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Fertility and Child Mortality in India: A District Level Analysis Using Simultaneous Equations

Introduction

IN India, over the past 50 years significant progress has been made in the economic, social, demographic and health fields. However, these achievements have not been uniform through out the country. For example, in India, there exists a very wide regional disparity in the achievement of various stages of demographic transition. The main reason is that the level of action taken by various state governments to curtail the population growth in India is not similar. The recent population projections by the Registrar General revealed that India will reach the replacement level of fertility only in the year 2026. But three States namely Kerala. Tamil Nadu and Goa had already reached the replacement level of fertility. The other two South Indian States, Andhra Pradesh and Kamataka will reach the same only by the year 2002 and 2009 respectively (RGI. 1996). The large Hindi speaking States of Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh will reach the replacement level only after the year 2038 (RGI, 1996). This divergence provides useful opportunities for researchers to examine the interregional variations in the demographic outcomes in India. Various researches on Indian demographic transition suggested a stagnation in the decline of fertility and mortality in the 1970's (Srinivasan, 1996). One of the main reasons seems to be that the mortality of children in the first few years did not decline in the states that have a large population base. It has been evident from various empirical studies that a population characterised by low mortality of children in the first few years of life will normally have a low fertility.

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The regional variation in these demographic outcomes derived from the 1991 census suggests that under five mortality estimates varied from a high of 289 per 1000 live births in the district of East Kameng and a low of 32 per 1000 live births in Hyderabad. Similar variation was also observed in case of total fertility rate with a low of 1.85 children per woman in Pathanamthitta district of Kerala and a high of 7.08 children per woman in Karimganj district of Assam. There has been numerous attempts to explain the demographic diversity in India's population using state-level and district level information (Dyson and Moore, 1983; Srinivasan *et al.*, 1984; Gulati, 1992; Kishor, 1993; Murti *etal.*. 1995; Malhotra *et al.*, 1995; Srinivasan, 1996; Mari Bhat, 1996 etc.). Some of these studies have used child mortality as a factor for explaining fertility differentials. In addition, most of the earlier research has employed ordinary least square methods in explaining the demographic divergence. In fact, child mortality and fertility influence each other. In otherwords, there exists a simultaneous causal link between child mortality and fertility. The ordinary least square estimates will be inconsistent in such situations, and the estimated coefficients will not approach their true values. The recommended strategy in such circumstances is to utilise simultaneous equations. Also, some of these researches have appreciated the potential use of simultaneous equations in explaining the differentials in these demographic out comes (Murti *et* a/., 1995; Mari Bhat, 1996).

The task of the present paper is to make an analysis of fertility and child mortality in India based on secondary data available at the district level. The paper utilises simultaneous equations for examining the demographic divergence in India by using district level data from 1991 Census of India and various other sources. Particular attention is paid to female literacy, female age at marriage, family planning, availability of health services, urbanization, economic structure and other related socio-economic variables. The present analysis confines to 384 districts in India for which detailed information is available from the census and other sources.

Data

The data used for the present analysis is basically from the Census of India 1991. Under five mortality and total fertility are the demographic outcomes examined in the present analysis. The under five mortality were estimated indirectly using the children ever born and children surviving data from the 1991 census (RGI, 1997). The total fertility rate from the 1991 census was estimated using Arriaga method. A detailed information regarding the estimation of these measures can be obtained from occasional paper number 1 of 1997 (RGI, 1997).

Shifting to the explanatory variables, our indicator of female literacy is the adult female literacy, measured as the percentage of literate females in the age group 15-34. The female labour force is defined as the percentage of total female work force to the total female population of above 7 years of age. Urbanization is the proportion of the total population living in the urban areas. The availability of health care services is indirectly measured by proportion of villages having medical facility. The development variable is measured by the percentage of agricultural labourer to total work force. In addition, two variable representing the composition of the population, percentage of scheduled caste and tribe population and percentage of Muslim population are included in the analysis. Thus we have included various indicators of both social and economic development in the examination of regional demographic diversity in India. Two proximate variables such as female age at marriage and contraceptive prevalence rate due to sterilization are also included in the analysis. Finally, four dummies are used to present regional patterns: South, for districts of Kerala, Tamil Nadu, Kamataka and Andhra Pradesh; North, for Punjab. Haryana and Himachal Pradesh; West, for Maharashtra and Gujarat; East, for Orissa, West Bengal and Assam. The control region, as usual, consists of Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh.

Selection of Variables

The choice of variables for the present article is based on a review of previous search that has been conducted using data from various countries. Several micro and macro level studies have appraised that demographic transition is a byproduct of economic development. However, scholars have all along differed in opinion on the decline in fertility and as well as on the impact of its determinants, and no single theoretical model has yet been developed which captures all aspects of fertility behaviour. Empirical research conducted in developing countries has suggested that the key variables that explain variations in fertility at the aggregate or individual level are education and labour force participation of women, marital patterns, the fertility reducing Feet of prolonged breastfeeding, the link between high mortality and high fertility and impact of a population's age structure on birth rates. Some researchers argue that; transition in fertility patterns has been widely linked with socio-economic development and the process of industrialization. In their theories of fertility, economists, utilizing various economic concepts, viewed fertility performance simply "as economic behaviour" with the exclusion of well known sociological importance of reproductive behaviour. is has apparently led Easterlin (1975, 1985 with Crimmins) to propose a frame work combining sociology and economics of human fertility. Easterlin's approach is a recognition it although the process of child bearing is biological in nature, it is affected by social, .rural and economic factors. Earlier Davis and Blake (1956) have deliberated convincingly it socio-economic variables could not have a direct effect on fertility, rather socio-economic effects had to operate through other variables which they termed "intermediate"— ranging from permanent celibacy to contraception, and induced abortion. Subsequently, Bongaarts (1978) argued that among other intermediate variables, the four most important proximate variables are marriage, postpartum infecundability due to variations in breastfeeding, contraception, and induced abortion. The aggregate analysis of Bongaarts (1982) though has further reinforced the importance of these four proximate variables, is not methodologically appropriate in certain respects (Wilmsen. 1986).

