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Between Cultures and Markets: An Eclectic Analysis of Juvenile Gender Ratios in India

by

I. Dasgupta, R. Palmer-Jones and A. Parikh

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Abstract
There exist large variations in juvenile sex ratios across districts and social groups in India. Economic and cultural factors have been advanced as contending explanations for these variations. We propose a household optimization model that integrates cultural explanations with economic ones. Female literacy (FLIT) and female labour participation (FLP) together with culture are likely to determine perceived value of females, and to result in regional variations in child survival and hence in sex ratios. We estimate this model using data from 1961, 1971 and 1981 censuses. We use cross section estimation with and without restrictions, estimate and use first differencing to eliminate district (fixed) effects. We find that female labour force participation, female literacy, and the predominance of the Indo-Aryan kinship system in a district account for much of the variation in juvenile sex ratios. Although FLP and FLIT are significant explanatory factors, culture is also significant in determining the sex ratios, suggesting that policy could include explicit attempts to manipulate culture as well as to promote female employment and literacy.

Outline

I INTRODUCTION

The proportion of females in India's population as reported in the decennial censuses is relatively low and reached its lowest level in 1991. The low ratio of women to men in some groups and the reported decline in the female-male ratio (FMR) since censuses were started in 1871 have generated extensive debate (Visaria, 1971). Sex ratios summarize the relative cumulative life chances of the different sexes from even before birth through to death. Relative deficiencies in the number of either sex constitute an important issue for public policy. The large number of 'missing women', and the consequent population imbalance, in India is one of the most extreme cases (Coale, 1991; Sen, 1992).

In recent years, both the low level and the decline in the sex ratio in South Asia have been attributed to discrimination against girls and women, especially in nutrition and health care. This, in turn, has been related to the either a cultural devaluation or an unfavourable economic position of women[1]. The Indian sub-continent is characterised by what can be crudely described as a north-south divide, with lower female-to-male ratios in the north and more favourable to female ratios in the south. The cultural devaluation view highlights the concentration of districts with low sex ratios in the north and west of the Indian sub-continent, and attributes the anti-female bias to the predominant Indo-Aryan culture of these regions. The less unfavourable ratios in the south are attributed to the predominance of Dravidian culture (Dyson and Moore, 1983). The alternative, 'economic', account suggests that the low perceived economic contribution of women, typically measured by Female Labour Participation (FLP), accounts for the their devaluation and consequent neglect (Miller, 1981). Bardhan (1974) pointed out that rice cultivation requires female labour for transplanting and weeding, while wheat cultivation requires the plough which is almost exclusively handled by males in the Indian context. Thus the demand for female labour is less in the northern wheat growing regions and higher in southern rice areas. He traced the regional differences in gender ratios to this difference in agricultural practices. Recent analyses have combined cultural and economic accounts (Bardhan, 1986; Kishor, 1993; Agarwal, 1995; Agnihotri, 1997), and

1 A number of other explanations of the unfavourable to females sex ratio in South Asia have been disposed of in the past. These include: sex discrepant migration (dealt with by using juvenile sex-ratios); under-enumeration of females (of limited significance, as shown by Visaria (1971)); and exceptionally masculinised sex ratios at birth (Sudha and Rajan, (1999)).

extended the range of explanatory factors to include female literacy (Murthi, Guido, and Dreze, 1995).

The existing literature has not developed integrated explanations that are explicitly derived from a household optimization exercise. That is the analytical point of departure for this paper. We propose a model that combines cultural factors with economic ones to provide an integrated approach to the issue of missing girls based on a household optimization framework. We then use panel data for 317 Indian districts, available from Census Reports for 1961, 1971 and 1981, to derive the estimated effects of cultural factors, female literacy rate and FLP rate on the female-male ratio for juvenile age groups. The empirical contribution of this paper consists of the econometric evidence presented, which suggests that declining FMRs may be due to declines in FLP and increases in intensity of Indo-Aryan kinship patterns, perhaps related to processes of Sanskritization (Srinivas, 1962), only partly offset by rising female literacy. Variations in FMRs between districts are largely explained by variations in FLP, female literacy rates and kinship norms. In policy terms this suggests attaching the cultural trend as well as, or even as a precondition for advancing the economic and educational attainments of women.

