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Tackling Daughter Deficits in Tamil Nadu, India

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Tackling Daughter Deficits in Tamil Nadu, India

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Abstract

A well-known demographic feature in several East and South Asian countries is the continuing decline in the proportion of girls to boys. In India, till recently, the skewed sex ratio was treated as a Northern and Western Indian phenomenon. However, analysis of the 2001 Census shows that some of the districts with the most unbalanced sex ratios lie in the Southern state of Tamil Nadu. Notwithstanding its recent addition to the list of states exhibiting daughter deficit, the state has pioneered initiatives to prevent daughter elimination and to measure daughter deficit. The availability of district-level panel data on infant mortality and sex ratio at birth covering the years 1996-1999 and 2003, periods which may be characterized by sharp differences in programs and initiatives to reduce daughter elimination combined with spatial variation in these programs, provides an unusual opportunity to identify the causal effect of interventions on both, pre- and post-birth daughter deficit. We find evidence of daughter deficit in at least half the state's districts with a majority of the deficit (60 to 70 percent) occurring before birth, potentially due to sex selective abortion as compared to after birth due to female infanticide and neglect. The temporal analysis over the period 1996-1999 and 2003, shows a 46 percent decline in post-birth deficit, without a corresponding increase in pre-birth deficit. Our difference-in-differences estimates suggest that at least 79 percent of the decline in post-birth deficit may be attributed to the set of policy interventions pursued by the state and civil society actors.

JEL Codes: J12, J15, J16

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I. Introduction

A well-known feature of demographic trends in several East and South Asian countries is the continuing decline in the proportion of females to males. In contrast to the female-male population ratio in Europe and the United States which is about one and the sex ratio at birth which typically lies between 944 and 952 females per 1000 males, unusually low female-male population and sex ratios at birth have been recorded in Bangladesh, China, India, Nepal Pakistan and South Korea (United Nations, 2004).[1] In terms of temporal patterns, for a large part of the previous century India has witnessed a steady decline in its population sex ratio, reaching its 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. In China, there were 901 girls born for every 1000 male births in 1985 while the corresponding numbers in 1995 and 2005 were 806 and 826 (Westley and Choe, 2007).[2] South Korea witnessed a decline in sex ratio at birth from 914 in 1985 to 865 in 1994 (KNSO, 2004) and since the mid-1990s has experienced an increase in the rate (Chung and Das Gupta, 2007). While the decline in sex ratios has attracted scrutiny in these three countries and other parts of the Indian sub-continent, concerns about the decline in the number of females is emerging in other Asian countries, such as Vietnam, and also within countries.[3]

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 ratios in the south and the east (for example, Sopher, 1980: 294-296; Miller, 1981: 71-74; Dyson and Moore, 1983).

[1] Internationally, sex ratios are expressed in terms of the proportion of males to females. However, in India the practice is to express the population sex ratio and 0-6 sex ratio as the proportion of females to males while sex ratio at birth is expressed as the proportion of males to females. For the sake of consistency, we express sex ratios across all age groups and for all countries in terms of the proportion of females to males.

[2] For analyses of sex ratio at birth in China see Hull (1990), Tuljapurkar, Li and Feldman (1995).

[3] Based on data from Vietnam's 1999 Population Census, Truong (2006) points out that the sex ratio at birth in almost all the provinces of Red River Delta is unusually low, ranging from 909 in Ha Noi to 833 in Thai Binh.

More recently, based on an analysis of the 0-6 sex ratio in the Eastern state of Orissa, Agnihotri (2003) argues that this diagonal divide is no longer valid. Similarly, despite the relatively high status of women, the Southern state of Tamil Nadu has recorded a steady decline in its 0-6 sex ratio. This 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.[4]

While it is often argued that a shortage of women may have positive consequences for them (e.g., Samuelson, 1985; Park and Cho, 1995), empirical evidence on this issue is scarce. Indeed, the implications of a growing female deficit in India are yet to be understood and contrary to the idea that scarcity of women "tends towards value" (Samuleson, 1985), the shortage of women in the North Indian states of Haryana and Punjab is reported to have led to a rise in marriage migration, abduction and kidnapping of girls and forced polyandry (Hivos, 2005; Kaur, 2004).[5] Departing from the idea of a scarcity induced increase in value of women, Edlund (1999) argues that the greatest danger associated with pre-natal sex determination is the emergence of a female underclass with low-status parents opting for daughters and high-status families opting for sons. Reports of girls from lower castes, where the sex ratio is not as adverse, being sold to upper caste families for marriage (Aravamudan, 2007; Hivos, 2005; Kaur, 2004) is consistent with this idea.

Despite these grim possibilities, there is limited work on documenting and examining the effectiveness of interventions that have been used to prevent daughter elimination.[6] While daughter shortages in the Southern Indian state of Tamil Nadu are not as severe as in North

[4] While the level of the 0-6 sex ratio and the SRB in Tamil Nadu is higher than the national average of 909, temporal patterns show that the state is experiencing a trend that is similar to the rest of the country (see Srinivasan and Bedi, 2008a).

[5] At a macro-level, Hudson and Den Boer (2004) predict that by the year 2020, 12 to 15 percent of the young adult male population in China and India will not find brides which may result in a rise in violent crime rates and diminishing prospects for democracy, stability and peace which is likely to affect not only Asia but the world.

[6] Lin, Lui and Qian (2007) use data from Taiwan to identify the causal effect of access to abortion on sex ratios. Their estimates show that access to abortion accounted for "approximately 100%" of the change in sex ratios at birth during the 1980s and at the same time this access led to a reduction in relative female mortality. From a policy perspective they argue that banning sex-selective abortion may be expected to lead to excess female mortality.

India, the state has pioneered initiatives to measure daughter shortages and has been active in introducing programs to prevent daughter elimination, some of which have been considered for introduction on an all-India basis.[7] For instance, Tamil Nadu is the only state in the Indian union that frequently conducts vital event surveys which are representative at the district level. The availability of district-level panel data on infant mortality and sex ratio at birth covering the years 1996 to 1999 and then again in 2003, periods which may be characterized by sharp differences in programs and initiatives to prevent daughter elimination combined with cross-district variation in these programs, provides an unusual opportunity to examine the link between interventions and both pre- and post-birth daughter deficits. Set against this backdrop of temporal and spatial variations in interventions to prevent daughter elimination, the main aims of this paper are to analyze daughter deficits between 1996-1999 and 2003 and to identify the causal effect of government and NGO interventions on daughter shortages.

While the paper focuses on temporal changes in daughter deficits, there are other notable features. For example, 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.[8] 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 does not capture the extent of female deficit before birth, within a year after birth and between ages 1 and 6. Furthermore, state-level analyses may be misleading as they mask wide intra-state variations. This paper's use of district-level information on sex ratio at birth and infant mortality permits an analysis of the dynamics underlying the development of female deficit while a district-level analysis allows us to capture the wide intra-state variation in female deficit.

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[7] The terms missing women, female deficit, daughter deficit and daughter shortage are used synonymously. However, we draw a distinction between daughter 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 due to sex selective abortion or infanticide, is treated as a potential reason for the observed deficit.

[8] For instance, Agnihotri (2003), Bhat (2002a, 2002b), Premi (2001). Exceptions are Jha et al. (2006) who rely on a 1997 survey and Bhat and Zavier (2007) who examine inter-state variations in the SRB using census data.

The following section of the paper provides a discussion of the emergence of daughter elimination in Tamil Nadu and an account of measures and policy responses that have been undertaken to address the issue. The discussion in this section is used to develop hypotheses regarding the effect of various intervention programs on post and pre-birth daughter deficit. Section III discusses the main data sources. Section IV discusses the approach used to estimate the extent of pre-birth and post-birth (within a year after birth) deficit, and develops frameworks for decomposing temporal changes in these deficits and identifying the effect of policies on daughter deficits. Section V contains estimates while section VI summarizes and concludes.

II. Daughter elimination, policy responses and hypotheses[9]

Daughter elimination first came to light in Tamil Nadu in the form of female infanticide among the Kallars of district Madurai. Two media articles, Soundarapandian (1985) and Venkatramani (1986) revealed that female infanticide had been practised for over a decade and a half among the Kallars. The investigations claimed that about 6,000 female babies had been poisoned to death in the sub-district Usilampatti in the preceding decade and that the practice was prevalent mainly amongst poor Kallar families and was driven by their inability to finance dowries.

In the 1990s, George *et al.* (1992) reported the prevalence of female infanticide amongst the Gounders of Vellore while Venkatachalam and Srinivasan (1993) wrote on the widespread prevalence of female infanticide amongst the Gounders of Salem district. While initial reports of female infanticide amongst the Kallars had been viewed as a "savage" practice amongst poor families belonging to a "criminal" caste, evidence on the prevalence of female infanticide amongst the relatively wealthy Gounder community located in different parts of the state suggested that the practice was more widespread. Chunkath and Athreya (1997) challenged the view that female infanticide occurred mainly amongst the poor and was restricted to a few castes.

[9] This section is based on government and NGO documents and interactions with NGOs such as the Indian Council for Child Welfare and The Campaign Against Sex Selective Abortion in Madurai, Community Services Guild, Village Reconstruction and Development Programme and Poonthalir in Salem, Alternative for India Development in Dharmapuri, concerned government officials, health and nutrition workers at the state and district levels, women's self-help groups in Salem and residents of rural Salem.

Based on a vital events survey conducted in 1996 and records of births and infant deaths maintained by primary health centers (PHCs), the authors provided evidence on the prevalence of female infanticide in eight districts and amongst at least 35 self-ascribed caste groups in the state. More recently, based on vital events surveys covering the years 1996 to 1999 and primary village data collected in 2002, Srinivasan and Bedi (2008a) show the widespread prevalence of female deficit before and after birth in Tamil Nadu.

II.1 Policy responses 1992-2000

Prior to 1992-93, the Tamil Nadu government denied the existence of female infanticide. However, sustained media attention and reports of female infanticide prompted government acknowledgement and action. In 1992 the state government headed by Ms. J. Jayalalitha, introduced several schemes and initiatives to tackle female infanticide. These included the Cradle Baby Scheme (CBS), legal action against perpetrators of infanticide and the Girl Child Protection Scheme (GCPS).

The CBS was introduced in Salem district in 1992 and provides a more humane option to murder. Instead of resorting to infanticide, parents unwilling to raise female babies could place them in cradles located in primary health care centers, noon meal centers and selected government orphanages. Subsequently, orphanages offer the cradle babies for adoption.[10] Between 1992 and 1996, 140 babies were placed in government cradles (*The Hindu*, June 24, 2001). The scheme had a short life and following elections and a change of government in 1996, it was shelved. Despite the closure of the scheme some babies continued to be deposited with the administration, and between 1993 and 2001 a total of 150 babies had been received in Salem district (see Table 1).

In 1992-93 the government decided to pursue legal action against those who committed or attempted female infanticide. According to police records obtained from various districts (see

[10] The scheme appears to have been hastily set up without much thought being given to the future of babies who would be handed over to the CBS. According to information gathered during field work, the mortality of babies surrendered to the CBS was about four times higher than the state's female IMR.

Table 2), the first arrests for female infanticide were made in Salem district in December 1992. In July 1995, the arrested parents were convicted with the father receiving life imprisonment while the mother received five years rigorous imprisonment. Other early examples of legal action come from Madurai (January 1994) and several cases in Theni (January 1997 and February 1998) and Perambalur (1997). According to these records, between 1992 and 2000 there appear to be at least seven cases of police and legal action. While the fairness of punishing mothers who may be compelled to eliminate their daughters by their husbands or other family members may be questioned, legal action may be viewed as a signal of the state's willingness to prosecute perpetrators.[11]

The GCPS was launched in 1992 with the aim of changing attitudes towards girl children. Among others, the aim of the scheme was to enhance the image of the girl child as well as her economic value by providing financial support for her education and marriage and to discourage parental preferences for sons. The scheme was targeted at poor (below the poverty line) families, who have daughters in the age group 0-4 and no son, and if either of the parents had undergone sterilization before the age of 35 years. As per the scheme, for every eligible girl child, Rs.2,000 was to be deposited in an interest-bearing special public fund maintained by the government. Money from this fund was to be paid out to families on occasions such as the first birthday of the child, on joining school and on joining class VI. On attaining 20 years of age a lump sum of Rs.10,000 is provided which may be used to pursue higher education or meet marriage expenses. A sum of Rs. 40 million per year was allocated for the scheme (*Frontline*, 19(03), Feb.02-15, 2002). Program uptake was limited, and between 1992 and 1997, only 2,039 families had benefited from the scheme (Social Welfare Department, Government of Tamil Nadu). Following elections and a change of government in 1996, the scheme was placed on the backburner.

[11] Extreme examples of the consequences of legal action come from the cases of two women who attempted suicide and the case of Lakshmi, a mother from Theni district who committed suicide, when she was found guilty of infanticide (*The Hindu*, July 31, 2001). In part due to such responses, NGOs such as the Indian Council for Child Welfare, which helped file the first case against female infanticide in Madurai, has, over the years come to oppose legal action.

