A NEW MEASURE OF GENDER BIAS

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ABSTRACT

This paper proposes a simple measure of gender bias through quantifying differential stopping behaviour, a particular method of obtaining a higher proportion of sons by parents. There have been very few theoretical attempts towards the measurement of such bias and this measure is purpose-built to capture that. It uses only observed data on the distribution of children in a household, the age and sex of the offspring, rather than stated preferences about ideal figures, which are always suspect. We also illustrate our measure using household level data from the state of Tamilnadu in India.

NON-TECHNICAL SUMMARY

In this paper we have hypothesised a simple measure of son preference by parents as revealed through the age and sex composition of their children. Our measure does not take into account the stated preferences or any other information apart from the realised situation of the distribution of children. The measure looks at how many times the parents have attempted procreation after an increase or decrease in the sex ratio of their children. Our purpose in developing the methodology is to emphasise the lack of theoretical research in this particular direction that seems to be pregnant with exciting possibilities.

We illustrated our definition through an empirical exercise using NSSO data on Tamilnadu. The frequency distributions of our bias measures are bimodal showing a polarisation of the population into low and high bias segments with a sparse middle region.

I Introduction

It has been well documented in the economics and sociological literature that parents exhibit preference for sons across geographical, economic and social boundaries. Adult sons are expected to provide economic support and hence having more sons is always desirable (Das 1984, Lahiri 1984, Miller 1987, ORG 1983). On the other hand daughters are supposed to create an economic burden for the parents in terms of dowry etc. As a consequence, parents desire a high proportion of sons. This paper attempts to quantify this feeling of bias of the parents as revealed by a few simple characteristics of the offspring. In this paper, we look at the parents' decision problem at the procreation stage rather than about household budget allocation decisions where the daughters are discriminated against in terms of expenditure on health and education. A large literature has developed, dealing with this latter issue. See Rose, 1999, Dutta and Panda, 2000, Chakrabarty, 2000, Schultz, 2001 and the references cited therein for some recent investigations along this line.

While this preference is generic, as it is not possible for the parents to pre-determine the sex of their unborn children, realising an ideal outcome is not possible directly. But there are indirect methods by which the parents can improve the proportion of sons among their children. The most common ones that have been documented in the literature are the following.

Better health care for sons affects the sex composition of surviving children (Bardhan 1974, 82 etc.). But, surprisingly, this does not effect the sex ratio at the national level. The sex ratio at birth (boy per girl, surviving children) varies between 1.02 and 1.14 across regions and over a long time period for India. This is also true for most western countries (Waldron, 1983, 87). Recent research on genetics show that, at the family level, there is no bias towards either sex (Rodgers, 1997). Thus, for demographic purposes, the sex of any given child may be considered a random event with the probability of having a boy being 0.513 (sex ratio = 1.05). In this paper, for simplicity, we take this probability to be ½. This does not bias our measure significantly.

The second and more drastic method of doing this is the use of sex selective abortion (Park and Cho 1995, Yi, Liao and Cho 1997). This involves use of simple chemical tests to determine the sex of an unborn child. Sex selective abortion has not yet become such a significant factor in determining the sex ratio in India (Arnold, 1997; Dasgupta and Bhat, 1995; Nair, 1996). Although the data on stillbirths is very difficult to get for Indian families (usual surveys record only surviving children), we may safely assume that this will not affect our analysis in any significant manner.

The third and, in a way, the most benevolent method for achieving a higher proportion of sons is to practise differential stopping behaviour (DSB). This means that the parents stop having children when they think that they have enough (in absolute or relative terms) sons. Amin and Mariam (1987), Arnold (1997), Arnold and Zhaoxiang (1986) De Silva (1993), Rahman et. al. (1992), Sarma and Jain (1994) provide evidences of such behaviour.

As a consequence of the above, we have the following broad observations that have been supported by data. (i) Families with a large number of children will have a large proportion of daughters (Park and Cho 1995)) and (ii) for a given family size, socio-economic characteristics of couples who *want* a higher proportion of sons will be the same as those who *have* a higher proportion.

In this paper, we focus on modelling the third method of achieving a better proportion of sons by the parents, namely **differential stopping behaviour (DSB).** Our aim here is to measure the extent of DSB that the parents practice at the family level. This is arguably a difficult task. The exact stopping rule followed by a couple depends on both magnitude (desired proportion) and intensity (how determined they are to have their desired number of sons) of their feeling of bias. There have been very few earlier attempts at developing a theory towards the measurement of son preference (Ben-Porath and Welch (1976), Davies and Zhang (1997)).

