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Christophe Z. Guilmoto*

Economic, Social and Spatial Dimensions of India's Excess Child Masculinity

The Indian subcontinent is a region characterized by a large diversity of populations, languages, cultures and faiths. Based on structure of castes whose practices and attitudes are changing, the Indian population is adopting new demographic behaviours whose diffusion and extent can be analysed spatially. In this article, Christophe Z. Guilmoto *proposes a spatialized analysis of the recent aggravation of the gender imbalance in the child population, using data from the 2001 census for the 591 districts in India. This approach takes account of the spatial diffusion of behaviour, identifies more clearly the specific effects of the social and economic factors at work and proposes possible interpretations of the phenomenon.*

The demographic masculinization of India's child population has taken place during the last twenty years and is part of a transformation of the Asian population that is also illustrated by changes recorded in China[1]. This unprecedented demographic development in India coincides with a gradual reversal in sex-specific mortality differentials among children and adults: female life expectancy is rapidly increasing above male levels after traditionally being lower[2]. Consequently, although the sex ratio[3] for the population as a whole has remained largely steady since 1971, at between 107 and 108 men for 100 women, this stability conceals a regular rise in the young male surplus, from fewer than 98 boys per 100 girls among children under 5 before 1941 to over 107 today (Figure 1). In the last twenty years, as the use of sex-selective abortion has spread, this rise has been particularly steep, with the child sex ratio rising from

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Translated by Roger Depledge.

(1) For an overview, see Croll (2000). For recent demographic analyses, see Attané and Guilmoto (2007).

(2) For an initial historical summary of the sex ratio imbalance, see Bhat (2002).

(3) We use the term "sex ratio" as it is understood internationally, i.e. the number of boys per 100 girls. Indian usage is the reverse, and measures the number of girls per 1,000 boys.

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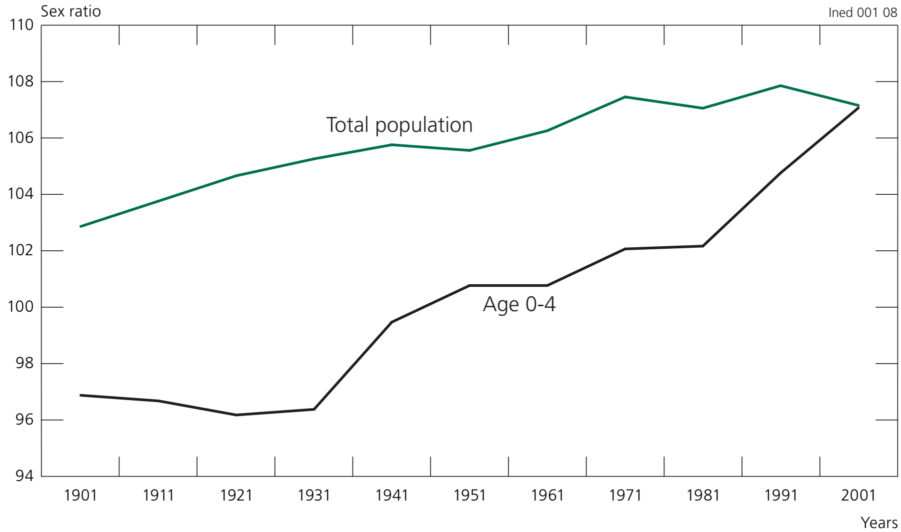
Figure 1. Sex ratio in India, 1901-2001



Source: Population censuses.

102 to 108 between 1981 and 2001. But there are sharp geographical differences between those Indian regions where the rise in surplus males has been considerable and others where the effects have been apparently minimal.

The concomitant fall in fertility in India is a reminder that the rise in the sex ratio is due to the contemporary redefinition of gender relations within the Indian family structure. Its characteristics differ from the historic forms of discrimination against girls, most apparent in the colonial period, in their intensity, their geography and the means employed. Apart from statistical recognition of the phenomenon, there have been few convincing interpretations of this rapid rise in surplus males in India. Observers first linked it to lower fertility, but this explanation has been abandoned, largely because there is no general correlation between low-fertility regions and those where the sex ratio is increasing. Another approach involved finding an association with some of the factors already related to lower fertility, such as the importance of patriarchal systems, economic growth or improved education (Das Gupta and Bhat, 1997; Drèze and Murthi, 2001; Arokiasamy, 2004). The generalization of dowries and the recent inflation in their value have also been put forward as explanatory factors, but major surveys do not collect any data on this practice and the origin of its contemporary spread across the castes and communities of India remains unexplained[(4)].

No strong explanatory relationship has emerged from the study of pre-2001 data. This paper uses the most recent census data to examine three analytical

(4) For a recent economic analysis of dowries, see Dalmia and Lawrence (2005), who highlight regional differences and the influence of the social status of the husband's family.

frameworks commonly used to account for the recent rise in the child sex ratio in India: the economic, social and spatial determinants of the rise in the child sex ratio. For reasons of simplicity and space, this analysis proposes a synchronous (or cross-sectional) model that ignores the chronological dimension of the spread of discrimination since Independence. However, the analysis does directly address the question of the factors associated with contemporary discrimination, by examining a varied panel of social, economic and cultural determinants. This article aims, in particular, to revive the question of geographical determinants, often relegated in analyses to the rank of the idiosyncratic or anecdotal, and consequently considered to be of little use for understanding discriminatory mechanisms. It directly explores the geographical dimension in order to understand this social change and employs instruments as yet relatively unused in the social sciences, based on the methods of spatial econometrics. By allowing for the possible spatial autocorrelation of the error terms, it is possible to improve the quality of the model and correct the erroneous specifications, in particular by calculating the coefficients that link the independent variable and these potential correlates. Because of the highly spatialized nature of the demographic phenomena usually studied (migration, mortality, reproductive behaviour, etc.), the potential contribution of these methods to demographic analysis is considerable, and this analysis will provide an example of their application(5). It will lead on to an examination of the nature of spatial dependency: is it a bias to be corrected or rather an autonomous dimension of demographic mechanisms?

The article begins with a brief presentation of the data available for the study of sex discrimination among children in India. It then analyses the results of an "ecological" model based on aggregate data from some 590 districts. The standard statistical model is then enriched by introducing a spatial autocorrelation variable to reveal the weight of the residual geographical factor. The discussion section summarizes the main original results of the analysis and proposes possible interpretations, particularly for understanding the mechanisms of social change at work in contemporary Indian society.

I. Heterogeneity of sex discrimination in India

1. Measuring discrimination

There are no major statistical irregularities or known distortions of the sex ratio at birth for biological reasons in South Asian population groups. Analysis of variations in the sex ratio therefore involves examining the

(5) For a recent presentation of the contribution of spatial analysis, see the overview by Voss et al. (2006) and Goodchild and Janelle (2003). For an early illustration of the application of geostatistics to demographic change, see Bocquet-Appel (1993).

intermediate socio-demographic factors responsible for these variations[(6)]. They are based on three relatively distinct mechanisms: sex-selective abortion, sex-selective infanticide and sex-specific excess mortality. Other potential mechanisms, such as sex selection before birth (sexing of embryos) may be ignored here, since they have not been described nor their existence conclusively demonstrated in India.