Section 2 of the paper presents the general background of the district level information available in the Indian Census and reviews the factors that have been held responsible for low levels and decline in FMRs. In section 3, we propose a household optimization model to analyse the impact of female labour participation, female literacy rate, and kinship relations on juvenile FMRs. In section 4 we discuss features of the data which affect the choice of variables and their interpretation. The econometric analysis, presented in section 5, uses a variety of econometric models to explore the validity of the analytical model put forward. We use continuous and combined cross-section studies with and without restrictions, and models when district effects are absent are estimated. Both FLP and FMR are treated as endogenous variables in one of the models. These results consistently show the importance of FLP, female literacy rate and kinship variables in predicting juvenile FMRs and support the conclusions derived from the analytical model. Section 6 summarizes and concludes our discussion.

II BACKGROUND

By the late 1980s two apparently contradictory strong lines of argument explained the sex ratio disparities in the Indian population – kinship practices and the perceived economic value of women (Kishore, 1993, Murthi et al. 1995, Malhotra et al, 1995). Agnihotri (1997) sought to reconcile these conflicting accounts in terms of the entitlements framework expounded by Amartya Sen (Sen, 1981 and 1985)[2]. This model suggested that female survival relative to males was determined by both a culturally determined core entitlement and an economic component affected by the perceived economic contributions of women. Agnihotri also suggested several methodological advances crucial to empirical examination of these issues using district level census information. Following Miller and others, he emphasised the need to focus on juvenile sex ratios because sex ratios of the whole population are biased by differential adult migration. Furthermore, he drew attention for the first time in connection to this issue to the differential effect of the level of infant mortality on males and females, and to the different demographic features of different social groups in the Indian population.

A third feature is the spatially uneven distribution of the scheduled tribes (ST), which have distinctly different demographic characteristics from the majority Hindu caste population. The 1981 census provided data for the whole population and General Caste (Hindu main castes), Scheduled Castes (SC - the former Hindu 'Untouchable' Castes) and the Scheduled Tribes (ST)[3]. The General Castes are present in all districts and are the overwhelming majority in most districts. The ST are a significant proportion of the population in a number of districts[4] and have quite different demographic characteristics to the caste population, both General and Scheduled as shown in Table 1.

2 See also Agnihotri et al, 1998.

3 But not Muslims.

4 In 10% of the districts ST's are more than 30% of the district population.

Table 1: Female to Male Ratios

(FMR) in India, 1961 - 91
(No. of Females per 100 men)

	TOTAL POPULATION	GENERAL CASTES	SCHEDULED CASTES	SCHEDULED TRIBES
1961	941	934	957	987
1971	930	924	935	982
1981	934	930	932	983
1991	927	923	922	972

Source: Census of India, various dates.

It would be incorrect to group the ST population with other populations because of the disproportionate effect the presence of ST would have on the district level data in districts where they are a high proportion. The SC are more than 30% of the population in only 5% of the districts, and have demographic characteristics similar to those of the General Castes.[5] Hence we construct most of the analysis on the Non-Tribal population.

In the next section we derive an analytical model to explore factors which might account for differential survival rates of girls and boys, before going on to describe the data in more detail and to present the econometric methods and results.

III. THE ANALYTICAL FRAMEWORK

In a seminal paper, Rosenzweig and Schultz (1982) developed an explanation for the higher mortality rates of female children in India in terms of relative expected net transfers from adult sons and daughters. The analytical model we develop is similar in structure. Rosenzweig and Schultz used their model to highlight the role played by labor market

5 The major feature of the SC group has been the rapid deterioration in the sex ratio in the last four censuses (1961 - 91).

opportunities for adult women in determining the level of resources a household would allocate to girls. Our focus, however, is on explicitly integrating kinship structures and social norms with labor market variables. As Agarwal (1994) points out, kinship norms of Northern India imply that, ceteris paribus, parents in Northern India would typically expect, and receive, lower net transfers, direct or indirect, from daughters, relative to those in Southern India. A similar difference exists between Scheduled Tribe households and non-tribal Hindu households. One would then expect differences in incentive structures to translate into differences in allocation of resources to female children, a point noted by Dasgupta (1993) in a related context. The model below formalizes this argument.

Consider a representative household in any district consisting of adults who live for two periods, 1 and 2, and of children who are born at the beginning of period 1. Suppose, at the beginning of period 1, the household maximizes its inter-temporal expected utility

$$EU = x_1 + \delta E x_2, \qquad (1)$$

where x_i is the amount of a composite consumption good that the adult members of the household consume in period $i, i \in \{1,2\}$, and δ is the time discount factor, $\delta \in [0,1]$.