Female mean age at marriage and couple protection rate due to sterilization are the proximate variables used in the present analysis. In the Indian society where the birth occurs within wedlock and thus the timing of marriage has a direct influence on fertility. The age at marriage has a biological component too, as Jain (1969) and James (1973) have suggested that mean marital fecundability increases upto the age 22 year after which it shows a decline—and plays a crucial intervening role in the explanation of differences in average risk of conception among women. Female age at marriage is regarded as a powerful indicator of status of women, with early marrying population characterised by low female autonomy (Mason, 1984).

The levels of child mortality also has been found to have influence the fertility levels. There are behavioural and physiological effects which link the death of a child. The death of a child may elicit a desire to have another one soon. In populations where breastfeeding is practised widely, a biological phenomenon reinforces this influence. It is well documented that breastfeeding prolongs the sterile period following child death. By interrupting breastfeeding, the death of a young child leads to moving forward the arrival of the next. However, fertility levels may also influence child mortality levels.

Several research studies have identified that among the factors basic education— especially female education—is one of the most powerful. Several reasons have been advanced for the influence of female education on fertility and child mortality. Usually, a negative relationship is found between female education and these demographic outcomes. It is generally believed that education of women may affect child spacing pattern because education facilitates the acquisition of information about family planning, and encourages attempts to control child bearing. It has been established that relatively large and significant rates of childlessness are found among ever-married women with higher levels of education (Jacobson *et al.*, 1988). Educational attainment is increasingly important to women as a means of achieving financial independence, enhanced social status and great personal freedom. Specifically, educational attainment may be increasingly important in determining the timing of motherhood as it affects the attitude towards marriage and more educated women are presumably better able to assess the advantages and disadvantages of rapid child bearing. Psychologically, education may further facilitate the fulfilment of individual aspirations with development of a heightened sense of personal efficacy in matters pertaining to family and child bearing. Biologically, educated women are often associated with lower prevalence of disease affecting fecundability with better health and nutrition. Coital frequency may also vary by education but the relationship is not clear. Namboodiri (1974) has shown that at lower parities, very little influence is apparent for mothers education and at parities higher than three, the higher the mother's education the greater the pull towards no more births. Similarly, educated omen are more frequently members of labour force and begin child bearing later than hers, these factors results in an over all lower level of child bearing (Hoem and Hoem,1989).

Occupational prestige, which is an important consequence of education, has been found to be related to fertility. Potential causal linkages between work and fertility elude the incompatibility of child-care and work, exposure to different attitude towards amen's role and greater access to information particularly concerning family planning. is a premise that in order to combine child bearing with employment, women increasingly space their births. There are two competing hypotheses: one contends at women lengthen their birth intervals in order to minimize interruption to their careers, the other suggests that they reduce their child spacing in order to minimize the time spent out side the labour force. Work is not likely to displace births of lower order together, but that is the main factor in the postponement of births of third or higher orders.

It is also evident from different studies that the demographic outcomes vary between different social groups. A religion of some kind is constitutive of people's reproductive behaviour as a form of religious practice. In India majority of Hindus are found to be 'serving sexual abstinence during certain occasions such as religious festivals, new moon days and full moon days (Samuel, 1971). In India, it is believed that Muslims have higher fertility due to minority status, illiteracy and religious practice. The significance other social groups namely "scheduled caste and tribe" population is also of particular interest for studying the regional variations in these demographic outcomes in India. This section of the population is considered to be socially and economically backward and us a higher proportion of such population lean to affect the demographic outcomes.

The advocates of demographic transition theory considered urbanization as an essential pre-requisite for fertility decline. As a result of development the urban population benefit from improved health services and have an increased knowledge and accessibility family planning programme. Also. urban areas are associated with better education d employment opportunities for women. So a higher proportion of urban population thought to influence the demographic outcomes.

However, in the rural areas the availability of medical facility tends to increase the knowledge and accessibility of family planning programme and thus influence fertility levels. Thus the proportion of villages having medical facility is also an important variable in explaining the regional variations in fertility.

The percentage of agricultural labourer to total working population is considered be a measure of development and thus thought to influence the demographic outcomes. However the influence of this variable on fertility and child mortality is not well established.

Methodology

It is important to remember that child mortality and fertility tend to be positively related. For example, high fertility is typically combined with short birth spacing, repeated childbearing by mothers, and a large proportion of higher order birth, which are often harmful to child health. Similarly, high child mortality raise the number of children required to achieve a given desired family size and thus increases the fertility. Under such circumstances, the estimates from ordinary least square (OLS) regression are biased due to the feedback relationship. In view of these considerations, we have explored alternative analysis using two stage least square (2SLS) regression method. The 2SLS is an important regression technique for models in which one (or more) of the predictor variables is thought to be correlated with the error term (Gosh, 1994; Gujarati, 1995). In a feedback situation, each of the variables in the feedback relationship is called endogenous variable. The variables that are not influenced by other variables in the model but that do influence the endogenous variables are called instrument variables. To be effective, instruments should be: highly correlated with the endogenous variable and not correlated with the error term. In practice it is very difficult to be sure whether the instrument variable is correlated with the error term. Based on the 2SLS we made an attempt to study the determinants of fertility and child mortality in the districts of India. The demographic outcomes of total fertility rate and under five mortality used as the endogenous variables. The instrumental variables are selected based on the correlation of these variables with the endogenous variables. However, it must be remembered that. theoretically, such selection of the instrument variables may not be valid.