Assessing the relative importance of the three main factors in the rising surplus of boys is, however, a difficult task. In the absence of any systematic records, abortion is poorly understood and can only be assessed by retrospective surveys that tend to underestimate its frequency[(7)]. Selective abortion following detection of the sex of the embryo, which has been illegal since 1994, cannot be directly measured and only indirect, potentially unreliable methods give some isolated evaluations of its frequency[(8)]. Sex ratio at birth, the first indisputable evidence of prenatal manipulation, is only imperfectly recorded, since birth registration statistics are seriously defective in India[(9)]. Estimates of births by back-projection from the number of children recorded in the 1991 census have made it possible to evaluate the sex ratio at birth by district, but these calculations in themselves are closely based on indirect estimates of child and infant mortality and differences in mortality between the sexes, which are fairly unreliable[(10)]. The occasional estimates of major surveys such as the NFHS (National Family Health Surveys) and the SRS (Sample Registration System) provide an alternative data source. They are not, however, statistically beyond reproach and cannot be used for detailed disaggregation by sub-population[(11)]. Post-natal mortality, calculated from the same samples, is hardly known in any greater detail. Note that these sources cannot be used to identify crimes such as infanticide, which are recorded as stillbirths or as early neonatal mortality.

This brief overview shows that the contribution of various discriminatory mechanisms to the shortfall of girls is still impossible to evaluate systematically. Furthermore, the geographical scale is particularly unsatisfactory, generally giving rise to a single figure per State, although some of these States contain

(6) Note, however, Oster's (2005) attempt, using partial data, to explain the high sex ratio observed in Asia by the effect of the hepatitis B virus. This supposed biological causality, highly controversial (Das Gupta, 2006), appears to be of negligible influence compared with the specifically sociocultural dimensions of gender imbalance.

(7) See Ganatra (2000) and the journal *Seminar* (Abortion, 2003).

(8) Ultrasound scanning, a precondition for selective abortion, has been studied using data from the NFHS (National Family Health Surveys), throwing some indirect light on couples' behaviour (Bhat and Zavier, 2007).

(9) The quality of birth and death registration (theoretically compulsory) is notoriously poor in India: the 2000 MICS survey estimated the proportion of children under 5 whose birth had not been registered at 30% (MICS, 2000).

(10) See Sudha and Rajan (2003).

(11) See, for example, the instability of the annual NFHS-3 data (2007b, p. 235). See also Griffiths et al. (2000) and Retherford and Roy (2003) on the NFHS estimates.

populations of over 50 million[(12)]. For this purpose, the derived census measurement of child sex ratio is particularly valuable: it is the only sex ratio calculated for children (in this case, those under 7) available at the finest administrative level. These calculations are also more reliable than those in the sources mentioned earlier, which are based on samples or indirect estimates. Taking the district level, which is used here, the average population of children under 7 was 267,000 in 2001 and the purely statistical variations in sex ratio are negligible. Likewise, age reporting errors – which vary slightly by sex, as shown by the higher number of girls at rounded ages – probably have only a modest effect on differences between districts for the 0-6 age group.

The value of the child sex ratio reflects the combined effect of the various methods used to reduce the proportion of girls in the population, so it will not be possible to isolate the proportions attributable to each of the components mentioned here. On the other hand, this method complements the partial, and sometimes ambiguous, results obtained by earlier analyses of the 1981 and 1991 data, which concerned only one of the two dimensions of discrimination: selective abortion or excess mortality among female infants[(13)].

2. Sex ratio differences between social groups and regions

Analyses of the increasing sex ratio in India tend to give a uniform image of the country and to interpret the skewed sex ratio as a general phenomenon related to major trends in the economy or to social change. These approaches may not only overlook the social and geographical variations in the phenomena under study, but also fail to provide the conceptual instruments required to understand the patterns behind these demographic changes. In India, as in China, there are considerable disparities between social groups and regions, and these disparities reflect processes that are engendering new forms of prenatal discrimination. The existing variations identify the groups that are pioneers in these new sex discrimination practices and help to explain how behavioural innovations have spread throughout the local, regional or even national population.

The main dimensions observed in this diversity of discriminatory behaviour will be reviewed by examining the sex ratio of children under 7 in 2001. This is only possible when numbers of children by sex are available, which is not the case for individual socioeconomic markers (such as parents' educational level, living standards, etc.). It is necessary therefore to use regression techniques to study the effect of these characteristics. However, some unusual data on the

(12) In 2001, India was divided into 35 States and Union Territories, themselves divided into 593 districts.

(13) See Bhat and Zavier, 2003; Retherford and Roy, 2003; Clark, 2000; Murthi et al., 1995; and Kishor, 1993.

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Table 1. Child sex ratio (0-6 years) in selected Indian sub-populations, 2001

Sub-population	Sex ratio	Percentage of Indian population
Urban population	110.3	27.8
State		
Punjab	125.3	2.2
Haryana	122.1	1.9
Delhi	115.2	1.4
Gujarat	113.2	5.0
West Bengal	104.2	8.2
Kerala	104.1	3.5
Andhra Pradesh	104.1	8.8
Assam	103.6	2.5
Jharkhand	103.6	2.5
Chhattisgarh	102.6	2.1
Religious and other communities		
Sikhs	127.3	1.9
Jains	115.0	0.4
Hindus	108.2	80.5
Muslims	105.3	13.4
Christians	103.7	2.3
Dalits	106.6	16.2
Tribes	102.8	8.2
Total India	107.8	100.0

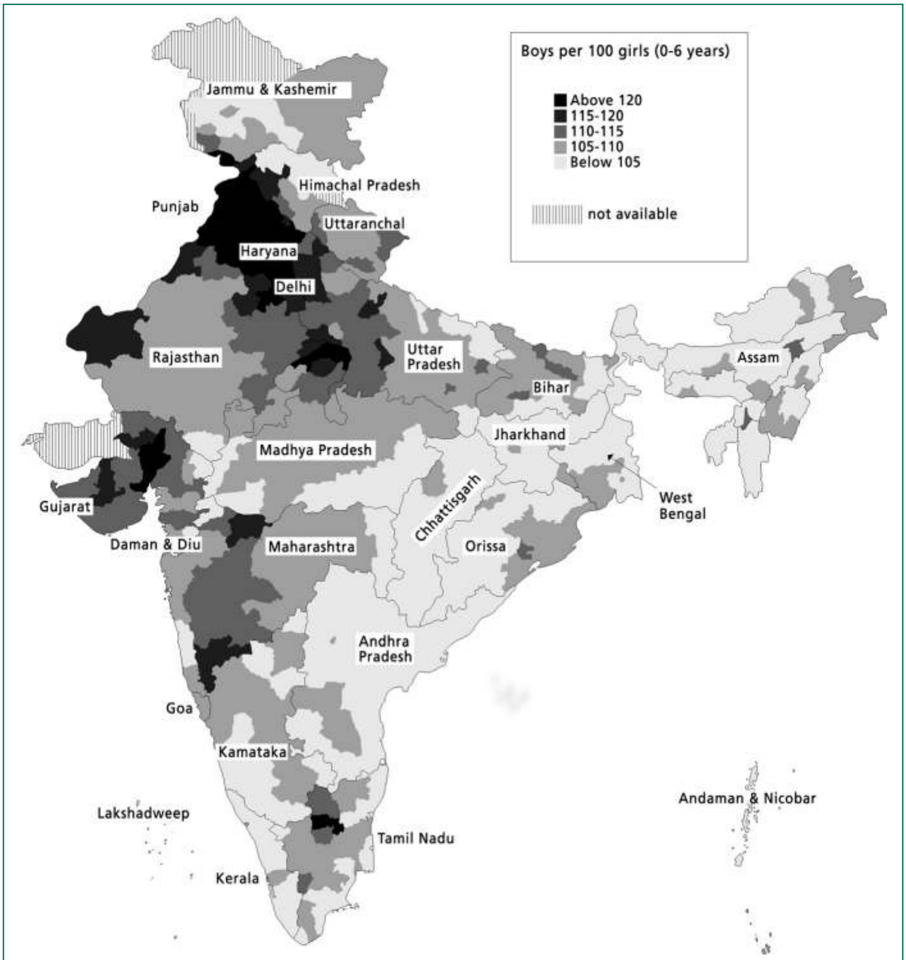
Source: 2001 Census.

breakdown by age and religious group taken from the census were published in 2004. We also have a data breakdown for rural as opposed to urban areas, for example, and also at the level of districts or smaller units.