In addition to these three government-led interventions, several initiatives were located in the three districts of Madurai (including Theni), Salem (including Namakkal) and Dharmapuri.[12] While details of the approach used by NGOs operating in each district differ, broadly, the strategy consisted of three aspects (for details see George, 1997; Srinivasan, 2006). First, formation of women's self-help groups (SHGs) for savings and income generation and to explicitly tackle female infanticide.[13] Group members were provided with training and other inputs on various aspects of gender discrimination including female infanticide and every member took a vow that she would not practice or let others practice female infanticide. Second, at the village level, with the support of NGOs, members of the self-help groups identified, monitored and counseled high risk pregnant women (those with more than one daughter and no son) and their families on the value of girl children and against any attempt at female infanticide. Along with counseling the threat of police and legal action was invoked and specific cases of female infanticide were reported to the police. Third, the NGO provided information and encouraged eligible families to access the GCPS or provided direct economic support to families with girl children. Surrendering the female baby for adoption, that is using the CBS, was usually a last resort.[14] While NGO-led interventions, unlike government-led interventions, were active during the entire period (1992-2000), they were concentrated in a few areas. For instance, the Indian Council for Child Welfare operated in two of Madurai district's 13 blocks. In Salem,

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[12] Till January 1997, Theni was part of Madurai district, while Namakkal was part of Salem.

[13] The formation of these self-help groups was sponsored by the government and executed with the assistance of the International Fund for Agricultural Development, (IFAD). The program started in Dharmapuri district in 1989 and was extended to Salem and Villupuram districts in 1991-1992 and to Madurai and Ramanathapuram in 1992-93. At the end of December 1998 there were 5,207 women's self-help groups in these five districts with an average of 20 women per group. By 2000 the program had been extended to all the districts in the state and as of January 2003 there were 118,413 self-help groups operating in the state. Women belonging to these groups contribute money on a monthly basis which is placed in a bank account in the name of the group. While small loans for consumption can be availed through group savings, group membership provides access to bank loans for economic activities (for more details see, http://www.tamilnaduwomen.org/).

[14] This combination of monitoring through self-help groups, providing economic support (through the GCPS or otherwise) and using the threat of legal action appears to have been developed by the Indian Council for Child Welfare (ICCW) which has been operating mainly in Usilampatti block of Madurai district (the district where female infanticide was first reported) since 1992-93.

NGOs such as the Community Services Guild, Village Reconstruction and Development Programme (VRDP) operated in three of the district's 20 blocks and in Dharmapuri, AID's (Alternative for India Development) efforts were restricted to one of the district's eighteen blocks.

The only large scale activity during this period, led by project administrators under the aegis of a Tamil Nadu Area Health Care Project was a behavioral change communicaiton campaign conducted in Dharmapuri district. The project implementation team developed a strategy to tackle female infanticide through a process of social mobilization. A strong communications program with *kalaipayanams* (itinerant street theatre) at its centerpiece was used to create awareness and mobilize the population against female infanticide.[15] According to Athreya and Chunkath (2000) the direct and indirect reach of the program was universal and "every one either knew of it beforehand or came to know of it afterward". In order to ensure sustainability of the message delivered through the *kalaipayanams*, the project leadership built a long term intervention strategy around the elected local body leaders. In 1999, conferences of panchayat presidents, health functionaries and social activists were held in the eight panchayat unions of Dharmapuri health unit district. At each of these the panchayat presidents committed themselves to working for elimination of female infanticide. The entire period of this intervention, from initial preparatory work to the panchayat commitment covered the years 1997 to 1999. Soon after, based on an analysis of differences in female-male infant mortality between 1996 and 1999, the project leadership claimed that their social mobilization program had led to a reduction in infanticide in Dharmapuri. Whether this claim is valid and whether the effects of these activities persisted after 1999 still needs verification.

II.2 Policy responses, May 2001-

[15] Performing troupes, typically consisting of eight men and eight women were trained in each of the 18 blocks of the district for about 40 days. Then between April 26 and June 6, 1998 these troupes covered their respective blocks and delivered about 3,000 performances which were watched by about a third of the district's population.

Notwithstanding these initiatives, as compared to 1991, the 2001 census pointed to a further decline in the state's child sex ratio. While the government had been quick to introduce various initiatives in the early 1990s and interventions in specific districts continued during the decade, as discussed above, in general, the period 1996 to 2000 was characterized by a reduction in government efforts to tackle daughter deficits (Srinivasan, 2006). In May 2001, J. Jayalalitha, who had initiated action against female infanticide in 1992-93, returned to government. Her return led to a renewal of governmental action against daughter elimination. The post-2001 period may be treated as the second phase of interventions against daughter elimination and is marked by several changes.

In May 2001, the Cradle Baby Scheme was resurrected in Salem and extended, initially, to four other districts (Madurai, Theni, Dindigul and Dharmapuri). This was soon followed by an extension of the program to all the state's districts. Additional resources were provided and the program was executed in a more systematic manner. The involvement of NGOs in scheme implementation and placement of the babies for adoption was enhanced. Numerous cradle points were opened in PHCs, hospitals, orphanages, railway stations, and bus-stands and frequent public announcements and advertisements in the press popularised the scheme. The scheme recorded a sharp increase in the number of babies and between May 2001 and November 2007, 2410 baby girls had been received in this second phase of the scheme (see Table 1). Of these, 75 percent were from the five districts which had been initially targeted for program placement.

As displayed in Table 2, during this time period police and legal action against infanticide registered an increase especially in Salem and Theni districts. Ten cases of police and legal action were recorded between in 2001 and 2003 as compared to seven cases between 1992 and 2000.

In 2001-02 the GCPS was restructured to confer increased financial benefits. In the case of poor families with only one girl and no sons and where either parent had undergone sterilization before the age of 35 years, the government deposits Rs.22,200 and in the case of poor families with two girls and no sons, Rs.15,200 each, for 20 years in the Tamil Nadu Power

Finance and Infrastructure Development Corporation. Interest accruing from this deposit provides monthly payments of about Rs.150 to the family and a terminal payment, at age 20, of Rs.80, 000 for a one-girl family and a benefit of Rs.40, 000 per girl for families with two girls.[16] A sum of Rs.227 million, in real terms 2.83 times more than the allocation in 1991-92, was allocated for the scheme in 2001-02. The scheme has witnessed a 50 fold increase in the number of beneficiaries and according to policy note 2006-2007 prepared by the Corporation, a sum of about Rs.1750 million benefiting 115,171 children has been received under the scheme.[17]

In addition to the resurrection of these schemes, the government directed district administrations to prevent female infanticide and sex selective abortion in five high-prevalence districts, namely Dharmapuri, Madurai, Salem, Theni and Namakkal.[18] The case of Salem, the district with the lowest 0-6 ratio in South India, is illustrative. Between June 2001 and July 2003 under the leadership of the collector, Dr.Radhakrishnan, the Salem district administration worked closely with NGOs and took several measures to prevent female infanticide and sex selective abortion.

The NGO model of monitoring and counseling high-risk pregnant women through the active involvement of women's SHG and provision of economic support was adopted and scaled up. Village-level committees, consisting of Panchayat members, SHG representatives, Village

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[16] Based on income limits for scheme eligibility, the sum of Rs.150 per month amounts minimally to a 15 percent increase in income for families with two girls and a 4 percent increase for families with one girl. The final payments are meant to be used for the education of girls or to meet their marriage expenses, including dowry. While the amount of dowry depends an household wealth and income, based on field work conducted in a village in Salem district we found that in 2003, the average dowry amounted to about Rs. 50,000 (Srinivasan and Bedi, 2007). Based on current rates of inflation (6 percent), a 20 year horizon and no dowry inflation, a payout of Rs. 80 000 would finance about half the expected dowry.

[17] See, http://www.tntdpc.com/government/energy.pdf, accessed on Oct. 2, 2007.

[18] These districts were targeted through the Cradle Baby Scheme (Policy Notes, Government of Tamil Nadu, 2001-02 at http://www.tn.gov.in/policynotes/archives/, accessed on July 10, 2008), they were amongst the seven districts that received funding to conduct behavioural change campaigns against infanticide and foeticide (Policy Notes, Government of Tamil Nadu, 2003-04 at http://www.tn.gov.in/policynotes/archives/, accessed on July 10, 2008) and the two districts, Madurai and Theni were targeted as part of the government's reproductive and child health project, through which the districts received funding to conduct communication and awareness campaigns to tackle infanticide (details are at http://www.tnhealth.org/externallyaidedprojects.htm, accessed on July 10, 2008).

Health Nurses (VHN) and nutrition workers, to monitor pregnant women were set up in 385 of the district's 557 villages.[19] At least six cases of police and legal action were initiated during this period as compared to one during 1992-2000 (see Table 2). A dedicated 24 hour toll-free phone number with direct access to the collector's bungalow was set up to report female infanticide and sex selective abortion. A death audit was started and any infant death—male or female—was investigated (if need be, bodies were exhumed). These activities were conducted in a high profile manner and district officials utilized every opportunity to condemn infanticide and foeticide.

While some measures against sex selective abortion were also taken during this period, the focus of the interventions remained primarily on prevention female infanticide. For example, in Salem, a senior health official instructed VHNs to,

"let them scan and abort. We do not want a FI death at any cost."

In 2002, the Salem district administration claimed that, as compared to female IMR in 1999, the efforts of the administration and NGOs had led to a drastic reduction in female IMR/female infanticide. However, various NGOs under the umbrella of the Campaign against Sex Selective Abortion (CASSA) argued that the problem had not been tackled and had led to an increase in sex-selective abortion (SSA).[20] Both, the reduction in female infanticide claimed by the district administration and the potential increase in SSA need empirical verification.

In 1998 several activists and NGOs combined forces to constitute a state-wide Campaign against Sex Selective Abortion (CASSA). At present CASSA has a membership of more than 60 organizations and its main aim is to ensure effective implementation of the Pre-Conception and Pre-Natal Diagnostic Techniques Act 1994 (amended in 2003), which provides the legislative framework prohibiting sex selective abortion. The Campaign's activities include, lobbying the state's Directorate of Medical Services to implement the various provisions of the law,

[19] In Tamil Nadu, pregnant women register with the VHN and nutrition worker in the third month of pregnancy to receive medical services and nutritional supplements.

monitoring scan centers and genetic clinics to ensure implementation of the PCPNDT, conducting educational and awareness program on SSA and monitoring changes in the state's sex ratio. CASSA started its operations in Madurai but now operates in eight other districts. While the Campaign started in 1998, it became relatively more active only in 2001 when it was successful in pressurizing the government to register scan centers.

II.3 Hypotheses

As discussed above, the period after May 2001 is characterized by sharp increases in public resources, administrative energy and overall, a rejuvenation of interventions to tackle daughter deficits. While there has been a state-wide renewal of schemes there is substantial spatial variation in the policy treatment received by different districts. Based on the preceding discussion and as shown in Table 3, the 29 districts in the state may be divided into three categories. The first set consists of five districts that have been purposively targeted by state and NGO-led interventions, they account for a majority of legal actions initiated against infanticide and have access to the GCPS and CBS. This set of districts, may be characterized as "heavily treated districts". The second set consists of six districts where legal actions have been initiated and these districts have access to GCPS and CBS but there are no widespread NGO-led interventions. These districts may be characterized as "lightly treated" districts. The third set consists of districts where *no* legal action has taken place, these districts (not shown in table) have access to GCPS and CBS but there is no widespread NGO-led intervention. These districts may be described as "minimally treated" districts.

Based on the previous discussion, we hypothesize that between 1996-1999 and 2003, there should have been a reduction in female infanticide, as captured by a reduction in post-birth deficit. Second, over time and as compared to the minimally treated districts, the heavily treated districts, should have experienced the sharpest reductions in post-birth deficit followed by the set

[20] Scan centers offering sex-selection technology emerged in Tamil Nadu in the mid-1990s (Srinivasan, 2006). Based on information from the Directorate of Public Health, Government of Tamil Nadu, there were 389 registered scan centers in the state in 1999. By 2003, this number had increased to 2325.

of lightly treated districts. Third, given the focus of the interventions on preventing infanticide, an externality associated with these programs may have been an increase in sex selective abortion, as captured by an increase in pre-birth deficit.

III. Data

At the very least, an intra-state assessment of daughter deficits requires district-level data on SRB and male and female infant mortality. The civil registration system which in principle should contain figures on these vital events is not complete. In the absence of such information, Indian data on vital events is generated through a Sample Registration System (SRS), a countrywide annual survey of vital events covering about 1.1 million households (six million individuals) in each round, conducted under the aegis of the federal government's Office of the Registrar General. While the SRS provides information on SRB and mortality, these are available only at the state-level and do not support an examination of intra-state patterns.

In the absence of district-level information on vital events, a widely used source to assess recent patterns in district-level daughter deficit has been Census 2001 data on sex ratio for the 0-6 age group. While census data on the 0-6 sex ratio were released soon after its completion, SRB data, *collected for the first time in 2001*, have only recently become available. These data provide an opportunity to assess intra-state patterns in SRB on the basis of a (relatively) complete and reliable source, they however do not permit a temporal analysis.[21]

While we use SRS and Census 2001 data, the bulk of the paper relies on five rounds of Vital Events Surveys (VES) conducted by the Directorate of Public Health (DPH) of Tamil Nadu every year between 1998 and 2000 (covering vital events in the years 1996, 1997, 1998 and 1999) and again in 2004 (covering vital events in 2003). These surveys were launched by the state government to track vital events on a more regular basis and to generate district-level information

[21] Since the Indian census is decennial, relying on this information source to assess changes in SRB over time implies a long wait. Information on the SRB from Census 2001 became available to a limited set of researchers in 2005 and more widely only in 2006. If this practice were to continue then district-level data on SRB collected in census 2011 would only be available in 2015.

for the purpose of planning and implementation. Among others, the VES gathers information on number of male and female live births, and infant deaths during the year preceding the survey. Each of the surveys is based on a sample of about six million individuals in rural (non-municipal) areas and three million individuals in urban (municipalities and corporations) areas.[22] 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. While additional details on the surveys are available in 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. The volume of data available in each of the VES, nine million individuals and 174,000 births, may be contrasted with the SRS which usually covers 355,000 individuals and about 6000-7000 births in each round.