There have been some empirical attempts at this measurement problem. Coombs 1979, Coombs, Coombs and McClelland 1975, Coombs and Sun 1978, Kwan and Lee 1976, Widmer, McClelland and Nickerson 1981 are a few of the recent papers in this area. Recently, Clark (2000) attempted a very extensive analysis using survey data for India asking each couple about their actual and ideal proportion or number of sons. She shows that ideal figures are related to age of mother, education, caste, residence (rural/ urban), religion and geographic region. Her analysis relies on sex ratios (proportions) of the stated preferences and actual figures.

This paper hypothesises a simple measure of (male) gender bias based on an idea akin to DSB. This measure uses data on only the actual distribution of children (and not stated ideal numbers, which is suspect in any context). In particular, it uses the actual (age, sex) composition of children in a family. In the second section we formulate the procreation decision by parents as a dynamic utility maximisation problem and hence show that changes in the sex ratio are more important in gauging the extent of bias of the parents than the actual proportions. That is, a couple's decision to procreate further is affected more by a favourable or adverse change in the sex ratio than the actual value of the ratio. We discuss this in greater detail in Remark 1 below.

We go on to suggest a simple measure that captures these changes. The simplification we have achieved for our measure relies on certain assumptions. But the justification for these assumptions lies in the fact that otherwise the problem would be too complex to capture using a simple functional form. Very few empirical studies exist, focussing on the distribution of children, due to the lack of such simplified measures. We believe that there exists a strong need for economic insights and inferences in this area. Here, we have purpose-built a measure that facilitate this. Another implicit justification would be if our measure throws up plausible inferences.

In section 3, we have carried out an illustrative empirical exercise estimating family level gender bias using NSSO 50th round data from Tamilnadu, a state of India. The last section offers some concluding remarks.

II Motivation and Methodology

We first sketch our model of male bias for parents. In the ensuing discussion, we will always assume that any future child is a male with probability ½. To develop notation, we consider our data or primitive to be the vector of children in a family with k children: $(c_1, c_2 \ldots c_k)$, where $c_i = 1$ (0) if child is male (female). The vector is ordered according to age. That is, the sex of the eldest child is recorded in c_1 and so on.

We assume that the parents face a dynamic problem of optimal stopping time in terms of utility maximisation. Let $p_k = \sum_{i=1}^{k} c_i \Big/ k$ be the proportion of male children in the family when the family has k children. Let the utility of the parents be a function of the number of children, n, along with the proportion of male, p_n. Thus, the parents' utility function is given by $u = u(n, p_n)$.

After the k^th procreation, the utility of the parents is given by $u(k, p_k)$. If they attempt again, the expected utility will be given by

$$Eu_{k+1} = \frac{1}{2}u(k+1, \frac{k}{k+1}p_k + \frac{1}{k+1}) + \frac{1}{2}u(k+1, \frac{k}{k+1}p_k), \quad (1)$$

where the first (second) term in the expected utility expression in (1) depicts the possibility where a male (female) child is born in the (k+1)^st attempt. So the parents will try again, after the k^th procreation, if $Eu_{k+1} > u(k, p_k)$.

We take the following assumption regarding the shape of the utility function:

A1: $\Delta u/\Delta k < 0$ for $k \geq k_0$, that is, utility is decreasing in k, the number of children, after some critical number k_0.

In other words, the parents may, at first, like having more children, when they have only a few. However, after some stage, additional children are undesirable per se, the only motivation for further procreation is having additional sons. This assumption is very reasonable in terms of affordability (in terms of both resource and time) and the urge for continuation of lineage. The critical number, k_0, may depend on many socio-economic factors like biological supply children (fecundity), social location, income, size of the family etc.

A2: (a) For parents who are male biased, $\Delta u/\Delta p_k$ >0 and

(b) For parents who are female biased, $\Delta u/\Delta p_k$ <0.

The above assumptions imply the following.

Remark 1: A one-time increase in p_k would discourage parents with high male bias to try again (if they are beyond k_0).

Proof: The requirement of $k > k_0$ is due to the fact that for $k \leq k_0$, simply adding to the number of children is utility augmenting. In this situation, expected utility may be unambiguously increasing and hence, in that range, our proposition may not hold.