The urban population accounts for just over one-quarter of the Indian total. In geographical terms, the sex ratio is higher among children under 7 living in urban areas: 110.3 compared with 107.8 for India as a whole (Table 1). But regional figures reveal even sharper differences between the north-western regions (Punjab, Haryana, etc.) and those in the south or east, such as West Bengal and Andhra Pradesh. The least skewed ratio is recorded in Chhattisgarh, a landlocked hilly and forested State with a large tribal population. Map 1 provides a more precise image of the regional variations, because one-quarter of the Indian population lives in regions where the sex ratio is above 115, corresponding approximately to a 10% deficit of girls.

The religious breakdown reveals the special position of the Sikhs, who have the highest sex ratio: 127.3 boys per 100 girls. The Jains, much fewer in number, also have a large surplus of males. Conversely, among Christians and Muslims, the ratio is closer to normal values, noticeably less skewed than the

Map 1. Child sex ratio (0-6 years) by district, India, 2001



Source: Population Census.

national average. The sex ratio is lowest among tribal groups (102.8 boys per 100 girls) and is only slightly below the Indian average among Dalits (also known as untouchables, Harijan or scheduled castes).

3. Mapping and geostatistics of geographical variations

Regional averages by State conceal differences within regions. For instance, the sex ratio of Madhya Pradesh is lower than the national average, but two of its districts record values higher than 120 boys per 100 girls. Map 1 shows the distribution of sex ratios by district, a finer level of analysis. In 2001, 148 districts recorded sex ratios for the under-7s greater than 110. Of these, 39 are remarkable for extreme values above the 120 threshold. Conversely, 12 districts, usually with a tribal majority, have more girls than boys under 7, which may also be seen as unusual[14].

While the map reveals sharp regional differences, it also shows a clear geographical patterning in the distribution of values. A number of “hot spots” may be seen where the male surplus peaks. The first is centred on a contiguous area made up of Punjab and Haryana and overlapping with all their bordering States to the south, the east and, to a lesser extent, the north. A second regional hot spot is located in Gujarat around the capital Ahmadabad, extending south towards Maharashtra. The location of these two hot spots of surplus males corresponds to the spatial concentration of female infanticide in colonial India, extensively attested by the earliest censuses and documentary material[15].

However, the 2001 map shows that central Gujarat contrasts with a surrounding cluster of districts where the child sex ratio is less skewed, on the borders with Gujarat, Rajasthan and Madhya Pradesh. This is a region with a rural, predominantly tribal population (Bhil ethnic group) which, like other tribal parts of India, has a sex ratio close to normal. The two surplus male hot spots are joined in a long block of States or parts of States that covers most of the north-west. This region stretching from Bihar to Jammu and to south Maharashtra corresponds to the greater part of Hindi-speaking India, but also includes contiguous regions that speak Gujarati, Marathi and Punjabi. In the rest of the country, there are hardly any zones of surplus boys. However, a few smaller pockets can be identified, such as in coastal Orissa and north-western Tamil Nadu. The case of Salem district in Tamil Nadu is noteworthy both by its highly skewed sex ratio, in excess of 120, and by its relative geographical isolation in southern India.

The map also reveals the relatively regular distribution of the sex ratio across the country, with no sharp divisions between regions. This regularity can be measured by calculating the degree of spatial autocorrelation of the sex ratio values, on a principle similar to that of autocorrelation in time series[16]. Spatial autocorrelation represents the tendency of neighbouring observations to display similar values. Its intensity is calculated with Moran’s *I*, which is equivalent to the measure of correlation between two variables applied in this case to a single variable (child sex ratio sr_i for district *i*). This index indicates the ratio of covariance between *n* pairs of neighbouring observations *i* and *j*, namely the average product of deviations from the mean ($\overline{sr}$), to the total variance of the sample (σ^2) containing *m* observations:

(14) This situation may be due to sex ratio imbalance at birth or particularly high excess mortality among boys.

(15) In 1861, the province of Punjab was already distinguished by an overall sex ratio of 119, compared with 105 for colonial India as a whole (Plowden, 188, p. 51). Concerning Punjab and Gujarat during the British period, see, for example, Clark (1983) and Oldenburg (2002).

(16) These geostatistical measurements are described, for example, in Baily and Gatrell (1995) and Haining (2003).

$$I = \frac{\sum_{i,j}(sr_i - \overline{sr}) \times (sr_j - \overline{sr})}{n} \times \frac{1}{\sigma^2}$$

Where neighbouring districts (in this case adjacent ones) have dissimilar values, the covariance is low and Moran's *I* is close to zero. Conversely, where neighbouring districts display similar values, Moran's *I* tends to approach or exceed 1, since the covariance increasingly resembles the mean sample variance.

Moran's *I* was calculated for adjacent districts (with a common border), using the method from Anselin et al. (2006) with row standardization for consistency with the calculations made below. This method makes it possible later to run spatial regressions. The value obtained, 0.785, is very high, higher than that obtained for all the other indices used in this study (except for the proportion of Sikhs)[(17)]. This result confirms the high degree of geographical clustering illustrated by Map 1. An alternative, more detailed calculation based on the correlogram (Moran's *I* against various distance intervals) not presented here, shows that this spatial autocorrelation remains very high for child sex ratio for distances greater than 300 km between districts. This means that spatial autocorrelation does not merely affect immediately adjacent districts but also all those that are geographically close, to an extent that is strictly inverse to distance.

II. Modelling the child sex ratio

The discriminating dimensions presented above are entangled, which leads to conclusions that are still ambiguous. Initial hypotheses suggest that the sex ratio is more skewed in the north, among advantaged urban groups and certain castes and religions, but it is important to rank the effect of these factors: does Punjab have such a high rate of surplus males because it contains Sikhs or because it is urban and prosperous? Conversely, is it relative under-development or tribal population that explains the low sex ratios in parts of central India?

1. Statistical model of regional variations

The census figures, based on exhaustive enumeration, prove highly robust and can be used to make a detailed regional breakdown. Their main limitation is the nature of the variables available and the effect of aggregation itself. Here figures come from the 591 districts surveyed in the 2001 census. The analysis

(17) See for comparison the autocorrelation of other indices, such as the fertility estimates in Guilmoto and Rajan (2001).

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starts with a standard linear regression model. The variables used cover a deliberately wide range of social and economic dimensions: demographic indicators (population density, fertility, infant mortality), socioeconomic indicators (urbanization, literacy, and male-female literacy ratio, employment rate, proportion of labour force in agriculture, irrigation, comfort index) and religious and social composition (religion, Dalits, tribal groups). These variables are presented in the Appendix Table, with a brief statistical description. Note that only a few variables do not come from the census: distance (computed from Amritsar to the district centre), fertility and mortality estimates (Guilmoto and Rajan, 2001) and the district indicator of irrigation (CMIE, 2000). Some variables were not used because of systematic lack of statistical significance (employment rate, proportion of non-agricultural labour force, other religions) or a risk of colinearity.

