경제학석사 학위논문

Son Preference and Birth Outcomes of Girls: Evidence from Korea

한국의 남아선호와 여아의 출생 성과

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서울대학교 대학원
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지도교수 홍 석 철

이 논문을 경제학석사 학위논문으로 제출함

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Abstract

Son Preference and Birth Outcomes of Girls:
Evidence from Korea

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Recent economic studies report that son-biased investment still exists in Korea. This paper studies the relationship between son preference in the region of birth and birth outcomes of girls, employing population-level data. Using a regional sex ratio at birth (SRB) of the specific period in each county as a measure for regional son preference, I find the incidence of girls' low birth weight (LBW) is positively correlated with son preference in the region where they are born. The results suggest that 19 percent of the gender gap in LBW incidence is accounted for by the full variation in SRB in one's county of birth. I also show that girls whose parents wanted a son during pregnancy tend to be LBW. Furthermore, I explore parents' prenatal care as a potential channel. Employing a strategy to address the endogeneity of child gender, girls born in regions with strong son preference are likely to receive less investment than boys.

Keywords: Low birth weight, Son preference, Gender gap, Sex ratio at birth
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Table of Contents

List of Figures

List of Tables

1 Introduction

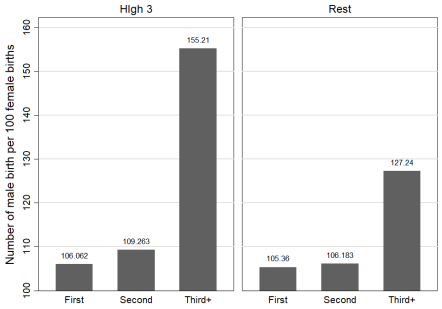
Like other countries in Asia (Sen, 1992), South Korea was one with a strong preference for sons. But in the last decades, the disparity in social status in South Korea between males and females has narrowed significantly, and even women outperform men in some merit-based competitions, including the high ranking government official selection tests. Accordingly, it seems that parental preference for sons has disappeared.

However, the sex ratio at birth (SRB, defined as the number of male births per 100 female births) shows surviving son preference in Korea, which is depicted in Figure 1. As its natural level ranges from 103 to 107, SRB above 107 means that there are son-biased interventions such as sex-selective abortion and infanticide. The Figure shows that there still exists a substantial imbalance in SRB across birth orders and sex of the first-born. In three provinces with strong son preference, Daegu, Gyeongsangbuk-do, and Ulsan (denoted by *High 3* as in Lee and Lee (2015)), sex-selective abortions are most prevalent considering that SRB increases with birth order, the magnitude of which is far higher than the rest. Also, in panel B, it is observed that abortions of parents whose first-born child is female are the main driver. Moreover, recent economics studies report there still exists Korean parents' son-biased input even in children's early stages of life (Choi and Hwang, 2015; Lee and Lee, 2015).

However, it is well-recognized that early life conditions are crucial to human capital accumulation (Barker, 1992; Heckman, 2007; Almond and Currie, 2011; Almond et al., 2018). Especially, the vast economic literature

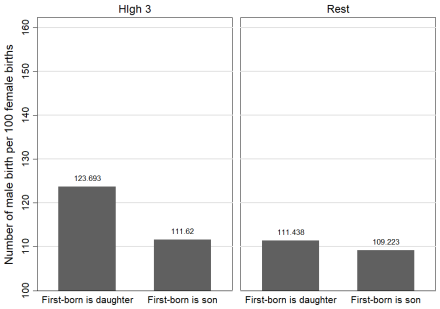
Figure 1: SRB in provinces with strong son preference and the rest

Panel A. SRB across birth order



Source: Vital Statistics of Korea 1997-2011; Microdata Integrated Service of Statistics Korea (https://mdis.kostat.go.kr).

Panel B. Second-born's SRB



Source: Census 2000-2015; Microdata Integrated Service of Statistics Korea
Notes: I examine children born from 1997 to 2011.

has shown that the environment before age five and even during pregnancy has significant effects on various later outcomes such as health, schooling, and income, as I discuss in Section 2. It is found that various factors impact, but among them, some studies (Currie and Gruber, 1996; Hanratty, 1996; Warner, 1998; Rous et al., 2004; Evans and Lien, 2005; Gonzalez and Kumar, 2018) highlight the importance of prenatal care visit. In economic articles, birth weight and low birth weight (LBW, defined as weighing less than 2,500 grams at birth) are extensively examined indicators of fetal conditions. In this regard, it is plausible to hypothesize that son-biasedness affects differential prenatal investment, and in turn, the gender gap in birth outcomes.