The number of children at birth of either type is normalized to 1. Let m and f be the proportion of male and female children, respectively, who survive period 1. Let

$$f = f(x_f, l), \qquad (2)$$

and

$$m = m(x_m, l), \qquad (3)$$

where x_m, x_f are the amounts of resources allocated to a male and a female child, respectively, in period 1, and l measures the mother's educational level. We shall assume that additional resources increase survival chances at a decreasing rate, and increase in mother's educational level does not reduce the proportion of surviving children of either type. These assumptions are expressed as:

A1. $\frac{\partial j}{\partial x_j} > 0, \frac{\partial^2 j}{\partial x_j^{\,2}} < 0, \frac{\partial j}{\partial l} \geq 0$ for all $j \in \{m, f\}$.

The household's budget constraints are given by

$$x_1 = V_1 - x_m - x_f \,, \tag{4}$$

and

$$x_2 = V_2 + fR_f + mR_m \,; \tag{5}$$

where V_i is the exogenously given income of the household from its own sources in period i, and R_j is the net transfer from a surviving progeny of type j in period 2; $j \in \{m, f\}$. Then, given the survival rates, the household's expected consumption in period 2 is:

$$Ex_2 = EV_2 + fER_f + mER_m \,. \tag{6}$$

At the beginning of period 1, the adult members of the household form their expectations about future transfers from surviving children, ER_j according to the function

$$ER_j = R_j^e\left(b_{j1}, k, c\right) \tag{7}$$

where b_{j1} is the labor force participation rate for adult agents of type j in period 1, k measures the extent of Indo-Aryan kinship practices followed by the household and c is a variable measuring the extent of non-integration of the household into the Hindu caste structure. Thus, the higher the influence of Aryan cultural practices in a region, the higher will be the value of k. Similarly, c increases with an increase in the proportion of Scheduled Tribes in the population.

Expectations about the magnitude of net future transfers should, clearly, depend on expectations about future earnings of children. Given that the rural Indian economy, as a whole, has been changing relatively slowly over time, it is intuitively plausible that agent's expectations about future labor market conditions would be primarily determined by their own labor market experiences. Assuming that average current labor income and the current labor force participation rate are positively correlated, we can take the latter as a proxy for the former.

The amount of net transfer that parents can expect from sons or daughters depends not only on their earnings, but also on kinship structures and the associated cultural norms influencing such transfers. The principal innovation of the model lies in taking explicit account of kinship structures through the variables k and c. The amount of net (direct or indirect) transfer from an adult daughter that parents can expect, given her earnings, is likely to differ significantly between Scheduled Tribe households and non-tribal Hindu households. This is also likely to vary across non-tribal Hindu households according to regional kinship norms. We shall assume that, given identical earnings, the net transfer from a daughter to her parents is at least as much in a Scheduled Tribe household, as compared to a non-tribal Hindu household. Furthermore, it is at least as much in a South Indian household, as compared to a North Indian household. These assumptions are formalised as:

A.2. $\dfrac{\partial R_f^e}{\partial b_{1f}}, \dfrac{\partial R_f^e}{\partial c} \geq 0$; and $\dfrac{\partial R_f^e}{\partial k} \leq 0$.

The representative household's problem is to maximize (1) by choosing x_m, x_f in period 1, subject to the constraints (2) – (7). From the first order conditions, we get

$$f_{x_f} R_f^e = m_{x_m} R_m^e = \frac{1}{\mathrm{d}} \tag{8}$$

Clearly, from (8), we can derive the gender – specific resource allocation functions

$$x_j = x_j\left(l, R_j^e\right), \quad \text{for all} \quad j \in \{m, f\}. \tag{9}$$

Let $s = m/f$, a measure of the survival chances of boys relative to those of girls. Then, taking a log transformation and using (2), (3) and (9), we get:

$$\frac{\partial s}{\partial R_f^e} = -\left(\frac{s}{f}\right) f_{x_f} \frac{\partial x_f}{\partial R_f^e} . \tag{10}$$

