1. Introduction

Since Sen (1992) found evidence of “missing women” in India, discrimination against women, as evidenced by imbalanced sex ratios, was recognized as a critical issue. Imbalances in sex ratio at birth in Southeast and East Asia increased especially after the mid-1980s (Chung & Das Gupta, 2007; Das Gupta et al., 2003; Hesketh et al., 2011; Yi et al., 1993), drawing considerable research attention. Park and Cho (1995) reported that sex ratios are imbalanced at birth in Korea between 1976 and 2005 and seek to determine how the changes in sex ratios of newborns by birth year. We then study periodic effects on the fertility stopping rule, using the 2006 Korean Longitudinal Study of Aging, which provides birth years for all children. Between 1985 and 1995 there was a large increase in the fraction of boy babies at birth orders of three or more. Despite these fractions falling in the subsequent time period when fetal screening became illegal, they remained above plausible biological levels. Supporting earlier findings in the literature, the increase in sex ratios was especially large when prior sibling composition was entirely female. We also find that having only daughters significantly increases the probability of parents having another child, and this effect is greater for parents with any child born after 1985 than the parents with all children born before 1985. There exist significant period effects, suggesting that sex ratios at birth became imbalanced when ultrasound technology became available. The availability of ultrasound technology also influenced parents’ fertility decisions, seen especially in parents with only daughters deciding to have another child. Our study provides new evidence for how the availability of ultrasound technology influenced sex ratios at birth and influenced fertility behaviors in Korea.

In this paper, we investigate the changes in sex ratios at birth in Korea between 1976 and 2005 and seek to determine how the changes in sex ratios at birth are associated with the introduction of ultrasound diagnostic technology for fetal sex screening and the subsequent illegality of the fetal sex screening practice. We also examine the changes in fertility behavior, particularly the “stopping rule,” before and after the introduction of ultrasonic diagnostic technology for fetal sex screening. One way to adjust fertility with respect to the sex of one’s children is to avoid further births once the desired gender composition is attained (Arnold, 1985). This practice has been described in the literature as the “stopping rule,” whereby parents of sons avoid additional births in greater proportions than do son-less parents (Guilmoto, 2009). For parents preferring sons, especially those with only daughters, the gender composition of existing children may greatly influence the utility parents find in having an additional child. We hypothesize this effect would be even stronger after the introduction of ultrasonic diagnostic technology.

We identify precise periods when fetal screening was widely accessible and then became illegal with substantial penalties in South
Korea. Using the 1985, 1995, and 2005 South Korean Census micro data, we examine changes in sex of newborns by birth year. We then study periodic effects on the fertility stopping rule using the birth year of all children provided by the 2006 Korean Longitudinal Study of Aging.

The paper is divided into four sections. The next section explains the changing legal and policy landscape of ultrasonic diagnostic technology in Korea. Section 4 describes the data and our analytical approach, while Section 5 summarizes our main findings. The final section highlights our conclusions.

2. Background

Starting in 1961, the South Korean government adopted an explicit population policy, which has changed over time with the population’s changing demographic structure. The legality of and attitude toward induced abortion changed several times, alongside the access and legality of fetal sex screening using ultrasonic diagnostic technology. The following is a brief history of how access and legality have changed together with the government’s population policies.¹

2.1. Abortion

Abortion was strictly prohibited in Korea during the Japanese colonial period (1910–1945) (Tedesco, 1996) and was outlawed under the Criminal Code when the newly formed Republic of Korea established its laws in 1948. During this period, the prohibition was strictly observed and few induced abortions were performed (Sung, 2012).

However, a more permissive attitude toward induced abortion began to develop during the Korean War (1950–1953) when many women experienced unwanted pregnancies including those resulting from sexual violence (Kwon, 1993). This permissive attitude continued after the war, as the idea of limiting family size increased in popularity into the 1990s (Choe & Park, 2005; Tedesco, 1996). According to the 1991 National Fertility and Family Health Survey, ever-married women aged 15 to 49 supported induced abortions if the mother’s health is in danger (93%), if the pregnancy was the result of sexual violence (98%), and if the mother is unmarried (87%). The same survey also found that 32% supported induced abortion if the sex of the fetus is not what the parents desired.