In this study, I report girls born in the region with strong son preference are more likely to have worse birth outcomes, using population-level administrative data. Following Hwang et al. (2019), I employ each county's SRB in the early-1990s as a measure of region-specific son preference. The result shows that four standard deviation increase in SRB in the period is

related to 6.8 percent of LBW incidence of girls and 19 percent of the gender gap in LBW incidence. What needs to be noted here is that this result does not imply causality due to the potential endogeneity of child gender, as I discuss in Section 3.3.3. I also find evidence suggesting neglective prenatal care for 'undesired daughters' during pregnancy using unique questions in Panel Study on Korea Children. I explore prenatal care as a possible channel through which the son preference affects birth outcomes. Employing an empirical strategy to cope with the endogeneity of child gender, I find that girls born in provinces with the highest SRB in the early-1990s tend to receive under-investment as fetuses compared to boys.

The rest of this paper is organized as follows. In Section 2, I discuss the existing literature on parents' son-biased input, the gender gap in early outcomes, and the effect of childhood circumstances on later outcomes such as educational attainment and labor market outcomes. In Section 3, I investigate the relationship between regional son preference and infants' birth outcomes. In Section 4, I discuss different health investment by gender in regions with strong son preference, and then I conclude in Section 5.

2 Literature Review

Economists have observed the gender gap both in investment within households and outcomes of women has, using data not only from developing but developed countries. The gender gap in a variety of outcomes has been studied extensively in early-life and childhood as well. Almond et al. (2010) report that neonatal mortality has increased after the diffusion of sex determination

technology in China. Jayachandran and Pande (2017) shows that in India, the height of girls is shorter in the region with a strong preference for sons. Furthermore, in many countries, it is reported that boys tend to do better in mathematics than girls (Fryer Jr and Levitt, 2010; Bharadwaj et al., 2016; Lee and Lim, 2019). In particular, Dossi et al. (2019) shows that girls from the son-biased family score lower than ones from the other using administrative data from Florida.

There have been many studies on differential parental input to boys and girls. Dahl and Moretti (2008) found that in the United States, first-born girls are more likely to have unmarried mothers and parents who divorce compared to first-born sons. They also showed that it negatively affected children in their educational and labor market outcomes. In India, mothers pregnant with a boy visit antenatal clinics less frequently than ones with a girl, and this difference is greater in the region with stronger son preference (Bharadwaj and Lakdawala, 2013). Beside them, a lot of papers report gender differences in health input after birth (Jayachandran and Kuziemko, 2011; Barcellos et al., 2014). More importantly, in South Korea, parents invest less in girls than boys in various forms including perinatal care, especially in regions where son preference is strong (Choi and Hwang, 2015; Lee and Lee, 2015).

However, voluminous studies by economists show that the early life before age five, including the nine months in utero, is one of the most important periods in human capital formation (Almond and Currie, 2011; Currie, 2011; Currie and Almond, 2011; Almond et al., 2018). Barker (1992) suggests that insufficient nutrition in utero is closely related to diabetes and heart diseases

as adults. Low birth is the most important and most frequently examined indicator of conditions during pregnancy (Currie and Gruber, 1996). According to the previous literature in economics, it is known that various shocks affect infants' birth outcomes such as nutritional deprivation (Almond and Mazumder, 2011), maternal stress (Black et al., 2016; Persson and Rossin-Slater, 2018), disease environment during pregnancy (Almond et al., 2012), pollution (Currie and Schmieder, 2009; Currie et al., 2009; Currie and Walker, 2011; Knittel et al., 2016) and smoking (Almond et al., 2005; Lien and Evans, 2005). It is also found that weighing less than 2,500 grams at birth have negative long-term effects on not only health (Currie and Hyson, 1999; Almond and Mazumder, 2005; Lee, 2014) but socioeconomic outcomes such as academic achievements, educational attainments, and labor market outcomes (Currie and Hyson, 1999; Conley and Bennett, 2001; Behrman and Rosenzweig, 2004; Currie and Moretti, 2007; Oreopoulos et al., 2008; Almond et al., 2009; Johnson and Schoeni, 2011; Aizer et al., 2016).

Still, there remains an avenue for research that integrates son preference and fetal origins hypothesis, as Almond and Currie (2011) points. This study contributes to the literature in this light. Girls' adverse outcomes in early-life due to son-biased prenatal care have been barely reported, even though it might provide some clues to the gender gap in childhood and adolescence mentioned above. And to my knowledge, this paper is the first to find that the gender gap in birth weight which is correlated to son preference.