Results

The 1991 census information on total fertility and child mortality was available for 452 districts ofmdia. Since, information on some of the variables used in the present analysis was not available for all these districts, we restricted our analysis by using data from 384 districts. For example, village level information was not available for the districts of Mumbai, Calcutta, Hyderabad and Madras. The data on contraceptive use due to sterilization used in the analysis corresponds to the year 1990 and it is available only for 382 districts. For the year 1990. same contraceptive use due to sterilization was taken for two districts namely Paschim Singhbhum and Purabi Singhbhum in Bihar and Ranpur Nagar and Kanpur Dehat in Uttar Pradesh. Similarly, for four districts of Haryana (Kaithal. Panipat, Rewari and Yamunanagar) and one district in Rajasthan (Dholpur). we used the contraceptive use due to sterilization for the year 1991. The name of the districts included in the analysis and the basic estimates of fertility and child mortality utilized in the present study are shown in the Appendix. An attempt is made to compare the fertility and child mortality used in the present study with estimates from some other sources. There are two studies which gives estimates of fertility and child mortality at district level. One is Mart Bhat's (1996) study which provides estimates of total fertility rate and the other study is by Rajan and Mohanachandran (1998) which gives estimate of the child mortality rate at district level. It is important to note that fertility rate estimated by Mari Bhat (1996) refer to the period 1984-90. The RGI estimate of total fertility is lower in 128 districts and is higher in 199 districts than Mari Bhat's estimate. The fertility rate is same for 28 districts from these two sources. It is important to note that the RGI fertility estimates for all the districts ofKerala and Tamil Nadu are higher than Mari Bhat's estimates. Comparing the child mortality estimates, we see that RGI estimates are higher in 200 districts and lower in 154 district than Rajan and Mohanachandran's study. The same child mortality rate is observed for 30 districts.

An overview of the census data for these 384 districts reveals that only 4 of the districts have anything below or near replacement level of fertility. Majority of the districts (about 93%) have under five mortality of above 60 per 1000 live births. Similarly only one third of the districts have female adult literacy rate of above 50 per cent. Also the female age at marriage is below 18 years in 65 per cent of the districts.

Table 1 gives the list of variables used in the present study. The mean and standard deviation of the variables used is also shown in the same table. As mentioned earlier, the instrument variables are selected based on results of correlation between the variables and endogenous variables. The result of correlation analysis is provided in

TABLE 1: VARIABLES USED AND SELECTED STATISTICS

Variable	*Mean*	*Standard deviation*
Total Fertility Rate (TFR)	4.42	0.96
Under Five Mortality (U5MR)	107.11	35.39
Percentage of SC and ST Population (SCST)	26.24	14.34
Adult Female Literacy (ADFL)	39.98	20.37
Percentage of urban population (URB)	20.78	13.89
Percentage of Muslim population (MUS)	10.76	10.81
Percentage of agricultural labourers to total work force (AGL)	21.49	11.25
Female work participation rate (FWP)	29.44	15.87
Contraceptive use due to sterilization (CEPS)	30.28	11.36
Female age at marriage (AGEM)	17.65	1.19
Percentage of villages having some medical facility (MED)	36.89	29.00
Southern states	0.20	0.40
Northern states	0.10	0.31
Western states	0.13	0.33
Eastern states	0.12	0.33
Total number of cases	384	

TABLE 2: CORRELATION OF EXPLANATORY VARIABLES WITH FERTILITY AND UNDER FIVE MORTALITY

Variable	*TFR*	*U5MR*
TFR	-1.0000	0.6255**
U5MR	0.6255**	1.0000
ADFL	-0.6793**	-0.5027**
SCST	0.0895	0.3369**
URB	-0.3009**	-0.3101**
MUS	0.2624**	0.0213
AGL	-0.0878	-0.1265*
FWP	-0.2157**	0.0691
CEPS	-0.7313**	-0.4754**
AGEM	-0.5212**	-0.4490**
MED	-0.0456	-0.2141**

** Significant at 0.001 level. * Significant at 0.01 level.

Table 2. The variables that have weak correlation with total fertility rate are percentage of scheduled caste and tribe population, percentage of agricultural labourer and percentage of villages having medical facilities. Hence, the fertility equation exclude these variables. Similarly, percentage of Muslim population and female work participation do not show any significant correlation with under five mortality. The under five mortality equation excludes these two variables.

Using 2SLS regression models, we have estimated the coefficients for fertility and under five mortality equations. The fertility and child mortality equations are solved by utilizing the 2SLS command available in the software package SPSS/PC+. This command can be used to estimate coefficients for several equations simultaneously. A detailed description of the use of this command can be obtained from SPSS/PC+ Trends (SPSS Inc.. 1990).

The estimated coefficients for fertility equation from both OLS and 2SLS regressions are provided in Table 3. From the said Table it is possible to make quantitative effect of various variables on fertility. The results from the 2SLS suggest that adult female literacy has a negative and statistically significant effect on TFR. Similarly, higher female labour force participation also reduces TFR. However, fertility is significantly higher in districts with a high proportion of Muslim population. Although the increase in female age at marriage reduces fertility, its effect is not significant after controlling for the other explanatory variables. As expected, urbanization and couple protection due to sterilization significantly lowers the fertility. Considering the regional dummies, it is evident that southern, northern and eastern districts of India have significantly less fertility than the districts ofBihar. Madhya Pradesh. Rajasthan and Uttar Pradesh. The results clearly indicate that the model is able to explain as much as 76 percent of the

TABLE 3. DETERMINANTS OF TFR: RESULTS FROM OLS AND 2SLS

	OLS		*2SLS*	
	Coefficient	*S.E.*	*Coefficient*	*S.E.*
ADFL	-0.0142*	0.0018	-0.0144*	0.0019
FWP	- 0.0086*	0.0020	- 0.0080*	0.0030
AGEM	0.0037	0.0275	0.0008	0.0292
CEPS	-0.0232*	0.0035	- 0.0239*	0.00-41
MUS	0.0123*	0.0027	0.0122 *	0.0027
URB	- 0.0050*	0.0020	- 0.0052*	0.0022
U5MR	0.0062*	0.0009	0.0047	0.0051
South	-0.5741*	0.0978	- 0.6396*	0.2395
North	- 0.2334*	0.1005	- 0.2657**	0.1474
West	0.1252	0.1071	0.0892	0.1612
East	- 0.5060*	0.0862	- 0.5074*	0.0867
Constant	5.3657*	0.4852	5.6153 *	0.9638
Adj/R^2	0.7720		0.7643	

*Significant at below 0.05 level.

