

# We Prefer Sons, But Does It Matter? Evidence From Matched Administrative Data from Taiwan (Preliminary and Incomplete)

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Unequal treatment of females in Asia and North Africa has drawn much attention from various scientific disciplines since Amartya Sen's article on "Missing Women" was published in 1990. His article revealed a striking fact that the ratio of men-to-women in those regions considerably exceeds the ratio in richer countries. One of the most popular explanations for the deficit of women in Asia is the strong "preference for sons" (interchangeable with the "demand for sons" in this paper), which has been blamed for creating inequality for women, ranging from selective abortion and infanticide (e.g., Goodkind 1996) to unequal allocation of intrafamily resources between sons and daughters (e.g., Becker and Thomas 1979, 1986; Becker 1991).<sup>1</sup>

Confucianism – the grounding philosophy in Japan, Korea, Taiwan, and Vietnam – prescribes disciplines and provides rationales for the subordination of women to men in a strict hierarchy. By the practices of Confucianism, men inherit family wealth when their fathers die and stay within the household with their wives when they marry. In contrast,

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<sup>1</sup>For other possible explanations for sex-ratio imbalance, see Oster (2005, 2006), Das Guspa (2006), and Lin and Luoh (2006).

women move out of the family and bring a dowry to their husbands at marriage. The study of Confucian classics and disciplines, such as Analects (ca 479 BCE), has been at the core of the educational curriculum in imperial China for more than two millennia, since the Han Dynasty. A Chinese poem, dated centuries before Confucius, even advised parents to allocate family resources unevenly between sons and daughters:<sup>2</sup>

When a son is born  
Let him sleep on the bed  
Dress him with fine ropes  
And give him jade to play  
When a daughter is born  
Let her sleep on the ground  
Cover her in usual wrappings  
And give her broken tiles for playing

Using matched administrative data from Taiwan, where Confucianism remains a dominant component of the educational curriculum, we examine one important concern surrounding female inequality: the link between sibling gender and daughters' education. If son-preferring parents divert family resources to a son from daughters, then the daughters may have fewer opportunities to attend college than if they had a sister instead of a brother.

The existing evidence on the relationship between sibling gender and children's outcomes is mixed. Garg and Morduch (1998) and Morduch (2000) suggest that child health and education are *negatively* associated with the number of brothers in the family, holding constant the number of siblings. Using Taiwanese data, Parish and Willis (1993) find that this disadvantage can be greater for daughters than for sons. However, the disadvantages of having a brother may be overcome or even reversed for daughters by positive spillovers

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<sup>2</sup>See "Si Gan" from *Book of Songs*, also called *Shi-Jing*, compilation of which was traditionally ascribed to Confucius.

in the home production of human capital. For example, even with son-preferring parents, observed educational achievements of daughters may increase with the birth of a male sibling relative to a female. This is because the son's birth may increase the mother's parenting time (e.g., Rose 2000), increase the father's labor supply and earnings (e.g., Lundberg and Rose 2002), or increase the probability of marriage or having a resident father (e.g., Lundberg and Rose 2003; Dahl and Moretti 2007; Lundberg *et al.* 2007; see Lundberg 2005 for more discussions). These empirical findings have been used to offer important implications for intrafamily allocation of resources.

Alternatively, the gender role of sons may influence their female siblings through a non-resource-based channel. Koch (1955) and Butcher and Case (1994) have noted that masculine traits of brothers may help their sisters to develop positive attitudes toward greater educational achievement. Kaestner (1997), in contrast, found little correlation between sibling gender composition and educational attainment of children, particularly in the case of later cohorts. There is little consensus in the literature on the relationship between sibling gender and children's outcomes.

In this literature, one of the most challenging issues is endogenous child gender, which can be potentially pervasive for son-preferring Taiwanese, particularly since ultrasound and technologies for sex-selective abortion became widely available after 1986. On the one hand, "missing women," because of infanticide or sex-selective abortion, most likely came from families that would have allocated their resources in favor of sons at the cost of daughters. Consequently, sibling gender effects on female survivors' education may *understate* the true effects, i.e., the effects on the average education level that would have been achieved by females in a no-infanticide and no-selective abortion society. On the other hand, the birth of a male sibling may be a consequence of sex selection; thus, the family may divert resources to the son from the existing daughters. As a result, the observed contrast in daughters' education by the birth of a brother relative to a sister may *overstate* the causal effect of sibling gender on daughters' education.