3 Son Preference and Birth Outcomes

3.1 Background: Son Preference in South Korea

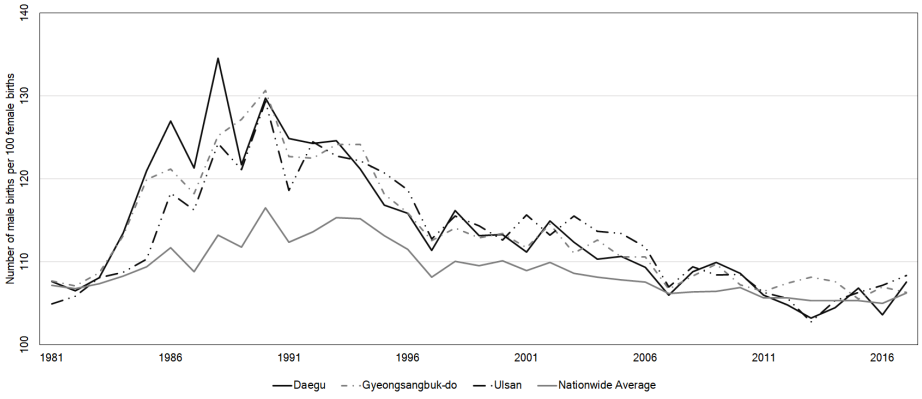
Inveterate preference for son in Korea is rooted in Confucianism (Hwang et al., 2019). It was the ideology of ruling in the Joseon dynasty that lasted for about 500 years until the late nineteenth century. With the prevalence of the agnatic principle of Confucianism, the preferential treatment for the eldest sons and discrimination against daughters had been reinforced from the seventeenth-century (Deuchler, 1992; Shim, 2005). Particularity, in Confucian culture, the eldest son is the successor to his family, and it is one of the seven grounds on which men could divorce his wife that she does not have a boy (Kang, 2004; Seth, 2010).

Confucianism was more prevalent in some area than others for some historical reasons, and accordingly, son preference has been strong in some regions (Kim, 1995), as shown in the regional variation of sex ratio at birth (SRB) in the late 1980s and the early 1990s (see Figure 2). In Korea, with the introduction of sex determination technology including ultrasound which made sex-selective abortion available, SRB began to rise since the mid-1980s and peaked in 1990. Starting to decrease since the mid-1990s, it reached the natural level around the mid-2000s. This regional variation is highly correlated to SRB in the early-1990s.

3.2 Undesired Daughters

Here I give motivation that parents' preference for sons is a factor closely related to the incidence of LBW among newborn girls, using Panel Study

Figure 2: Sex ratio at birth in Korea and selected provinces



Source: Vital Statistics of Korea 1981-2017.

on Korean Children (PSKC) which contains unique questions. PSKC is the data provided by the Korea Institute of Child Care and Education affiliated to the South Korean Government. It contains a variety of questions, including children's health and development; mothers' health; parents' socioeconomic status, and other basic information on the households. The sample comprises of 2,150 households nationwide with children who are born in 2008, but in the sampling, ones are not included where mother or baby is seriously out of health, the mother is minor and has multiple babies.

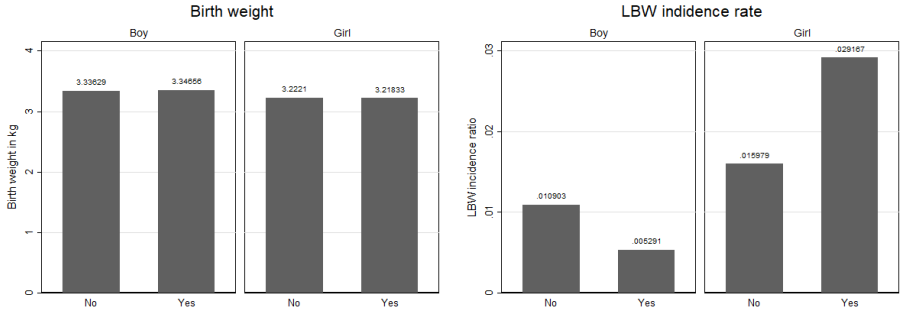
In the survey, there are questions to mothers after her delivery asking "which gender of your baby did you wish during the pregnancy," and "which gender of your baby did your husband wish during the pregnancy." And she can answer boy, girl or no wish for each question. Using them, I look into different birth outcomes between gender across whether parents wanted the other gender than their baby's. To explain, for example, if parents of a girl wanted a baby boy during pregnancy, then they are regarded to wish to have

the other gender. Whereas, if parents of a girl wanted a girl or neither gender, they are considered that they did not want the other gender.