The most innovative variable used here to account for sex ratio variations is the household comfort indicator constructed from census data. Data on housing quality and household possessions have been published recently (CensusInfo, 2005). The set of nearly 100 indicators was subjected to factor analysis for this study. First, 23 variables were extracted that represent various dimensions of household well-being, including dwelling construction materials (roof, walls, floor), home fittings (electricity, toilet, bathroom, kitchen, etc.), household amenities (vehicle, telephone, television, banking services, etc.)[18]. Second, we made a principal components factorial analysis, using the 23 variables for each district. The first axis has an eigenvalue of 10.5, which accounts for 45% of total variance. This measurement was adopted as an indicator of household comfort, because it sums up the original 23 indicators in a single variable. It turns out to be particularly robust with respect to regional variations because of its factorial construction, and consequently provides an invaluable indicator for India, in the absence of any measurement of income or living standards available at district level. In my opinion, it is the best existing indicator for evaluating differences in household socioeconomic status at this level.

To achieve comparability, the various variables were first entered separately into the linear models. A distinction was made between demographic (Model A), socioeconomic (Model B) and social composition variables (Model C). They were brought together in a synthesis model (Model D). To simplify analysis, only variables that were significant at the 10% level at least once were retained in the table representing the various models. The results are given in Table 2.

Model A demonstrates the absence of strong links between the regional demographic profile and the child sex ratio, except for the link with population density. The sex ratio of children under 7, in particular, is not systematically

(18) The 23 variables were obtained after eliminating characteristics that are redundant, rare or unrelated to general living standards.

Table 2. Results of linear regression models for child sex ratio (0-6 years) with no spatial dimension, Indian districts in 2001

Variable	Model A (Demographic)			Model B (Socioeconomic)			Model C (Social composition)			Model D (Synthesis)		
	Coeff.	*t*	Prob.	Coeff.	*t*	Prob.	Coeff.	*t*	Prob.	Coeff.	*t*	Prob.
Population density (log)	0.012	5.95	0.000							– 0.003	– 1.33	0.183
Fertility rate	– 0.001	– 0.40	0.691							0.012	4.22	0.000
Child survival	0.037	0.39	0.698							– 0.168	– 2.26	0.024
Percentage urban				– 0.710	– 3.51	0.000				– 0.078	– 4.93	0.000
Literacy rate				0.001	1.68	0.094				0.001	1.89	0.059
M/F literacy ratio				0.207	1.42	0.155				0.004	0.33	0.740
M/F economic activity ratio				– 0.000	– 0.24	0.808				0.003	1.93	0.054
Share of workforce in agriculture				0.114	5.58	0.000				0.042	2.64	0.009
Gross irrigation				0.000	5.60	0.000						
Comfort index				0.188	12.96	0.000				0.014	12.28	0.000
Proportion of Buddhists							– 0.006	– 0.20	0.841	– 0.052	– 1.95	0.051
Proportion of Christians							0.008	0.60	0.548	– 0.012	– 0.93	0.353
Proportion of Jains							1.746	5.47	0.000	0.873	2.89	0.004
Proportion of Muslims							– 0.055	– 4.17	0.000	– 0.069	– 5.41	0.000
Proportion of Sikhs							0.297	16.17	0.000	0.195	10.13	0.000
Proportion of Dalits							– 0.002	– 0.07	0.943	– 0.029	– 1.05	0.296
Proportion of tribal groups							– 0.078	– 6.72	0.000	– 0.032	– 2.63	0.009
Constant	0.976	10.24	0.000	0.941	20.37	0.000	1.085	157.20	0.000	1.173	13.86	0.000
Number of observations	591			488			591			591		
R^2	0.062			0.507			0.465			0.620		

Notes: Coeff.: coefficient; *t*: Student's *t*; Prob.: proba ($t = 0$).
Sources: see Appendix for definition and source of variables.

related to fertility, largely because the lowest fertility districts are divided between the north-west and the south, areas diametrically opposed in terms of child sex ratio. This factor does play, however, a significant role after controlling for the other socioeconomic variables (see below).

Model B demonstrates the low correlation with some of the socioeconomic variables tested, such as literacy and the male and female labour force participation rate. We note a tangible effect of the share of the labour force in agriculture. But it is primarily the composite comfort variable that is most closely correlated with a skewed sex ratio and is the most important factor in the sex ratio variations between districts. This phenomenon has rarely been shown so clearly, probably because of the samples used and the poor reliability of socioeconomic indicators. For example, Clark claims to detect a negative correlation between socioeconomic level and child sex ratio, while Bhat and Zavier (2003) consider that modernization reduces son preference(19). The exemplary analysis by Agnihotri (2003), however, shows the positive correlation between socioeconomic level and sex ratio using an innovative source of data. We now have a highly robust index based on factorial aggregation which clearly shows that discrimination against young girls is (partly) linked to the local development level and the living standards of Indian households. This correlation may be interpreted either as an income effect (access to sex-selection techniques) or as pure demand for discrimination (an increasing need for sex discrimination on the part of prosperous households), a question to which we shall return later. It illustrates the extent to which sex selection using technological innovation represents a dimension of the modernization of behaviour and is not merely a legacy of the past, as is the case for female infanticide (Varma, 2002).

Model C indicates that variables relating to districts' religious and social composition alone account for a large proportion of the geographical variations observed, with a correlation coefficient barely lower than for Model B, which incorporates socioeconomic variables. Sikhs and Jains display highly skewed sex ratios, whereas the presence of Muslims or tribal groups substantially lowers the sex ratio. These results are consistent with the aggregate figures given above in Table 1. The over-representation of boys among Sikhs has been attested in Punjab since 1881 (Plowden, 1883, p.153).

These models were consolidated in a single model, which has the advantage of eliminating a number of artificial correlations and confirming ambiguous links. Model D on the right of Table 2 explains more than 60% of sex ratio differences between districts. In this synthesis model, into which variables such as proportion of Sikhs in the population have been entered, the child sex ratio is positively correlated with fertility and less strongly so with infant mortality. This means that lower fertility could in the long term have the effect

(19) See also the ambiguous results of Murthi et al. (1995) and Retherford and Roy (2003). Amartya Sen mentions this partial anomaly in his most recent book (2005, p. 222), but fails to explain it.

of slightly reducing the child sex ratio[20]. The variables associated with the modernization of regional rural areas play a more ambiguous role. The comfort index remains the main factor and tends to increase the child sex ratio; the same is true to a lesser extent for the literacy rate. It would appear that it is the economically advantaged social strata and regions that act as pioneers on this point: the phenomenon is mainly explained by the level of economic development and household prosperity. But, all other things being equal, urbanization remains, on the contrary, a factor in reducing the child sex ratio. The influence of the proportion of labour force in agriculture is still visible, recalling the fact that one of the traditional foundations of patriarchy is the patrilineal transmission of land in the wealthy rural social strata.

Unlike the results of other univariate analyses (Agnihotri, 2000), the female labour force participation rate does not reduce the sex ratio, which contradicts the longstanding hypothesis of a correlation between female paid work and lower gender discrimination, as proposed by Bardhan (1974).

The influence of these economic and social variables on the child sex ratio far from neutralizes the specific effects of settlement patterns and religious composition, however. The households' community affiliation remains just as crucial in defining gender behaviour as socioeconomic status. This dimension of gender geography in India suggests that structural economic determinants – the effect of free-market development, increasing monetization of trade and their impact on social relations – certainly do not explain everything. If the weakening of the perceived value of girls in Indian demographic thinking were primarily a consequence of economic and social modernization, this mechanism should have operated uniformly across all communities. But the various communities display a highly variable degree of openness or resistance to the penetration of the new discriminatory practices observed in the last twenty years.

