The Implementation of Preferences for Male Offspring

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In many societies a preference for sons is a long-standing cultural custom. Son preference often leads to higher mortality among girls and women than among boys and men, and to a population with an excess of males over females. In contrast, for most of human history the sex ratio at birth (SRB, or "sex ratio") was not elevated above its natural level of about 105 male per 100 female newborns.[1] This ratio remained also largely unchanged during much of the global fertility decline that occurred over the past two centuries, first in the developed and then in the developing world. The main reason for this normal SRB, even in countries with strong son preference, is the lack of safe, effective, inexpensive, and accessible technologies to determine the sex of a fetus and to abort unwanted pregnancies.

Over the past quarter century, however, such technologies have become increasingly available and, as a result, sex ratios have risen in a number of countries where son preference has remained strong, mostly in Asia (Attané and Guilmoto 2007a; Das Gupta et al. 2003; Das Gupta and Bhat 1997; Guilmoto 2007, 2009, 2012a; Retherford and Roy 2003; Pison 2004; Sen 1990; Zeng et al. 1993). These trends indicate a strong discrimination against girls and have led to widespread concern among human rights advocates, researchers, and policymakers. In a number of countries policies have been implemented to attempt to reduce this bias against girls, but policymakers are hampered by an absence of methods for projecting trends in sex ratios at birth. Will sex ratios decline in the future without direct intervention, or could they rise further, thus requiring vigorous government action? What will happen to the sex ratio in developing countries with son preferences when technology for sex-selective abortion becomes more widely available and affordable?

This article first documents levels and trends in the sex ratio at birth, in preferences for male offspring ("son preference"), and in the actions taken to implement these preferences. The focus is on prenatal sex bias, and postnatal sex discrimination is not examined. The main sources of data for this analysis

are Demographic and Health Surveys (DHS) from 61 countries in Africa, Asia, and Latin America and estimates of demographic variables made by the Population Division of the United Nations (see Appendix for countries and year of latest DHS survey). After a summary of recent estimates of sex ratios and of missing girl births, the article presents evidence for son preferences using responses to the survey question about ideal number of sons and daughters and compares desired with actual sex ratios. Since China does not have a DHS survey, it is largely excluded from this analysis. Next, the actions taken to implement these preferences, either through contraception or sex-selective abortion, are examined. The conclusion summarizes implications for future trends in the sex ratio at birth.

Sex ratio at birth and missing girl births

Global and regional estimates of the sex ratio at birth prepared by the United Nations are presented in Table 1 (UN 2011). The world's sex ratio in 2010 is estimated at 107, slightly above its natural level. The highest sex ratio of 119 is found in China, and India's level is estimated at 108. The other regional estimates (which exclude China and India) are near normal, but as is shown below these regional results conceal a number of elevated ratios in specific countries. These UN estimates for 2010 may not be fully up-to-date, and some countries have multiple sources of information that are not consistent (e.g., India). Nevertheless, the UN is the only organization that provides global, regional, and country estimates of the SRB. Where available, the UN reviews evidence from multiple sources and takes into account various biases that may exist.[2]

A widely used measure of the consequence of elevated sex ratios is the number of missing girl births—that is, girl births that did not occur

TABLE 1 Regional estimates of sex ratio at birth and annual number and percent of missing girl births in 2010

	Sex ratio at birth	Missing girls at birth (1000s)	Percent of girl births missing
China	1.19	1,092	12.7
India	1.08	257	1.9
Other Asia	1.06	57	0.5
Middle East and North Africa	1.06	6	0.1
Europe and Central Asia	1.06	14	0.3
Sub-Saharan Africa	1.04	1	0.0
Latin America and Caribbean	1.05	0	0.0
North America	1.05	NA	NA
World total	1.07	1,427	2.1

SOURCES: United Nations 2011; World Bank 2012; author's calculations.

because of sex-selective abortion. This number is calculated as the difference between the number of girl births that did occur and the hypothetical number that would have occurred in the absence of sex-selective abortion, which is calculated from the normal sex ratio.[3] As shown in Table 1, the global number of missing girl births is estimated at 1,427 thousands in 2010 (World Bank 2012). China accounts for three quarters of these missing births, and China and India together account for 95 percent of the total.[4] The last column gives the percentages of girl births that are missing: 12.7 percent in China, 2 percent in India, and small fractions of one percent in the remaining regions.

The distribution of country-level sex ratios as estimated by the UN is highly skewed, with near normal ratios in the large majority of countries while a few countries have substantially elevated ratios.[5] As noted, the highest sex ratio of 119 is estimated in China. Armenia, Azerbaijan, and Georgia have ratios above 110 (Duthé et al. 2012). South Korea's ratio reached near 115 in the 1990s but has since declined to near normal levels. An analysis of birth registration and survey data by Guilmoto (2009) suggests that India, Pakistan, and Vietnam also have SRBs near 110, which are somewhat higher than the corresponding UN estimates. A number of states in India have sex ratios exceeding 110.

Desired sex ratio at birth

Parents who have resorted to sex-selective abortion are strongly motivated and have overcome the potential medical, technical, ethical, social, and economic obstacles they faced when considering this procedure. The existence of these obstacles suggests that a substantial number of couples who would like to change the sex composition of their families have not been able to do so. An analysis of the desired sex ratio at birth can shed light on this issue.

Most DHS surveys collect information on family size and sex composition preferences. Respondents are asked to provide their ideal family size as well as their ideal number of sons and daughters. From this information the desired sex ratio at birth is readily calculated (Retherford and Roy 2003).[6] These estimates of desired family size and composition contain two potential biases. The first is "rationalization," in which a respondent provides a desired family size that is influenced by the actual family size at the time of the survey. For example, a woman may be reluctant to provide an ideal family size that is smaller than her current number of living children. Rationalization is most common among older women who have many living children (Lightbourne 1985). To minimize rationalization, respondents older than 35 are excluded from the analysis. A second potential bias occurs if a response is influenced by established government policy. For example, some governments have taken measures to reduce sex-selective abortion, and this may lead couples to report

a more balanced desired sex composition than would have been reported in the absence of interventions.

Estimates of desired sex ratio at birth (DSRB, or "desired sex ratio") are available for women in 61 countries and for men in 45 countries (16 of the 61 countries did not conduct male surveys). The unweighted average desired sex ratio was 105 for currently married women and 123 for currently married men in the 45 surveys that collected information on both female and male preferences. The male–female gap averages a substantial 18 and varies widely among countries; for example, it is near zero in India but exceeds 30 in Azerbaijan and Armenia.

