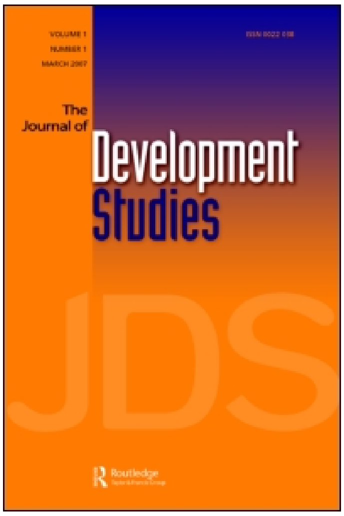

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Daughter Elimination in Tamil Nadu, India: A Tale of Two Ratios

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ABSTRACT *A disturbing feature of demographic trends in India is the sharp decline in the proportion of girls to boys. Most existing analyses of the Indian child sex ratio present a country wide picture and focus on trends across states. Such state level analyses may hide intra state variation. This paper uses district and village data on sex ratio at birth and infant mortality to examine the extent, geographical spread and nature (before or after birth) of daughter deficit within the South Indian state of Tamil Nadu. Our analysis shows that (i) daughter deficit in Tamil Nadu occurs in nearly half the state's districts; (ii) a large proportion of daughter deficit occurs before birth; (iii) daughter deficit rises with birth order and (iv) daughter elimination is not confined to particular socio-economic groups.*

I. Introduction

For a large part of the previous century India has witnessed a steady decline in its population sex ratio, reaching the lowest ever recorded ratio of 927 females per 1000 males in 1991. While the 2001 Census points to a slight improvement in the overall population sex ratio, the proportion of girls to boys or the sex ratio for the 0–6 age group continues to decline. This ratio has fallen from 976 in 1961 to 927 in 2001, giving 'rise to both alarm and despair' (Agnihotri, 2003: 4351). A substantial proportion of the decline is attributed to the differential survival chances of girls and boys in the 0–6 age group due to sex selective abortion, neglect, and female infanticide. In geographic terms, much of this decline is concentrated in states with a long history of gender differentials in survival among children notably Punjab, Haryana and Delhi in the north and Gujarat and Maharashtra in the west. However, a troublesome aspect is that gender differentials in survival are also becoming noticeable in other states. Tamil Nadu, a south Indian state and the focus of this paper, is one such case.

Early work on sex ratios in India pointed out a sharp regional dichotomy with masculine sex ratios in the north and the west and less adverse female to male sex

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ratios in the south and the east (for example, Sopher, 1980: 294–296; Miller, 1981: 71–74; Dyson and Moore, 1983). More recent work (Agnihotri, 2003) based on an analysis of the 2001 census data argues that the traditional north/west-south/east divide is no longer valid.[1] In the case of Tamil Nadu, despite the relatively high status of women, the state has recorded a steady decline in its 0–6 age group sex ratio. The ratio has fallen from 985 in 1961 to 942 in 2001 and some of the districts with the most unequal 0–6 sex ratios in the country lie within the state. Thus, while the level of the 0–6 sex ratio in Tamil Nadu may be higher than the national average, the temporal patterns in the ratio suggest that the state is experiencing a trend that is similar to the rest of the country.

Most existing analyses of sex ratios in India present a country-wide picture and focus on state level trends in the 0–6 sex ratio. While useful, since the 0–6 sex ratio reflects the combined effect of the sex ratio at birth (SRB) as well as age specific mortality up to age six it probably hides the extent of the female deficit occurring before and within a year after birth.[2] Furthermore, state level analyses may be misleading as they may mask wide intra state variations. Accordingly, this paper uses district level secondary data and village level primary data on sex ratio at birth and infant mortality to examine the extent, the geographical spread and the nature (before or after birth) of daughter deficit within the south Indian state of Tamil Nadu. Analysis of sex ratio at birth and infant mortality provides an idea of the dynamics underlying the development of female deficit while an intra state analysis allows us to capture the wide intra state variation in female deficit.

Existing work on Tamil Nadu focuses mainly on daughter deficit in the form of female infanticide.[3] Indeed, in the 1980s daughter elimination first came to light in Tamil Nadu in the form of female infanticide among certain castes such as the Kallars in Madurai (Soundarapandian, 1985; Venkatramani, 1986; Jeeva et al., 1998), Gounders in Salem district (Venkatachalam and Srinivasan, 1993) and Gounders in Vellore district (George et al., 1992). While these papers suggested that daughter deficit is restricted to a limited geographic area and occurs only among certain castes, more recent work by Chunkath and Athreya (1997) displays that female infanticide is far more widespread and occurs in several districts and across several castes. This paper extends the work of Chunkath and Athreya (1997) by systematically documenting the extent and geographic spread of daughter deficits before and after birth.

Consistent with the focus on infanticide, government and NGO interventions have mainly paid attention to preventing female infanticide. Female infanticide has been framed as a problem of poverty, and programmes and schemes have been targeted at households living below the poverty line (Srinivasan, 2006).[4] The notion that daughter elimination is a problem of underdevelopment and poverty receives support from George et al. (1992) and Natarajan (1997). For instance, based on data collected between 1987 and 1989 from Vellore district, George et al. (1992) point out that female infanticide is more likely to occur in remote villages with less educated populations. On the contrary, Nillesen and Harriss-White's (2004) analysis, based on data collected from Vellore and Thiruvanamallai districts in 1994 suggests that females are less likely to survive in wealthier households. This paper adds to the literature on such village level investigations. We use primary data collected from the

Salem district in 2002 to explore the link between daughter deficit and various socioeconomic characteristics.

The paper is organised as follows. The following section presents a description of the databases used. In sections III and IV we assess the extent, spread and magnitude of pre-birth and post-birth daughter deficit. These sections examine the 0–6 sex ratio, the sex ratio at birth (SRB) and infant mortality rate (IMR) separately for India and Tamil Nadu as a whole and, then in more detail for urban and rural Tamil Nadu. Section V examines the link between daughter elimination and various socio-economic characteristics. Section VI summarises and concludes the paper.

II. Data

Our analysis of daughter elimination is based on a combination of secondary and primary data on vital events from the state to village level. Secondary data sources used in this paper are the Census 2001 and, the Sample Registration System (SRS) of the Government of India (GOI) and, most importantly, the Vital Events Surveys (VES) conducted between 1996 and 2000 by the Government of Tamil Nadu. Primary data were obtained from a 2002 survey conducted in a village located in Salem, the district with the most masculine 0–6 sex ratio in the state.

Secondary Data

An intra state assessment of daughter deficit requires district level data on sex ratio at birth and information on male and female infant mortality. The civil registration system which in principle should be able to provide district level figures on birth, death, infant mortality and other vital events is not complete and far from reliable. In the absence of reliable data from the civil registration system, a widely used source to assess the extent of daughter deficit in India is census data on sex ratio for the 0–6 age group. These data are available for all districts. In addition to the census data we use information from the Sample Registration System (SRS), a countrywide survey of vital events covering about 1.1 million households (six million individuals) in each round. While SRS provides information on sex ratio at birth and infant mortality, these are available only at the state level and, therefore, unlike the census, do not support examination of intra state patterns.

To explore intra state patterns, we use four rounds of the Vital Events Surveys (VES) conducted by the Directorate of Public Health (DPH) of Tamil Nadu between 1996 and 2000. These surveys contain a large amount of information on vital events and for the most part have not yet been analysed. The surveys *do* provide data on sex ratio at birth, infant deaths, and other demographic variables disaggregated by district and gender. The first survey was carried out in 1996 for the reference year 1995. Subsequently, a second round was conducted in 1998 for the reference years 1996 and 1997, a third round was undertaken in 1999 for the reference period 1998 and, a fourth round was completed in 2000 for the reference year 1999. Each of the surveys gathered information from a sample of about six million individuals in rural (non-municipal) areas and three million individuals in urban (municipalities and corporations) areas.[5] At the district level, this entails a sample size of about 200,000 individuals in rural (non-municipal) areas and 100,000 individuals in municipal areas. Pre-tested, machine readable questionnaires were developed for the exercise and the surveys were conducted by 36 trained enumerators per district; additional details on the surveys are available from Athreya (1999). The methodical approach to data collection and data capture and the large size of the sample suggest that the surveys contain high quality data on vital events.

We rely on the information gathered during the second, third and fourth rounds or surveys covering the reference period 1996–1999 for our analysis.[6] We pool together the information from the various rounds of the surveys to provide figures on sex ratio at birth and infant mortality rate. Thus, our analysis relies on responses from 36 million individuals or about 1.25 million individuals per district. The total number of births analysed in the paper are 694,605. The volume of data available in each of the VES surveys (nine million individuals and 174,000 births) may be contrasted with the SRS surveys for Tamil Nadu which usually cover 355,000 individuals and about 6000–7000 births in each round.

Primary Data

While the secondary data provide an idea of the extent of missing daughters, the geographic spread and pre- and post-birth deficit, they do not reveal the anatomy of missing daughters. For example, does the likelihood of daughter deficit vary with birth order? Are households with certain socioeconomic characteristics more likely to record daughter deficit? To provide answers to such questions the paper draws upon village level data. A detailed village study was carried out in 2002 in Salem. The village, located in Idapadi block, is a small agrarian multicaste village with three of the major castes of Salem district. In 2002, there were 184 households with a total population of 671 persons, 306 female and 365 male.

