.0107)	(0.0128)
Girl*1990	-0.0284	-0.0352	-0.0310
	(0.0226)	(0.0237)	(0.0253)
High4*1990	-0.0898***	-0.0956***	-0.212***
	(0.0342)	(0.0357)	(0.0211)
Girl*high4*1990	0.187***	0.191***	0.205***
	(0.0586)	(0.0593)	(0.0521)
Mother's years of education		0.00200	0.00187
		(0.00435)	(0.00401)
Father's years of education		-0.0106*	-0.00897
		(0.00583)	(0.00576)
Firstborn		-0.0551***	-0.0522***
		(0.0161)	(0.0170)
Natural birth		0.127***	0.123***
		(0.0268)	(0.0269)
Mother's age at birth		-0.00454*	-0.00389
		(0.00264)	(0.00292)
Province fixed effect	No	No	Yes
Year-of-birth fixed effect	No	No	Yes
Province x year-of-birth fixed effect	No	No	Yes
Observations	2,748	2,748	2,748

Source: National Survey on Fertility, Family health and Welfare in Korea for 1991 and 1994.
Note: The dependent mean is 0.713. Robust standard errors are in parentheses.
*** p<0.01, **p<0.05, *p<0.1

<Table 7>

Sensitivity Tests for the Results on Postnatal Health Investment

		Postnatal Investment		
	Sample size	Model 1	Model 2	Model 3
	Dependent variables: Mother Breastfeed her Child (1=Yes, 0=No)			
A. Continuous Variable				
Girl*Sexratio*1990	2,736	0.0156***	0.0164***	0.0170***
		(0.00202)	(0.00192)	(0.00184)
B. Year of birth 1988-1994				
Girl*High4*1990	3,478	0.181***	0.187***	0.200***
		(0.0698)	(0.0675)	(0.0564)
C. + Mother's work status				
Girl*High4*1990	1,623	0.218***	0.246***	0.259***
		(0.0432)	(0.0403)	(0.0441)
D. Linear Probability Model				
Girl*High4*1990	2,736	0.183***	0.188***	0.204***
		(0.0607)	(0.0617)	(0.0578)
E. Falsification Test (1992)				
Girl*High4*1992	2,736	0.0532	0.0598	0.129
		(0.0600)	(0.0595)	(0.0822)
	Dependent variables: Mother Breastfeed her Child for more than 3 months (1=Yes, 0=No)			
F. Breastfed 3 months+				
Girl*Sexratio*1990	2,458	0.0157***	0.0164***	0.0172***
		(0.00431)	(0.00461)	(0.00462)
	Dependent variables: Mother Breastfeed her Child for more than 6 months (1=Yes, 0=No)			
G. Breastfed 6 months+				
Girl*Sexratio*1990	2,322	0.0178***	0.0185***	0.0202***
		(0.00543)	(0.00549)	(0.00542)

Source: National Survey on Fertility, Family health and Welfare in Korea for 1991 and 1994.

Note: The dependent mean is 0.713 for panel A, D, and F, 0.723 for panel B, 0.712 for panel C, 0.576 for panel F, and 0.578 for panel G, respectively. For panel A, instead of sex ratios at birth, dummy that indicates the child was born in one of the four regions with higher sex ratio is used. The information on the working status of the mother is included only in the 1991 survey. Thus, panel C is restricted to babies born between 1988 and 1991. For Panels F and G, indicators are defined conditional on babies being at least 3 or 6 months old, respectively, at the time of the survey. Robust standard errors are in parentheses.

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

<Table 8>
Triple-Difference Regressions for Private Education Expenditure
(Second-Stage of Heckman Two-Step Estimation)

	Monthly Private Education Expenditure		
	Model 1	Model 2	Model 3
Girl	-0.00650	-0.0638**	-0.0462*
	(0.0546)	(0.0304)	(0.0260)
High4	-0.0764	-0.0986**	0.00698
	(0.0877)	(0.0473)	(0.124)
1990 birth cohort	0.200**	0.0354	-0.0649
	(0.0927)	(0.0488)	(0.0763)
Girl*High4	-0.114	0.0405	-0.0109
	(0.132)	(0.0711)	(0.0607)
Girl*1990 birth cohort	-0.181	0.111	0.0198
	(0.135)	(0.0723)	(0.0587)
High4*1990 birth cohort	-0.271	-0.144	-0.0458
	(0.186)	(0.103)	(0.207)
Girl*High4*1990 birth cohort	0.521*	0.225	0.328**
	(0.292)	(0.160)	(0.137)
Father's years of schooling		0.0391***	0.0332***
		(0.00772)	(0.00591)
Mother's years of schooling		0.0235***	0.0163**
		(0.00753)	(0.00637)
Log of household income		0.306***	0.178***
		(0.0427)	(0.0309)
Sibling size		-0.138***	-0.0817***
		(0.0249)	(0.0197)
General school		0.547***	0.318***
		(0.0969)	(0.0657)
Lambda	-1.259**	0.570**	-0.0673
	(0.507)	(0.278)	(0.175)
Constant	3.954***	-0.0775	1.752***
	(0.151)	(0.527)	(0.364)
Province fixed effect	No	No	Yes
Year-of-birth fixed effect	No	No	Yes
Province x year-of-birth fixed effect	No	No	Yes
Number of censored observation	644	644	644
Number of uncensored observation	3108	3108	3108
Observations	3,752	3,752	3,752

