Estimates of Abortion Rate in Sri Lanka using Bongaarts Model of Proximate Determinants of Fertility

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Introduction

In recent decades much interest has been focused on the rising number of induced abortions in Sri Lanka. However, reliable estimates of the incidence of abortions are not available as it is illegal to carry out an abortion except to save the life of the mother. Nevertheless, attempts have been made to estimate the incidence of induced abortions in Sri Lanka. A study undertaken in the late 1990s indicated that about 125,000 to 175,000 induced abortions are performed annually (De Silva, 1997). A subsequent study estimated a much higher figure of 658 induced abortions per day giving an abortion ratio of 741 per 1000 live births (Rajapaksa, 2000). It is generally perceived that induced abortions have increased from a low level in the early 1990s to a peak level by the end of the decade and thereafter has gradually declined to a low level at the present time.

Therefore, an attempt is made in this paper to estimate the total abortion rate for Sri Lanka during 1993 to 2006/07 and for selected districts in 2006/07 using Bongaarts model of proximate determinants of fertility (Bongaarts, 1978) to add to the existing knowledge on the subject.

Fertility Determinants

It was two renowned demographers Kingsley Davis and his wife Judith Blake who in 1956 for the first time introduced a framework for the analysis of fertility determinants (Davis and Blake, 1956). The Davis-Blake classification of "intermediate variables" affecting fertility is as follows:

Intermediate Fertility Variables

A. Factors affecting exposure to intercourse ("intercourse variables")

I. Those governing the formation and dissolution of unions in the reproductive period
   1. Age of entry into sexual unions
   2. Permanent celibacy: proportion of women never entering sexual unions
   3. Amount of reproductive period spent after or between unions
      (a) When unions are broken by divorce, separation of desertion
      (b) When unions are broken by death of husband

II. Those governing the exposure to intercourse within unions
   1. Voluntary abstinence
   2. Involuntary abstinence (from impotence, illness, unavoidable but temporary separations)
   3. Coital frequency (excluding periods of abstinence)

B. Factors affecting exposure to conception ("conception variables")

I. Fecundity or infecundity, as affected by involuntary causes

II. Use or non-use of contraception
   (a) By mechanical and chemical means
   (b) By other means

III. Fecundity or infecundity, as affected by voluntary causes (sterilization, subincision, medical treatment etc.)

C. Factors affecting gestation and successful parturition ("gestation variables")

I. Foetal mortality from involuntary causes
II. Foetal mortality from voluntary causes

This framework divides the "intermediate variables into three broad groups corresponding to three phases namely, sexual intercourse, conception and parturition. Each of the eleven intermediate variables can operate either to decrease or increase fertility. Thus a population even though it may have a high fertility value on some variables, may have low or moderate fertility level due to low fertility value on other variables. Thus it is also possible for two populations to have approximately the same level of fertility despite very different values on all or most of the intermediate variables.

The Bongaarts Model

John Bongaarts used the Davis-Blake framework to develop a model to quantify the factors influencing fertility. The Bongaarts model basically states that certain number of proximate variables determine human fertility through the influence of socio-economic factors (Bongaarts, 1978). The proximate variables are as follows:

A. Exposure Factors

1. Proportion Married

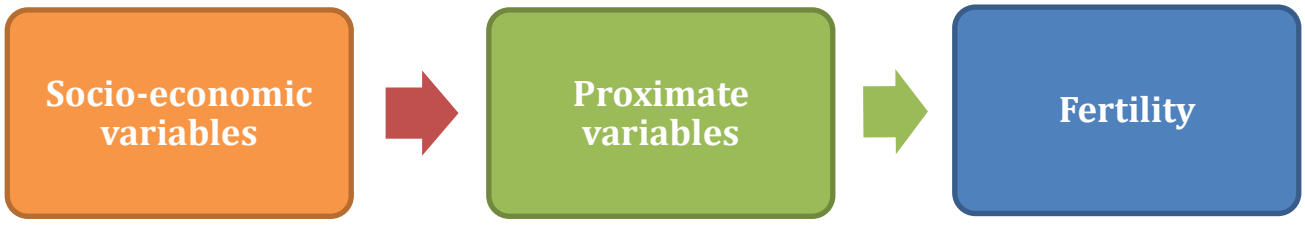
B. Deliberate marital fertility control factors