The Korean government adopted an explicit population control policy in 1961 as a component of the first Five-Year Economic Development Plan. The government promoted small families to increase per capita income and to alleviate poverty. The government launched a fertility planning campaign with slogans such as, “Unplanned parenthood traps you in poverty” and “Have fewer children and achieve prosperity” (Stephen, 2012). This campaign was well received by the general public during these early years of economic development, and the family planning program was successful in its first decade, as observed in the total fertility rate; the average number of children born to a woman over her lifetime sharply dropped from 6 in the early 1960s to 4.5 in 1970 (KOSIS, 2014).

As a direct means of avoiding unwanted births, particularly after contraceptive failure, induced abortion gradually increased in Korea, especially among urban women (Choe & Park, 2005; Stephen, 2012). By 1970, abortion had become a common practice with more than 40% of women reporting having had an induced abortion to terminate unwanted pregnancies, and this rate rose to over 50% by the 1980s (Chun and Das Gupta, 2009). Abortions were easy to obtain in clinics throughout the country, and the operations performed were safe, cheap, and completed without social resistance despite the illegality of the procedure (Tedesco, 1999).

Abortion remains common in South Korea. Although the annual number of abortions is difficult to ascertain as no national data are available, Ahn et al. (2011) estimated that 342,433 induced abortions are performed annually at a rate of 29 abortions per 1000 women aged 15 to 44, while 440,000 childbirths are reported. There seems to still be a discrepancy between the widespread practice of abortion and Korean law.

2.2. Ultrasound diagnostic technology

The obstetric use of ultrasound technology was first introduced in Korea in 1980. In 1985, ultrasonic diagnostic equipment was domestically produced (Jeong, 2000) and became widely available and affordable for fetal sex screening. In 1984, ultrasound screening cost about $75 US dollars, while chorionic biopsy cost almost nine times more, and amniocentesis cost five times more than ultrasound (Park & Cho, 1995).

Ultrasound spread widely and were even performed at private clinics. In 1987, fetal screening was legally authorized for the detection of genetic problems and for the monitoring of fetal growth only, but was prohibited for the purpose of prenatal sex screening. However, there were no substantive penalties associated with such use. The Korean fertility rate fell sharply until 1987 and continued to decline until 2005, attaining the world’s lowest fertility rate of 1.076.

With the continuing rapid decline in fertility, the government amended regulations on medical care to prohibit prenatal sex screening by sharply increasing the penalty for performing prenatal sex determination procedures in 1994. Before this amendment, laws prohibiting fetal sex screening were not enforced, and the penalty for violation was minimal (Kim, 1999). After this amendment, Chapter 2 of the Medical Practices Act states that a medical provider must not personally examine or assist another in examining a pregnant woman for the purpose of determining the sex of the fetus, and upon determining sex of the fetus through examination, must not reveal such information to the pregnant woman, to her family member, or to any other persons (Kim, 1999). Upon violation of this law, a physician could face up to three years imprisonment and a fine of up to US $25,000, as well as the revocation of one’s medical license. In March of 1996, the first administrative punishment for violation of the Medical Practices Act took place when a doctor received a one month suspension for conducting ultrasound tests for sex determination. In October of 1996, a doctor was first arrested and charged with informing pregnant women of the sex of their unborn children.

The suspension of medical licenses for eight doctors who performed sex determination tests on fetuses was widely publicized in the media. The Korean Medical Association launched a self-reform campaign to stop fetal sex screening in 1995 (Tedesco, 1996). The government also adopted a new population policy goal in 1996 to achieve replacement-level fertility (Stephen, 2012). However, this population policy was not very effective, with the total fertility rate still remaining at 1.18 in 2013.

Despite the illegality of fetal sex screening, ultrasonic diagnostic technology is widely used to detect genetic problems and presumably in the determination of the sex of the fetus. While it is difficult to obtain direct evidence of the illegal practice, indirect evidence for fetal sex screening is the unnatural imbalance of the sex ratio at birth.

3. Analytic approach

3.1. Data

To study changes in the sex ratio at birth over time, we use data on children born from 1976 to 2005 drawn from one-percent of the Korean census micro files for 1985, 1995, and 2005. Census micro data are the largest representative data with information about population characteristics, including sex, age, education, marital status, and religion of...
all household members. From each census we analyze information on children 0 to 9 years of age and their parents and siblings in the same household.