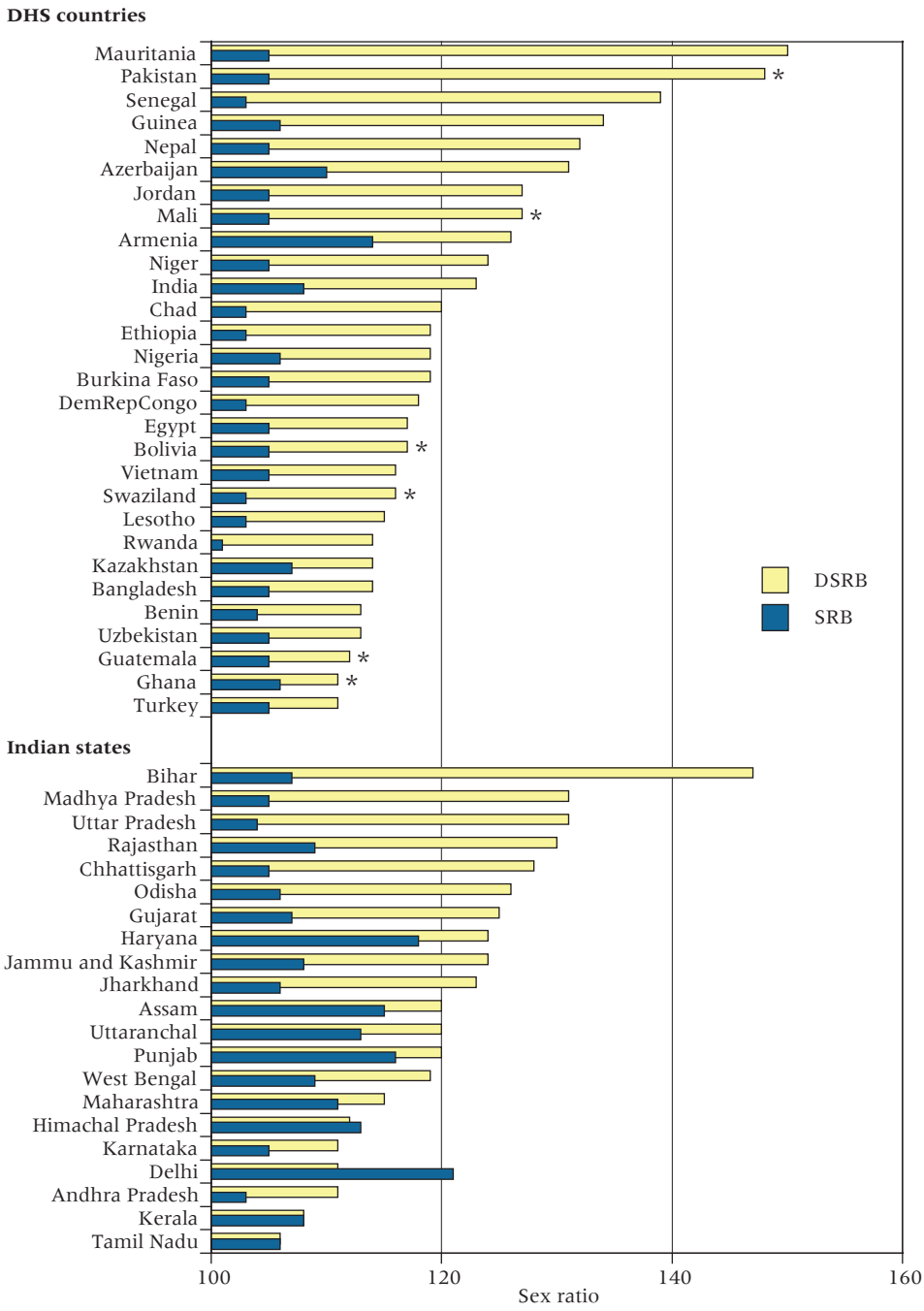
It is not clear how husbands and wives resolve their differences in son preferences. For purposes of further analysis below, I use the average of male and female preferences and consider this average to reflect the couple's preference. In addition, in countries with a female but not a male survey, the average DSRB is estimated by assuming that the male–female gap equals 18; these countries are indicated by an asterisk in the figures.

Figure 1 presents estimates of the desired sex ratio in the 29 countries in which the ratio exceeds 110 (i.e., about half the countries are not included because they have lower ratios). The countries are ordered from highest to lowest DSRB. The strongest son preferences are observed in countries with ratios exceeding 120: Mauritania, Pakistan, Senegal, Guinea, Nepal, Azerbaijan, Jordan, Mali, Armenia, Niger, India, and Chad. As expected, several of these countries are Asian, but it is somewhat surprising to see six African countries with such high DSRBs.[7]

India's DHS surveys have large sample sizes, which allow estimation of desired sex ratios for states (IIPS 1995, 2000, 2007). Figure 1 includes state-specific DSRBs derived from the 2005–06 survey.[8] The highest ratios are observed in Bihar, Madhya Pradesh, Uttar Pradesh, and Rajasthan, which have among the lowest levels of development and the highest levels of fertility among states in India (Guilmoto and Irudayarajan 2001).

Figure 1 also presents corresponding estimates of the actual sex ratio at birth for each country. Before commenting on these findings two brief methodological issues should be noted. First, the SRB estimates for countries are taken from UN (2011) because DHS estimates of sex ratios contain significant sampling errors. For example, with a true sex ratio of 106, the 95 percent confidence interval is 100.0–112.0 if based on a sample of 5,000 births, and 101.8–110.2 if based on a sample of 10,000 births (Arnold, Kishor, and Roy 2002). Most DHS country surveys and all Indian states have fewer than 10,000 births in the five years before the survey, and caution must be used to interpret results because it is difficult to distinguish between a small real difference in the sex ratio and random error. This problem is avoided by relying on UN estimates. Second, sex ratios for 1995–2000 are plotted rather than more recent values in order to make them more comparable in time with the

FIGURE 1 Desired and observed sex ratios at birth in 29 DHS countries and states of India



NOTE: Countries with DSRB <110 are excluded. For explanation of asterisks see text.
SOURCES: DHS files; United Nations 2011.

estimates of desired sex ratio at births calculated from responses of respondents under age 35 in the most recent survey. These responses are supposed to refer to the time before the respondents' first birth, but are probably affected to some extent by subsequent events.[9] For the same reason, the sex ratios of Indian states are taken from the 1998–99 National Family Health Survey.

The most important finding from Figure 1 is that the desired sex ratio exceeds the observed sex ratio by a wide margin in all countries. The likely explanation for this gap is that the means to identify the sex of a fetus and safe abortion services are not available to many couples; and even when these are available, couples do not want to rely on abortion for moral, religious, or other reasons. The gap varies from country to country presumably because access to sex-selection technology varies. In addition, it is plausible that the strength with which son preferences are held differs among countries.

The desired sex ratio for all of India exceeds the actual sex ratio by 15, but this gap varies widely by state. The gap is largest (>20) in Bihar, Madhya Pradesh, Uttar Pradesh, Rajasthan, and Chhattisgarh. Presumably access to sex-selective abortion technology has been very limited in these states and their fertility is still relatively high. The finding that in Delhi the estimated SRB is higher than stated preferences is surprising and is probably due to sampling errors in the SRB and DSRB (only 1,400 births occurred to survey respondents in the five years before the survey). It is also possible that the desired sex ratio is understated in response to government campaigns to reduce sex-selective abortions.