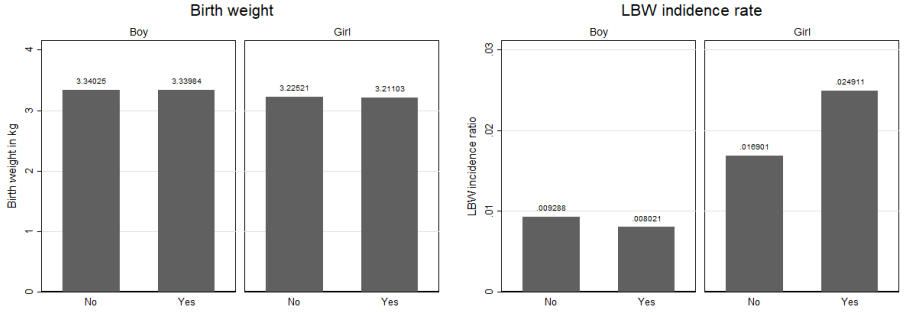
As shown in Figure 3, whether parents desired the other gender was not related to birth weight. However, as for LBW, girls have the worse outcome if parents wanted other fetal sex. In particular, a girl is twice as likely to weigh less than 2500 g at birth when a father wanted a son during pregnancy. These results allude that parents' preference for a son might affect girls' birth outcomes adversely.

Figure 3: Birth outcomes across gender parents wanted

Panel A. Whether father wanted the other gender



Panel B. Whether mother wanted the other gender



Source: Panel Study on Korean Children
Notes: Only households are sampled where the baby is born singleton in 2008, and he/she and his/her mother do not have serious health problem. I additionally excluded premature birth.

3.3 SRB in County of Birth and Birth Outcomes

3.3.1 Data

I employ population-level administrative birth records from 1997 to 2011 in South Korea. The data provides a date of birth, birth weight, gestation week of the infants, and whether they are a singleton or not. It also includes basic information about their parents, such as region they live, age, education attainment, occupation in large categories, and their marital status.

I examine infants only who are singleton since multiple births reduce the birth weight of babies regardless of other adverse environments during pregnancy. Furthermore, in the baseline specification, I exclude deliveries conducted outside hospitals due to concern about measurement error. I also restrict my sample to full-term births to estimate the effects attributable to intrauterine growth retardation (IUGR) as opposed to premature, or preterm births (birth of a baby at fewer than 37 weeks' gestation) following Almond and Mazumder (2011).[1] Results of regressions including premature births and babies born in sites other than hospitals are reported as robustness checks, which are, however, not far from the baseline in their magnitude.

3.3.2 Assumptions

Considering medical and anecdotal evidence, it is quite possible that son-biased parents treated girls differently. Efrat et al. (1999) shows that the accuracy of sex determination using ultrasound is 98.7 percent at 12th ges-

[1] IUGR and prematurity are two major factors that affect birth outcomes (Almond et al., 2005). But previous studies on the fetal origins have focused on IUGR (Almond and Mazumder, 2011).

Table 1: Summary statistics (Birth records)

	(1) Total	(2) Boy	(3) Girl	(4) Diff.
BW (gram)	3298.871	3349.498	3244.423	105.075
	(397.584)	(398.512)	(389.303)	
LBW incidence	0.015	0.012	0.019	-0.007
	(0.123)	(0.109)	(0.136)	
Birth order	1.601	1.618	1.584	0.034
	(0.691)	(0.705)	(0.676)	
Gestational age (week)	39.310	39.263	39.360	-0.097
	(1.091)	(1.095)	(1.084)	
Father's age	32.073	32.106	32.036	0.070
	(4.277)	(4.288)	(4.265)	
Mothers's age	29.210	29.243	29.176	0.067
	(3.972)	(3.981)	(3.962)	
Father's education (year)	13.607	13.602	13.612	-0.010
	(1.922)	(1.924)	(1.920)	
Mother's eduacion (year)	13.391	13.384	13.399	-0.015
	(1.828)	(1.829)	(1.827)	
Birth out of wedlock	0.007	0.007	0.007	-0.000
	(0.084)	(0.083)	(0.085)	
Observations	7,135,673	3,697,567	3,438,106	7,135,673

Source: Vital Statistics of Korea 1997-2011; Microdata Integrated Service of Statistics Korea (https://mdis.kostat.go.kr).
Notes: I examine babies only who are born singleton, in hospital, and whose gestational period is longer than or equal to 37 weeks.

tational week and 100 percent at 13th, which is a routine procedure during pregnancy in South Korea. Thus, given that the average gestational age is around 39, there can exist differential health behavior and maternal stress by gender for a considerable period before birth. Furthermore, although in 1987, the Medical Service Act was revised to prohibit examinations to discern a fetus' gender and divulgence of it even to mothers, the article was in name only. Since the revision, only 18 doctors were charged with violating

the article until 2003, and the penalty was minute (*Hankyoreh*, November 2003).

I also rely on the assumption that without awareness of fetal gender, there should be no gender difference in prenatal investment and consequential adverse birth outcomes since recommended prenatal investment in health does not differ systematically by sex of a fetus, following Bharadwaj and Lakdawala (2013). Unlike previous studies (Dahl and Moretti, 2008; Lhila and Simon, 2008), they show robust results on gender-biased prenatal health care without using ultrasound scanning receipts.