Since, by assumption, survival probabilities increase with resource allocation, the sign of the expression on the right-hand side depends on how the change in expected return from girls affects the amount of resources allocated to them. It can be checked that, given A1, (9) implies $\frac{\partial x_f}{\partial R_f^e} > 0$. Hence, from (10), we have

$$\frac{\partial s}{\partial R_f^e} < 0 \tag{11}$$

Thus, survival probability of girls relative to that of boys rises if the expected transfer from daughters is higher. Given A.2, (11) implies

$$\frac{\partial s}{\partial b_{f1}}, \frac{\partial s}{\partial c} \leq 0, \frac{\partial s}{\partial k} \geq 0 . \tag{12}$$

The model therefore predicts the following. *Ceteris paribus*, the difference in survival rates between boys and girls will be lower in districts with (a) a larger scheduled tribe population, and (b) in districts which exhibit a higher female labor participation rate; and (c) it will be higher in districts with patrilineal/patrilocal kinship norms. Furthermore,

$$\frac{\partial s}{\partial l} = \left(\frac{s}{m}\right)\left[m_l + m_{x_m} \frac{\partial x_m}{\partial l}\right] - \left(\frac{s}{f}\right)\left[f_l + f_{x_f} \frac{\partial x_f}{\partial l}\right]. \tag{13}$$

The expression in (13) cannot be signed. An increase in female literacy may improve the survival prospects of both types of children. Without further restrictions, however, it is not possible to predict how the *survival ratio* will change. We shall test the restrictions imposed in (12) and estimate $\frac{\partial s}{\partial l}$.

IV. DATA AND VARIABLES

In this section we discuss features of the data which affect the choice of variables and their interpretation, in addition to those mentioned above. As noted above, there are several features of the data used in this analysis which are due to the specificities of the data sources and of Indian demography. The uneven geographical distribution of factors likely to confound the use of the whole district populations is the main problem. Thus, we use juvenile sex ratios to eliminate differential sex-specific adult migration; we separate the population of Scheduled Tribes from the caste (general Hindu castes and Scheduled Castes) population; and we accommodate the spatially uneven distribution of excess male infant mortality, which arises from biological factors rather than of sex-bias. Data for Female Labour Force Participation and Female Literacy, and a dummy variable for the kinship/cultural differences in the caste population (in addition to separation of the ST population) introduced above, as well as other variables used in the analysis calculated from the censuses, are described in the remaining section.

IV.i Excess Male Infant Mortality

The first two features have been discussed above. A major feature of this analysis is the split of the juvenile population into the 0-4 and 5-9 age groups. Both these age ranges are free from sex selective migration and both reflect the pattern of excess girl child mortality in the 0-4 age group. Child mortality falls off significantly in subsequent years. Excess male mortality during infancy is primarily a biological phenomenon. In western societies more males than females die at all ages, and in most societies up to the age at which maternal mortality becomes possible, more male children die than female children. This is not the case in much of South Asia (and in China, the West Asia, the Middle East and North Africa). In these regions, excess female child mortality is common from the first year of birth, and, in extreme cases, occurs in the first year and even in the first months after birth.

Female-Male Ratios in juvenile age groups represent the net outcome of these mortality patterns. Ideally, one could separate out the 'biological' phenomenon of excess male infant morality from socially influenced differentials in child mortality by comparing sex ratios in the first year with sex ratios in subsequent year (i.e. comparing FMRs 0-1 and FMRs 1-4, 5-9 etc.). However, the data published from the Indian Census does not provide these age ranges, publishing data for 0-4 and 5-9 instead. FMRs in the age 0-4 and 5-9 age groups differ significantly due to the cumulative influence of differences in child mortality by sex. A negative gap between FMR 5-9 and FMR 0-4 will indicate excess female child mortality since one would generally expect a slight increase in this gap due to excess male child mortality. The more severe the proportion of girls dropping out during the second to fifth year, the lower will be the proportion entering the sixth year and the lower will be the FMR in 5-9 age group as compared to FMR of 0-4 age range. Low infant mortality combined with 'natural excess male child mortality' would result in an increase in FMR 59 over FMR04.

Infant mortality and poverty are positively associated in the Indian districts. It may also be that there is less discrimination against girls in poorer households and less migration among poor resulting in higher FMRs. But, higher than normal infant mortality among poorer families will yield higher male than female infant mortality due to the greater frailty of the male infant, and this can result in higher FMRs for these groups producing the same empirical result of higher FMRs. We do not have separate data on excess male infant mortality for all the census years used in the study, so this issue is not covered here.