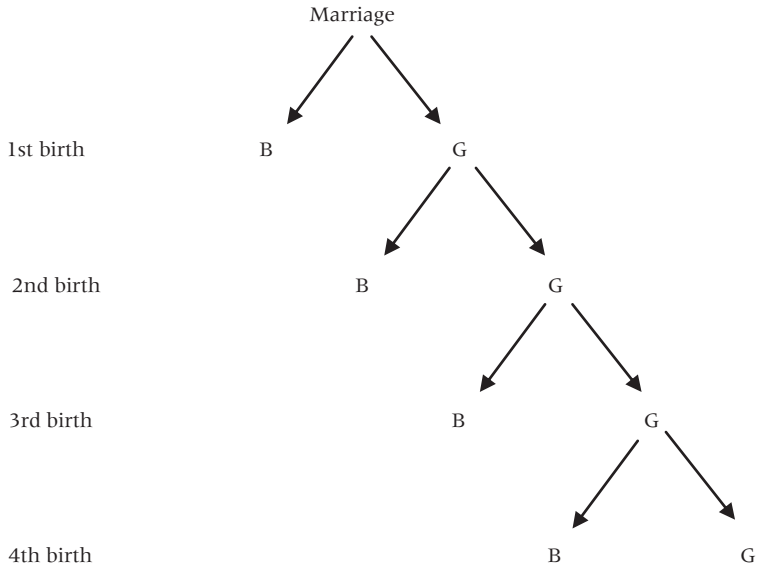
Implementation of son preferences

Couples who prefer male over female births can implement their reproductive preferences by relying on sex-selective abortion and/or contraception.[10] Contraception alone cannot influence the sex ratio of births in a family or in a population but, as shown below, it provides parents some control over the sex composition of their offspring.

Contraception

Couples can vary contraceptive use depending on the number of sons and daughters already born. Research has shown that in countries with a son preference, the proportion of women using contraception is higher after the birth of sons than after the birth of daughters (Arnold 1997; Retherford and Roy 2003). While contraception cannot change the sex ratio of all births in a population, it can ensure that a family has at least the number of sons desired while minimizing the total number of children the couple must bear to achieve its son preference.

FIGURE 2 Hypothetical childbearing pattern of a couple who want one son (B = boy,G = girl)

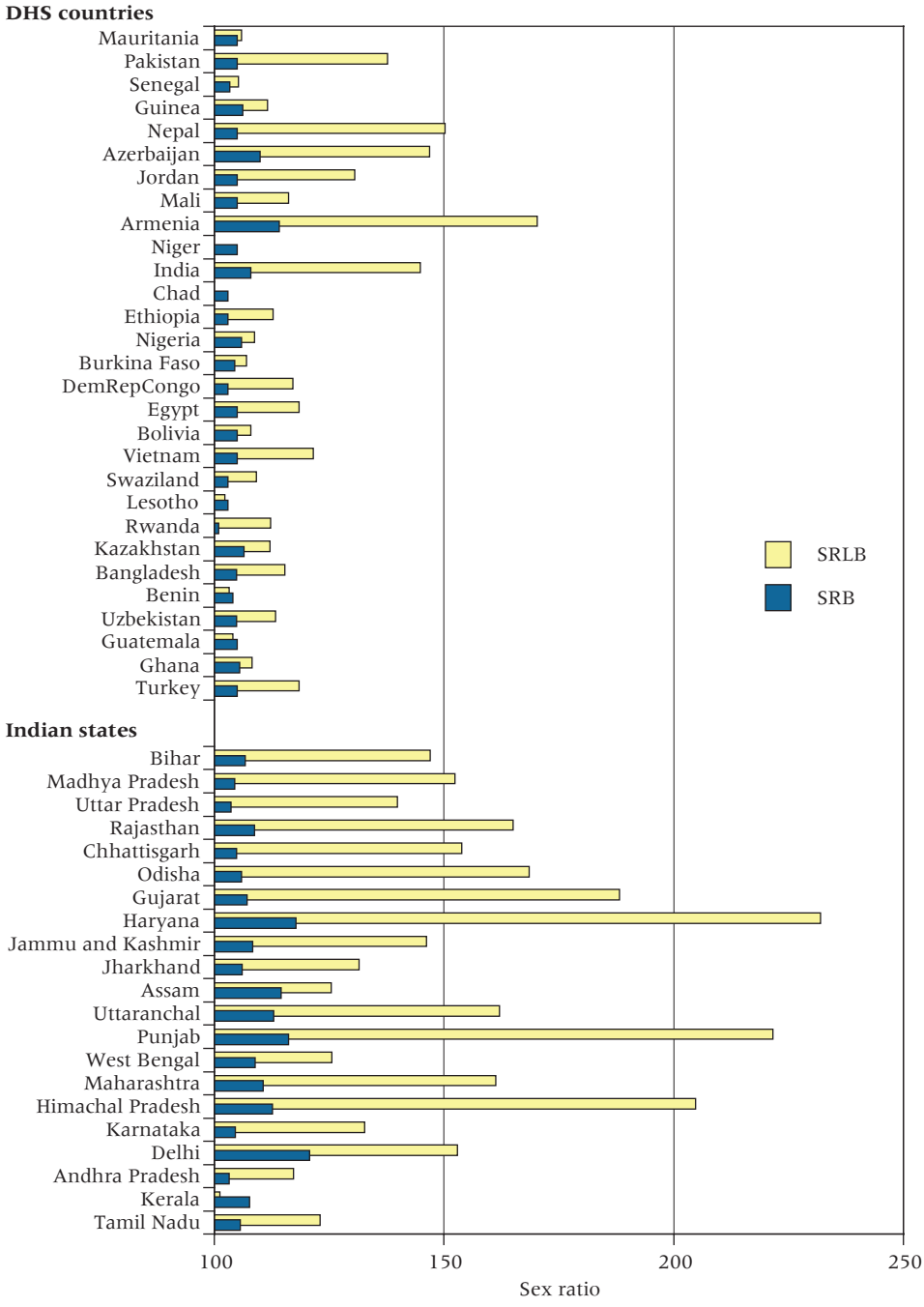


To illustrate, I examine the reproductive outcomes for couples who want exactly one son. Figure 2 presents the range of outcomes in such a hypothetical population. Immediately following marriage, no contraception is used and the couple has either a boy (B) or girl (G) (for simplicity infecundity and multiple births are ignored). The couples who have a boy end childbearing (by using effective contraception) because they have achieved their goal. But couples who have a girl as a first child continue to have a second child. The second child can again be a boy or a girl, and couples who now have two girls continue childbearing (i.e., avoid using contraception) until a son is born. In a population in which this particular childbearing pattern prevails, couples would have exactly one son (or, in rare cases, no sons) but can have any number of daughters.

In this hypothetical population the sex ratio of all births is normal and the sex ratio does not vary by birth order because no intervention is made during pregnancies. However, progression to the next birth depends on the sex composition of preceding births. Interestingly, as childbearing continues, the proportion of last births that are boys approaches one, because families stop after having a boy. As a result the sex ratio at last birth (SRLB) approaches infinity in this illustration. This finding makes the sex ratio of the last birth a very sensitive indicator of sex-selective stopping behavior.[11]

Figure 3 presents the sex ratio of last births, measured as the sex ratio of the most recent birth among women who want no more children at the time of the survey.[12] The countries included are the same as those in Figure 1

FIGURE 3 Sex ratios for all births (SRB) and last births (SRLB) in 29 DHS countries and states of India



NOTE: Countries with DSRB <110 are excluded. SRLB <100 in Chad and Niger.
SOURCE: DHS files; United Nations 2011.

and are ordered in the same way from high to low DSRB. Highest SRLBs are found in Armenia, Azerbaijan, India, Jordan, Pakistan, and Nepal, which also have high DSRBs. Surprisingly, some countries have high desired sex ratios but only a slightly elevated sex ratio at last birth (e.g., Mauritania, Senegal, Guinea). A plausible explanation is the low level of contraceptive use in these countries. To obtain an elevated sex ratio at last birth, couples must have a preference for sons *and* use contraception to implement stopping behavior.