Consistent with the narrative provided in the previous section and the aim of the paper, we break the period 1996 to 2003 into a period before and after intensification of efforts to reduce daughter deficit, that is, a period before and after 2001. To focus on these two broad periods, pre-2001 estimates are based on the vital events surveys covering the period 1996 to 1999. Information from the four surveys is pooled and accordingly, the pre-2001 analysis relies on responses from 36 million individuals or about 1.25 million individuals per district. The total numbers of births analyzed during this period are 694,605. For the post-2001 analysis we rely on VES 2003 which covers 9 million individuals and includes 171,427 births. In addition, we also use data from census 2001 which covers 14 million households and 895,765 births.

IV. Measuring daughter deficits

[22] The definition of urban and rural areas used in the Vital Event Surveys 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).

Daughter deficit, defined as the gap between the number of expected daughters and the number of daughters born or alive in a certain age group, may occur before birth, within a year after birth (post-birth deficit) or beyond age one. In this paper we focus on two sources of daughter deficits, that is, deficits which occur before birth and within a year after birth. This section considers how these deficits may be identified and discusses the ratios which may be expected in the absence of interference against which the prevailing ratios may be compared. Before proceeding, it should be pointed out that, while in principle there is no need to stop at age one, our previous work (Srinivasan and Bedi, 2008b), where we decompose daughter deficit into pre-birth deficit, early post-birth deficit (age 0-1), and late-post birth deficit (1-5), using state-level data from Tamil Nadu shows that in the period that we focus on (1996 to 2003) daughter deficit may be attributed entirely to pre- and early post-birth deficit.[23]

IV. 1 Benchmarking the SRB and measuring pre-birth daughter deficit

International evidence on the expected sex ratio at birth in countries without a record of pre-birth interventions is available from several sources. Based on an analysis of 240 years of Swedish data, Johansson and Nygren (1991), henceforth JN, conclude that the sex ratio at birth is 'biologically very stable' and is close to 952 females per 1000 males. They note that the SRB does not show any significant variation across regions, not does it vary with birth order or mother's age. JN also analyze data on live births from 12 other Western industrialized countries for the period 1970-84 and conclude that the SRB in these countries also conforms to the patterns found

[23] Based on state-level data covering the period 1981 to 2002 and an analysis of SRB, infant mortality rates, under-5 mortality rates and sex ratios in the age group 0 to 6, we show that in 1981, 93 percent of the deficit may be attributed to late-post birth deficit and 7 percent to early-post birth deficit. In 1991, 63 percent of the deficit may be attributed to late post-birth deficit and 37 to early-post birth deficit. During the mid-90s, the share of late-post birth deficit declines and the bulk of the deficit appears to stem from early-post birth deficit (69 percent). Towards the end of the 90s (1997-2000) and in 2001 and beyond, the shortfalls may be attributed entirely to early post-birth deficit and pre-birth deficit, with pre-birth deficit beginning to dominate. The numbers which form the basis for this analysis are provided in Table A1 and a discussion of the numbers is available in Srinivasan and Bedi (2008b) and at http://campus.iss.nl/~bedi/TDD_june08.pdf. Furthermore, beyond age 5, the data suggest that mortality rates for boys and girls are not very different. For instance, according to the Planning Commission's, National Human Development Report 2001 (2002:233) even in 1981 and 1991, mortality rate in the age group 5-9 in Tamil Nadu was lower for girls (2.9 and 1.8 in 1981 and 1991, respectively) than for boys (3 and 2.4 in 1981 and 1991, respectively). For Tamil Nadu, Premi (2001) reports a similar pattern of lower female mortality in the age group 5-9 for the years 1989 to 1994.

in Swedish data. To update these numbers we used data available in the United Nations Demographic Yearbook (2004) and computed the SRB for all countries with a relatively complete civil registration system (estimated to be at least 90% complete) with 170,000 or more live births per year (about the same number as recorded in the Tamil Nadu VES) and with, as far as we are aware, no record of pre-birth interference (except for Japan, we excluded all South and East Asian countries). The SRB for the set of 16 countries satisfying these criteria lies between 932 and 965 with a median of 950 and a weighted mean of 948.[24] Clearly, there is variation in the SRB across countries. However, given the various biological and social factors that may have a bearing on the SRB, it is remarkable that the SRB lies in a fairly narrow range.[25]

In the Indian context, an idea of the 'normal' SRB may be obtained by examining SRB at a time when it may have been relatively difficult to carry out accurate pre-birth sex selection. The earliest source that we have been able to locate is Ramachandran and Deshpande (1964), henceforth RD. Based on 1.93 million births in hospitals and health centres during the period 1949-1958, RD report an all-India SRB of 943 and based on 736,216 births a SRB of 943 for south India. Clearly, the SRB figures reported by RD lies within the range found in the set of 16 countries. While hospital data reflect only a small proportion of births, RD examine the sensitivity of their estimates and conclude that given the large size of their sample it is likely that the hospital sex ratio is a "valid indicator of the order of magnitude of the SRB for the population at large". While RD's figures are based on actual birth data, estimates of the Indian SRB based on the link between SRB and life expectancy at birth have been computed by Klasen

[24] Some countries satisfying these criteria were excluded, such as United States and Russia, as information on the number of live births was not disaggregated by sex. Countries included are, Australia (2004) 944, Canada (2003) 952, Chile (2003) 955, France (2004) 951, Germany (2004) 949, Guatemala (1999) 965, Italy (2003) 946, Japan (2004) 950, Kazakhstan (2003) 943, Morocco (2001) 952, Netherlands (2004) 955, Poland (2004) 942, Romania (2003) 940, Spain (2003) 942, United Kingdom (2003) 951, Venezuela (2002) 932. The weights are based on the number of births in each country.

[25] Various factors other than pre-birth interference may have an effect on the sex ratio at birth. These include maternal calorie intake and nutrition (Williams and Gloster, 1992; Goodkind, 1996; Jayaraj and Subramaniam, 2004), Hepatitis-B virus infection (Drew et al. 1986; Oster, 2005), parental hormonal levels at the time of conception (James, 1996) 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).

and Wink (2003) and Sudha and Rajan (2003). Both papers report an expected SRB of about 961-962 for India.

Regardless of the approach (comparisons with international data, Indian hospital data or on SRB estimates) the Indian SRB in the absence of interference may be expected to lie in a fairly narrow range. To benchmark pre-birth daughter deficit we decided to work with the average of the (South) India-specific estimates (943 and 962). Accordingly, we use 952 female births per 1000 male births as the sex ratio which may be expected to prevail in India and in Tamil Nadu in the absence of interference. Sex ratios at birth which are statistically different from and less than 952 are treated as evidence of pre-birth daughter deficit.[26] Thus, pre-birth daughter deficit (DD_{pre}) defined as the gap between the number of expected girls and the number of girls born may be calculated as,

$$DD_{pre} = N_m SRB_e - N_f , \tag{1}$$

where, N_m and N_f denote the number of live male and female births and SRB_e denotes expected SRB. Dividing and multiplying the right-hand-side of (1) by N_f yields,

$$DD_{pre} = \left(\frac{SRB_e}{SRB_s} - 1 \right) N_f , \tag{2}$$

where $SRB_s = N_f / N_m$, denotes the estimated sex ratio at birth. Districts where SRB_s is less than SRB_e experience a daughter deficit and (2) provides a measure of the extent of this deficit. Districts where SRB_s is not statistically different from and less than the expected SRB ((2) is zero or negative) are viewed as areas with no evidence of daughter deficit.

IV.2 Benchmarking infant mortality and post-birth daughter deficit

[26] Based on the argument that carriers of the Hepatitis B virus (HBV) are more likely to have male children, Oster (2005), computes an expected SRB of 935 for India. This ratio is based on an estimated SRB of 649 amongst carriers of the virus, a ratio of 954 for non-carriers and a HBV prevalence rate of about 4.2 percent for India. While a number of authors (see Srinivasan and Bedi, 2008a; Dasgupta, 2008) have argued that a HBV based explanation plays a marginal role in explaining daughter deficit, based on Oster's calculations of the effect of the HBV on SRB and Tamil Nadu's estimated HBV prevalence rate of 2.3 (WHO, 2002), the state's expected SRB would be 944, that is, within the international and national range of estimates (943 to 962), suggesting that our use of 952 (mid-point of the set of estimates) is not unreasonable.

For various biological reasons, IMR, defined as mortality in the age group 0-365 days and expressed as infant deaths per 1000 live births is usually higher for males (for an early review, see Waldron, 1983). JN (1991), analyze male and female infant deaths in several countries for the period 1976-84, and conclude that in the countries included in their analysis, the number of male infant deaths is higher than female infant deaths and that the number of female deaths for every 100 male infant death lies between 75 and 78. They conclude that there is a 'natural' ratio of about 77 female infant deaths for every 100 male infant deaths.[27] To update these figures we gathered information from United Nations (2004) on male and female infant deaths from the set of countries that satisfy the criteria that we used to establish the benchmark for SRB (see section IV.1). The ratio of female to male infant deaths in these countries ranges from 71 to 83 with a median of 78 and a weighted mean of 76.5.[28]

Unlike the SRB, benchmarking gender differences in infant mortality using Indian data is not possible. Evidence of post-birth interference and female infanticide in India stretches at least as far back as the first census conducted in 1871 (Sudha and Rajan, 2003) and even the neighboring state of Kerala, which is recognized for its relatively higher level of social development and could have been used to create a benchmark has recorded a decline in 0-6 ratio from 972 in 1961 to 963 in 2001 (Premi, 2001), suggesting post-birth interference. Since it is unlikely that any source of information on infant mortality in India will be free of interference, we rely on international comparisons to develop the appropriate benchmark.

Working with a naturally occurring SRB of 952 females per 1000 males and a potential range of 71 to 83 female infant deaths for every 100 male infant deaths and adjusting for the

[27] Based on data covering the period 1976-84 the ratio of female to male infant deaths was 75.1 in Canada, 75.2 in Japan, 76.3 in the United States, 77.5 in Hong Kong, 75.2 in France, 75.8 in Belgium, 76.3 in Austria, 76.9 in Sweden. This pattern also prevails in less developed countries. For the same period the ratio was 78.1 in Malaysia and The Philippines (for more details see Johansson and Nygren, 1991).

[28] The countries included are Australia (2004) 77, Canada (2003) 79, Chile (2003)82, France (2004) 74, Germany (2004) 79, Guatemala (1999) 79, Italy (2003) 81, Japan (2004) 82, Kazakhstan (2004)72, Morocco (2001) 83, Netherlands (2004) 71, Poland (2004) 77, Romania (2003) 72, Russia (2004) 72, Spain (2003) 80, United Kingdom (2003) 82, Venezuela (2001) 73, United States (2003) 76. The weights are based on the number of infant deaths in each country.

smaller number of female births, yields an expected female IMR of between 75 (71/0.952) to 87 (83/0.952) percent of the male IMR. Based on the weighted mean of the ratio of female to male infant deaths we may define the expected female IMR as 80 percent of the male IMR (76.5/.952). The range developed here is very similar to the figures reported in Hill and Upchurch (1995). Based on the historical experience of several currently developed countries, Hill and Upchurch (1995) estimate that the expected female IMR lies between 76.7 and 84.6 percent of male IMR.[29] According to their estimates, the expected female IMR ranges from 76.7 percent of male IMR for countries at low (25 per 1000 live births) levels of male under-5 mortality to 84.6 percent in countries at high levels of under-5 male mortality (300 per 1000 live births). Based on NFHS-2, Tamil Nadu's male under-5 mortality is estimated to be 66.8 per 1000 live births for the period 1989-98 (Pandey, et al. 1998), which yields an expected female IMR of between 77.8 and 78.6 of male IMR. Thus, regardless of whether we work with the figures in JN (1991), Hill and Upchurch (1995) or the comparisons developed on the basis of more recent date, it would seem that an expected female IMR of 77 to 80 percent of male IMR in the absence of interference is an appropriate benchmark. We work with a benchmark of 80 percent, thus, post-birth daughter deficit (DD_{post}) may be written as,

$$DD_{post} = \{FIMR_s - (0.8 * MIMR_s)\}N_f, \tag{3}$$

where $FIMR_s$ and $MIMR_s$ are estimated female and male infant mortality, respectively.[30]

Alternatively, (3) may be expressed as,

$$DD_{post} = (FIMR_s - FIMR_e)N_f, \tag{4}$$

where $FIMR_e$ denotes the expected female IMR. If estimated female IMR is higher and statistically, significantly different from the expected female IMR, it is treated as evidence of post-birth daughter deficit.

[29] Data from England and Wales, France, the Netherlands, New Zealand and Sweden covering the period 1820 to 1964 is used to construct the expected female infant mortality rate.

[30] A benchmark of 77 percent yields slightly larger estimates of post-birth daughter deficit but does not lead to remarkable changes in the estimates.

IV.3 Total daughter deficit and changes in the deficit over time

Combining (2) and (4), we obtain total daughter deficit (*TD*) as,

$$TD = \underbrace{\left(\frac{SRB_e}{SRB_s} - 1\right)N_f}_{DD_{pre}} + \underbrace{\{FIMR_s - FIMR_e\}N_f}_{DD_{post}}. \qquad (5)$$

This expression may be used to compute the absolute daughter deficit in a given year/period and dividing by N_f, may be used to express daughter deficit in terms of a daughter deficit rate ($DDR=TD/N_f$) per 1000 live female births.