By high male bias we imply that $\Delta u/\Delta p_k$ is a large positive number. Now, given p_k, the gain potential from another procreation, through improvement of p_k (if a male is born), is $(1-p_k)/(k+1)$ $(= p_k \frac{k}{k+1} + \frac{1}{k+1} - p_k)$ and the loss potential (when there is a female birth) is $p_k/(k+1)$ $(= p_k - \frac{k}{k+1} p_k)$. That is, overall benefit potential decreases if there is a favourable change in p_k. Given that expected utility is now decreasing in *k*, for a couple with high male bias after experiencing an increase in p_k, it becomes more likely that they will value the status quo $u(k, p_k)$ more than the expected utility, Eu_{k+1}, given by equation (1).

Remark 2: The stopping time or the maximum number of attempts by the parents will be finite.

Proof: As $k \to \infty$, $\dfrac{1}{k+1} \to 0$, so $Eu_{k+1} \approx u(k+1, p_k) < u(k, p_k)$ for $k \geq k_0$.

We now postulate a reasonable quantification of male bias. In general, the measure of bias is $B = B(c_1, c_2 \ldots c_k)$. We now take recourse to the following simplifications.

We can reasonably assume that the measure B will depend on the total number of children and the stopping state or the sex of the last child (c_k). Also the total number of children, k, helps to get the measure in a ratio form (dimension free number). c_k captures the stopping state which is important in the sense that it reflects what you want at the end (may be waiting for this to happen).

Remark 1 shows that a male (female) biased couple would be encouraged to continue procreation if there is a favourable change in the direction of movement of the quantity p_k. That is, an increase (decrease) after a sequence of decreases (increases). Again, this is equivalent to the occurrence of a male or 1 (female or 0) after a series of 0's (1's). These occurrences can be tracked if we count the occurrence of the pairs (0, 1) or (1, 0) in the vector $(c_1, c_2 \ldots c_k)$. For this we use the notation k_{01} = number of (0,1) pairs and k_{10}= number of (1,0) pairs in $(c_1, .., c_k)$. Thus, we postulate the following.

k_{10} (k_{01}) captures attitude to risk exposure revealed through another attempt of procreation even after a detoriation (improvement) in the ratio. Once achieving (0, 1), if one attempts again, we assume that it indicates less male bias. Similarly, we take it that after the occurrence of the pair (1, 0), similar behaviour implies more male bias.

These behavioural assumptions in turn implicitly suggest that the underlying utility function might exhibit convexity in the p_k term. This is at variance with the usual concavity assumption on utility functions but given the nature of the variable, this is not implausible.

Note that we are ignoring the effect of infant mortality on our utility maximisation problem. An additional child may be demanded to replace a dead child. Given that female births are systematically underreported in many developing countries like India (Rose, 1999 and many others) and female infanticide is not rare; the implication of this simplification for our measure is that, in expected terms, we are underestimating the value of k_{10} and hence gender bias. A solution to this problem increases our data requirement. For our present discussion, we are ignoring this component.

We now state our next assumption. We assume that our measure of bias depends on only the factors that we have discussed so far. That is, we simplify the measure to the following form[1].

B1: $B = B(k, c_k, k_{10}, k_{01})$.

Now, as we have said that the presence of the number of children, k, as an argument of the bias function is solely to make it a dimension free pure number. Hence, given that the maximum value of k_{01} and k_{10} can be $[k/2]$, we simplify the measure of bias to the following.

B2: $B = B\left(c_k, \frac{k_{01}}{[k/2]}, \frac{k_{10}}{[k/2]}\right)$, where B is decreasing (increasing) in the second (third) argument.

We now go for a further simplification to two directional components, one in terms of {0,1} switches (female direction) and one with {1,0} (male direction). This will help us in our empirical exercise later. We assume that the marginal effect of k_{01} on the measure of bias B is independent of the value of k_{10} and vice versa. More precisely, we are assuming

[1] Ideally, one should also take account of k_0 here. But, as we do not have an estimate for it, for the time being this lacuna is ignored.

B3: $\frac{\Delta^2 B(.)}{\Delta k_{10} \Delta k_{01}} = 0.$

This is analogous to the assumption that $\frac{\partial^2 B(.)}{\partial k_{10} \partial k_{01}} = 0$ in the continuum situation. This kind of assumption imposes a separability restriction on the measure under consideration.