Based on structured surveys, information on household characteristics, the desired and actual number and composition of children, total number of pregnancies, outcomes by birth order, abortions and fertility status was gathered. These data were collected for 220 of the 240 married women in the village. In addition, unstructured interviews were conducted with women and men from different castes, classes and age groups to gather information on the emergence and prevalence of practices of female infanticide and sex selective abortion.

The sensitivity of the issue under investigation imposes some limitations on a direct assessment of the extent of daughter elimination. Additionally, fieldwork was carried out at a time when government and non-government agencies were under enormous pressure to prevent daughter elimination in Salem. During the discussions it seemed clear that information on households that had resorted to daughter elimination was commonplace. While most respondents denied the practice in their own households they talked easily about the practice in general and in impersonal terms. Although rare, some respondents did reveal that they had resorted to eliminating the female offspring.

Based on discussions with key informants (including the local nutrition and health workers, members of the women's self-help group) and an analysis of birth and death records in the local health and nutrition (Tamil Nadu Nutrition Programme) centre, a list of cases of female infanticide and sex selective abortion was drawn up.[7] Only women whose names were common across the key informants (or if they had reported daughter elimination) were identified as households which had practised daughter elimination. Based on this approach we estimate that 50 of the 220 women in our sample had eliminated daughters (through sex selective abortion or infanticide). It is possible that the identification of respondents who have eliminated a daughter is incomplete and that we have a conservative estimate of daughter elimination.

III. The Spread of Daughter Deficit in Tamil Nadu

Benchmarking Sex Ratio at Birth and Infant Mortality Rates

To examine the pattern of daughter deficit in Tamil Nadu we pay attention to two ratios in particular. These are the sex ratio at birth (SRB) and differences in male and female infant mortality. Internationally, sex ratios are expressed as a proportion of males to females. However, in India the practice is to express population sex ratio and 0–6 sex ratio as proportion of females to males while sex ratio at birth is expressed as proportion of males to females. For the sake of consistency and to highlight daughter deficit, we define sex ratios across all age groups in terms of the proportion of females to males. To aid international comparisons, Table A1 (see Appendix) contains the female to male ratio and the corresponding male to female ratio.

To detect the extent of daughter deficit occurring before birth we need to compare the observed SRB with a ‘normal’ SRB. Thus, the first question is, what is the SRB which would prevail in India in the absence of interference? While there are variations over time and across regions, according to Guilmoto (2004) a ratio of 952 females to 1000 males appears to be ‘a biological invariant observed in all human populations with only minor variations’. Based on their analysis of 240 years of Swedish data, Johansson and Nygren (1991) show that the SRB among live births is ‘biologically very stable’ and is close to 952 females per 1000 males. They point out that the SRB does not show significant variation across regions, nor does it vary with birth order or by mother’s age. Johansson and Nygren (1991) also analyse data on live births for 12 other Western industrialised countries for the period 1970–1984. According to their analysis, the SRB in these countries conforms to the patterns found in the Swedish data. Based on 1994–2003 data from the United Nations *Demographic Yearbook* (United Nations, 2003), the sex ratio at birth for countries with a complete registration system (civil registration estimated at being over 90% complete) and with 150,000 or more live births per year (about the number of yearly live births in Tamil Nadu) lies between 939 and 965 with a mode of 951.[8] In the Indian context, in the absence of a complete civil registration system, the sex ratio at birth is commonly assumed to be 952 female live births per 1000 male live births (for instance, see Agnihotri, 2000; Premi, 2001; Bhat, 2002).[9]

Accordingly, in this paper we use 952 female births per 1000 male births as the SRB which may be expected to prevail in the absence of any interference. An SRB which is statistically different and less than 952 is treated as evidence of pre-birth daughter deficit. While there may be several factors that lead to a gap between the observed and the expected SRB, as will be discussed and argued later on in the text, the evidence assembled in the paper suggests that sex selective abortion is one of the most likely explanations for the observed pre-birth daughter deficit in Tamil Nadu.[10]

Turning to the expected pattern of infant mortality rates, due to various factors, infant mortality (mortality in the age group 0–365 days and expressed as infant deaths per 1000 live births) is usually higher for males. Based on a review of the literature, Waldron (1983) concludes that, 'in most available data males have had higher mortality than females during the first year of birth'. Based on their analysis of male and female infant deaths in several developed countries for the period 1976–1984, Johansson and Nygren (1991) show that there is a consistent pattern. In all the countries that they analyse, male infant mortality is higher than female infant mortality. Additionally, there appears to be a 'normal' sex ratio of 130 male infant deaths for every 100 female infant deaths.[11] Despite this regularity, we adopt a cautious approach, and view situations where female infant mortality is statistically different from and higher than male infant mortality as evidence of post-birth deficit and in turn of female infanticide and neglect.

Temporal Patterns

We begin our discussion of daughter deficit by examining, in seriatim, temporal patterns in the 0–6 age range sex ratio, the sex ratio at birth and infant mortality rates. Table 1 presents and enables a comparison of temporal patterns in the all India and Tamil Nadu child (0–6 years) sex ratio. Between the period 1961 and 2001, the all India 0–6 sex ratio fell by 49 points from 976 to 927. Over the same duration, the 0–6 sex ratio in Tamil Nadu fell by 43 points from 985 to 942. While the extent of decline in Tamil Nadu is smaller than the decline recorded in several north Indian states, the state is clearly not an exception to the nationwide trend of declining 0–6 sex ratio. A visual depiction of the declining 0–6 sex ratio in Tamil Nadu is provided

Table 1. Population sex ratio, 0–6 sex ratio in India and Tamil Nadu

Year	1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001
Population sex ratio in India	972	964	955	950	945	946	941	930	934	927	933
Population sex ratio in Tamil Nadu	1044	1042	1029	1027	1012	1007	992	978	977	974	987
0–6 sex ratio in India	–	–	–	–	–	–	976	964	962	945	927
0–6 sex ratio in urban India	–	–	–	–	–	–	–	–	–	935	903
0–6 sex ratio in rural India	–	–	–	–	–	–	–	–	–	948	934
0–6 sex ratio in Tamil Nadu	–	–	–	–	–	–	985	974	967	948	942
0–6 sex ratio in urban Tamil Nadu							–	–	–	955	951
0–6 sex ratio in rural Tamil Nadu							–	–	–	945	931

Note: The ratios are defined as the number of females per 1000 males. All figures are based on census data.

in Figure 1. The changes are startling. In 1971, the 0–6 sex ratio was greater than 952 for the entire state, however by 2001, large parts of the state record ratios between 909–952 with some patches recording sex ratios lower than 869.[12]

A comparison of the 0–6 sex ratio across urban and rural areas provides a clearer picture of the similarities and differences between Tamil Nadu and the rest of the country. Unlike the rest of the country where the urban 0–6 sex ratio is considerably lower than the rural 0–6 sex ratio (903 versus 934 in 2001), the pattern in Tamil Nadu is exactly the opposite (951 versus 931 in 2001). Between 1991 and 2001, the 0–6 sex ratio in urban India records a drop of 32 points (935 to 903). Over the same period there is a modest decline of four points (955 to 951) in urban Tamil Nadu. The considerably higher 0–6 sex ratio and the smaller decline over the decade suggests that urban Tamil Nadu is different and does not closely track the trend prevailing in other parts of urban India. In marked contrast, the rural 0–6 sex ratio for Tamil Nadu is lower than the 0–6 sex ratio for rural India. Additionally, between 1991 and 2001, the 16 point decline in the 0–6 sex ratio in rural Tamil Nadu is similar to the decline (14 points) in the 0–6 sex ratio for rural India.

Turning to SRB, as shown in Table 2, the all India SRB has recorded a steady decline over time. The ratio drops from 943 in the period 1978–1992 to 899 in 1997, a drop of 44 points. Over the same duration, the Tamil Nadu SRB declines from 980 to 935, a decline of 45 points. Thus, while Tamil Nadu's SRB is higher than the all India SRB, the absolute decline is similar. A comparison of the 1997 SRB by urban and rural status shows that at 878 the SRB in urban India is substantially lower than the SRB in rural India (903). In contrast, at 943, the SRB in urban Tamil Nadu is

