SEX PREFERENCES AND FERTILITY IN SOUTH KOREA DURING THE YEAR OF THE *HORSE**

JUNGMIN LEE AND MYUNGHO PAIK

Since antiquity, people in several East Asian countries, such as China, Japan, and South Korea, have believed that a person is destined to possess specific characteristics according to the sign of the zodiac under which he or she was born. South Koreans, in particular, have traditionally considered that the year of the Horse *bears inauspicious implications for the birth of daughters. Using monthly longitudinal data at the region level in South Korea between 1970 and 2003, we found that in the year of the Horse, the sex ratio at birth significantly increased while fertility decreased.*

Since antiquity, people in several East Asian countries, such as China, Japan, and South Korea, have used the lunar calendar, in which each year is symbolized by a zodiacal sign according to a rotating cycle of 12 animals: Rat, Ox, Tiger, Rabbit, Dragon, Snake, Horse, Sheep, Monkey, Rooster, Dog, and Pig. The belief is that people are destined to possess specific personality traits or characteristics according to the sign of the zodiac under which they are born.[1]

The contents and interpretation of zodiac astrology differ across countries and cultures. There is widespread documentation that the Japanese consider the year of the *Fire Horse* (*Hinoeuma*) ominous for the birth of girls (Aso 1978; Kaku and Matsumoto 1975).[2] The Chinese regard the year of the *Dragon* as auspicious for new business ventures, marriage, and childbearing, while they think of the *Tiger* and the *Sheep* as inauspicious.

South Koreans have traditionally thought that the year of the *Horse* bears inauspicious implications for the destiny of girls. According to zodiac astrology, the *Horse* is generally believed to symbolize masculinity. It is energetic and optimistic and has high spirits. As such, the *Horse* implies undesirable traits for women as wives. In patriarchal and Confucian society, women are expected to be subservient to men. Women born in the year of the *Horse* are believed to suffer unhappiness and misfortune. Similar though less strongly held beliefs extend to women born in *Tiger* and *Dragon* years.[3]

Although the origin in South Korea of this mythical faith is not exactly known, it is said that it was imported from Japan quite recently, during the colonial period (1910–1945). Various suggestions have been made concerning the origin of the *Hinoeuma* in Japan: a coincidence between the year of the *Fire Horse* and disastrous famines (1786 and 1846);

*Jungmin Lee, Department of Economics, Sam M. Walton College of Business, Business Building 402, University of Arkansas, Fayetteville, AR 72701-1201; E-mail: jlee@walton.uark.edu. Myungho Paik, Department of Economics, University of Texas at Austin. We are thankful to Dan Hamermesh, George Holmes, and Robert Oppenheim for their comments. We owe special thanks to Heebong Hwang in the Korea National Statistical Office for data help. We would also like to thank the editors, anonymous referees and participants at seminars at the 2003 annual conference of the Southern Economic Association and the Center for East Asian Studies at the University of Texas at Austin.

1. Astrology is also popular in Western countries (Eysenck and Nias 1982). Western astrology also implies that those who are born under the same zodiacal sign share specific characteristics. Bennett and Barth (1973) tested for whether people born under Aries and Scorpio, who are supposed to be brave, militant, and aggressive according to astrology, are more likely to join the army. Mock and Weisberg (1992) investigated how a person's zodiac sign is correlated with partisanship. Neither study found any significant result.

2. Combined with the five major elements (metal, water, wood, fire, and soil) of which the world is composed, 12 animal years form a complete 60-year cycle. Thus, the year of the *Fire Horse* comes every 60 years.

3. The *Tiger* and *Dragon* are believed to have characteristics similar to those of the *Horse*, and they are also considered bad zodiacs for girls in South Korea. The origin of the belief for these two zodiacal signs is uncertain, although it has been said that the Korean War happened in the year of the *Tiger*. As we will see, zodiacal preferences are not as apparent during the years of the *Tiger* and *Dragon* as during the year of the *Horse*.

or a famous tale of Yaoya-Oshichi, a woman born in a *Fire Horse* year, who burned down her house for love, a tale often depicted in Kabuki plays and Odori dances. The belief was transformed and modified as it crossed the sea. South Koreans consider the *White (Metal) Horse,* rather than the *Fire Horse,* inauspicious for girls. The reason for this transformation is not known, but people in South Korea consider white horses a rare breed. The social origins of the belief that girls born in *Tiger* or *Dragon* years will suffer misfortune are not clear; again, though, the Korean War occurred in the year of the *Tiger*. It is likely that the distaste is irrationally associated with the distaste for the *Horse.* However, the distaste for the *Tiger* and the *Dragon* is not as strong as for the *Horse*.

Zodiac astrology is widespread in South Korea. People read their fortunes in newspapers every day, and they often consult with fortune tellers for advice about their careers or family matters. In 2003, there were 13,929 establishments in astrological services (compared with 605,614 restaurants and 7,511 banks, for example), according to the *Census on Basic Characteristics of Establishment*. The antipathy for the *Horse* is often documented in the press. Women born in the year of the *Horse* report that they are told that they are too strong and argumentative, that they are likely to fail in their first marriage or to be widowed, and that they should marry later in life to avoid their bad luck (see, e.g., "Bad Year for Girls" 1990; Choe 2003; Kim 2001; Lee 1990).

Regardless of superstition, the culture of zodiac astrology in South Korea provides a unique opportunity to study the effects of cultural sex preferences on demographic outcomes. If parents are concerned about their children's destinies, they would not want to give birth, in particular to daughters, during the year of the inauspicious *Horse*. In this study, we examine how parents' preferences and cultural values could influence their demographic decisions.

There are a few previous studies of the impact of zodiac astrology on demographic outcomes. For example, research suggests that the inauspicious *Hinoeuma* may have lowered fertility in Japan (Coleman 1983). This pattern was most apparent in 1966, when fertility dropped by over 25%. Kaku and Matsumoto (1975) found that the fertility rate of Japanese Americans in California and Hawaii also dropped by 3.3% and 1.8%, respectively, in the same year. In a series of articles, Goodkind (1993, 1995, 1996) examined how the culture of zodiac astrology affected fertility among the Chinese in Taiwan, Malaysia, and Singapore. He also made comparisons across countries, including Hong Kong and the People's Republic of China (PRC; Goodkind 1991). The empirical regularity is that fertility is significantly higher among the Chinese in Taiwan, Hong Kong, Malaysia, and Singapore in the auspicious *Dragon* years. Goodkind revealed three interesting findings: (1) zodiacal preferences have not been visible in fertility until recently (1976 and 1988), (2) zodiacal preferences outside the PRC were apparent only among the Chinese, and (3) the effect of zodiacal preferences on fertility is not uniform across countries. As a result, Goodkind rejected a simple explanation that a fertility response to the traditional belief in the auspicious *Dragon* became feasible and evident with the help of modern contraceptive technology and birth timing. Rather, he argued that the phenomenon should be understood in a more comprehensive context of historical, political, social, and cultural forces.

We believe that the study of zodiacal preferences in South Korea provides another unique case for two reasons. First, unlike in other countries, zodiacal preferences in South Korea were imported. It would be interesting to see how cultural values have changed as the country has undergone economic development and modernization. Second, zodiacal preferences in South Korea are closely related to a preference for sons. As a result, this study will shed light on the interaction between zodiacal preferences and son preferences.[4] Using monthly longitudinal data at the regional level from 1970 to 2003, we found that, during

4. To our knowledge, there is no demographic study on zodiacal preferences in South Korea. Park and Cho (1995) and T. Kim (1997) only briefly mentioned the effect of zodiacal preferences on the sex ratio in South Korea.

the year of the *Horse,* fertility significantly decreased and the sex ratio at birth increased, although the magnitude of the effects varied across regions and changed over the years.

DATA

In this study, we use a regional-level panel data set constructed from monthly vital statistics.[5] Every birth must be reported because the birth registration is used for various purposes, such as school attendance and mandatory military service. However, the birth data have been known to be incomplete, especially in earlier years, due to problems of delayed registration. The completeness of registration of births in the year of occurrence was below 50% in the early 1970s (Choi 1991; N. Kim 1997); the rate increased substantially to 70% in the late 1970s and to more than 90% in the late 1980s.[6] Fortunately, the delayed reports of births have been continuously reported by the National Statistical Office (NSO). In this article, we use the most updated data available from the NSO.

Considering delayed birth reports, the NSO waits for 10 years to finalize birth records. For example, the number of births in 1970 was updated during the 1970s and was finalized in 1979. We obtained the data directly from the NSO in January 2005. In a previous version of this article, we used the birth statistics published in *Annual Report on the Vital Statistics* from various years (1986, 1994, 1999, 2000). Each annual report shows the birth statistics in the past decade. We found that there are missing births in the published statistics, particularly in earlier years. In Appendix Table A1 and Appendix Figure A1, we compare the old data with the new data. As a check of data quality, survivorship ratios from birth to 2003 are calculated based on the 2003 civil registration data that identify all legal residents. The survivorship ratios are more reasonable for the new data, particularly since 1977. It is notable that the birth statistics in the late 1970s and early 1980s have been updated and improved substantially. However, there are still some defects in the new data. First, the survivorship ratio in 1980 is higher for males than for females. Second, the survivorship for males is abnormally low in 1975. Lastly, there exists an anomaly in the last year of the study period because some births in 2003 were not reported by parents or were not yet updated by the NSO. The completeness of birth registration in the year of occurrence is estimated at 96.4% in the early 1990s (N. Kim 1997; Lee 1998).