Some algebra demonstrates that the implication of (B3) is that the measure B becomes additively separable in these two components. That is, we have

$$B = B_M\left(c_k, \frac{k_{10}}{[k/2]}\right) + B_F\left(c_k, \frac{k_{01}}{[k/2]}\right)$$

The impact of c_k is assumed to be in assigning relative weight to the factors $\frac{k_{10}}{[k/2]}$ and $\frac{k_{01}}{[k/2]}$. As c_k can only take two possible values (0 or 1) we can, without loss of generality, assume that

$$B_M\left(c_k, \frac{k_{10}}{[k/2]}\right) = G_M\left(\frac{k_{10}}{[k/2]}\right) w_M(c_k) \text{ and } B_F\left(c_k, \frac{k_{01}}{[k/2]}\right) = G_F\left(\frac{k_{01}}{[k/2]}\right) w_F(c_k),$$

where $w_M(c_k) + w_F(c_k) = 1$ (as these are meaningful in the relative sense). From the above discussion, obviously, G_M (G_F) is increasing (decreasing) in k_{10} (k_{01}) as k_{10} (k_{01}) is directly (inversely) related to male bias.

More simply, we can now finally rewrite our measure of bias B as

$$B = G_M\left(\frac{k_{10}}{[k/2]}\right) w(c_k) + G_F\left(\frac{k_{01}}{[k/2]}\right)(1 - w(c_k)). \qquad (2)$$

$w(c_k)$ is the importance attached to B_M with $w(1) + w(0) = 1, w(1) \geq w(0).$ G_M captures the male direction. So, if last child is a male, this gets higher weight.

Note: This measure works for $k \geq 2$ only (not defined for k=0 and 1). This is not a serious shortcoming as with realized k=0 or 1, a manifestation of bias is not possible.

Finally, to illustrate our concept through a simple functional form, we postulate

B4: $B_F = \left\{1 - \frac{k_{01}}{[k/2]}\right\}[1 - w(c_k)]$ and $B_M = \frac{k_{10}}{[k/2]} w(c_k)$.

This is a simple special case of the general form (2). For the empirical part of our paper, in section 3, we will consider this special case only. This is one simple measure that illustrates our idea. As k_{01} is inversely related to male bias, so we take $1 - k_{01}/[k/2]$ as an indicator of male bias. Similarly, k_{10} is directly related to male bias, so male bias is assumed to be linearly increasing in k_{10}. In our empirical illustration, we have tried $w(1) = 0.9$ (BIAS90) and 0.70 (BIAS70). As B is assumed to be linear in G_M and G_F, considering any two distinct values of $w(c_k)$ is sufficient. Using the value of B for these two choices, one can generate a complete family of distributions of B for all permissible values of $w(c_k)$.

One may note the difference of the measure suggested in (2) with conventional measures like the sex ratio. Our measure does not look at the ratio $\sum c_i / k$ or the simple proportion of male in the distribution of children, because this ratio has probabilistic components to it. Given our assumption of equal probability of a male or female child, $\sum c_i$ is binomially distributed, given k. Also intention of the parents is better captured by looking at the sequence of offspring rather than the final proportion. So we look at shifts in the ratio and corresponding stopping rules.

The number of shifts from male to female (1 to 0) that is allowed by the parents indicates their intensity of bias towards a male child, intensity of desire for more boys. Conversely, if the parents allow for more children even after favourable shifts from female to male (0 to 1), a lack of such bias is exhibited.

Example 1: Consider the vector of offspring (0, 0, 0, 0, 0, 0, 0, 1). This reveals a couple who has a high degree of bias and waited till the 8th child to get a son. For this, the computed value of bias, using our measure given by equation (2), under the assumption (B4), is 0.425 (with $w(1) = 0.70$). This value turns out to be higher than the conventional measure (say, sex ratio = 0.125) which would suggest a low male bias.

Note that (1,1) (or (0,0)) also imply improvement (or detoriation) in ratio, but we want to focus on shifts, so we only look at (1,0) or (0,1) pair. One might look at longer strings and study changes of a higher order, but that will complicate the intuition and also lower the number of admissible data points (if we look at strings of length 3, we can only look at data for which $k \geq 3$, etc.)

Finally, we discuss another class of examples about which our measure can not say anything. These are the sequences (0, 0, …, 0, 0) and (1, 1, …, 1, 1), which, according to subjective judgement, show a large degree of bias. However, for these two sequences, as both k_{01} and k_{10} are equal to 0; the value of the measure will be $w(0)$ or $w(1)$. This causes some indeterminacy in the pattern of bias which we will discuss later. But, it is to be noted that in our setup the generic probability of any future child being male is equal to ½. With this assumption, both the strings are equally likely (for any given size). Hence the values $w(0)$ or $w(1)$ will also occur with equal probability and, in expected terms, the resulting distribution will remain unbiased.