3.3.3 Specification and Identification Issues

Many studies including Barcellos et al. (2014) estimate gender difference in parental input using the following specification:

$$y_i = \beta Girl_i + X_i' + \epsilon_i,$$

where $Girl_i$ is a dummy variable for females, which is, however, not able to capture the gender gap in LBW attributed to the regional difference in son preference. Female infants biologically tend to born lighter than male and the difference is about 90 to 120 gram (Kramer, 1987; Van Vliet et al., 2009). With the equation, the coefficient β merely shows the inherent difference between boys and girls in birth weight and LBW incidence. In this regard, to show of gender gap in birth outcome attributed to son preference in the region of birth, I employ the mean of SRB in 1991-1994 in each county as the measure, SRB_c, following previous papers (Lee and Lee, 2015; Kim et al.,

2018; Hwang et al., 2019). Akerlof and Kranton (2000) discusses that an individual's social identity affects his behavior. Moreover, social norms do not change rapidly and tend to be transmitted intergenerationally (Fernández et al., 2004; Farre and Vella, 2013). Hwang et al. (2019) shows that in Korea, differences in SRB between provinces has narrowed but the ranking is sTableover time.

Therefore, I estimate linear models with following specification to show the relationship between regional son preference and girls' birth outcome:

$$y_{ict} = \beta_1 Girl_i + \beta_2 SRB_c + \beta_3 Girl_i \times SRB_c + \mathbf{X}_i'\gamma + \phi_t + \phi_p + \epsilon_{ict}, \quad (1)$$

where $y_{i,c,t}$ is birth outcomes of children i born in county c in year t, including birth weight and incidence of low birth weight. For estimation of LBW incidence, linear probability models are employed. SRB_c is normalized for convenience of interpretation, and $Girl_i$ is a dummy equal to one if i is girl. $\mathbf{X}_i$ is a vector of control variables that include birth order and parents' characteristics such as age, educational attainment, and marital status. I also control for year-of-birth and province fixed effects. β_3, the coefficient of interest, captures the correlation of son preference in region of birth and girls' outcomes.

In the interpretation of the results above, however, it is important to note that the coefficients β_1 and β_3 represent correlations, not causal effects since, in this specification, the exogeneity of the variable $Girl_i$ is not guaranteed. That is, the coefficient of the dummy variable may be biased due to the endogeneity whose major potential sources are sex-selective abortions and

son-biased fertility stopping rules(Bharadwaj and Lakdawala, 2013; Dahl and Moretti, 2008), which here I discuss.

Figure 1 shows that there still exist son-biased abortions in some provinces, although SRB is at its natural level in the country level since the mid-2000s. With sex-selective abortions, only babies who are not aborted remain in the data. This omission gives rise bias if parents who chose to abort daughter would have invested less in her health than a boy when forced to carry to term. Therefore, under the assumption that prenatal care and selective abortions are correlated with parental son preferences and those with the strongest preference for sons would conduct sex-selective abortions, the magnitude of β_1 would be underestimated.

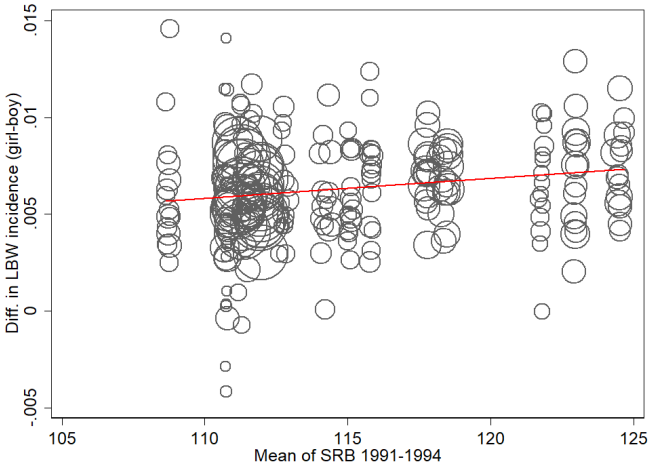
Son-biased fertility stopping rules, or son-targeting, are the practice of having more children until bearing the desired number of sons, which are observed extensively around the world, including the United States (Choi and Hwang, 2019). If the son targeting fertility behavior is prevalent, among the youngest children, the ratio of males is increasing with the age of them because parents have more time to adjust their fertility based on the gender of their last child (Bharadwaj and Lakdawala, 2013; Barcellos et al., 2014). It means that parents whose recent birth is daughter are more likely to have weaker son preference when she is old enough for parents' fertility adjusting.

The other limitation is the lack of covariates. It is highly likely that the birth outcomes are correlated with the characteristics of parents and households. However, since the data I use in this analysis does not include many variables to control, the estimates are prone to omitted variable bias.

