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Measuring Regional Variation in Sex Preference in China: A Cautionary Note

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This paper critically examines the issue of measuring regional variation in sex preference in China. It demonstrates that the conclusion of previous research (Fred Arnold and Zhaoxiang Liu, 1986 Population and Development Review **12**, 221–246) on this subject is largely an artifact that is due to floor and ceiling effects as well as sampling variability. This paper proposes alternative measures that are combined with statistical models. After correcting for floor and ceiling effects and considering sampling variability, it is shown that while sex preference undoubtedly exists in China, the degree of sex preference does not vary by region. Differentials are evident, however, by educational attainment and urban status.

To some extent son preference is a universal phenomenon (Williamson, 1976; Bennett, 1983; Cleland, Verrall, and Vaessen, 1983). It is especially strong and pervasive in East Asia, where one observes a cultural linkage between China and her neighboring countries. Because of the importance of sex preference in affecting the fertility transition in this part of the world, extensive research on this subject has been carried out in places like Korea and Taiwan (Cho, Arnold, and Kwon, 1982; Freedman and Coombs, 1974; Coombs and Sun, 1981). Recently, Arnold and Liu (1986) provide empirical evidence for the first time on sex preference in mainland China.

Arnold and Liu find not only that sex preference is still strong in China, despite the efforts of the Chinese Communist Party to promote sexual equality, but also that the degree of sex preference varies by

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region, educational attainment, place of residence, and nationality. In this paper we argue that their conclusion about the regional variation in sex preference in China is largely an artifact that is partly due to floor and ceiling effects contained in their measures and partly due to sampling variability. Applying different measures and taking the problem of sampling variability seriously, we demonstrate that the degree of sex preference in China is basically homogeneous across regions.

ARNOLD AND LIU'S MEASURES OF SEX PREFERENCE

Arnold and Liu's finding about the regional variation in sex preference is at odds with our knowledge about the regional variations in other demographic variables and in the level of socioeconomic development in China (Xie, 1987; Poston and Gu, 1987). While in general a negative correlation between the level of socioeconomic development and sex preference is expected (Williamson, 1976; Bennett, 1983), Arnold and Liu's measures have been shown to be either positively correlated or uncorrelated with many indices for socioeconomic development (Xie, 1987). In fact, anyone knowledgeable about China would be surprised by the map provided by Arnold and Liu (1986, Fig. 1), which shows that there is generally more sex preference in the more developed, eastern part of the country than in the less developed, remote hinterland.

To consider this puzzle, we must start with the measurement of sex preference. Even though sex preference in theory always refers to parents' attitude, many measures of sex preference are based on fertility behavior. Over the past decade, criticisms of measures of sex preference have been raised, and new measures have been proposed as a result (Coombs, Coombs, and McClelland, 1975; Arnold, 1985). In the case of China, however, these new techniques cannot be applied due to limitations of data. Arnold and Liu (1986), who have access to the One-Per-Thousand National Sample Fertility Survey conducted in 1982, construct behavioral measures. They pay special attention to how couples with one child at the time of the survey have responded to the one-child policy, which has been implemented in China since 1979 (Chen, 1985). Since Arnold and Liu's measures are behavioral, they share the same limitations with all other behavioral measures of sex preference (McClelland, 1983).[1] Our main concern here, however, is whether Arnold and Liu's analysis is accurate and whether we can do any better with these imperfect data at hand.

[1] The problems with behavioral measures derive from two major sources (McClelland, 1983, pp. 29–31). First, the heterogeneity of either size or sex preference in a region makes behavioral measures biased. Second, due to the lack of exact knowledge about the sex of the next birth, sex preference does not necessarily translate into decisions regarding fertility behavior.

The first measure that Arnold and Liu use is the *difference in percentages* of acceptance of a one-child certificate between couples with one boy and couples with one girl. One-child certificates are given to couples who pledge under penalty not to have a second child and who then in return receive certain monetary and other rewards. Let us denote S_i ($i = 0, 1$) for the sex of the only child (S_0 for girls and S_1 for boys) and $P_k(C_j|S_i)$ ($j = 0, 1$) for the conditional probability of receiving or not receiving a one-child certificate in the kth region (C_0 for not receiving and C_1 for receiving). For the time being, we ignore the distinction between sample estimates and population parameters. The measure used by Arnold and Liu (hereafter AL) is the difference in the conditional probabilities:

$$AL_k = P_K(C_1|S_1) - P_k(C_1|S_0). \quad (1)$$

Table 1 gives raw data in the form of percentages from which the AL measure can be computed. The values (in percent) of the AL measure as reported by Arnold and Liu for each of the regions are displayed in the first column of Table 2.