Most states in India have high SRLBs; the main exception is Kerala, which also has a low DSRB. In 11 states sex ratios of the last birth exceed 150, and in Punjab, Haryana, and Himachal Pradesh this ratio even exceeds 200. These findings are consistent with the strong son preferences and high levels of contraceptive use found in these states.

Sex-selective abortion

An elevated sex ratio at birth in a population is an unambiguous indication that couples are relying on sex-selective abortion. For every missing girl birth there is an abortion of a female fetus.[13] Worldwide there are therefore about 1.4 million such abortions (see Table 1). Since an estimated 44 million abortions occur each year (Sedgh et al. 2012), sex-selective abortions represent around 3 percent of this total.

The results for son preferences and their implementation suggest that populations can be loosely categorized into four groups according to their son preference and level and type of implementation (sex ratios below 108 are considered normal):

1) Little or no son preference, i.e., normal SRB, SRLB, DSRB (e.g., much of Latin America, Kerala).

2) Son preference but little or no implementation, i.e., normal SRB and SRLB, high DSRB (e.g., Mauritania, Senegal).

3) Son preference and contraceptive stopping behavior, but little or no sex-selective abortion, i.e., normal SRB, high DSRB, high SRLB (e.g., Nepal, Bihar, Madhya Pradesh, Uttar Pradesh).

4) Son preference, stopping behavior, and significant use of sex-selective abortion, i.e., high SRB, high DSRB, high SRLB (e.g., Armenia, Azerbaijan, India, Haryana, Punjab).

It is important to emphasize that sex ratios at birth are only elevated in the last group.

Differentials and trends

The empirical evidence summarized in the preceding sections shows very wide variation in son preferences and their implementation among and within

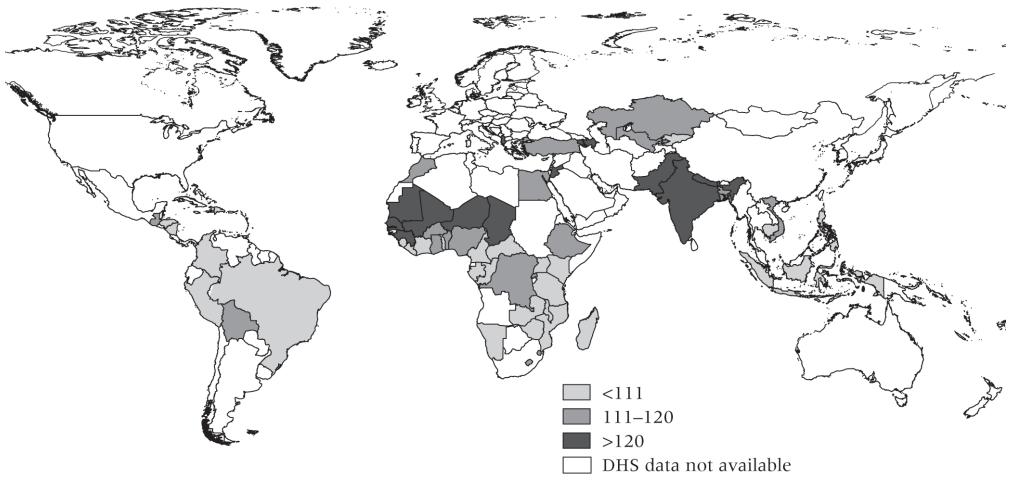
countries. Although a full analysis of the social, economic, and demographic determinants of this variation is beyond the scope of this study, a few factors affecting actual and/or desired sex ratios are particularly noteworthy.

Geographic patterns

Son preferences show clear regional patterns around the globe (see Figure 4). Research on elevated sex ratios often focuses on Asian countries, which account for nearly all missing girls. But the map demonstrates that son preferences are also elevated in Northern and Western Africa and in parts of Central Africa (at least in the countries for which data are available). These African countries still have near normal sex ratios, but the potential for increases in the future must be recognized.

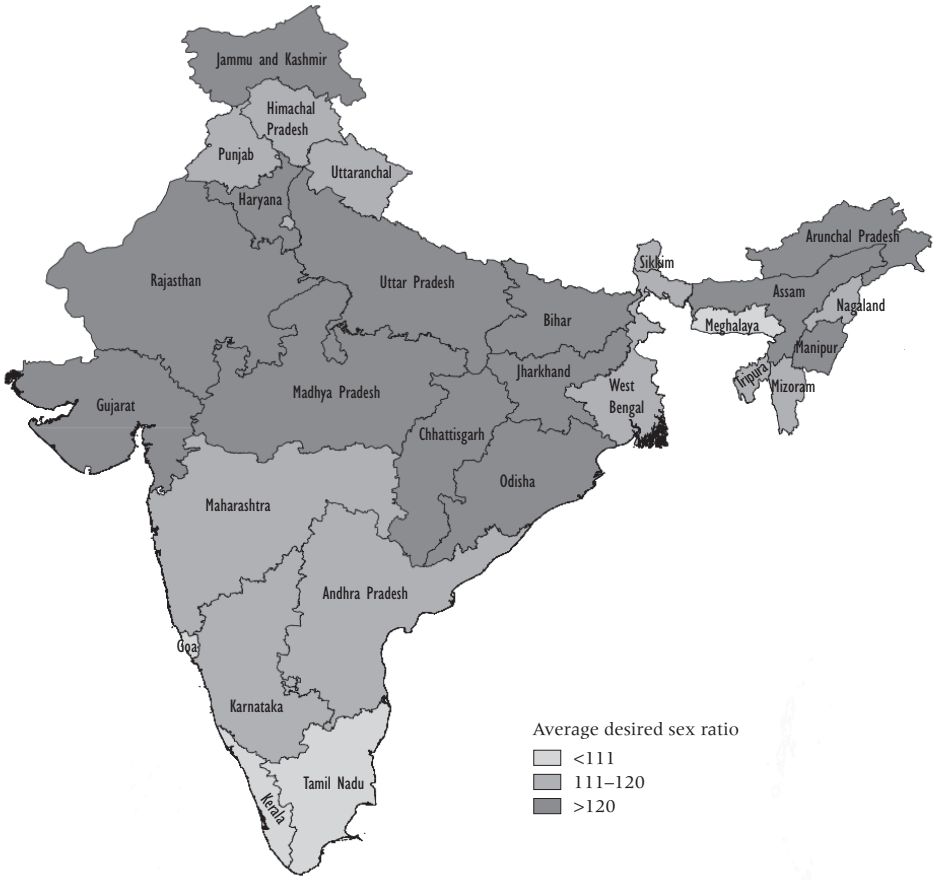
Variations in son preferences among Indian states are also patterned by region, with a clear north/south divide (Figure 5). High DSRBs are found in Bihar, Madhya Pradesh, Uttar Pradesh, Rajasthan, Odisha, Gujarat, Haryana, Jammu and Kashmir, Jharkhand, and Assam, while Kerala and Tamil Nadu have the lowest. Other demographic factors show a broadly similar pattern, as documented by Dyson and Moore (1983): "the main states of India can be broadly grouped into two basic demographic regimes. In contrast to the north, states in the south and east are characterized by the following: relatively low overall fertility; lower marital fertility; later age at first marriage; lower infant and child mortality; comparatively low ratios of female to male infant and child mortality, and, largely as a consequence, relatively low sex ratios" (p. 42). As noted, in several states with high son preferences the actual sex ratio is still low.