3.3.4 Results and Robustness Checks

Figure 4 depicts the approximate illustration of the baseline specification. Each circle represents differences in LBW incidence between boys and girls in each province and each year-of-birth and is weighted by the observations. It shows the positive relationship between the gender gap in LBW incidence and SRB in 1991-1994 of provinces.

Figure 4: Gender gap in LBW and SRB in provinces of birth



Source: Vital Statistics of Korea 1997-2011.

The results of the regression equation (1) are reported in Table2. As presented in Panel A, regional son preference is not associated with the birth weight of girls itself. Rather, the higher SRB in their place of birth, the lighter the boy's birth weight is, but the magnitude is neither substantial nor robust. Even six standard deviations in SRB are related to less than 1 percent of the mean birth weight of boys based on column (2), which is not significant after controlling year-of-birth and province fixed effects. The coefficient of the

dummy $Girl_i$ may reflect the biological difference. However, panel B shows significant relationships between the incidence of LBW and son preference in the region of birth. The coefficients in the column (3) in panel B, my baseline result, suggests that an increase in four standard deviations of SRB in the county of birth explains 7.2 percent of girls' LBW incidence and 20 percent of the gender gap in LBW incidence, approximately. Furthermore, the incidence of LBW of boys is not relevant to the preference for sons in the region of birth. However, as mentioned already, it should be noted that the result does show correlation, not a causal effect.

Because of the limitation in the birth records, it is not possible to use SRB of the regions where parents are born as the proxy for their son preference, which could be more persuasive. Alternatively, using 2000, 2010, and 2015 censuses which contain each household member's region of birth, I construct the proxy for average son preference of parents residing in each region as follows:

$$SonPrefer_{c,t} = \frac{1}{n_{c,t}} \sum_{i}^{n_{c,t}} SRB_{i,c,t}^{Father}, \tag{2}$$

where $n_{c,t}$ is the number of babies born in the county c in the year t, and $SRB_{i,c,t}^{Father}$ is SRB in the early 90s in the birth region of father of the baby i who was born in the county c in the year t. It can be interpreted as the weighted average of fathers' son preference in the county c who have a baby born in the year t, assuming that one's son preference is proxied by SRB in the early 90s in his region of birth.

Table 3 shows that the results of specifications using alternative explanatory variables. $SonPrefer_{i,c,t}$ in equation (2) is employed in panel A. The

Table 2: Birth Outcomes and Son Preference in Region of Birth

	Birth weight (gram)		
	(1)	(2)	(3)
Panel A			
SRB	-4.852***	-4.823***	-1.814
	(1.071)	(1.065)	(1.783)
Girl	-105.2***	-104.2***	-104.1***
	(0.316)	(0.319)	(0.320)
Girl × SRB	-0.305	0.0653	0.0712
	(0.346)	(0.345)	(0.344)
Controls	no	yes	yes
Year-of-birth FE	no	no	yes
Province FE	no	no	yes
YOB × Province FE	no	no	yes
	LBW incidence (1=Yes, 0=No)		
	(1)	(2)	(3)
Panel B			
SRB	0.000232**	0.000263**	0.000139
	(0.000116)	(0.000116)	(0.000191)
Girl	0.00684***	0.00673***	0.00673***
	(0.0000881)	(0.0000883)	(0.0000880)
Girl × SRB	0.000433***	0.000398***	0.000402***
	(0.000106)	(0.000106)	(0.000105)
Controls	no	yes	yes
Year-of-birth FE	no	no	yes
Province FE	no	no	yes
YOB × Province FE	no	no	yes
Observations	7,135,673	7,135,673	7,135,673

Standard errors in parentheses

Source: Vital Statistics of Korea 1997-2011.

Notes: I examine babies only who are born singleton, in hospital, and whose gestational period is longer than or equal to 37 weeks. The variable SRB is the mean of SRB from 1991 to 1994 in each county, which is standardized.

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

variable of interest is an indicator that is equal to one, if the county c where the baby i is born is among *High 3* provinces in panel B, and the ratio of fathers in the county c born whose province of birth is among *High 3* provinces in panel C, respectively. Overall, the results are consistent with the baseline result in their statistical significance and the sign of the coefficients.

In Table4, I report the results of another robustness checks including observations omitted in the base sample: babies born with less than 37 gestational weeks and/or not in hospitals. Note that multiple births are still not included throughout the columns. However, the coefficients of the variable I am interested in, β_3, do not greatly differ from the baseline result in column (3) in Table2 in their magnitude and sign.