To compute changes over time, consider that in year *t*, the total district (state)-specific daughter deficit (*TD*) is written as,

$$TD_t = \underbrace{\left(\frac{SRB_e}{SRB_{st}} - 1\right)N_{ft}}_{DD_{pre,t}} + \underbrace{(FIMR_{st} - FIMR_{et})N_{ft}}_{DD_{post,t}}. \qquad (6)$$

Over time, the total daughter deficit may change due to changes in pre-birth deficit, post-birth deficit or both. *In seriatim* let us consider each of the two deficits. The change in pre-birth daughter deficit between two years *t* and *j* may be written as

$$DD_{pre,t} - DD_{pre,j} = \left(\frac{SRB_e}{SRB_{st}} - 1\right)N_{ft} - \left(\frac{SRB_e}{SRB_{sj}} - 1\right)N_{fj}. \qquad (7)$$

Adding and subtracting $\left(\frac{SRB_e}{SRB_{st}} - 1\right)N_{fj}$ to the right-hand-side of (7) and manipulating yields,

$$DD_{pre,t} - DD_{pre,j} = \left(\frac{SRB_e}{SRB_{st}} - 1\right)(N_{ft} - N_{fj}) + N_{fj}\left(\frac{SRB_e}{SRB_{st}} - \frac{SRB_e}{SRB_{sj}}\right). \qquad (8)$$

As (8) shows, changes in pre-birth daughter deficit may be decomposed into a part that may be attributed to changes in number of female births between year *t* and *j*, while keeping the observed *SRB* fixed (first term on the RHS) and a portion that may be attributed to changes in the estimated *SRB* while keeping number of female births fixed.[31] We are mainly interested in the latter term. If pre-birth daughter deficit declines over time, due to a decline in the number of births and/or an increase in SRB, then (8) will be positive, on the other hand if (8) is negative it indicates a worsening of pre-birth daughter deficit.

Similarly, over time, changes in post-birth daughter deficit between period *t* and *j* may be written as,

$$DD_{post,t} - DD_{post,j} = (FIMR_{st} - FIMR_{et})N_{ft} - (FIMR_{sj} - FIMR_{ej})N_{fj} \quad (9)$$

To simplify, let $dFIMR$ represent the difference between estimated and expected female infant mortality rates. Accordingly, (9) is rewritten as,

$$DD_{post,t} - DD_{post,j} = dFIMR_t N_{ft} - dFIMR_j N_{fj} \,. \quad (10)$$

Adding and subtracting $dFIMR_t\ N_{fj}$ to the right-hand-side of (10) and manipulating yields,

$$DD_{post,t} - DD_{post,j} = dFIMR_t(N_{ft} - N_{fj}) + N_{fj}(dFIMR_t - dFIMR_j) \,. \quad (11)$$

As (11) shows, a part of the temporal change in post-birth daughter deficit may be attributed to changes in the number of female births keeping differential mortality fixed (first term on the RHS) while another part may be attributed to changes in differential mortality keeping the number of births fixed. Furthermore, changes in post-birth daughter deficit which may be attributed to the decline in the number of female births (first term on the RHS) may be due to a decline in fertility or a decline in female births due to the use of sex-selective abortion. This possibility highlights the need to analyze changes in SRB and IMR simultaneously.

Combining (8) and (11) permits a simultaneous analysis of SRB and IMR and allows a tri-partite decomposition of changes in daughter deficit over time,

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[31] In general, estimates of daughter deficit would differ if we were to use $\left(\frac{SRB_e}{SRB_{sj}} - 1\right)N_{ft}$ to obtain (8). However, in this case, as will be discussed later, we assume $N_{ft} = N_{fj}$ and hence the decomposition is not sensitive to the normalization used. In fact with this assumption, an expression to obtain changes in daughter deficit over time may be directly obtained from (6) without the need for this decomposition. However, we display the various steps as our aim is to develop a more general approach that may be used in cases where time periods are further apart and this assumption is not invoked.

$$TD_t - TD_j = \left[\left(\frac{SRB_e}{SRB_{st}} - 1\right) + dFIMR_t\right](N_{ft} - N_{fj}) + N_{fj}\left(\frac{SRB_e}{SRB_{st}} - \frac{SRB_e}{SRB_{sj}}\right) + N_{fj}(dFIMR_t - dFIMR_j) \quad (12)$$

As shown in (12), temporal changes in total daughter deficit may be decomposed into a part which may be attributed to a secular change in number of female births (that is, a change in birth rates), to changes in SRB and to changes in differential mortality.

In practice, while we have survey based estimates of *SRB* and *IMR* at different points in time, information on the total (census of births as opposed to survey-based) number of male and female births is available only from Census 2001. Since it is unlikely that there has been a sharp secular change in female births (birth rates) during the period under analysis we assume that $N_{ft} = N_{fj}$ and treat changes in total daughter deficit before and after 2001 as a function of changes in *SRB* and changes in differential mortality.[32] With this simplification (12) reduces to,

$$TD_t - TD_j = N_{fj}\left(\frac{SRB_e}{SRB_{st}} - \frac{SRB_e}{SRB_{sj}}\right) + N_{fj}(dFIMR_t - dFIMR_j). \quad (13)$$

To compute (13), we use the total number of live female births from the census conducted in 2001, while vital events surveys covering the period 1996-1999 and 2003 are used to obtain estimates of *SRB* and *IMR* for the period before and after 2001, respectively.

IV.4 Daughter deficits and interventions

The preceding sub-section discussed an approach that may be used to decompose changes in daughter deficits over time. However, the framework does not explicitly deal with the impact of interventions on daughter deficits. To isolate the impact of these interventions we propose to exploit the sharp variations in policy interventions before and after 2001 and the spatial variations in policy intensity across districts. Specifically, we construct a district-level data set for the two time periods (1996-1999 and 2003) and estimate difference-in-differences type regressions to isolate the effect of interventions on daughter deficits. Consider the following model for (pre and post) daughter deficit rate (*DDR*) in district *i*, area *a* (rural or urban), in year *t*:

$$DDR_{iat} = X'_{iat}\mu + \beta_i + \delta_1 t + \alpha_0 R*t + \alpha_1 T*t + \varepsilon_{iat} \ , \qquad (14)$$

where X_{iat} is a set of time-varying characteristics, β_i is a district fixed-effect, *t* indicates the time period of the observation, *R* indicates rural areas of the district, and *T* equals unity for treated districts (heavily and lightly) and zero otherwise (minimally treated). The main parameter of interest is α_1 which measures the difference in the average temporal change in daughter deficit between treated and minimally-treated districts which may be attributed to the various policies. To push the analysis further we also distinguish between heavily treated and lightly treated districts to identify the effect of the full suite of intervention programs versus the limited set of interventions as reflected in the lightly treated districts. This model is estimated as,

$$DDR_{iat} = X'_{iat}\mu + \beta_i + \delta_1 t + \alpha_0 R*t + \alpha_1 HT*t + \alpha_2 LT*t + \varepsilon_{iat} \ , \qquad (15)$$

where *HT* and *LT* indicate heavily and lightly treated districts, respectively and the main parameters of interest are α_1 and α_2. Equations (14) and (15) are also estimated for districts as a whole.

Drawing on the existing literature (Rosenzweig and Schultz, 1982; Murthi, Guio and Dreze, 1995; Rose, 1999) on gender differences in infant mortality in India, the set of variables included in *X* are female and male work participation rates, female and male literacy and per

[32] While we do not have census information on the number of births for 1996-1999 and for 2003, the VES data show that the average number of births per year between 1996 and 1999 was 173,651 while in 2003 the number of births was 171,427 or a small reduction of 1.28 percent. According to the SRS (www.census.tn.nic.in accessed on December 10, 2007) in 1997, the birth rate (95% C.I.), that is, the number of live births per 1000 population, was 19 (18.4-19.6) per 1000 for the state and 19.3 (18.6-20) and 18.3 (17.1-19.5) in rural and urban areas, respectively. In 2003, the birth rates (95% C.I.) were 18.3 (17.8-18.8), 18.8 (18.2-19.4) and 17.3 (16.2-18.4) for the state, rural and urban areas, respectively. These figures show that between 1997 and 2003 the birth rates in rural and urban areas are not statistically different at a significance level of 5 percent.

capita income. Rose (1999) argues that favorable rainfall shocks increase the survival rate for girls and accordingly, the specification controls for the amount of rainfall during the two time periods. During this time period two changes which may have a bearing on daughter deficits are the spread of women's SHGs throughout the state and an increase in the number of medical centers offering ultrasound (scanning) services. While some SHGs worked with NGOs to tackle daughter elimination, their spread, regardless of whether they work with NGOs, may have an independent effect on reducing daughter deficit. The spread of scanning services may work towards reducing post-birth daughter deficit and increasing pre-birth deficit. To capture these possibilities we control for the number of SHGs and the number of registered/ legal scan centers per district.

These specifications, (14) and (15), control for district fixed effects and for a number of time-varying characteristics, and as long as important time-varying variables have not been omitted, the error terms should not be correlated with the explanatory variables, and these regressions should yield credible estimates of the impact of interventions on daughter deficits.[33]

V. Estimates

V.1 Infant mortality and post-birth deficit, 1996-2003

Table 4 provides VES based estimates of IMR over the period 1996-1999 and for 2003. As shown in the table, in 1996-1999 the male IMR is 36; the female IMR is 39 as opposed to an expected female IMR of 29. In terms of a broad spatial distribution, the female disadvantage emanates mainly from rural areas. In the urban areas of the state the estimated and expected female IMR (19 versus 18.4, respectively) are not statistically different. The rural areas of the state reveal a different picture with a male IMR of 41 and a female IMR of 48 as compared to an expected female IMR of 33.

[33] In addition, we also controlled for changes in access to electricity and sanitation (percentage of households in district with access to electricity and toilets), for access to educational facilities as measured by enrolment rates, quality of education as measured by primary school dropout rates and although endogenous, also for birth rates. The estimates, discussed later, were not substantially affected by these inclusions.

A few years later, based on VES 2003, the male and female IMR are the same (30 per 1000). While these numbers still reflect a statistically significant 6 point female disadvantage, temporally, the decline in female IMR outstrips the decline in male IMR, resulting in a 4.5 point decline in the gap between estimated and expected female IMR. The decline is pronounced in rural areas with a sharp 8.2 point reduction in the gap between estimated and expected female IMR (a reduction in the gap from 15.2 to 7). In contrast, in urban areas the temporal change between estimated and expected female IMR is statistically significant and suggests an increase in female deficit. However, the magnitude of the gap is not large.

Table 5 provides a district-specific picture of male and female infant mortality for 1996-1999. As shown in the table, consistent with the overall state pattern of low post-birth female deficits in urban areas, in the period 1996-1999, post-birth deficit appears to exist in the urban areas of only three districts (Dharmapuri and Dindigul and Salem). In contrast, the estimated female IMR in rural areas of 19 of the state's 29 districts is (statistically) greater than the expected female IMR. While the shortage exists in many districts, districts with the strongest evidence of post-birth female deficit are Salem and Dharmapuri where the gap between estimated and expected female IMR is 82 and 66 points, respectively. These two districts are followed by Theni (43 points), Namakkal (25.6) and Madurai (25.2). While there are other districts such as Vellore (22.4 points) and Dindgul (21.6) which record large differentials, based on the figures presented here, it is clear that the attention received by the purposively targeted districts, especially, Salem and Dharmapuri, is justified.

Table 6 provides district-specific figures for 2003. These figures show a clear decline in the number of districts with evidence of daughter deficit. There is evidence of post-birth daughter deficit in the urban area of one district while daughter shortages are now restricted to the rural areas of ten districts as compared to nineteen districts in 1996-1999. While both districts with the largest female disadvantage in 1996-1999 continue to display evidence of post-birth deficit in 2003, there is a sharp decline in the extent of the deficit. Across the various districts, Salem and Dharmapuri experience the sharpest decline in the gap between estimated and expected female IMR. The gap drops from 82 to 17 in Salem and from 66 to 13 in Dharmapuri. These two districts no longer have the highest differential between estimated and expected female IMR and are replaced by Dindigul and Tiruchirraplli. Between the two time periods, the gap in these districts increases from 21 to about 30 and 6 to 18 respectively. While the declines in Salem and Dharmapuri have been accompanied by increases in deficits in other districts, the overall message from the temporal comparison of the differences between the estimated and expected female IMR is one of declining post-birth female deficits.

To obtain an idea of the absolute magnitude of post-birth daughter deficit we use (4) and the estimated and expected female IMR for 1996-1999 and 2003 to compute deficits for both periods and (13) to compute changes in post-birth deficit over time. As shown in Table 7, we estimate an annual state-wide post-birth deficit of 4,485 girls for the period 1996-1999.[34] As discussed earlier, daughter deficit is essentially a rural phenomenon and the rural areas of the state account for almost the entire deficit. In terms of a district-specific distribution, a little more than 50 percent of the deficit may be attributed to just two districts. Dharmapuri accounts for 26.5 percent of the deficit while Salem accounts for 24 percent of the deficit (Table 7, column 1). Other districts such as Vellore, Madurai and Dindigul account for about four to eight percent of the deficit.