2. Limitations of aspatial modelling

There remains a grey area in our modelling that needs to be examined, namely the relatively high degree of variance (38%) that even our best models cannot account for[21]. The limitations of our models are unlikely to come from the nature of the data, which are based on sufficiently large child populations, or from unobserved dimensions. For the study by district we have a battery of variables, and those used reflect most of the social, economic and cultural dimensions one may suppose to be related to a higher sex ratio. It is unlikely that some unsuspected variable accounts for the unexplained variance. On

(20) The interpretation of the positive correlation between fertility and sex ratio remains, however, controversial (Drèze and Murthi, 2001; Das Gupta and Bhat, 1997).

(21) The other models cited above do not obtain any better results, no doubt due to the lack of robust economic indicators.

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Table 3. Results of linear regression models for child sex ratio (0-6 years) with spatial dimension, Indian districts in 2001

Variable	Model E (distance from Amritsar)			Model F (synthesis + distance)			Model D (aspatial synthesis)			Model H (with spatial errors)		
	Coeff.	*t*	Prob.	Coeff.	*t*	Prob.	Coeff.	*t*	Prob.	Coeff.	*t*	Prob.
Population density (log)				– 0.001	– 0.68	0.496	– 0.003	– 1.33	0.183	– 0.002	– 0.73	0.466
Fertility rate				0.004	1.35	0.176	0.012	4.22	0.000	0.003	0.83	0.407
Child survival				0.004	0.05	0.957	– 0.168	– 2.26	0.024	– 0.021	– 0.27	0.783
Percentage urban				– 0.044	– 2.86	0.004	– 0.078	– 4.93	0.000	– 0.037	– 2.54	0.011
Literacy rate				0.000	– 0.01	0.996	0.001	1.89	0.059	0.000	1.54	0.124
M/F literacy ratio				– 0.020	– 1.73	0.083	0.004	0.33	0.740	0.017	1.51	0.131
M/F economic activity ratio				0.003	2.00	0.046	0.003	1.93	0.054	0.004	2.50	0.012
Share of workforce in agriculture				– 0.002	– 0.11	0.914	0.042	2.64	0.009	0.018	1.18	0.236
Gross irrigation				0.006	4.42	0.000	0.014	12.28	0.000	0.007	4.98	0.000
Comfort index				– 0.050	– 2.00	0.045	– 0.052	– 1.95	0.051	– 0.025	– 0.93	0.351
Proportion of Buddhists				0.021	1.60	0.109	– 0.012	– 0.93	0.353	– 0.031	– 2.05	0.041
Proportion of Christians				0.525	1.85	0.065	0.873	2.89	0.004	0.577	1.87	0.061
Proportion of Jains				– 0.090	– 7.43	0.000	– 0.069	– 5.41	0.000	– 0.065	– 4.12	0.000
Proportion of Muslims				0.156	8.48	0.000	0.195	10.13	0.000	0.147	5.94	0.000
Proportion of Sikhs				– 0.064	– 2.46	0.014	– 0.029	– 1.05	0.296	– 0.024	– 0.97	0.331
Proportion of Dalits				– 0.055	– 4.76	0.000	– 0.032	– 2.63	0.009	– 0.018	– 1.58	0.115
Distance from Amritsar	– 0.006	– 19.11	0.000	– 0.004	– 9.41	0.000						
Spatial autocorrelation (λ)										0.799	29.22	0.000
Constant	1.153	262.34	0.000	1.179	14.97	0.000	1.173	13.86	0.000	1.042	12.50	0.000
Number of observations	591			591			591			591		
R^2	0.383			0.671			0.620			0.810		
Maximum likelihood							1095.1			1249.1		

Notes: Coeff.: coefficient; *t*: Student's *t*; Prob.: proba ($t = 0$); linear regressions except Model H (log-likelihood).
Sources: see Appendix for definition and source of variables.

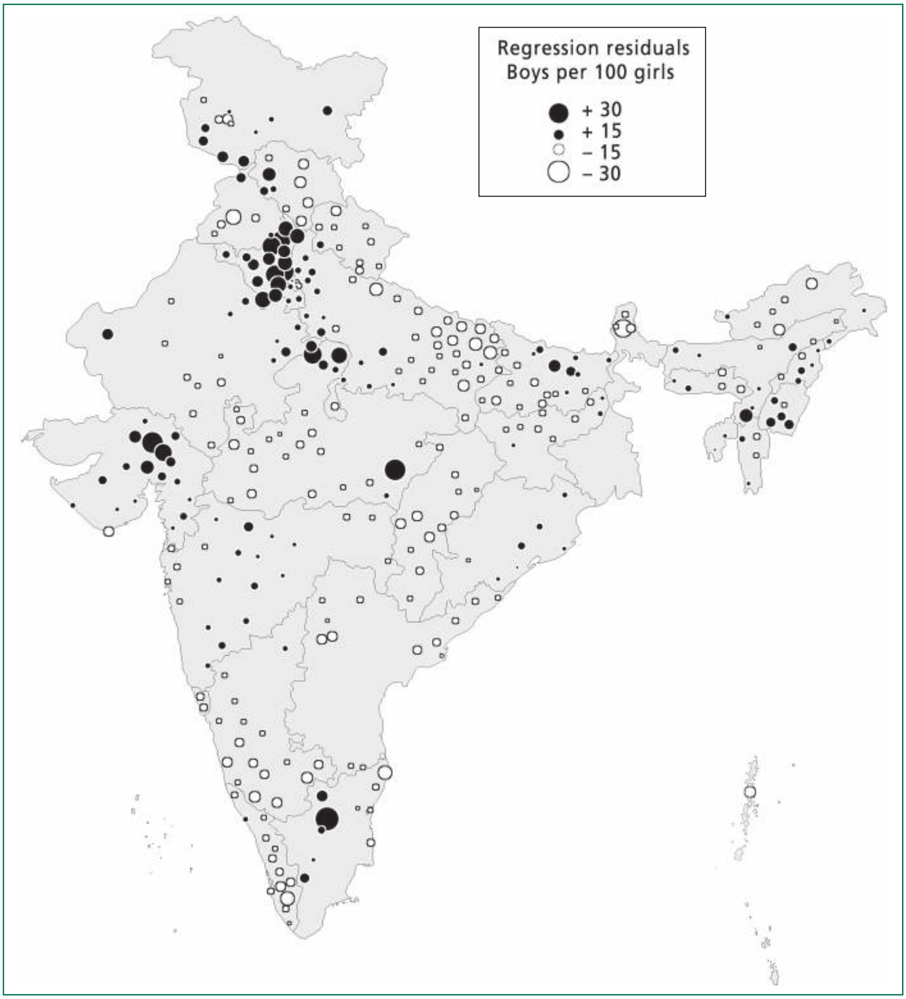
the other hand, the strong spatial dimension of the phenomenon has until now been ignored in our models.

A first, quite elementary approach is to take account of the spatial polarization around the north-west that we observe on the child sex ratio map. To that end, a spatial variable was created measuring the distance of each district from Amritsar, the religious capital of Sikhism located in a western district of Punjab not far from the border with Pakistan. This variable correlates strongly with the child sex ratio; as Model E shows, more than one-third of sex ratio variance is explained by the distance from Amritsar alone (Table 3). In Model F, derived from the synthesis Model D examined above, this distance is added to the other social and economic variables. Distance immediately appears as the model's most powerful variable ($t = -9.41$) and partly neutralizes the specific effect of the composite comfort variable. But distance from Amritsar is a rather approximate indicator of the spatial dimension of the sex ratio. It does not account for the presence of secondary clusters of surplus males in India, as in Gujarat, and ignores the presence of spatial barriers, i.e. regions that offer considerable resistance to a more skewed sex ratio, such as the Himalayan foothills in northern Punjab and Haryana, where the sex ratio has barely risen(22). The spatial patterns shown in Map 1 are more complex than a simple unipolar concentration.