IV.ii Female Labour Participation and FMR

Female Labour Participation is defined as proportion of women who are classified as main workers as a proportion to total female population above 10 years of age[6]. This is converted to percentage terms. Higher female labour participation may raise the returns to investment in girls directly as well as indirectly. Hence, an increase in female labour participation may increase the Female-Male Ratios in developing societies. We use the FLP as the explanatory variable to explain FMRs with the reservation that this itself could be an endogenous variable and some of the structural and cultural variables could determine the FLP decision. This aspect is considered in one of the econometric models in section 5.

IV.iii Female Literacy Rate and FMR

Female literacy may be a major influence on both FLP and FMR. It is defined as:

$$\text{FLIT} = \frac{\text{Total Literate Population Less Total Male Literate Population}}{\text{Total Population Less Total Male Population}}$$

$$= \frac{\text{Total Female Literates}}{\text{Total Females}}$$

The above is defined in percentage terms.

IV.iv Kinship and Impact on FMR

The North-South divide in sex ratio pattern is basically linked to differences in kinship systems in different regions. The Southern kinship system and norms of inheritance allow a greater autonomy to women and hence a better decision making ability with respect to personal affairs. The "Male Centred" kinship system in the North undervalues and subordinates females while the Southern kinship system values them more and allows them to retain ties with their natal kin (Agarwal, 1994).

The Indo-Aryan zone in the Northwest follows the Indo-Aryan practices. The Dravidian customs are followed largely in the Southern region. In the intermediate zone, from Gujarat in the West to Orissa in the East, both systems coexist. The Mundas in central region follow a kinship system closer to Dravidian one as far as marriage rules are concerned. In this study kinship variable is defined as zero-one variable. When district is classed as predominantly Indo-Aryan, kinship = 1 and otherwise zero. The Indo-Aryan district classification was based on the analysis of languages spoken in the district in 1961 and other variables such as caste, religion etc. (Agnihotri, 1997).

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6 In some cases more than 100% of females above the age of 14 are classified as main workers.

TABLE 2

Means and Standard Deviations of All Variables Used

	No. of obs	*Mean*	*S.D*
FMR59 (%)	951	94.54	6.414
FLIT (%)	951	16.6374	12.4830
FLP (%)	951	27.67	21.03
SCP (%)	951	15.20	7.50
STP (%)	951	8.62	16.02
TCULT (%)	951	63.3289	18.9336
KINS (Dummy)	951	0.7224	0.4480
FMRO4 (%)	951	98.05	4.10
FMR5961 (%)	317	95.18	5.39
FLIT61 (%)	317	11.0842	8.8437
FLP61 (%)	317	14.42	22.211
FMR0461(%)	317	98.81	3.724
KINS61(Dummy)	317	0.7224	0.44850
FLIT71 (%)	317	16.5078	11.6655
FLP71 (%)	317	18.50	14.473
FMR5971 (%)	317	94.12	7.879
KINS71(Dummy)	317	0.7224	0.44850
FMR0471 (%)	317	97.68	5.070
FMR5981 (%)	317	94.31	5.640
FLIT81 (%)	317	22.3203	13.81360
FLP81 (%)	317	20.29	14.588
FMR0481 (%)	317	97.64	3.182
KINS81 (Dummy)	317	0.7224	0.44852

KINSHIP is a dummy taking the value of 1 for Indo-Aryan culture. It remains constant across three censuses.

IV.iv Other Variables and Descriptive Statistics

Table 2 gives the variable names and their descriptive statistics. The juvenile sex-ratios in the 0-4 and 5-9 age range, female total main workers as a proportion to females of age group above 14, female literacy rate as defined before, kinship, scheduled caste and scheduled tribe proportions are shown in this table. Data on total cultivators as a proportion to total main and marginal workers are also provided and used as an instrument later in the study. Proportions of urban population (URBPCNT) and other agricultural population proportions are also made use of in the instrumental variable estimation of Female Labour Participation and FMR equations.

V. ECONOMETRIC MODELS AND RESULTS

The model developed above employs the household as the decision-making unit, but it is to be estimated using data on sex ratios and other variables for Indian districts, rather than data on individual households[7]. Disaggregated juvenile sex ratios are the dependent variables, female labour force participation, female literacy, and culture/kinship are the explanatory variables suggested by the analytical framework. Previous work relating sex ratios to the variables of interest has employed single census year district data, mainly the 1981 data. The problems caused by the use of spatial aggregates in a single cross-section analysis can be diagnosed and to some extent corrected using spatial econometric methods (Anselin, 1990; Agnihotri et al, 1998). Here we use the information from three census years as a panel data set, extending the econometric methods that have been deployed to deal with these problems.