**Significant at below 0.1 level.

district level variations in fertility. The marginal unexplained variation in fertility may be due to the non-inclusion of factors viz., the rising aspiration of the people, the values attached to male children (son preference), exposure to mass media, breast feeding practice and the experience of abortion, in the model. However, the information on these factors is not very easily available at district level.

Comparing OLS and 2SLS regression results given in the Table 3, we see that the two regressions produced the same R^2 value. Although, there are certain differences bund in the coefficients and respective standard errors estimated from these two egression, in the present situation the two results are found practically identical. The results indicate that the effect of under five mortality is significant in the OLS regression, nit its effect turns out to be not significant in the 2SLS regression.

Table 4 shows parameters of the model in which under five mortality is estimated is a function of social and economic factors. Most of the variables show their effects in the expected direction. Under five mortality is significantly lower in areas with a higher urbanization, later marriages, and higher use of sterilization method. However, though the effects of adult female literacy and availability of medical facilities are in the expected direction it is not significant when other variables are accounted for. The social stratification measure, the percentage of scheduled castes and tribes has a strong positive relationship to under five mortality. Moreover, the regional variation in under five mortality remains significant even after controlling for the social and economic factors. The Southern, Northern and Western districts of India have a significantly lower

TABLE 4: DETERMINANTS OF UNDER FIVE MORTALITY: RESULTS FROM OLS AND 2SLS

	OLS		*2SLS*	
	Coefficient	*S.E.*	*Coefficient*	*S.E.*
ADFL	0.1702	0.1064	-0.1968	0.1840
AGEM	-4.0325*	1.5261	-3.8557*	1.7148
CEPS	0.0903	0.1942	-0.7147**	0.3766
SCST	0.5533*	0.1046	0.4790*	0.1208
URB	-0.2236*	0.1031	-0.3215*	0.1216
AGL	-0.1058	0.1233	- 0.0868	0.1386
MED	- 0.0752	0.0506	- 0.0242	0.0601
TFR	15.4011*	2.5207	-9.3827	9.8652
South	- 20.3960*	5.3433	-42.1630*	10.2412
North	-17.3149*	5.3330	- 26.6869*	6.9730
West	- 12.4366*	5.5482	- 14.6594*	6.2866
East	-1.0719	4.7047	-9.1650	6.1177
Constant	103.3538*	28.8813	257.0989*	66.9960
Adjusted R^2	0.5168		0.4341	

* Significant at below 0.05 level.
** Significant at below 0.1 level.

under five mortality than the districts of Bihar, Rajasthan, Madhya Pradesh and Uttar Pradesh. The model used here explained only 43 percent of the district level variation in under five mortality. Thus the unexplained variation is very large in case of under five mortality and it is possibly due to the fact that the equation do not include certain factors like mass media exposure, breast feeding practices, differential treatment of children by sex, availability of health personnels in the community and most importantly immunization coverage that are found to influence child mortality.

From Table 4, it is found that the results obtained through OLS and 2SLS are different. The explained variation in the under five mortality is about 52 percent according to OLS regression, however it is reduced to 43 percent when 2SLS regression is applied. Similarly, striking differences in the coefficients and respective standard errors are also noticed between these two regressions. It is observed that the effect as well as the significance of fertility and adult female literacy on under five mortality has changed while comparing these two regressions.

Discussion and Conclusions

In this article we have tried to explain the variations in fertility and child mortality in India using simultaneous equations. It is found that the models used here are able to capture 76 percent and 43 percent of district level variations in fertility and under five mortality respectively. Although there is some unexplained regional variation in fertility and child mortality in India, the results from this analysis have some important implications. Urbanization is a powerful variable that influence both mortality and fertility. It has a significantly negative influence on both fertility and under five mortality. Another variable which has a significantly negative effect on both fertility and mortality is the family planning variable. Moreover, in affecting fertility and under five mortality, the measure of urbanization is closely linked with economic development, while the family planning acceptance is closely related to both social and economic development. However, the adult female literacy has a significantly negative effect on fertility, but it is not a powerful variable in explaining the under five mortality. A higher presence of Muslim population significantly increases fertility, possibly due to some distinctive aspects of family size, greater restriction on women and restrictions on family; planning acceptance. Hence, to reduce the fertility in India, programmes in areas with a higher presence of Muslim population should focus to alter these aspects. Similarly, the negative relationship between fertility and female labour force participation indicate the requirement of programmes that controls the conditions of labour force market. The message seems to be quite surprising, but it is important to note that variables related to status of women (female literacy and female work participation) have a significant and strong influence on fertility than under five mortality. The study clearly brought out that for accelerating the fertility decline in various districts of India, programme efforts can be made more effective by giving particular attention to key structural variables namely female literacy, female labour force participation, urbanization and proportion of Muslim population. Similarly, the under five mortality can be reduced by focusing special attention to the variables of female age at marriage, family planning and urbanization. Thus in India, the process of demographic change can clearly be reinforced through variety of channels.

Comparing the results obtained through the simultaneous equation method and least square method, we see that these two methods produce virtually identical results for fertility. This generally happens when the R^2 value in the first stage is very high. However, the results are not similar in case of under five mortality.

Since the unit of our analysis is district, it is possible that an attribute of one district is correlated with its value in another district because of the spatial proximity of the two district and one limitation of the study is the non-correction of the estimate for the possible presence of spatially correlated errors.