We will explore the spatial dimension more systematically by examining the residuals from aspatial synthesis Model D (reproduced from Table 2). These residuals were calculated for each district, and then plotted on Map 2, omitting the smallest ones. Negative residuals (observed values lower than estimated values) are smaller and dispersed, except in central India and Kerala. Positive residuals (observed values higher than estimated values) are larger and recall certain spatial distortions already observed: they are concentrated in Haryana and Gujarat, and in the Salem district of Tamil Nadu. The limitation of community variables appears clearly: they have an influence in Punjab (where Sikhs are a majority), but create high positive residuals in neighbouring regions such as Haryana and Delhi, where Hindus are much more numerous than Sikhs. Furthermore, the residuals map shows that the geographical nature of the phenomenon remains, particularly for the highest sex ratios. Table 4 shows that the degree of spatial autocorrelation for these residuals remains marked, which indicates a violation of the assumption of homoskedasticity, whereby residual error terms should be linearly independent of each other. Standard tests such as the Breusch-Pagan test can be used to confirm the correlation of the error terms. When applied to an aspatial synthesis model of child sex ratio (Model D), this test reveals the heteroskedasticity of the residuals (Table 4).

(22) For example, the States of Jammu-and-Kashmir, Uttaranchal and Himachal Pradesh, do not seem to have been "contaminated" by neighbouring Punjab.

Map 2. Residuals of Model D (synthesis model) by district, India, 2001



Source: Population Census.

Table 4. Results of tests applied to regression residuals

Index	Phenomenon tested	Model D	Model H
Moran's *I*	Spatial autocorrelation of residuals	0.474***	-0.030^{ns}
Breusch-Pagan test	Heteroskedasticity	41.9***	25.9^{ns}
Note: ***: significant at 1% level; ^{ns}: not significant at 5% level.			

3. Spatial regression

Spatial econometrics and quantitative geography have been concerned with the problem of heteroskedasticity ever since the measurement of spatial autocorrelation became common. Various solutions have been proposed, the simplest of which is to enter dummy variables ("south", "Punjab") to correct regional effects. But these are arbitrary *ad hoc* solutions. They also contribute to imposing a definitive regional explanation ("southern India"), without exhausting the effect of spatial autocorrelation, which exists both within the designated regions and between adjacent regions. One example is the north-west where the geography of the sex ratio is highly structured, both across the adjacent States of Haryana, Punjab, Uttar Pradesh and Rajasthan and within each of them.

Other methods derived from spatial econometrics address heteroskedasticity more directly. They consist of integrating into the equation the spatially autoregressive phenomenon whereby the value of a variable in one locality is partly determined by the value observed near that locality(23). The general form of a spatial econometric model is given in formulas [1] and [2].

$$sr = \theta W_1 sr + X\beta + u \quad [1]$$

$$u = \lambda W_2 u + \varepsilon \quad [2]$$

where sr: child sex ratio

X: vector of independent variables

β: vector of parameters to be estimated

W_1: contiguity matrices (1 for "neighbouring" districts, 0 otherwise)

u: residual

θ and λ: parameters of spatially autoregressive terms

ε: error term centred on 0 with standard deviation σ

A form such as $sr = \theta W_1 sr$ indicates that sex ratio sr is spatially autocorrelated according to a parameter θ and a matrix W_1 determining which are neighbouring localities. The spatially autoregressive mechanism may affect the variable sr itself or the residual u. Consequently, two main forms of spatial regression are deduced in the case of heteroskedasticity. Where $\lambda = 0$ in general equation [2], we are dealing with a spatial lag model. The value of the sex ratio comprises a spatially autoregressive component but the residual has no spatial autocorrelation. But where $\theta = 0$ we obtain a spatial error (or disturbance) model: it is the residual term, which captures the unobserved dimensions, that then behaves in a spatially autoregressive manner. Note that where $\theta = 0$ and $\lambda = 0$, the model is reduced to a standard linear regression of the sort used before (formula [3]).

$$sr = X\beta + \varepsilon \quad [3]$$

(23) Method described in Bailey and Gatrel (1995), Haining (2003) and Anselin et al. (2006), among others. A presentation for demography is now available in Chi and Zhu (2008).

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A system of two simultaneous equations can be derived from each of the two autoregressive models whose solution is calculated by the maximum likelihood method. It is also important that the results of the spatial regression should properly neutralize the heteroskedasticity of the residuals, in order to obtain more robust estimates of the equation parameters. The two models were consequently tested using the variables of the linear equation models, by calculating the proximity matrix for immediately adjacent districts with a common border (order 1 contiguity). In the light of the results obtained for sex ratio, the spatial lag model was abandoned. This model provides no significant gain in terms of maximum likelihood and leads to results still marked by a high degree of heteroskedasticity as measured by the Breusch-Pagan test. We thus dropped the method and focused on the much better results relating to the autoregressive residuals model. The simplified formulation of the spatial error model is as follows:

$$sr = X\beta + u \qquad [4]$$

$$u = \lambda W u + \varepsilon \qquad [5]$$

In this model, contiguity (or proximity) matrix W is used to model residual u autoregressively: a local deviation in unobserved dimensions is therefore a function of adjacent values. This spatial error model is applicable notably where unobserved factors present in the residual error term are spatially autocorrelated (Haining, 2003). In the case in point, this hypothesis suggests, for example, that detailed socioeconomic or cultural indicators missing from our model are strongly spatially correlated and determine the residual variations.

The parameters obtained by the autoregressive model with spatial errors are given in Table 3 (Model H) and may be compared with the corresponding aspatial model (Model D). First, the model's overall correlation coefficient rises sharply from 0.62 to 0.80 when spatial errors are entered. However, in the case of spatial regressions, it is the difference in terms of likelihood that needs to be highlighted: the improvement achieved by Model H over Model D is clearly shown by the corresponding values for maximum likelihood. Second, the observable gain is directly attributable to the autoregressive factor of the spatial error model: parameter λ rises to 0.7999, not far from unity, indicating a maximum correlation level ($t = 29.2$). As Formula [5] indicates, this parameter is the coefficient of the autoregressive effect of proximity on the distribution of residuals of the linear equation. Note also that the residuals in the new Model H are no longer autocorrelated, as shown by the results of the Breusch-Pagan test (Table 4).

It is important to note the effect of spatialization on the estimated value of coefficients in the child sex ratio model, bearing in mind the risk of poor estimation of linear coefficients in the presence of heteroskedasticity (Models A-D): with this improved specification, the values of these coefficients almost systematically drop for all model variables. Hence, a number of indicators closely associated with regional sex ratio variations in the aspatial model (Model D) cease to be significantly associated or their degree of association is greatly reduced: this is true of variables relating to mortality, literacy, proportion of tribal groups and Jains. The variables that best withstand the introduction of the spatial corrective are the proportion of Sikhs and Muslims in the population and the composite comfort index, although the values of their coefficients do fall.