The units of observation are administrative regions (metropolitan cities and provinces). Five metropolitan cities were created as independent administrative units from the surrounding provinces during the study period. As of 2003, there were nine provinces and seven metropolitan cities. The maximum number of observations for a given year is 16. Each city has a population in excess of 1 million. Table 1 summarizes the regional composition of the data set, which consists of a total of 5,508 month × region observations. To supplement the monthly data, we constructed yearly data from the same source, producing an additional 459 year × region observations.

Table 2 shows long-term trends for population size and the sex ratio at birth (the ratio of male births to female births) in South Korea. The average sex ratio is 1.11, higher than the world or biological average of 1.06, indicating that South Korea is one of the countries with a strong preference for sons, as is well-documented by other researchers (T. Kim 1997; Larsen, Chun, and Das Gupta 1998; Park 1978; Park and Cho 1995). The high sex ratio is evident across all regions during the 1990s, the period during which sex-selective abortion is thought to have been widespread. For instance, there were 152,425 births (79,818 boys and 72,607 girls) in the capital city of Seoul in 1996. If the sex ratio were normal (1.06), we could expect 2,693 additional girls. It is also notable that during the 1970s and 1980s, the sex ratio was high in such conservative southeastern regions as

5. The data on annual statistics are accessible online at http://www.nso.go.kr/eng/index.html.

6. The improvement is the result of various factors, such as improvements in the registration system, the beginning of a social security system (1977), and legal enforcement (N. Kim 1997).

Table 1. Data Availability by Regions

Region	Available Years	Number of Observations (yearly)	Number of Observations (monthly)
Seoul	1970–2003	34 years	34 years × 12 months = 408
Pusan	1970–2003	34 years	34 years × 12 months = 408
Taegu	1981–2003	23 years	23 years × 12 months = 276
Incheon	1981–2003	23 years	23 years × 12 months = 276
Gwangju	1987–2003	17 years	17 years × 12 months = 204
Daejon	1989–2003	15 years	15 years × 12 months = 180
Ulsan	1997–2003	7 years	7 years × 12 months = 84
9 Provinces	1970–2003	34 years × 9 provinces = 306	34 years × 12 months × 9 provinces = 3,672
Total		459	5,508

Note: The nine provinces are Gyungki, Gangwon, Choongbuk, Choongnam, Chonbuk, Chonnam, Kyungbuk, Kyungnam, and Cheju. Metropolitan cities except Seoul and Pusan are separated from provinces during the sample periods.

Taegu, Kyungbuk, and Kyungnam and that the ratios remained high in the 2000s, although less so than in the 1990s in all regions except one.

One noteworthy fact about our data is that parents in South Korea may report their child's birth date according to either the Western or lunar calendar, even though they are supposed to report the date based on the Western calendar.[7] The mixed use of the Western and lunar calendar is important for the purpose of this article because a person's zodiac must be assigned by the lunar year of the birth. Unfortunately, because we cannot determine whether parents in our sample reported these births according to the Western or lunar calendar, our calculation of the number of births during the year of the *Horse* is subject to some imprecision.

We use two different measures to analyze the monthly data, each based on a different extreme assumption about the calendar use: (1) that all births were reported based on the lunar calendar, and (2) that all births were reported based on the Western calendar. Each assumption has its own advantages. The first assumption is advantageous because we are interested in revealing zodiacal preferences, and parents who have zodiacal preferences are likely to prefer the lunar calendar. The second assumption is likely to be more valid in recent years because more people have recently gravitated toward using the Western calendar.[8] Under the first assumption (lunar-calendar reporting), the *Horse* is assigned to all births registered in 1978, 1990, and 2002. Under the second assumption, we convert the Western birth dates to the equivalent lunar birth dates. In terms of the Western calendar, the lunar years of the *Horse* are from February 7, 1978, to January 28, 1979; from January 26, 1990, to February 14, 1991; and from February 11, 2002, to February 1, 2003. We treat the periods between February 1978 and January 1979, February 1990 and February 1991, and February 2002 and January 2003 as the year of the *Horse*. As an added precaution, we

7. According to the NSO, vital statistics, including birth, death, marriage, and divorce, are to be reported using the Western calendar. However, there is no means to enforce this, and the report form does not ask about which type of calendar is used. To avoid this problem, the census has asked whether the birth date is based on the lunar calendar or on the Western calendar and has recoded the reported lunar birth date. Unfortunately, the vital statistics do not have this procedure, so we cannot ignore the possibility of the lunar-calendar reporting, especially in earlier years. Indeed, N. Kim (1997) pointed out that the lunar calendar has been widely used.

8. Appendix Table A2 shows that the calendar used depends on age and education. The younger and more educated tend to prefer the Western calendar. However, note that this shows that *they* use the Western calendar for their birth date. It does not imply that their official birth date in birth registration is based on the Western calendar. Some use the lunar calendar for their birthday, but their official birth date is in the Western calendar, and vice versa.

Table 2. Regional Distribution of Population and the Sex Ratio at Birth

	Population				Sex Ratio			
Region	1970s	1980s	1990s	2000s	1970s	1980s	1990s	2000s
Metropolitan								
Seoul	6,905,110	9,524,536	10,292,583	10,051,220	1.088	1.084	**1.103**	1.079
Pusan	2,582,711	3,588,557	3,814,412	3,708,935	1.089	1.081	**1.155**	**1.103**
Taegu	NA	2,117,478	2,432,005	2,538,287	NA	**1.179**	**1.198**	**1.130**
Incheon	NA	1,538,018	2,242,656	2,570,421	NA	1.072	**1.103**	1.077
Gwangju	NA	1,082,304	1,250,742	1,405,902	NA	1.069	1.099	**1.103**
Daejon	NA	NA	1,234,732	1,430,210	NA	NA	**1.135**	1.091
Ulsan	NA	NA	1,021,855	1,051,235	NA	NA	**1.144**	**1.143**
Province								
Gyungki	4,084,502	4,783,321	7,513,881	9,502,590	1.064	1.064	**1.104**	1.084
Gangwon	1,888,649	1,743,385	1,512,293	1,519,885	1.064	1.064	**1.109**	1.093
Choongbuk	1,520,096	1,412,831	1,420,213	1,507,483	1.065	1.089	**1.130**	**1.102**
Choongnam	2,982,104	2,926,824	1,868,401	1,894,231	1.088	1.085	**1.127**	1.092
Chonbuk	2,467,015	2,226,407	1,961,202	1,920,175	1.074	1.071	1.090	1.079
Chonnam	4,030,986	3,454,087	2,193,679	2,015,162	1.055	1.081	**1.108**	1.091
Kyungbuk	4,883,494	3,169,488	2,733,275	2,775,701	**1.108**	**1.153**	**1.198**	**1.128**
Kyungnam	3,185,967	3,426,688	3,532,250	3,058,073	**1.147**	**1.104**	**1.175**	**1.129**
Cheju	416,250	490,042	513,474	529,461	1.054	1.080	**1.117**	**1.115**

Notes: All values are averages of all available yearly data during each 10-year period. NA indicates that data are not available in most years. The sex ratios above 1.1 are emphasized in boldface.

compare the results from the two measures. Although the true effects of zodiacal preferences will be somewhere between the two sets of estimates, we believe that the estimates based on the lunar-calendar assumption will be more accurate, for reasons explained later.

Comparison With Neighboring Years

Figures 1 and 2 show the yearly trends of the sex ratio at birth (defined as the ratio of male births to female births) and the general fertility rate (births per woman aged 15–49). Figure 1 shows that the sex ratio has increased since 1980. The ratio is highly unbalanced in the mid-1990s, clearly suggesting a strong preference for sons and widespread fetal sex determination (Park and Cho 1995). The ratio started to decrease in 1994, when the government strengthened the penalty for illegal abortions (Cho 1998); however, the ratio is still higher than the value of 1.06 believed to be normal. Figure 2 shows that fertility has dropped rapidly over the past three decades.

If people attempted to avoid having daughters in the year of the *Horse,* one would expect to see a decline in fertility and an increase in the sex ratio. There are detectable peaks in the sex ratio in the years of the *Horse.* The sex ratio seems to vary randomly before 1976, which probably reflects low data quality. The sex ratio also rises in the years of the *Tiger* and *Dragon,* which are also considered inauspicious zodiacs for girls.[9] Our analysis focuses on the *Horse.*