Post-birth deficit figures for 2003 are presented in column 2 of table 7 while changes in the deficit between the two periods, 1996-1999 and 2003 are provided in column 3. District-specific figures in column 3 indicate whether changes in the post-birth deficit are statistically different from zero, a positive number indicates that the deficit has declined while a negative number indicates that the deficit has increased over time. As shown in Table 7, post-birth deficit

[34] Based on records maintained by primary health care centers in the state, for the birth year 1995, Chunkath and Athreya (1997) report 3,226 cases of female infant deaths due to 'social causes', a euphemism for infanticide. The authors write that PHC records may not be complete but that they provide useful information to support district-level comparisons.

records a sharp decline of a little more than 2,000 girls, which translates into a decline of 46 percent between the two reference periods. The decline is dominated by Dharmapuri and Salem which together account for 85 percent of the decline. Post-birth daughter deficit in Dharmapuri declines from 1,189 to 219 or a reduction of about 82 percent while the corresponding decline in Salem is 73 percent (from 1067 to 283).[35] Other districts such as Theni, Namakkal, Madurai, Vellore and Dindigul which displayed strong evidence of post-birth daughter deficit in 1996-1999, present a mixed picture. Theni, Madurai and Namakkal experience a decline in post-birth daughter deficit, there is no increase in Vellore while Dindigul experiences an increase in the deficit. While there are a number of districts (four) in which the deficit is statistically different and larger than in 1996-1999, these increases are modest. The main picture emerging from the numbers displayed in column 3 is that post-birth daughter deficit experienced a spectacular decline between 1996-1999 and 2003.

V.3 Post-birth daughter deficit and interventions

Difference-in-differences estimates of the impact of policy interventions on daughter deficit are presented in Table 8. The first column shows that between the two time periods, as compared to urban areas, daughter deficit declines by 9.4 points in the rural areas of the state. This estimate matches the numbers in Table 4 which show that, between 1996-1999 and 2003, daughter deficit declines by 8.2 points in rural areas while it increases by 1.2 points in urban areas.

Estimates in column 2 show that the temporal decline in daughter deficit may be attributed mainly to the treated districts. Column 3 provides a sharper picture and displays that in fact the policy-induced decline in daughter deficits may be attributed only to the heavily treated districts. The lightly treated districts also experience a decline but the effect is small and

[35] The decline in these two districts may be exaggerated if individuals move across district borders to resort to post-birth interventions. While this is a possibility the data do not support the idea that the reduction in Salem and Dharmapuri has been matched by an increase in post-birth deficit in neighbouring districts. Two (Erode and Namakkal) of the five districts that share borders with Salem experience a statistically significant decline in post-birth deficit, in two (Perambalur and Villupuram) there are no changes while in one (Tiruchirrapalli) there is a statistically significant but modest increase. Overall, these five adjoining districts also experience a net decrease in post-birth deficit. None of the three districts (Vellore, Thiruvannamalai, Villupuram) adjoining Dharmapuri experience an increase in post-birth daughter deficit.

statistically insignificant. Estimates in columns 4 and 5 control for several time-varying covariates which may be expected to have an impact on daughter deficit, namely, female and male work participation rates, female and male literacy rates and rainfall. The inclusion of these covariates leads to a reduction of the treatment effect in heavily treated districts from 35 points to about 32 points but the effect remains large and statistically significant. Estimates in column 6 show that the number of self-help groups is significantly associated with a reduction in post-birth deficit, suggesting that such groups do exert an independent effect on daughter deficit. On average, policy interventions in heavily treated districts appear to be responsible for at least a 32 point decline in daughter deficit as compared to an overall decline of about 36 points (see Table A2). That is, interventions account for about 88 percent of the decline recorded in heavily treated districts. At the same time, it seems that the interventions operating in lightly treated districts are not responsible for the 2.4 point reduction in daughter deficits experienced in these districts. Information on per capita income and the number of scan centers for the two reference periods is available for the district as a whole (and not separately for rural and urban areas). Table 9 provides overall district estimates controlling for changes in per capita income and the number of scan centers. Similar to the estimates reported in Table 8, these estimates show that the policy effect is restricted to heavily treated districts and that the inclusion of a number of time-varying covariates does not alter this conclusion. Based on Table 9-column 3, in the heavily treated districts the interventions appear to be responsible for a 20.5 point decline in daughter deficit as compared to the overall decline of 25 points (see Table A2) or about 82 percent of the total decline. To get a sense of the treatment effect, consider that during this period post-birth daughter deficit, as displayed in Table 7, fell by about 46 percent (4485 to 2070) with the five highly treated districts accounting for almost the entire decline (96.4 percent or 1996/2070). Combining this with the intervention effect obtained from Table 9, shows that at least 79 percent of the total decline in daughter deficits may be attributed to the interventions (0.964*0.82).

Briefly, as far as other variables are concerned, during this period work participation rates rose marginally, and these do not exert an effect on daughter deficit. The coefficient on rainfall is statistically insignificant but negative suggesting that positive rainfall shocks are likely to reduce daughter deficits. Female literacy rose by about 10 percentage points during this period while male literacy rates rose by about seven percent. The estimates show that increases in female literacy are accompanied by an increase in daughter deficit while an increase in male literacy is accompanied by a decline. While the effect of female literacy may seem unexpected, as reviewed by Murthi et al. (1995), the relationship between female literacy and gender bias is not clear-cut and there are reasons to support both positive and negative effects of increases in female literacy on daughter deficit. As may be expected, the number of SHGs and the number of scan centers are negatively associated with post-birth deficit but are not statistically significant.[36]

The pattern of results and the differences across heavily and lightly treated districts provides clues on the relative effectiveness of the various intervention programs operating in the state. The chief difference between the two categories of treated districts is the monitoring and counseling strategy used in the heavily treated districts. In terms of policy effectiveness, the inference which may be drawn from these estimates is that legal action against infanticide and state-wide schemes such as the CBS and the GCPS without being linked to a grassroots monitoring and counseling approach (that is, the involvement of local women through SHGs supported by NGOs and VHNs) and the participation and mobilization of the district administration is unlikely to lead to a reduction in female deficit.

[36] Taking a cue from Oster (2008), we also considered the potential role that may be played by gender differences in access to immunization and access to food on the estimates reported here. While we do not have district-specific information on such patterns, state-level figures show that Tamil Nadu has amongst the highest rates of full immunization in the country (89 percent in 1998-99, according to NFHS 2) and that there are no gender differences in immunizations (89.5% for males and 88% for female in 1999, see www.nfhsindia.org/data/tn/tnchap6.pdf, accessed on July 17, 2008). Similarly, there are limited gender differences in nutritional status for children below age three as measured by standard anthropometric measures (see www.nfhsindia.org/data/tn/tnchap7.pdf, accessed on July 17, 2008). Given these patterns it seems unlikely that changes in gender differences in immunization (increased immunization for girls) play a role in explaining the decline in excess female infant mortality during this period. Furthermore, over the two periods that we analyse there was a decline in rainfall (2003 was declared a drought year in all the districts of the state) and the corresponding decline in food availability should have worked towards exacerbating female mortality and hence gender differences in improvements to nutrition are unlikely to have driven the decline in excess female IMR during this period.

The estimates may also be used to shed light on the controversial idea of extending the CBS to an all-India level.[37] According to the estimates presented here, 82 percent of the decline in the heavily treated districts may be attributed to the suite of policy interventions located in these districts. As shown in Table 7, in absolute terms the rural areas of these five districts record a post-birth daughter-deficit decline of 1,996 baby girls of which 82 percent or 1,637 may be attributed to the policy interventions. According to information from the state's Directorate of Social Welfare, the heavily treated districts received 1,885 female babies over the course of 6.5 years or about 290 female babies per year over the period May 2001 to November 2007 (see Table 1). Thus, this scheme by itself may (causally) account for about 18 percent (290/1637) of the reduction in post-birth daughter deficit observed between 1996-1999 and 2003. While the merits of the scheme and the (perverse) incentives that it may generate are open questions, the analysis here shows that the scheme has played an important role in reducing post-birth daughter deficit in Tamil Nadu.

A final concern is the reliability of the data on which the estimates presented here are based. Given the pressure exerted on government officials and on families to reduce infanticide it is possible that individuals gathering data in highly treated districts may have been persuaded to adjust their figures and/or families in highly treated districts may have provided incorrect information. Let us consider both these possibilities. To get an idea of errors and omissions introduced by data enumerators we examine patterns in infant mortality based on other data sources. That is, we compare estimates based on VES data (on which the estimates presented here are based) which is canvassed and managed by the state government with estimates based on SRS data, which is executed and managed by the central government and data from the National Family Health Survey (NFHS-3) which is conducted by academic institutions in various parts of

[37] The scheme has attracted criticism as various NGO and campaigns such as CASSA argue that through the scheme the government is "formally inviting the parents to abandon their unwanted, newly born girl infants"(CASSA, Cradle Baby Scheme, position note, May 2007). There are also additional concerns about the capacity of the state to settle the cradle babies in adopted homes and the survival rate of babies handed over to the CBS.

the country in co-operation with Macro International, an international consultancy firm. As shown in Table 4, the gap between estimated and expected female IMR for Tamil Nadu was 10 points in 1996-1999 which drops to a gap of 5.7 in 2003. Over roughly the same period, while the level of IMR for the state is much higher, SRS based estimates display temporal patterns that are remarkably similar. According to SRS data, in 1999, the gap between estimated and expected female IMR was 14 points while in 2003 the gap declined to 5.8 points (see Table A3). In 2004, the gap remained in the same range (3.6 points). Both sources of data support the conclusion that during this period post-birth daughter deficit drops sharply and may have halved between 1996-1999 and 2003. The third data source, NFHS-3, conducted in 2005-06 does not yet provide state-level gender-specific IMR, however, existing data show that for the five-year period preceding the survey, the IMR in Tamil Nadu was 30.4 (see *www.nfhsindia.org/nfhs3_national_report*), a figure which matches the IMR estimate of 30 obtained using VES 2003 (Table 4). A fourth data source, state PHC records also leads to the same conclusion. According to these data the number of female infant deaths due to "social causes" declined from an average of about 3000 a year between 1995 and 1999 to only 372 in 2002, that is, a decline of about 88 percent (State Planning Commission, 2005). While this claim may be exaggerated, given the consistency across the various data sources it does not seem that the results are unduly influenced by errors in data enumeration.

Regardless of the consistency across data sources, the data may be error-prone as all the surveys are based on populations which may be responding to the pressures introduced by the interventions and providing incorrect information. There are two ways in which households in heavily treated districts who have had a daughter and committed infanticide (experienced an infant death) may provide erroneous information. First, they may state that they had no child (no girl). If this is the case then it should be reflected in an increase in pre-birth deficit especially in the heavily treated districts. Second, they may state that they had a boy and that the infant died. This would indeed reduce gender differences in infant mortality and lead to a reduction in post-birth deficit, but at the same time should lead to an increase in pre-birth deficit. Thus, if the infant mortality figures in 2003 are heavily influenced by households providing incorrect information, then the decline in post-birth deficit should be accompanied by an increase in pre-birth deficit. This is the issue to which we now turn.

V.4 SRB and pre-birth daughter deficits, 1996-2003

Computations covering the period 1996-1999, yield a SRB of 935 for the state and 943 and 932 for the urban and rural parts of the state respectively (Table 10). While the urban SRB of 943 lies just about within the expected range (a 95 confidence interval of 935 to 951), the rural SRB of 932 and the SRB for the state as a whole (935) are statistically different from 952, suggesting pre-birth daughter deficit. Census information confirms this pattern—the state's SRB in 2001 remains at 935, indicating possible pre-birth deficit. The lower than expected ratio is driven by the rural SRB (919) which is 33 points lower than expected. At 960, the SRB in urban areas does not suggest a pre-birth deficit.

To focus on changes in SRB over time we compare the ratios computed from the VES for the period 1996-1999 and 2003. For the state as a whole there is a 9 point increase in the SRB from 935 to 944 between the two reference periods (p-value 0.092). While both urban and rural Tamil Nadu experience an increases in the SRB, in neither case are the changes statistically significant. However, while the SRB for urban Tamil Nadu is well within the normal range, for the rural parts the data continue to indicate the presence of pre-birth daughter deficit. Thus, similar to the IMR patterns, it seems that pre-birth daughter deficit arises mainly from rural areas of the state.

Table 11 provides district-specific information on SRB for 1996-1999, 2001 and 2003. As displayed in column 1 of the table, based on the 1996-1999 VES data the SRB ranges from a low of 874 in the Northern district of Salem to a high of 965 in the southern district of Thuthukudi. Eleven of the state's districts have ratios that are statistically different and lower than 952 at conventional levels of significance. Census based figures for 2001 (column 2) show that the SRB varies from a low of 838 in Salem to a high of 988 in the Nilgiris. According to the census there are 18 districts where the SRB is less than 952 and 12 where it is less than or equal to 935. A comparison of the VES and census based figures suggest that the VES data are reliable in terms of identifying districts with unusually low SRB. Except for one district (Nagapattinam), the remaining 10 districts which have a SRB statistically lower than 952 in the VES also show up as districts with a shortfall in the census figures. Of the eight additional districts displaying shortfalls based on census figures, five also had ratios less than 952 in the VES but were not statistically different from the expected ratio. There are clear differences across the rural and urban parts of the districts. In 1996-1999 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 (column 4). In contrast there is evidence of pre-birth deficit in the rural areas of 10 districts (column 7).