2. Contraception
3. Induced Abortion

C. Natural marital fertility factors

4. Lactational Infecundability
5. Frequency of intercourse
6. Sterility
7. Spontaneous intrauterine Mortality
8. Duration of the fertile period

Figure 1: The Bongaarts Model of Proximate Determinants of Fertility



Bongaarts has described the proximate variables as follows:

1. **Proportion Married:** This variable is intended to measure the proportion of women of reproductive age that engages in sexual intercourse regularly. Theoretically, it should include

all women living in sexual unions. Due to difficulties in measurement, the analysis uses only women living in stable sexual unions, such as marriages, legal or customary.

2. **Contraception:** Any deliberate parity-dependent practice, including abstention and sterilization, undertaken to reduce the risk of conception is considered contraception.

3. **Induced Abortion:** This variable includes any practice that deliberately interrupts the normal course of gestation. Thus the absence of contraception and induced abortion implies the existence of natural fertility.

4. **Lactational Infecundability:** Following a pregnancy a woman remains infecundable (unable to conceive) until the normal pattern of ovulation and menstruation is restored. The duration of the period of infecundability is a function of the duration and intensity of breastfeeding.

5. **Frequency of Intercourse:** This variable measures normal variations in the rate of intercourse, including those due to temporary separation or illness. Excluded are voluntary abstinence (total or periodic) to avoid pregnancy.

6. **Sterility:** Women are sterile before menarche and after menopause, but a couple may become sterile before the woman reaches menopause for reasons other than contraceptive sterilization.

7. **Spontaneous Intrauterine mortality:** A proportion of all conceptions does not result in a live birth because some pregnancies end in a spontaneous abortion or stillbirth.

8. **Duration of the Fertile Period:** A woman is able to conceive for only a short period of approximately two days in the middle of the menstrual cycle when ovulation takes place. The duration of this fertile period is a function of the viability of the sperm and ovum.

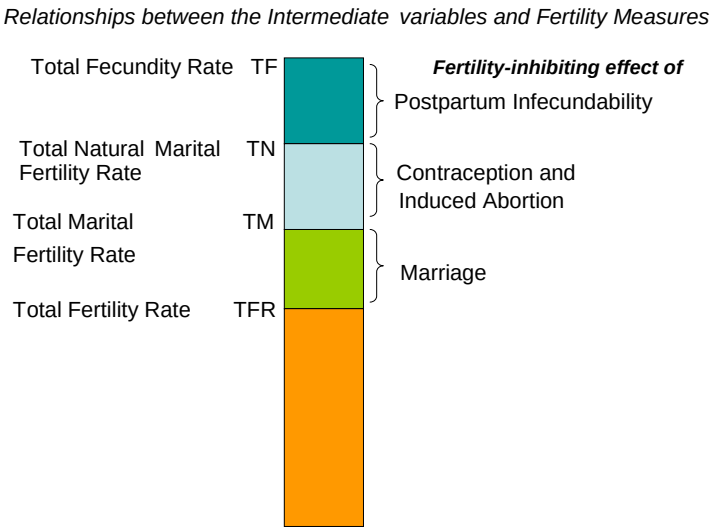
Bongaarts has further noted that the first four variables namely, proportions married, contraception, induced abortion, and postpartum infecundability are the most important intermediate fertility variables as they explain about 96 per cent of the variation in the observed fertility rate.

Thus in Bongaart's model, the four principal intermediate variables are considered inhibitors of fertility. The maximum value of fertility in a population is called the total fecundity rate. As a result of delayed marriage (and marital disruption), the use of contraception and induced abortion and postpartum infecundability induced by breastfeeding (or abstinence) fertility in a population is lower than the maximum value (total fecundity). Bongaarts has noted that although these four variables explain a large proportion of the variation in fertility in human populations, other variables may also be important given situations. For example, a population may have lower fertility than expected if there is widespread venereal disease causing high prevalence of sterility, or if fecundability is reduced substantially by prolonged separations of couples.