We address these issues using the plausibly exogenous variation in sibling gender among *first-born twins* during the period of 1978 to 1985. Sibling gender is plausibly exogenous with twins in our data because the technology for selective reduction or termination of twins was first developed in laboratories in 1988 (for reviews see Cunningham *et al.*, 2005), about three years after ultrasonography became available. As expected, the our statistics show that twin sex of the first-born sample is virtually random; the sex ratio is almost unity, about .02 to .05 smaller than the sex ratio of singletons but equal to the natural twin-sex ratio documented in the medical literature (e.g., James 1980; Derom *et al.* 1988; see discussions in Machin 1996). Further by focusing on the first-born sample, we avoid the possibility that survival rates of twins depend on early-born children's gender composition. Perhaps surprisingly, our twins estimates show that sibling gender has no effect on children's educational attainment, irrespective of the methods of estimation or the inclusion of birth weight, family size, or parental education. These results are very precise and robust across various specifications

## 1 Extraordinary Strong Demand for Sons

### 1.1 Birth Registry Data

Taiwan is the third most sex-imbalanced country in Asia, only next to South Korea and China, by sex ratios of men-to-women at birth in 2006, published in the CIA Report. The sex ratio of boys to girls at birth is 1.081 for all children born between 1978 to 1999. Son-preferring Taiwanese couples tend to continue having children until they have sons, but this trend seems declining over time. On average, among those who were born in 1978, first-born girls have .27 more siblings than first-born boys. The same difference decreases to less than .2 for newborns in 1985. The estimates below suggest that the pro-son preference in Taiwan has been falling over the years but it is still much stronger than in other countries, such as the U.S.

Our statistics and estimates are based primarily on the national birth registry records of Taiwan, which cover all of the 7,053,190 newborns from 1978 to 1999, including birth date, order, weight, place, and parental age and education. We use birth date and order to construct the *first-born samples* for the *earlier cohort*, referring to those born between 1 September 1978 and 31 August 1981, and the *later cohort*, referring to those born between 1 September 1981 and 31 August 1985. The beginning year of birth, 1978, is chosen for the earlier cohort because it is the *earliest* year available in the birth registry administrative records. The ending year of birth, 1985, is selected for the later cohort in order to link the birth registry to the *latest* administrative records of college entrance examinations. More importantly, the threshold year of birth, 1981, is chosen to reflect the end of the largest expansion of higher education systems in Taiwanese history (1996-1999), which affected children born before 1 September 1981; i.e., the earlier cohort, not the later cohort.

We then separately analyze the samples of first-born twins and first-born single births. Our data include 4,922 and 7,428 first-born twin siblings and 394,684 and 488,969 first-born singletons in the earlier and later cohorts, respectively. As Figure 1 shows, gender ratios among twins (either first or second -born) range from .97 to 1.023, about .05 lower than those among singles for the first two births, over the years between 1978 and 1990. It is noteworthy that within 5 years after 1986, when ultrasound became available and widespread in Taiwan, the gender ratios at birth increased by .05 for twins at the second birth and .04 for singles at the second births. Therefore, this paper focuses on children born before 1985; in particular, we use first-born twins, whose gender ratios nearly equal 1 during the pre-1985 period. Further, as the first 2 rows of Table 1 show, the gender composition of first-born twins is nearly random; the probability of having same-sex twins does not depend on child gender. In contrast, the gender composition of first two single births appears to be non-random; the probability of having two boys is about 3 percentage points higher than the probability of having two girls. In addition, compared to first two single births, first-born twins have .13 to .25 more siblings and have slightly older and

more educated parents, as summarized in Table 1.

Family size is an important covariate in our analysis because it is correlated with both sibling gender and children's education. It is noteworthy that our family size measure is completed family size, constructed by tracing all births by each mother who had a first child at the age of 15 to 50 between 1978 and 1985 over at least a 15 years period (until 1999). Our data indicate that no mothers in either of the cohorts had another child after 1997, suggesting that our measurements of completed family size and sibling gender composition are very accurate.