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Appendix

BASIC DATA USED AND ITS COMPARISON WITH OTHER SOURCES

Sla tes districts	*Total fertility estimates*			*Under jive mortality*		
	RGI	*Bhat*	*Diffe rence*	*RGI*	*Rajan*	*Diffe rence*
Uttar Pradesh						
Uttarkashi	4.7	4.6	0.1	142	140	2
Ciiamoli	4.1	4.0	0.1	82	84	-2
Tehri Garhwal	4.8	4.2	0.6	93	97	-4
Dehradun	4.0	3.8	0.2	76	73	3
Garhwal	4.3	3.4	0.9	90	70	20
Pithoragarh	4.1	3.8	0.3	99	103	-4
Almora	4.5	3.8	0.7	84	80	4
Nainital	5.4	4.7	0.7	111	117	-6
Bijnor	6.3	6.0	0.3	120	126	-6
Moradabad	5.5	6.3	-0.8	125	126	-1
Rampur	5.9	6.4	-0.5	137	146	-9
Saharanpur	5.5	5.6	-0.1	104	101	3
Hardwar	5.4	5.3	0.1	98	97	1
Muzaffarnagar	5.8	5.8	0	129	132	-3
Meerut	5.1	5.5	-0.4	104	91	13
Ghaziabad	4.5	5.7	-1.2	73	72	1 ;
Bulandshahr	5.9	6.0	-0.1	117	102	15
Aligarh	5.7	6.4	-0.7	126	124	2
Mathura	5.7	6.3	-0.6	111	110	1
Agra	4.9	5.7	-0.8	89	92	-3
Firozabad	6.7	5.9	0.8	143	142	1
Etah	6.0	6.3	-0.3	161	176	-15
Mainpuri	5.8	5.9	-0.1	128	127	1
Budaun	6.3	6.6	-0.3	171	211	-40
Bareilly	5.8	5.9	-0.1	139	130	9
Pilibhit	6.3	5.9	0.4	137	145	-8
Shahjahanpur	5.5	5.5	0	164	175	-11
Kheri	5.1	5.1	0	129	105	24
Sitapur	5.1	5.3	-0.2	137	142	-5
Hardoi	5.1	5.4	-0.3	184	188	-4
Unnao	5.7	5.1	0.6	144	140	4
Lucknow	4.4	4.2	0.2	103	89	14
Rae Bareli	6.0	5.2	0.8	163	158	5
Farrukhabad	5.4	5.6	-0.2	132	131	1
Etawah	5.1	5.4	-0.3	144	137	7
Kanpur (Dehat)	6.2	4.5	1.7	131	130	1
Kanpur (Nagar)	^3.9	3,6	0.3	111	48	63
Jalaun	' 4.9	5.2	-0.3	132	132	0
Jhansi	4.3	4.8	-0.5	126	118	8

Lalitpur	5.6	6.1	-0.5	158	160	-2
Hamirpur	4.9	5.4	-0.5	148	150	-2
Banda	5.8	5.4	0.4	141	134	7
Fatehpur	6.1	5.5	0.6	162	151	11
Pratapgarh	5.6	5.0	0.6	147	145	2
Allahabad	5.8	5.3	0.5	143	143	0
Bahraich	5.6	5.2	0.4	169	183	-14
Gonda	6.4	5.3	1.1	157	156	1
Barabanki	5.2	5.0	0.2	127	124	3
Faizabad	5.4	5.0	0.4	110	109	1
Sultanpur	5.8	4.9	0.9	143	144	-1
Siddharthnaga	6.4	5.6	0.8	158	156	2
Basti	5.5	5.5	0	205	128	77
Gorakhpur	5.3	5.1	0.2	96	98	-2
Deoria	5.8	5.1	0.7	116	115	1
Mau	5.6	5.3	0.3	97	91	6
Azamgarh	5.8	5.3	0.5	127	109	18
Jaunpur	5.6	5.3	0.3	124	125	-1
Ballia	5.0	4.8	0.2	61	55	6
Ghazipur	5.2	5.1	0.1	79	79	0
Varanasi	5.1	5.5	-0.4	112	99	13
Mirzapur	6.0	6.0	0	132	131	1
Sonbhadra	5.3	5.9	-0.6	112	112	0
Bihar						
Aurangabad	5.2	5.2	0	89	91	-2
Begusarai	5.4	5.3	0.1	98	96	2
Bhagalpur	4.7	5.5	-0.8	86	87	-1
Bhojpur	4.9	4.9	0	76	76	0
Darbhanga	• 5.5	5.0	0.5	96	96	0
Deoghar	5.3	5.6	-0.3	128	128	0
Dhanbad	4.7	3.8	0.9	41	40	1
Dumka	4.1	5.0	-0.9	85	82	3
Gaya	5.4	5.3	0.1	104	100	4
Giridih	5.2	5.2	0	96	96	0
Godda	4.3	5.0	-0.7	104	84	20
Gopalganj	5.5	5.3	0.2	68	69	-1
Gumla	5.4	4.7	0.7	116	128	-12
Hazaribag	5.0	5.4	-0.4	80	73	7
Jehanabad	4.8	4.9	-0.1	105	90	15
Katihar	5.5	6.0	-0.5	121	124	-3
Khagaria	5.5	5.7	-0.2	101	91	10
Lohardaga	5.7	5.3	0.4	110	103	7
Madhepura	4.7	5.4	-0.7	106	110	-4
Madhubani	4.8	4.6	0.2	89	94	-5
Munger	6.2	5.3	0.9	99	94	5
Muzaffarpur	5.1	5.1	0	109	100	9
Nalanda	^ 5.1	4.9	0.2	101	93	8
Nawada	5.3	5.1	0.2	100	96	4

Appendix *(contd. on* p. 68)

Appendix *(contd. from* p. 67)