V.i Cross Section Analysis

In Table 3, we follow the cross section analysis for each census year to examine whether the decline in female-male percentages are related to any of the changes in the exogenous variables and whether structural relationship has changed. A simple Chow test using three periods compared to pooled data suggests evidence of structural change.

Our model equation for cross-section regression is:

7 There have been many previous contributions to discussions about the sex ratio in Indian populations which have used the Indian Census District level data (Miller, 1981, Kishor, 1993, Murthi et al., 1995, Malhotra et al., 1995); our work seeks to contribute to these debates.

$$FMR59_{it} = constant + \beta_1 FMR04_{it} + \beta_2 FLP_{it} + \beta_3 FLIT_{it} + \beta_4 KINS_{it} + \varepsilon_{it} \qquad (14)$$

t = 1961,1971, 1981 and i=1…..317

TABLE 3

Unrestricted and Restricted Estimates with Four Explanatory Variables FMR04, FLP, FLIT, KINS

UNRESTRICTED (Three Stage Least Squares with endogenous FLP)			*RESTRICTED (Three Stage Least Squares with Restrictions*		
Variable	Coefficient	t-ratio	Variable	Coefficient	t-ratio
CONSTANT	35.12	8.1056	CONS61	36.14	10.5101
FMRO461	0.5937	13.9307	FMRO4	0.5953	17.5352
FLP61	0.0743	9.7704	FLP	0.0625	9.0056
FLIT61	0.1064	5.0476	FLIT	0.6580	3.9295
KINS61	-4.25	10.3840	KINS	-4.420	11.5960
CONST71	47.22	8.1458	CONS71	37.06	10.7477
FMR0471	0.4827	8.4569	CONS81	36.81	10.6330
FLP71	0.1241	5.6183			
FLIT71	0.0327	1.1054			
KINS71	-4.2741	5.2437			
CONS81	18.0241	3.4198			
FMRO481	0.7659	14.5586			
FLP81	0.1064	8.3724			
FLIT81	0.0683	4.7429			
KINS81	-3.0362	6.4658			
LogL		-2495.23			-2516.92
No. Observations		317			951

Note: Both of them were estimated by three stage least squares with instruments.

Test of restrictions: χ^2 (8) =43.78

These estimates treat Female Labour Participation rate as an endogenous variable. Both unrestricted and restricted estimates are obtained. In order to obtain a parsimonious model, we use the most important explanatory variables namely FLP, FLIT FMR04 and Kinship and exclude scheduled tribe proportions and total cultivators as a proportion to total population since they were not significant in all the years. However, for FLP, they are used as instruments. The coefficient of FMRO4 for each year is highly significant and varies widely from one census year to another in unrestricted estimation. The range of coefficients of FLP is between 0.07 to 0.12, while the coefficients of female literacy rate show variation between 0.032 to o.106. The coefficient of kinship variable is always negative and constant terms in all three years are significant varying from 18.02 to 47.22. When the estimation is conducted with restrictions on the coefficients to be identical over the three years for FLP, FLIT and Kinship, we retain the correct signs and all estimates are highly significant. The value of the likelihood ratio ($c^2 = 43.78$ with 8 degrees of freedom) rejects the restricted model. On the basis of these tests, we conclude that unrestricted estimation is preferred to restricted model. The coefficient FMRO4 is 0.5953 suggesting that an increase in FMR for 0-4 group will raise the FMR59 by approximately 0.6. The constants of regression from year to year in the restricted estimation are around 36 to 37 per cent and this means that FMR59 will be 36 per cent irrespective of what happens to kinship, FLP or female literacy rate. Excess female-male ratios[8] for 5-9 age group expressed as a difference from age group 0-4 can be due to higher male child mortality in the age group 0-1. However, if this is due to higher female mortality in the age group 0-4 due to either neglect of female children, it will be reflected in lower excess female-male ratio. If we refer to table 2 on means of FMR59 and FMR04, we find that they are negative. An improvement in survival for girls between age 0-4 would increase the ratio in the age group 5-9.