## 1.2 Child Gender and Family Size

Differential stopping behavior in fertility of parents to achieve a desirable number of sons has been used to measure the degree of preference for sons, at least since Ben-Porath and Welch (1976). The statistics of the Taiwanese birth registry for both the earlier and later cohorts indicate that families with two daughters are nearly 30 percentage points more likely to have a third child than those with two sons. The same estimates are virtually zero using the 1970 U.S. Census (Ben-Porath and Welch 1976); no more than 2 percentage points using the 1980 and 1990 U.S. censuses (Angrist and Evans 1998); and approximately .6 percentage points for Asian and African Israelis (Angrist *et al.* 2006). Alternatively, the degree of preference for sons can be measured by direct survey questions or by variations in parental labor supply and earnings, expenditure on housing, or marriage stability in response to the variation in child gender (e.g., Ananat and Michaels 2004; Dahl and Moretti 2004; Lundberg and Rose 2002, 2003, 2007; Rose 2000). While these estimates are mostly based on the U.S. data, only a few similar estimates using data from Asia are reported in the existing literature.

The estimated degree of son preference is remarkably strong but has been weakening across cohorts. As shown in Table 2 using first-born samples, families with female twin have .45 more children than those with male twin in the earlier cohort. The same estimate

for the later cohort falls to .41. Given that the average family size in both cohorts is about 2.5 to 2.7, these estimated degrees of son preference are remarkably large, about triple the estimates reported in Angrist *et al.* (2007) for Asian and African Israelis.

Further, by comparing the degree of son preference between first-born twins and first two single birth, we find that as the interval between the first two births increases, the sibling gender effect on family size rises considerably. In particular, the gender effect of single births on family size is about .55 and .49 in the earlier and later cohorts, about 20 percent stronger than the results based on twins. However, the observed relationship between spacing and gender effects on fertility has no causal interpretation because spacing can be endogenous.

Unlike American families in favor of sibling sex mix (see, e.g., Ben-Porath and Welch 1976; Angrist and Evans 1998), average Taiwanese families strongly prefer two boys to mixed-gender siblings in the first 2 births, although this preference has been weakening considerably. Compared to average first-born male twins, mixed-gender twins have about one additional sibling in the earlier cohort but less than .04 siblings in the later cohort, with a large standard error. The dominance of pro-male over mixed-sex preference appears to be more evident and enduring among families without first-born twins, compared to those with twins. Panel (B) of Table 2 shows that in the earlier cohort, families with mixed-gender siblings in the first two births have .1 more children than families with two boys. The same estimates fall to about .08 in the later cohort but remain significantly positive.

## **2 Effects of Sibling Gender on Children's Education**

Issues of endogenous child gender composition arise when unobserved factors, such as parental preference for sons, affect children's gender and education simultaneously. Sex-selective abortion, for example, can be resorted to by parents who are most likely to divert family resources to sons from daughters. The observed difference in children's education

by sibling gender may be contaminated by the simultaneity bias. Given that sex ratios are highly imbalanced in Taiwan, sex-selective abortion may be pervasive, particularly after 1985 when ultrasound technologies became available for pre-birth sex determination.

One important observation in Figure 1 is that before 1985, the sex ratio among first-born twins ranges between .97 and 1.02, around the natural ratio of boys to girls for twins (e.g., James 1980; Derom *et al.* 1988) and considerably more balanced than the sex ratio for the sample of first two singletons. Moreover, for both earlier and later cohorts, the unconditional probability of having girl twins at the first birth almost exactly equals the unconditional probability of having boy twins at the first birth (their difference is about .0011 to .0016), as Table 1 shows. These statistics strongly suggest that gender composition of first-born twins is nearly random.