FIGURE 4 Desired sex ratio at birth for DHS countries



SOURCE: DHS files. (See Appendix for countries and survey years.)

FIGURE 5 Desired sex ratio at birth for Indian states 2005–06



SOURCE: DHS files.

Fertility transitions

The developing countries examined here differ widely in the progress they have made through the demographic transition. At one end of the spectrum are early transitional countries, mostly in West and Central Africa, that are characterized by low education and income levels as well as high birth and death rates. At the other end of the spectrum are late transitional countries such as Brazil and Turkey with relatively high education and income levels as well as low fertility and mortality.

It is plausible to assume that son preferences and their implementation vary by stage of the transition. To test this hypothesis Figures 6, 7, and 8 plot the three indicators—DSRB, SRLB, and SRB—by the level of fertility as measured by the total fertility rate (using the same data as in Figures 1 and 3). The figures include only countries with elevated son preferences (i.e.,

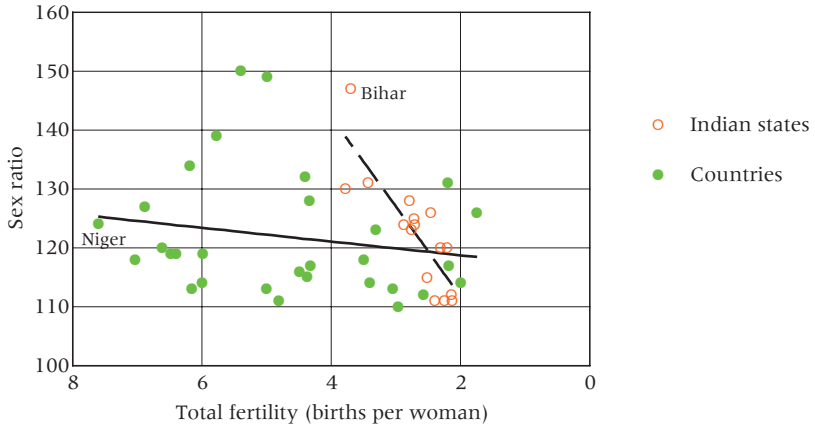
DSRB>110), because levels and trends in sex ratios are near normal, hence of little interest, in countries without son preferences.

Figure 6 plots the desired sex ratio at birth by the TFR. The solid markers represent country observations (with a solid line fitted to them), and the open markers represent states of India (with a dashed line fitted). The majority of countries have ratios between 110 and 120, but there are two mid-transitional countries (Mauritania and Senegal) and one Indian state (Bihar) with values near 150. There is only a weak negative correlation between desired sex ratio and the TFR among countries, but this correlation is much stronger among Indian states. This suggests declines in son preferences at the end of the fertility transition.

Figure 7 shows the sex ratios at last birth in the same format as Figure 6. The SRLBs are clearly higher in late than in early transitional countries. This association is the result of higher levels of contraceptive use and access in late transition countries (in fact, a rise in contraceptive use is the main reason for the decline in the TFR over the course of the transition). The Indian states have higher SRLBs than the countries at a given level of fertility. This difference is due to fact that India has stronger son preferences than most other countries included here at the same level of fertility.[14] A "fertility squeeze" (discussed below) that appears at the end of the transition also plays a key role in raising sex ratios at last birth.

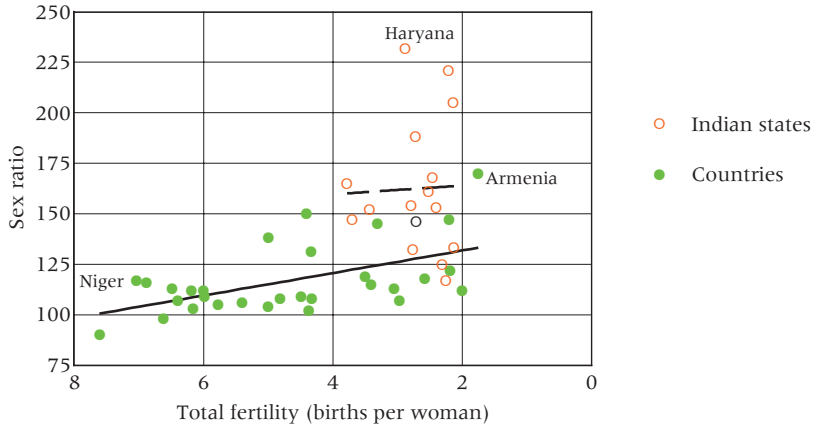
Figure 8 provides a similar plot for the actual sex ratio, which is the outcome of multiple forces (son preferences, fertility squeeze, and the supply of sex-selection technology). During most of the transition SRBs are near normal, despite elevated son preferences, indicating an absence of preference imple-

FIGURE 6 Desired sex ratio at birth by total fertility rate



NOTE: Countries with DSRB < 110 are excluded.
SOURCE: DHS files; United Nations 2011.

FIGURE 7 Sex ratio at last birth by total fertility rate

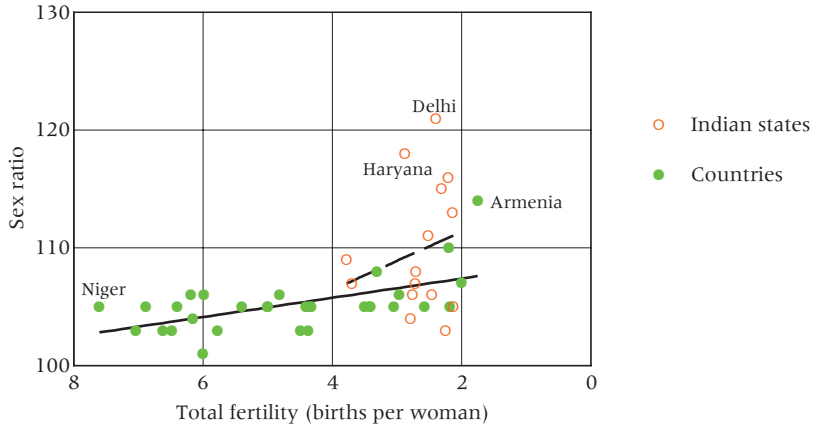


NOTE: Countries with DSRB < 110 are excluded.
SOURCE: DHS files; United Nations 2011.

mentation. Elevated sex ratios are largely confined to populations near the end of the transition. Among these populations with fertility near the replacement level, the range of sex ratios is wide: from 103 to 121 among Indian states and from 105 to 114 among countries. This variation is partly due to differences in preferences and to differences in access to sex-selection technology.