Source: Youth Panel Survey Project for the second phase (YP 2007).
Note: The dependent mean before logarithmic transformation is about $430.1 (calculated under the condition that 1 dollar equals to 1,000 Korean Won). Standard errors are in parentheses.
*** p<0.01, **p<0.05, *p<0.1

<Table 9>

Sensitivity Tests for the Results on Educational Investment

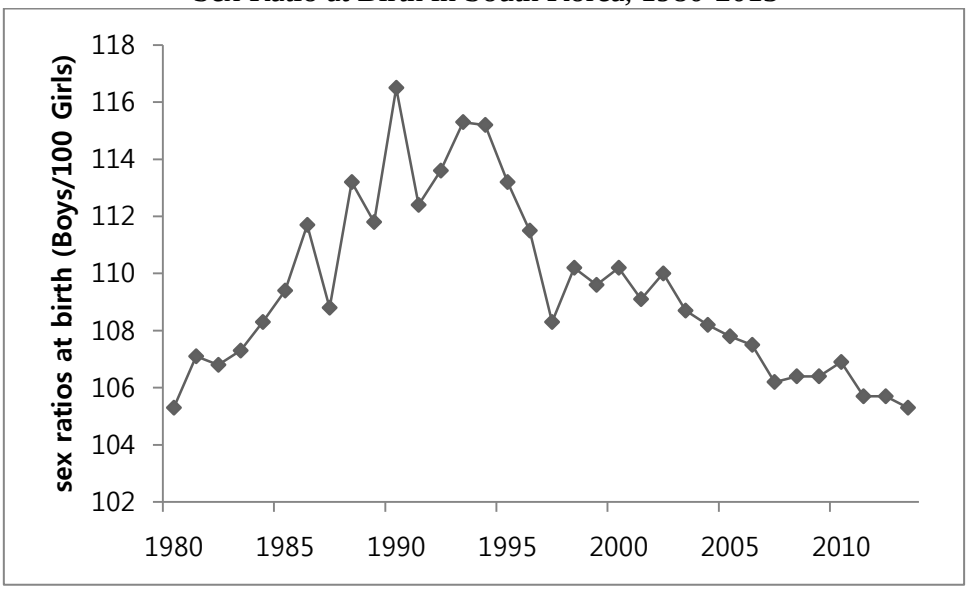
		Educational Investment		
	Sample size	Model 1	Model 2	Model 3
	Dependent variables: Monthly Private Education Expenditures			
A. Adding Busan to High4				
Girl*High5*1990	3,752	0.353	0.215*	0.280**
		(0.231)	(0.127)	(0.113)
B. Continuous Variable				
Girl*Sexratio*1990	3,655	0.00924	0.00282	0.00533
		(0.0169)	(0.0102)	(0.00916)
C. Falsification Test (1991)				
Girl*High4*1991	3,752	-0.183	-0.0111	-0.0532
		(0.247)	(0.136)	(0.123)

Source: Youth Panel Survey Project for the second phase (YP 2007).

Note: The number of observations is reported in column 1. The dependent mean before logarithmic transformation is about $430.1 (calculated under the condition that 1 dollar equals to 1,000 Korean Won). Panel A estimates equation (1) using "high 5" instead of "high 4". Dummy "high 5" indicates whether the place of residence of the respondents at age 14 is one of the four provinces with higher sex ratios at birth (high 4) or Busan, which cover the entire southeast region. Panel B uses continuous variable on the sex ratio in the place residence at age 14 instead of dummy for regions with higher sex ratios. Standard errors are in parentheses.