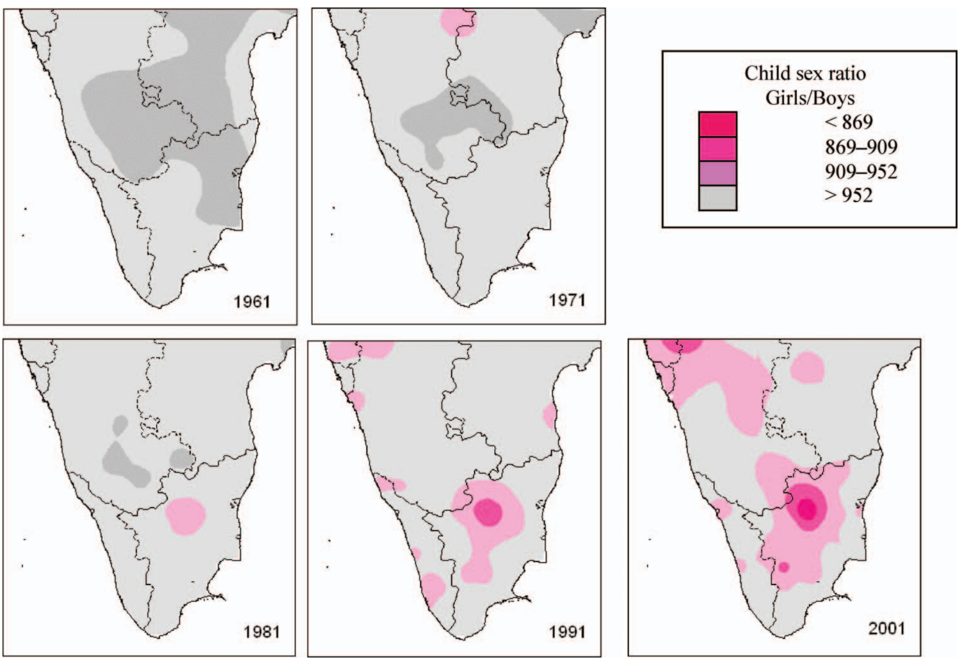

Figure 1. Child (0–6) sex ratio, Tamil Nadu (based on census data 1961–2001)

Table 2. Sex ratio at birth in India and Tamil Nadu

Year/statistic	Source	SRB India	SRB urban India	SRB rural India	SRB Tamil Nadu	SRB urban Tamil Nadu	SRB rural Tamil Nadu
1978–1992	NFHS-1[a]	943	–	–	980	–	–
1984–1998	NFHS-2[a]	926	–	–	952	–	–
1981–1990	SRS[a]	909	–	–	952	–	–
1996–1998	SRS[a]	901	–	–	952	–	–
1997	SFMS[b]	899	878	903	–	–	–
1996–1999	VES[c]	–	–	–	935	943	932
(95% Confidence interval)					(931–939)	(935–951)	(926–937)
Number of births – female/male					*335,712/ 358,893*	*100,380/ 106,406*	*235,332/ 252,487*

Notes: The sex ratio at birth is defined as the number of female live births per 1000 male live births.

a. These SRB figures based on the National Family Health Survey (NFHS) 1 and 2, and the Sample Registration System (SRS) are from Retherford and Roy (2003).

b. These SRB figures for 1997 are based on the Special Fertility and Mortality Survey and are from Jha et al. (2006).

c. These SRB figures are our calculations based on the Vital Events Surveys (VES), 1996–1999.

higher than the SRB in rural Tamil Nadu (932). Despite the higher SRB in Tamil Nadu as compared to the national figures, the sex ratios at birth for the state as a whole and for urban and rural Tamil Nadu are statistically different and lower than the expected SRB of 952.

Table 3 presents information on infant mortality rates (IMR) for Tamil Nadu.[13] There is a clear and large decline in IMR over time. However, as compared to higher male IMR in 1981, more recent data reveal higher mortality rates for females. Based on the VES data, the male IMR is 36 and the female IMR is 39. Statistical tests support the hypothesis that female IMR is higher than male IMR.

There are sharp gender differences in IMR across urban and rural Tamil Nadu. Consistent with internationally expected patterns, the female IMR in urban Tamil Nadu is lower than the male IMR (18 versus 23). In contrast, the patterns in rural Tamil Nadu are the opposite. The male IMR is 41 as compared to a female IMR of 48 (the differences are statistically significant). The sharp gap between the internationally expected pattern of infant mortality and the numbers observed in rural Tamil Nadu suggests post-birth interference (or negligence) and supports the idea that excessive female infant mortality may be driven by 'social causes', a euphemism for infanticide and neglect.

To summarise, the figures presented in this section show that while there are differences in the level of the 0–6 sex ratio and SRB for Tamil Nadu and all India, the temporal patterns do not differ. An examination of rural and urban patterns displayed that the decline in the 0–6 sex ratio and the SRB are pronounced in rural Tamil Nadu.[14] We also found strong evidence of post-birth daughter deficit in rural

Table 3. Infant mortality rates in Tamil Nadu

		IMR Tamil Nadu		IMR urban Tamil Nadu		IMR rural Tamil Nadu	
Year/Statistic	Source	Male	Female	Male	Female	Male	Female
1981	NHDR	114	93	–	–	–	–
1991	NHDR	55	51	–	–	–	–
1996–1999	VES[a]	36	39	23	18	41	48
Infant Deaths		12866	13214	2435	1898	10431	11316
Absolute value of test statistic[b]		7.70		6.31		11.45	
p-*value*		0.0000		1.0000		0.0000	

Notes: Infant mortality rate (IMR) is defined as the number of infant deaths (age 0–365 days) per 1000 live births.
a. These IMR figures are our calculations based on the Vital Events Surveys (VES), 1996–1999.
b. The null hypothesis is that female IMR is equal to male IMR, the alternative is that female IMR is higher than male IMR.

Tamil Nadu. The data presented here support the argument that daughter deficit occurs in Tamil Nadu, especially in rural areas, and is consistent with Agnihotri's (2003) findings that daughter deficits are no longer restricted to northern and western India.

Intra State Geographic Patterns

For the most part, daughter deficit in Tamil Nadu has been characterised as a problem of infanticide in a geographical area running 'north to south along a western corridor of the state' (Athreya and Chunkath, 2000). Chunkath and Athreya (1997) document female infanticide in eight districts, from Vellore in the north, and running through Dharmapuri, Salem, Namakkal, Karur, Dindigul and Theni and Madurai in the south (see Figure 2). In this section, we use the VES data to examine district level SRB and gender differences in IMR to infer the prevalence of pre-birth and post-birth deficit across the state. If it is indeed the case that daughter deficit in Tamil Nadu is mainly due to infanticide then district SRB should not be systematically different from the expected SRB and evidence of gender differentials in infant mortality should be restricted to the districts mentioned above.

Tables 4 and 5 provide information on SRB and IMR, respectively. The information is provided for each district as a whole and then for the rural and urban parts of the district. As displayed in Table 4, the SRB ranges from a low of 874 in the northern district of Salem to a high of 965 in the southern district of Thoothukudi. Fourteen districts (out of 29) have an unusually low SRB. Eleven of these 14 districts have ratios that are statistically different and lower than 952, at conventional levels of significance. In addition, there are at least three more districts (Perambalur, Sivaganga and Thanjavur) where the SRB is 13–20 points lower than 952 although not statistically significant at conventional levels.

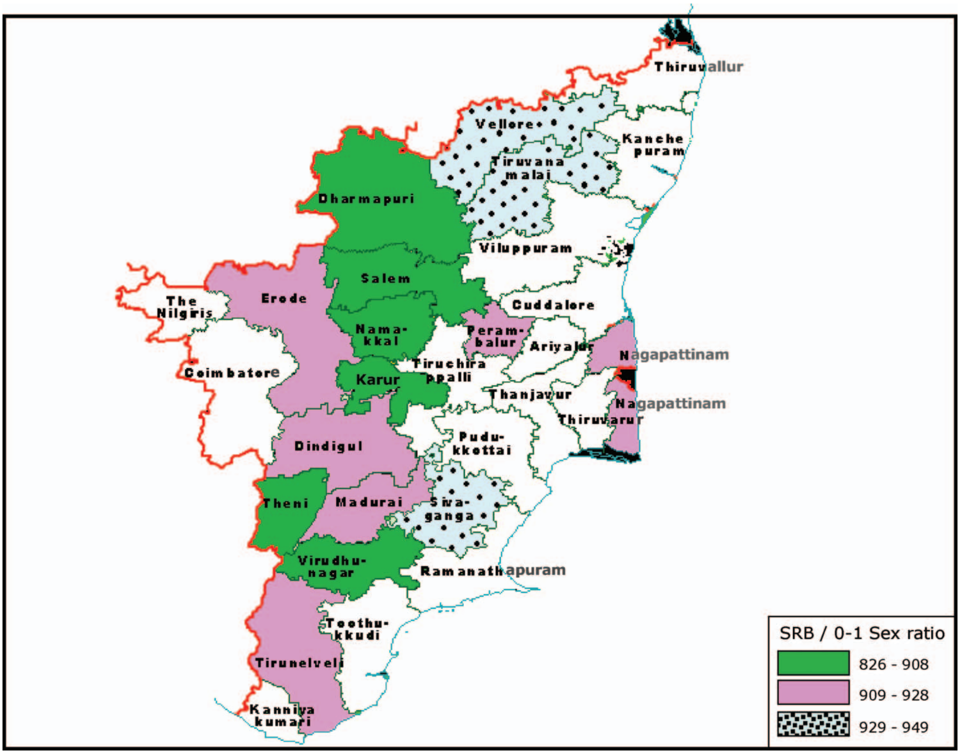

Figure 2. Districts with pre-birth and/or post-birth daughter deficit, Tamil Nadu

There are clear differences across the rural and urban parts of the districts (see Table 4). Except for two districts (870 in urban Karur and 880 in urban Virudhunagar), the urban parts of most other districts have SRB that are not statistically different from the expected SRB. However, in addition to these two districts there are at least nine other districts where the SRB is 16 to 36 points lower than the expected SRB, although not statistically different from 952. In contrast, the rural areas of 10 districts record SRB that are statistically different from 952 and, in another six districts the rural SRB is 13–20 points lower than the expected ratio although not statistically different from it.