V.ii First Differences

In the model where all three years' data are combined, a panel study using individual observations (317x3) is conducted. As this model uses explicitly fixed effects to account for district effects we find that the majority of regression coefficients are insignificant and

8 When excess female-male ratio (FMR59-FMR04) was regressed on FLIT, FLP and Kinship variables using constraints that the coefficients are identical among three years, we found that all coefficients had correct

this is due to the domination of district effects and the collinearity of district dummies with kinship and other variables. The best way to account for this is to conduct the analysis based on first differences for each period of specified variables and in this model, both the fixed effects and kinship cancel out. This will permit us to measure the role of FLP, FLIT and FMR04 explicitly after eliminating the fixed variables.

Consider a simple three-period model (t = 1, 2, 3).

$$\mathbf{y}_{it} = \mathbf{x}_{it}\,\boldsymbol{\beta} + \mathbf{z}_i\,\boldsymbol{\delta} + \boldsymbol{\varepsilon}_{it} \qquad (15)$$

x = a matrix of explanatory variables that varies across time and individual Districts

z = a matrix of variables observed that vary across individual Districts but for each individual District they are constant across all three periods (e.g. kinship).

$\boldsymbol{\varepsilon}_{it} = \alpha_i + \mathbf{n}_{it}$

The above model implies that:

$$\mathbf{y}_{it} - \mathbf{y}_{it-1} = (\mathbf{x}_{it} - \mathbf{x}_{it-1})\,\boldsymbol{\beta} + (\mathbf{z}_{it} - \mathbf{z}_{it-1})\,\boldsymbol{\delta} + (\mathbf{n}_{it} - \mathbf{n}_{it-1})$$

and

$$\Delta\mathbf{y} = \Delta\mathbf{x}\,\boldsymbol{\beta} + \Delta\mathbf{z}\,\boldsymbol{\delta} + \Delta\mathbf{n}. \qquad (16)$$

The time-invariant z (Kinship) terms cancel out and the model reduces to:

$$\Delta\mathbf{y} = \Delta\mathbf{x}\boldsymbol{\beta} + \Delta\mathbf{n} \qquad (17)$$

The OLS on the transformed data yields unbiased estimates. In our terminology,

$$\begin{aligned} FMR59_t = {} & b_1 FMRO4_t - b_1 FMRO4_{t-1} \\ & + b_2 FLP_t - b_2 FLP_{t-1} \\ & + b_3 FLIT_t - b_3 FLIT_{t-1} \qquad (t = 1971, 1981) \qquad (18) \\ & + b_4 KINS_t - b_4 KINS_{t-1} \\ & + FMR59_{t-1} + (n_t - n_{t-1}) \end{aligned}$$

(the district symbol (i) is suppressed for clarity of notation)

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signs and again restrictions were rejected. These results were similar excepting that it restricts the coefficient of FMR04 to unity.

In the above equation KINS is constant across all three years and therefore the model reduces to:

$$\Delta FMRO59_t = b_1 \Delta FMRO4_t + b_2 \Delta FLP_t + b_3 \Delta FLIT_t + (n_t - n_{t-1}) \qquad (19)$$

Such a model is estimated for two years, 1971 and 1981; again we proceeded sequentially testing the restrictions on coefficients of lagged variables. The results are presented in Table 4. The constrained estimators do not pass the test on restrictions, so we use the unconstrained model in first difference regressions. Changes in FLP and FLIT have positive effects on FMRs. District effects, treated as fixed effects, are eliminated by first differences.

TABLE 4

First Differences of FMR59
Regressed on first differences of FLP; FLIT; FMRO4 to eliminate fixed effects

Name of the Variable	Coefficient	t-ratio	Coefficient	t-ratio
CONST71-61	-2.3514	4.3609	-2.0886	4.7673
K_1:FLIT71-61	-0.0485	4.3889	-0.0423	3.9063
K_2:FLP71-61	0.3690	8.1323	-0.6230	15.4486
K_3:FMRO4	0.0874	1.6445	0.0690	2.7899
CONST81-71	-0.2886	0.6603	-0.1343	0.4479
L_1 :FLIT81-71	0.0331	1.2165		
L_2:FLP81-71	0.3823	8.7778		
L_3:FMR04781-71	0.0732	1.2601		
LOGL		- 164 8.24		-1689.04

$\chi^2(3) = 9.60$

Note: 1971 data suffers from measurement errors.