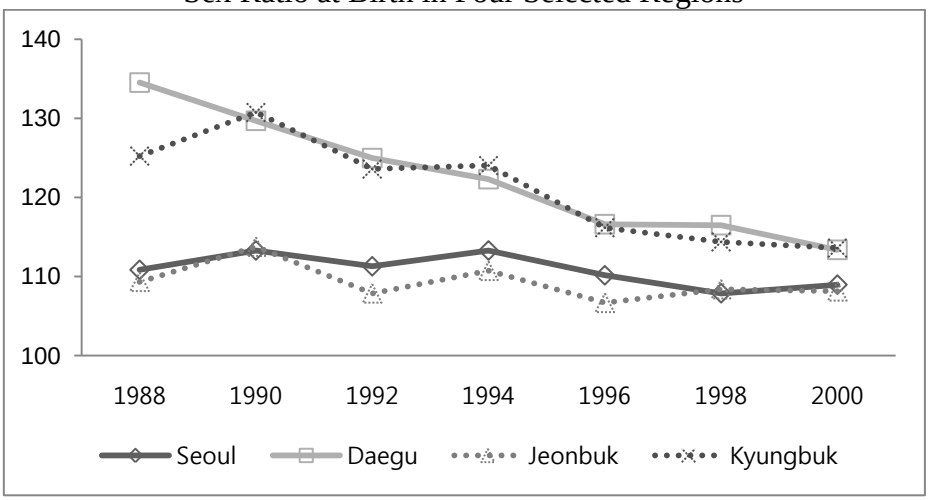
*** p<0.01, **p<0.05, *p<0.1

<Figure 1>
Sex Ratio at Birth in South Korea, 1980-2013



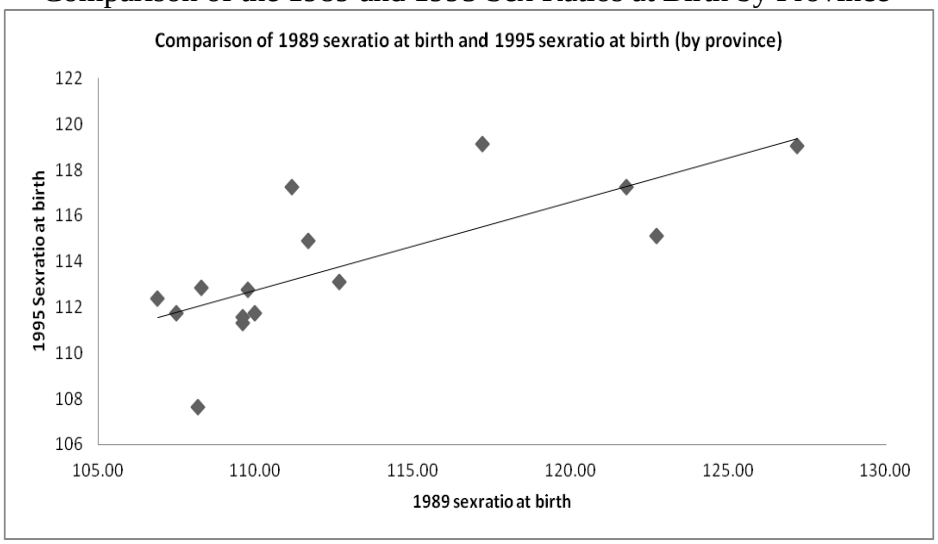
Source: Vital Statistics of Korea: Births and Deaths, each year; Drawn from the website of Korean Statistical Information Service (http://www.kosis.kr).

<Figure 2>
Sex Ratio at Birth in Four Selected Regions



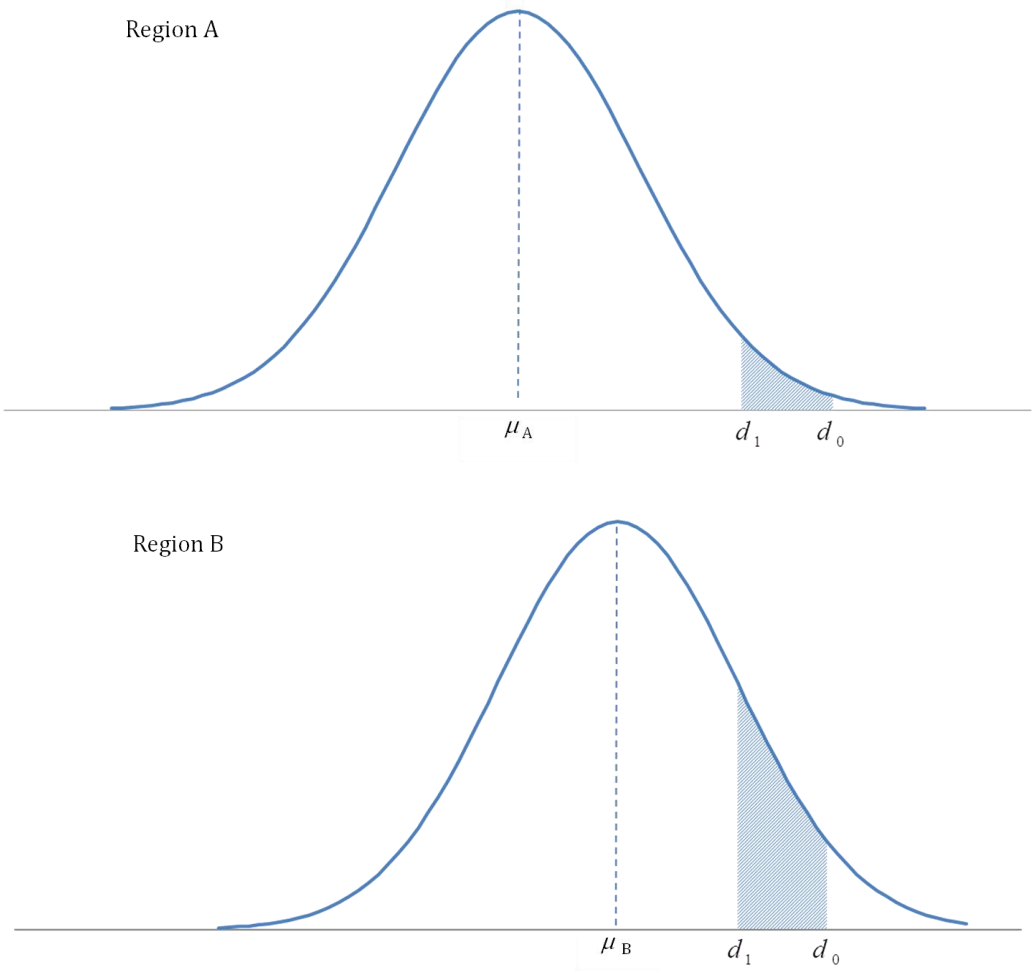
Source: Annual Reports on Live Births and Deaths Statistics. 1988-2000