In sum, as countries with son preferences approach the mid stages of their fertility transition, their sex ratios at last birth rise as contraceptive use makes stopping behavior possible, and very late in the transition the sex ra-

FIGURE 8 Sex ratio at birth by total fertility rate



NOTE: Countries with DSRB < 110 are excluded.
SOURCE: DHS files; United Nations 2011.

tio at birth also rises if sex-selection technology is accessible. In contrast, the desired sex ratio tends to be lower in late than in early transition countries.

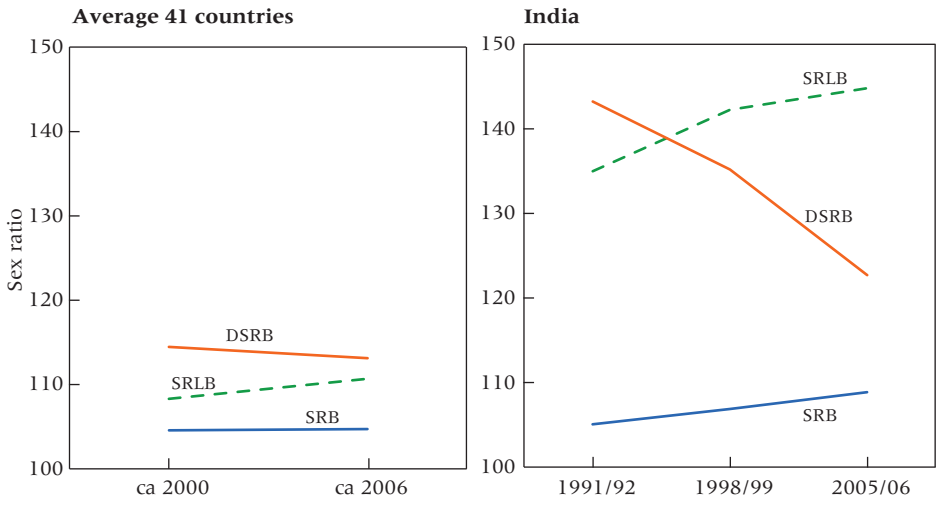
Trends

The preceding discussion focused on cross-sectional differences between populations in observed and desired sex ratios at birth and in the sex ratio of all versus last births. I turn now to trends in these indicators. Specifically I examine changes between the two most recent DHS surveys in the 41 countries with at least two surveys. Countries with only one DHS survey are by necessity excluded from this trend analysis. On average the last survey was conducted in 2006 and the next-to-last in 2000. For India three surveys (1991–92, 1998–99, and 2005–06) are available, providing a longer time series.[15]

Figure 9 plots unweighted average trends in the SRB, DSRB, and SRLB for 41 countries. Most countries experienced little or no change in the sex ratio at birth, but the average desired sex ratio declined slightly, while the ratio at last birth rose.

For India all three indicators are much higher than the country averages. The sex ratio at birth rose from 106 in 1991 to 109 in 2005 according to the DHS estimates. The ratio at last birth rose even more from 135 to 145. In contrast the desired ratio declined sharply from 143 to 123. The SRB and the SRLB may rise even though the desired ratio declines because couples are increasingly able to implement their preferences (Bhat and Zavier 2003). The downward trend in the desired sex ratio at birth for all India is observed in each of the states. The sharpest decline occurred in Uttar Pradesh and the

FIGURE 9 Trends in average DSRB, SRB, and SRLB



SOURCE: DHS files.

smallest in West Bengal. These trends may in part be a response to the campaign by the Indian government to reduce son preferences and to discourage sex-selective abortion. In addition, India has experienced rapid development and levels of education have risen sharply, leading to a decline in traditional patriarchal values.

Long-range transition patterns

The observed differences in sex ratios among populations are caused by differences in three factors that have been identified in the literature and are discussed in detail by Guilmoto (2009, 2012a). He describes the following preconditions for sex ratios to be elevated: access to sex-selection technology; preference for sons and moral acceptance of sex selection; and low fertility, which produces a fertility squeeze. All three of these conditions are typically found in populations with high sex ratios, and the absence of any one usually leaves the sex ratio normal.

These insights can now be used to interpret levels and trends in the SRB, SRLB, and DSRB observed in the preceding section and to develop a clearer picture of the transition in son preferences and its implementation over time. Because estimates of indicators are available for only a limited number of years, long-range trends are unclear. Nevertheless, it is possible to suggest broad trends and the forces underlying them across the fertility transition.

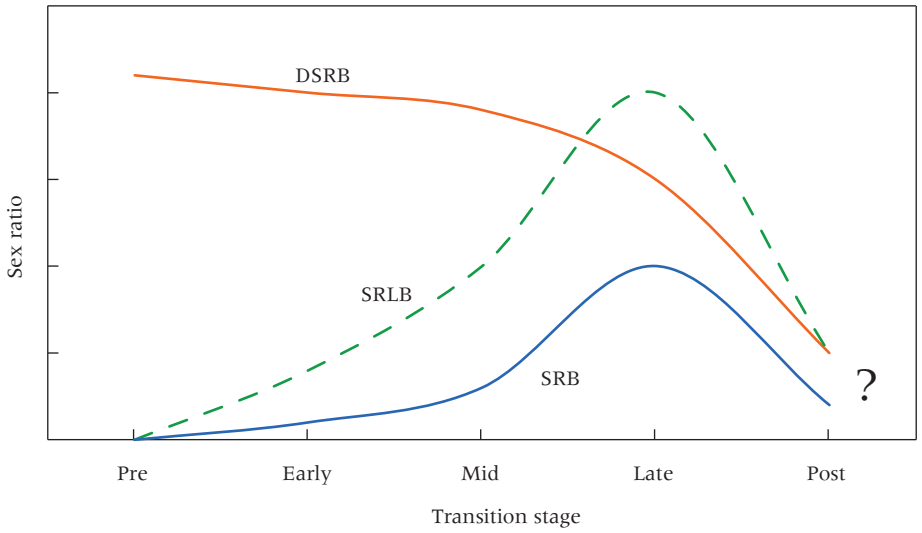
Figure 10 plots hypothetical long-range trajectories in the three indicators (SRB, DSRB, and SRLB) over the full course of a transition:

Pre or early transition. Fertility is high and contraception and abortion are rarely used. Son preferences, if they exist, have deep and long-standing historical and cultural roots that tend to be stable over time. Son preferences vary widely among populations, ranging from very strong to nonexistent, and in a few countries couples even prefer daughters. The focus in Figure 10 is on populations with substantial son preference, because in its absence there is of course no implementation. While sex ratios at birth are normal at this stage of the transition, son preferences can be implemented through postnatal practices that discriminate against girls.

Mid-transition. Son preferences are stable or may have declined slightly (apparently, increases are rare), but access to contraception has increased. Many couples with son preferences begin implementing sex-specific stopping behavior. As a result, the sex ratio at last birth rises. In fact, in Figure 7 all mid-transitional countries with son preferences have elevated sex ratios at last birth. Access to abortion is often limited, hence the sex ratio is usually normal or near normal.