Arnold and Liu also give two other measures of sex preference across regions. We will call them AL2 and AL3. AL2 and AL3 measures are defined as follows:

AL2 equals the *difference in percentages* between one-girl and one-boy coules who, after having received one-child certificates, renounced them by having a second child (Arnold and Liu, 1986, Table 3).

AL3 equals the *difference in percentages* between one-boy and one-girl couples who, while currently married, were practicing contraception in 1982 (Arnold and Liu, 1986, Table 4).

We will discuss the relationships among AL, AL2, and AL3 later in the paper. Because AL2 and AL3 are methodologically very similar to AL, our discussion is primarily about the first measure AL. The conclusions to be drawn about AL, however, are equally applicable to the AL2 and AL3 measures.

One problem with the AL measure is that, as a difference in percentages, it is contaminated with floor and ceiling effects. The bias caused by the floor and ceiling effects is in the direction of underestimation for regions with extremely high or low overall rates of accepting the certificate, and conversely, in the direction of overestimation for regions with the overall rates near 50%. For example, according to AL, sex preference is low in Qinghai (12.7% − 6.6% = 6.1%) even though couples in that province with one boy are nearly twice as likely to receive a one-child certificate as couples with one girl. By the same token, AL overestimates sex preference in Jiangsu (63.6% − 52.7% = 10.9%) and Shandong

TABLE 1
Percentage and Base of One-Child Couples in 1982 Who Have Received a One-Child Certificate by Region[a]

	Sex of child					
	Girl		Boy		Total	
Region	Percentage (1)	Base (2)	Percentage (3)	Base (4)	Percentage (5)	Base (6)
Beijing	76.4	250	74.6	280	75.5	530
Tianjin	78.6	206	86.2	224	82.6	430
Hebei	30.1	1040	37.5	1237	34.1	2277
Shanxi	15.3	426	16.8	481	16.1	907
Inner Mongolia	31.6	370	41.5	398	36.7	768
Liaoning	66.1	866	74.6	1093	70.8	1959
Jilin	32.5	351	46.5	529	40.9	880
Heilongjiang	31.5	502	38.0	652	35.2	1154
Shanghai	77.3	419	78.8	454	78.1	873
Jiangsu	52.7	1439	63.6	2022	59.0	3461
Zhejiang	22.1	660	30.4	737	26.5	1397
Anhui	13.2	623	22.5	775	18.3	1398
Fujian	13.6	324	17.1	409	15.5	733
Jiangxi	6.8	367	7.1	534	7.0	901
Shandong	48.1	1317	58.7	1787	54.2	3104
Henan	18.1	915	22.4	1243	20.6	2158
Hubei	39.6	923	41.2	1087	40.5	2010
Hunan	14.3	791	19.8	972	17.3	1763
Guangdong	13.5	784	12.2	937	12.8	1721
Guangxi	9.7	453	10.9	488	10.3	941
Sichuan	47.3	1799	54.0	2172	50.9	3971
Guizhou	9.3	323	13.9	375	11.7	698
Yunnan	14.8	480	17.4	564	16.2	1044
Shaanxi	30.5	417	37.3	574	34.4	991
Gansu	15.7	274	17.7	311	16.7	585
Qinghai	6.6	76	12.7	79	9.7	155
Ningxia	25.0	72	33.3	75	29.3	147
Xinjiang	10.6	217	11.9	253	11.3	470

[a] Source: Columns (1), (3), and (5) are from Arnold and Liu (1986, Table 1); columns (2), (4), and (6) were kindly provided by Fred Arnold.