9. The years of the *Tiger* are 1974, 1986, and 1998, and the years of the *Dragon* are 1976, 1988, and 2000.

Figure 1. Yearly Trend of the Sex Ratio at Birth, 1970–2003

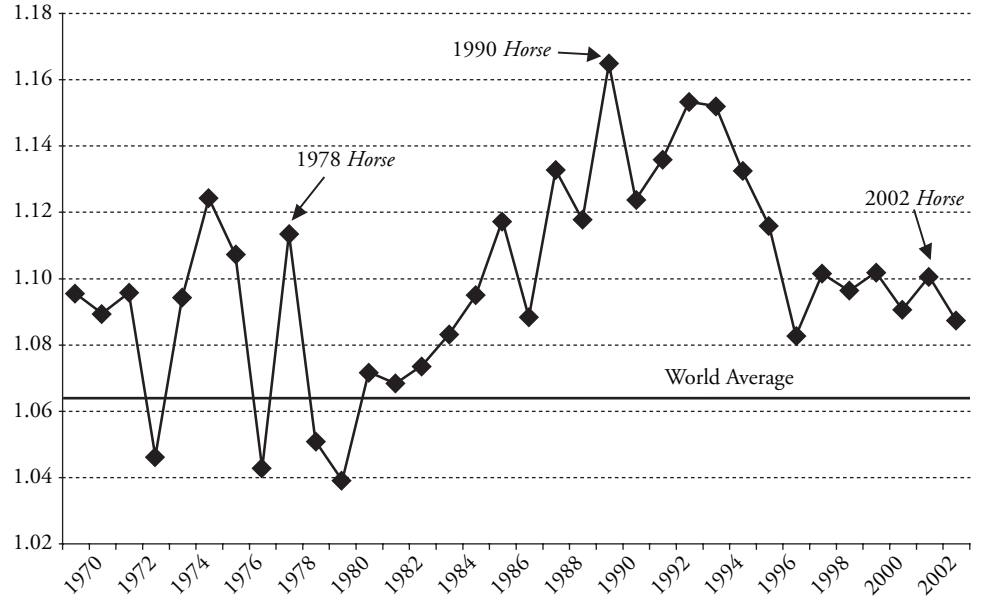
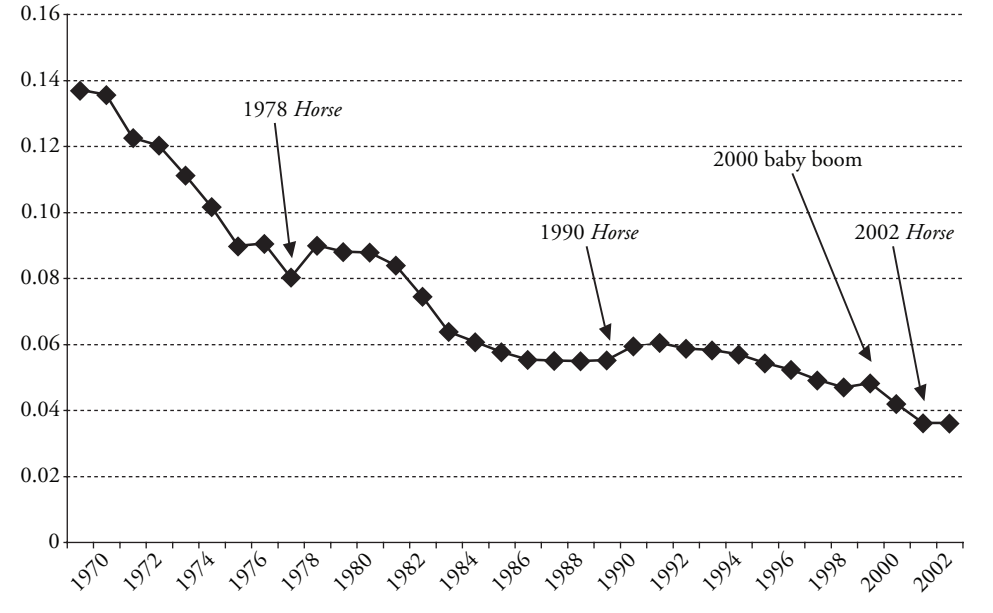


Figure 2. Yearly Trend of the General Fertility Rate, 1970–2003



Unlike the sex ratio, the zodiacal cycle of fertility is less apparent in Figure 2 except for an abrupt drop in 1978. Nevertheless, we can observe that fertility decreases slightly in 1990 and 2002.[10] Detecting the zodiacal cycle of fertility is more difficult in part because fertility is significantly affected by other confounding variables, such as income. In addition, because fertility in South Korea has been very low since the mid-1980s, the effect of zodiacal preferences may not be distinguishable from the long-term trend, even though the effect may be quantitatively substantial. For example, suppose that there were 354,310 male births and 334,254 female births from 11,904,344 females of reproductive age in a year.[11] Had there been 10,000 missing girls, the sex ratio would have changed from 1.06 to 1.09. On the other hand, the general fertility rate would have changed only slightly, from 0.058 to 0.057.

In Tables 3 and 4, we compare the general fertility rate and sex ratio at birth between the year of the *Horse* and its neighboring years, the years of the *Snake* and *Sheep.* In this section, we assume the lunar-calendar reporting. We examine whether the demographic outcomes deviate from their trends in the year of the *Horse.* The trend value is calculated as an arithmetic average of the neighboring years' values, assuming that the three-year trend can be linearly approximated.

The general fertility rate in the year of the *Horse* is lower than the trend value. The rate drops by about 11% in 1978, by 3.6% in 1990, and by 7.5% in 2002. In terms of number of births, our results imply that fertility decreased by about 93,000 births in 1978, by 23,700 in 1990, and by 30,700 in 2002.[12] This pattern holds across regions. As expected, the sex ratio at birth is higher than the predicted trend, especially in 1978 and 1990. Although in some cities and provinces the ratio is actually lower in 2002 compared with the neighboring years, the ratio is still higher at the national level than the predicted ratio. The ratio increases by about 6.4% in 1978, 3.9% in 1990, and 1.1% in 2002. In Figure 3, comparing across regions, we show that the effects of zodiacal preferences on the sex ratio are stronger where the effects on fertility are stronger. We can see from simple statistics that zodiacal preferences affect demographic outcomes.

Intentional Misreporting of Birth Date

One of the main reasons why couples might avoid having girls in the year of the *Horse* is that their daughters might have difficulty finding a marriage partner, even if parents themselves do not believe zodiac astrology (Lee 2005). One might wonder whether births of girls are intentionally misreported in months before and after the year of the *Horse.* In doing so, parents can hide their daughters' inauspicious zodiac.

Figure 4 shows the sex ratio at birth by months. First, it is notable that there are spikes in the sex ratio (more boys or fewer girls) in January of 1978, 1990, and 2002. This implies that births, perhaps in particular those to parents with zodiacal preferences, are reported based on the lunar calendar: if they were reported on the basis of the Western calendar, the January spikes cannot be reasonably explained because January in 1978, 1990, and 2002 is, in fact, in the year of the *Snake* in the lunar calendar. This finding is informative: although we cannot identify whether births are reported on the basis of the Western or lunar calendar, we expect that the assumption of the lunar-calendar reporting should be more valid. From this point, we will discuss mainly the results based on the lunar-calendar reporting.

In Figure 4, we show some evidence for parents' strategic misreporting. Note that the January spikes correspond to the preceding December dips in 1977, 1989, and 2001. This

10. On the other hand, fertility does not deviate from the trend in the years of the *Tiger* and *Dragon*. In fact, it is higher in 2000, the year of the *Tiger*, which seems to reflect the millennium baby boom.

11. The example is close to the actual birth statistics in 1990.

12. The actual fertility drop in 2002 is larger than our estimate here because the reporting of some births in 2003 is delayed.

Table 3. Comparison With Neighboring Years: Fertility (annual data)

Region	1977 *Snake*	1978 *Horse*	1979 *Sheep*	1989 *Snake*	1990 *Horse*	1991 *Sheep*	2001 *Snake*	2002 *Horse*	2003 *Sheep*
Seoul	0.0732	0.0667 (0.0098)	0.0799	0.0526	0.0527 (–0.0017)	0.0562	0.0369	0.0324 (–0.0023)	0.0324
Pusan	0.0752	0.0703 (–0.0082)	0.0818	0.0503	0.0486 (–0.0024)	0.0517	0.0321	0.0276 (–0.0023)	0.0275
Taegu				0.0487	0.0485 (–0.0011)	0.0505	0.0371	0.0323 (–0.0027)	0.0329
Incheon				0.0600	0.0636 (–0.0021)	0.0714	0.0401	0.0347 (–0.0028)	0.0350
Gwangju				0.0504	0.0539 (–0.0014)	0.0601	0.0434	0.0388 (–0.0023)	0.0388
Daejon				0.0504	0.0529 (–0.0017)	0.0587	0.0403	0.0365 (–0.0019)	0.0365
Ulsan							0.0434	0.0364 (–0.0036)	0.0366
Gyungki	0.0811	0.0736 (–0.0112)	0.0884	0.0663	0.0679 (–0.0019)	0.0733	0.0458	0.0401 (–0.0029)	0.0403
Gangwon	0.0975	0.0881 (–0.0075)	0.0937	0.0488	0.0477 (–0.0014)	0.0494	0.0421	0.0372 (–0.0016)	0.0354
Choongbuk	0.1032	0.0887 (–0.0112)	0.0964	0.0496	0.0501 (–0.0017)	0.0539	0.0425	0.0377 (–0.0017)	0.0363
Choongnam	0.1009	0.0886 (–0.0087)	0.0938	0.0451	0.0434 (–0.0022)	0.0462	0.0466	0.0391 (–0.0033)	0.0383
Chonbuk	0.1073	0.0927 (–0.0081)	0.0944	0.0462	0.0463 (–0.0010)	0.0482	0.0450	0.0377 (–0.0030)	0.0364
Chonnam	0.1138	0.0962 (–0.0109)	0.1004	0.0484	0.0464 (–0.0029)	0.0502	0.0478	0.0390 (–0.0040)	0.0383
Kyungbuk	0.0891	0.0765 (–0.0102)	0.0843	0.0549	0.0531 (–0.0023)	0.0558	0.0426	0.0361 (–0.0033)	0.0363
Kyungnam	0.1002	0.0908 (–0.0107)	0.1029	0.0607	0.0602 (–0.0031)	0.0659	0.0440	0.0374 (–0.0033)	0.0373
Cheju	0.0912	0.0744 (–0.0115)	0.0805	0.0461	0.0482 (–0.0036)	0.0575	0.0522	0.0433 (–0.0048)	0.0439

Note: Numbers in parentheses are deviations from the trend.

pattern cannot be found elsewhere, suggesting that the parents of some girls who were actually born in January backdated the month of birth to December in order to avoid the *Horse*. Suppose that the patterns in January and December are due totally to intentional misreporting. For simplicity, assume that the sex ratio for December should have been the same as that for November in the same year if there were no misreporting. Note that parents have no incentive to advance the month of male births. Now it is possible to predict the number of added female births that are reported as occurring in December but actually occurred in January. On the other hand, assuming that the sex ratio for January should have been the same as for February if there was no intentional misreporting, we can also predict the number of missing female births in January by using the sex ratio for February and the number of male births in January.