Because of suspected data problems in 1971, the same tests were performed using the difference between 1981-1961 data, with results that were not significantly different.

These tests supplemented by the three individual cross section analyses estimated jointly, suggest that the hypothesis of identical coefficients across equations is rejected. Similar conclusions are reached using the first difference model where fixed (District) effects are eliminated through differencing. This implies that there is a significant difference in the impact of female literacy rate, female labour participation rate and FMR04 rates between three census years. Pooling the data in panel estimation with different stuctures did not alter the conclusion from both cross-sections and first differences where the restrictions are rejected. These can be obtained from the authors.

VI. SUMMARY AND CONCLUSIONS

Our empirical results confirm our theoretical expectations about Female-Male ratios in India by highlighting the importance of FLP, FLIT and kinship factors. Variations in FMRs between districts are largely explained by variations in FLP, FLIT and kinship. Our study thus suggests that an increase in FLP, FLIT and a spread of Dravidian social norms and practices could increase FMRs in Indian districts. Our results based on combined cross-section studies confirm the importance of these variables even when FLP is treated as endogenous.

Analysis based on the endogeneity of FLP, using year by year cross section data with structural dependence of the error term (Table 3), concludes that the three variables FLP, FLIT and Kinship, play a significant role in explaining inter-district variations in sex ratios, consistent with the model put forward. When district effects are eliminated, by taking first differences (Table 4), FLP and FLIT both have significant effects in explaining sex ratios. However, the higher female literacy rate did not show a positive effect, which could be due to the effect of data errors in the 1971 Census. When we use the first difference model, the constraints across equations are rejected, so if we analyse the left hand side of Table 4 we find that both FLP and FMR04 are highly significant. When we look at the combined cross-section results (Table 3), the restrictions are rejected and we find that FLP, FLIT, Kinship and FMR04 all appear with the correct sign and are highly significant for majority of the census years.

It is expected that, *a priori*, an increase in female literacy rate could contribute towards balanced sex-ratios in several ways; for example, through improvement in female labour participation rates and improved nutrition and healthcare. The latter in particular could lead to reduction in sex discrepant infant and child mortality over all households[9]. However, if wealthy families choose the sex of unborn children through ultrasound and amniocentesis procedures in urban areas, interactions of female literacy with other variables may contribute negatively to FMRs at the margin.

FLP was associated with sex ratios, indicating that the demand for female labour might improve the survival chances of females. However, the inclusion of neither the proportion of cultivator households nor the proportion of agricultural labouring households (TCULT or TAGLAB, might indicate demand for agricultural labour), improved the results in our case. This supports to some extent the case against there being any relationship between agricultural employment and higher FMRs[10]. Harriss and Watson (1989) also concluded that the "agricultural determinant case does not stand up the evidence". Kinship was one of the most important ingredients of the determination of FMRs. However, our ability to explore the influence of this variable more thoroughly is limited by our inability to capture kinship in any other way than using a time invariant (0,1) dummy variable. This is not a plausible assumption, since the constancy of kinship over three census years belies changing social practices, such as changing dowry levels, that are likely to have affected the relative expected returns to sons and daughters, and could contribute to falling FMRs. This requires further investigation, although it is unlikely that the census data provide suitable means.

This study has provided a suitable neoclassical model that predicts that in districts where there is higher female labour participation and smaller role of Aryan norms, the greater will be the female-male survival ratio. The model was put to an empirical test using the Indian Census data of three decades. It was concluded by rigorous econometric tests that

9 Reduction in infant mortality would reduce male infant mortality more than female infant mortality. We are suggesting that improved female literacy will improve child nutrition and health care and to the extent that excess girl child mortality is due to poor nutrition and health care this will reduce their deaths relative to male child deaths.

10 While the rice crop zone provided employment opportunities for women and we find that the FMRs are higher in districts where rice is the predominant staple crop; the strongest effect was in districts where wheat is a major crop. Employment opportunities for females have been limited in these regions, and FMRs were significantly lower.

an increase in female labour participation rate, female literacy rate and non-Aryan kinship status would contribute to an increase in female-male ratio for the juvenile age group.

We have not discussed policy prescriptions that have been derived in earlier studies, since this would extend the paper considerably. However, the significance of the culture/kinship variable suggests the importance of attempting to alter these practices. For example, the content of education, for males as well as females, may have an important role to play, as well as extending education and employment to women.

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