(58.7% − 48.1 = 10.6%), because in these two provinces the overall percentages of receiving the certificate among one-child couples are in the middle range, close to 50%. One way to correct for the floor and ceiling effects is to use log-odds-ratios (LOR). We define LOR as:

$$\mathrm{LOR}_k = \log\{[P(C_1|S_1)/P(C_0|S_1)]/[P(C_1|S_0)/P(C_0|S_0)]\}. \tag{2}$$

Odds-ratios have a natural interpretation as measuring association in any 2 × 2 subtable (Bishop, Fienberg, and Holland, 1975, pp. 11–24). A natural

TABLE 2
Comparison of Three Different Measures of Sex Preference and Total Fertility Rate by Region[a]

Region	AL	LOR	SR	TFR
Beijing	−1.8	−0.097	1.120	1.588
Tianjin	7.5	0.531	1.087	1.645
Hebei	7.4	0.332	1.189	2.650
Shanxi	1.6	0.111	1.129	2.385
Inner Mongolia	9.8	0.429	1.076	2.621
Liaoning	8.5	0.410	1.262	1.773
Jilin	14.0	0.591	1.507	1.842
Heilongjiang	6.6	0.287	1.299	2.061
Shanghai	1.5	0.088	1.084	1.316
Jiangsu	10.9	0.450	1.405	2.075
Zhejiang	8.3	0.432	1.117	1.982
Anhui	9.3	0.647	1.244	2.799
Fujian	3.5	0.270	1.262	2.717
Jiangxi	0.3	0.046	1.455	2.790
Shandong	10.6	0.428	1.357	2.104
Henan	4.3	0.267	1.358	2.651
Hubei	1.6	0.066	1.178	2.445
Hunan	5.5	0.392	1.229	2.833
Guangdong	−1.3	−0.116	1.195	3.283
Guangxi	1.2	0.130	1.077	4.103
Sichuan	6.7	0.268	1.207	2.434
Guizhou	4.6	0.454	1.161	4.355
Yunnan	2.6	0.193	1.175	3.814
Shaanxi	6.8	0.304	1.377	2.394
Gansu	2.0	0.144	1.135	2.728
Qinghai	6.1	0.722	1.039	3.927
Ningxia	8.3	0.404	1.042	4.120
Xingiang	1.3	0.130	1.166	3.883

[a] See text for the definitions of the three measures. TFR is taken from Poston and Gu (1987, Table 2).

log transformation makes LOR to vary from minus infinity to positive infinity. From the information in Table 1, we can obtain LOR for each of the regions. The values of the LOR measure are presented in the second column in Table 2.

Another problem with the AL measure is that it ignores the information contained in the marginal distribution of the sex of the children of one-child families (hereafter only children). It is well known that the sex ratio of the lastborn can be used as a behavioral measure of sex preference (e.g., McClelland, 1983, p. 28). Arnold and Liu, in other parts of the same paper (Arnold and Liu, 1986, Table 7), examine at the national level the sex ratio of the only children and correctly attribute the high sex ratio (125.0) to the prevailing son preference in China. This is because, under the same pressure from local authorities to have only one child, couples with one girl are more likely to have a second birth than couples with one boy when they are compelled by their preference for sons over daughters. We can also use the sex ratio of the only children to measure sex preference at the regional level. To do that, we define SR as

$$SR_k = N_{1k}/N_{0k}, \tag{3}$$

where N_{1k} is the total number of the male only children in the kth region, and N_{0k} the total number of the female only children. The estimates of this measure are reported in the third column of Table 2. SR varies from as low as 1.039 in Qinghai to as high as 1.507 in Jilin.

We compare all of the three measures of sex preference against the total fertility rate (TFR), a fertility measure also affected by socioeconomic development, as shown in Table 2. The correlation matrix of the three measures and TFR is presented in Table 3. Several observations can be made from Table 3. First of all, there is little correlation between the SR measure and the other two measures. The convergent validity of the measures is then questionable (Borhnstedt, 1983). Second, there is no consistent relationship between the measures of sex preference and the total fertility rate. While the correlations between TFR and the AL and SR measures are unexpectedly negative, the LOR measure is almost orthogonal to TFR. Since we already know that the AL measure is contaminated by ceiling and floor effects, our discussion of the measurement of sex preference in the rest of the paper will focus on the LOR and SR measures.

MEASUREMENT OF SEX PREFERENCE AND SAMPLE VARIABILITY

The results from Table 3 raise further questions. If both the LOR measure and the SR measure are purported to measure the same entity, why do they behave in such an inconsistent way? Should we prefer the

TABLE 3
The Correlation Matrix of Measures of Sex Preference and Total Fertility Rate across Regions[a]

	AL	LOR	SR	TFR
AL	1.000			
LOR	0.851	1.000		
SR	0.333	0.092	1.000	
TFR	−0.240	0.029	−0.313	1.000

[a] Computed without weighting across the 28 regions shown in Table 2.