4 Differential investment in Health of Girls

In this section, I explore prenatal care, one of the potential channels where the parental preference for sons affects birth outcomes of daughters. According to the literature, both early initiation and the number of prenatal care matters for birth outcomes. Receiving care in the first trimester is important (Currie and Gruber, 1996). Rosenzweig and Schultz (1983) and following studies (Grossman and Joyce, 1990; Warner, 1995) estimate the negative impact of delay in the initiation of first care. On top of that, previous studies estimate that an additional prenatal care increase birth weight by 15 to 71 g, although the magnitude varies across the papers (Warner, 1998; Rous et al., 2004; Evans and Lien, 2005; Wehby et al., 2009). Also, Gonzalez and Kumar (2018) reports one more prenatal care decreases the LBW incidence by 1.7%p. In

Table 3: Robustness checks for the results on LBW (Alternative variables)

	LBW incidence (1=Yes, 0=No)		
	(1)	(2)	(3)
Panel A			
SonPrefer	0.000235***	0.000274***	-0.000235
	(0.0000639)	(0.0000640)	(0.000268)
Girl	0.00677***	0.00667***	0.00666***
	(0.0000921)	(0.0000921)	(0.0000921)
Girl × SonPrefer	0.000545***	0.000528***	0.000526***
	(0.0000923)	(0.0000922)	(0.0000922)
Panel B			
High3	0.000638***	0.000712***	0.00292***
	(0.000192)	(0.000192)	(0.000756)
Girl	0.00666***	0.00656***	0.00656***
	(0.0000985)	(0.0000985)	(0.0000985)
High3 × Girl	0.000897**	0.000814**	0.000812**
	(0.000278)	(0.000278)	(0.000278)
Panel C			
High3 Father	0.000984***	0.00120***	-0.00101
	(0.000246)	(0.000247)	(0.000696)
Girl	0.00638***	0.00628***	0.00628***
	(0.000120)	(0.000120)	(0.000120)
Girl × High3 Father	0.00182***	0.00178***	0.00176***
	(0.000356)	(0.000356)	(0.000356)
Controls	no	yes	yes
Year-of-birth FE	no	no	yes
Province FE	no	no	yes
YOB × Province FE	no	no	yes
Observations	7,134,465	7,134,465	7,134,465

Standard errors in parentheses

Source: Vital Statistics of Korea 1997-2011.

Notes: I examine babies only who are born singleton, in hospital, and whose gestational period is longer than or equal to 37 weeks. County fixed effects controlled in Panel C.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Robustness checks for the results on LBW (Alternative samples)

	LBW incidence (1=Yes, 0=No)		
	(1)	(2)	(3)
SRB	0.000301	0.000283	0.000135
	(0.000226)	(0.000226)	(0.000166)
Girl	0.00613***	0.00613***	0.00666***
	(0.000118)	(0.000119)	(0.0000850)
Girl × SRB	0.000379***	0.000361***	0.000357***
	(0.000125)	(0.000124)	(0.0000908)
Preterm birth included	yes	yes	no
Out-of-hospital birth included	yes	no	yes
Controls	yes	yes	yes
Year-of-birth FE	yes	yes	yes
Province FE	yes	yes	yes
YOB × Province FE	yes	yes	yes
Observations	7,530,317	7,407,592	7,253,281

Standard errors in parentheses
Source: Vital Statistics of Korea. 1997-2011.
Notes: The variable SRB is the mean of SRB from 1991 to 1994 in each county, which is standardized.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

this regard, if parents' prenatal care differs by the gender of fetuses in some regions for some reason, it can be a channel through which regional preference for son affects the birth outcomes of girls in that regions.

4.1 Data and Specification

I employ pooled cross-section data from the National Survey on Fertility, Family Health, and Welfare in Korea (NSF). It is conducted triennially by the Korea Institute for Health and Social Affairs, one of the government-funded research institutes, to investigate marriage, fertility history, rearing, and attitude toward them. Nationally representative married women aged

between 15 and 49 and unmarried men and women aged between 20 and 44 are surveyed. Among them, women with her youngest child aged below 3 are asked questions on prenatal care for the child, the number of which ranges from approximately 900 to 1,000 every survey year. Although it is retrospective, to secure the accuracy, surveyors were instructed to refer to standard maternal health diaries that have been provided by the government for free to all the pregnant.

I use the sample from surveys conducted from 1997 to 2012 to investigate babies born from 1997 to 2012. Here I again confine the sample to singletons whose gestational period is longer than or equal to 37 weeks for consistency with main results.

To examine how region-specific son preference affects health investment during pregnancy measured by the number of prenatal checkups, I estimate following equation:

$$y_{ict} = \beta_1 Girl_i + \beta_2 High3_c + \beta_3 Girl_i \times High3_c + \mathbf{X}_i'\gamma + \phi_t + \phi_p + \epsilon_{ict}. \quad (3)$$

As NSF includes a greater set of covariates than the birth records that I use in Section 3, I control more for mother's age at her first birth, household income, and the number of older brothers and sisters. As mentioned in the previous section, the gender of children is highly endogenous mainly due to sex-selective abortions and son-biased fertility stopping rules. Since NSF comprises only the youngest children, it is prone to the bias attributed to the son-biased stopping. To deal with it, I confine their sample to families with the young enough last-child aged one year or less, as in Barcellos et al.