Table 5 presents figures on male and female infant deaths. These numbers are presented for each district as a whole and for the urban and rural parts of a district separately. As displayed in the table, higher female infant mortality is restricted to the rural areas of the state and prevails in nine of the state's 29 districts.[15] In these nine districts, female IMR is statistically different and higher than male IMR, contradicting international patterns. Except for minor differences, districts which display higher female IMR are the same as the districts in which female infanticide has been reported (see Chunkath and Athreya, 1997). These districts lie in the western part of the state, in an almost contiguous belt from Vellore in the north to Madurai in the south. As compared to Chunkath and Athreya (1997), higher female infant mortality is evident in two additional districts (Perambalur and rural

Table 4. District specific births and sex ratio at birth, Tamil Nadu, 1996–1999

District	Overall			Urban			Rural		
	Female births	Male births	Sex ratio (95% CI)	Female births	Male births	Sex ratio (95% CI)	Female births	Male births	Sex ratio (95% CI)
Chennai	9928	10485	947 (921–973)	9928	10485	947 (921–973)	–	–	–
Coimbatore	12893	13578	950 (927–973)	3503	3505	999 (953–1047)	9390	10073	932 (906–959)
Cuddalore	11832	12511	946 (922–970)	3574	3739	956 (912–1000)	8258	8772	941 (913–970)
Dharmapuri	15468	16785	922 (902–942)*	3969	4139	958 (918–1001)	11499	12646	909 (886–933)*
Dindigul	12604	13675	922 (900–944)*	3417	3651	936 (893–981)	9187	10024	917 (891–943)*
Erode	10531	11348	928 (904–953)**	3108	3270	950 (905–999)	7423	8078	919 (890–948)*
Kancheepuram	13825	14611	946 (924–969)	3344	3515	951 (907–997)	10481	11096	945 (920–970)
Kanyakumari	9647	10176	948 (922–975)	2580	2764	933 (884–985)	7067	7412	953 (923–985)
Karur	10033	11237	893 (869–917)*	2683	3083	870 (826–916)*	7350	8154	901 (873–930)*
Madurai	12669	13709	924 (902–947)*	3581	3902	918 (876–960)	9088	9807	927 (901–954)**
Nagapattinam	11601	12496	928 (905–952)**	3442	3759	916 (874–959)	8159	8737	934 (906–963)
Namakkal	11082	12171	911 (887–934)*	3310	3552	932 (888–977)	7772	8619	902 (874–930)*
Nilgiris	7549	7868	959 (930–990)	2598	2719	955 (905–1008)	4951	5149	962 (925–1000)
Permabalur	8975	9626	932 (906–960)	–	–	–	8975	9626	932 (906–960)
Pudukottai	13309	14050	947 (925–970)	3634	3961	917 (876–959)	9675	10089	959 (932–986)
Ramanathapuram	11180	11777	949 (925–975)	3471	3681	943 (899–987)	7709	8096	952 (923–982)
Salem	11502	13164	874 (852–896)*	3855	4090	943 (902–985)	7647	9074	843 (817–869)*
Sivaganga	10930	11701	934 (910–959)	3230	3358	962 (916–1009)	7700	8343	923 (894–952)**
Thanjavur	11648	12402	939 (916–963)	3284	3403	965 (919–1012)	8364	8999	929 (902–958)

(*continued*)

Table 4. (*Continued*)

District	Overall			Urban			Rural		
	Female births	Male births	Sex ratio (95% CI)	Female births	Male births	Sex ratio (95% CI)	Female births	Male births	Sex ratio (95% CI)
Theni	12152	13034	932 (909–956)**	3313	3597	921 (878–965)	8839	9437	937 (910–964)
Thirunelveli	11928	12895	925 (902–948)*	3729	4036	924 (886–966)	8199	8859	925 (898–954)**
Thiruvallur	13037	13803	945 (922–967)	3596	3832	938 (896–982)	9441	9971	947 (920–974)
Thiruvannamalai	11238	11745	957 (932–982)	3576	3702	966 (922–1011)	7662	8043	953 (923–983)
Thiruvarur	11677	12173	959 (935–984)	3350	3443	973 (927–1020)	8327	8730	954 (925–983)
Thuthukudi	10218	10586	965 (939–992)	3194	3221	992 (943–1041)	7024	7365	954 (923–985)
Tiruchirapalli	11192	11840	945 (921–970)	3252	3383	961 (915–1008)	7940	8457	939 (910–968)
Vellore	12793	13440	952 (929–975)	3444	3594	958 (914–1004)	9349	9846	950 (923–977)
Villupuram	12422	12964	958 (935–982)	3381	3573	946 (920–1021)	9041	9391	963 (935–991)
Virudhunagar	11849	13043	908 (886–931)*	3034	3449	880 (837–923)*	8815	9594	919 (893–946)*

Notes: The sex ratio at birth (SRB) is defined as the number of female live births per 1000 male live births. The SRB figures are our calculations based on the Vital Events Surveys (VES), 1996–1999. *, **indicate that the SRB is statistically different from 952, the expected SRB, at the 5 per cent and 10 per cent level of significance, respectively·

Table 5. District specific infant deaths and infant mortality rates, Tamil Nadu, 1996–1999

	Overall				Urban				Rural			
District	Female deaths	Male deaths	Female IMR	Male IMR	Female deaths	Male deaths	Female IMR	Male IMR	Female deaths	Male deaths	Female IMR	Male IMR
Chennai	145	195	15	19	145	195	15	19	–	–	–	–
Coimbatore	351	483	27	36	70	93	20	27	281	390	30	39
Cuddalore	353	389	30	31	57	68	16	18	296	321	36	37
Dharmapuri	1380	798	89*	48*	101	85	25	21	1279	713	111*	56*
Dindigul	610	524	48*	38*	92	90	27	25	518	434	56*	43*
Erode	367	408	35	36	65	74	21	23	302	334	41	41
Kancheepuram	315	394	23	27	53	56	16	16	262	338	25	30
Kanyakumari	161	181	17	18	24	35	9	13	137	146	19	20
Karur	353	411	35	37	53	62	20	20	300	349	41	43
Madurai	611	521	48*	38*	87	121	24	31	524	400	58*	41*
Nagapattinam	335	390	29	31	56	71	16	19	279	319	34	37
Namakkal	521	465	47*	38*	53	91	16	26	468	374	60*	43*
Nilgiris	207	257	27	33	33	48	13	18	174	209	35	41
Permabalur	459	448	51**	47**	–	–	–	–	459	448	51**	47**
Pudukottai	434	475	33	34	68	111	19	28	366	364	38	36
Ramanathapuram	423	514	38	44	59	104	17	28	364	410	47	51
Salem	1050	571	91*	43*	128	129	33	32	922	442	121*	49*
Sivaganga	328	353	30	30	54	70	17	21	274	283	36	34
Thanjavur	339	468	29	38	54	80	16	24	285	388	34	43
Theni	789	530	65*	41*	70	81	21	23	719	449	81*	48*
Thirunelveli	419	487	35	38	128	140	34	35	291	347	35	39

(*continued*)

Table 5. (*Continued*)

District	Overall				Urban				Rural			
	Female deaths	Male deaths	Female IMR	Male IMR	Female deaths	Male deaths	Female IMR	Male IMR	Female deaths	Male deaths	Female IMR	Male IMR
Thiruvallur	332	399	25	29	52	86	14	22	280	313	30	31
Thiruvannamalai	383	398	34	34	61	91	17	25	322	307	42**	38**
Thiruvarur	312	421	27	35	48	79	14	23	264	342	32	39
Thuthukudi	324	394	32	37	41	64	13	20	283	330	40	45
Tiruchirapalli	450	510	40	43	71	70	22	21	379	440	48	52
Vellore	589	512	46*	38*	62	94	18	26	527	418	56*	42*
Villupuram	460	517	40	57	49	68	14	19	411	449	45	48
Virudhunagar	414	453	35	35	64	79	21	23	350	374	40	39

Notes: Infant mortality rates are defined as number of infant deaths (age 0–365 days) per 1000 live births. The IMR figures are our calculations based on the Vital Events Surveys (VES), 1996–1999.*,** indicate that the female mortality rate is statistically higher than the male mortality rate at the 5 per cent and 10 per cent level of significance, respectively·

Thiruvannamalai) while Karur, which is identified as one of the core districts in the female infanticide belt, shows no evidence of higher female IMR, although it does record a very low SRB (893).

Overall, there appears to be strong evidence of pre-birth deficit signalling the use of sex selective abortion in several districts in Tamil Nadu. About half the districts in the state (with roughly half the population of the state) have SRB which are between 13–78 points lower than the expected SRB. Post-birth deficit as measured by gender differences in IMR are limited to nine of the state's 29 districts.

