# STATISTICAL DISTRIBUTION OF BIRTH INTERVALS

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**ABSTRACT**

In this paper interbirth interval in rural community of Ethiopia was considered. The aim was to study the distribution of this variable and to see if it varies across regions and socio economic groups. The data for the study was obtained from a socio demographic multipurpose survey conducted in rural Ethiopia in 1989 and 1990. The approach of the study was to fit probability density functions and then generate probabilities so that relate this probabilities to fertility rates and levels.

While none of the densities fitted perfectly to each consecutive birth interval, the lognormal distribution was found to be relatively better for the first and second intervals. A wider mean first birth interval was observed in Northwest and a relatively smaller one in South, indicating a relatively high fertility rate in the Southern region.

For lower parities, interval length of 1.45-2.45 years was observed as a most probable interval length and this shifts to .45-1.45 years at higher parities. For a given interval length and birth order, probability of having a child is higher in South and smaller in Northwest, indicating a relatively high fertility in South and a lower one in the Northwestern region.

In a final consideration of family size, education, sex of the first two children in a family and religion, there was no significant difference observed in birth interval pattern in different regions of the country.

## CONTENTS

# CHAPTER 1

## INTRODUCTION

Government of third world countries are aiming at reducing the high rate of fertility. In spite of an all out effort to do so the fertility levels of these countries, as measured by different indices,continues to be high. Recently there has been a slight reduction in total fertility rate in Sudan, Kenya and Zimbabwe; however, such reduction is not substantial and there is little indication that the reduction will continue to decline.

Birth intervals are believed to affect fertility, mortality and population growth. In a country like Ethiopia where there is a high rate of population growth and where the use of contraceptives is almost nonexistent birth intervals play a crucial role in increasing or decreasing fertility.

There are various direct and indirect methods of reducing fertility voluntarily. Provision of low cost contraceptive pills, delayed age at marriage, or delayed age at first birth and widening the length of interbirth intervals are some of the means. Various studies have been conducted to study the effect of each and all of these controlling mechanisms. The relative contribution of each of these variables have been considerable. Unfortunately most of the studies are confined to already developed countries. Little attention have been given to see the effect of these controlling variables on least developed countries in general and rural area of least developed countries in particular.

Fitting various distribution functions to birth intervals based on survey data could give some insight into the distribution of birth intervals. Once these intervals have been approximated by various distribution functions, one may be able to infer the behaviour of families as to what affects the shortening and lengthening of birth intervals.

In this paper we will consider the possible effect of inter-birth interval on fertility. The study will not directly relate birth interval with fertility; instead different birth intervals will be estimated by a probability density function and then generate probabilities. We shall then attempt to relate this probability to fertility rates and levels. This probability estimates will enable policy makers to consider various policy measures so as to intervene and thereby increase the inter-birth interval.

# CHAPTER 2

# OBJECTIVES OF THE STUDY AND METHODS OF DATA COLLECTION

## 2.1 OBJECTIVE OF THE STUDY

Birth interval is introduced as one of the possible indices that are used to measure the extent of fertility control. The aim of this study is thus to have a closer look at this variable in rural community of Ethiopia. We will attempt to see if there is a certain pattern in the distribution of birth intervals and if such a pattern vary across regions and socio economic groups. This being the general objective of the study the specific objectives are :

i) To fit three probability density functions, namely Normal, Lognormal and Gamma, to different birth intervals.

ii) To select the distribution that best approximates the variable under consideration .

iii) To trace some common patterns in the distribution of birth intervals.

iv) To generate Probabilities by using the selected probability density function and to attempt to relate this probabilities to fertility.

## 2.2 METHOD OF DATA COLLECTION

The data for this study is obtained from a socio economic and demographic multipurpose survey conducted during 1989 in Northwest and Southern regions of Ethiopia and during 1990 in

Central region. The survey was part of a wider research undertaking entitled "Economic and Demographic Household Behaviour in Rural Ethiopia" and financed by Rockfeller Foundation.

The country was stratified into three regions; namely Northwest, Central and South. The reason for this first stage stratification is that there is distinct cultural, ethnic and religious differences between the regions. This is especially so between Northwest and Southern Ethiopia. There is also physical and other geographical variations between the regions.

When the survey was conducted in Northwest and South, the country was subdivided into 14 administrative regions. Five of these are in the North and nine in the South. The five administrative regions had a population of about 12 million while the nine in the South had a population of 36 million. Within each administrative region, there are several districts and each district contains a set of villages and within a village one gets peasant associations. The sampling frame was a list of members of peasant association which was readily available.

In taking a sample a district was randomly selected within each administrative region. Once a district is selected a village was chosen on the basis of stratified sampling with a probability proportional to size (PPS). Within a village one peasant association was again selected randomly. Every household in a chosen peasant association was expected to be interviewed. But because of high non-response rates only a fraction of the residents were included. Thus even though a peasant association was considered as a cluster only some members of this cluster were interviewed. A sample of 801 and 855 were collected from Northwest and South respectively.

One year after the first survey, it was decided to administer the questionnaire (with some revisions) in central Ethiopia. A sample of 1012 households were taken and the method of selection was again the probability proportional to size method.

The data were cleaned, checked for internal consistency and the values of the variable of interest were extracted. In the literature, first birth interval is taken as the difference of mother's age at marriage and at first birth. However, we took it as the age difference of the first two children in a family. This is because age at marriage in rural Ethiopia may go down to 10 years old and we did not, therefore, feel that birth interval defined in the literature measures the variable in good way in rural Ethiopia.

## CHAPTER 3

## SELECTED STATISTICAL DISTRIBUTIONS FOR BIRTH INTERVAL

The aim of this study will be to fit the best probability density function (pdf) among Gamma, Normal, and Lognormal probability distributions to birth intervals collected in north-west, central and southern Ethiopia. The choice of these three was dictated by the prevailing literature on birth interval estimates. We have included Normal Distribution as a point of reference even-though we are aware that this distribution cannot be the best fit. Below we briefly consider the three pdfs.

### 2.1 NORMAL DISTRIBUTION

A random variable (r.v) X is said to be normally distributed with mean $\mu$ and standard deviation (s.d) $\sigma$ if it has a pdf of

$$f(x)=\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right) \quad (1)$$

This distribution is uniquely determined by its two parameters, i.e, its mean and s.d. It is used as a limiting distribution of many statistical distributions. Hence, it has a unique position in probability theory.

If a random variable X with mean $\mu$ and s.d $\sigma$ has pdf given in equation (1) then another random variable **Z** defined as

$$Z = (X-\mu)/\sigma$$

is also normally distributed random variable with mean 0 and standard deviation 1. Tables of such probabilities are given in any statistical text for this distribution and they are used for calculations related to all normal distributions.