<Figure 3>
Comparison of the 1989 and 1995 Sex Ratios at Birth by Province

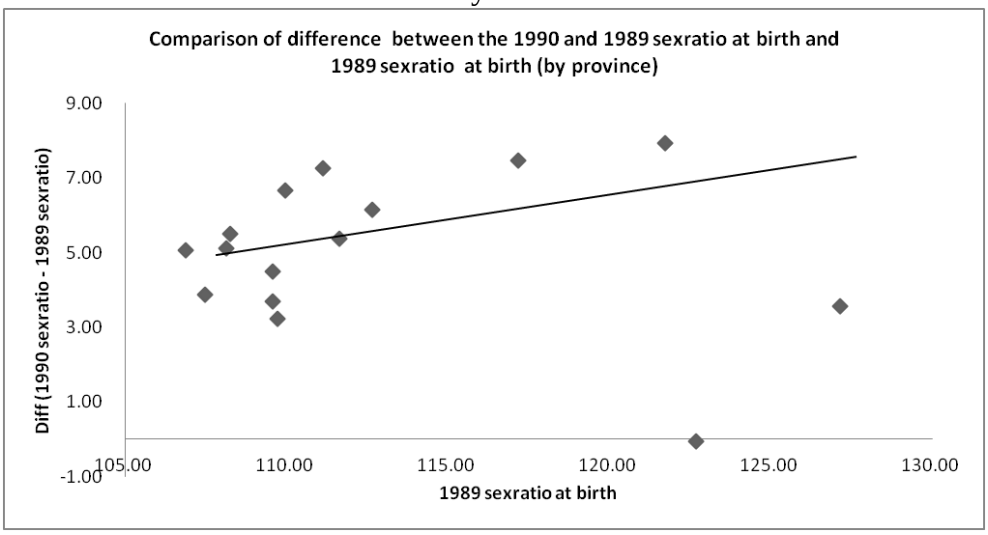


Source: Annual Report on Live Births and Deaths Statistics. 1989-1995

<Figure 4>
Hypothetical Distributions of Parental Son Preference in Two Regions



<Figure 5>
Magnitude of the Change in the Sex Ratio at Birth in each Province between 1989 and 1990 by the 1989 Sex Ratio at Birth



Source: Annual Report on Live Births and Deaths Statistics. 1989-1990

Appendix Tables

<Table A1>

First-Stage Results of Heckman Two-Step Estimations for Private Education Participation

	Dependent variable: Dummy for Private Education Participation (1=Yes, 0=No)		
Variables	(1)	(2)	(3)
Girl	-0.0818	-0.0963	-0.103
	(0.0606)	(0.0647)	(0.0680)
High4	-0.100	-0.0424	0.361
	(0.0959)	(0.101)	(0.315)
1990 birth cohort	-0.204**	-0.176*	0.490**
	(0.0888)	(0.0953)	(0.192)
Girl*High4	0.204	0.184	0.160
	(0.144)	(0.151)	(0.160)
Girl*1990 birth cohort	0.350***	0.360***	0.341**
	(0.131)	(0.139)	(0.145)
High4*1990 birth cohort	0.105	0.131	-6.131***
	(0.200)	(0.213)	(0.462)
Girl*High4*1990 birth cohort	-0.375	-0.412	-0.340
	(0.314)	(0.328)	(0.339)
Father's years of schooling		0.0537***	0.0494***
		(0.0135)	(0.0143)
Mother's years of schooling		0.0201	0.0113
		(0.0154)	(0.0163)
Log of household income		0.305***	0.335***
		(0.0489)	(0.0509)
Sibling size		-0.124***	-0.135***
		(0.0413)	(0.0438)
Birth order		0.731***	0.833***
		(0.0586)	(0.0624)
General school		-0.0542	-0.0936**
		(0.0420)	(0.0446)
Constant	1.262***	-2.600***	-3.017***
	(0.0728)	(0.390)	(0.433)
Province fixed effects	No	No	Yes
Year-of-birth fixed effects	No	No	Yes
Province x year-of-birth fixed effect	No	No	Yes
Number of censored observation	644	644	644
Number of uncensored observation	3,108	3,108	3,108
Observations	3,752	3,752	3,752