IV. Pre-birth and Post-birth Daughter Deficit

State and District

In this section we combine information on SRB and gender differences in IMR to provide an idea of the extent of daughter deficit, before and after birth in the state (Table 6) and in each district (Table 7). The overall SRB for the state is 935 or a pre-birth deficit of 17 females per 1000 males. The higher female infant mortality leads to an additional deficit of three female infants per 1000 males resulting in a 0–1 sex ratio of 932. Thus, by the first year of birth, there is an overall deficit of *at least* 20 females per 1000 males.[16] In absolute terms, based on the population of the state and the male birth rate, the pre-birth deficit is about 11,000 females per year and the post-birth deficit is about 2000 females per year.[17] Thus, almost 85 per cent of the daughter deficit arises before birth.

The bulk of the deficit arises in the rural areas of the state. In rural Tamil Nadu, the pre-birth deficit of 20 points is exacerbated in the first year of birth leading to a deficit of *at least* 27 females for every 1000 males or a sex ratio of 925 by the age of one. Thereafter, the sex ratio improves, resulting in a rural 0–6 sex ratio of 931. In urban areas there is a nine point pre-birth deficit. However, unlike in rural areas, urban male IMR is higher than urban female IMR resulting in an improvement in

Table 6. Development of sex ratios and female deficit in Tamil Nadu

Year	SRB 1996–1999	Female deficit at birth (952-SRB) 1996–1999	FIMR-MIMR 1996–1999	0–1 sex ratio 1996–1999	0–6 sex ratio 2001	Population sex ratio 2001
Tamil Nadu – overall	935*	17	3*	932	942	987
Tamil Nadu – urban	943*	9	−4	947	951	982
Tamil Nadu – rural	932*	20	7*	925	931	992

Notes: The sex ratio at birth (SRB) is the number of female live births per 1000 male live births. Infant mortality rate (IMR) is defined as number of infant deaths (0–365 days) per 1000 live births. The SRB and IMR figures are our calculations based on the Vital Events Surveys (VES), 1996–1999. The 0–6 sex ratio and population sex ratio are from the 2001 census. *indicates that the SRB is statistically different from 952, that is the expected SRB, at the 5 per cent level at least or that the Female IMR is higher than the male IMR by at least the 5 per cent level.

Table 7. District specific development of sex ratios and female deficit, Tamil Nadu, 1996–1999

District	Overall				Urban				Rural			
	SRB	Female deficit at birth 952-SRB	FIMR-MIMR	0–1 Sex ratio	SRB	Female deficit at birth 952-SRB	FIMR-MIMR	0–1 Sex Ratio	SRB	Female deficit at birth 952-SRB	FIMR-MIMR	0–1 Sex Ratio
Chennai	947	5	−4	951	947	5	−4	951	–	–	–	–
Coimbatore	950	2	−9	959	999	−47	−7	1006	932	20	−9	941
Cuddalore	946	6	−1	947	956	−4	−2	958	941	11	−1	942
Dharmapuri	922*	30	41*	881	958	−6	4	954	909*	43	55*	854
Dindigul	922*	30	10*	912	936	16	2	934	917*	35	13*	904
Erode	928**	24	−1	929	950	2	−2	952	919*	33	0	919
Kancheepuram	946	6	−4	950	951	1	0	951	945	7	−5	950
Kanyakumari	948	4	−1	949	933	19	−4	937	953	−1	−1	954
Karur	893*	59	−2	895	870*	82	0	870	901*	51	−2	903
Madurai	924*	28	10*	914	918	34	−7	925	927**	25	17*	910
Nagapattinam	928**	24	−2	930	916	36	−3	919	934	18	−3	937
Namakkal	911*	41	9*	870	932	20	−10	942	902*	50	17*	885
Nilgiris	959	7	−6	965	955	−3	−5	960	962	−10	−6	968
Permabalur	932	20	4**	928	–	–	–	–	932	20	4**	928
Pudukottai	947	5	−1	948	917	35	−9	926	959	−7	2	957
Ramanathapuram	949	3	−6	955	943	9	−11	954	952	0	−4	956
Salem	874*	78	48*	826	943	9	1	942	843*	109	72*	771
Sivaganga	934	18	0	934	962	−10	−4	966	923*	29	2	921
Thanjavur	939	13	−9	948	965	−13	−8	973	929	23	−9	938

(*continued*)

Table 7. (*Continued*)

District	Overall				Urban				Rural			
	SRB	Female deficit at birth 952-SRB	FIMR-MIMR	0–1 Sex ratio	SRB	Female deficit at birth 952-SRB	FIMR-MIMR	0–1 Sex Ratio	SRB	Female deficit at birth 952-SRB	FIMR-MIMR	0–1 Sex Ratio
Theni	932**	20	24*	908	921	31	−2	923	937	15	33*	904
Thirunelveli	925*	27	−3	928	924	28	−1	925	925**	27	−4	929
Thiruvallur	945	7	−4	949	938	14	−8	946	947	5	−1	948
Thiruvanna malai	957	−5	0	957	966	−14	−8	974	953	−1	4**	949
Thiruvarur	959	−7	−8	967	973	−21	−9	982	954	−2	−7	961
Thuthukudi	965	−13	−5	970	992	−40	−7	999	954	−2	−5	959
Tiruchirapalli	945	7	−3	948	961	−9	1	960	939	13	−4	943
Vellore	952	0	8*	944	958	−6	−8	966	950	2	14*	936
Villupuram	958	−6	−17	975	946	6	−5	951	963	11	−3	966
Virudhunagar	908*	44	0	908	880*	72	−2	882	919*	33	−1	920

Notes: The sex ratio at birth (SRB) is the number of female live births per 1000 male live births. Infant mortality rate (IMR) is defined as number of infant deaths (0–365 days) per 1000 live births. The SRB and IMR figures are our calculations based on the Vital Events Surveys (VES), 1996–1999. *,**indicate that the SRB (female IMR) is statistically different from 952 (male IMR) at the 5 per cent and 10 per cent level of significance respectively.

the 0–1 sex ratio. The 0–1 sex ratio in urban areas is 947 and the 0–6 ratio is 951. To the extent that pre-birth and post-birth deficit reflect sex selective abortion and infanticide respectively, the patterns in the sex ratio suggest that in rural areas of the state these two practices are additive while in urban areas sex selective abortion is the preferred approach. The increase in sex ratio after the age of one suggests that beyond this age discrimination against females may be muted or at least does not result in outcomes that lead to a further deterioration in the sex ratio.

Table 7 presents district-wise figures on pre-birth and post-birth deficit. Several patterns emerge. There are 15 districts in the state where there is evidence of some type of deficit. A comparison of the extent of the two deficits shows that in almost all districts pre-birth deficit is higher than post-birth deficit. The exceptions are Dharmapuri, Theni and Vellore where the reverse is true. Almost all (seven out of nine) the districts that display post-birth deficit have a low SRB except Vellore (rural, urban and combined) and rural Thiruvannamalai. In these two cases, female deficit seems to be a post-birth phenomenon. For the remaining seven districts there is evidence of pre-birth and post-birth deficit and the 0–1 sex ratio is lower than the SRB, implying that the two deficits are additive. By far, Salem district exhibits the lowest SRB and 0–1 sex ratio. The pre-birth deficit in Salem is 78 females per 1000 males while an additional post-birth deficit of 48 females per 1000 males results in a sex ratio of 826 females per 1000 by age one. The other districts in which there is evidence of both types of deficit are: Dharmapuri, Dindigul, Madurai, Namakkal, Perambalur and Theni. A third set of seven districts (Erode, Karur, Nagapattinam, rural Sivaganaga, Thanjavur, Thirunelveli and Virudhunagar) displays evidence only of pre-birth deficit. These districts have a low SRB but exhibit the expected pattern of IMR. Accordingly, the 0–1 sex ratio is higher than the SRB, suggesting that pre-birth deficit substitutes post-birth deficit or occurs independently. It is notable that Karur, identified as part of the infanticide belt, falls in the list of districts with only pre-birth deficit. While the IMR data for Karur show no evidence of excessive female mortality, at 893, Karur's SRB is amongst the lowest in the state, highlighting a strong possibility of sex selective abortion substituting female infanticide.

Overall, the 15 districts exhibiting some form of deficit may be classified into six districts that exhibit only pre-birth deficit, two districts that exhibit only post-birth deficit and seven districts where both forms prevail. Figure 2 displays the location and the SRB/0–1 sex ratio prevailing in these districts on a map of Tamil Nadu. Our work is consistent with Chunkath and Athreya's (1997) paper on female infanticide. We find that daughter deficits are not confined to a few districts but are geographically widespread and that the districts with the lowest sex ratios (highest daughter deficit) are located in the western part of the state and lie in a belt running from Dharmapuri/Salem in the north to Virudhunagar in the south. In addition, the analysis presented in this section shows that daughter deficit may be attributed mainly to pre-birth deficit.

Village

As shown in the previous section, Salem district has the lowest SRB and 0–1 sex ratio in the state. It also claims a place amongst the country's 10 districts with the lowest rural 0–6 sex ratio. To explore the anatomy of daughter deficit, we undertook a detailed qualitative and quantitative study of issues surrounding daughter deficit in a village located in this district.