To compute the absolute magnitude of pre-birth daughter deficit for 1996-1999 we rely on (2), while changes in pre-birth daughter deficit between the reference periods are computed on the basis of (13). Estimates of pre-birth daughter deficit are displayed in Table 12. Based on the gap between the expected and actual SRB in 1996-1999 and the total number of live births in 2000, we compute a pre-birth deficit of 6,244 females (column 1).[38] Most of this shortfall emanates from the rural areas of the state and is dominated by Salem (27 percent of the deficit) followed by Dharmapuri (12 percent). Between 1996-1999 and 2003 the shortfall declines slightly from 6,244 to 5,294 (6,244 - 950). For the most part there is not much change in pre-birth daughter deficit in urban areas as 26 of the 28 districts do not display statistically significant differences in SRB between 1996-1999 and 2003 (column 6). In rural areas, pre-birth daughter deficit declines from 4,386 to about 3,318 (4386-1068) and five districts display a reduction in

[38] This figure, which depends on survey based estimates of SRB and only on those districts where the gap between the estimated and expected SRB are statistically different, understates the extent of pre-birth daughter deficit. Based on census figures the extent of the pre-birth daughter deficit is closer to 10,000 (see Table A4). We rely on the survey based estimates as we are interested in temporal changes.

pre-birth daughter deficit that is statistically different from zero (column 9). Between 1996-1999 and 2003 the SRB in rural Salem records a statistically significant increase from 843 to 893 translating into a reduction in pre-birth daughter deficit in the district. In Dharmapuri and the other heavily targeted districts the differences in SRB are not statistically significant and the extent of pre-birth deficit remains unchanged. While the decline in pre-birth deficit is not as spectacular as the decline in post-birth deficit, at least during the period examined here, there seems to be no support for the claim that the reduction in post-birth deficit (infanticide) in the districts that experienced a reduction has been matched by an increase in pre-birth deficit (sex selective abortion).

V.5 Pre-birth deficit and interventions, 1996-2003

Difference-in-differences estimates of the impact of policy interventions on pre-birth daughter deficit are presented in Table 13. Columns 2 and 3 of the table display the impact of policy interventions in treated districts and heavily treated districts, respectively. In both cases the interventions appear to be associated with a decline in the deficit but the effects are statistically insignificant. The inclusion of additional time-varying characteristics does not alter this conclusion and across all columns there seems to be no association between treatment and a reduction in pre-birth daughter deficit, suggesting that the 16 point decline (see Table A2) in pre-birth deficit in heavily treated areas and the 7 point decline in lightly treated areas may not be attributed to the set of policy interventions.[39] Based on the figures in Table 12, over this period, there has been a statistically significant decline in pre-birth daughter deficit in Salem and at least four other districts. While these declines in pre-birth deficit may not be attributed to the policy interventions, the analysis shows that the policy-induced decline in post-birth deficit has not led to a policy-induced increase in pre-birth deficit. The decline in post-birth deficit without a corresponding increase in pre-birth deficit also lends support to the idea that the VES data are

[39] Estimates based on the data set which does not distinguish between rural and urban areas leads to the same conclusion.

not unduly influenced by erroneous information which may have been provided by households in heavily treated districts.

VI. Concluding remarks

Set against the backdrop of sharp temporal and spatial variations in policies and programs designed to reduce daughter elimination, this paper examined the impact of policy interventions on pre- and post-birth daughter deficits in Tamil Nadu. Total daughter deficit in 1996-1999, a period characterized by a lull in government efforts, amounted to an annual shortfall of about 11,000 daughters with pre-birth shortfall accounting for about 60 percent of the deficit. In 2003 daughter deficit declined to about 7,700 with a pre-birth share of 69 percent. The decline between 1996-1999 and 2003 was driven mainly by a 46 percent reduction in post-birth daughter deficit. The reduction was concentrated in heavily treated districts, of which, Salem and Dharmapuri recorded the sharpest reductions. These districts displayed the highest incidence of pre- and post-birth deficit in 1996-1999 and were the focus of various government and NGO initiatives to prevent female infanticide and sex selective abortion. These efforts appear to have paid off, with 82 to 88 percent of the reduction in post-birth deficit in these heavily treated districts attributable to the various interventions. For the state as a whole, the analysis showed that about 79 percent of the decline in post-birth daughter deficit may be attributed to the set of policy interventions pursued by the state and civil society actors. At the same time, there was no support for the hypothesis that reductions in post-birth daughter deficit are matched by an increase in pre-birth deficit between 1996-99 and 2003.

In our empirical work we drew a distinction between heavily and lightly treated districts. The pattern of results across these two categories and the overall reduction in daughter deficit provides clues on the manner in which future intervention strategies in the state and other parts of India may be designed. First, the reduction in daughter deficit between 1996-1999 and 2003 suggests the importance of large scale district-wide interventions mobilized by the district administration, as in Salem and Dharmapuri. Second, the estimates presented in this paper suggest that district-wide monitoring and counseling of high-risk mothers at the grassroots level (through SHGs/NGOs/VHNs), linked to the credible threat of police and legal action and economic support through schemes such as the GCPS, comprises an intervention model which may be used in other parts of the country. While the manner in which the various programs interact to reduce daughter deficit needs to be explored more fully, what seems clear is that, on their own, police and legal action, or schemes such as the CBS and GCPS and the spread of women's SHGs are unlikely to lead to a reduction in daughter deficit.[40]

While the clear decline in post-birth deficit without an increase in pre-birth interference is heartening, it is unlikely that these declines will be sustained without continued attention. Nevertheless, this paper showed that daughter deficits are amenable to public policy, that they can be reduced and son preference and increasing access to modern reproductive technology need not inevitably result in daughter deficits.

[40] It is likely that the threat of police and legal action is not credible without the counselling and monitoring of high-risk mothers. Similarly the presence of programs such as the GCPS without guidance on how to access such programs may render them less effective.

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Table 1
Babies received in the Cradle Baby Scheme

	Male	Female
Phase 1: 1992-13.05.2001		
Salem	0	150
Phase 2: 14.05.2001-30.11.2007		
Salem	57	665
Madurai	30	109
Theni	20	146
Dharmapuri	40	965
Dindigul	12	38
Other districts	231	487
Total	390	2410

Source: Directorate of Social Welfare, Government of Tamil Nadu.

Table 2: Legal action against female infanticide, 1992 to 2003

District	**Date arrested**	**Status of case**
Chennai	No information	.
Coimbatore	0	.
Cuddalore	0	.
Dharmapuri*	December 2000	November 2004 , mother convicted, life imprisonment
Dindigul	2 cases, no dates available	One convicted, one dismissed
Erode	0	.
Kancheepuram	0	.
Kanyakumari	0	.
Karur	0	.
Madurai	January 1994	December 1996, mother convicted, life imprisonment; sentence commuted in 2004
Nagapattinam	0	.
Namakkal [a]	0	.
Nilgiris	December 2001	January 2003, mother convicted, 3 months simple imprisonment
Perambalur*	1997	2003, mother convicted, life imprisonment
Pudukottai	0	.
Ramanathapuram	0	.
Salem	December 1992	July 1995, father and mother convicted, life imprisonment and 5 years rigorous imprisonment respectively
	May 2001	November 2003, acquitted
	July 2001	February 2003, convicted
	September 2001	April 2003, convicted
	November 2001	November 2002, acquitted
	2002	2 cases booked, both acquitted
Sivaganga	0	.
Thanjavur	0	.
Theni [a]	January 1997	September 2003, acquitted
	January 1997	December 2004, acquitted
	February 1998	.
	January 2001	Convicted, 3 years imprisonment and Rs. 1000 fine
	July 2003	May 2004, acquited
	August 2003	May 2005, convicted, 3 years rigorous imprisonment and Rs. 500 fine
	August 2003	October 2005, acquitted
Thirunelveli	0	.
Thiruvallur	No information	.
Thiruvannamalai	2001	July 2004, acquitted
Thiruvarur	0	.
Thuthukudi	0	.
Tiruchirapalli	0	.
Vellore	No information	.
Villupuram	0	.
Virudhunagar	October 2002	April 2004, acquitted

Notes: [a] Till January 1997, Namakkal was part of Salem district and Theni was part of Madurai district. ***Source***: Reports obtained from the district offices of the Assistant/Deputy Superintendent of Police. * Information for Perambalur and Dharmapuri comes from newspaper reports (*The Hindu*, July 31, 2001 and *The Hindu*, November 27, 2004)

Table 3
Intervention intensity

District	**Cradle Baby Scheme Initially targeted districts**	**Evidence of Legal Action (1992-2003)**	**Funds for behavioral change communication (BCC)/Monitoring and counseling of high-risk mothers**	**Treatment status**
Dharmapuri	X	X	X	Heavily treated
Dindigul	X	X	0	Lightly treated
Erode	0	0	X [b]	Lightly treated
Madurai	X	X	X	Heavily treated
Namakkal [a]	0	X	X	Heavily treated
Nilgiris	0	X	0	Lightly treated
Perambalur	0	X	0	Lightly treated
Salem	X	X	X	Heavily treated
Theni [a]	X	X	X	Heavily treated
Thiruvannamalai	0	X	0	Lightly treated
Virudhunagar	0	X	0	Lightly treated

Notes: [a] Till January 1997, Namakkal was part of Salem district and Theni was part of Madurai district. [b] Only behavioral change communication.
X indicates the presence of an intervention while 0 indicates absence. The remaining 18 districts are referred to as minimally treated districts.

Table 4
Infant Mortality Rates in Tamil Nadu

Year/Statistic	IMR Tamil Nadu			IMR Urban Tamil Nadu			IMR Rural Tamil Nadu		
	Male	**Female**	**Expected Female**	**Male**	**Female**	**Expected Female**	**Male**	**Female**	**Expected Female**
1996-1999	36	39	28.8	23	19	18.4	41	48	32.8
Absolute value of test statistic		23.5			1.01			26.8	
p-value [a]		(0.000)			(0.313)			(0.000)	
2003	30	29.7	24	24	21	19.2	32.6	33.1	26.1
Absolute value of test statistic		7.20			1.43			7.11	
p-value [a]		(0.000)			(0.152)			(0.000)	
Change in *dIMR* (1996-1999 to 2003)		4.5			-1.2			8.2	
Absolute value of test statistic		17.15			8.33			21.6	
p-value [b]		(0.000)			(0.000)			(0.000)	

Notes: Infant mortality rate (IMR) is defined as the number of infant deaths (age 0-365 days) per 1000 live births. All calculations are based on the Vital Events Surveys 1996-1999 and 2003. [a] H_0: estimated female IMR is greater than the expected female IMR (0.8*MIMR). [b] H_0: temporal change in difference between estimated female IMR and expected female IMR (*dIMR*) is zero.

Table 5
District Specific Male and Female Infant Mortality Rates
Tamil Nadu, 1996-1999

	MIMR Overall	FIMR Overall	MIMR Urban	FIMR Urban	MIMR Rural	FIMR Rural
Chennai	19	15	19	15	.	.
Coimbatore	36	27	27	20	39	30
Cuddalore	31	30 *	18	16	37	36*
Dharmapuri	48	89 *	21	25 *	56	111*
Dindigul	38	48 *	25	27 *	43	56*
Erode	36	35 *	23	21	41	41*
Kancheepuram	27	23	16	16	30	25
Kanyakumari	18	17	13	9	20	19
Karur	37	35 *	20	20	43	41*
Madurai	38	48 *	31	24	41	58*
Nagapattinam	31	29 *	19	16	37	34
Namakkal	38	47 *	26	16	43	60*
Nilgiris	33	27	18	13	41	35
Perambalur	47	51 *	.	.	47	51*
Pudukottai	34	33 *	28	19	36	38*
Ramanathapuram	44	38	28	17	51	47*
Salem	43	91 *	32	33 *	49	121*
Sivaganga	30	30 *	21	17	34	36*
Thanjavur	38	29	24	16	43	34
Theni	41	65 *	23	21	48	81*
Thirunelveli	38	35 *	35	34	39	35
Thiruvallur	29	25	22	14	31	30*
Thiruvannamalai	34	34 *	25	17	38	42*
Thiruvarur	35	27	23	14	39	32
Thuthukudi	37	32	20	13	45	40
Tiruchirapalli	43	40 *	21	22	52	48*
Vellore	38	46 *	26	18	42	56*
Villupuram	40	37 *	19	14	48	45*
Virudhunagar	35	35 *	23	21	39	40*

Notes: Infant mortality rate (IMR) is 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, 1996-1999. * indicates that the estimated female IMR is greater than the expected female IMR at at least the 5% level of significance.

Table 6
District Specific Male and Female Infant Mortality Rates
Tamil Nadu, 2003

	MIMR Overall	FIMR Overall	MIMR Urban	FIMR Urban	MIMR Rural	FIMR Rural
Chennai	17	14	17	14	.	.
Coimbatore	23	19	15	13	25	21
Cuddalore	32	31	32	22	32	35
Dharmapuri	39	40*	21	16	45	49*
Dindigul	31	48*	33	35	30	54*
Erode	32	25	26	18	34	28
Kancheepuram	23	21	23	21	23	22
Kanyakumari	.	.	26	11	.	.
Karur	34	34	26	31	37	35
Madurai	28	35*	22	20	30	42*
Nagapattinam	32	29	25	26	34	30
Namakkal	26	21	13	9	31	26
Nilgiris	28	24	20	26	32	24
Perambalur	31	38*	.	.	31	38*
Pudukottai	28	30*	20	19	31	35*
Ramanathapuram	34	31	27	31	37	31
Salem	33	41*	29	33	35	45*
Sivaganga	28	20	27	10	28	24
Thanjavur	33	23	18	13	38	26
Theni	33	39*	28	31	35	42*
Thirunelveli	37	32	38	31	36	32
Thiruvallur	25	22	16	15	28	24
Thiruvannamalai	30	29	25	18	32	34
Thiruvarur	28	21	13	26*	34	19
Thuthukudi	30	27	24	20	33	30
Tiruchirapalli	29	37*	30	24	29	42*
Vellore	33	40*	24	20	36	48*
Villupuram	32	32	33	22	32	36*
Virudhunagar	34	30	24	28	38	31

Notes: Infant mortality rate (IMR) is 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 Survey, 2003. * indicates that the estimated female IMR is greater than the expected FIMR at at least the 5% level of significance.