As shown in Figure 2, four different types of fertility levels are identified from which the impact of the intermediate variables can be derived. With the inhibiting effects of all intermediate variables present, a population's actual level of fertility is measured by the Total Fertility Rate (TFR). If the fertility-inhibiting effect of celibacy is removed, fertility will increase to a level TM, the Total Marital Fertility Rate. If all practice of contraception and induced abortion is also removed, fertility will rise further to a level TN, the Total Natural Marital Fertility Rate. Removing the practice of lactation and postpartum abstinence further increases fertility very close to the Total Fecundity Rate (TF).

The total fecundity rate is influenced by the combined effect of the remaining intermediate variables: frequency of intercourse, spontaneous intrauterine mortality and permanent sterility. While TFR, TM, TN vary widely among populations, the TF is rather stable ranging from 13 to 17 births per woman.

Figure 2: Relationship between Intermediate Variables and Fertility Measures



The fertility effects of the four most important intermediate variables are measured in the model by four indexes. The indexes can only take values between 0 and 1. When there is no fertility-inhibiting effect of a given intermediate variable, the corresponding index equals 1; if the fertility inhibiting effect is complete, the index takes the value 0.

The four indices are defined as follows:

Cm = Index of marriage (equals 1 if all women of reproductive age are married and 0 in the absence of marriage)

Cc = Index of contraception (equals 1 in the absence of contraception and 0 if all fecund women use 100 per cent effective contraception)

Ca = Index of induced abortion (equals 1 in the absence of induced abortions and 0 if all pregnancies are aborted)

Ci = Index of postpartum infecundability (equals 1 in the absence of lactation and postpartum abstinence and 0 if the duration of infecundability is infinite)

Thus,

TFR = Cm × Cc × Ca × Ci × TF ……(1)

Where the Total Fecundity (TF) is 15.3

The TF values for most populations fall within the range of 13 to 17 births per woman, with an average of about 15.3. Thus the model can be used to estimate abortion when data are available to calculate the other indexes.

The Demographic and Health Surveys conducted in Sri Lanka provide reliable data on all variables except on Abortion. In the present study, we use the data from the Demographic and Health Surveys to estimate the abortion rate.

Application of Bongaarts Model

Taking Ca the index of abortion as unknown, The Bongaarts model is applied to data of the DHS of 2006/07. Table 1 gives the indices of the three known variables for 2006/07 and compared with values derived from previous DHS surveys (Abeykoon, 2006). However, it should be noted that in 1993 and 2000 surveys, the Northern and Eastern Provinces were not included while in the 2006/07 survey the Eastern Province was included but not the Northern Province. Detailed computation of the indexes using the 2006/07 DHS data are given in annex I.

Table 1
Proximate Determinants, 1993 to 2006/07

Year	TFR	Cm	Cc	Ci	TF
1993	2.3	0.503	0.525	0.575	15.3
2000	1.9	0.507	0.494	0.522	15.3
2006/07	2.3	0.556	0.382	0.727	15.3

Note: The indices for 1993 and 2000 are from Abeykoon (2006)

By applying the data in Table 1 to equation (1), we obtained the following values for Index of Induced Abortion (Ca) for 2006/07 and is compared with Ca estimated from earlier surveys (Table 2).

Table 2
Fertility Inhibiting Effect of Induced Abortion (Ca), 1993 to 2006/07

Proximate Determinant	1993	2000	2006/07
Index of Abortion (Ca)	0.990	0.950	0.975

The index of induced abortion is given as:

$$Ca = \frac{TFR}{TFR + 0.4 \times (1+u) \times TA} \quad \text{.....(2)}$$

Where TA is the total abortion rate (includes only abortions among married women). It is assumed that an induced abortion averts about 0.4 births. Therefore, TA can be computed as follows:

$$TA = \frac{TFR\ (1- Ca)}{Ca \times 0.4\ (1+u)} \quad \text{.....(3)}$$

The derived total abortion rates using the above formula are presented in Table 3.