Normal theory can frequently be applied, with small risk of serious error, when substantially non-normal distribution correspond more closely to observed values. Most theoretical arguments for the use of this distribution are based on central limit theorem that identify sufficient conditions to ensure asymptotic normality.

For further discussion of the distribution one may refer to Johnson and Kotz (1970) and for some important properties Mood and others (1986) may be considered. In this paper the parameters will be estimated using Maximum Likelihood Method. The estimates are

$$\hat{\mu}=\bar{x}=\frac{\sum x_i}{n} \quad \text{and} \quad \hat{\sigma}^2=S^2=\sum (x_i-\bar{x})^2/n$$

**2.2 LOGNORMAL DISTRIBUTION**

Sometimes it is possible to face random variable which is not normally distributed but appropriate transformations may result in normal distribution. Most common transformation used in practice is logarithmic transformation. Some other type of transformations are also discussed (Dixon , 1983).

If X is a random variable such that another random variable Y defined as Y= LOG(X) is normally distributed with mean $\mu$ and standard deviation $\sigma$, then X is said to be log-normally distributed random variable and its pdf is given as:

$$f(x)=\frac{1}{X\sqrt{2\pi}\sigma}\exp\left(-\frac{1}{2}\left(\frac{\log(x)-\mu}{\sigma}\right)^2\right) \tag{2}$$

The distribution is positively skewed to a degree that depends on the standard deviation of log(x). It has been successfully fitted to many kinds of duration and size distribution (Bartholomew, 1967). Lognormality offers substantial statistical advantages since, by working with the logarithm of the variable, the whole range of 'normal theory' methods becomes available.

Bartholomew,(1967) and others show that the length of human life, the age at marriage, the spacing between successive births in a family and others are examples of durational variables of fundamental interest in demography; Lognormal distribution is a good candidate to approximate our variable of interest,that is, birth interval. Reference for a full account of the distribution including both its properties and some applications is given in Bartholomew (1967). The case of three parameter is also discussed elsewhere ( Johnson and Kotz, 1970).

For the two parameter case the maximum likelihood estimators of the parameters are:

$$\hat{\mu}=\bar{x}=\left(\sum \log(x_i)\right)/n$$

and

$$\hat{\sigma}^2 = S^2 = \frac{\sum (\log(x_i) - \bar{x})^2}{n}$$

In this paper, we shall consider two parameter lognormal distribution and we shall use the above estimates.

**2.3 GAMMA DISTRIBUTION**

The gamma model with parameters $\gamma$, $\alpha$, and $\beta$ has pdf

$$f(x) = \frac{(x-\gamma)^{\alpha-1}\exp(-\frac{x}{\beta})}{\beta^{\alpha}\Gamma(\alpha)} \qquad (3)$$

where $\alpha>0$, $\beta>0$, $X>\gamma$

In most applications the two parameter form ($\gamma=0$)

$$f(x) = \frac{x^{\alpha-1}\exp(-\frac{x}{\beta})}{\beta^{\alpha}\Gamma(\alpha)} \qquad (4)$$

is used. By increasing $\alpha$, the shape of the curve becomes similar to the normal probability density curve.

Johnson and Kotz (1967) gave a good general review of this distribution, including several references to applications in diverse fields. They have also indicated that it is a generalization of the exponential distribution and it provides flexible skewed density defined over the positive range.

Bartholomew (1967) observed that exponential distribution has a central role in modelling duration variables in industrial application. He forwards that where the exponential distribution fails the Weibull or the gamma distributions are often used. He also stressed that the models which have been found to describe the life of industrial components satisfactorily are **rarely** suitable for the durations of social processes.

Statistical techniques have been somewhat difficult to develop for the gamma distribution. This is partly because the parameters are not of the convenient location and scale type.

In estimating equation (3) Johnson and Kotz (1967) have used maximum likelihood method followed by iterative method as well as the method of moments. They pointed out that the former one gives more accurate results than the latter one. They also noted, however, that when $\alpha$ is less than 2.5, the maximum likelihood estimates are of doubtful utility.

To estimate equation (4), maximum likelihood method may be employed assuming **n** independent gamma distributed random variables. We have to solve the following two equations:

$$\frac{1}{n}\Sigma\log(x_i)=\log(\hat{\beta})+\psi(\hat{\alpha}) \tag{5}$$

$$\bar{x}=\hat{\alpha}\beta \tag{6}$$

We solve equation (6) for $\beta$ and use it in equation (5) to get

$$\log(\hat{\alpha})-\psi(\hat{\alpha})=\log(\frac{\bar{x}}{G}) \tag{7}$$

Where $\psi(\hat{\alpha})$ is digmma function , $\bar{x}$ is arithmetic mean and G is geometric mean

One possible way to get $\alpha$ is to use table for $\log(\hat{\alpha})-\psi(\hat{\alpha})$. Other possibility is to use one of different approximations that can be made for $\psi(\hat{\alpha})$. In literature different approximations of $\psi(\hat{\alpha})$ are given and some of these references are given in Johnson and Kotz (1967). One of these approximations is

$$\psi(\hat{\alpha}) = \log(\alpha-.5)$$

Using this approximation parameters of equation (4), which is the same as equation (3) with $\gamma$ =0, are solved as :

$$\hat{\alpha} = \frac{\overline{x}}{\overline{x} - G} \quad \text{and} \quad \beta = \frac{\overline{X}}{\hat{\alpha}}$$

Alternatively, the following highly accurate approximation stressed by Bury (1975) can be used to obtain $\hat{\alpha}$ directly as follows:

$$\hat{\alpha} = \{ \; (.5001 + .1649g - .0544g^{22})g^{-1} \;, \; 0 < g < .577$$

$$(17.80 + 11.97g + g^{2})^{-1}.(8.899 + 9.060g + .9775g^{2})g^{-1} \;, \; .577<g<17$$

where $g = \log(\overline{x}/G)$

Johnson and Kotz (1967) and Bury (1975) indicated that the error of the formula is less than 0.01% by giving reference and hence in this paper we shall use this approximation for the estimation of gamma parameters.

# CHAPTER 4

## TECHNIQUES OF MODEL SELECTION AND THEIR APPLICATION

Often the hypotheses being tested are statements concerning the unknown probability distribution of the random variable being observed. According to Conover (1980) a test for goodness of fit usually involves examining a random sample from some unknown distribution in order to test the null hypotheses, $H_0$, that the unknown distribution function is in fact a known, specified function. It has been stated (Gibbon, 1971) that several test statistic for examination of this hypotheses are functions of the deviations between the observed cumulative distribution and the corresponding cumulative probabilities expected under the null hypotheses. The function of these deviations used to perform a test include the sum of squares, or absolute values, or the maximum deviation. It is also noted (Wilks, 1962) that the cumulative distribution function of a random variable is uniquely determined by its probability density (mass) function and vice versa.