LOR measure over the SR measure because the latter is calculated from marginal distributions while the former estimates two-way associations?[2]

Before we rush to such a conclusion, it is necessary to consider the sampling variability of the estimates of the LOR and SR measures. We know that these data are from a sample, albeit a high-quality one (Yu and Xiao, 1984; Li, 1984). For sample data, we need to take sampling variability into account, and we should not treat samples as populations. That is, a certain degree of sampling variability is allowed and even expected in any analysis of sample data. In other words, some irregularities in sample data might best be attributed to sampling error. For example, we see in Table 2 that couples in Beijing and Guangdong prefer daughters to sons according to both the AL and LOR measures. Should we conclude that there is daughter preference in Beijing and Guangdong? No, not unless we are given a very good reason. Since all of our theories, experiences, and other data sources support the thesis that there is son preference in China as a whole, but not daughter preference, we should consider the possibility that the negative cases of Beijing and Guangdong may be due to sampling variation.[3]

For the same reason, we should not conclude that there is a regional variation in sex preference unless we have compelling evidence to disprove the hypothesis of homogeneity, which is in accordance with Coombs' (1977) observation that the variation in sex preference is much smaller within countries than between countries. The lack of convergent validity among the different measures shown in Table 3 suggests that the regional variation in sex preference in China is not so great as to be precisely determined with crude behavioral measures. Why can we not retain the hypothesis of homogeneity of sex preference, if the contrary evidence is weak and inconsistent?

Nothing can be "truly" homogeneous across regions. What is at issue is whether the differences among regions are so great as to be theoretically interesting and statistically reliable. In the case of China, we know that there are considerable regional variations in socioeconomic development, in population density, and in fertility rate (Poston and Gu, 1987). These variations draw our attention because they tell us that different parts of the country are at different levels of development and in different stages of the demographic transition. They also have implications for

[2] In the tradition of contingency table analysis, marginal distributions are usually less of interest than are association parameters. See Bishop, Fienberg, and Holland (1975) and Goodman (1978, 1984).

[3] In interpreting the evidence of daughter preference in Beijing, Arnold and Liu give two possible reasons, which do not seem very plausible to the author: (1) "daughters are widely believed to be closer to the parents" and (2) "sons may be more expensive because the parents need to provide them with sufficient resources to find a suitable marriage partner" (Arnold and Liu, 1986, p. 223).

policy-makers. To be sure, Arnold and Liu were cautious in their interpretation of their finding of the regional variation in sex preference. Their main purpose is to ascertain the existence of sex preference in China and the effect of sex preference on fertility and family planning.

To detect sampling variabilities in observed rates, formal statistical modeling is helpful (Clogg, Shockey, and Eliason, 1987). In line with this logic, we apply standard log-linear models (Bishop, Fienberg, and Holland, 1975; Goodman, 1978, 1984). Log-linear models have already been applied in analysis of sex preference (Cleland, Verrall, and Vaessen, 1983). We can view the data (presented as percentages in Table 1) as a three-way table: sex by acceptance and by region. Let R_k ($k = 1, \ldots, 28$) denote region. The dimension of the table is then $S_i \times C_j \times R_k$, where $i = 0, 1$; $j = 0, 1$; and $k = 1, \ldots, 28$. There are 28 log-odds-ratios (defined in Eq. (2)) in the saturated model. We can constrain all of the log-odds-ratios to be equal and have a χ^2 test with 27 *df* for the null hypothesis of the homogeneity of log-odds-ratios. Likewise, we can test the homogeneity of the sex ratios through an equality constraint on the marginals. The goodness of fit statistics of relevant models are shown in Table 4.

In Table 4, there are two models for the hypothesis of homogeneous sex preference in China: Model (3) and Model (4). Model (4) tests the homogeneity of log-odds-ratios, whereas Model (3) tests the homogeneity not only of log-odds-ratios but also of the marginal distribution of the sex of the only children. In other words, Model (3) says not only that the log-odds-ratios of accepting a one-child certificate are the same across regions, but that the sex ratios of the only children are the same across regions. By a formal log-likelihood ratio test, we would prefer Model (4) over Model (3) (the χ^2 statistic being 89.4 for 27 *df*) but fail to reject

TABLE 4
Log-linear Models of Sex Preference[a]

Model	Description[b]	L^2[c]	*df*[d]	BIC[e]
(1)	$S + C + R$	7299	82	6436
(2)	$(1) + R * C$	296.2	55	−283.0
(3)	$(2) + C * S$	136.7	54	−431.9
(4)	$(3) + R * S$	47.3	27	−237.3

[a] The sample size is 37,426.