III Empirical Illustration

We now illustrate the pattern of male bias distribution among households in rural Tamilnadu, using NSSO 50th round (1993 – 94) data. The sample included 3901 households. From each household, we select the family originating from the head of the household. That is, we consider the children sired by the head. Among these households, the head of 2092 households has 2 or more children. Also, one needs to consider a completed family to get to the stopping state for them. For this purpose, we selected only those families among these 2092 where the mother was aged 50 or more (assuming this to be the end of the fertile age). 241 families were thus selected. These were suitable for our exercise and constituted our final sample. As mentioned earlier, we ignored the effect of lack of information on dead children.

For each of the families, the ordered sequence $\underline{c}$ is constructed by looking at the age and sex of each child. Then, this vector is used for computing the value of the bias measures. A sample of our method of calculation is presented below.

Example 2: Consider a family with the ordered sequence of offspring given by (boy, girl, girl, boy, boy). This translates into the vector of offspring $\underline{c}$ = (1, 0, 0, 1, 1) and k = 5. For this, one can compute k_{10} = 1, k_{01} = 1 and c_k =1. Hence, the measure of bias for this family, as given by (2), is BIAS70 = 0.5 and BIAS90 = 0.5. Again consider another vector $\underline{c}$ = (0, 1, 0, 1, 0, 0). One can similarly calculate k = 6, k_{10} = 2, k_{01} = 2 and c_k =0. Hence BIAS70 = 0.433333 and BIAS90 = 0.36667.

The Histograms for the distribution of BIAS70 and BIAS90 are attached below. From these, one can see that both the distributions show a heavy left tail signifying that most of the families under consideration exhibit a small degree of male bias in our sample. Also, there is a smaller concentration at the right extreme. This depicts a smaller group of highly biased families. Thus, the distribution of the population, according to their male bias, may be classified into three categories. (a) A large group of unbiased people, (b) a sparse middle group and (c) a group of biased families who although are fewer in number than those in category (a). Hence, one may say that the population under consideration exhibits some degree of polarisation in terms of their attitude towards male bias. This is definitely not an agreeable finding, demonstrating a significant proportion of the population showing a high bias, but it conforms with sociological observations that some people tend to exhibit extreme behaviour with respect to sex bias.

IV Conclusion

In this paper we have hypothesised a simple measure of son preference by parents as revealed through the age and sex composition of their children. Our measure does not take into account the stated preferences or any other information apart from the realised situation of the distribution of children. The measure looks at how many times the parents have attempted procreation after an increase or decrease in the sex ratio of their children. Our purpose in developing the methodology is to emphasise the lack of theoretical research in this particular direction that seems to be pregnant with exciting possibilities.

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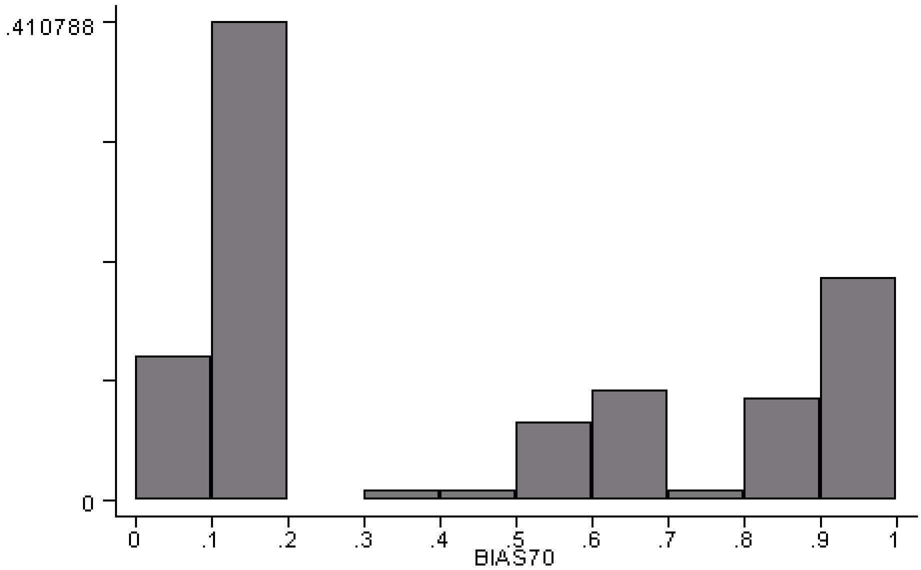
Histogram showing the proportional frequency distribution of BIAS70



Histogram showing the proportional frequency distribution of BIAS90