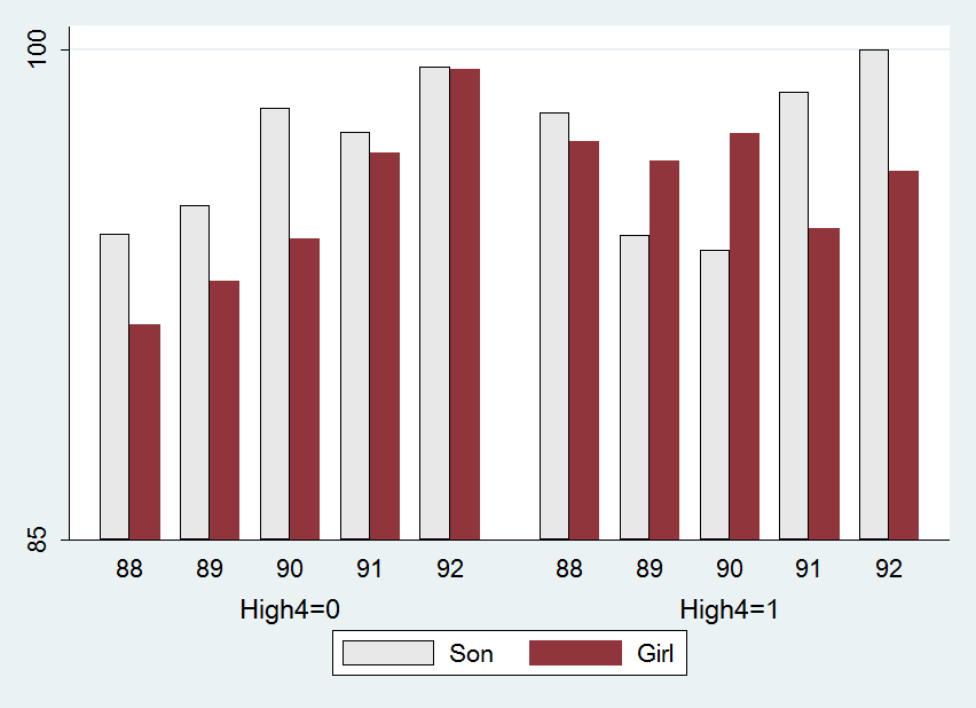
Source: Youth Panel Survey Project for the second phase (YP 2007).

Note: The number of observations is 3,752. The dependent mean is 82.9%. Standard errors are in parentheses.