Census data contains individual records of all people residing in the household for all three years, but contains no information about family members residing outside of the household in 1985 and 1995, while the 2005 Census micro data contains information on both. Using the 2005 Census micro data, we examined the percentage of non-resident siblings of children in the household, acknowledging that some older siblings may reside outside of the household. We find that only 2% of children aged 0 to 9 have a sibling residing outside of the household who is not captured in the household interview. Thus, from the 2005 census micro data we select information about children who were born from 1996 to 2005 and information about their parents and siblings. Likewise, we use information from children aged 0 to 9, their parents, and siblings from the 1985 and 1995 Census micro data. It would be important to note that this measure of sex ratios may have some bias due to infant and child mortality, although the extent of biasness is not substantial given the infant mortality rates during that period. Infant mortality rates were 13.0 per 1000 live births in 1985, 9.9 per 1000 live births in 1993, and 4.7 per 1000 live births in 2005 (OECD, 2017).

Our second data source is the 2006 Korean Longitudinal Study of Aging (KLoSA), a large-scale, longitudinal survey representative of the South Korean population aged 45 and older residing in the community. Unlike the Census micro data, the KLoSA collects information about all family members, both co-residing and not co-residing, enabling us to capture the complete fertility history for the representative sample. The baseline survey instrument, modeled after the Health and Retirement Survey, included questions on demographics and family, including all co-residing and not co-residing children (Lee, 2010). A total of 10,254 respondents completed the baseline wave interview. We use the baseline KLoSA for two reasons: first, it provides complete fertility behaviors for a representative Korean population, and second, it provides a complete sex composition of children with their birth years, as well as information about their parents' socioeconomic status. This allows us to estimate the effects of the sex composition of children on parents' fertility behavior and to determine whether such effects varied over time, especially after the ultrasonic fetal screening became widely available.

3.2. Estimation strategy

The critical period for identifying effects on sex-selection extends from the mid-1980s, when fetal-screening technology became widely available, to 1994, when it was prohibited by law with significant penalties. To examine this period effect, we use Korean Census micro data to calculate sex ratios of children born by calendar year. Our empirical strategy to identify parents’ fetal screening practices is to examine the sex of children born in a particular birth year. Additionally, the availability of fetal sex screening accompanied by elective abortion permits parents to avoid children of unwanted sex. Given the lack of access to sex selection technology, we expect sex imbalances would not be very significant before the mid-1980s. We further hypothesize that the sex imbalance at birth is greatest between the mid-1980s and 1995. We expect some sex imbalance may remain after 1995, but it should be greatly reduced after the prohibition of fetal sex screening.

It is important to acknowledge that there has been a downward trend in son preference in Korea. Chung and Gupta (2007) documented the changes in Korean women's attitude, a continuous downward trend of son preference from 1985 till 2003 (data are available only during this period). Such changes in women's attitude over time makes it difficult to identify how much of changes in fertility behavior are driven by the availability of fetal sex screening. We fully acknowledge this limitation associated with examining period effect, particularly difficult after 1994 when fetal sex screening was prohibited with significant penalty as both trends are predicting the reduction of sex imbalance, and use caution in interpreting our findings.

Prior literature recognized that sex ratios at birth vary by the birth order and the sex composition of older siblings (Park & Cho, 1995). We therefore hypothesize that son-prefering parents who have only daughters are more likely to seek fetal screening and to select the sex of their unborn children. Since more-educated parents have an increased likelihood of embracing innovation (Rogers, 2010), we hypothesize that more educated parents are more likely to use ultrasonic diagnostic technology. Therefore, we examine the sex ratio at birth across different levels of the mother's educational attainment by birth year. Region and religion are other influencing factors that might affect the use of abortion to select the gender of the next birth (Chung and Gupta, 2007): living in an urban area is significantly associated with lower son preference and being “Buddhist” is strongly associated with higher son preference. Son preference is rooted in Confucianism, which has exerted a great effect on the daily life and social values of Koreans, but few considering it as a religion (Kim & Song, 2005).

We will estimate the probability of a child being a boy using a linear probability model, regressing on the year the child was born, the gender composition of siblings, mother’s education (or father’s when the mother’s information is unavailable), region, and religion, using Korean Census micro data. We will stratify our model by birth order, estimating the model separately for first- or second-born children and for children whose birth order was three or higher.