[b] *S*, sex of only children, boys vs. girls; *C*, acceptance of one-child certificates, yes vs. no; *R*, regions, 28 categories.

[c] L^2, log-likelihood ratio statistic.

[d] *df*, degrees of freedom.

[e] BIC = $L^2 - (df) \log N$, where *N* is the sample size.

Model (4) only at the significance level of 0.005 (χ^2 statistic being 47.3 with 27 *df*).[4] However, Models (3) and (4) are actually much more powerful than the log-likelihood ratio test suggests if we consider the large size (37,426 observations) of the sample in this 2 × 2 × 8 cross-classified table. We know that, with large samples, the log-likelihood ratio test is likely to reject a good model. Raftery (1986) proposes the BIC statistic for large samples: BIC = $L^2 - (df) \log N$, where L^2 is the log-likelihood ratio statistic, *df* is the associated degrees of freedom, and *N* is the sample size. If BIC is negative, we should accept the null hypothesis. When comparing several models, we should select the model with the lowest BIC value. By the BIC criterion, Model (3) should be selected as the preferred model. Therefore, the hypothesis of homogeneity of sex preference in China is retained. This conclusion holds at two levels: the log-odds-ratio of accepting a one-child certificate and the marginal distribution of the sex of the only children.

Similar results, not to be reported here, are obtained when we analyze the other two tables on which the AL2 and AL3 measures are based. In Arnold and Liu's treatment, these three pieces of information from the same sample do not give rise to a consistent measurement of sex preference at the regional level (the correlations among AL, AL2, and AL3 are between 0.012 and 0.357; see Xie, 1987). Now they tell us the same story. Table 4 shows that even though there is overwhelming evidence confirming Arnold and Liu's finding that sex preference is strong in contemporary China,[5] the regional variation in sex preference is insignificant so that we can treat it as a result of sampling variation. The attempt to measure the regional variation with the data at hand is premature because the sampling variation renders a precise measurement improbable. Without other information and data sources, we are content with the conclusion that the degree of sex preference in China is about the same.

VARIATIONS IN SEX PREFERENCE ALONG OTHER DIMENSIONS

Arnold and Liu also find variations in sex preference along the dimensions of nationality, place of residence, and educational attainment. According to Arnold and Liu (1986, p. 229), nationality is an important dimension in explaining the regional variation in sex preference: "Several of the areas with low levels of son preference have large minority populations that exhibit different sex preferences for children than the Han

[4] The log-likelihood ratio statistic L^2 asymptotically follows a χ^2 distribution. For nested models (3) and (4), $L_3^2 - L_4^2$ is also asymptotically distributed as a χ^2 with $df_3 - df_4$ degrees of freedom. See Bishop, Fienberg, and Holland (1975).

[5] By nesting models (2) and (3) in Table 4, we obtain a χ^2 test statistic of 159.5 with 1 *df*.

majority." Since minorities are predominant in several regions, variation in sex preference among nationalities means variation across regions.

Table 5 presents percentages and bases of one-child couples who have received a one-child certificate by nationality, place of residence, and educational attainment. Again, Arnold and Liu use the differences in percentages of accepting a one-child certificate among one-child couples as measures of sex preference. We denote these measures as NAT, PLA,

TABLE 5
Percentage and Base of One-Child Couples in 1982 Who Have Received a One-Child Certificate by Characteristics[a]

	Sex of child						
	Girl		Boy		Total		
Characteristic of wife	Percentage (1)	Base (2)	Percentage (3)	Base (4)	Percentage (5)	Base (6)	(3)–(1) (7)
Nationality							NAT
Han	35.7	15,655	42.1	19,529	39.2	35,184	6.4
Zhuang	4.2	216	5.8	242	5.0	458	1.6
Hui	25.3	99	27.8	144	26.7	243	2.5
Wei	2.0	149	2.3	173	2.2	322	0.3
Yi	7.1	42	1.4	70	3.6	112	−5.7
Miao	1.4	72	2.7	73	2.1	145	1.3
Manchu	31.5	73	44.8	125	39.9	198	13.3
Tibetan	1.0	104	0.0	95	0.5	199	−1.0
Mongolian	15.7	51	17.7	51	16.7	102	2.0
Other minority	3.6	223	6.3	240	5.0	463	2.7
Place of residence							PLA
City	74.8	3,279	76.7	3,759	75.9	7,038	1.9
Town	43.0	721	53.1	910	48.6	1,631	10.1
Rural nonfarm	38.3	214	44.8	252	41.9	466	6.5
Rural farm	22.6	12,470	30.8	15,821	27.2	28,291	8.2
Educational attainment							EDU
Illiterate	15.5	6,332	22.2	8,203	19.3	14,535	6.7
Elementary school	31.5	4,484	41.6	5,651	37.2	10,135	10.1
Junior high school	56.1	4,102	61.9	4,828	59.3	8,930	5.8
Senior high school	53.1	1,607	56.6	1,902	55.0	3,509	3.5
University	73.4	158	76.6	158	75.0	316	3.2