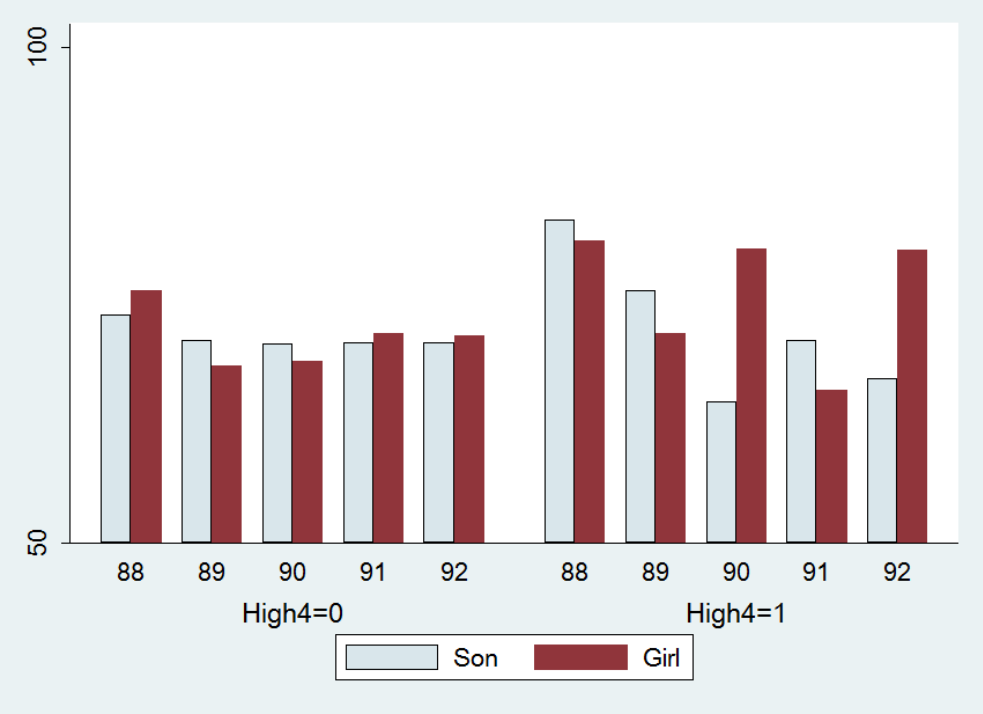
*** p<0.01, **p<0.05, *p<0.1

Appendix Figures

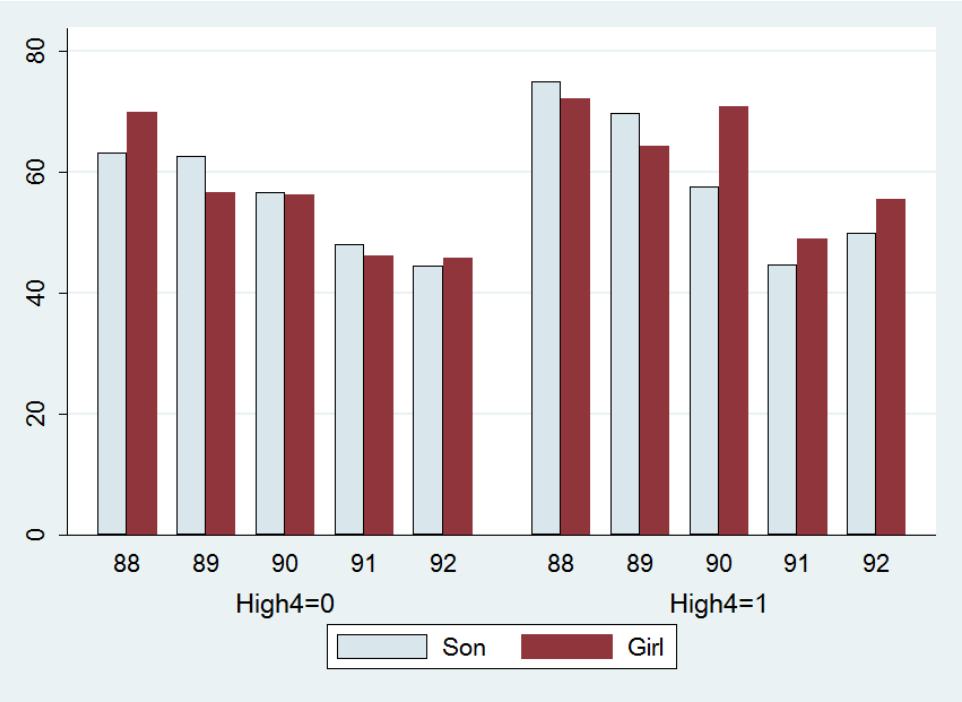
<Figure A1>
Percentage of Infants Whose Mother Received Prenatal Care by Child Gender, Year of Birth and Region



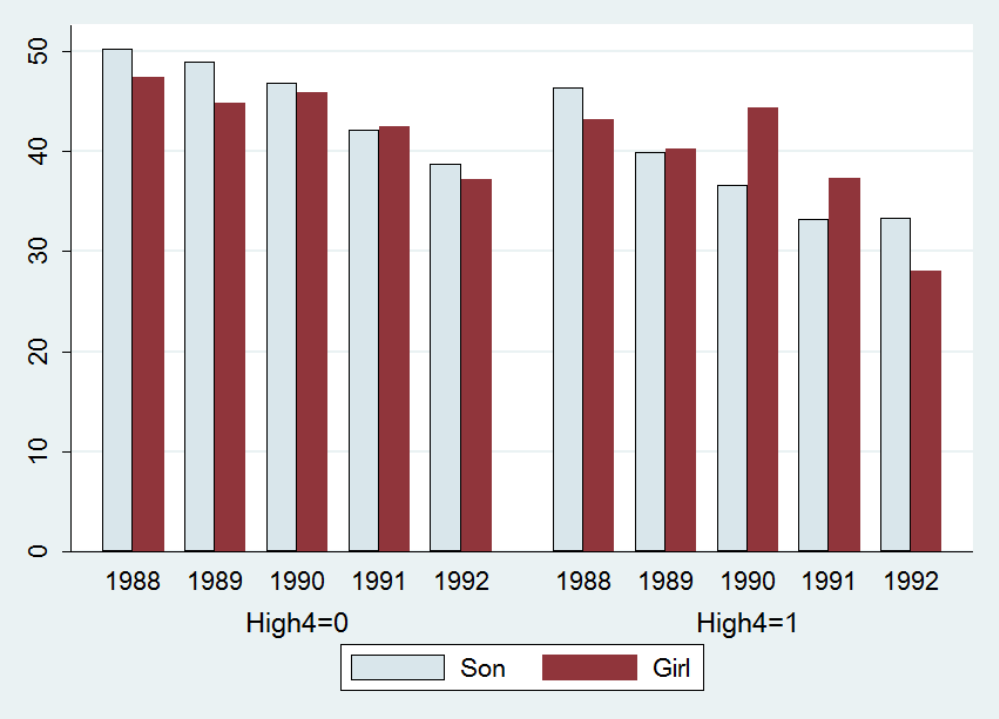
<Figure A2>
Percentage of Infants Who Were Breastfed by Child Gender, Year of Birth and Region