For the purpose of this paper, we analysed the fertility history of 220 married women living in the village in June 2002. Table 8 presents data on total pregnancies and their outcomes by parity (birth order) for these women. In all, 611 pregnancies were reported, of which 131 have been aborted, an abortion rate of 21 per cent.[18] The total number of children ever born includes 259 sons and 208 daughters or an SRB of 803. The number of female infant deaths (30) is higher than the number of male infant deaths (21). The low SRB and the higher female IMR are consistent with the patterns found in the rest of the district.

The interesting aspect of the table is the variation in abortion rates, SRB and infant deaths by birth order. The abortion rate for the first pregnancy is 6.1 per cent, that is, much lower than the average. There are 98 male and 96 female births or a SRB of 979 (against an expected SRB of 952) at parity one and the number of female infant deaths is not higher than the number of male deaths. Thus, the patterns for the first birth order match internationally expected norms. The situation for subsequent births especially the second and third births is remarkably different. The abortion rates for the second pregnancy are 16 and 35 per cent respectively. The number of male births from the second pregnancy is 86 while there are 53 female births or a SRB of 616. For the third pregnancy, there are 44 male births and 29 female births yielding a SRB of 659. The number of female infant deaths is also higher than the male infant deaths for the second and third birth orders.

Table 9 provides an estimate of daughter deficit before and after birth. A comparison of the number of daughters born with the expected number of daughters yields a pre-birth deficit of 42 daughters. Based on the assumption that the IMR for the first birth is the expected mortality rate in the absence of interference, the number of excess female infant deaths in subsequent births is 13. Thus, similar to the state and district patterns, our primary village data show that the bulk of the deficit may be attributed to pre-birth rather than post-birth deficit. The additional insights yielded by the village level data are that the deficit is particularly sharp for higher birth orders and there appears to be no parental interference during the first pregnancy.

Table 8. Fertility history of married women (Village in Salem district, 2002)

Birth order	Total pregnancies	Aborted	Male births	Female births	Sex ratio at birth	Male infant deaths	Female infant deaths
One	210	13	98	96	979	8	8
Two	171	28	86	53	616	4	6
Three	117	41	44	29	659	2	7
Four	73	31	20	19	952	4	4
Five	40	18	11	11	1000	3	5
Total	611	131	259	208	803	21	30

Notes: N = 220. Sex ratio at birth is the number of female births divided by male births. The figures are based on a village survey carried out by the first author.

Table 9. Daughter deficit pre- and post-birth among married women (Village in Salem district, 2002)

Birth order	Total pregnancies	Aborted	Males born	Females expected	Females born	Estimated daughter deficit before birth[a]	Estimated daughter deficit after birth[b]
One	210	13	98	93	96	0	0
Two	171	28	86	82	53	29	2
Three	117	41	44	42	29	13	5
Four	73	31	20	19	19	0	2
Five	40	18	11	11	11	0	4
Total	611	131	259	247	208	42	13

Notes: N = 220. The figures are based on a village survey carried out by the first author.
a. Estimated deficit before birth is based on an expected ratio of 952 females per 1000 males.
b. The figures for estimated daughter deficit after birth are based on the assumption that in the absence of any interference, the female mortality rate for the first pregnancy would prevail. For the first pregnancy, the number of infant deaths as a percentage of total births is 8.3 per cent and in the absence of any interference, 4 (8.3% of 53) female infant deaths may be expected in the second pregnancy. Thus, the number of females that may have been eliminated due to social reasons is 2 (6–4).

The sex of the first child appears to have an effect on the sex ratio of subsequent births. In our data we find that in the 98 cases where the first-born is a male and there is a second pregnancy, there are 32 sons and 23 daughters or a sex ratio of 720 for the second order births. In the 96 cases where the first-born is a female and there is a second pregnancy, we observe 48 male and 29 female births or a sex ratio of 600 for the second order births. Although our data are restricted to a single village and a small number of births, a similar pattern has been reported with larger data sets at state and national levels. For example, based on a 1997 survey, Jha et al. (2006) show that sex ratios of higher order births are influenced by the sex of the first child. For Tamil Nadu, the authors report a sex ratio of 1048 for second order births (349 female and 333 male births) if the first birth was male and a sex ratio of 801 for second order births (298 female and 372 male births) if the first birth was female. They also report similar patterns at the national level (see Appendix, Table A2). Additionally, based on their analysis of the National Family Health Survey II, Retherford and Roy (2003) predict that at the national level, the SRB for a second order birth conditional on the first child being a male is 952 while it is 909 if the first birth was female.

A final point is the relationship between the number and sex of the desired children and the actual outcomes. In the study village, the average number of desired children among married women is less than two (1.6). The number of desired sons is 0.9 while the number of desired daughters is 0.7 or a desired sex ratio of 777 which is close to the sex ratio of 803 observed in the village. Clearly, the objective is to achieve the desired sex composition of children while keeping their numbers small. The household strategy to achieve this objective seems to be non-interference in the first birth while ensuring that a child of the desired sex is born thereafter.[19]

V. Socioeconomic Characteristics and Daughter Deficit/Elimination

Current policy initiatives (to prevent daughter elimination) are based on the premise that daughter elimination is a consequence of poverty and that the practice is restricted to poorer households. To examine the validity of this idea, we use village level data to study the link between various socioeconomic attributes and the incidence of infant deaths (which includes cases of infanticide), the incidence of abortion (which includes cases of sex selective abortion) and the incidence of daughter elimination (sex selective abortion and female infanticide). While the first two measures include potential cases of infanticide and sex selective abortion, the last indicator identifies households in which sex selective abortion and/or female infanticide has occurred.

The socioeconomic variables include household and female ownership of land, household income, household ownership of consumer durables such as TV and a moped, woman's education and indicators for caste (Gounder, Vanniyar and Dalit). If daughter elimination is indeed more likely to occur in poorer households, then we may expect a negative relationship between daughter elimination and household income and wealth variables (land, consumer durables). Similarly, a woman's education and land ownership may be expected to exert a negative effect on daughter elimination.[20]

Table 10 displays bivariate relationships, while table 11 contains estimates from probit regressions of the incidence of infanticide, abortion and daughter elimination on the various characteristics. As can be seen in Table 10, infant deaths (male or female) are less likely to occur in households with higher income and wealth (as reflected by household ownership of consumer durables) and in households where women are more educated. The regression analysis suggests a similar story but highlights the role of women's education and ownership of land in reducing infant mortality. To the extent that infant deaths include female infanticide, the results suggest that post-birth daughter elimination is more likely to occur in households with low income and less educated women.

The bivariate analysis between the incidence of abortion and socioeconomic characteristics suggests that abortion is more likely to occur in households with higher income and where women are more educated. However, the regression analysis does not display any systematic relationship between the incidence of abortion and income, education or caste. Thus, to the extent that abortion is used as a family planning device the results indicate that the small family norm is universal and, to the extent that abortion is used to influence the sex composition of children, it appears to be used across caste, education and income groups.

An examination of the relationship between daughter elimination and various socioeconomic variables does not reveal any systematic patterns.[21] Neither the bivariate correlations nor the regression analysis (Table 11) display any link between daughter elimination and the variables reflecting the wealth, income, education and caste of households. Thus, unlike infant mortality which is more likely to occur in poorer households and abortion which is somewhat more likely to occur in richer households, daughter elimination does not appear to differ across castes or to be responsive to differences in income, wealth and education. While the mode of achieving the appropriate number and composition of children may differ, the desire

Table 10. Household characteristics and the incidence of infant death, abortion and daughter elimination

Variable	Infant death = 0 (N = 166)	Infant death = 1 (N = 53)	*p*-value	Abortion = 0 (N = 143)	Abortion = 1 (N = 77)	*p*-value	Daughter elimination = 0 (N = 170)	Daughter elimination = 1 (N = 50)	*p*-value
Land owned by household (acres of land)	1.63	1.10	0.151	1.46	1.59	0.705	1.49	1.55	0.891
Land owned by woman (acres of land)	0.078	0.018	0.246	0.055	0.077	0.526	0.064	0.06	0.908
Household possesses a TV = 1	0.418	0.226	0.012*	0.34	0.42	0.255	0.40	0.28	0.135
Household has a moped = 1	0.418	0.173	0.001*	0.34	0.40	0.391	0.36	0.34	0.719
Per capita household monthly income (in Rupees)	456	306	0.012*	386	481	0.077**	428	388	0.510
Wife's education (years of schooling)	2.94	1.20	0.005*	2.20	3.09	0.114	2.56	2.36	0.925
Vanniyar = 1	0.55	0.56	0.914	0.55	0.56	0.851	0.55	0.58	0.712
Pavallam Katti Gounder = 1	0.24	0.19	0.472	0.24	0.20	0.428	0.23	0.22	0.874
Kongu Vellala Gounder = 1	0.10	0.09	0.855	0.09	0.12	0.521	0.11	0.08	0.589
Dalit = 1	0.10	0.15	0.343	0.11	0.12	0.886	0.11	0.12	0.883

Notes: The last column of the table reports the p-value for a two-tail t-test. The null hypothesis is equality of means. *is statistically significant at the 5 per cent level, **is statistically significant at 10 per cent level of significance.