[a] Source: Columns (1), (3), (5), and (7) are from Arnold and Liu (1986, Table 2); columns (2), (4), and (6) were kindly provided by Fred Arnold.

and EDU, shown in Table 5. It is clear by now that these measures are subject to the same criticisms that we raised against AL. With that in mind, one should not be surprised to see that according to the PLA measure, there is greater sex preference in towns than in either rural nonfarm villages or rural farm villages. Neither should one be surprised to note that couples with wives who have completed elementary education are more sex preferential than couples with illiterate wives. We will not construct alternative measures to correct the problems in the NAT, PLA, and EDU measures. Since our main concern is with the hypothesis of homogeneity, we will discuss nationality, place of residence, and educational attainment separately in relation to that hypothesis.

Nationality

There are 55 minor nationalities in addition to the majority Han listed in Census tabulations (Population Census Office, 1985). Five autonomous regions (administrative units similar to provinces for areas with heavy minority populations) are named after minorities: Inner Mongolia A.R., Guangxi Zhuang A.R., Ningxia Hui A.R., Tibet A.R., and Xinjiang Uighur A.R. The total population of the minorities is sixty-seven million, or 6% of the total population (Population Census Office, 1985). It has been shown that minorities in general have a lower age at marriage and a higher fertility rate (Shen and Ma, 1984; Qiu and He, 1984). To keep the distinction between size and sex preferences (Coombs, Coombs, and McClelland, 1975), however, high fertility means that there are few couples who want only one child, but not necessarily that there is less sex preference. Since a very small proportion of minority couples accepted one-child certificates, NAT is ill-suited to measure sex preference among minorities. Here, the problems of floor and ceiling effects and of sampling variability become particularly acute. Consequently, NAT, purported to measure the regional variation in sex preference, is dominated by regional variation in fertility control. Panel A of Table 6 gives a series of log-linear models on the nationality data in Table 5.

The log-linear models along the nationality dimension confirm the existence of sex preference in China.[6] But we cannot accept the assertion of Arnold and Liu that Han and Manchu are significantly more sex preferential than other nationalities since the model of homogeneity (Model A3) fits the data very well ($L^2 = 21.21$ with 18 *df*, BIC = -168.3). Therefore, we conclude that the differences in the degree of sex preference among nationalities observed by Arnold and Liu is attributable to floor and ceiling effects and sampling variability. The nationality

[6] By nesting Models A2 and A3 in Table 6, we obtain a χ^2 statistic of 158.9 with 1 *df*.

TABLE 6
Log-linear Models of Sex Preference for Data in Table 5[a]

Model	Description[b]	L^{2c}	df^d	BIC[e]
	A: Nationality			
(A1)	$S + C + N$	1411	28	1116
(A2)	(A1) + $N \times C$	180.1	19	−20.0
(A3)	(A2) + $C \times S$	21.21	18	−168.3
(A4)	(A3) + $N \times S$	6.767	9	−88.0
	B: Place of residence			
(B1)	$S + C + P$	5990	10	5885
(B2)	(B1) + $P \times C$	276.2	7	202.5
(B3)	(B2) + $C \times S$	117.8	6	54.6
(B4)	(B3) + $P \times S$	26.79	3	−4.8
(B5)	(B3) + PL $\times S$ + PL $\times C \times S$	5.152	4	−37.0
	C: Educational attainment			
(C1)	$S + C + E$	4896	13	4759
(C2)	(C1) + $E \times C$	270.1	9	175.3
(C3)	(C2) + $C \times S$	110.2	8	26.0
(C4)	(C3) + $E \times S$	24.98	4	−17.1
(C5)	(C3) + EL $\times S$ + EL $\times C \times S$	14.68	6	−48.5