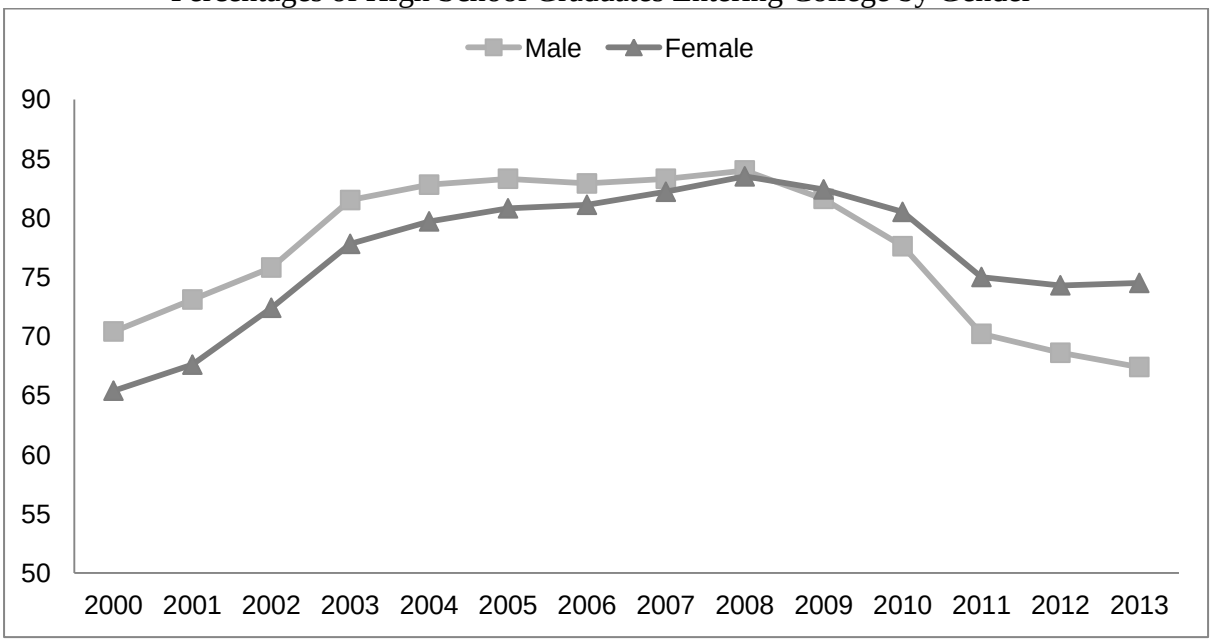
<Figure A3>
Percentage of Infants Who Were Breastfed for More than 3 Months
by Child Gender, Year of Birth and Region



<Figure A4>
Average Expenditures on Private Tutoring by Child Gender, Year of Birth and Region
(10,000 Korean Won)