We then investigate the potential effects of ultrasonic diagnostic technology on fertility decisions using the 2006 Korean Longitudinal Study of Aging (KLoSA). Depending on the ideal and achieved gender composition of children, parents might adjust their fertility decisions. As discussed earlier, one way to adjust one’s fertility with respect to the sex of one’s children is to avoid further births once the ideal sex composition of children is attained. For parents preferring sons, especially those with only daughters, the gender composition of existing children may greatly influence the utility parents find in having an additional child. We hypothesize that this effect would be even stronger after the introduction of ultrasonic diagnostic technology.

We use a linear probability model to estimate the parents’ decision to have additional children, regressing fertility behavior on the gender composition of existing children, doing so separately for the decision to have a second and third child. To identify period effects, we further stratify by families with all children born before 1985, and families with any child born after 1985. Our equations control for mother’s age to capture decreases in fertility over time, as well as religion, urban/rural residence, and region.

4. Findings

Table 1 presents the sex ratio, the ratio of males to females multiplied by 100, of children born in five-year birth cohorts for the years 1976–2005 using Korean Census micro data. These sex ratios are displayed for all births and also distinguish between 1st born, 2nd born, and 3rd or later birth-order births. The top panel in Table 1 lists the sex ratios for all new mothers, while subsequent panels stratify sex ratios by the mother’s educational attainment: less than a high school degree, exactly a high school degree, and more than a high school degree.

Among all mothers, there is an evident increase in the sex ratio for new births from 1986 through 1995 despite the declining trend of mother’s attitude toward preferring son and a subsequent drop since 1996, supporting our hypothesized period effect on the availability of fetal screening technology and its subsequent legal prohibition. The increase in the imbalance of the sex ratios at birth is highly concentrated among later-born birth order children. Among third- or later-born children, the sex ratio increased from 115 between 1981 and 1985 to 206 between 1991 and 1995. A sex ratio of this magnitude would only be possible with a combination of abortion and fetal screening. After 1995, the sex ratio of new births in this birth order group fell to just above 140, still higher than the pre-1985 levels. This finding suggests that induced abortion, exploiting sex screening technology were
Sex ratio by sibling order and birth year. Still practiced despite the sanctions. Source: 1985, 1995, 2005 Korean Census Micro Data.

| Kid’s birth year | Sex ratio by birth order |
|------------------|-------------------------|
|                  | All | 1st born | 2nd born | 3rd or later |
| 1976–1980        | 105 | 107 | 103 | 106 |
| 1981–1985        | 107 | 107 | 102 | 115 |
| 1986–1990        | 111 | 104 | 112 | 159 |
| 1991–1995        | 116 | 107 | 114 | 206 |
| 1996–2000        | 108 | 102 | 108 | 149 |
| 2001–2005        | 108 | 103 | 107 | 143 |
| **For less than HS moms** |     |       |       |       |
| 1976–1980        | 106 | 108 | 103 | 105 |
| 1981–1985        | 106 | 106 | 103 | 111 |
| 1986–1990        | 112 | 107 | 106 | 143 |
| 1991–1995        | 116 | 102 | 105 | 181 |
| 1996–2000        | 98  | 97  | 95  | 109 |
| 2001–2005        | 109 | 113 | 94  | 128 |
| **For HS graduated moms** |     |       |       |       |
| 1976–1980        | 107 | 108 | 105 | 111 |
| 1981–1985        | 108 | 110 | 100 | 136 |
| 1986–1990        | 110 | 103 | 112 | 189 |
| 1991–1995        | 116 | 107 | 115 | 226 |
| 1996–2000        | 110 | 103 | 109 | 151 |
| 2001–2005        | 107 | 102 | 105 | 142 |
| **For moms with more than HS** |     |       |       |       |
| 1976–1980        | 99  | 102 | 90  | 111 |
| 1981–1985        | 104 | 108 | 102 | 95  |
| 1986–1990        | 112 | 106 | 120 | 165 |
| 1991–1995        | 115 | 109 | 117 | 201 |
| 1996–2000        | 108 | 102 | 108 | 165 |
| 2001–2005        | 108 | 103 | 110 | 149 |

Still practiced despite the sanctions.