Table 7
Post-Birth Daughter Deficit

	Overall Deficit 1996-1999 (1)	Overall Deficit 2003 (2)	Overall Change in deficit 1996-1999 to 2003 (3)	Urban Deficit 1996-1999 (4)	Urban Deficit 2003 (5)	Urban Change in deficit 1996-1999 to 2003 (6)	Rural Deficit 1996-1999 (7)	Rural Deficit 2003 (8)	Rural Change in deficit 1996-1999 to 2003 (9)
Tamil Nadu [a]	*4485*	*1829*	*2070*	*130*	*26*	*-63*	*4017*	*1799*	*1978*
Chennai	0	2	-2	0	2	-2	.	.	.
Coimbatore	0	11	-11†	0	14	-14†	0	2	- 2†
Cuddalore	85*	98	-13	7	0	7	78 *	110*	-32
Dharmapuri	1189*	219*	970†	31 *	0	31†	1311*	258*	1053†
Dindigul	222*	289*	-67†	31 *	37	-6	177 *	241*	-64†
Erode	89*	0	89†	19	0	19†	60*	3	57†
Kancheepuram	24	58	-34†	32	21	11	6	31	-25†
Kanyakumari	28	.	.	0	0	0	15	.	.
Karur	38*	41	-3	8	21	-13†	28*	22	6
Madurai	311*	230*	81†	0	19	-19†	198*	138*	60†
Nagapattinam	45*	40	5	3	14	-11†	46	24	22†
Namakkal	135*	4	131†	0	0	0	132*	7	126†
Nilgiris	7	12	-5	0	33	-33†	6	0	6†
Perambalur	52*	49*	3	.	.	.	45*	42*	3
Pudukottai	66*	92*	-26†	0	6	-6†	91*	97*	-6
Ramanathapuram	28	36	-8	0	22	-22†	48*	11	37†
Salem	1067*	283*	784†	68 *	83	-15	844*	178*	666†
Sivaganga	45*	0	45†	0	0	0	47*	8	39†
Thanjavur	0	0	0	0	0	0	0	0	0
Theni	227*	88*	139†	12	31	19†	137*	46*	91†
Thirunelveli	101*	59	42†	61	11	50†	47	42	5
Thiruvallur	48	35	13	0	25	-25†	46*	13	33†
Thiruvannamalai	110*	82	28	0	0	0	149*	107	42
Thiruvarur	0	0	0	0	26 *	-26†	2	0	2
Thuthukudi	24	37	-13	0	7	-7†	31	27	4
Tiruchirapalli	98 *	230*	-132†	39	6	30†	58*	182*	-124†
Vellore	395*	349*	46	0	1	0	367*	312*	55
Villupuram	113*	143	-30	0	0	0	137*	195*	-58†
Virudhunagar	96*	37	59†	16	52	-36†	64*	3	61†

Notes: [a]The total for the state is based on districts where the estimated FIMR is statistically greater than the expected FIMR * indicates that the estimated FIMR is greater than the expected FIMR at at least the 5% level of significance. † indicates that the temporal change in difference between estimated female IMR and expected female is statistically different from zero at at least the 5% level of significance.

Table 8
Post-Birth Daughter Deficit and Interventions
Difference-in-differences estimates

Variable	1	2	3	4	5	6
2003	1.85	1.85	1.85	-6.04	-7.32	-6.00
	(2.45)	(2.20)	(1.68)	(6.95)	(8.21)	(8.04)
Rural*2003	-9.37**	-2.51	-2.51	-6.14	-6.01	0.524
	(3.49)	(3.65)	(2.79)	(5.01)	(5.21)	(6.22)
Treated*2003	.	-16.84**	.	.	.	.
		(4.56)				
Heavily treated*2003	.	.	-34.97**	-31.87**	-32.7**	-35.27**
			(4.57)	(5.12)	(5.33)	(5.39)
Lightly treated*2003	.	.	-1.73	0.20	-0.423	-1.90
			(4.27)	(4.82)	(4.96)	(4.91)
Female work participation rate	.	.	.	0.313	0.149	0.254
				(0.406)	(0.483)	(0.475)
Male work participation rate	.	.	.	-0.329	-0.124	-0.015
				(1.21)	(1.26)	(1.238)
Female literacy	.	.	.	1.713+	1.553	1.641
				(0.99)	(1.151)	(1.123)
Male literacy	.	.	.	-1.44	-1.272	-1.356
				(1.11)	(1.21)	(1.176)
Rainfall	.	.	.	.	-0.006	-0.006
					(0.008)	(0.008)
Number of self-help groups	.	.	.	.	.	-0.005+
						(0.003)
N	110	110	110	110	108	108
R^2 *(within)*	0.154	0.329	0.615	0.641	0.643	0.668

Notes: Standard errors in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%.

Table 9
Post-Birth Daughter Deficit and Interventions
Difference-in-differences estimates

Variable	1	2	3	4	5	6
2003	0.623	0.623	-17.35	-18.62	-18.00	-10.71
	(2.56)	(1.78)	(12.21)	(12.38)	(12.49)	(16.75)
Treated*2003	-12.55*	.	.	.	.	.
	(4.08)					
Heavily treated*2003	.	-25.58**	-20.54**	-22.19**	-23.08**	-22.64**
		(3.73)	(4.07)	(4.53)	(4.68)	(4.80)
Lightly treated*2003	.	-1.69	2.03	1.091	0.128	-0.407
		(3.48)	(3.70)	(3.890)	(4.079)	(4.221)
Female work participation rate	.	.	1.28	1.101	1.255	1.478
			(0.778)	(0.813)	(0.839)	(0.916)
Male work participation rate	.	.	-0.429	-0.344	-0.722	-0.997
			(1.66)	(1.679)	(1.749)	(1.824)
Male literacy	.	.	4.493*	4.249*	4.718*	4.314*
			(1.889)	(1.923)	(2.015)	(2.135)
Female literacy	.	.	-5.073*	-4.785*	-4.941*	-4.927*
			(1.84)	(1.890)	(1.913)	(1.943)
Per capita income	.	.	-0.0003	-0.0007	-0.0003	0.0002
			(0.001)	(0.001)	(0.001)	(0.001)
Rainfall	.	.	.	-0.008	-0.008	-0.008
				(0.009)	(0.010)	(0.010)
Number of self-help groups	.	.	.	.	-0.0014	-0.0016
					(0.0016)	(0.002)
Number of registered scan centers	.	.	.	.	.	-0.029
						(0.044)
N	56	56	56	56	56	56
R^2 *(within)*	0.351	0.699	0.789	0.796	0.804	0.809

Notes: Standard errors in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%.

Table 10
Sex Ratio at Birth in India and Tamil Nadu

Birth Year/Statistic	Source	SRB Tamil Nadu	SRB Urban Tamil Nadu	SRB Rural Tamil Nadu
1996-1999	VES[a]	935	943	932
(95% Confidence Interval)		(931-940)	(935-952)	(927-937)
Number of births – female/male		*335,712/358,893*	*100,380/106,406*	*235,332/252,487*
2001	Census[b]	935	960	919
Number of births – female/male		*432,923/462,842*	*177,230/184,609*	*255,693/278,233*
2003	VES[a]	944	954	940
(95% Confidence Interval)		(935-953)	(937-971)	(929-951)
Number of births – female/male		*80,771/85,539*	*24,290/25,466*	*57,245/60,872*
SRB change, 1996-1999 to 2003		9	11	8
(p-value) [c]		*(0.092)*	*(0.262)*	*(0.175)*

Notes: The sex ratio at birth is defined as the number of female live births per 1000 male live births. [a] Our calculations based on the Vital Events Surveys 1996-1999 and 2003. [b] Based on data from Census 2001, Table F-9 [c] H_0: SRB in 1996-1999 is equal to the SRB in 2002. In 2003, Kanyakumari is not included in the calculations as we do not have complete information on the district.

Table 11
District Specific Sex Ratios at Birth
(95% C.I.)

District	Overall			Urban			Rural		
	1996-1999 VES (1)	**2001** Census (2)	**2003** VES (3)	**1996-1999** VES (4)	**2001** Census (5)	**2003** VES (6)	**1996-1999** VES (7)	**2001** Census (8)	**2003** VES (9)
Chennai	947 (921-973)	979	970 (916-1028)	947 (921-973)	979	970 (916-1028)	.	.	.
Coimbatore	950 (927-973)	963	928 (885-973)	999 (953-1047)	964	904 (819-997)	932 (906-959)	961	935 (886-987)
Cuddalore	946 (922-970)	930	953 (907-1001)	956 (912-1000)	932	979 (890-1077)	941 (913-970)	929	943 (890-1000)
Dharmapuri	922 (902-942)*	869	931 (888-976)	958 (918-1001)	936	945 (860-1037)	909 (886-933)*	859	926 (876-978)
Dindigul	922 (900-944)*	934	950 (901-1001)	936 (893-981)	955	1006(913-1109)	917 (891-943)*	923	926 (870-987)
Erode	928 (904-953)**	934	942 (892-994)	950 (905-999)	962	985 (888-1093)	919 (890-948)*	910	926 (868-987)
Kancheepuram	946 (924-969)	949	931 (890-974)	951 (907-997)	964	951 (861-1050)	945 (920-970)	934	926 (881-974)
Kanyakumari	948 (922-975)	988	.	933 (884-985)	1000	956 (865-1057)	953 (923-985)	968	.
Karur	893 (869-917)*	910	928 (879-979)	870 (826-916)*	941	984 (884-1095)	901 (873-930)*	895	909 (854-968)
Madurai	924 (902-947)*	951	922 (878-968)	918 (876-960)	973	911 (830-1000)	927 (901-954)**	925	926 (875-981)
Nagapattinam	928 (905-952)**	982	987(938-1038)	916 (874-959)	975	978 (891-1073)	934 (906-963)	984	990 (932-1052)
Namakkal	911 (887-934)*	859	903 (856-952)*	932 (888-977)	916	906 (816-1105)	902 (874-930)*	829	901 (847-960)**
Nilgiris	959 (930-990)	988	964 (902-1029)	955 (905-1008)	963	1007(896-1131)	962 (925-1000)	1023	943 (871-1022)
Perambalur	932 (906-960)	896	943(888-1000)	.	903	.	932 (906-960)	894	943 (888-1000)
Pudukottai	947 (925-970)	935	926 (882-972)	917 (876-959)	879	978 (887-1076)	959 (932-986)	945	909 (859-962)
Ramanathapuram	949 (925-975)	990	922 (875-971)	943 (899-987)	1019	953 (865-1050)	952 (923-982)	981	909 (853-968)
Salem	874 (852-896)*	838	899 (853-947)*	943 (902-985)	880	912 (827-1005)	843 (817-869)*	806	893 (839-951)*
Sivaganga	934 (910-959)	955	976 (927-1026)	962 (916-1009)	952	966 (880-1059)	923 (894-952)**	956	980 (922-1041)
Thanjavur	939 (916-963)	962	981 (932-1032)	965 (919-1012)	994	931 (843-1027)	929 (902-958)	948	1000(942-1060)
Theni	932 (909-956)**	895	960 (913-1012)	921 (878-965)	924	983 (894-1080)	937 (910-964)	862	952 (895-1012)
Thirunelveli	925 (902-948)*	946	939 (893-988)	924 (886-966)	944	894 (817-977)	925 (898-954)**	948	962 (904-1023)
Thiruvallur	945 (922-967)	953	974 (930-1020)	938 (896-982)	971	902 (822-989)	947 (920-974)	936	1000(948-1054)
Thiruvannamalai	957 (932-982)	922	924 (877-973)	966 (922-1011)	1016	940 (854-1033)	953 (923-983)	905	917 (862-976)
Thiruvarur	959 (935-984)	967	934 (887-984)	973 (927-1020)	999	977 (887-1075)	954 (925-983)	960	917 (861-976)
Thuthukudi	965 (939-992)	956	1022 (969-1078)	992 (943-1041)	977	1048(953-1153)	954 (923-985)	941	1010(947-1078)
Tiruchirapalli	945 (921-970)	951	932 (883-982)	961 (915-1008)	964	1009(914-1113)	939 (910-968)	941	901 (846-960)**
Vellore	952 (929-975)	907	923 (878-969)	958 (914-1004)	951	961 (874-1056)	950 (923-977)	885	909 (859-963)
Villupuram	958 (935-982)	938	947 (902-994)	946 (920-1021)	955	933 (848-1025)	963 (935-991)	936	952 (890-1008)
Virudhunagar	908 (886-931)*	945	955 (908-1003)	880 (837-923)*	966	859 (778-948)*	919 (893-946)*	930	990 (935-1049)

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 the expected SRB of 952, at the 5% and 10% level of significance, respectively.