The idea of the identification strategy is thus to exploit the randomness of gender composition of first-born twins. Assuming momentarily that all twins are dizygotic twins and that the completed family size is not correlated with the gender of the first birth, we compare the education of a first-born daughter who has a twin brother, with the education of a first-born daughter who has a twin sister, using the difference in their outcome as our estimate of the causal effect of sibling gender. The “gender shock” in first-born twins represents truly exogenous events that can be used to identify the causal effect of sibling gender on children’s education, uncontaminated by either simultaneity bias or unobserved heterogeneity in parental influences on children’s education. This approach, based on first-born twins, allows us to estimate the effect of sibling gender on children’s outcome, using simple statistical methods. Essentially, the causal effect of interest is the difference between average education levels in the treatment and comparison groups.

Child gender, however, is correlated with parental education and completed family size. Edlund (1999) has noted that economically lower status parents with preference for sons might also opt for a daughter because she could marry a man from a wealthier family. Another possibility is that more educated women tend to marry richer husbands,

who strongly prefer a male offspring in order to increase their chances of inheriting the family's wealth. These factors suggest that relatively more educated parents may have stronger preference for sons, than the less educated. Figure 2 shows some evidence of a positive correlation between maternal education and sex-selective abortion. The ratio of boys to girls at the third birth has been *increasing* with mothers' education since 1986, when ultrasound technologies (for pre-birth sex determination) became widely available. In addition, girls have more siblings than boys because of parents' preference for sons in fertility behaviors, as Section 1 has shown. Thus, the failure to control for family size or parental education could result in inconsistent estimates. To account for these potential problems, our analysis below includes both factors and focuses on the pre-1986 cohorts in regressions.

Another issue is that mixed-sex twins must be dizygotic but dizygotic and monozygotic twins are indistinguishable in our data. Consequently, the probability of male twins, conditional on a same-sex twin sibling, exceeds the same probability, if conditional on a twin sibling of the opposite sex. Indeed, statistics indicate that the conditional probability of a twin's sex, given the gender of the twin sibling, is  $Pr\{M|M\} = .8693 > Pr\{M|F\} = .2603$  in the earlier cohort and  $Pr\{M|M\} = .8439 > Pr\{M|F\} = .3114$  in the later cohort. Given that about 68 to 74 percent of twins are monozygotic in both cohorts (according to our approximation, using the observed distribution of twins gender), gender effects suggested by the comparison across dizygotic twins might not be similar to those suggested by the comparison between monozygotic and dizygotic twins. As a result, the gender difference in outcomes across twins may be a consequence of the systematic heterogeneity between dizygotic and monozygotic twins, not a gender shock.

To address this issue, our analysis includes birth weights of twin siblings to capture unobserved heterogeneity between dizygotic and monozygotic twins. This approach is motivated by the medical evidence that marked size discordance is more likely to arise in dizygotic than monozygotic twins because size differences among dizygotic twins may

reflect different genetic fetal growth potentials, which would not occur in monozygotic twins (Cunningham *et al.* 2005).

Even with strong son-preference in Taiwan, Table 3 shows *no* evidence of sibling-gender effects on Taiwanese women's (or men's) educational achievements, irrespective of the inclusion of family size, parental education, or twin birth weights. This finding is very robust and the estimates are markedly precise. As shown in Panel (A) based on female twins, the gender effect is as small as .008 to .035, with standard errors of about .02. The gender effects on boys are also insignificant and even smaller in size. Notice that these findings are valid for both the earlier and later cohorts, although female inequality is traditionally believed to be more severe in the earlier cohort.

Children's educational attainment in this paper is measured by college attendance at the age of 18. College enrollment data is derived from the national administrative records of College Entrance Tests from 1997 to 2003, matched with the first-born population in the birth registry, using children's UINs. About 12 to 14 percent of first-born twins (both siblings) have attended college; about 10 to 14 percent have only one sibling enrolled in college at 18. Notice that children who did not survive until 18, or those who enrolled in college after 18, are considered as not college educated in our paper (i.e. the college attendance dummy equals zero). Therefore, our estimates potentially *understate* the negative impact of child gender on college enrollment.

Unlike most of the prior studies in this area focusing on children's outcomes at an early stage of life, we look at the long-term impact of sibling gender on children's college enrollment. As noted by, e.g., Cameron and Heckman(1998), Heckman and Lochner (2000), and Cameron and Taber (2004), the long-term impact of family nurturing on children's college attendance can potentially be more important than short-term effects of liquidity constraints. Alternatively, the short-term sibling impact may also play an important role, as suggested by Ellwood and Kane (2000). Absence of a sibling-gender effect in either of the cases suggests that the issues of endogenous child gender and parental

behavioral changes in response to child gender cannot be neglected in studies of within-family allocation of resources.