Similar effects are seen among mothers of varying education levels in Table 1. The imbalance in the sex ratio is greater for later birth order children of mothers at all educational levels, with the greatest imbalance being observed for mothers with high school education (226), followed by mothers with more than high school education (201), and then by mothers with less than high school education (181). The imbalance in the sex ratio is quite high during 1986 to 1990, but more so for mothers with at least a high school education. It appears to have taken more time for less-educated mothers to adjust to the availability of the new screening technology. Less-educated mothers also experienced a sharper drop in the sex ratio of new births after 1995, which may indicate that it was more difficult for them to find ways around the new prohibition of the use of fetal sex screening technology.

Table 2 supplements Table 1 by presenting Census micro data on sample sizes for female and male births by birth order and sex composition of older siblings over time alongside the sex ratios of new births. We divided the time period into three ten-year groups, with the middle group (1986–1995) being the years when fetal sex screening technology was widely available, and the other two groups representing ten years before and ten years after the era of legally permissible sex screening. Within each birth order, we provide sex ratios separately by the gender composition of the existing siblings, with all sisters in the top row and all brothers in the bottom row for each birth order.

Among first-born children, sex ratios are relatively balanced with little difference between our three ten-year time periods. However, birth sex ratios become more imbalanced for later-born children, particularly those with older sisters. Among second-born children born between 1986 and 1995, when sex-selection technology was most available, the sex ratio was 117 for those with a sister, but only 108 for those with a brother. There was little difference in sex ratios for the pre- and post-critical period time spans, suggesting little use of fetal sex screening technology in first- and even second-order births.

The sex ratio imbalance is more pronounced among third-born children born between 1986 and 1995. The sex ratio was 232 for those with two older sisters, but only 96 for those with two older brothers. This imbalance among third-born children diminished only slightly from 1996 to 2005; in this period the sex ratio was 212 for those with two older sisters, and 98 for those with two older brothers. For fourth or later born children, we observe a similar pattern of a huge increase in the sex imbalance between 1986 and 1995, especially when comparing all-girl sibling and all-boy sibling groups, though the imbalance among sibling order is less consistent due to smaller sample sizes among fourth or later born children.

Sample sizes in Table 2 dramatically illustrate the influence of prior-gender composition of children on decisions to have and to follow through to an actual birth. Using the 3rd born birth order during the years 1976–1985, those with two girl siblings were slightly more than twice as likely to have another birth compared to those with two boy siblings.
sibling. This ratio rose to almost eight times as likely to have another birth during the open fetal sex screening era, and then fell back to three times as likely in the post-open screening era.

Using a linear probability model with Korean Census data, Table 3 shows the estimated odds ratios (OR) of a child being male relative to being female separately for first or second born children, and for third-born children. This model includes dummy variables for each calendar year, a dummy variable for mothers with a high school education or more, dummy variables for religious preference, and dummy variables for prior sex composition of siblings.

We do not observe any statistically significant year effects on the probability of a child being male for first- or second-born cases, but we find significant year effects for 3rd birth-order children. Specifically, the probability of a 3rd birth-order child being a boy is significantly influenced by year when the child was born starting in the calendar year 1986, when fetal screening technology became widely available, with an OR of 1.07 (95% CI: 1.01,1.13) and peaking in 1993 with an OR of 1.19 (95% CI: 1.12,1.25), before decreasing in size in subsequent years (though mostly remaining statistically significantly).

Consistent with the descriptive results presented in Table 1, we find that for children at the third birth-order, the probability of a child being male is slightly higher for those with more educated mothers than mothers with less than high school education, as shown by an OR of 1.04 (95% CI: 1.02,1.06). For the first and second born, mother’s education is not associated with the sex of child.

For the third-born children, having two older sisters significantly increased the probability of a child being male, with an OR of 1.10 (95% CI: 1.08,1.12), relative to having two older brothers. When prior siblings are balanced by gender, the probability of another birth is higher when the sequence is first sister and then brother (OR: 1.04, 95% CI: 1.02,1.07). We interpret this as a selection effect since this group is more likely to have a stronger boy preference, which contributed in part to having the second child when their first child was female. Given that screening now allows for sex selection of the next birth, they are more likely to choose to have another child.