Table 3
Total Induced Abortion Rate (TA), 1993 to 2006/07

Rate	1993	2000	2006/07
Total Induced Abortion Rate	0.035	0.147	0.087

The **Total Induced Abortion Rate** is defined as the average number of induced abortions a woman would have during her reproductive life span. Thus it is evident from Table 3 that the total abortion rate in Sri Lanka has increased from a relatively low level of 0.035 per woman in the early 1990s to more than four times its level (0.147) by the year 2000 and has thereafter declined by about 40 percent from that level to 0.087 per woman during 2006/07.

District Level Analysis

The Bongaarts model was also applied to ten selected districts, namely Colombo, Gampha, Kandy, Galle, Batticaloa, Amparai, Trincomalee, Kurunegala Badulla and Ratnapura. The values computed for the known components of the model are given in Table 4. It is evident that the fertility inhibiting effect of marriage and contraception are relatively low in Batticaloa and Trincomalee.

Table 4
Fertility inhibiting effects of Marriage (Cm), Contraception (Cc) and Postpartum Infecundability (Ci) by Selected Districts, 2006/07

District	TFR	Cm	Cc	Ci	TF
Colombo	2.2	0.531	0.435	0.760	15.3
Gampha	2.2	0.497	0.418	0.692	15.3
Kandy	2.4	0.566	0.354	0.719	15.3
Galle	2.1	0.539	0.373	0.730	15.3
Batticaloa	2.8	0.608	0.655	0.733	15.3
Amparai	2.9	0.547	0.461	0.749	15.3
Trincomalee	2.9	0.612	0.485	0.707	15.3
Kurunegala	2.5	0.592	0.319	0.719	15.3
Badulla	2.4	0.590	0.304	0.746	15.3
Ratnapura	2.4	0.586	0.345	0.781	15.3

Table 5 shows the fertility inhibiting effect of induced abortion and the total induced abortion rate for the districts. It is evident that the induced abortion rate in Batticaloa is relatively high, being 3.1 induced abortions per married woman during her reproductive lifespan. Colombo and

- Trincomalee and Galle districts show rates below 1 induced abortion per woman. Ratnapura, Gampha and Ampara show negligible rates of induced abortions. The data for Kandy, Kurunegala and Badulla do not seem fit the Bongaarts model.

Table 5
Fertility inhibiting effect of Induced Abortions (Ca) and the Total Induced Abortion Rate, 2006/07

District	Ca	Total Abortion Rate
Colombo	0.819	0.74
Gampha	1.0	0
Kandy	*	*
Galle	0.935	0.21
Batticaloa	0.627	3.1
Amparai	1.0	0
Trincomalee	0.903	0.51
Kurunegala	*	*
Badulla	*	*
Ratnapura	0.993	0.02

*do not fit the Bongaarts Model

Estimates of Induced Abortions using a Linear Regression Model

The extent of induced abortions can also be assessed by estimating the total fertility rate using a linear regression model as given below and comparing it with the observed total fertility rate. This linear regression model was estimated using data from 83 developed and developing countries from the UN Population Division online database.

TFR = 7.0995 – 0.0695 X ..... (4)

Where X is the Contraceptive Prevalence Rate (CPR)

Table 6
Contraceptive Prevalence Rate, Total Fertility Rate, Estimated Total Fertility Rate and Unmet Need for Contraception by District, 2006/07

District	CPR (1)	TFR (observed) (2)	TFR (estimated) (3)	Difference (3) – (2) (4)	Unmet Need (%) (5)
Colombo	65.2	2.2	2.6	-0.4	6.9
Gampha	67.3	2.2	2.4	-0.2	7.8
Kandy	69.1	2.4	2.3	0.1	6.4
Galle	73.6	2.1	2.0	0.1	6.3
Batticaloa	34.5	2.8	4.7	-1.9	22.9
Ampara	55.7	2.9	3.2	-0.3	15.4
Trincomalee	52.8	2.9	3.4	-0.5	18.7
Kurunegala	75.5	2.5	1.9	0.6	4.3
Badulla	72.4	2.4	2.1	0.3	6.7
Ratnapura	73.4	2.4	2.0	0.4	3.5
Sri Lanka	68.4	2.3	2.3	0.0	7.3