Palamu	5.6	6.4	-0.8	131	118	13
Pashchim Champaran	5.3	5.1	0.2	101	101	0
Pashchimi Singhbhum	4.5	4.4	0.1	96	79	17
Patna	5.2	4.5	0.7	94	70	24
Purba Champaran	4.6	5.2	-0.6	101	79	22
Purbi Singhbhum	3.5	3.5	0	92	44	48
Pumia	5.4	5.6	-0.2	114	109	5
Ranchi	4.7	4.7	0	79	70	9
Rohtas	5.3	5.3	0	89	90	-1
Saharsa	4.5	5.4	-0.9	93	102	-9
Sahibganj	3.7	5.3	-1.6	129	118	11
Samastipur	4.8	5.2	-0.4	124	103	21
Saran	5.1	5.2	-0.1	104	100	4
Sitamarhi	5.0	5.2	-0.2	145	125	20
Siwan	5.4	5.1	0.3	75	82	-7
Vaishali	5.0	5.4	-0.4	71	71	0
Maharashtra						
Thane	3.4	3.4	0	54	54	0
Raigarh	3.8	3.4	0.4	87	66	21
Ratnagiri	3.7	3.0	0.7	90	51	39
Sindhudurg	3.3	2.5	0.8	87	50	37
Nashik	4.1	4.2	-0.1	88	84	4
Dhule	4.2	3.8	0.4	95	96	-1
Jalgaon	3.9	3.8	0.1	84	82	2
Ahmadnagar	3.8	3.9	-0.1	60	61	-1
Pune	3.2	3.1	0.1	70	44	26
Satara	3.3	3.1	0.2	61	48	13
Sangli	3.0	3.2	-0.2	53	47	6
Solapur	3.5	4.0	-0.5	83	65	18
Kolhapur	2.9	3.0	-0.1	74	49	25
Aurangabad	4.6	5.2 .	-0.6	81	79	2
Jalna	4.5	5.4	-0.9	94	80	14
Parbhani	4.5	5.4	-0.9	95	93	2
Bid	4.4	5.4	-1	80	75	5
Nanded	4.6	5.4	-0.8	87	88	-1
Osmanabad	3.9	4.6	-0.7	96	86	10
Latur	4.3	5.0	-0.7	71	67	4
Buldana	4.5	4.7	-0.2	97	98	-1
Akola	4.6	4.1	0.5	115	96	19
Amravati	4.0	3.7	0.3	114	105	9
Yavatmal	3.9	4.1	-0.2	143	142	1
Wardha	3.5	3.2	0.3	104	102	2
Nagpur	3.5	3.3	0.2	10]	84	17
Bhandara	3.8	3,4	0.4	115	117	-2
Chandrapur	3.8	3.6	0.2	137	118	19
Gadchiroli	4.0	4.0	0	144	152	-8

Kooch Bihar	4.1	4.0	0.1	128	128	0
Jalpaiguri	3.9	3.9	0	109	108	1
Darjeeling	3.5	3.0	0.5	75	78	-3
West Dinajpur	4.4	4.6	-0.2	113	112	1
Maldah	5.0	5.1	-0.1	140	142	-2
Murshidabad	4.9	5.1	-0.2	122	120	2
Nadia	3.7	3.5	0.2	103	104	-1
North 24 parganas	3.3	3.2	0.1	101	83	18
South 24 parganas	4.9	4.0	0.9	106	112	-6
Haora	3.6	3.0	0.6	71	52	19
Hugli	2.9	2.8	0.1	64	45	19
Medinipur	3.7	3.7	0	90	90	0
Bankura	3.5	3.4	0.1	85	67	18
Puruliya	4.1	4.1	0	76	76	0
Barddhaman	3.6	3.3	0.3	74	65	9
Birbhum	3.8	4.1	-0.3	117	97	20
Andhra Pradesh						
Srikakulam	3.4	3.5	-0.1	101	99	2
Vizianagaram	3.4	3.2	0.2	120	122	-2
Visakhapatnam	3.4	2.9	0.5	86	80	6
East Godavari	3.4	3.2	0.2	73	73	0
West Godavari	3.0	2.9	0.1	79	70	9
Krishna	3.3	2.9	0.4	47	47	0
Guntur	3.2	2.7	0.5	56	48	8
Prakasam	3.5	3.0	0.5	64	64	0
Nellore	3.1	2.6	0.5	62	62	0
Chittoor	3.1	2.7	0.4	76	55	21
Cuddapah	3.4	2.8	0.6	52	53	-1
Anantapur	3.9	3.6	0.3	88	89	-1
Kumool	4.3	4.1	0.2	89	91	-2
Mahbubnagar	4.5	4.2	0.3	95	96	-1
Rangareddi	3.9	4.0	-0.1	65	54	11
Medak	4.2	3.9	0.3	68	65	3
Nizamabad	3.3	3.2	0.1	58	59	-1
Adilabad	3.8	4.0	-0.2	75	61	14
Karimnagar	3.4	3.2	0.2	45	42	3
Warangal	4.1	3.4	0.7	77	78	-1
Khammam	3.7	3.5	0.2	68	66	2
Nalgonda	4.3	3.6	0.7	72	73	-1
Madhya Pradesb						
Morena	6.6	6.0	0.6	138	139	-1
Bhind	5.6	5.8	-0.2	149	149	0
Gwalior	4.9	4.7	0.2	119	108	11
Datia	^ 5-1	5.8	-0.7	178	181	-3
Shivpuri	5.4	6.3	-0.9	200	239	-39
Guna	5.9	5.9	0	195	204	-9

Appendix *(contd. on* p. 70)

Appendix *(contd. from* p. 69)