Table 12

Pre-Birth Daughter Deficit

District	Overall			Urban			Rural		
	1996-1999 VES (1)	**2003** VES (2)	**Change 1996-1999 to 2003** VES (p-value) (3)	**1996-1999** VES (4)	**2003** VES (5)	**Change 1996-1999 to 2003** VES (p-value) (6)	**1996-1999** VES (7)	**2003** VES (8)	**Change 1996-1999 to 2003** VES (p-value) (9)
Tamil Nadu [a]	*6244*	*1563*	*950*	*682*	*635*	*-720*	*4386*	*1514*	*1068*
Chennai	124	0	124 (0.453)	124	0	124 (0.453)	.	.	.
Coimbatore	53	665	-612 (0.390)	0	894	-894 (0.066) †	185	158	27 (0.914)
Cuddalore	108	0	108 (0.789)	0	0	0 (0.651)	133	113	20 (0.956)
Dharmapuri	756*	534	222(0.711)	0	26	-26 (0.776)	930*	556	374 (0.560)
Dindigul	407*	31	376(0.312)	75	0	75 (0.184)	316*	229	87 (0.759)
Erode	380**	162	218(0.635)	11	0	11 (0.537)	283*	221	62 (0.843)
Kancheepuram	126	449	-323(0.529)	7	10	-3 (0.996)	77	275	-197(0.491)
Kanyakumari	48	.	.	149	0	149 (0.675)	0	.	.
Karur	422*	165	257(0.206)	198*	0	198 (0.040)†	240*	202	38 (0.809)
Madurai	529*	567	-38(0.934)	355	427	(0.891)	216**	222	-6 (0.988)
Nagapattinam	301**	0	301(0.034) †	97	0	97 (0.209)	178	0	178(0.086)†
Namakkal	368*	448*	-80(0.771)	65	153	-88 (0.624)	287*	292**	-5 (0.991)
Nilgiris	0	0	-0(0.909)	0	0	0 (0.418)	0	22	-22(0.673)
Perambalur	81	37	44(0.740)	.	.	.	68	31	37(0.740)
Pudukottai	63	332	-269 (0.411)	66	0	66 (0.237)	0	480	-480(0.094)†
Ramanathapuram	30	315	-285(0.322)	23	0	23 (0.840)	0	339	-339(0.189)
Salem	1682*	1115*	567 (0.338)	85	371	-286 (0.546)	1342*	683*	659(0.099)†
Sivaganga	149	0	149 (0.133)	0	0	0 (0.939)	174**	0	174 (0.084)†
Thanjavur	224	0	224 (0.131)	0	116	-116 (0.520)	266	0	266 (0.030)†
Theni	150**	0	150 (0.295)	129	0	129 (0.220)	52	0	52 (0.645)
Thirunelveli	600*	281	319 (0.597)	279	599	-320 (0.513)	326**	0	326 (0.271)
Thiruvallur	151	0	151 (0.241)	148	570	-422 (0.448)	55	0	55 (0.077)
Thiruvannamalai	0	479	-479 (0.233)	0	35	-35 (0.609)	0	496	-496 (0.280)
Thiruvarur	0	162	-162 (0.367)	0	0	0 (0.943)	0	261	-261 (0.257)
Thuthukudi	0	0	0 (0.059)	0	0	0 (0.304)	0	0	0 (0.118)
Tiruchirapalli	125	374	-249 (0.624)	0	0	0 (0.384)	133	539**	-406 (0.249)
Vellore	0	796	-796 (0.267)	0	0	0 (0.955)	43	774	-731 (0.182)
Villupuram	0	117	-117 (0.670)	18	62	-44 (0.789)	0	0	0 (0.732)
Virudhunagar	649*	0	649 (0.077) †	484*	635**	-151 (0.673)	271*	0	271 (0.022)†

Notes: [a]The total for the state is based on districts where the difference between the estimated and expected SRB is statistically different.*, ** indicate that the SRB is statistically different from the expected SRB of 952, at the 5% and 10% level of significance, respectively.† Indicates that the temporal change in SRB is statistically different from zero at at least the 10% level of significance.

Table 13
Pre-Birth Daughter Deficit and Interventions
Difference-in-differences estimates

Variable	1	2	3	4	5	6
2003	-11.36	-11.35	-11.35	-83.57*	-79.68*	-170.38*
	(7.72)	(7.79)	(7.85)	(37.55)	(37.58)	(61.03)
Rural*2003	2.95	4.857	4.857	-9.05	10.09	-4.379
	(11.02)	(12.918)	(13.03)	(23.82)	(29.07)	(17.484)
Treated*2003	.	-4.681	.	.	.	.
		(16.145)				
Heavily treated*2003	.	.	-9.5	0.647	-6.86	-4.379
			(21.31)	(24.4)	(25.19)	(17.48)
Lightly treated*2003	.	.	-0.666	-2.97	-7.30	-8.105
			(19.90)	(22.76)	(22.76)	(15.37)
Female work participation rate	.	.	.	3.84+	4.16+	4.87
				(2.21)	(2.22)	(3.33)
Male work participation rate	.	.	.	2.23	2.55	4.10
				(5.80)	(5.78)	(6.64)
Female literacy	.	.	.	9.75+	10.02+	20.27*
				(5.26)	(5.25)	(7.77)
Male literacy	.	.	.	-6.27	-6.52	-12.15+
				(5.51)	(5.50)	(7.07)
Rainfall	.	.	.	0.010	0.011	0.004
				(0.039)	(0.039)	(0.036)
Number of self-help groups	.	.	.	.	-0.014	-0.004
					(0.012)	(0.006)
Number of scan centers	.	.	.	.	.	0.165
						(0.159)
Per capita income	.	.	.	.	.	-0.003
						(0.005)
N	110	110	110	108	108	56
R^2 *(within)*	0.06	0.06	0.06	0.164	0.188	0.502

Notes: Standard errors in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%

Table A1
Development of Sex Ratios and Sources of Female Deficit in Tamil Nadu

Year	SRB	MIMR	FIMR	0-1 Sex Ratio	Under 5 MMR	Under 5 FMR	0-5 Sex Ratio	0-6 Sex Ratio
Row 1: 1981	969	114	93	989	134	131	968	967
Row 2: 1981	952	93	89	951	.	.	.	.
Row 3: 1991	952	55	51	952	64	70	942	948
Row 4: 1991	952	60	54	955	.	.	.	.
Row 5: 1984-98 (SRB) & 1989-98 (IMR)	952	50.2	51.8	948	62.3	66.8	944	.
Row 6: 1997-2000	935	36	39	929	.	.	.	.
Row 7: 2001	935	45	54	923	.	.	.	942
Row 8: 2001(SRB) & 2003 (IMR)	935	44	41	935	.	.	.	.
Row 9: 2003	944	30	29.7	943	34		.	.

Sources: (a) Figures in row 1 and row 3 are census based estimates reported in National Human Development Report 2001, Planning Commission, Government of India (2002). The SRB figures are weighted averages of the rural and urban SRB. (b) SRB figures in row 2 and row 4 are estimates based on SRS data for the period 1981-90/1996-98 reported in Retherford and Roy (2003). IMR figures for 1981 and 1991 are from SRS bulletins, Vol. 19, No. 1 and Vol. 31, No. 1, respectively. (c) Figures in row 5 are based on NFHS 2. SRB figures computed for the period 1984-98 are from Retherford and Roy (2003) and IMR figures for the period 1989-98 are from Pandey et al. (1998). (d) Figures in row 6 are based on the Vital Events Surveys conducted by the Directorate of Public Health, Government of Tamil Nadu. (e) SRB figures in row 7 and row 8 are based on Census 2001, Table F-9 while IMR figures in row 7 and 8 are from SRS bulletins, Vol. 37, No.1 and Vol. 39, No.1. (f) SRB and IMR figures in row 9 are our calculations based on the VES conducted by the Directorate of Public Health, Government of Tamil Nadu. U5MR is from Health Indicators 2003, Directorate of Public Health, Government of Tamil Nadu.

Table A2
Descriptive Statistics-Means
(standard deviations)

Variable	(1) 1996-1999	(2) 2003	(3) 1996-99	(4) 2003
Post-birth deficit in treated districts (per 1000 live female births)	27.9	10.41	20.47	8.54
	(25.5)	(9.66)	(18.43)	(7.43)
Post-birth deficit in heavily treated districts	48.28	12.64	34.72	9.76
	(25.11)	(6.71)	(18.43)	(5.74)
Post-birth deficit in lightly treated districts	10.96	8.56	8.6	7.53
	(6.45)	(11.8)	(5.99)	(9.03)
Post-birth deficit in minimally treated districts	2.32	3.24	3.55	4.24
	(5.09)	(6.69)	(3.97)	(5.02)
Pre-birth deficit in treated districts (per 1000 live female births)	32	20.81	27.54	16.27
	(31.17)	(26.17)	(23.21)	(21.96)
Pre-birth deficit in heavily treated districts	48.4	32.4	39.4	29
	(36.63)	(23.37)	(22.84)	(24.54)
Pre-birth deficit in lightly treated districts	18.33	11.16	17.66	5.66
	(19.42)	(26.21)	(20.06)	(13.63)
Pre-birth deficit in minimally treated districts	9.53	0.181	8.88	0.647
	(24.09)	(40.51)	(16.01)	(28.8)
Female work participation rate (percent)	26.37	30.36	31.49	33.00
	(14.49)	(13.93)	(9.15)	(9.31)
Male work participation rate (percent)	55.26	57.06	56.71	57.60
	(4.73)	(3.99)	(3.43)	(3.26)
Female literacy rate (percent)	56.03	66.53	50.74	63.99
	(15.08)	(11.42)	(10.58)	(8.15)
Male literacy rate (percent)	77.26	84.03	73.68	82.52
	(10.08)	(6.82)	(7.28)	(4.74)
Annual rainfall (millimetres)	1460.47	1101.3	1461.15	1101.5
	(522.74)	(386.97)	(522.76)	(386.97)
Per capita income (Rupees) at constant 1993-94 prices	.	.	11075.89	12113.76
			(3022.6)	(3528.3)
Number of self-help groups	1024	2077	176	4083
	(952)	(1553)	(373)	(1162)
Number of registered scan centers	.	.	13.2	70
			(16.5)	(68.2)

Notes: The unit of observation for the figures in columns 1 and 2 are rural and urban parts of the districts. Figures in columns 3 and 4 are for the district as a whole. ***Sources*:** Data on work participation rates are from Census Paper 3, Government of Tamil Nadu, available at, http://gisd.tn.nic.in/census-paper3/ (accessed on July 3, 2008) and are based on census 1991 and census 2001. Data on male and female literacy rates are from the Tamil Nadu Human Development Report (2003) and are based on census 1991 and census 2001. Data on rainfall were obtained from http://www.indiawaterportal.org/ and are for the years 1997 and 2002. Data on per capita income are for 1997-98 and 2001-02 at constant 1993-94 prices and are from Tamil Nadu's State Planning Commission http://www.tn.gov.in/spc/workshop/MS_paper-HD.pdf (accessed on July 3, 2008). The data on self-help groups in columns 1 and 2 are for the years 2000 and 2003, respectively, while in columns 3 and 4 the data are for 1998 and 2003, respectively. The data were obtained from http://www.tamilnaduwomen.org/ for 1998 and for 2002 and 2003 from the Tamil Nadu Corporation for Development of Women. Data on number of registered scan centers is for 1999 and 2003 and were obtained from the Directorate of Public Health, Government of Tamil Nadu.

Table A3

Infant Mortality Rates based on the Sample Registration System

Year	IMR Tamil Nadu Combined (95% C.I.)		IMR Rural Tamil Nadu Combined (95% C.I.)		IMR Urban Tamil Nadu Combined (95% C.I.)	
1997	53 (47.4-54.8)		58 (52.4-64.2)		40 (30.4-50.4)	
1998	53 (46.4-59.5)		59 (50.3-67.4)		40 (30.8-40.8)	
1999	52 (46.0-58.2)		58 (50.1-65.7)		39 (30.2-47.7)	
2000	51 (46.2-55.7)		56 (50.5-62.5)		38 (31.0-45.9)	
2001	49 (44-54)		55 (49-62)		35 (27-43)	
2003	43 (39-47)		48 (43-53)		31 (24-38)	
2004	41 (36-46)		45 (38-51)		35 (27-43)	
	Male	Female	Male	Female	Male	Female
1997	48	57.3	54.5	62.3	33.9	47
1998	48.3	58.1	52.1	65.9	40	39.5
1999	50.3	54.5	57.5	58.8	33.8	45.1
2000	48.5	53.7	52.6	60.7	39.7	37.1
2001	45	54	50	61	33	38
2002	46	43	.	.	.	.
2003	44	41	50	46	32	31
2004	43	38	46	44	39	30

Source: Sample Registration System, various bulletins, Office of the Registrar General, India

Table A4
Pre-Birth Daughter Deficit
Census 2001

	Overall (1)	**Urban** (2)	**Rural** (3)
Tamil Nadu [a]	*10,207*	*1380*	*9901*
Chennai	0	0	.
Coimbatore	0	0	0
Cuddalore	409	114	295
Dharmapuri	2212	58	2154
Dindigul	242	0	256
Erode	289	0	362
Kancheepuram	62	0	191
Kanyakumari	0	0	0
Karur	296	24	272
Madurai	24	0	228
Nagapattinam	0	0	0
Namakkal	885	119	766
Nilgiris	0	0	0
Perambalur	237	29	208
Pudukottai	219	145	74
Ramanathapuram	0	0	0
Salem	2567	694	1873
Sivaganga	0	0	0
Thanjavur	0	0	45
Theni	444	114	330
Thirunelveli	137	83	54
Thiruvallur	0	0	170
Thiruvannamalai	504	0	680
Thiruvarur	0	0	0
Thuthukudi	0	0	83
Tiruchirapalli	19	0	111
Vellore	1250	9	1241
Villupuram	318	0	328
Virudhunagar	93	0	180

Source : F- series Tables, Census 2001