It is noteworthy that completed family size is assumed to be exogenous in the twins' study. The intensive literature on children's quantity-quality trade-off, however, has documented that the observed negative correlation between children's outcomes and family size is driven mostly by self selection because wealthier or more educated parents tend to choose quality over quantity (e.g., Black *et al.* 2005; Angrist *et al.* 2006). Consequently, the family size coefficients in Table 3 are not causal. In particular, because a son's birth tends to lower the family size, the twin estimates that assume exogenous family size may understate the detrimental effect of a male sibling (relative to a female sibling) on daughters' education.

To indirectly examine the importance of endogenous family size in the twins' study, Chen *et al.* (2007a) estimated the association between sibling gender at the second birth and the first-born daughter's educational achievement, using data covering *first-born singletons* from the same administrative birth records. There, we instrument for family size using twins at the second birth in families with at least two children, as suggested by Black *et al.* (2005) and Angrist *et al.* (2006). This study, based on the sample of first-born singletons, reconfirms our findings presented in this paper using the sample of first-born twins: average first-born daughters' or sons' education has almost no correlation with the gender of their subsequent siblings, when we include parental education or when we use twins at the second birth to instrument for family size. The estimates there are more precise than the estimates presented here, because of the sizable sample of first-born singletons.

### 3 Concluding Remarks

The evidence presented here strongly suggests no long-term sibling-gender effects on Taiwanese women's or men's educational achievements. Our estimates are very precise be-

cause the primary data source is the national birth records of all Taiwanese births since 1978. The estimated degree of parental preference for sons seems diminishing over the years but is still markedly stronger than most of the western countries. Even with the long-lasting and extraordinarily strong preference for sons, we find no detrimental effects of having a male sibling (relative to having a female sibling) on women's educational achievements. In fact, Taiwanese women have been more likely to enroll in college than men by 2 to 3 percentage points on average during the late 1990s and early 2000s.

The findings presented here are important because they show that a strong preference for sons does not necessarily lead to sibling gender affecting women's education. This suggests that a son's birth may create parental behavioral changes that may, perhaps unintentionally, benefit the existing daughters' educational achievement. Chen, Chen, and Liu (2007b) provide evidence suggesting that Taiwanese mothers work significantly less during the first two years after a son's birth, relative to a daughter's. The increased parenting time provided by mothers, because of the presence of a male offspring, may have benefited daughters also, offsetting the negative impact of uneven allocation of family resources between sons and daughters. Finally, the converging or even reversing gender differences in the return to education since the mid 1990s may have been associated with diminishing preference for sons. Our ongoing research is exploring this possibility.

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Figure 1. Sex-ratio at 1st and 2nd birth