[a] The sample size is 37,426.
[b] *S*, sex of only children, boys vs. girls; *C*, acceptance of one-child certificates, yes vs. no; *N*, nationality, 10 categories; *P*, place of residence, 4 categories; PL, linear scoring of *P*, with city = 1, town = 2, etc.; *E*, educational attainment of the wife, 5 categories; EL, linear scoring of *E*, with illiterate = 1, elementary = 2, etc.
[c] L^2, log-likelihood ratio statistic.
[d] *df*, degrees of freedom.
[e] BIC = $L^2 - (df) \log N$, where *N* is the sample size.

groups in China are homogeneous with respect to the degree to which they prefer sons to daughters.

Place of Residence

About 20% of the population in China was classified as "urban" in the 1982 Census (State Statistical Bureau, 1984, p. 87). This includes people living both in towns in the countryside and in suburban counties of large cities. Since urbanization is one of the major aspects of modernization, and since modernization is believed to be the major force to reduce sex preference, we would expect that in urban areas there is less sex preference than in rural areas. Arnold and Liu correctly point out the variation in sex preference along this dimension. However, in the continuum of city, town, rural nonfarm village, and rural farm village, they find that the highest level of sex preference is in towns, followed by the two types of rural villages. This is an anomaly which we will address with the technique of log-linear modeling.

Panel B of Table 6 displays the results of a set of log-linear models. Here for the first time the model of homogeneity of sex preference (Model B3) clearly cannot hold. The model of homogeneous log-odds-ratios (Model B4), though superior to Model B3, does not fit the data very well (L^2 = 26.79 with 3 *df*, BIC = −4.8). Since we lack degrees of freedom to test the three-way interactions, we take the advantage of the ordering of the *P* (place) variable. We make PL a linear transformation of *P*, with city = 1, town = 2, rural nonfarm = 3, and rural farm = 4. If the sex preference varies inversely with the degree of urbanization, we should expect that PL will explain much of the association in the cross-classified table. Model B5 confirms our speculation since it has a very good fit (L^2 = 5.152 with 4 *df*, BIC = −37.0). Model B5 says that sex preference in China varies with place of residence along the continuum with roughly equal intervals, in two aspects: the marginal distribution of the sex of the only children, and the log-odds-ratio of accepting a one-child certificate.

Educational Attainment

A similar story can be told about educational attainment. Arnold and Liu use five categories of education: illiterate, elementary school, junior high school, senior high school, and university. We expect to see that there is less sex preference among couples with more educated wives. The failure of Arnold and Liu's measure to find less sex preference among couples with wives of elementary school education than among couples with illiterate wives is troublesome. The root of the problem is, again, floor and ceiling effects and sampling variability.

As illustrated in Panel C of Table 6, we run the same set of models as in Panel B. It is clear that the model of homogeneous sex preference (Model C3) needs to be rejected. The model of the homogeneous log-odds-ratios (Model C4) is marginally acceptable by the BIC criterion (BIC = −17.1) but very unsatisfactory by the log-likelihood ratio test (L^2 = 24.98 with 4 *df*). However, Model C5, representing the hypothesis of equal-interval gradient of sex preference along the dimension of wife's educational attainment, is a superior model (L^2 = 14.68 with 6 *df*, BIC = −48.5).

CONCLUSION

The preceding exercise has demonstrated that Arnold and Liu's (1986) previous finding regarding the regional variation in sex preference in China may well be an artifact of the methodological deficiencies in the measures based on differences in percentages. Through log-linear modeling we suggest instead that sex preference in China is largely homogeneous across regions and nationalities. Along the dimensions of educational attainment and place of residence, however, we do find variation in sex preference. Our results may have implications for research in other areas of social science, for it is not uncommon to see measures formed by taking the difference between two percentages. This type of measure suffers first from being contaminated by floor and ceiling effects and second from sampling variability. In contrast, it is often fruitful to combine descriptive measures with statistical models as has been demonstrated by the present analysis.

REFERENCES

Arnold, Fred (1985). "Measuring the effect of sex preference on fertility: The case of Korea," Demography **22,** 280–288.

Arnold, Fred, and Liu, Zhaoxiang (1986). "Sex preference, fertility, and family planning in China," Population and Development Review **12,** 221–246.

Bennett, Neil G. (1983). "Sex selection of children: An overview," *in* Sex Selection of Children (Neil Bennett, Ed.), pp. 1–12, Academic Press, New York.