Late and end transition. Son preferences are typically on a downward trajectory, but the desired sex ratio is almost always much higher than the

FIGURE 10 Model transition patterns for sex ratios over the course of the transition in son preference



SOURCE: Author's estimates.

actual sex ratio. Most couples use contraception to limit fertility and practice at least some stopping behavior. In countries where abortion is available, the sex ratio at birth rises to close the gap between desired and actual ratios. The fertility squeeze is at its maximum.

Post transition. Evidence is very thin for this stage, but it is plausible to assume that in the long run the sex ratio declines in populations in which it has been elevated. The trajectories of indicators at this stage depend on several offsetting factors, as discussed next.

Implications for the future

The United Nations makes projections of the sex ratio at birth to 2100 for all countries (United Nations 2011). In countries where the SRB is not elevated in 2010, these projections hold the ratio at its current level, but in countries with high SRBs a decline over time is assumed. This assumption is consistent with analyses of Guilmoto (2009) and Das Gupta, Chung, and Li (2009), which point to a leveling off and actual declines that have already occurred in several populations. In particular, the SRB in Korea rose to high levels before returning to near normal. However, even if the UN projections are correct in the long run, it is not clear what trends will be seen in the short run. As noted by Guilmoto (2009), "A rising SRB in several parts of Asia is a distinct possibility in the next decade" (p. 541).

Making projections of the SRB for countries or regions is complicated by the lack of a sufficient historical record to determine likely future trajectories and the lack of a widely tested and accepted theory for predicting trends. As the following sections reveal, multiple factors can raise or lower the future SRB in a particular population (Guilmoto 2009, 2012a).

Factors that raise the sex ratio at birth

Wider availability of technology. Sex-selective abortion requires two separate technologies: determination of the sex of the fetus and a method for abortion. Parents often learn about the sex of the fetus through amniocentesis, a widely used procedure that is invasive and is usually conducted between 15 and 20 weeks of pregnancy. Its main medical justification is the determination of fetal abnormalities. Ultrasonography can determine the sex as early as 11 weeks and is highly accurate by 13 weeks of gestation. Alternative tests are available to parents who simply want to know the sex of the fetus. For example, a simple blood test can determine the sex from an analysis of fetal DNA circulating in the mother's bloodstream (Devaney et al. 2011). This test is minimally invasive (requiring just a drop of blood), can be done at home, and is 95 percent effective at 7 weeks. Urine-based tests are also available but of uncertain reliability.

Several abortion methods are available. Surgical abortions are still the most common, but are relatively expensive because they require trained personnel and medical backup facilities. In recent years pharmaceutical drugs to induce abortion have become available and their use is spreading rapidly. Mifepristone (in combination with a prostaglandin) is the most expensive and most effective, but is at present not legally available in many countries. Prostaglandins alone are less effective, but are widely available in the developing world and are inexpensive. Medical abortion is a relatively convenient form of abortion but is limited to the early weeks of pregnancy, so its use for sex selection is limited.

These technologies are rapidly evolving and becoming more easily accessible and affordable even to the poorest couples.

High desired sex ratios. As shown in Figure 1 the desired sex ratio exceeds the actual ratio in many populations. In these cases the sex ratios will likely rise if and when existing obstacles to the use of sex-selective abortion are removed.

Fertility decline. The fertility decline that occurs during the demographic transition has implications for parents who have a preference for a particular sex composition of offspring. In particular, as fertility reaches the replacement level it becomes more difficult for parents to attain both their low desired family size and their desired sex composition without resorting to sex selection. This process is referred to as the "fertility squeeze" (Guilmoto 2009). For example,

suppose couples want at least one son. The proportion of couples who will have one son without sex selection will be 51 percent in a one-child family, 76 percent in a two-child family, and 88 percent in a three-child family (ignoring mortality). These probabilities can be raised with sex selection. In a one-child family, ensuring that this only child is a son implies the use of sex selection by 49 percent of couples at the first pregnancy, and repeat sex selections for 24 percent and 12 percent at the second and third pregnancy respectively. In a two-child family, ensuring at least one son and assuming no selection at the first pregnancy requires 24 percent of couples to use sex selection at the second pregnancy, 12 percent at the third, and so on. As fertility drops, couples who want to have at least one son must increasingly rely on sex selection.

Factors that reduce the sex ratio at birth

Rising gender equality. Over time, as countries approach high levels of development, modernization, and urbanization, the value of sons and daughters to parents tends to become more equal (Chung and Das Gupta 2007; World Bank 2012). This change comes about through several mechanisms: higher education and labor force participation make women valuable income earners, and modern urban societies bring about the decline of traditional and patriarchal institutions. In addition, women are increasingly able to exert political influence and to advocate for laws that favor gender equality in all domains of life. In many countries these trends are actively promoted by governments through laws, regulations, and policies that emphasize gender equality (Das Gupta et al. 2004; Guilmoto 2012a). For example, several states in India have introduced financial incentives to discourage son preference among parents and encourage investment in daughters' education and health (Sinha and Yoong 2009).

The rapid spread of radio and television throughout the developing world has also contributed to important social changes. These modern media expose viewers to new information about the outside world and other ways of life, which can bring about changes in attitudes and behaviors. For example, Jensen and Oster (2009, p. 1057) conclude that the introduction of cable television has had a positive impact on women's status in rural India through "significant decreases in the reported acceptability of domestic violence toward women and son preference, as well as increases in women's autonomy and decreases in fertility." More generally, changes in norms and values can occur through the rapid diffusion through societies of new ideas about gender, reproductive behavior, and other economic and social issues (Casterline 2001; Chung and Das Gupta 2007; Rogers 2003).

These social and economic transformations lead to a decline in son preference in the long run. This conclusion is supported by the fact that in nearly all DHS countries and in states of India, the desired sex ratio at birth

has either remained constant or has declined between the two most recent surveys. In a separate study of trends in son preference in Korea, Chung and Das Gupta (2007) found that the proportion of women reporting "must have a son" declined from nearly 50 percent in 1985 to less than 20 percent in 2003.

Further support for the argument that modern societies would not readily accept high sex ratios comes from Singapore and Taiwan. These largely Chinese populations presumably had strong son preferences in the past but now have sex ratios that are only slightly above normal (108) despite easy access to sex-selective abortion. However, Hong Kong still has a sex ratio of 116, presumably because of its social, economic, and cultural links to China. It is therefore possible for sex ratios to remain elevated in some highly developed societies.

Laws banning prenatal sex selection. Several countries have taken action to reduce high sex ratios at birth by outlawing sex-selective abortion. China prohibited sex-selective abortion in the late 1980s and incorporated this prohibition in the Family Planning Law in 2005. But the one-child policy produced a severe fertility squeeze that was a key cause of the rise in the sex ratio. India's government responded in 1994 by passing the Pre-Conception and Pre-Natal Diagnostics Techniques Act, which prohibits health care providers who perform prenatal tests from revealing the sex of the fetus (Retherford and Roy 2003). In South Korea a ban on sex selection was put into effect in 1987.