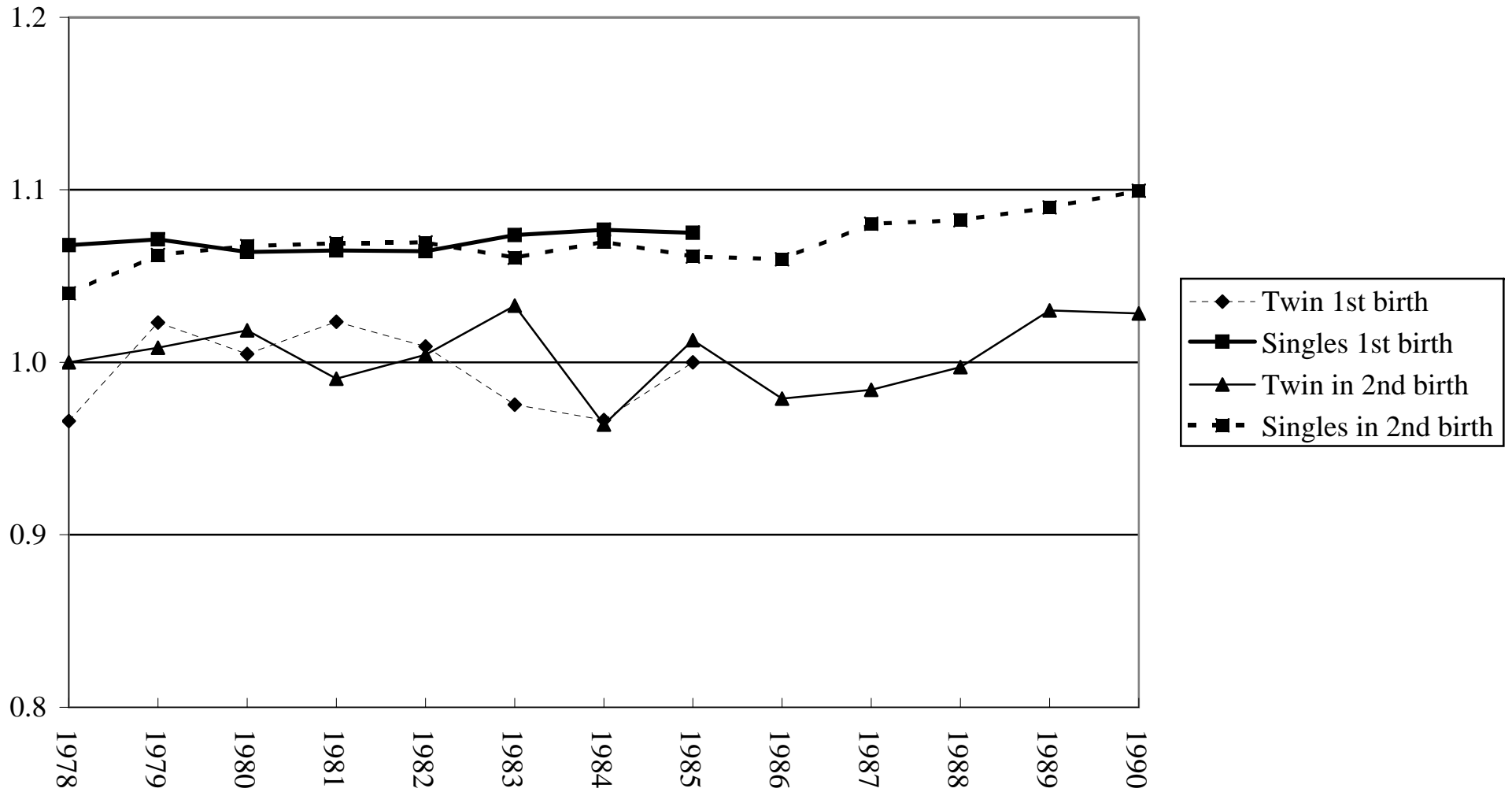
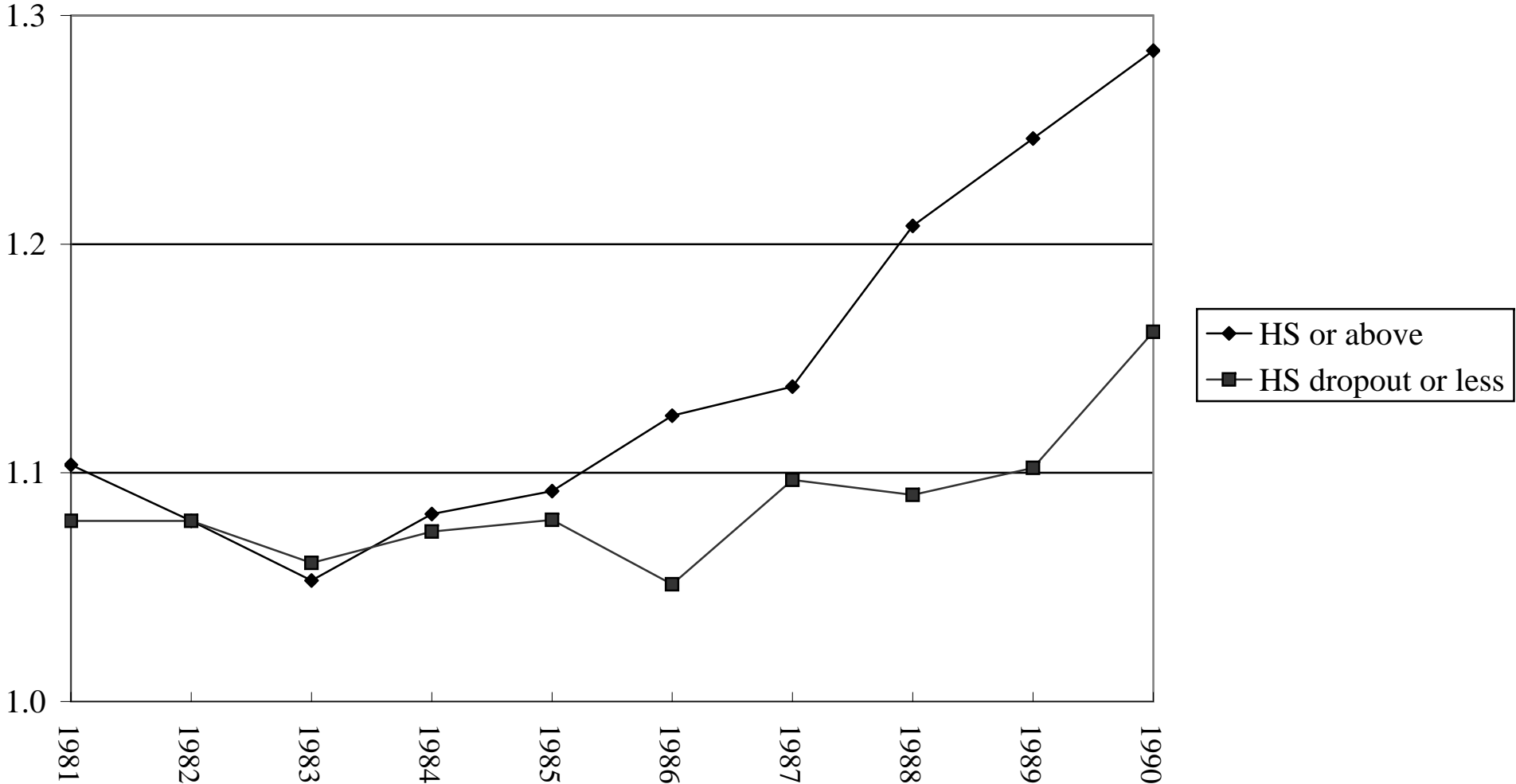