In literatures Pearson chi-square test and Kolmogorov test are the two known goodness-of-fit tests. When these tests are used, calculated values of the test statistic are compared with tabulated values and the null hypotheses is accepted or rejected. Detailed examination of these tests with several examples and reference publications are discussed elsewhere (Conover, 1980).

Amendu (1981) performed chi-square test in evaluating goodness-of-fit of his estimated distributions. It is noted (Conover, 1980) that in any goodness-of-fit test null hypotheses will be rejected if the sample size is large . Amendu (1981) was faced with the same problem while the contours of the estimated and observed curves fit closely. Hence, he compared chi-square statistics themselves for various probability distributions and chose the one with minimum value. Jan and others (1981) also used comparison of least squares accuracy, curve plots and similar measures of fit to select the best fit.

In mathematics general criteria for selecting the best approximating function is minimization of distance between the function to be approximated and hypothesized function. For this minimization norm of difference of functions is used.

For a given discrete function **f**, with functional values $f(x_1)$, $f(x_2)$, . . . , $f(x_n)$, norm of **f** is defined (Taylor and Lay, 1980 ) as

$$\|f\| = \left(\sum |f(x_i)|^m\right)^{\frac{1}{m}} \qquad i=1,2,\ldots n$$

for any positive integer m. In our case we only know functional values of relative frequency polygon of birth interval data at some selected points, that is, we do not know the exact function that represents the data. The aim is to find the exact if not the close approximate of this unknown function. We may be quite sure (Conover, 1980) that the true distribution function is never exactly the same as the hypothesized distribution function. However, in many cases we are looking for a good approximation to the true distribution function and this test provides a means of justifying the use of hypothesized function by accepting null hypotheses.

In this paper we have three null hypotheses regarding the distribution of birth interval in rural community of Ethiopia. After fitting the pdfs' to the observed birth intervals regionally and overall, we shall select the model that best approximates the observed relative frequency polygon. The same will also be done considering socio economic and demographic determinants of the household head. To select one of the fitted pdfs we shall use the norm defined above for three values of m. The following notations shall be used in the paper:

**f** = relative frequency polygon to be estimated

$f_n$ =fitted normal pdf

$f_g$= fitted gamma pdf

$f_l$ = fitted lognormal pdf

$X_k = \|f-f_k\|$ k= n,g,l when m= 2

$Y_k = \|f-f_k\|$ k= n,g,l when m= 1

$Z_k= \|f-f_k\|$ k= n,g,l when m is very large

$X_k$ and $Y_k$ give measure of a norm on the average taking every point available into consideration while $Z_k$ ,limiting value of the defined norm as m approach to infinity and is equal to the maximum difference between the two functions, considers only the influential point. Selection of one among the above three depends on the problem at hand. In our case we don't have extreme points that may affect the fit at least for the first two birth interval which are expected to be the best indicators for the nature of

Table 1: Empirical Results of "Goodness of Fit"

Table 1a: North-West

| $i^{th}$ Birth Interval | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .14 | .34 | .08 | .17 | .45 | .10 | .24 | .72 | .15 |
| 2 | .14 | .29 | .10 | .14 | .35 | .10 | .22 | .63 | .14 |
| 3 | .17 | .33 | .14 | .14 | .30 | .09 | .17 | .46 | .10 |
| 4 | .22 | .46 | .19 | .17 | .38 | .12 | .17 | .48 | .12 |
| 5 | .22 | .44 | .18 | .14 | .34 | .11 | .14 | .37 | .08 |
| 6 | .24 | .50 | .21 | .17 | .36 | .15 | .14 | .38 | .08 |
| 7 | .26 | .49 | .22 | .17 | .34 | .16 | .20 | .47 | .12 |

Table 1b: Central

| $i^{th}$ BIRTH INTERVAL | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .10 | .26 | .06 | .15 | .39 | .11 | .26 | .69 | .29 |
| 2 | .11 | .29 | .07 | .15 | .39 | .12 | .27 | .68 | .21 |
| 3 | .18 | .36 | .12 | .19 | .40 | .15 | .29 | .64 | .25 |
| 4 | .23 | .45 | .16 | .22 | .48 | .18 | .31 | .69 | .27 |
| 5 | .20 | .41 | .15 | .19 | .41 | .15 | .28 | .62 | .24 |
| 6 | .25 | .51 | .19 | .20 | .48 | .14 | .26 | .59 | .21 |
| 7 | .23 | .45 | .19 | .16 | .32 | .13 | .19 | .45 | .11 |

Table 1c: South

| $i^{th}$ BIRTH INTERVAL | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .20 | .42 | .14 | .22 | .48 | .18 | .33 | .79 | .28 |
| 2 | .20 | .37 | .14 | .20 | .44 | .18 | .32 | .66 | .27 |
| 3 | .24 | .40 | .18 | .20 | .37 | .15 | .24 | .54 | .20 |
| 4 | .26 | .44 | .19 | .22 | .39 | .16 | .26 | .56 | .21 |
| 5 | .36 | .60 | .25 | .03 | .53 | .22 | .30 | .65 | .24 |
| 6 | .28 | .52 | .20 | .24 | .50 | .18 | .28 | .64 | .23 |
| 7 | .03 | .56 | .21 | .24 | .54 | .17 | .24 | .55 | .17 |

Table 1d: Overall

| $i^{th}$ BIRTH INTERVAL | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .14 | .34 | .08 | .17 | .47 | .13 | .28 | .76 | .22 |
| 2 | .14 | .30 | .09 | .17 | .40 | .12 | .26 | .65 | .21 |
| 3 | .20 | .38 | .15 | .17 | .36 | .13 | .24 | .56 | .21 |
| 4 | .24 | .46 | .18 | .20 | .43 | .16 | .28 | .61 | .25 |
| 5 | .26 | .49 | .20 | .22 | .45 | .16 | .28 | .59 | .23 |
| 6 | .26 | .49 | .20 | .22 | .47 | .16 | .26 | .60 | .21 |
| 7 | .24 | .54 | .17 | .17 | .41 | .12 | .20 | .51 | .12 |

fertility pattern, specially in rural Ethiopia. And Theoretically they are supposed to give the same function since we are measuring the same norm. Various measures-of-goodness of fits are given in Tables 1a to 1d and different pdfs' are shown graphically in Figures 1 to 7

The first and second birth intervals are usually the most important and best predictors of subsequent intervals and we shall put more emphasis on these two birth intervals.