Table 4. Comparison With Neighboring Years: Sex Ratio (annual data)

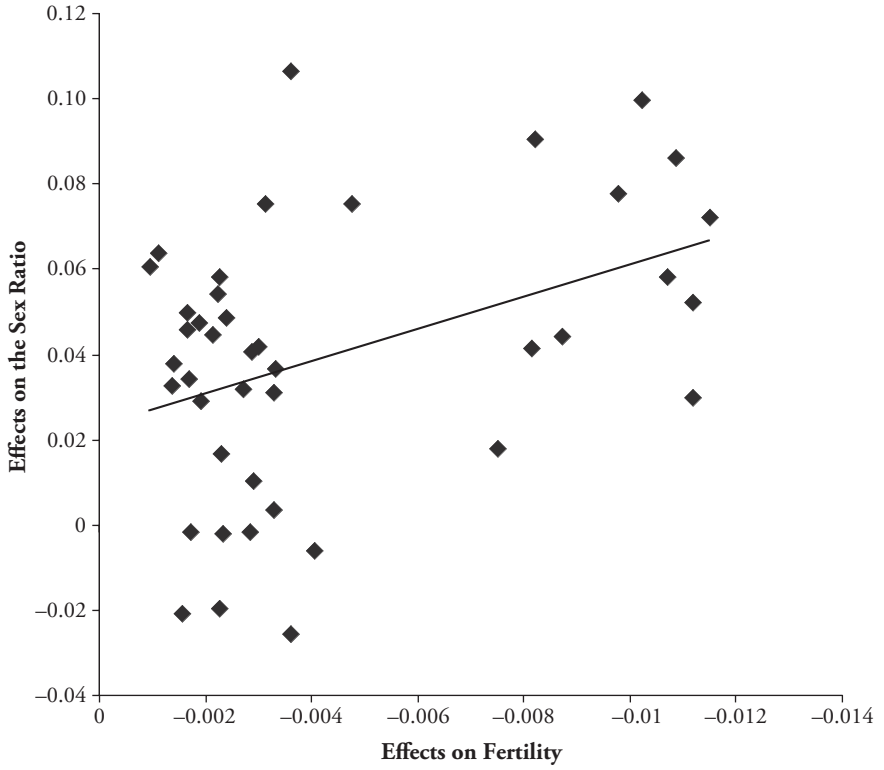
Region	1977 *Snake*	1978 *Horse*	1979 *Sheep*	1989 *Snake*	1990 *Horse*	1991 *Sheep*	2001 *Snake*	2002 *Horse*	2003 *Sheep*
Seoul	1.0388	1.1261 (0.0779)	1.0577	1.0959	1.1327 (0.0343)	1.1009	1.0757	1.0873 (0.0167)	1.0654
Pusan	1.0300	1.1285 (0.0905)	1.0461	1.1115	1.1842 (0.0488)	1.1594	1.1050	1.0814 (–0.0195)	1.0968
Taegu				1.2175	1.2968 (0.0636)	1.2489	1.1108	1.1497 (0.0317)	1.1252
Incheon				1.0688	1.1195 (0.0444)	1.0814	1.0849	1.0720 (–0.0018)	1.0628
Gwangju				1.0815	1.1327 (0.0378)	1.1084	1.0882	1.1026 (–0.0020)	1.1210
Daejon				1.2271	1.2266 (0.0458)	1.1345	1.0852	1.1289 (0.0475)	1.0775
Ulsan							1.1592	1.1317 (–0.0258)	1.1558
Gyungki	1.0398	1.0987 (0.0522)	1.0532	1.0747	1.1134 (0.0290)	1.0940	1.0786	1.0879 (0.0104)	1.0763
Gangwon	1.0387	1.0681 (0.0178)	1.0619	1.0973	1.1296 (0.0326)	1.0968	1.1144	1.0744 (–0.0209)	1.0761
Choongbuk	1.0571	1.1027 (0.0298)	1.0885	1.1165	1.1703 (0.0499)	1.1242	1.0995	1.0927 (–0.0018)	1.0895
Choongnam	1.0448	1.0865 (0.0443)	1.0396	1.0996	1.1663 (0.0541)	1.1248	1.0703	1.1134 (0.0365)	1.0835
Chonbuk	1.0309	1.0824 (0.0415)	1.0510	1.0826	1.1376 (0.0604)	1.0718	1.0666	1.1063 (0.0417)	1.0625
Chonnam	1.0472	1.1213 (0.0860)	1.0234	1.0957	1.1406 (0.0406)	1.1042	1.0860	1.0864 (–0.0062)	1.0991
Kyungbuk	1.0551	1.1545 (0.0995)	1.0550	1.2717	1.3074 (0.0582)	1.2267	1.1193	1.1455 (0.0311)	1.1094
Kyungnam	1.0364	1.0995 (0.0583)	1.0460	1.1718	1.2466 (0.0751)	1.1711	1.1192	1.1318 (0.0035)	1.1375
Cheju	1.0646	1.1342 (0.0723)	1.0592	1.1266	1.1880 (0.1064)	1.0367	1.1119	1.1842 (0.0753)	1.1059

Note: Numbers in parentheses are deviations from the trend.

The comparison between added and missing girls supports the existence of intentional misreporting. The numbers of added and missing girls are very similar over all three periods. About 4,615 girls were added in December 1977, while 4,586 girls were missing in January 1978; about 4,460 girls were added in December 1989, and 4,656 were missing in January 1990; and about 775 were added in December 2001, with about 1,123 missing in January 2002. Intentional misreporting plays a significant role in the abnormal sex ratios. The number of misreported births amounts to about 0.5% of total births.

However, keep in mind that parents' misreporting alone cannot fully explain the higher sex ratios during the *Horse* years. First, we observe some spikes in December and January during the year of the *Horse*. If the December spikes were also due to misreporting (delayed registration), we should observe corresponding dips for the following January or

Figure 3. Effects of the *Horse* Year on Fertility and Sex Ratio at Birth From a Comparison With Neighboring Years



February. There are actually some observable dips in January and February in 1979, but we cannot find any noticeable dips in 1991 and 2003. It is likely that misreporting was more prevalent in the late 1970s than after 1990. Also, notice that the sex ratio is higher for most of 1978, which cannot be satisfactorily explained by parents' misreporting because it is unlikely that parents misreport their children's birth date by more than one or two months; most parents register their children as soon as possible in order to obtain benefits from the national health insurance and social security system. In 1990, there are small but visible spikes in February, March, April, and November. In 2002, we can also observe small but discernible spikes throughout from May to August.

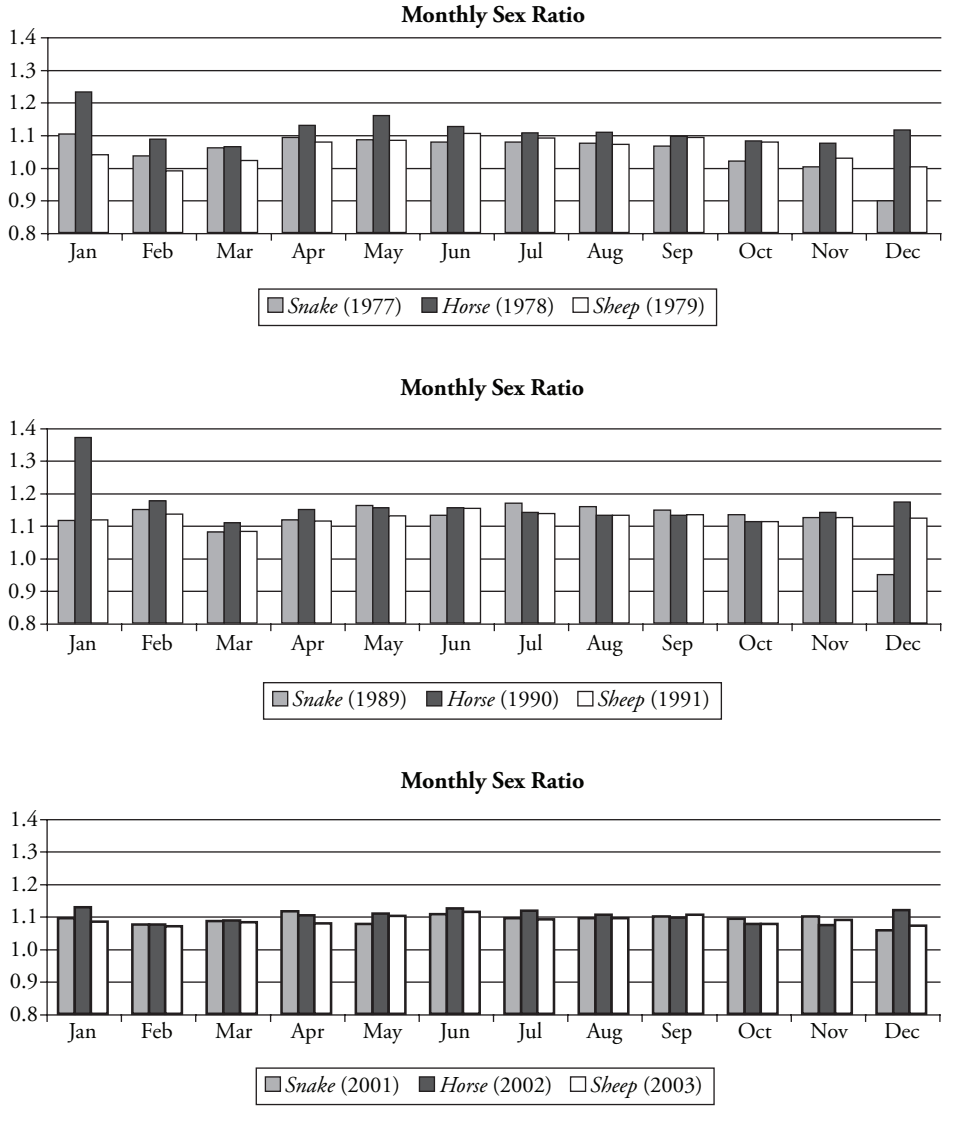
MULTIVARIATE ANALYSIS

We estimate the effects of the *Horse* on the sex ratio (S) and the general fertility rate (F). The basic estimation equations are as follows:

$$\ln S_{it} = \alpha_S HORSE_t + \epsilon_{SY} \ln Y_{it} + \mathbf{X}_{it}\beta_S + u_{Sit}$$

$$\ln F_{it} = \alpha_F HORSE_t + \epsilon_{FY} \ln Y_{it} + \mathbf{X}_{it}\beta_F + u_{Fit},$$