Figure 2. Sex ratios at 3rd birth (no twins), by maternal education



**Table 1: Descriptive statistics of first-born samples**

	First-born twin siblings		First two single births	
	Earlier cohort (1)	Later cohort (2)	Earlier cohort (3)	Later cohort (4)
<b>Gender of 2 oldest children</b>				
Two boys	0.434	0.422	0.262	0.262
Two girls	0.436	0.423	0.236	0.237
Second birth was born after 1985	0.128	0.436	0.091	0.684
<b>College attendance at age 18</b>				
Boys	0.174	0.202	0.171	0.220
Girls	0.168	0.203	0.179	0.236
<b>Demographics</b>				
<i>Family size</i>	2.903	2.744	2.748	2.611
<i>Cohort information</i>				
Subject's year of birth	1979 (.941)	1983 (1.228)	1979 (0.948)	1983 (1.216)
Mother's year of birth	1955 ( 3.618)	1958 (3.834)	1956 (3.378)	1959 (3.504)
Father's year of birth	1952 ( 4.810)	1955 (4.846)	1952 (4.363)	1956 (4.134)
Mother's age at first birth	23.999 (3.562)	24.716 (3.735)	23.257 ( 3.293)	23.759 (3.390)
<i>Father's highest degree completed</i>				
College degree or above	0.070	0.101	0.061	0.065
Prof training degree	0.081	0.091	0.070	0.078
HS degree	0.092	0.093	0.089	0.095
Vocational HS degree	0.168	0.191	0.164	0.197
Junior HS degree	0.194	0.243	0.197	0.281
Primary school or less	0.395	0.280	0.418	0.284
<i>Mother's highest degree completed</i>				
College degree or above	0.034	0.042	0.027	0.031
Prof training degree	0.046	0.065	0.039	0.044
HS degree	0.066	0.077	0.056	0.069
Vocational HS degree	0.193	0.229	0.172	0.215
Junior HS degree	0.231	0.276	0.230	0.305
Primary school or less	0.431	0.311	0.476	0.337
Sample size	4,922	7,428	394,684	488,969

Note: (1) The twins data in firstborn sample only include families with twins in the first born. The single-births sample include families with at least 2 children, excluding those with first-born twins. (2) We trace back for each firstborn all siblings until 1999.