From Table 1 we observe that first, second and to some extent the third birth intervals are best approximated by lognormal distribution. The dominance of gamma and to some degree normal distributions at higher birth intervals is observed. However, for most of these birth intervals in which gamma seems the best fit $\alpha$ is less than 2.5 and under this condition maximum likelihood estimates of this distribution are of marginal values (Johnson and Kotz, 1970). Another point is that as sample size decreases which is naturally associated with increase in birth order or parity we do not expect normal distribution. In other words, we expect the limiting distribution of normal as well as non normal to be normal from low of large numbers as the sample size increases. Therefore, it seems reasonable to say that higher birth intervals may be approximated by the distribution which estimates the first two or three birth intervals.

For the purpose of generating probabilities we shall choose the distribution which seems best estimator of the first two birth intervals, that is, lognormal distribution. In such a process the probabilities that will be generated at large birth interval length would be too small. This is a result which one expects from lognormal pdf because of its skewness.

Finally it should be noted that one could obtain better parameter estimates if the criteria used for selecting the appropriate pdf is used for estimating the parameters. We did not follow this procedure because the software required for estimating parameters by minimization of norm is not available. Chances are that the net contribution would be minimal.

*Figure 1: Comparative first birth interval by region*

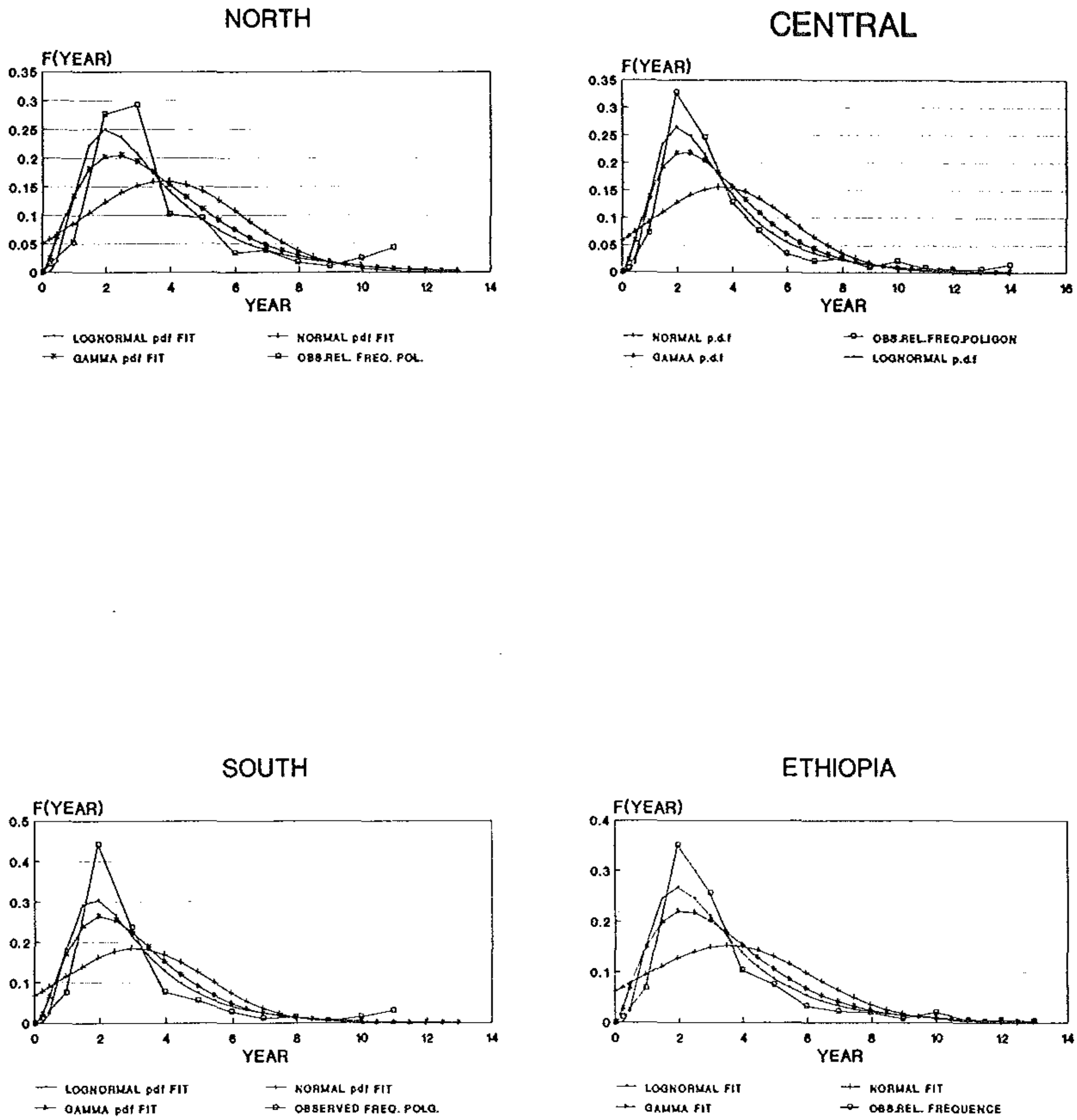


*Figure 2: Comparaive second birth interval by region*

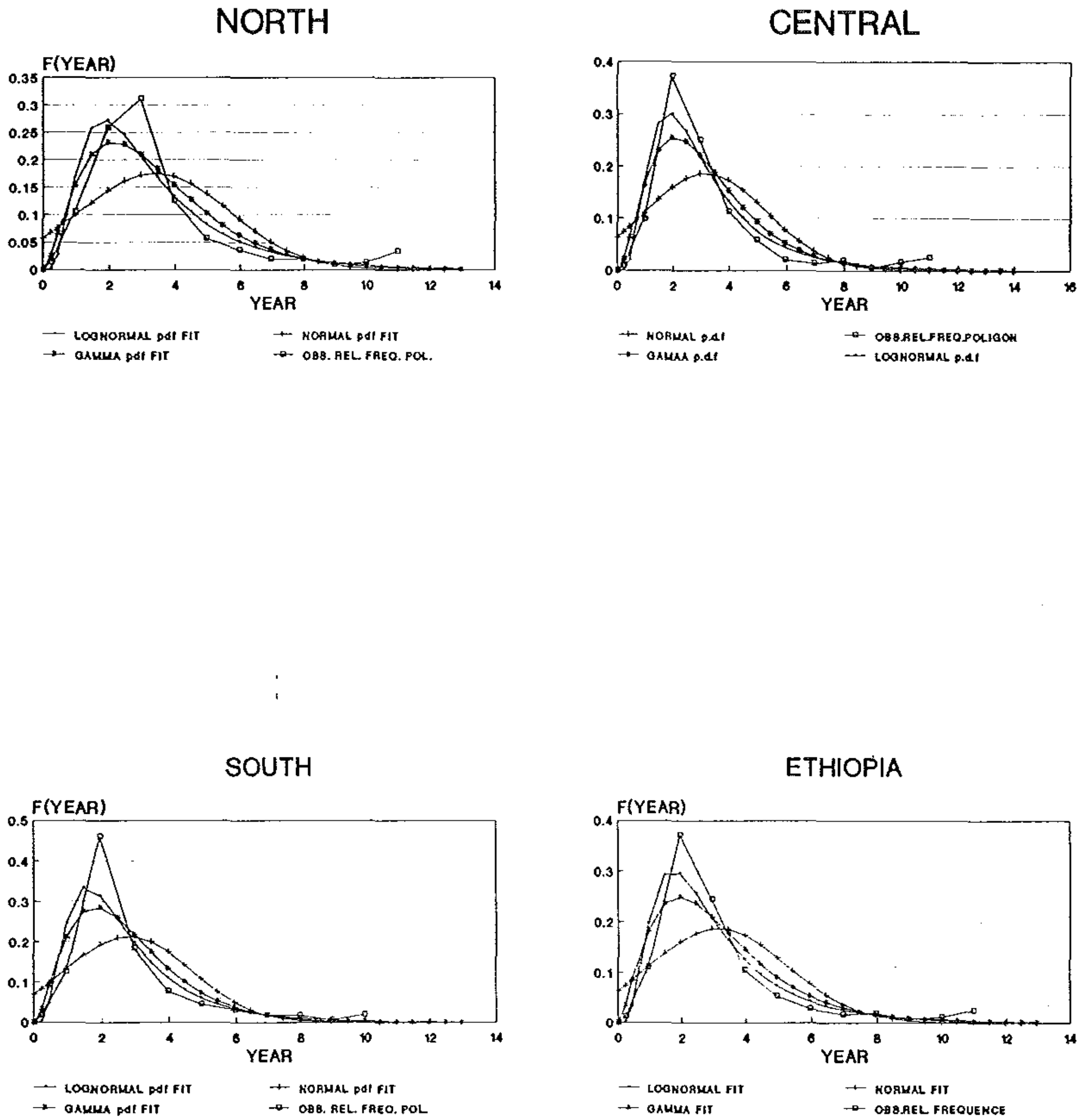


*Figure 3: Comparative third birth interval by region*

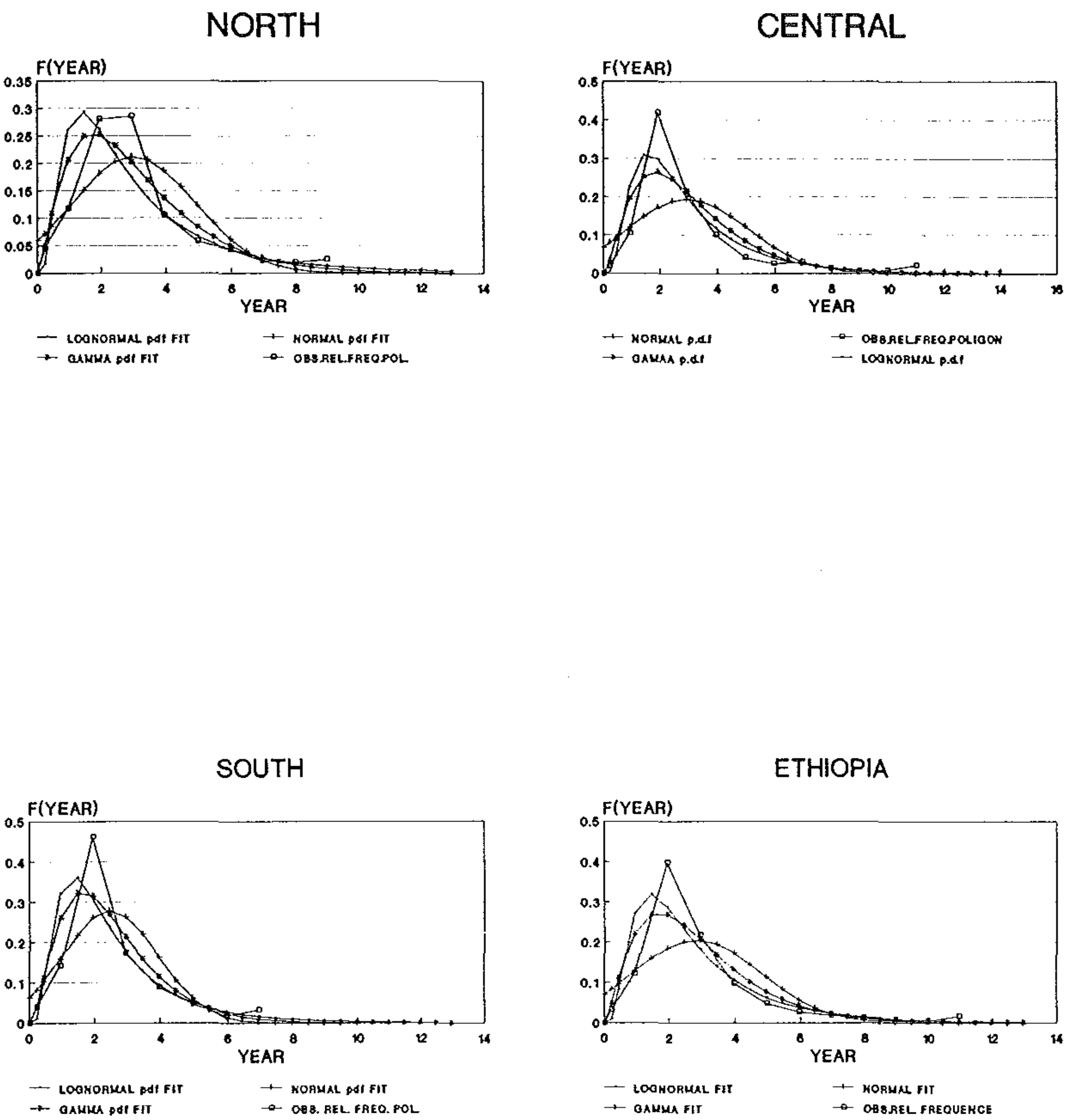


*Figure 4: Comparative fourth birth interval by region*

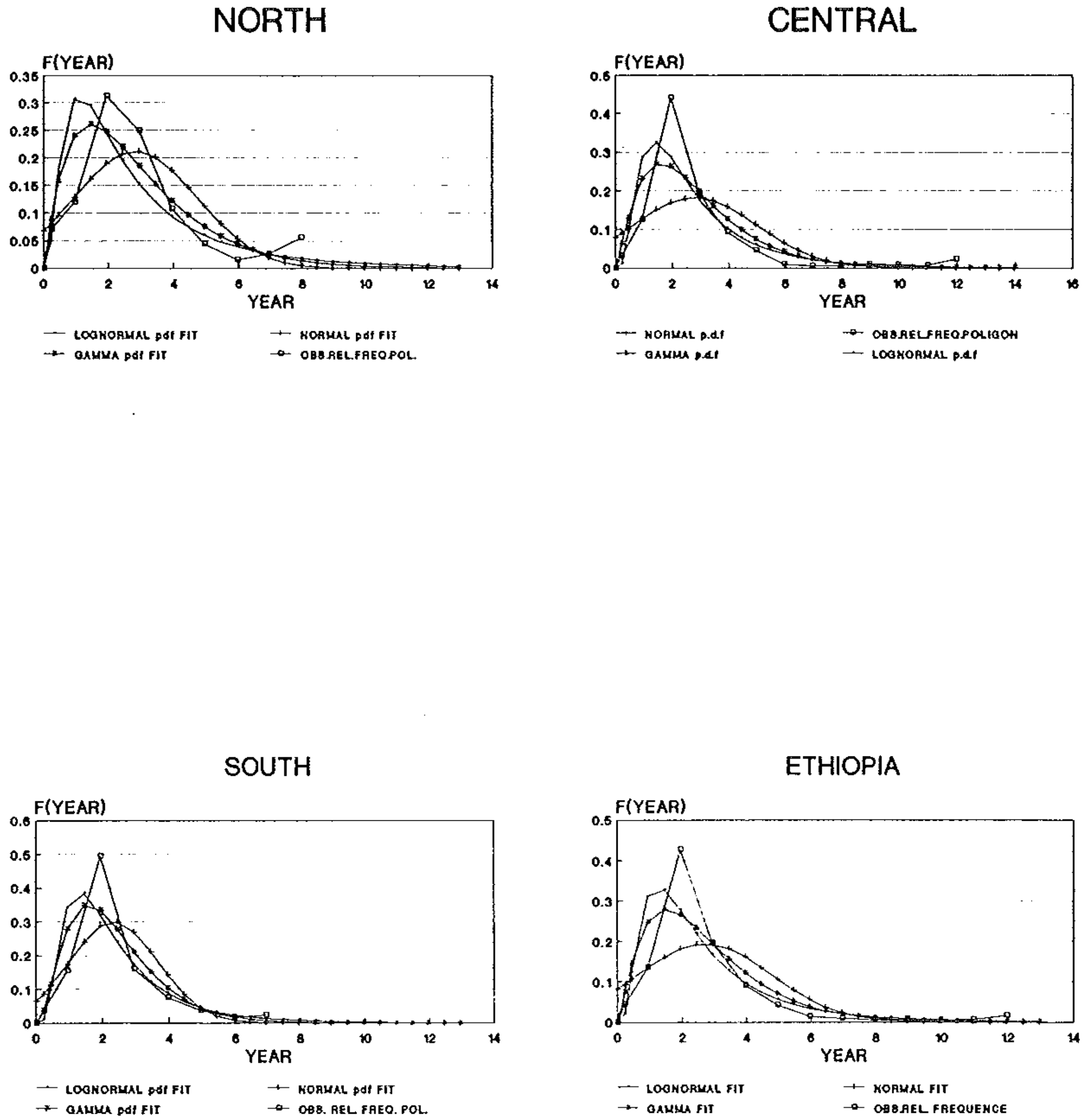


*Figure 5: Comparative fifth birth interval by region*

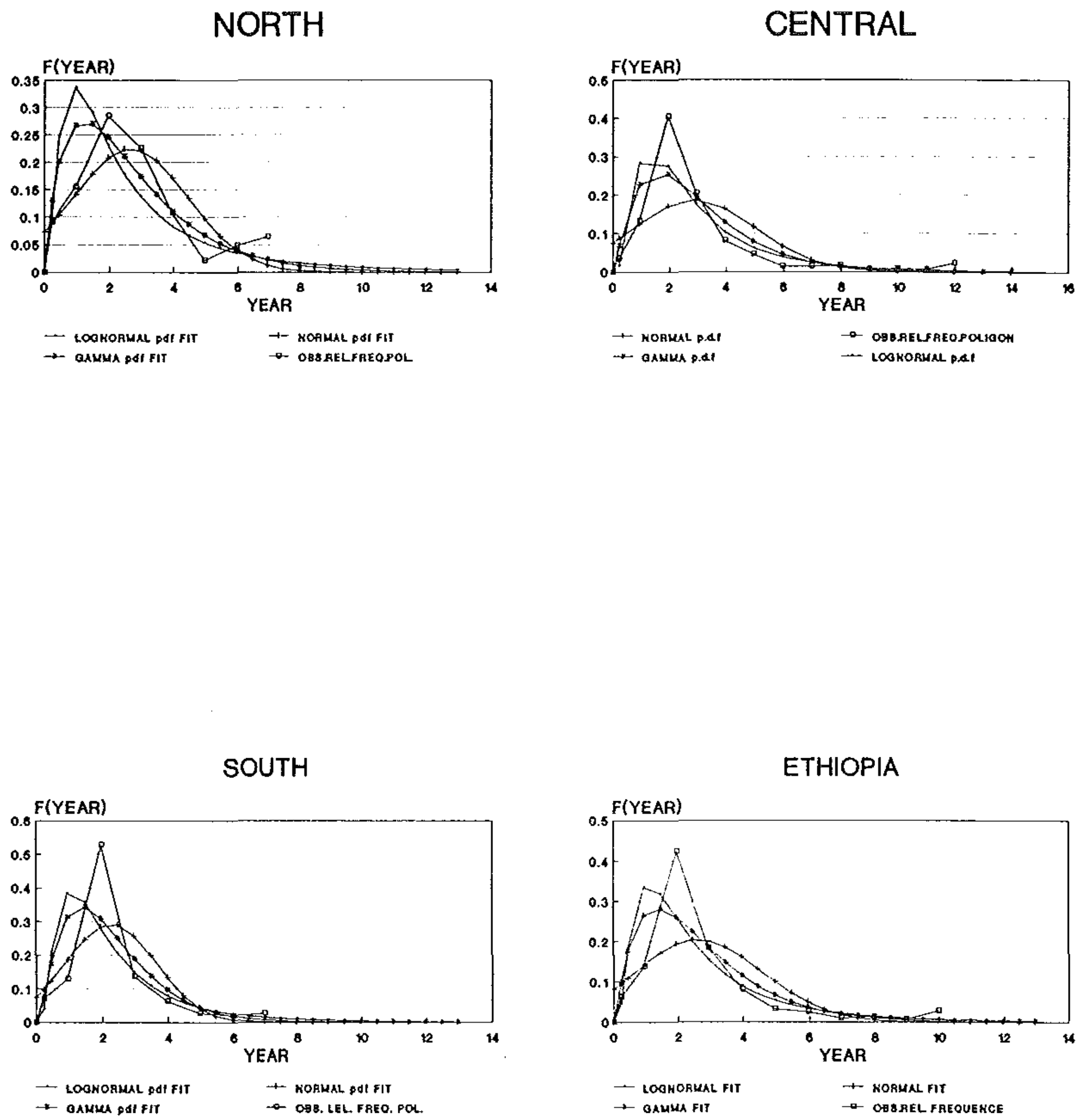


*Figure 6: Comparative sixth birth interval by region*

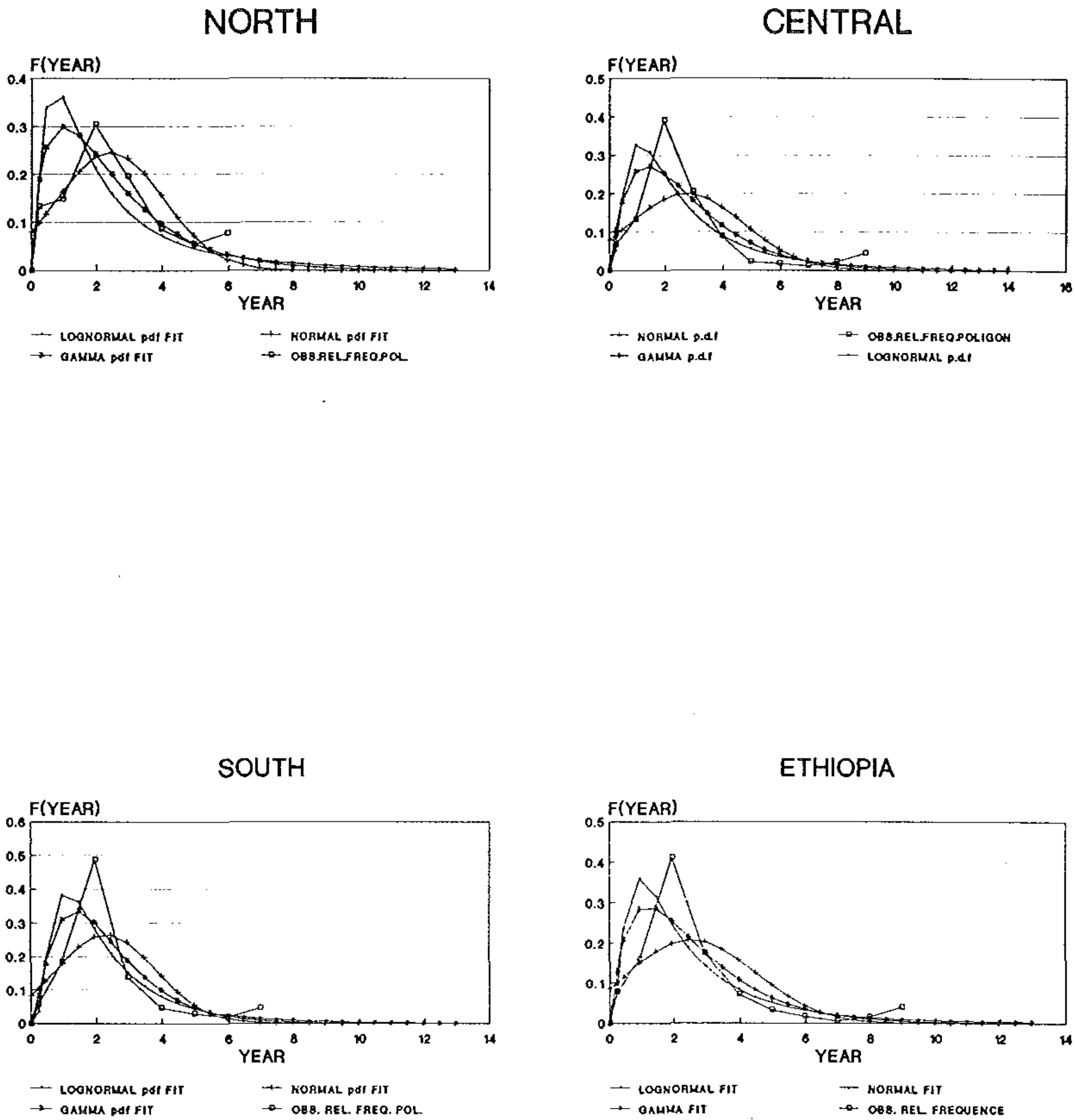
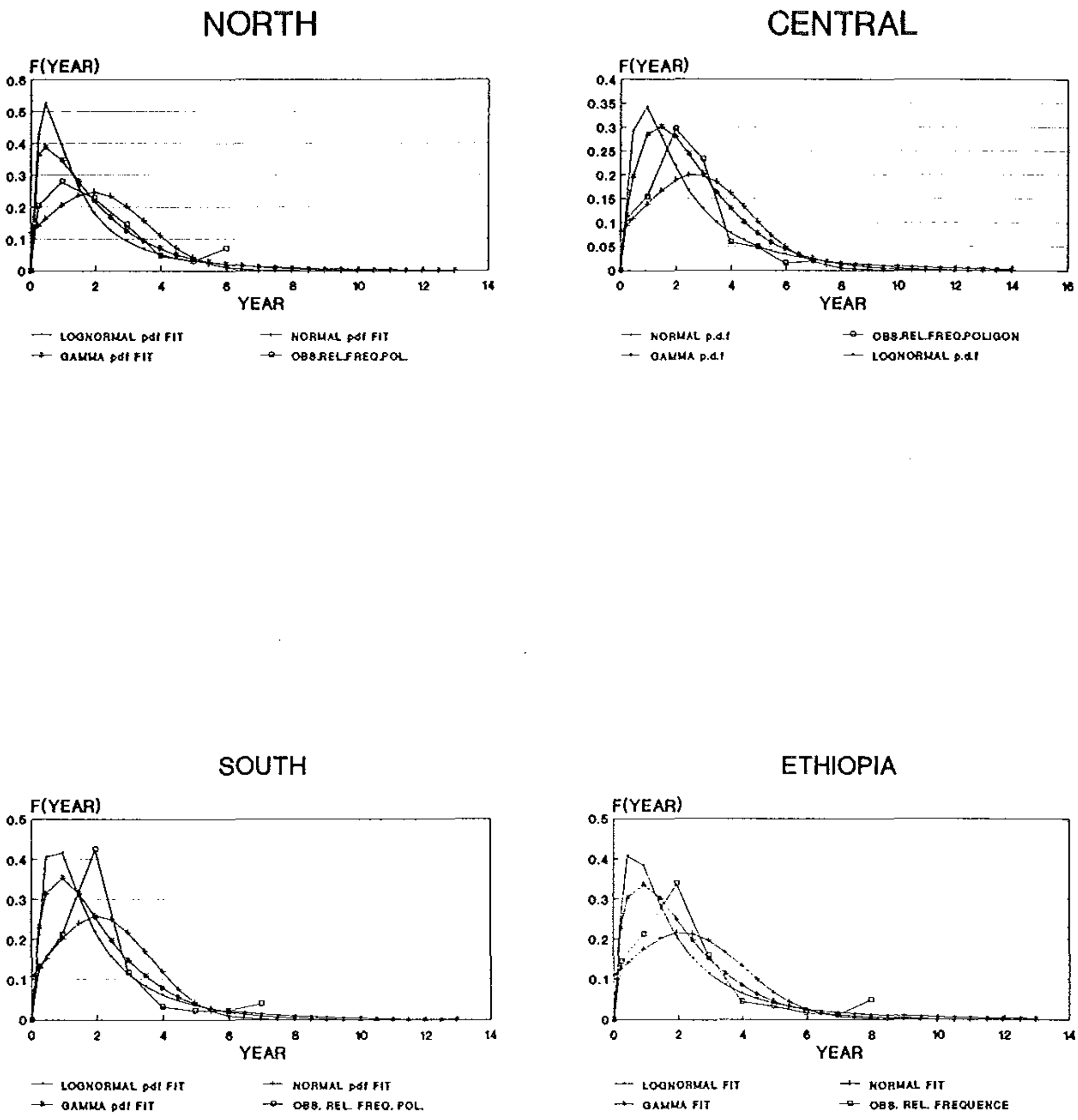