Figure 4. Monthly Sex Ratio



where the subscripts represent region i at time t (year-month). The dependent variables, $\ln S_{it}$ and $\ln F_{it}$, are the natural logarithm of the monthly sex ratio at birth and the monthly general fertility rate, respectively. $\ln Y_{it}$ is the natural logarithm of the average annual wage/salary per employee in manufacturing in real terms. The coefficients, ϵ, represent income elasticities, each of which shows the size of percentage change in each demographic outcome caused by the percentage change in income. Unfortunately the data on per capita gross regional domestic product are not available for the years preceding 1985. A vector $\mathbf{X}_{it}$ is a

set of control variables, including a constant, the number of females aged 15–49, variables for annual and monthly trends, and dummy variables for metropolitan cities and provinces. The number of females aged 15–49 is included to capture any effect of female cohort size on the demographic outcomes.[13] In addition, considering the nonlinearity of the effects of income, we include its squared term. The dummy variable $HORSE_t$ equals 1 if time t is the year of the *Horse* and equals 0 otherwise. Basically, α_S and α_F capture the effects of zodiacal preferences. In order to assess whether zodiacal preferences have changed over years, we estimate

$$lnS_{it} = \alpha_{S,78}HORSE_{78} + \alpha_{S,90}HORSE_{90} + \alpha_{S,02}HORSE_{02} + \epsilon_{SY}\, lnY_{it} + \mathbf{X_{it}}\beta_S + u_{Sit},$$

$$lnF_{it} = \alpha_{F,78}HORSE_{78} + \alpha_{F,90}HORSE_{90} + \alpha_{F,02}HORSE_{02} + \epsilon_{FY}\, lnY_{it} + \mathbf{X_{it}}\beta_F + u_{Fit}.$$

As noted earlier, the effects of zodiacal preferences should appear in the form of deviations from long-term time trends. Thus, we include yearly trend variables. Figures 1 and 2 show that fertility has been declining steadily but at a decreasing rate, but the sex ratio reached its peak in the mid-1990s and decreased thereafter. Therefore, we allow for a cubic trend for the sex ratio and a quadratic trend for fertility. Lastly, we include dummy variables for region to control for any omitted time-invariant regional characteristics. For instance, it is likely that regions are heterogeneous in demographic characteristics. Fertility might be persistently different between urban and rural areas, and the accessibility of fetal sex determination and abortion could be higher for those in urban areas; on the other hand, those in urban areas are likely to be more highly educated.

Some econometric issues remain. First, the unit of observation is a *region* (metropolitan city or province). Because regions vary greatly in population size, we estimate the equations by using weighted least squares. This method ensures that our estimates are nationally representative. Specifically, the equation for the sex ratio is weighted by the number of monthly births, and the equation for fertility is weighted by the number of females of reproductive age in the population. Second, because some explanatory variables, including *HORSE,* are constant within a year, we correct the standard errors by clustering for years. This problem is also avoided by using yearly data.

ESTIMATION RESULTS

Sex Ratio at Birth

Table 5 shows the results for the sex ratio at birth. The results from the multivariate regressions are consistent with our expectations. Based on the lunar-calendar reporting, the sex ratio rises by 3.7% in the year of the *Horse.* The effect is the strongest and robust to the assumption of the lunar or Western calendar in 1990, when the *Horse* is associated with an increase in the sex ratio of about 4.1%. This is in part because 1990 is the year of the *White Horse,* the most hated year in South Korea. Our estimates suggest that the sex ratio should have been about 111.9 without zodiacal preferences, implying that about 12,500 girls are missing because of zodiacal preferences. Recall that about 4,500 girls who were born in 1990 were likely to be registered in 1989 by intentional misreporting. Even after we take misreported births into account, the results imply that an excess of about 8,000 female fetuses were aborted in 1990.[14] The number amounts to 1.1% of the number of pregnancies that should have resulted in a birth in 1990.

13. Female cohort size could affect fertility through its impact on the marriage market or the demand for obstetrician services. It also might affect the sex ratio in that sex predetermination is more accessible in larger population centers. Yet, our results are qualitatively the same without controlling for number of females.

14. We control for the possibility of intentional misreporting by including the indicator for neighboring years. By misreporting, the sex ratio in the years that neighbor the inauspicious *Horse* should be lower. Suppose that a girl's birth date is changed from 1978 to 1977 or 1979. Then, statistically, we lose one female birth in 1978, but

Table 5. Regression of Sex Ratio at Birth by Weighted Least Squares, 1970–2003

	Lunar Calendar Reporting			Western Calendar Reporting		
	(1)	(2)	(3)	(1)	(2)	(3)
Horse	0.037			0.019		
	(0.006)			(0.007)		
Horse, 1978		0.042	0.039		0.019	0.019
		(0.009)	(0.010)		(0.015)	(0.017)
Horse, 1990		0.042	0.041		0.026	0.026
		(0.005)	(0.005)		(0.005)	(0.005)
Horse, 2002		0.021	0.017		0.012	0.012
		(0.009)	(0.012)		(0.011)	(0.011)
Neighboring years			–0.007			0.000
			(0.009)			(0.009)
Per capita income	–0.002	–0.005	–0.003	0.000	–0.001	–0.001
	(0.024)	(0.025)	(0.025)	(0.024)	(0.025)	(0.025)
Per capita income, squared	0.003	0.003	0.004	0.003	0.003	0.003
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Taegu	0.062	0.061	0.062	0.063	0.062	0.062
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Kyungbuk	0.034	0.033	0.034	0.035	0.034	0.034
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Pusan	0.006	0.005	0.007	0.007	0.007	0.007
	(0.009)	(0.010)	(0.010)	(0.009)	(0.009)	(0.010)
Ulsan	0.032	0.032	0.029	0.031	0.031	0.031
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.021)
Kyungnam	0.038	0.038	0.038	0.038	0.038	0.038
	(0.020)	(0.020)	(0.019)	(0.020)	(0.020)	(0.019)
Female population aged 15–49	0.002	0.002	0.002	0.002	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female population, squared	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

(continued)

The effect is also substantial in 1978. The *Horse* is associated with an increase in the sex ratio of about 3.9%. This means that an excess of about 13,800 girls were either aborted or had misreported birth dates. Because about 4,600 girls are likely to have been misreported and transferred to 1977, an excess of about 9,200 female fetuses may have been aborted in 1978, corresponding to 1.1% of the number of pregnancies that should have been born in 1978 in the absence of prejudice associated with the *Horse*. If we take the assumption of the Western-calendar reporting, the effect in 1978 becomes insignificant. Thus, we need to be cautious about these results, even though the assumption of the lunar-calendar reporting is more reasonable for the purpose of this paper and the lunar calendar was more widely used in the late 1970s than more recently.

gain one in 1977 or 1979. We already considered the possibility of misreporting in the multivariate regression analysis, even though it is not significant. As a result, the actual number of aborted female fetuses should be greater than our estimates here.

(Table 5, continued)

	Lunar Calendar Reporting			Western Calendar Reporting		
	(1)	(2)	(3)	(1)	(2)	(3)
January	0.061	0.061	0.061	0.060	0.061	0.061
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
February	0.017	0.017	0.017	0.016	0.017	0.017
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
March	0.007	0.007	0.007	0.007	0.007	0.007
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
April	0.029	0.029	0.029	0.029	0.029	0.029
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
May	0.035	0.035	0.035	0.035	0.035	0.035
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
June	0.045	0.045	0.045	0.046	0.046	0.046
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
July	0.039	0.039	0.038	0.039	0.039	0.039
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
August	0.035	0.035	0.035	0.035	0.035	0.035
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
September	0.039	0.039	0.039	0.040	0.040	0.040
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
October	0.030	0.030	0.030	0.030	0.030	0.030
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
November	0.024	0.024	0.024	0.024	0.024	0.024
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Year	–0.479	–0.466	–0.432	–0.453	–0.443	–0.442
	(0.102)	(0.105)	(0.117)	(0.099)	(0.102)	(0.107)
Year, squared	0.006	0.006	0.005	0.005	0.005	0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Year, cubed	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.287	0.288	0.289	0.276	0.272	0.272

Notes: Robust standard errors are in parentheses. The dummy variables for cities and provinces are included, and the reference region is Seoul.