Tikamgarh	6.2	6.1	0.1	187	189	-2
Chhatarpur	5.6	6.6	-1	199	230	-31
Panna	5.7	5.9	-0.2	204	210	-6
Sagar	5.5	5.5	0	172	180	-8
Damoh	5.1	5.3	-0.2	194	192	2
Satna	5.5	5.7	-0.2	203	223	-20
Rewa	5.6	5.8	-0.2	196	202	-6
Shahdol	5.0	5.3	-0.3	160	173	-13
Sidhi	6.0	6.7	-0.7	165	155	10
Mandsaur	4.1	4.1	0	150	151	-1
Ratlam	4.7	4.6	0.1	149	153	-4
Ujjain	4.2	4.2	0	147	150	-3
Shajapur	5.0	5.1	-0.1	168	168	0
Dewas	4.9	5.0	-0.1	129	132	-3
Jhabua	5.7	7.0	-1.3	169	206	-37
Dhar	5.0	5.1	-0.1	122	126	-4
Indore	3.8	3.6	0.2	94	97	-3
West Nimar	5.1	5.3	-0.2	158	163	-5
East Nimar	5.2	5.2	0	151	156	-5
Rajgarh	5.2	5.3	-0.1	182	183	-1
\^idisha	5.6	5.6	0	191	190	1
Bhopal	4.8	3.8	1	105	122	-17
Sehore	5.2	6.0	-0.8	178	189	-11
Raisen	6.1	5.3	0.8	179	186	-7
Betui	5.3	5.6	-0.3	180	214	-34
Hoshangabad	4.7	5.4	-0.7	179	171	8
Jabalpur	4.6	4.2	0.4	147	163	-16
Narsimhapur	4.0	4.6	-0.6	148	167	-19
Mandia	4.1	5.0	-0.9	132	133	-1
Chhindwara	5.2	5.3	-0.1	142	165	-23
Seoni	4.3	5.0	-0.7	152	153	-1
Balaghat	3.9	4.2	-0.3	167	168	-1
Surguja	4.3	5.3	-1	113	114	-1
Bilaspur	4.7	5.0	-0.3	123	128	-5
Raigarh	4.0	4.3	-0.3	131	137	-6
Rajnandgaon	4.2	5.0	-0.8	150	151	-1
Durg	4.2	4.2	0	122	117	5
Raipur	4.3	4.6	-0.3	137	142	-5
Bastar	4.5	5.0	-0.5	129	128	1
Tamil Nadu						
Chengalpattu M.G.R.	3.2	2.5	0.7	64	65	-1
North Arcot	3.5	2.6	0.9	70	72	-2
Dharmapuri	3.5	3.0	0.5	82	77	5
Tiruvannamalai	3.4	2.8	0.6	72	73	-1
South Arcot	^	2.8	0.6	84	86	-2
Salem	2.7	2.0	0.7	71	69	2
Periyar	2.9	1.6	1.3	87	92	-5

Nilgiri	2.5	1.6	0.9	61	62	-1
Coimbatore	2.5	1.7	0.8	58	54	4
Dindigul-Anna	2.7	2.1	0.6	94	88	6
Tiruchirappalli	3.1	2.2	0.9	74	89	-15
Thanjavur	3.0	2.3	0.7	54	55	-1
Pudukkottai	4.0	2.3	1.7	75	77	-2
Pasumpon-	3.6	2.3	1.3	72	76	-^t
Madurai	3.3	2.2	1.1	77	67	10
Kamaraja	3.0	2.4	0.6	85	87	-2
Ramanathapuram	3.5	2.6	0.9	70	68	2
Chidambaranar	3.1	2.4	0.7	70	71	-1
Tinmelveli-Kanabomm	3.6	2.4	1.2	95	100	-5
Kanniyakumari	3.1	2.1	1	46	48	-2
Karoatak*						
Bangalore	3.5	2.5	1	67	58	9
Bangalore Rural	3.8	2.6	1.2	67	67	0
Belgaum	3.6	3.7	-0.1	69	70	-1
Bellary	4.9	4.2	0.7	119	119	0
Bidar	4.8	5.1	-0.3	85	66	19
Bijapur	4.3	4.4	-0.1	88	85	3
Chikmagalur	3.1	2.5	0.6	75	79	-4
Chitradurga	3.6	3.4	0.2	104	105	-1
Dakshin Kannada	3.6	2.5	1.1	46	49	-3
Dharwad	3.9	3.6	0.3	95	96	-1
Gulbarga	4.8	4.9	-0.1	86	86	0
Hassan	2.9	2.8	0.1	78	79	-1
Kodagu	2.8	2.4	0.4	66	68	-2
Kolar	3.9	3.1	0.8	100	85	15
Mandya	3.1	2.7	0.4	84	74	10
Mysore	3.6	2.9	0.7	89	91	-2
Raichur	4.7	5.0	-0.3	80	81	-1
Shimoga	3.7	2.8	0.9	88	90	-2
Tumkur	3.5	2.9	0.6	102	102	0
Uttar Kannada	3.7	2.9	0.8	69	67	2
Rajasthan						
Ganganagar	4.2	4.3	-0.1	73	68	5
Bikaner	5.0	4.7	6.3	82	73	9
Churu	4.1	5.3	-1.2	83	85	-2
Jhunjhunu	4.8	5.2	-0.4	80	78	2
Alwar	5.0	6.1	-1.1	124	125	-1
Bharatpur	5.3	6.5	-1.2	126	129	-3
Dholpur	6.4	6.7	-0.3	150	152	-2
Sawai Madhopur	6.0	6.1	-0.1	122	128	-6
Jaipur	4.9	5.3	-0.4	94	96	-2
Sikar	5.4	6.0	-0.6	78	79	-1
Ajmer it	4.8	4.6	0.2	130	120	10
Tonk	5.0	5.4	-0.4	149	153	-A

Appendix *(contd. on p.* 72)

Appendix {*contd. from* p. 71)