The lower observed total fertility rate than the expected total fertility rate on the basis of prevailing contraceptive prevalence rate would indicate that induced abortion could be one of the reasons for the difference. The lower observed fertility rate than the estimated rate is seen in the districts of Batticaloa, Trincomalee, Ampara, Colombo and Gampha.

Thus by comparing the results in Tables 5 and 6 one can conclude with some confidence that the prevalence of induced abortion is relatively high in the Districts of Batticaloa and Trincomalee and Colombo. While unmet need of contraception seems to be the main reason for high induced abortions in Batticaloa and Trincomalee, in Colombo district the contraceptive needs seem to be largely met implying that induced abortions are resorted to probably due to method failure.
The results of the regression model also indicate that the prevalence of induced abortions may be high in the districts of Ampara and Gampha though not evident from the Bangaarts model. In Ampara it may be due to lack of adequate contraceptive services as evident from the high unmet need while in Gampha as in the case of Colombo the prevalence of induced abortions may be due to method failure. Data for Sri Lanka as a whole (as evident from Table 6), confirms the earlier finding using Bongaarts model that the prevalence of induced abortion for the country as a whole at present is quite low.

Conclusion and Recommendations

In interpreting the results it must be noted that the total abortion rate is a hypothetical estimate similar to the total fertility rate. Thus the total abortion rate is the average number of induced abortions per woman at the end of the reproductive period if induced abortion rates remain at prevailing levels throughout the reproductive period. The total abortion rate excludes induced abortions to unmarried women.

It is evident from the foregoing analysis that the induced abortion rate in Sri Lanka has risen from a low level in the early 1990s to a peak level by the end of the decade and thereafter declined. The Bongaarts model and the regression model applied to the 2006/07 Demographic and Health survey data confirms that at present the induced abortion rate in Sri Lanka is low. However, at the sub-national level, the situation is different with regard to some districts. When data of selected districts are examined by using both methods, one can conclude that the prevalence of induced abortion in the Batticaloa district is notably high. Colombo and Trincomalee districts also show relatively high rates.

In Batticaloa and Trincomalee, the main cause for induced abortions may be the lack of adequate contraceptives services or reluctance to use them, as evident from the high unmet need. In the Colombo district it may be that induced abortions are resorted to, due to method failure or is being used as a method of family planning.

There are also indications that induced abortion is high in the Ampara and Gampha districts. In Ampara it may be due the relatively high unmet need for contraception and in Gampha as in the case of Colombo, it is possible that induced abortions are resorted to due to method failure.

The study highlights the necessity to strengthen the family planning service delivery and educational programmes in the districts of Batticaloa, Trincomalee and Ampra. In the districts of Colombo and Gampha educational programmes need to focus on the effective use of contraceptive methods as well as on the adverse effects of induced abortion.

It has to be emphasized that when the overall level of indicators for the country are low, it is imperative to identify pockets where the rates are relatively high and focus attention and resources on those sub-national areas and population groups.

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Annexure I

The Methodology for calculation of indices of the Bongaarts Model

Index of Marriage (C_m)

$$C_m = \frac{TFR}{TM} = \frac{\sum f(a)}{\sum f(a)/m(a)} \quad \text{.....(1)}$$

Where m(a) equals the proportion currently married among females, by age and f(a) is the age specific fertility rate. Only births to married women are included in f(a), while m(a) should include consensual unions, but visiting unions are given a weight of 0.5. TFR is the total fertility rate and TM is total marital fertility rate.