Bishop, Yvonne, M. M., Fienberg, Stephen E., and Holland, Paul W. (1975). Discrete Multivariate Analysis: Theory and Practice, MIT Press, Cambridge.

Borhnstedt, George W. (1983). "Measurement," *in* Handbook of Survey Research (Peter H. Rossi, James D. Wright, and Andy B. Anderson, Eds.), pp. 69–121, Academic Press, New York.

Chen, Xiangming (1985). "The one-child population policy, modernization, and the extended Chinese family," Journal of Marriage and the Family **47,** 193–201.

Cho, Lee-Jay, Arnold, Fred, and Kwon, Tai Hwan (1982). The Determinants of Fertility in the Republic of Korea, Committee on Population and Demography, Report No. 14, National Academy Press, Washington, DC.

Cleland, John, Verrall, Jane, and Vaessen, Martin (1983). "Preferences for the sex of children and their influence on reproductive behavior," World Fertility Survey Comparative Studies, No. 27, International Statistical Institute, Voorburg.

Clogg, Clifford C., Shockey, James W., and Eliason, Scott R. (1987). A General Statistical Framework for Adjustment of Rates, Paper presented at the 1987 annual meetings of the American Sociological Association, Chicago.

Coombs, Clyde H., Coombs, Lolagene C., and McClelland, Gary H. (1975). "Preference scales for number and sex of children," Population Studies **29,** 273–298.

Coombs, Lolagene (1977). "Preferences for sex of children among U.S. couples," Family Planning Perspectives **9,** 259–265.

Coombs, Lolagene, and Sun, Te-Hsiung (1981). "Familial values in a developing society: A decade of change in Taiwan," Social Forces **59,** 1229–1255.

Freedman, Ronald, and Coombs, Lolagene C. (1974). Cross-Cultural Comparisons: Data on Two Factors in Fertility Behavior, Report of a Project of the Subcommittee on Comparative Fertility Analysis of the International Union for the Scientific Study of Population, The Population Council, New York.

Goodman, Leo A. (1978). Analyzing Qualitative/Categorical Data, Abt Books, Lanham.

Goodman, Leo A. (1984). The Analysis of Cross-Classified Data Having Ordered Categories, Harvard Univ. Press, Cambridge.

Li, Baohua (1984). "Assessment of the accuracy of a sampling survey," *in* Analysis on China's National One-per-Thousand-Population Fertility Sampling Survey (China Population Information Center, Ed.), English ed., pp. 24–32, Beijing.

McClelland, Gary H. (1983). "Measuring sex preferences and their effects on fertility," *in* Sex Selection of Children (Neil Bennett, Ed.), pp. 13–45, Academic Press, New York.

Population Census Office (1985). 1982 Population Census of China (Results of Computer Tabulation), Beijing. [in Chinese]

Poston, Dudley L., Jr., and Gu, Baochang (1987). "Socioeconomic development, family planning, and fertility in China," Demography **24,** 531–51.

Qiu, Xielan, and He, Xinhua (1984). "The number of existing children of women of Han and minority nationalities in rural areas," *in* Analysis on China's National One-per-Thousand-Population Fertility Sampling Survey (China Population Information Center, Ed.), English ed., pp. 91–99, Beijing.

Raftery, Adrian E. (1986). "Choosing models for cross-classifications," American Sociological Review **51,** 145–146.

Shen, Biguang, and Ma, Qingping (1984). "Recent nuptiality of rural women of Han and minority nationalities," *in* Analysis on China's National One-per-Thousand-Population Fertility Sampling Survey (China Population Information Center, Ed.), English ed., pp. 131–134, Beijing.

State Statistical Bureau, People's Republic of China (1984). Statistical Yearbook of China—1984, English ed., Economic Information and Agency, Hong Kong.

Williamson, Nancy E. (1976). Sons or Daughters, a Cross-Cultural Survey of Parental Preferences, Sage, Beverly Hills.

Xie, Yu (1987). On Regional Variation of Sex Preference in China, Center for Demography and Ecology Working Paper 87-16, University of Wisconsin-Madison.

Yu, Wang, and Xiao, Zhenyu (1984). "A brief account of the national one-per-thousand-population fertility sampling survey and preliminary analysis of its data," *in* Analysis on China's National One-per-Thousand-Population Fertility Sampling Survey (China Population Information Center, Ed.), English ed., pp. 3–11, Beijing.