The impact of these government interventions and their associated media campaigns has been debated and is sometimes considered small because sex ratios often continue to rise after their initiation. It is of course possible that the interventions have slowed the rise in sex ratios. This seems to have been the case in much of India until recently (Nandi and Deolalikar 2011). However, Guilmoto (2012b) documents recent substantial declines in SRBs in Northwest India and hypothesizes that regional policies have contributed to them. A decline in the sex ratio at birth is also well documented in Korea. This decline is apparently not attributable to direct government action but rather to social and economic development (very much encouraged by the government) that eroded traditional son preference, accelerated by the diffusion of new social norms (Chung and Das Gupta 2007).

Laws limiting access to abortion. Abortion laws in countries around the world range from outright prohibition (with no exceptions to save a woman's life) to without restriction (but with gestational limits) (Singh et al. 2009). Laws are generally much more restrictive in the developing than in the developed world; 47 percent of women in the developing world live under highly restrictive abortion laws. But this estimate is strongly affected by India and China, which permit abortion on broad grounds. Excluding these two large countries, 86 percent of women in the rest of the developing world live in countries with highly restrictive abortion laws. These laws are major obstacles

to couples who want to practice sex-selective abortion. Some governments are considering restrictions on access to abortion for this reason, but such a step risks an increase in the use of unsafe abortion, with obvious health consequences, among women who want to end a pregnancy for other reasons.

Adverse consequences from skewed sex ratios. Countries where sex ratios have been high for some time (e.g., China and Korea) are now experiencing significant adverse consequences (Ganatra 2008; Guilmoto 2010, 2012a, b; Hudson and den Boer 2004). Males of marriageable age are finding few potential partners, and, as a result, a substantial proportion of males may face a future without wives and children. The large population of single men may contribute to crime and political unrest. Undesirable consequences for women include an increase in the likelihood of coerced marriages or bride abduction, trafficking of women and girls, and violence against women and girls.

Conclusion

This review of the empirical evidence on son preference and its implementation leads to several broad conclusions. First, son preference is more widespread than is commonly acknowledged. In particular, a number of countries in North, West, and Central Africa have substantially elevated desired sex ratios. The actual sex ratios in Africa are still near normal, but the potential for increases clearly exists.

Second, the desired sex ratio exceeds the observed ratio, often by a large margin, in all countries and in most of the Indian states with elevated son preferences. This implies the potential for future increases in sex ratios if and when the medical, technical, ethical, social, and economic obstacles that now prevent sex selection are removed and if nothing is done to raise gender equality. There is a large pent-up demand for sex selection. Among countries with son preferences, the potential for a future rise in the still near-normal SRB is larger in the Middle East than in Africa because fertility is lower in the former.

Third, the future course of the sex ratio depends on the balance of multiple forces that can raise or lower it. The ratio could well continue to rise in countries and states where the facilitating factors dominate the inhibiting factors—for example, countries like India and states within India with a large gap between desired and actual sex ratios, together with rapidly changing access to technology and a growing fertility squeeze. In fact, the number of sex-selective abortions in India would grow several-fold if the actual sex ratio were to rise to the level desired in 2005. Fortunately, other factors operate to reduce the sex ratio. Son preferences are declining in many countries, the result of rapidly developing and modernizing economies and governments'

efforts to encourage gender equality. In addition, a variety of laws and regulations make access to technology and especially abortion difficult in many countries.

Finally, specific policies to prohibit the use of sex-selection technology appear to have only a modest effect. They should be supplemented by broader policies aimed at encouraging gender equality in all spheres of life through legal and regulatory reforms, incentives, and media campaigns (Guilmoto 2012a; WHO 2011). Such policies are desirable in their own right and are essential to reducing the practice of sex-selective abortion. Research on the effects of different policies is still in its early stages and should be encouraged to provide a firmer base for policymaking.

Appendix

List of countries and year of latest DHS survey

Armenia 2005, Azerbaijan 2006, Bangladesh 2007, Benin 2006, Bolivia 2008, Brazil 1996, Burkina Faso 2003, Cambodia 2010, Cameroon 2004, Central African Republic 1994–95, Chad 2004, Colombia 2010, Congo 2005, Côte d'Ivoire 1998–99, Dem. Rep. Congo 2007, Dominican Republic 2007, Egypt 2008, Ethiopia 2011, Gabon 2000, Ghana 2008, Guatemala 1998–99, Guinea 2005, Haiti 2005–06, Honduras 2005–06, India 2005–06, Indonesia 2007, Jordan 2009, Kazakhstan 1999, Kenya 2008–09, Kyrgyzstan 1997, Lesotho 2009, Liberia 2006, Madagascar 2008–09, Malawi 2010, Maldives 2009, Mali 2006, Mauritania 2000–01, Morocco 2003, Mozambique 2003, Namibia 2006–07, Nepal 2006, Nicaragua 2001, Niger 2006, Nigeria 2008, Pakistan 2006–07, Peru 2003, Philippines 2008, Rwanda 2010, São Tomé and Principe 2008–09, Senegal 2005, Sierra Leone 2008, Swaziland 2006–07, Tanzania 2010, Timor-Leste 2009–10, Togo 1998, Turkey 2003, Uganda 2006, Uzbekistan 1996, Vietnam 2002, Zambia 2007, Zimbabwe 2010

Notes

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1 Populations probably differ slightly in their natural levels of SRB, but these differences are difficult to measure and are not considered here.

2 For example, underreporting of female births is fairly widespread in China and is attributed to the one-child policy. There is no evidence that such a bias is important in other countries.

3 See Attané and Guilmoto 2007b for a critical discussion of this method.

4 Estimates of missing girls in India based on the 2011 census are significantly higher than reported in Table 1 (Jha et al. 2011).

5 Elevated sex ratios are also found in diasporic sub-populations in countries with near normal overall ratios (e.g., Indians in the UK).

6 Respondents who give no sex preference (e.g., "up to God") are assumed to want equal numbers of boys and girls.

7 The reasons for elevated desired sex ratios may vary among populations. In some it may represent a desire for a particular

number of sons, with parents becoming indifferent about children's sex once this objective is achieved. In other populations parents prefer boys over girls regardless of the current composition of their offspring. It is also possible that preferences for male offspring as measured in the DHS have different meanings or are held more or less strongly in different continents. In the absence of solid evidence on these issues, they are not taken into account here.

8 Goa and seven small northeastern states are excluded from the figures because of small sample sizes.

9 The DHS seeks to measure preferences at the time childbearing began, which is years in the past for most women. In reality it is likely that responses are affected by preferences at the time of the survey.

10 Pre-conception methods are not considered because they are of doubtful effectiveness (e.g., timing of intercourse, diet) or expensive and rarely used (e.g., sperm sorting, IVF).

11 The SRLB is not a pure indicator of demand for sons because it depends not only on preferences but also on access to contraception and the level of fertility. The issue of the fertility squeeze is discussed further below.

12 To keep this indicator reasonably contemporary, it is based on births in the ten years before the survey.

13 In reality, the number of sex-selective abortions slightly exceeds the number of missing girls, in part because in a small proportion of cases a pregnancy would have ended in a spontaneous abortion or stillbirth. No correction is made for this, and the estimates of number of abortions are therefore somewhat conservative.

14 It is not clear where China would be located in this figure, because estimates of the SRLB are lacking.

15 A number of other countries also have three DHS surveys. Because of space constraints, only trends between the last two surveys are examined here.

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