Results from both models suggest that the mother’s religion matters significantly. Catholics and Protestants, in Korea have campaigned against abortion. We find that the first- or second-born child and the third-born child are more likely to be male if born to mothers who practice Buddhism or Confucianism compared to those born to mothers without religion, with

### Table 3
Linear probability model of being a son by birth order.
Source: 1985, 1995, 2005 Korean Census Micro Data (1 ≤ 0.10, * ≤ 0.05, ** ≤ 0.01, *** ≤ 0.001)

| Sib*: older sis  | Birth order²: 2nd |
|------------------|------------------|
| OR               | OR               |
| CI              | CI              |
| p > |t| | p > |t| |
| 1.00            | 1.00            |
| (1.00,1.02)     | (1.00,1.02)     |
| B, S            | B, S            |
| 1.00            | 1.00            |
| (1.00,1.02)     | (1.00,1.02)     |
| B, B            | B, B            |

For birth orders beyond three, results were similar to the 3rd birth order model in Table 3.
odds ratios of 1.01 and 1.02, respectively. Among third- or later-born children, those born to Protestant mothers are less likely to be a boy than those born to mothers without religion (OR: 0.97, 95%CI: 0.95,0.99). We expect that the small proportion of Catholics in Korea than those born to mothers without religion (OR: 0.97, 95%CI: 0.95,0.99) seems to contribute to the lack of significance for that religion.

Table 4 presents results exploring the potential impact of ultrasonic diagnostic technology on decisions to cease fertility using the 2006 KLoSA data. Specifically, it presents the results of linear probability models of parents with one or more children having another child and of parents with two or more children having another child. These models are estimated separately for parents with all children born earlier than 1985, and for parents with any child born in 1985 or later. Given the youngest age (45) of the KLoSA sample, these are the only relevant groups with data in that sample.

For families with one child, we find that the first born being a girl rather than a boy increases the probability for parents to have a second child. Additionally, the marginal effect of the first born being a girl is more than four times greater for those with any child born in 1985 or later (OR: 1.09, 95% CI: 1.05,1.14), compared to those with all children born before 1985 (OR:1.02, 95%CI: 1.01,1.04). We also find significant negative effects of mother’s education and rural residence on the fertility decision of having a second in the earlier time period, but such effects no longer exist for parents with any child born in 1985 or later.

The decision to have a third child also shows sharp differences between the parents with all kids born earlier than 1985 and those with any child born in 1985 or later. The sex composition of the first two children matters greatly in the decision to have a third child, with having two daughters increasing the probability of having a third child with an OR of 1.05 for either combination of a male and female child, but for the parents with at least one child born in 1985 or later, having one girl and one boy no longer increases the probability of having a third child.

Maternal education significantly negatively influences the decision to have a third child only for parents with all children born before 1985 (OR:0.83, 95%CI: 0.80,0.86), but not for parents with any child born in 1985 or later. This result is consistent with the impact of the mother’s education on the decision to have a second child. In addition, we find a significant, small but significant age effect on the decision to have a third child for parents with all kids born before 1985 and for parents with any kids born in 1985 or later.

5. Conclusions

Until ultrasound technology became available, Korean parents had to wait until the child’s birth to discover gender. This changed with ultrasonic fetal screening, which became widely available in the mid-1980s in South Korea. Ultrasound plays an important role in health improvements, allowing for early diagnosis of fetal and maternal health conditions and leading to reduced infant and maternal mortality rates. However, the knowledge of a child’s gender before birth combined with a strong son preference and high abortion tolerance led many Korean parents to choose to abort their unborn daughters. Using 1985, 1995, and 2005 Censuses, we find significant period effects suggesting that sex ratios at birth became unnaturally imbalanced when ultrasound technology became available.

Obstetric use of ultrasound technology quickly became a part of routine prenatal care in South Korea. In the face of continuing fertility declines and increasing sex imbalances at birth, the Korean government started to regulate prenatal sex screening in 1994 with increasing penalties to doctors. We observe a significant drop in the sex imbalance from 1996 onwards, but they still remain far different from a natural sex ratio.

Beside strong period effects, we find that the following factors are associated with the sex of a newborn: birth order, sex of older siblings, mother’s education, and religion, supporting prior literature (Choe & Park, 2005; Chung & Das Gupta, 2007). For the first or second born child, the probability of a newborn being male is close to the natural sex ratio, but for the third or later-born child, the probability of a newborn being male is much higher than the biological norm during the years of availability of fetal sex screening technology and strongly depends on the gender of older siblings. Those with only sisters for older siblings are far more likely to be born male. We find that the sex imbalance is lowest among children born to mothers with less than high school (HS); (3) region: urban; (4) mother’s religion: no religion.