Table 11. Probit estimates of infant mortality, abortion and daughter elimination (absolute value of T-statistics)

Variable	Infant mortality marginal effects	Abortion marginal effects	Daughter elimination marginal effects
Land owned by household (acres of land)	0.015 (0.89)	−0.005 (0.31)	0.010 (0.70)
Land owned by woman (acres of land)	−0.196** (1.86)	0.179 (1.22)	−0.026 (0.21)
Household possesses a TV = 1	−0.050 (0.66)	0.020 (0.25)	−0.112 (1.51)
Household has a moped = 1	−0.159* (2.06)	0.019 (0.22)	0.054 (0.69)
Per capita household monthly income (in rupees)	−0.0002 (1.45)	0.0001 (1.15)	−0.0001 (0.53)
Wife's education (years of schooling)	−0.022* (2.20)	0.011 (1.25)	−0.0002 (0.02)
Vanniyar = 1	−0.038 (0.42)	−0.042 (0.39)	0.015 (0.15)
Pavallam Katti Gounder = 1	0.004 (0.04)	−0.151 (1.24)	−0.014 (0.12)
Kongu Vellala Gounder = 1	0.084 (0.56)	−0.051 (0.35)	−0.056 (0.41)
Pseudo R^2	0.107	0.027	0.015
N	206	207	207

Notes: *is statistically significant at the 5 per cent, **is statistically significant at the 10 per cent level of significance.

for a small family and the practice of daughter elimination does not appear to differ across socioeconomic groups.

Clearly, on the basis of these data, drawn from a village in a district with one of the lowest 0–6 sex ratios in the country, the finding that the likelihood of daughter elimination does not vary across socioeconomic groups cannot and should not be generalised. However, indirect examination of daughter elimination at a broader, that is, state and national level also leads to similar findings. For instance, we used district specific data to examine bivariate correlations between SRB and various socioeconomic indicators. The correlation between per capita income and SRB was negligible (−0.04) while there was a positive correlation between male literacy and SRB and between female literacy and SRB, 0.42 and 0.48 respectively. Notwithstanding these correlations, regression analysis based on these district data did not reveal any statistically significant link between the various indicators and SRB. Consistent with these district patterns, analysis of data presented in Siddhanta et al. (2003) reveal that there is a negligible correlation (−0.025) between per capita expenditure and the 0–14 age range sex ratio in rural Tamil Nadu. Based on a national survey, Jha et al. (2006) report that the reduction in the probability of having a second female child, conditional on the sex of the first child, is not influenced by religion, age or education of parents.[22]

VI. Discussion and Concluding Remarks

This paper analysed daughter deficit in Tamil Nadu. Our analysis identified several features of this phenomenon. First, consistent with Agnihotri (2003), we find that daughter deficit should not be considered a mainly northern and western Indian phenomenon. A comparison of national and state level trends in sex ratio at birth and the 0–6 sex ratio displayed that increasing masculinisation of these ratios is also occurring in Tamil Nadu, especially in the rural parts of the state. Second, similar to the conclusions drawn by Chunkath and Athreya (1997), analysis of district specific data on sex ratio at birth and infant mortality rates showed that daughter deficit is not confined to a few districts. Fifteen of the state's 29 districts exhibit some form of deficit. Third, the bulk of daughter deficit (85 per cent) appears to occur before birth. Fourth, analysis of the village level data on sex ratio by birth order suggested that daughters at higher parity are at a greater risk of elimination. This finding is similar to the patterns reported by George et al. (1992) and Chunkath and Athreya (1997). While the sex ratio for the first birth order matched internationally expected norms, the ratio for second and third birth orders was extremely masculine. The sex ratio pattern across orders and the number and composition of desired children suggest that in Tamil Nadu, parents intervene in higher order births in an attempt to retain a small family while at the same time ensuring that at least one son is born. This is unlike other parts of India where there is evidence (see George and Dahiya, 1998; Jha et al., 2006) that parents are likely to intervene even in the first birth, presumably in order to ensure that the eldest child is a son. Finally, analysis of the village level data revealed that the incidence of daughter elimination is not responsive to differences in income, wealth, education or caste and appears to be a norm enjoying widespread legitimacy. While this finding is unlike the pattern reported by George et al. (1992) and Nillesen and Harris-White (2004) who find evidence of a negative and a positive link between daughter deficit and wealth/income, respectively, it is consistent with the pattern, based on 1999–2000 National Sample Survey data, that there is no link between the 0–14 sex ratio and per capita expenditure in rural Tamil Nadu (Siddhanta et al., 2003).

While elimination of daughters may not be the only reason for the large daughter deficit, given the temporal decline in the sex ratio and the sex ratio pattern across birth order, it does seem to be the most plausible explanation. In the Indian context, two recent papers have argued that, in part, the unexpectedly masculine SRB may be driven by the incidence of Hepatitis B virus infection (Oster, 2005) and improvement in women's health status which may reduce foetal wastage and, in turn, lead to masculine SRB (Jayaraj and Subramanian, 2004). While these alternatives may explain some of the inequality in the sex ratio at birth, it is hard to see how they could be responsible for the steady temporal decline in the SRB and the 0–6 sex ratio, the gender differential IMR and the sex ratio across birth orders.

Let us briefly consider these two explanations in the light of the foregoing discussion. According to Oster (2005), women who are carriers of the Hepatitis B virus give birth to a higher ratio of boys to girls than non-carriers. While the prevalence of the Hepatitis B virus may indeed be responsible for a SRB that is lower than the expected ratio of 952, unless there has been an increase in the prevalence of Heptatis B carriers over time, this explanation cannot be responsible for the continued decline in the SRB in India or in Tamil Nadu.[23] If a Hepatitis B virus-based explanation had a large bearing on the masculinisation of the SRB, then the SRB should not display much variation across birth order and should not be affected by the sex of previous children. However, we observe clear patterns in the SRB across birth order. Based on the village data, the SRB for the second and third order births is much lower as compared to the first. Furthermore, analysis of village, state and national data shows that the sex of the previous child/children exerts a strong influence on the SRB of higher order births.

Better nutrition of women and the subsequent reduction in foetal wastage is consistent with the observed masculinization of SRB over time. In India, the SRB has declined from 943 in 1978–1992 to 899 in 1997, and in Tamil Nadu from 980 in 1978–1992 to 935 in 1996–1999. While part of the temporal decline in the SRB may be driven by reduced foetal wastage, it is not clear why this ratio should become less than the SRB observed in healthy populations in developed countries. According to the foetal wastage hypothesis, due to the deleterious effects of repeated child-bearing on a woman's health, the SRB should become more feminine at higher birth orders and as a corollary, the increase in the femininity of the SRB should not be influenced by the sex of previous children. The pattern observed in the village data is the opposite, that is, the SRB becomes more masculine at higher birth orders. Furthermore, the village level and all India data show that the sex of the previous child (children) exerts a strong influence on the sex of the higher order births. Second order births are only more feminine if the first child is male; while they are extremely masculine if the first child is female (see Appendix, Table A2). In fact, changes in the SRB with birth order may have less to do with maternal depletion and foetal wastage than with the intervention strategy employed by the household. If parents follow a strategy of non-interference in the first pregnancy while intervening in subsequent pregnancies to ensure that a boy is born, then the SRB will decline with birth order, as observed in our primary data. On the other hand, if parents choose to intervene in the first pregnancy to ensure that their first born is a boy and intervene less in subsequent pregnancies then the SRB will increase with birth order, as observed in the data analysed by Jayaraj and Subramanian (2004) and Jha et al. (2006).

Notwithstanding the discussion above, while the alternative explanations may be responsible for some of the observed deficit, based on the evidence assembled and the arguments advanced in this paper it does seem that the observed daughter deficit is mainly an outcome of deliberate pre-birth parental actions.

Looking ahead, access to sex selection technology is increasing in all parts of India, which raises the likelihood that sex selection induced daughter deficit will increase. While the legal framework designed to prevent sex determination is in place, implementation and prosecution under the Act has been limited.[24] Measures to ensure daughter survival include implementation of the law, a reworking of prevailing interventions which are based on the notion that daughter elimination is mainly a problem amongst the poor, and an explicit focus on tackling sex selection.