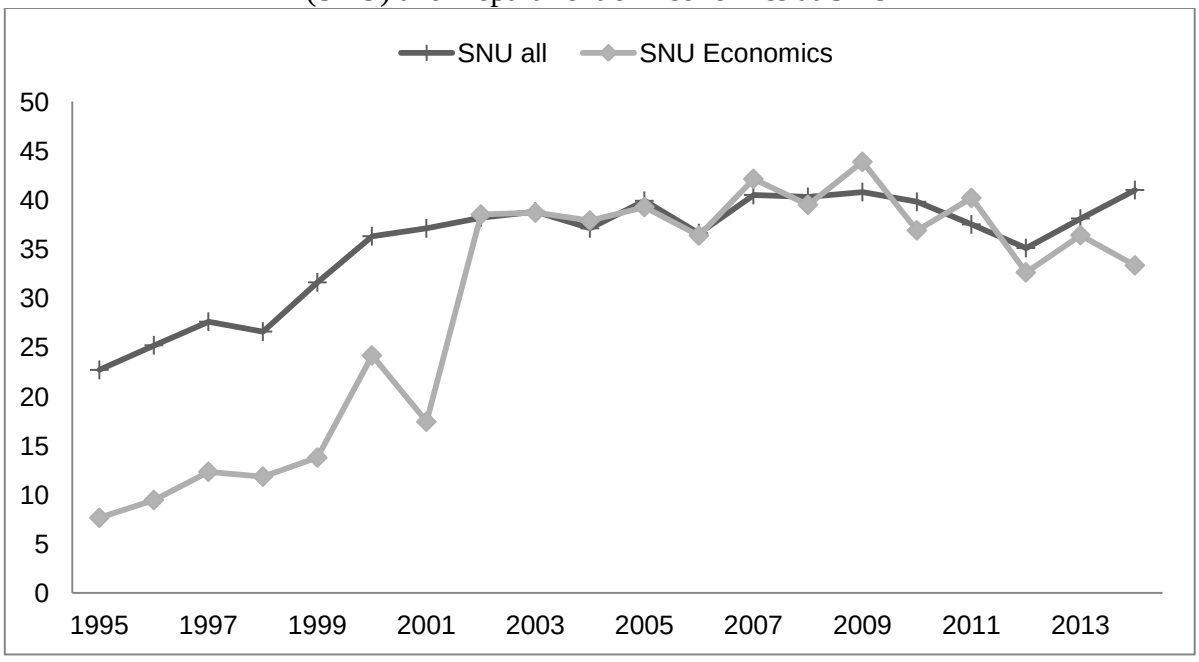


<Figure A5>
Percentages of High School Graduates Entering College by Gender



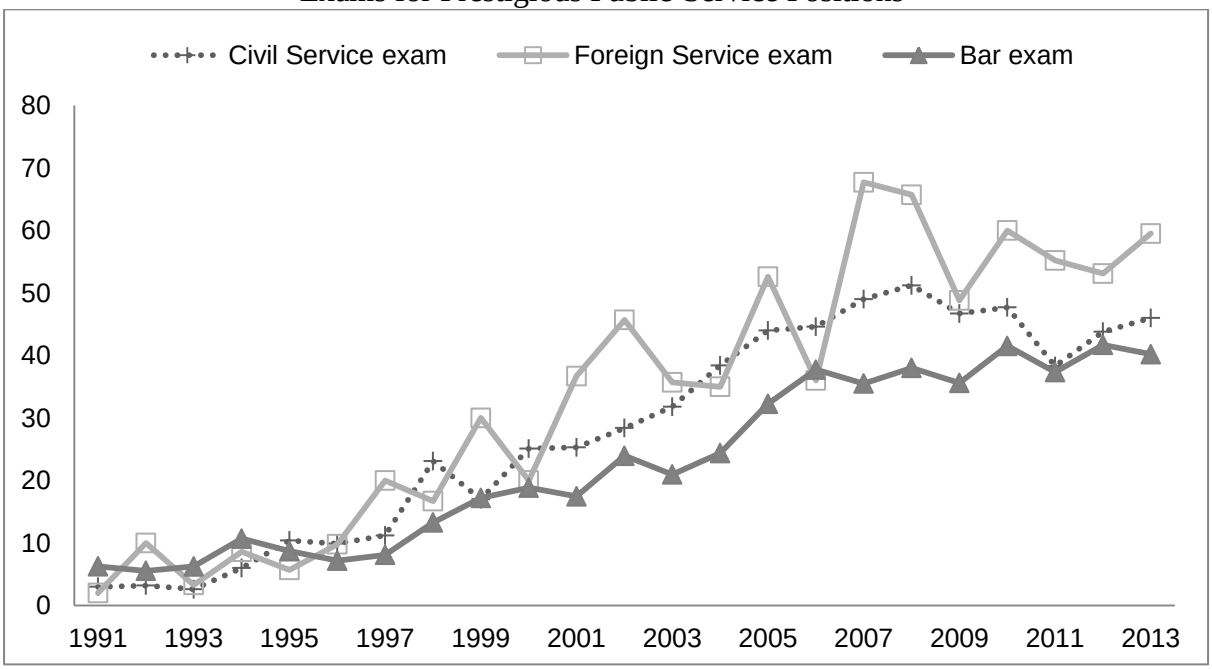
Source: Ministry of Education, Republic of Korea and Korean Educational Development Institute, *Statistical Yearbook of Education*

<Figure A6>
Percentages of Female Students among the Entering Class of Seoul National University (SNU) and Department of Economics at SNU



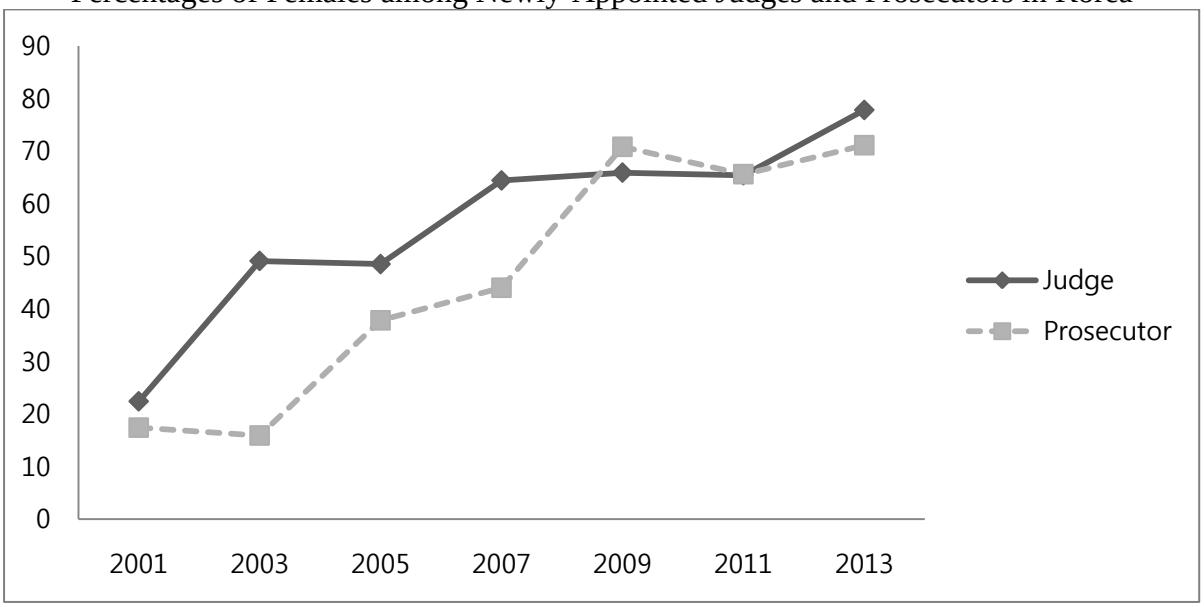
Source: Seoul National University, *Statistical Year book of Seoul National University*

<Figure A7>
Percentages of Females among the Individuals Who Pass Major Government-Administered Exams for Prestigious Public-Service Positions



Sources: Ministry of Public Administration and Security, Republic of Korea, *Statistical Yearbook of Ministry of Public Administration and Security (MOPAS)*, 2001-2013; Ministry of Justice, Republic of Korea Press Release; Korean Women's Development Institute; National Gender Statistics DB: Political and Social Participation; The website of Gender Statistics Information System (https://gsis.kwdi.re.kr).

<Figure A8>
Percentages of Females among Newly-Appointed Judges and Prosecutors in Korea



Source: Ministry of Justice, Republic of Korea.