Age group	f(a)	m(a)	f(a)/m(a)
15-19	28	0.090	179.9
20-24	101	0.421	239.9
25-29	145	o.723	200.6
30-34	121	0.900	134.4
35-39	54	0.889	60.7
40-44	13	0.852	15.3
45-49	1	0.804	1.2
∑	TFR=2.315		TM=4.16

$$C_m = \frac{TFR}{TM} = \frac{2.315}{4.160} = 0.556$$

The value of age specific marital fertility rate for the age group 15-19 is estimated as (0.75 **×** age specific marital fertility of 20-24 age group) as a direct estimate is unreliable especially in populations with low values for m (15-19)

Index of Contraception (C_c)

$$C_c = 1 - 1.08 \times e \times u \text{.....(2)}$$

Where *u* is the prevalence of current contraceptive use among married women of reproductive age (15-49); *e* is the average use-effectiveness of contraception and 1.08 is the sterility correction factor. The following standard method-specific use-effectiveness values are used in the absence of reliable data for Sri Lanka for the different methods.

Sterilization	1.0	Male Condom	0.70
IUD	0.95	Implants	0.95
Pill	0.90	LAM	0.70

Injectable	0.90	Traditional Method	0.50

The average use-effectiveness *e* is estimated as the weighted average of the method-specific use-effectiveness levels of *e(m),* with the weight equal to the proportion of women using a given method *u(m).*

$$e = \sum u(m).e(m)/u \quad \text{.....(3)}$$

Method	u(m)	e(m)	u(m).e(m)
Sterilization	0.171	1.00	0.171
IUD	0.069	0.95	0.066
Pill	0.084	0.90	0.076
Injectable	0.143	0.90	0.129
Male Condom	0.060	0.70	0.042
Implants	0.003	0.95	0.003
Traditional	0.170	0.50	0.085
∑	**0.700**		**0.572**

e = 0.572/ 0.700 = 0.817

$C_c = 1 - 1.08 \times 0.817 \times 0.700 = 0.382$

Index of Postpartum Infecundability (C_i)

$$C_i = \frac{20}{18.5 + i} \quad \text{..... (4)}$$

Where i is the mean duration of postpartum infecundability
When a direct estimate of i is not available, an approximate value can be obtained from the duration of breastfeeding (*B)* using the following equation.

$$i = 1.753 \exp (0.1396 \times B - 0.001872 \times B^2) \quad \text{.....(5)}$$

The DHS 2006/07 gives the direct estimate of the mean duration of postpartum insusceptibility as 9.0.

Therefore, by using the equation (**4**) $C_i = \frac{20}{18.5 + 9.0} = 0.727$

The infecundable interval immediately following a birth, in the absence of lactation is about 1.5 months. The waiting time to conception, which starts at the first ovulation following birth and ends with a conception averages around 7.5 months. On an average the time added by intrauterine mortality is about 2 months per birth interval. The gestation period ending a live birth is 9 months. Thus without lactation, a typical average birth interval can therefore, be estimated to equal 1.5+7.5+2+9 = 20 months. With lactation, it equals the period of lactational infecundability plus 18.5 months (7.5+2+9). The ratio of the average birth intervals without and with lactation is called the Index of Postpartum Infecundability.

Index of Induced Abortion (C_a)

$$Ca = \frac{TFR}{TFR + 0.4 \times (1+ u) \times TA} \quad \text{.....(6)}$$

Where TA is the total abortion rate (includes only abortions among married women). It is assumed that an induced abortion averts about 0.4 births. In this exercise TA is assumed to be unknown. Thus TA can be computed as follows:

$$TA = \frac{TFR\ (1- Ca)}{Ca \times 0.4\ (1+u)} \quad \text{...(7)}$$

Thus, by substituting the computed values to the following formula C_a can be derived:

$$TFR = C_m \times C_c \times C_a \times C_i \times TF \quad \text{..... (6)}$$

$$2.3 = 0.556 \times 0.382 \times C_a \times 0.727 \times 15.3$$

$$C_a = 0.975$$

Then the Total Abortion Rate can be computed from formula **(7)**

$$TA = \frac{2.3(1- 0.975)}{0.975 \times 0.4\ (1 + 0.700)}$$

$$TA = 0.087$$