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Notes

1. Kerala has witnessed a decline in child (0–6) sex ratio between 1961 and 1991 and although a slight improvement has been recorded in the 2001 Census, there are indications that this may be temporary (Sudha and Irudaya Rajan, 1999; Patel, 2002).
2. The 0–6 sex ratio reflects the combined effect of the SRB, infant mortality (0–365 days) and child mortality (1–6 years). Male mortality is typically higher than female mortality in the age group 1–6. Thus, the 0–6 sex ratio is likely to hide the extent of female deficit at birth and in the age group 0–365 days.
3. The terms female deficit and daughter deficit are used synonymously. However, we draw a distinction between daughter/female deficit and daughter elimination. Deficit implies that there is a gap between the number of expected daughters and the number of daughters actually born. Elimination, whether it is sex selective abortion or infanticide, is treated as a potential cause of the observed deficit.
4. For example the Tamil Nadu government's Girl Child Protection Scheme is described as a scheme intended for 'the education of girl children in poor families; to promote family planning, to eradicate female infanticide and to discourage preference for male child' (GoTN Policy note 2003–2004, Demand No. 43, G.O.Ms.No.131dt 17.7.2003, accessed at: www.tn.gov.in). The scheme explicitly targets families below the official poverty line. Programmes run by non-governmental organisations (NGOs), such as Poonthalir in Salem and the Indian Council for Child Welfare in Madurai, offer economic support and training to poor families in order to avert infanticide (see Srinivasan, 2006: 224).
5. The definition of urban and rural areas used in the Vital Event Surveys (VES) is the same as the definition used in the census. Urban is defined as all places declared by the state government under a statute as a municipality, corporation, cantonment board or notified town area committee. Any area, which is not covered by the definition of urban, is rural. More details are available at: http://www.censusindia.gov.in/Census_Data_2001/Census_Newsletters/Newsletter_Links/eci14mail.htm (accessed on 15 June 2008).
6. We do not use the survey which covers the reference period 1995 as there are some doubts about the quality of these data. According to Athreya (1999), the first round of the VES was conducted at very short notice, the planning and training of enumerators was inadequate and the sample was not selected on the basis of the specified design. Subsequent rounds of the survey were designed, planned and implemented keeping in mind the shortcomings and the lessons learnt from the first round.
7. Birth and death records in the nutrition and health centres were used to infer female infanticide (and, to a lesser extent, sex selection). Health records in Tamil Nadu use the category 'social' causes to record infant deaths due to infanticide or neglect. However, not all such deaths may be recorded accurately. In cases where the cause of female infant death was not reported, discussions with health and nutrition workers revealed whether death occurred due to unnatural causes or occurred in suspicious circumstances (for example, a newborn baby rolling across a bed and falling on the floor).
8. Countries included are, Egypt (1999) 946; Canada (2002) 947; Guatemala (1999) 965; Chile (2003) 955; Japan (2003) 948; Saudi Arabia (2000) 951; Sri Lanka (1996) 951; France (2002) 953; Netherlands (2002) 948; Poland (2003) 944; Romania (2003) 940; Spain (2002) 939; United Kingdom (2003) 951; and Australia (2003) 944.
9. Based on their analysis of almost 2 million births which occurred in hospitals and health centres during the period 1949–1958 (presumably a period when there was no pre-birth interference), Ramachandran and Deshpande (1964) conclude that during the period under analysis, the SRB in India was 943. The ratio varies between 926 in central India and 961 in north India. Despite the fact that sex ratios based on hospital data may reflect only a small proportion of births, the number of births analysed in their paper is quite large and the SRB lies in the range reported for other countries. Based on an estimate of the link between SRB and life expectancy at birth, Klasen and Wink (2003) compute an expected SRB of 962 for India.
10. The medical and social science literature identifies several medical and environmental factors that may have an effect on the sex of children and result in unusually skewed sex ratios at birth. These include: maternal nutrition (Goodkind, 1996; Jayaraj and Subramaniam, 2004); Hepatitis-B (Oster, 2005); father's occupation (Dickinson and Parker, 1997); father's presence at home (Norberg, 2003);

maternal dominance (Grant and Yang, 2003); smoking (Fukuda et al., 2002); and time taken to conceive (Smits et al., 2005).

11. Based on data covering the period 1976–1984, the ratio of male to female infant deaths was 133 in Canada, 133 in Japan, 131 in the United States, 129 in Hong Kong, 133 in France, 132 in Belgium, 131 in Austria, and 130 in Sweden. This pattern also prevails in less developed countries. For the same period the ratio was 128 in Malaysia and The Philippines (for more details see Johansson and Nygren, 1991).
12. Based on an expected SRB of 952 and the typically higher rates of male infant and child mortality, the lower limit for the 0–6 sex ratio in populations without any pre- or post-birth interference may be expected to be 952.
13. While the all-India infant mortality rate also exhibits a declining trend, the infant mortality rate in Tamil Nadu is considerably lower than the national IMR of 70 per 1000 live births in 1999. In the national figures, gender differences are not substantial although, contrary to international norms, the male IMR is lower than the female IMR (Planning Commission, 2001).
14. Given the concentration of medical facilities and professionals in urban areas, it is surmised that the lower SRB in urban India is driven by the widespread availability of the technology for sex selection (Agnihotri, 2003). In contrast, in Tamil Nadu, daughter deficit is mainly a rural phenomenon and may largely be driven by sex selective abortion. While a detailed analysis of the reasons for these differences is not pursued here, the extent of urbanisation and rural-urban connectivity in Tamil Nadu could have facilitated the spread, availability and access to sex selection technology. Tamil Nadu is the third most urbanised state in India with an urban population of 44 per cent. It has the highest composite index of urbanisation (as measured by urban population ratio, rural population served by urban centres and distance to the nearest town) resulting in better road facilities, development of transport network and migration (Rukmani, 1994). In addition, the focus of the state government on preventing female infanticide in rural areas may have created the demand for sex selection technology and led to its spread and availability in rural areas.
15. The total number of districts tends to vary over time. While our analysis is based on 29 districts, at the moment Tamil Nadu is divided into 30 districts (accessed at: www.tn.gov.in, 13 December 2006).
16. As mentioned earlier, we use gender differences in infant mortality rates as an indication of post-birth deficit. If we were to take into account that male IMR rates is expected to be higher than female IMR, it would lead to a larger estimate of the post-birth deficit. However, even with this adjustment the proportion of pre-birth deficit would be larger than post-birth deficit.
17. The male birth rate in 1999 was 20.9. Based on the state's male population of 31 million in 2001, this translates into 647,900 male births. An overall deficit of 20 females per 1000 males implies a female deficit of 12,958, that is, a pre-birth deficit of about 11,014 and a post birth deficit of 1943. Our estimate of about 2000 female infant deaths is somewhat lower than that reported in Chunkath and Athreya (1997). Based on data from primary health care centres, Chunkath and Athreya (1997) report that in 1995 there were 3226 female infant deaths due to social causes. Our figures refer to a slightly different period (1996–1999) during which the state government focused on preventing female infanticide in rural areas. This policy may have led to a reduction in female infanticide and, hence, the smaller number of cases but, at the same time, may have led to increased demand for sex selection technology in rural areas.
18. The incidence of abortion in Tamil Nadu is much higher than the corresponding national figures. According to International Institute for Population Sciences (1995) based on the National Family Health Survey 1992–1993, 11 per cent of pregnancies are aborted (spontaneous and induced) in Tamil Nadu, while the corresponding figure for the country as a whole is 5.8 per cent. Induced abortion rate for Tamil Nadu and India are 4.3 per cent and 1.3 per cent respectively.
19. More details on the patterns and the history of daughter elimination in this village are available in Srinivasan (2006).
20. Before carrying out their empirical work, Nillesen and Harris-White (2004) present a more detailed discussion of the potential link between household wealth, male and female education and the survival probability of females. They also draw a distinction between landed and landless households. Given the small sample at our disposal we do not attempt such distinctions and confine ourselves to examining the notion, implicit in intervention programmes, that daughter deficit is a problem of poverty.
21. Due to the small number of cases, we combine the two forms of daughter elimination rather than estimating separate models for female infanticide and sex selective abortion.

22. Comparisons across states shows that economically well-developed states tend to have lower female to male sex ratios and the most rapid decline in the ratio has also occurred in such states (see Premi, 2001). Based on data reported in Agnihotri (2003), in rural India, the correlation between the 0–14 female to male sex ratio and expenditure per capita is -0.82. Similarly, Siddhanta et al. (2003) show that in many large states the 0–14 female to male sex ratio declines with expenditure.
23. Based on the prevalence of Hepatitis B virus carriers and the effect of carrying this virus on SRB, Oster (2005) computes a 'normal' sex ratio of 935 for India. This may be compared with the national SRB of 899 in 1997.
24. A heartening feature is that for the first time, in April 2006, a doctor and a pharmacist in Haryana (a state with one of the lowest sex ratios in the country) were convicted and sentenced to two years in prison for violating the Pre-Natal Diagnostic Techniques (Regulation and Prevention of Misuse) Act, 1994. The state's health officials conducted 3200 inspections in 2005–2006 and revoked or suspended the licences of 114 ultrasound clinics. They also use decoy customers to test whether doctors are violating the law.

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Appendix

Table A1. Conversion chart

Female to male ratio (Females per 1000 Males)	Male to female ratio (Males per Female)
840	1.19
860	1.16
880	1.14
900	1.11
920	1.09
940	1.06
950	1.05
960	1.04
980	1.02
1000	1
1020	0.98
1040	0.96

Table A2. Sex ratio by birth order and sex of previous children (99% confidence interval)

Order	Sex of previous child	Overall	Urban	Rural
1	–	871 (849–893)	859 (811–908)	873 (848–898)
2	Male	1102 (1062–1143)	1101 (1008–1194)	1101 (1057–1146)
3	Female	759 (731–787)	743 (679–806)	762 (731–793)
	Both Male	1176 (1098–1254)	1044 (865–1023)	1201 (1114–1287)
	Both Female	719 (675–762)	611 (518–705)	741 (692–791)
	One Male, one Female	908 (866–950)	842 (740–944)	919 (873–965)

Notes: The figures in this table are taken from Jha et al. (2006). They are based on an all India survey of 1.1 million households conducted in 1997. A total of 133,738 births are used for the analysis.