Our findings suggest that sex-selection technology, such as ultrasound scanning and amniocentesis, enabled doctors and parents to identify and select the sex of their children through selective abortion. This is not surprising at all for 1990 because it is well known that child-sex detection and sex-selective abortion have been available and widely practiced since the late 1980s. What is surprising here is that sex-selective abortion was possible and was practiced as early as 1978. Anecdotal evidence is documented in the press. Ultrasound scanning was first introduced in 1969, and the number of ultrasound machines steadily increased to about 1,000 in the 1980s. More important, amniocentesis was accessible and quite widespread in the late 1970s. In fact, amniocentesis and its misuse were often mentioned in newspapers. It has been reported that some obstetricians in large cities advertised prenatal sex detection at a very low price in 1974 ("Fetus Sex Determination, Prenatal Test, Abused in Hospitals" 1974). Finally, the government recognized sex predetermination by amniocentesis as a social problem in 1980 and prohibited it in 1984 ("Prohibit

Amniocentesis for Fetus Sex Determination" 1980). Evidence suggests that the technology for fetal sex determination was available for those parents whose zodiacal preferences were strong enough to demand such technology.[15] Chronic villi sampling and amniocentesis were widely used even in the 1990s, when ultrasound scanning was available, although they carried a fairly high risk of complications and were not covered by health insurance (Cho 1998); chronic villi sampling and amniocentesis can determine the fetus's sex earlier than ultrasound scanning.

This effect becomes smaller in 2002. This positive result seems to be due, in part, to the government's effort. The government revised the Medical Law in 1987 and passed the Presidential Decree of Medical Administration Measure Standard in 1990 (T. Kim 1997), making it illegal for a doctor even to inform parents of their baby's sex before the child's birth. The government continued to strengthen its position against sex-selective abortion in the 1990s (Cho 1998). As a consequence, the sex ratio at birth has stabilized around 110 since 1996. However, the legal restriction alone is not sufficient to explain the success in 2002. Since the law was enacted, only about 30 doctors have lost their licenses (Carmichael et al. 2004). The apprehension rate is very low, and even when the practice is caught, doctors are rarely prosecuted or otherwise penalized (Jeon and Seo 2003).

Social commentators and major newspapers have criticized the phenomenon of the *Horse* year because they have recognized low fertility as a serious social problem. In this regard, it is interesting to draw comparisons with Singapore, where the government stimulated the folk belief in the auspicious *Dragon* in order to boost fertility (Goodkind 1996). In South Korea, social commentators and civil organizations, such as Prolife and Korea Women's Association United, are strictly against zodiacal preferences, and they sometimes even appeal to patriotism as a reason for opposing it, pointing out that the tradition was actually imported from Japan and is a shameful colonial heritage to be liquidated (Lee 1990). The worry about energetic and strong daughters appears to be fading as more married women are now working for pay and people recognize the social equality between men and women.

Other findings are worth noting. First, the larger the number of women aged 15–49, the higher the sex ratio. This may be explained in part by the greater accessibility of sex-determination technology when there is potentially higher demand. Second, the income elasticity of the sex ratio at birth—that is, the percentage change in the sex ratio divided by the percentage change in income—is insignificant. Lastly, the sex ratio is, on average, higher in urban areas and varies substantially across regions. As expected, it is very unbalanced in the southeastern regions, such as Taegu, Kyungbuk, and Kyungnam.[16] These regions are known to be relatively conservative, where traditional values, such as patriarchy and Confucianism, are still strong. However, our results do not show that zodiacal preferences are stronger in these regions than elsewhere.

Births

Table 6 presents the results for fertility. The general fertility rate is significantly lower, by 8.9% in the inauspicious year of the *Horse.* The effect is the smallest (6.7%) in 1990 and the largest (14.2%) in 1978. It is interesting that the effect on fertility is the smallest when the effect on the sex ratio is the largest. This shows that birth timing and sex-selective abortion are two alternative options for parents with zodiacal preferences.

There are at least three reasons why fertility is lower in the year of the *Horse.* First, fertility is lower as a result of misreporting date of birth. In the previous section, we showed

15. Modern methods for determining the sex of a fetus have been available in India since the 1970s (Arnold, Kishort, and Roy 2002) and in China since the 1980s (Coale and Banister 1994). It has been reported that preventing doctors from revealing the sex of the fetus to the client is, in practice, difficult ("Bad Year for Girls" 1990; Carmichael et al. 2004).

16. The estimates for regions other than the southeastern regions are available on request.

Table 6. Regression of General Fertility Rate by Weighted Least Squares, 1970–2003

	Lunar Calendar Reporting			Western Calendar Reporting		
	(1)	(2)	(3)	(1)	(2)	(3)
Horse	–0.089			–0.077		
	(0.020)			(0.019)		
Horse, 1978		–0.132	–0.142		–0.104	–0.113
		(0.033)	(0.036)		(0.042)	(0.045)
Horse, 1990		–0.062	–0.067		–0.064	–0.069
		(0.019)	(0.019)		(0.019)	(0.020)
Horse, 2002		–0.083	–0.105		–0.068	–0.083
		(0.019)	(0.030)		(0.019)	(0.033)
Neighboring years			–0.034			–0.031
			(0.028)			(0.027)
Per capita income	–0.300	–0.295	–0.292	–0.302	–0.298	–0.296
	(0.071)	(0.068)	(0.066)	(0.071)	(0.067)	(0.064)
Per capita income, squared	0.123	0.123	0.128	0.124	0.124	0.129
	(0.027)	(0.027)	(0.027)	(0.026)	(0.026)	(0.026)
Pusan	0.217	0.219	0.225	0.218	0.219	0.224
	(0.053)	(0.053)	(0.054)	(0.052)	(0.052)	(0.053)
Taegu	0.341	0.344	0.351	0.342	0.344	0.350
	(0.076)	(0.076)	(0.076)	(0.076)	(0.076)	(0.075)
Ulsan	0.383	0.382	0.370	0.379	0.379	0.367
	(0.109)	(0.110)	(0.112)	(0.109)	(0.109)	(0.111)
Kyungbuk	0.400	0.401	0.404	0.399	0.400	0.403
	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)
Kyungnam	0.476	0.476	0.474	0.475	0.475	0.472
	(0.075)	(0.075)	(0.076)	(0.075)	(0.075)	(0.076)
Female population aged 15–49	0.015	0.015	0.015	0.015	0.015	0.015
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Female population, squared	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

(continued)

that some girls born in the year of the *Horse* are registered in the previous year. Second, parents may advance or delay their childbearing to avoid the inauspicious zodiac by changing coital behavior or contraception. Lastly, fertility decreases because of abortion. Using our estimates, it is possible to decompose the effects of the *Horse* on fertility into these three causes. First, we can predict the fertility rate that should have been without zodiacal preferences. The fertility rate decreased by 14.2% in 1978 and 6.7% in 1990. This implies that the fertility rate should have been 0.0933 in 1978 and 0.0589 in 1990. The number of missing births amounts to 124,900 in 1978 and 47,500 in 1990. In the previous section, we estimated that, due to either misreporting or sex-selective abortion, there were about 13,800 missing girls (i.e., 4,600 misreported + 9,200 aborted) in 1978 and 12,500 missing girls (i.e., 4,500 misreported + 8,000 aborted) in 1990. Therefore, the number of advanced or delayed births by birth timing is 111,100 (i.e., 124,900 – 13,800) in 1978 and 35,000 (i.e., 47,500 – 12,500) in 1990.[17] Using the trend average of the sex ratio, we estimate that

17. According to Donaldson, Nichols, and Choe (1982), about 46% of women used contraception in 1974.

(Table 6, continued)

	Lunar Calendar Reporting			Western Calendar Reporting		
	(1)	(2)	(3)	(1)	(2)	(3)
January	0.235	0.235	0.235	0.235	0.235	0.234
	(0.018)	(0.018)	(0.018)	(0.018)	(0.019)	(0.019)
February	0.222	0.222	0.222	0.224	0.224	0.225
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
March	0.051	0.051	0.051	0.051	0.051	0.051
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
April	–0.023	–0.023	–0.020	–0.023	–0.023	–0.023
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
May	–0.028	–0.028	–0.025	–0.028	–0.028	–0.028
	(0.017)	(0.017)	(0.016)	(0.017)	(0.017)	(0.017)
June	–0.108	–0.108	–0.103	–0.108	–0.108	–0.108
	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)	(0.015)
July	–0.053	–0.053	–0.049	–0.053	–0.053	–0.053
	(0.016)	(0.016)	(0.015)	(0.016)	(0.016)	(0.016)
August	–0.027	–0.027	–0.024	–0.027	–0.027	–0.027
	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)	(0.015)
September	–0.007	–0.007	–0.002	–0.007	–0.007	–0.007
	(0.016)	(0.016)	(0.015)	(0.016)	(0.016)	(0.016)
October	0.049	0.049	0.050	0.049	0.049	0.049
	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)	(0.015)
November	0.008	0.008	0.009	0.008	0.008	0.008
	(0.019)	(0.019)	(0.017)	(0.019)	(0.019)	(0.019)
Year	15.221	16.017	21.065	15.132	15.629	14.699
	(3.756)	(4.155)	(4.302)	(3.699)	(3.997)	(3.970)
Year, squared	–0.272	–0.286	–0.372	–0.270	–0.279	–0.262
	(0.065)	(0.072)	(0.074)	(0.064)	(0.069)	(0.069)
Year, cubed	0.002	0.002	0.003	0.002	0.002	0.002
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Year, quartic	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.877	0.878	0.879	0.876	0.876	0.877

Notes: Robust standard errors are in parentheses. The dummy variables for cities and provinces are included, and the reference region is Seoul.

about 54,300 and 16,500 female pregnancies were strategically timed to avoid the *Horse* in 1978 and 1990, respectively.[18]

Table 7 summarizes our main results. There were approximately 68,100 missing girls or female pregnancies in 1978 and 29,000 in 1990. Among these, for 1978, 79.7% can be explained by birth timing, and about 6.8% can be explained by intentional misreporting. The remaining 13.5% can be ascribed to sex-selective abortion. For 1990, about 56.8%

18. The trend average is the average of the sex ratios of the two neighboring years. It is 1.05 for 1978, 1.12 for 1990, and 1.09 for 2002. Based on these estimates, there were 56,800 missing boys in 1978, 18,500 in 1990, and 28,000 in 2002.