(2014). However, my approach has a caveat of potential selection since the location of families can be affected by the gender of children as Barcellos et al. (2014) point.

4.2 Results

Table 5 presents the results of the above specification on parental health investment. Column (1) shows the result for the full sample, (2) for children born in *High 3* provinces, and (3) for the other areas. Overall, in the regions other than *High 3*, there is no statistically significant difference in the number of prenatal care visits between boys and girls. However, as shown in column (2), in provinces with strong son preference, girls in utero tend to receive less care than boys, whose magnitude is 9.3 percent of overall average prenatal care visits in the sample, considering the mean of the dependent variable. Mentioned above, sex-selective abortions in the area might bring about underestimation of β, considering that Figure 1 shows that substantial son-biased abortions exist in 1997-2011 cohorts.

5 Concluding Remarks

Even though in Korea, son preference has been weakened, and the gender gap in many aspects has been narrowed, still some studies are reporting there exists differential investment to and under-performance of women, especially in an environment with son preference. However, there has been a limited number of studies that seek to find where the gap originated.

An increasingly growing literature suggests that adverse early-life condi-

Table 5: Prenatal checkup and son preference in region of birth

	Number of prenatal care visits		
	(1)	(2)	(3)
	Full	Children Aged 2 or less	Children Aged 1 or less
Girl	0.0942	0.0537	-0.00906
	(0.163)	(0.210)	(0.261)
High3	0.687*	0.744*	1.269*
	(0.391)	(0.362)	(0.609)
Girl × High3	-0.397*	-0.537*	-1.008
	(0.196)	(0.295)	(0.798)
Year-of-birth FE	yes	yes	yes
Observations	4,445	3,690	1,884

Standard errors in parentheses

Source: National Survey on Fertility, Family Health, and Welfare in Korea 1997-2012.

Notes: The mean of the dependent variable is 12.80. Babies born in 1997-2012 and aged 12 months or less. Multi births and/or preterm births are excluded. Full set of controls is included in each estimation.

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

tion affects not only health but cognitive and non-cognitive skills and socioeconomic status (Barker, 1998; Heckman, 2007; Almond et al., 2018). Especially, negative conditions during pregnancy such as malnutrition, pollution, smoking, maternal stress, and prenatal neglective prenatal care visits have life-long impacts on health and labor market outcomes. In particular, LBW is a key indicator that reflects fetal environments. In this regard, I explore the hypothesis that surviving preference for sons is correlated with girls' negative birth weight, and it might be due to less investment to female fetuses.

This study investigates the possibility that the origin of the gender gap in adolescence and adults is an adverse condition in early life, which is proxied by birth weight. I use the son preference in the county where a child is born and household to verify the hypothesis, employing population-level data. The

results show that there is a positive correlation between son preference in the region of birth and incidence of LBW among girls. The magnitude accounts for 19 percent of the gender gap in LBW incidence. In the interpretation of it, it should be noted that the relationship does not imply causality. Using another dataset, I also report that girls have more LBW incidence than boys if parents wanted other fetal sex. Finally, employing an empirical strategy to address the endogeneity of child gender, I show the difference in the number of prenatal checkups between male and female fetuses in regions with strong son preference.

This paper contributes to a remaining avenue of the fetal origins literature, "the ramifications of sex discrimination in utero (Almond and Currie, 2011)." To my best knowledge, this paper is the first to report the correlation between son preference and the gender gap in LBW incidence. The findings in Section 3.2 and Section 4 are also the first report as far as I know.

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국문초록

최근 경제학 연구들은 한국에 여전히 남아선호적 투자가 존재함을 보고하였다. 이 논문은 전수 자료를 이용하여 출생 지역의 남아선호와 여아의 출생성과의 관계를 연구한다. 특정 시기의 시군구 출생 성비를 각 지역 남아선호의 측도로 이용하였으며, 여아의 출생 시 저체중 발생 확률이 출생 지역의 남아선호 정도와 양의 상관관계가 있음을 밝힌다. 출생성비의 총 변동에 따르는 여아의 출생 시 저체중 발생 비율 증가분은 남아와 여아의 저체중 발생비율 차이의 19%에 해당한다. 또한 임신 중 부모가 아들을 원했었다면, 그 딸은 출생 시 저체중일 확률이 높았다. 마지막으로, 그 잠재적 경로로서 부모의 산전 진료를 살펴본다. 아동 성별의 내생성을 통제하는 방법론을 이용하여, 남아선호가 강한 지역에서 태어난 여아는 남아에 비해 적은 투자를 받았음을 보인다.

주요어: 출생 시의 저체중, 남아 선호, 성별 격차, 출생 성비

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