4. Possible approaches for interpreting the spatial dimension

The contribution of spatialization appears to be a relatively major one for modelling child sex ratio variations, taking analysis further than the social and demographic dimensions usually mentioned. Spatial regression has three main effects: it qualifies the overestimated effects of a number of socioeconomic variables, confirms the importance of certain variables for understanding the phenomenon, and reveals a specific effect of spatial diffusion of behaviour. This effect, described in our model, has much more weight than the others. It corresponds to the influence of unobserved variables operating according to regionalized mechanisms: these factors play a considerable part in the distribution of sex ratio variations and display a very high level of spatial autocorrelation. They largely determine the spatial pattern of sex imbalance in India, a pattern that cannot be reduced to the wide range of socioeconomic and cultural factors tested in previous models.

Here we see a mechanism of spatial dependency frequently observed in the dynamics of demographic change in India, as is shown by the study of fertility decline (Guilmoto and Rajan, 2001; Bocquet-Appel et al., 2002). To give it more practical signification, this phenomenon might be called "spatial path dependency" by analogy with the path dependency observed in institutional change. Changes in this sort of phenomenon are largely based on the previous spatial context and follow a pattern of spatial diffusion, whereby changes in a local condition depend on conditions in neighbouring areas. Spatial diffusion, also visible on the maps that compare changes in the child sex ratio from one census to another[(24)], is based on spatial entrainment mechanisms that may be interpreted in various ways according to the perspective of a given discipline, because spatial proximity also means social proximity and a particular intensity of social and economic exchange. These interactions – between individuals, families, social groups and indeed places – evoke such phenomena as epidemic propagation, cascade effects, mimicry or social capillarity, etc. They involve both exchanges of persons and goods and transfers of knowledge and norms. It is not easy to describe the mechanisms at work, even if one may reasonably argue that two dimensions may well predominate: one, on the supply side, is

(24) The spatial progression of the sex ratio in China and India is analysed in Guilmoto and Attané (2007).

the spatial spread of medical infrastructure for sex selection. Another, on the demand side, is families' need for sex discrimination. The first hypothesis, presented in particular by Bhat and Zavier (2003), implies that central, well-equipped areas (transport hubs, conurbations, etc.) practise more sex discrimination than remote areas where clinics are less accessible, which does not seem to be confirmed by the more detailed 2001 maps[25]. It would appear more likely that discrimination first took hold in the historic areas of strong discrimination against girls, the western regions from Gujarat to Punjab, where the female infanticide combated by the colonial authorities was most frequent[26]. It is nonetheless clear that discrimination also spread gradually outwards from these centres to cover a large part of the country.

III. Factors underlying discrimination against girls in India

Gender discrimination, attributed to the persistence of patriarchal systems in India, is sometimes indirectly evaluated by high fertility, the prevalence of joint families, and various indicators of female disadvantage (violence against women, economic marginalization, dowry practices, etc.)[27]. Gender imbalances appear to be partly cultural phenomena that cannot be reduced to economic dimensions. The analysis presented in this paper has indeed shown that some of the factors associated with a highly skewed child sex ratio are closely connected with the social composition of the population: community and religious patterns appear to offer an initial interpretative framework, revealing the sharp differences in discriminatory behaviour according to social or religious affiliation. The hot spots of surplus boys in India correspond to specific population composition patterns. However, it is important to point out the limitations of a strictly sociological or anthropological analysis of community variables, which are based on broad categorization: for example, the "Muslim" variable refers to one of the largest Muslim populations in the world, a diverse mass of 138 million people[28], comprising several hundred communities with different languages, histories and sects. The term "tribal groups" covers an even more varied human reality, since tribal communities mainly live in extreme social and geographical isolation and have little in common other than their administrative status as "scheduled tribes" recorded

(25) It can be seen from the tehsil-level maps (CensusInfo 2005) that major cities (Amritsar, Ludhiana, Chandigarh, Ahmadabad, Pune, etc.) and their immediate suburbs are not necessarily the areas with the most skewed sex ratios. See also the local propagation maps presented by Vella and Oliveau (2005).

(26) See Plowden (1883), Clark (1983) and Oldenburg (2002).

(27) See the analysis by Drèze and Khera (2000) concerning the correlation between homicide and skewed sex ratios in India, which suggests a significant link between son preference and use of violence.

(28) The Muslim population of India is the second largest in the world, after Indonesia.

as such by the government. Even a group like the Sikhs, relatively concentrated in space and sharing a wide Punjabi cultural corpus, turns out to be fairly segmented, comprising both peasant castes like the Jats and marginalized groups of Dalit origin like Mazhabi Sikhs. Without engaging in the now ritual criticism of the census classification system, it would be easy to demonstrate the social heterogeneity of the various communities grouped together within census statistical categories.

It is thus all the more surprising to observe that these questionable criteria of social distinction make sense at the national level, be it for categories of caste or of religion. Alongside the geographical base of sex ratio differences, this confirmation of the crucial role of social composition suggests that further analysis must be based on a more finely-grained sociological disaggregation of the population, in order to come closer to the *jatis* (or sub-castes) that form the sociological texture of Indian society. Where the data refer to small groups, as in the particular case of the Jains (0.4% of the Indian population), they strengthen the model by isolating certain homogeneous features specific to sub-populations. Regional research often makes this point, showing how local dominant castes impose their own system of norms and contribute to the propagation of a new pattern of discrimination, which was long based on female infanticide(29). In the absence of such data on the contours of local castes and communities, we cannot carry our reasoning any further.

It seems most likely that within each community there is a relatively uniform sex ratio, corresponding to a system of values and practices that define the form and extent of sex discrimination (dowry, inheritance, age at marriage and remarriage norms, etc.). But is that a reason for taking caste as the basic unit for examining the unequal distribution of discrimination in India? The answer must once again contain reservations, because an anthropological analysis far from closes the debate. It would be illusory to stop at this level of reasoning and to think that India could be divided into hundreds of community segments, each covering a particular sub-caste or community, and thus provide a definitive demarcation of discriminatory behaviour. After all, if the community framework were the key to understanding the phenomenon, the sex ratio map of India would be a motley mosaic reflecting the contrasts between communities in each region. But, instead of the patchwork seen in eastern China (see, for example, the maps in Lavely and Cai, 2004), India presents a highly coherent geographical pattern. Location remains the first explanatory principle, ahead of community affiliation: the child sex ratio among Muslims in Punjab (115 boys for 100 girls) is, for example, much higher than that among Hindus in Kerala (104), even if, as we have seen, all other things being equal, discrimination is systematically lower among Muslim groups. Since the most uniform groups (mainly *jatis*) are concentrated geographically and no caste is uniformly

(29) For Salem, see Vella (2005). Caste distinctions are described in other local studies, such as George (1998) in Haryana.

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distributed across India, it may be deduced that the regular spatial pattern observed implies that communities must necessarily influence each other at a local level. The results of the spatial regression, by revealing the strongly spatial nature of the unexplained residual, bolster this impression. The impact of the anthropological factor should therefore be placed in perspective and one must recognise that although the unit for appreciating discrimination against girls is probably the community rather than the individual, residential intermingling of different groups and their ongoing interactions play a key role in behavioural homogenization. The cultural atoms that are castes in India, with their own systems of meaning and their distinct social institutions, turn out in fact to be relatively permeable to the local impact of a region's dominant pattern of discrimination.

Geographical distribution and the corresponding settlement patterns are reasons for supposing that the new type of discrimination against girls that has emerged with the advent of new techniques for detecting the sex of unborn children took root immediately in those regions marked by a vigorously patriarchal system. But the economic dimension of the phenomenon, illustrated by the high correlation between child sex ratio and the consolidated comfort index, which contradicts the ambiguous results presented earlier, enables us to extend the analysis. The most receptive groups have been the upper classes in the population, who acted as pioneers for the new technology. This process, to be sure, did not occur uniformly across India, since some regions counted as relatively prosperous by the comfort index have hardly been touched by the rise in the sex ratio. This is true, for example, for Kerala and many cities like Chennai and Kolkata.