Table 7. Decomposition of the Number of Missing Girls

	Missing Girls			
Year	Total	Timing	Misreporting	Abortion
1978	68,099	54,284 (79.7%)	4,601 (6.8%)	9,214 (13.5%)
1990	29,038	16,501 (56.8%)	4,558 (15.7%)	7,979 (27.5%)
2002	29,858	25,738 (86.2%)	949 (3.2%)	3,171 (10.6%)

Notes: The number of missing girls due to birth timing is based on the average of the sex ratios of neighboring years. The number of missing girls due to misreporting is calculated by comparing the numbers of girls born in January in the year of the *Horse* and in December in the previous year, the year of *Snake*.

of missing girls can be explained by birth timing, 15.7% by misreporting, and 27.5% by induced abortion. The number of abortions due only to zodiacal preferences is estimated at about 8,000.[19] It is notable that birth timing is the favored strategy to avoid the *Horse*. Parents would and could schedule childbearing strategically to avoid the inauspicious zodiac by measures, like the use of contraception, that cost less both monetarily and psychologically than abortion. Also, it is interesting that sex-selective abortion explains relatively more in 1990. This is reasonable because fetal sex determination and abortion became more available in 1990, as is clear from the sharp rise in sex ratios starting in the mid-1980s.

While the effect on the sex ratio is the weakest in 2002, the effect on fertility that year is quite large. Furthermore, about 5% of births in 2003 are not yet registered. As a result, the decrease in fertility in 2002, relative to the neighboring years, is actually larger than our estimate. The decrease in fertility in 2002 is, by and large, due to birth timing. There are approximately 29,900 missing girls or female pregnancies: 86% by birth timing, 3% by misreporting, and 11% by abortion. The large effect in 2002 has an important implication: zodiacal preferences have not disappeared, indicating that zodiacal preferences survive rapid social changes accompanied by economic development and social propaganda against the culture of the *Horse*.

Other findings are also worth noting. The income effect on fertility is significantly negative but not linear. An increase in income would decrease fertility, especially at lower income levels; after a certain level, income does not affect fertility. Regions are heterogeneous in fertility level. The fertility rate for Seoul is significantly lower than the average, and fertility is generally lower in urban areas than in rural areas. The size of the population of women of reproductive age does not affect fertility. An interesting finding is that fertility was abnormally high in January and February (24% higher than in December). This is a well-known phenomenon in South Korea, where parents prefer to report their children's birth date in January or February for those born in March or later so that their children may start school a year earlier. The reason for this unusual phenomenon is that college entrance exams are very competitive and many students fail to enter colleges at their first attempt and have to wait another year for a second chance. The same phenomenon is also observed in Japan, where the educational system is similar (Kaku 1972).

Lastly, the yearly data are used to test robustness because most of our key explanatory variables do not vary by month. Table 8 shows the results. The estimation model is the same as the monthly-data regression model but with monthly dummy variables dropped. The results confirm our previous findings. One notable difference is that the effect on the

19. T. Kim (1997) estimated that there were 22,626 abortions per year, on average, between 1989 and 1991.

Table 8. Regression Analysis Using Yearly Data: Lunar Calendar Reporting

	Sex Ratio at Birth			Fertility		
	(1)	(2)	(3)	(1)	(2)	(3)
Horse	0.037			–0.088		
	(0.005)			(0.020)		
Horse, 1978		0.041	0.038		–0.134	–0.144
		(0.009)	(0.009)		(0.024)	(0.025)
Horse, 1990		0.042	0.041		–0.057	–0.063
		(0.009)	(0.009)		(0.032)	(0.032)
Horse, 2002		0.022	0.020		–0.082	–0.094
		(0.006)	(0.007)		(0.038)	(0.040)
Neighboring years			–0.008			–0.032
			(0.005)			(0.018)
Per capita income	–0.003	–0.006	–0.005	–0.263	–0.257	–0.264
	(0.029)	(0.029)	(0.029)	(0.057)	(0.056)	(0.057)
Per capita income, squared	0.003	0.003	0.005	0.108	0.108	0.117
	(0.010)	(0.010)	(0.009)	(0.021)	(0.021)	(0.022)
Pusan	0.005	0.004	0.006	0.262	0.263	0.267
	(0.013)	(0.013)	(0.013)	(0.056)	(0.057)	(0.057)
Taegu	0.060	0.059	0.061	0.413	0.415	0.420
	(0.018)	(0.018)	(0.018)	(0.064)	(0.064)	(0.065)
Ulsan	0.030	0.030	0.025	0.527	0.525	0.500
	(0.029)	(0.029)	(0.028)	(0.083)	(0.083)	(0.086)
Kyungbuk	0.033	0.032	0.033	0.497	0.498	0.497
	(0.015)	(0.015)	(0.015)	(0.059)	(0.059)	(0.059)
Kyungnam	0.036	0.037	0.036	0.573	0.572	0.566
	(0.019)	(0.019)	(0.019)	(0.090)	(0.090)	(0.090)
Female population aged 15–49	0.002	0.002	0.002	0.025	0.025	0.025
	(0.002)	(0.002)	(0.001)	(0.008)	(0.008)	(0.008)
Female population, squared	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year	–0.479	–0.466	–0.432	15.717	16.598	15.563
	(0.059)	(0.061)	(0.066)	(2.984)	(3.167)	(3.174)
Year, squared	0.006	0.006	0.005	–0.280	–0.295	–0.276
	(0.001)	(0.001)	(0.001)	(0.052)	(0.055)	(0.055)
Year, cubed	0.000	0.000	0.000	0.002	0.002	0.002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year, quartic				0.000	0.000	0.000
				(0.000)	(0.000)	(0.000)
Number of observations	459	459	459	459	459	459
R^2	0.449	0.452	0.455	0.924	0.925	0.925

Notes: Robust standard errors are in parentheses. The dummy variables for cities and provinces are included, and the reference region is Seoul.

sex ratio in 2002 becomes statistically significant, although the effect is still weaker than in the previous years. The results from the yearly data actually strengthen our conclusion that zodiacal preferences have not yet disappeared. Using the assumption of the Western-calendar reporting does not change the results significantly.

CONCLUSION

This study examines the effects of zodiacal preferences on the sex ratio at birth and fertility. In the year of the *Horse*, the fertility rate drops significantly, while the sex ratio at birth increases, indicating that parents try to avoid having daughters with the inauspicious zodiacal sign. We found evidence from the sex ratio at birth that child sex determination and sex-selective abortion were available and affordable to South Korean households as early as the late 1970s, before the unbalanced sex ratio became widely recognized as a social problem. We also found that zodiacal preferences have different behavioral implications over time. First, birth timing has been the most common strategy to avoid childbirth during the year of the *Horse* over the past three decades. The importance of intentional misreporting has decreased over time as the national birth registration system has become better institutionalized. Sex-selective abortions were more widely used in 1990.

Although the effects were reduced, zodiacal preferences still had significant impacts on fertility and the sex ratio in 2002. A positive change is that induced abortions were substantially reduced. However, a large number of births were still affected by zodiacal preferences. In fact, the number of timed births was significantly larger than that in 1990. This finding is in contrast with the notion that traditional values will be gradually weakened by modernization. On the contrary, our findings show that zodiacal preferences have survived rapid economic development and legal sanction and will potentially appear again in the future.

The finding that a cultural belief significantly affects demographic outcomes suggests that cultural reform or popular education by government and civil organizations should play an important role for population policymakers. Zodiacal preferences have no reasonable socioeconomic root in South Korea. Nevertheless, if the folk belief is socially embedded, it works autonomously and self-reinforces its existence. Studies on culture and belief systems will lead us to a better understanding of demographic behaviors and policymaking (Hammel 1990).

Appendix Table A1. Old Versus New Data: Number of Births

	Old Data		New Data	
Birth Year	Male	Female	Male	Female
1970			526,222	480,423
1971			534,254	490,519
1972			499,468	455,970
1973			494,703	472,944
1974			482,895	441,416
1975			462,971	411,898
1976	408,055	368,645	418,963	378,499
1977	412,718	395,903	422,139	404,940
1978	387,926	348,339	396,373	356,036
1979	466,321	443,382	442,827	421,470
1980	448,744	430,955	440,926	424,424
1981	442,662	410,986	455,355	424,955
1982	429,820	400,377	443,544	415,288
1983	387,970	358,405	402,992	375,370
1984	351,610	324,711	354,675	327,542

(continued)

(Appendix Table A1, continued)

	Old Data		New Data	
Birth Year	Male	Female	Male	Female
1985	343,408	313,734	346,206	316,304
1986	336,338	301,039	338,591	303,053
1987	325,485	299,012	327,977	301,455
1988	335,870	296,297	338,543	298,919
1989	338,619	303,048	341,010	305,187
1990	350,862	301,282	354,310	304,242
1991	376,656	335,235	380,036	338,243
1992	390,072	343,453	393,138	346,153
1993	385,042	333,941	387,693	336,241
1994	387,559	336,476	389,957	338,558
1995	380,714	336,279	382,881	338,193
1996	365,194	327,301	366,950	328,875
1997	350,977	324,250	352,627	325,775
1998	335,488	304,638	336,980	305,992
1999	322,284	294,038	322,284	294,038
2000	333,797	302,983	333,797	302,983
2001	290,655	266,573	290,655	266,573
2002	259,123	235,502	259,123	235,502
2003			257,044	236,427