**Table 2: The effect of gender composition of the first 2 children on family size (based group=two boys)**

	Earlier cohort	Later cohort
<i>A) Twins at the first birth</i>		
(G1,G2)	.454*	.405*
	(.037)	(.028)
Mixed gender	.092	.037
	(.053)	(.033)
<i>B) Singles at the first 2 births</i>		
(G1,G2)	.554*	.487*
	(.004)	(.003)
(G1,B2)	.106*	.081*
	(.003)	(.003)
(B1,G2)	.11*	.076*
	(.003)	(.003)

Note: The average family size among first-born boy twins is 2.7 for the earlier cohort and 2.58 for the later cohort. For single boys at the first 2 births, the average family size is 2.57 for the earlier cohort and 2.46 for the later cohort. Control variables include the first-birth's birth place and age on the college entrance test day; the full set of dummies for parental age and education levels; the mother's age at first birth; and eligible college years.

**Table 3: Estimates of the gender effect of the twin-sibling on children's education, by gender and by cohort**  
**Dependent variable: college entry dummy**

	Earlier cohort (testyear:1997-1999)				Later cohort (testyear:2000-2003)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>A) Girls</b>								
B=1 if the twin-sibling was boy	-.0226 (.0238)	-.0344 (.0238)	-.0289 (.0231)	-.0343 (.0234)	.0215 (.0202)	.0087 (.0207)	.0137 (.0202)	.0129 (.0204)
Family size	-	-.0318* (.0086)	-.0169* (.0081)	-.0112 (.0084)	-	-.0341* (.0089)	-.0201* (.0087)	-.0171 (.0088)
Birth weight (kg) of subject	-	-	-	.0248* (.0118)	-	-	-	.0617* (.0141)
Birth weight (kg) of twin-sibling				.0205 (.0146)				.0038 (.0141)
<i>Parental education controls</i>	No	No	Yes	Yes	No	No	Yes	Yes
Sample size	2,535	2,535	2,535	2,535	3,717	3,717	3,717	3,717
<b>B) Boys</b>								
G=1 if the twin-sibling was gir	.0311 (.0250)	.0345 (.0249)	.0227 (.0238)	.0172 (.0242)	-.0026 (.0195)	-.0005 (.0194)	-.0007 (.0187)	-.0044 (.0188)
Family size	-	-.0376* (.0097)	-.0255* (.0091)	-.0219* (.0094)	-	-.0493* (.0097)	-.0342* (.0095)	-.0324* (.0095)
Birth weight (kg) of subject	-	-	-	.0451* (.0166)	-	-	-	.0478* (.0130)
Birth weight (kg) of twin-sibling				.0089 (.0180)				-.0374* (.0168)
<i>Parental education controls</i>	No	No	Yes	Yes	No	No	Yes	Yes
Sample size	2,457	2,457	2,457	2,457	3,711	3,711	3,711	3,711

Note: All regressions are based on the matched firstborn sample, controlling for mother's age, father's age, mother's age at first birt eligible college years, and birth place. Parental education includes a full set of dummies for categorical education levels separately for father and mother. The coefficients on interactions between sibling gender and parental education are all insignificant at the 5 percent level. \* means the estimate is significant at the 5% level. In earlier cohort, the avarage birth weight for girls with same gender is 2.412 kg, with mixed gender is 2.452kg; for boys with same gender is 2.524 kg; with mixed gender is 2.587 kg. In Later cohort, the avarage birth weight for girls with same gender is 2.429 kg, with mixed gender is 2.468kg; for boys with same gender is 2.517 kg; with mixed gender is 2.554 kg.