Table 4

| Having 2nd child | Families with 1+ child | Having 3rd child | Families with 2+ children |
|------------------|----------------------|------------------|-------------------------|
|                  | All kids born before 1985 | Any kids born after 1985 | All kids born before 1985 | Any kids born after 1985 |
|                  | OR      | CI      | p > | OR      | CI      | p > |
| Sib¹:            |         |         |     |         |         |     |
| Girl             | 1.02    | (1.01,1.04) *** | 1.09 | (1.05,1.14) *** | 1.24 | (1.20,1.27) *** | 1.57 | (1.46,1.69) *** |
| Girl             | 1.05    | (1.02,1.09)** |       | 0.97 | (0.92,1.03) ** |       | 0.99 | (0.93,1.05) ** |
| HS + mother²     | 0.95    | (0.93,0.97) ** | 1.00 | (0.96,1.05) ** | 0.83 | (0.80,0.86) ** | 0.96 | (0.91,1.02) ** |
| Age              | 1.00    | (1.00,1.00)†  | 1.00 | (0.99,1.00)†  | 1.02 | (1.02,1.02)*** | 1.02 | (1.01,1.03)*** |
| Rural³           | 1.02    | (1.01,1.04) * | 1.02 | (0.96,1.08) * | 1.06 | (1.03,1.09)*** | 1.15 | (1.05,1.26)*** |
| Religion²:       | 1.01    | (1.00,1.03) | 1.01 | (0.96,1.05) | 1.04 | (1.01,1.07)† | 1.06 | (1.00,1.13)† |
| Protestant       | 1.00    | (0.98,1.02) | 1.01 | (0.97,1.06) | 1.00 | (0.97,1.04) | 1.07 | (1.01,1.14) |
| Catholic         | 1.01    | (0.98,1.04) | 1.03 | (0.97,1.09) | 1.00 | (0.96,1.04) | 1.07 | (0.97,1.18) |
| _cons            | 2.30    | (2.17,2.44)*** | 2.54 | (1.88,3.45)*** | 0.61 | (0.55,0.67)*** | 0.43 | (0.25,0.76)*** |
| No of obs        | 5337    |          | 1159 |         | 1023 |          | 1023 |         |
| F-stat           | 6.04    |          | 2.19 |          | 79.72 |          | 15.9 |          |
| R-q              | 0.02    |          | 0.04 |          | 0.27 |          | 0.29 |          |

† R-sq

0.02 0.04 R-sq 0.27 0.29

0.05

R-sq 0.02 0.04 R-sq 0.27 0.29

0.01, *** 0.01, *** 0.01, *** 0.01, *** 0.01, ***

Reference categories are: (1) Sex previous child: boy (families with 1 child) and boy, boy (families with 2 children); (2) mother’s education: less than high school (HS); (3) region: urban; (4) mother’s religion: no religion.
more educated mothers. Supporting earlier literature on son preference and religion, we found that the sex of a newborn is more likely to be male if the mother is a Buddhist and more likely to be female if the mother is a Christian, compared to those with no religion.

Regarding the fertility stopping rules, we find that having only daughters increases the probability of parents having another child significantly, and that this effect is greater for the third born than for the second born. As hypothesized, we find that the effect of having only daughters on parents’ fertility decisions is much greater for parents with any child born after 1985.

It is important to recognize the declining trend of son preference in Korea, particularly during the period of 1985 to 2005, which we examined sex ratios at birth and fertility behaviors. Therefore, it calls for caution in attributing the period effect to the availability of ultrasound fetal sex screening technology. While additional factors likely had an impact on the sex ratio at birth and on parents’ fertility behaviors in Korea, it is clear that the availability of ultrasound diagnostic technology and its use for fetal sex screening made a definitive impact. Especially, its introduction has significantly increased sex imbalances at birth despite the declining trend of son preference and significantly increased parents without son to have another child despite the declining trend of fertility. On the other hand, given the declining trend of son preference in the society, it is difficult to tease out how much impact increased sanctions for illegal use of fetal sex screening might have had on reduced imbalance at birth.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical statement

We use only secondary data for analysis and have no conflict of interest.

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