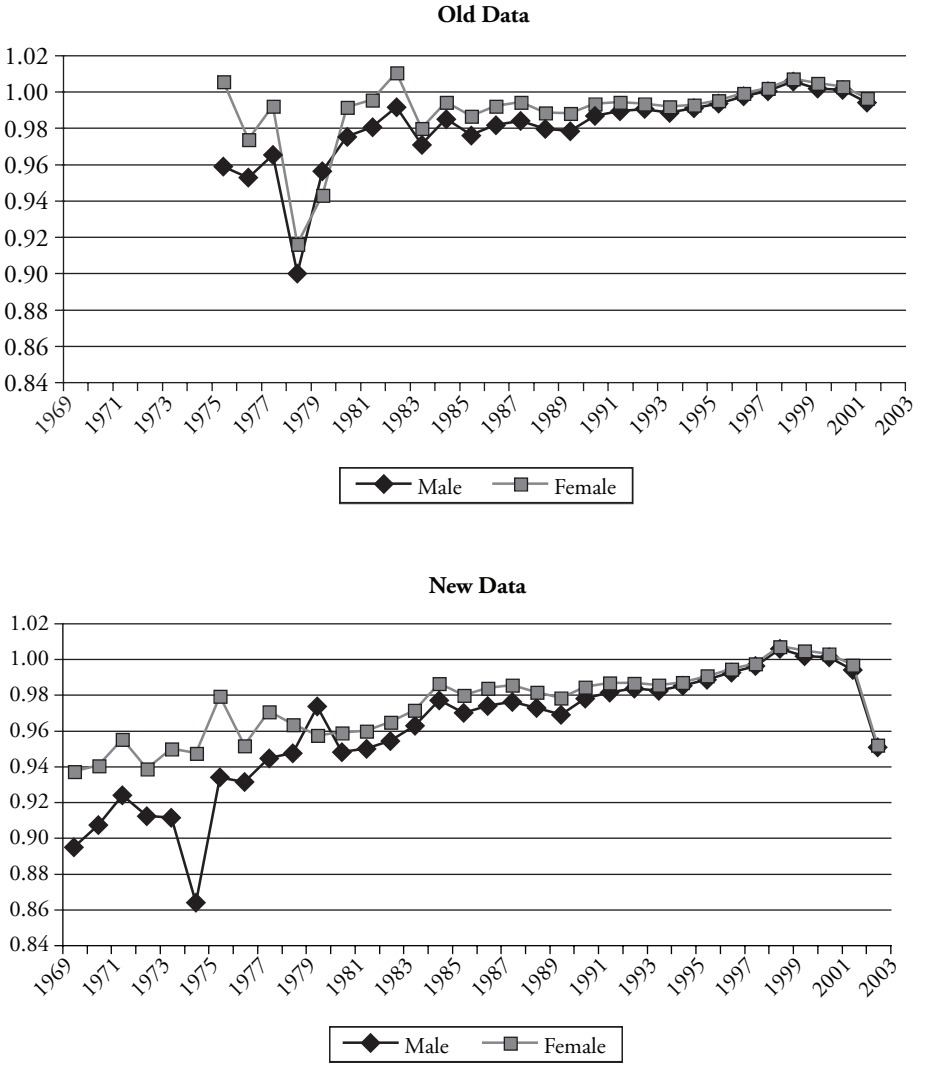
Sources: The old data are from *Annual Report on the Vital Statistics* (1986, 1994, 1999, 2000) by the National Statistical Office of Korea. The new data are from the National Statstical Office.

Appendix Table A2. Lunar-Calendar Use by Age and Household Head's Education Level in 1998

	Under High School		High School Graduate		College Experience		Total	
Age	% (lunar)	*N*	% (lunar)	*N*	% (lunar)	*N*	% (lunar)	*N*
0–4	13.2	167	8.0	561	4.8	499	7.4	1,227
5–9	19.4	252	9.2	586	5.4	426	10.0	1,264
10–14	23.2	367	16.3	559	8.8	330	16.3	1,256
15–19	41.5	696	27.1	632	13.0	322	30.4	1,650
20–24	60.9	717	50.1	505	24.9	265	50.8	1,487
25–29	70.7	508	72.1	603	53.0	406	66.5	1,517
30–34	86.1	266	86.4	612	74.9	553	81.9	1,431
35–39	91.3	401	90.6	700	81.4	521	87.8	1,622
40–44	94.5	470	90.8	619	77.8	342	88.9	1,431
45–49	92.4	487	89.3	394	79.3	242	88.5	1,123
50–54	91.1	426	83.1	308	73.1	156	85.2	890
55–59	87.0	471	80.6	196	73.7	137	83.2	804
60+	90.2	1,088	85.2	372	79.1	282	87.3	1,742
Total	71.4	6,316	58.0	6,647	47.6	4,481	60.2	17,444

Source: Korean Labor and Income Panel Study 1998 by the Korea Labor Institute, household data.

Appendix Figure A1. Old Versus New Data on Survivorship



REFERENCES

Arnold, F., S. Kishort, and T.K. Roy. 2002. "Sex-Selective Abortions in India." *Population and Development Review* 28:759–85.

Aso, T. 1978. "Cultural Influences on Fertility in Japan: The Case of the Years of the Fire Horse as an Application of the Modified Demographic Transition Model." Unpublished Ph.D. dissertation. Department of Sociology, Washington State University.

"Bad Year for Girls." 1990. *Newsweek.* April 16, p. 80.
Bennett, J.T. and J.R. Barth. 1973. "Astronomics: A New Approach to Economics?" *Journal of Political Economy* 81:1473–75.
Carmichael, M. S. Mazumdar, S. Schafer, and B.J. Lee. 2004. "No Girls, Please." *Newsweek.* January 26, p. 50.
Cho, N.H. 1998. "The Recent Trend of Population and Policy Strategies" (in Korean). Research Report No. 37. Korea Institute for Health and Social Affairs, Seoul, Korea.
Choe, C.D. 2003. "Zodiac Animals in East Asian Philosophy." *Korea Times.* February.
Choi, B. 1991. "Sources of Data for Vital Statistics in the Republic of Korea." *The Journal of the Population Association of Korea* 14(1):104–20.
Coale, A.J. and J. Banister. 1994. "Five Decades of Missing Females in China." *Demography* 31:459–79.
Coleman, S. 1983. *Family Planning in Japanese Society: Traditional Birth Control in Modern Urban Culture.* Princeton, NJ: Princeton University Press.
Donaldson, P.J., D.J. Nichols, and E.H. Choe. 1982. "Abortion and Contraception in the Korean Fertility Transition" *Population Studies* 36:227–35.
Eysenck, H. and D. Nias. 1982. *Astrology: Science or Superstition?* New York: St. Martin's Publisher.
"Fetus Sex Determination, Prenatal Test, Abused in Hospitals" (in Korean). 1974. *JoongAng Daily*. February 13.
Goodkind, D. 1991. "Creating New Traditions in Modern Chinese Populations: Aiming for Birth in the Year of the Dragon." *Population and Development Review* 17:663–86.
———. 1993. "New Zodiacal Influences on Chinese Family Formation: Taiwan, 1976." *Demography* 30:127–42.
———. 1995. "The Significance of Demographic Triviality: Minority Status and Zodiacal Fertility Timing Among Chinese Malaysians." *Population Studies* 49:45–55.
———. 1996. "Chinese Lunar Birth Timing in Singapore: New Concerns for Child Quality Amidst Multiculutural Modernity." *Journal of Marriage and the Family* 58:784–95.
Hammel, E.A. 1990. "A Theory of Culture for Demography." *Population and Development Review* 16:455–85.
Jeon, H.S. and H.G. Seo. 2003. "Abortion in Korea Since 1945" (in Korean). *Korean Journal of Medical History* 12:129–43.
Kaku, K. 1972. "Are Physicians Sympathetic to Superstition? A Study of Hinoe-Uma." *Social Biology* 19(1):60–64.
Kaku, K. and Y.S. Matsumoto. 1975. "Influence of a Folk Superstitution on Fertility of Japanese in California and Hawaii, 1966." *American Journal of Public Health* 65:170–74.
Kim, H.W. 2001. "God Bless Girls Born in the Year of the Horse." *Korea Times.* December.
Kim, N. 1997. "An Evaluation of the Vital Registration System in Korea" (in Korean). *Korea Demography* 20(1):47–63.
Kim, T.-H. 1997. "The Effects of Sex-Selective Abortion on Fertility Level in Korea." *Korea Journal of Population and Development* 26(1):43–60.
Larsen, U., W. Chun, and M. Das Gupta. 1998. "Fertility and Son Preferences in Korea." *Population Studies* 52:317–25.
Lee, J. 2005. "Marriage, Female Labor Force Participation, and Asian Zodiacs." *Economics Letters* 87:427–32.
Lee, K.T. 1990. "Fiction of the White Horse." *Chosun Daily*. January 4.
Lee, S. 1998. "Social and Demographic Implications of Sex Ratio at Birth." *Statistical Analysis Research* 3(1):157–86.
Mock, C. and H.F. Weisberg. 1992. "Political Innumeracy: Encounters With Coincidence, Improbability, and Chance." *American Journal of Political Science* 36:1023–46.
Park, C.B. 1978. "The Fourth Korean Child: The Effect of Son Preference on Subsequent Fertility." *Journal of Biosocial Science* 10:95–106.

Park, C.B. and N. Cho. 1995. "Consequences of Son Preference in a Low-Fertility Society: Imbalance of the Sex Ratio at Birth in Korea." *Population and Development Review* 21(1):59–84.

"Prohibit Amniocentesis for Fetus Sex Determination" (in Korean). 1980. *JoongAng Daily*. June 14.