Jaisalmer	5.5	5.2	0.3	124	111	13
Jodhpur	5.1	4.6	0.5	86	95	-9
Nagaur	4.8	5.4	-0.6	102	96	6
Pali	4.9	4.8	0.1	156	158	-2
Banner	5.6	4.9	0.7	143	134	9
Jalore	5.2	5.3	-0.1	129	129	0
Sirohi	4.7	4.7	0	139	141	-2
Bhilwara	4.8	4.6	0.2	143	138	5
Udaipur	4.6	4.3	0.3	129	130	J
Chittaurgarh	4.4	4.2	0.2	149	146	3
Dungarpur	5.2	4.4	0.8	140	149	-9
Banswara	5.1	5.2	-0.1	148	142	6
Bundi	5.0	5.3	-0.3	120	120	0
Kota	5.0	5.1	-0.1	140	107	33
Jhalawar	4.5	4.9	-0.4	124	121	3
Gujarat						
Jamnagar	4.0	3.0	1	66	64	2
Rajkot	4.0	3.0	1	66	62	4
Surendranagar	4.4	3.8	0.6	98	110	-12
Bhavnagar	4.6	3.9	0.7	59	65	-6
Amreli	4.2	3.4	0.8	97	64	33
Junagadh	4.0	3.1	0.9	78	64	14
Kachchh	4.4	3.9	0.5	98	97	1
Banas Kantha	5.3	4.7	0.6	116	112	4
Sabar Kantha	4.3	3.1	1.2	104	109	-5
Mahesana	4.1	3.3	0.8	122	124	-2
Gandhinagar	3.8	3.0	0.8	102	90	12
Ahmedabad	3.6	2.9	0.7	78	63	15
Kheda	4.1	2.9	1.2	117	116	1
Panch Mahals	4.7	4.6	0.1	111	122	-11
Vadodara	4.6	2.7	1.9	82	83	-1
Bharuch	3.6	3.5	0.1	86	89	-3
Surat	3.5	3.0	0.5	102	66	36
Valsad	3.4	2.8	0.6	83	46	37
The Dangs	5.0	5.0	0	112	113	-1
Orissa						
Sambalpur	4.2	3.6	0.6	131	163	-32
Sundargarh	3.9	3.5	0.4	115	120	-5
Kendujhar	4.2	4.2	0	137	142	-5
Mayurbhanj	4.1	4.3	-0.2	125	107	18
Baleshwar	5.0	4.3	0.7	164	246	-82
Cuttack	4.3	3.8	0.5	142	172	-30
Dhenkanal	4.4	4.0	0.4	148	164	-16
Phulbani	^ 5.0	4.6	0.4	170	206	-36
Balangir	4.3	3.7	0.6	139	153	-14

Kalahandi	3.8	3.7	0.1	158	168	-10
Koraput	4.2	4.2	0	140	159	-19
Ganjam	3.1	4.2	-1.1	149	153	-*A*
Puri	4.0	3.5	0.5	172	155	17
Kerala						
Kasargod	3.3	2.5	0.8	49	49	0
Kannur	2.5	2.1	0.4	50	42	8
Wayanad	2.6	2.3	0.3	89	58	31
Kozhikode	3.1	2.0	1.1	61	50	11
Malappuram	4.2	3.4	0.8	58	57	1
Palakkad	2.7	2.4	0.3	55	56	-1
Thrissur	2.1	1.9	0.2	47	46	1
Emakulam	2.1	1.6	0.5	48	42	6
Idukki	2.8	1.8	1	74	56	18
Kottayam	2.2	1.7	0.5	57	39	18
Alappuzha	2.0	1.6	0.4	45	42	3
Pathanamthitta	1.9	1.7	0.2	39	33	6
Kollam	2.1	1.8	0.3	50	47	3
Thiruvananthapuram	2.3	1.8	0.5	51	31	20
Assam						
Dhubri	5.1	NA	NA	166	160	6
Kokrajhar	5.3	NA	NA	110	97	13
Goalpara	4.5	NA	NA	133	129	4
Barpeta	6.4	NA	NA	142	137	5.
Nalbari	6.3	NA	NA	117	114	3
Kamrup	3.4	NA	NA	90	94	-4
Darrang	5.5	NA	NA	131	141	-10
Sonitpur	4.4	NA	NA	108	103	5
Lakhimpur	4.7	NA	NA	125	135	-10
Nagaon	4:8	NA	NA	117	116	1
Jorhat	4.4	NA	NA	77	71	6
Sibsagar	4.3	NA	NA	*89*	84	5
Dibrugarh	3.4	NA	NA	77	73	4
Karbi Anglong	4.4	NA	NA	124	106	18
North Cachar Hills	3.8	NA	NA	118	88	30
Karimganj	7.1	NA	NA	131	143	-12
Cachar	4.1	NA	NA	116	119	-3
Punjab						
Gurdaspur	3.7	3.6	0.1	99	65	34
Amritsar	4.0	3.7	0.3	61	61	0
Firozepur	4.2	4.1	0.1	77	72	5
Ludhiana	3.0	3.5	-0.5	60	51	9
Jalandhar	3.6	3.1	0.5	69	66	3
Kapunhala	3.4	3.3	0.1	122	61	61
Hoshiarpur ^	3.7	3.4	0.3	100	80	20
Rupnagar	4.0	3.6	0.4	76	68	8

Appendix *(contd. on* p. 74)

Patiala	4.0	3.5	0.5	80	67	13
Sangrur.	4.0	3.7	0.3	79	85	-6
Bhatinda	3.9	3.3	0.6	87	78	9
Faridkot	3.8	3.2	0.6	67	65	2
Haryana						
Ambala	3.5	3.6	-0.1	71	54	17
Yamuiranagar	4.3	3.8	0.5	76	65	11
Kurukshetra	3.8	3.9	-0.1	93	77	16
Kaithal	4.2	4.1	0.1	106	83	23
Kamal	4.4	4.5	-0.1	67	62	5
Panipat	4.6	4.8	-0.2	81	80	I
Sonepat	4.2	4.7	-0.5	94	61	33
Rohtak	4.4	4.1	0.3	76	64	12
Faridabad	4.8	5.4	-0.6	66	66	0
Gurgaon	5.7	5.9	-0.2	107	86	21
Rewari	4.1	4.3	-0.2	78	79	-1
Mahendragarh	4.4	4.5	-0.1	94	71	23
Bhiwani	4.2	4.4	-0.2	115	75	40
Jind	4.5	4.7	-0.2	99	95	4
Hisar	4.4	4.3	0.1	74	72	2
Sirsa	3.9	4.0	-0.1	80	74	6
Himachal Pradesh						
Chamba	4.5	NA	NA	113	107	6
Kangra	3.4	NA	NA	100	64	36
Hamirpur	3.0	NA	NA	81	61	20
Una	3.5	NA	NA	96	80	16
Bilaspur	3.3	NA	NA	82	86	-4
Mandi	3.5	NA	NA	90	90	0
Kullu	4.0	NA	NA	116	110	6
Lahaul and Spiti	3.8	NA	NA	122	121	1
Shimla	3.5	NA	NA	126	127	-1
Solan	3.5	NA	NA	101	107	-6
Sirmaur	4.5	NA	NA	118	129	-11
Kinnaur	4.0	NA	NA	152	154	-2