Should the link between socioeconomic status and skewed sex ratio be seen as an effect of educational level (better access to information, more planned reproductive behaviour), of financial ability to access medical services, or of upward social mobility (dowry inflation)? Over the last twenty years, selective abortion has become commonplace – despite attempts to stop it, such as the relatively ineffective 1994 law – and the effective "cost" of sex selection has gradually fallen, making it affordable by more people. On the other hand, it may be that demand is expressed differently by various social groups and that the relative cost of girls (compared with boys) has risen sharply in the better-off classes, largely because of dowry inflation and the cost of education. In a system based on hypergamy, whereby women seek to marry men of higher social or economic rank than themselves, the education and marriage of girls may involve considerable expense for the privileged classes, illustrated notably by the value of the dowry to be paid to the husband's family. In that case, socioeconomic status may increase the pressure to have boys, as well as making it easier to afford the necessary medical technology.

Conclusion

This study identifies three types of factor underpinning the rise in child sex ratio in contemporary India: the anthropological structure of population settlement and the historical distribution of groups with patriarchal traditions, the new-found prosperity of the rural and urban middle classes, and the spatial diffusion of norms of discrimination and new behaviour. The ethnic-religious composition of the population has facilitated the rapid introduction of new discriminatory attitudes into certain areas, and also created a glass wall preventing the advance of these new practices into nearly half the country. This resistance of social systems in south and east India explains why discrimination against girls has not spread further, as it has in China, where it affects most areas settled by Han Chinese. But the other components revealed by the study give greater cause for concern about the advance of the phenomenon: the diffusion mechanisms have helped to propagate a new discriminatory system based on sex-selection techniques beyond the pioneer communities and historical hot spots of high sex ratio in India. The 2001 census already revealed new local centres of skewed sex ratios (such as coastal Orissa) that reflect this contagion effect. Demographic innovation is also driven by the higher classes, a fact which encourages the spread of the new behaviours and mentalities to other social classes.

On a broader view, the country's rapid development could help to bolster selective behaviour among the middle classes: they were the first to benefit from the economic boom that followed liberalization in 1991 and their proportion in the national population will continue to grow, with a potentially negative effect on the child sex ratio if the upwardly mobile groups adopt the same discriminatory practices. The sex ratio is likely to rise still further before falling, as has been observed in Taiwan and South Korea, but only year-on-year monitoring, impossible given the inadequacy of the birth registration system, would provide a more finely-grained image of these changes. Future research therefore needs to focus partly on changes in the skewed child sex ratio in a country with incomplete statistical coverage, where measurement difficulties are considerable obstacles to understanding trends. Another relatively unexplored field concerns the effects of these demographic upheavals on the young adults who, upon reaching marriageable age, will be the first to suffer from the consequences of a shortfall in girls in recent cohorts.

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Appendix. Source and description of variables used to measure distance and in regressions

Variable	Number of observations	Unit	Mean	Standard deviation	Min	Max	Source
Population density	591	log (density)	5.79	1.19	0.69	10.29	2001 census
Percentage urban	591	%	24	20	0	100	2001 census
Population growth 1991-2001	591	%	22.5	11.6	– 3.5	95.0	2001 census
Fertility rate 1994-2001	591	children/woman	3.30	1.01	1.33	5.79	Guilmoto and Rajan (2002)
Child survival 1994-2001	591	survival at age 6 (L_{0-6})	0.92	0.03	0.83	1.00	Guilmoto and Rajan (2002)
Literacy rate	591	%	64	13	30	97	2001 census
M/F literacy ratio	591	ratio of literacy rates	1.49	0.29	0.91	2.53	2001 census
M/F economic activity ratio	591	ratio of activity rates	2.32	1.47	0.94	12.30	2001 census
Gross irrigation	488	irrigation index	39.3	27.2	0.24	114.3	CMIE (2000)
Share of workforce in agriculture	591	%	60	21	0	90	2001 census
Living conditions	591	factor score	0	3.23	– 5.03	11.56	Factor analysis (see text)
Proportion of Buddhists	591	%	2	7	0	77	2001 census
Proportion of Christians	591	%	7	19	0	98	2001 census
Proportion of Jains	591	%	0	1	0	5	2001 census
Proportion of Muslims	591	%	12	15	0	98	2001 census
Proportion of Sikhs	591	%	2	11	0	86	2001 census
Proportion of Dalits	591	%	15	9	0	50	2001 census
Proportion of tribal groups	591	%	16	26	0	100	2001 census
Distance from Amritsar	591	terrestrial degrees between district centre (latitude and longitude) and Amritsar	11.92	6.06	0	28.68	Calculation from a geographic information system

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CHRISTOPHE Z. GUILMOTO • INDIA'S EXCESS CHILD MASCULINITY

This article examines the determinants of the current increase in the sex ratio among children in India in the light of regional data from the 2001 census. The marked disparities between districts, as revealed by measuring spatial autocorrelation, are a key to understanding these recent developments. They can be used to assess the relative influence of a large number of social and economic characteristics on inter-regional sex ratio variation. The specific effect of economic prosperity is shown to be clearly correlated with the rising sex ratio. Extended modelling of these regional variations, incorporating the spatial dimension, demonstrates the specific roles played by the sociological composition of the population, economic development and diffusion effects. The conclusion offers an interpretation of these various determinants of high sex ratio in India.

CHRISTOPHE Z. GUILMOTO • L'ÉCONOMIQUE, LE SOCIAL ET LE SPATIAL. LES TROIS DIMENSIONS DE LA SURMASCULINITÉ JUVÉNILE EN INDE

L'article propose d'examiner les déterminants de la hausse contemporaine du rapport de masculinité parmi les enfants en Inde à la lumière des données régionales. Les disparités marquées entre districts indiens, mises en évidence par la mesure de l'autocorrélation spatiale, sont en effet une clé pour comprendre cette évolution récente. Elles permettent notamment d'évaluer l'influence relative d'un grand nombre de caractéristiques sociales et économiques sur les variations interrégionales du sex-ratio. On met en évidence l'effet propre de la prospérité économique qui apparaît nettement corrélé à la hausse du rapport de masculinité. Une modélisation élargie de ces différences régionales, incorporant la dimension spatiale, permet en outre de démontrer le rôle spécifique joué par la composition sociologique de la population, le développement économique et les phénomènes de diffusion. La conclusion vise à offrir une interprétation de ces différents déterminants de la masculinisation démographique en Inde.

CHRISTOPHE Z. GUILMOTO • LO ECONÓMICO, LO SOCIAL Y LO ESPACIAL. LAS TRES DIMENSIONES DE LA SUPERMASCULINIDAD JUVENIL EN INDIA

El artículo propone examinar los determinantes del alza contemporánea de la relación de masculinidad entre los niños en India a la luz de los datos regionales. Las disparidades marcadas entre distritos indios, evidenciadas por la medida de la autocorrelación espacial, son en efecto una clave para entender esta evolución reciente. Estas permiten sobre todo evaluar la influencia relativa de un gran número de características sociales y económicas en las variaciones interregionales del sex ratio. Se evidencia el efecto propio de la prosperidad económica que aparece claramente correlacionado con el alza de la relación de masculinidad. Una modelización ampliada de estas diferencias regionales, que incorpora la dimensión espacial, permite además demostrar el papel específico desempeñado por la composición sociológica de la población, el desarrollo económico y los fenómenos de difusión. La conclusión a ofrece una interpretación de estos diferentes determinantes de la masculinización demográfica en India.

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