*Figure 7: Comparative seventh birth interval by region*



# CHAPTER 5

# EMPIRICAL RESULTS

## 5.1 GENERAL

### 5.1.1 RESULTS ON MEAN BIRTH INTERVAL

We now discuss the empirical results of the various birth intervals. First we shall consider the mean, standard deviation and the coefficient of variation (c.v) for some of the above birth intervals. This is given in Table 5.1.

Table 5.1: Mean, Standard Deviation, and Coefficient of variation for Some Birth Intervals by Region

REGION

| BIRTH | NORTH-WEST | | | CENTRAL | | | SOUTH | | |
|---|---|---|---|---|---|---|---|---|---|
| INTERVAL | MEAN | S.D | C.V | MEAN | S.D | C.V | MEAN | S.D | C.V |
| 1 | 1.11 | .65 | .586 | 1.07 | .63 | .589 | .94 | .61 | .649 |
| 2 | 1.02 | .65 | .637 | .96 | .60 | .625 | .83 | .63 | .759 |
| 3 | .88 | .75 | .852 | .89 | .65 | .730 | .72 | .66 | .917 |
| 4 | .79 | .83 | 1.051 | .80 | .70 | .875 | .68 | .64 | .941 |

Table 5.1 suggests that birth interval tend to become small as we go from lower to higher parities. This is true for each of the three regions. The result suggests that women tend to desire less birth immediately after marriage and tend to compensate for this at latter ages. The reason for this may be that women's age at marriage is relatively early (18 years or less ) and child

birth during this period as being relatively risky.

Another result that one observes from Table 5.1 is that the variability of mean birth interval increases as birth order increases for each region. Mean first, second and third birth intervals for South are more variable relative to North-west and Central regions while mean second and third birth intervals are more consistent for Central region. From this one may conclude that even-though Southern region has less mean birth interval (high fertility pattern ) there is high variability among family fertility pattern relative to North-west and Central regions.

Menken and Trussell (1978) state that low first birth interval (high fertility at earlier ages of mothers) implies low subsequent birth intervals. In order to see whether this has applicability

Table 5.2: Mean, standard deviation and coefficient of variation of first birth interval by region.

| REGION | MEAN | S.D | C.V |
|---|---|---|---|
| North-West | 1.11 | .65 | .586 |
| Central | 1.07 | .063 | .589 |
| South | .94 | .61 | .649 |
| Ethiopia | 1.05 | .64 | .610 |

Table 5.3: Mean and Standard Deviation of Some Higher Birth Intervals By Region

| | INTERVAL 2 | | INTERVAL 3 | | INTERVAL 4 | |
|---|---|---|---|---|---|---|
| REGION | MEAN | S.D | MEAN | S.D | MEAN | S.D |
| North | 1.02 | .65 | .88 | .75 | .78 | .83 |
| Central | .96 | .60 | .89 | .65 | .80 | .70 |
| South | .83 | .63 | .72 | .66 | .68 | .64 |
| Ethiopia | .93 | .63 | .83 | .69 | .76 | .73 |

within the Ethiopian rural setting we used the results based on lognormal distribution and present the mean, standard deviation and coefficient of variation of first birth interval for each of the regions. This is given in Table 5.2.

Table 5.2 suggests that the mean first birth interval for North-west region is high while for the Southern region is relatively small. This suggests a low fertility schedule for the North-west compared to the South.

Given this preliminary finding we also estimated second and some higher birth intervals and this is given in Table 5.3. This result is similar to the first birth interval of Table 5.2. North-west has a higher second mean birth interval while Southern region has relatively lowest. This again suggests voluntary fertility control in the North-west. However, at higher birth intervals (greater than 2) the central region shows relatively

Table 5.4: Relation Between Overall Mean Birth Interval and CEB by Region

| Region | Overall mean birth interval | Children everborn |
|---|---|---|
| North-west | .87 | 3.72 |
| Central | .91 | 3.79 |
| South | .73 | 4.56 |
| Ethiopia | .84 | 4.00 |

higher fertility control. In all cases the Southern region does not exhibit a fertility control through child spacing.

It may be argued that child spacing may not after all reduce the total fertility rate because higher birth interval at earlier births may be offset by lower birth interval length at latter ages. In an attempt to verify this we related the overall mean birth interval with the number of children everborn (CEB). This is given in Table 5.4.

The result in Table 5.4 suggests that child spacing does reduce the fertility rate as measured by the number of children everborn. Even-though the number of CEB has not been controlled for the age of mothers, we can safely conclude that child spacing is a common means of voluntary birth control in rural communities.

### 5.1.2 PROBABILITIES OF BIRTH INTERVAL LENGTH AND THEIR INTERPRETATION

Based on the lognormal distribution we are able to generate probabilities associated with a given range of birth interval length. This is shown in Tables 5.5a-5.5d.

In calculating the parameters of the distribution detailed classification of interval length was used and in the following tables the probability of having a child with interval lengths of more than about 6 years and 6 months are aggregated and taken as

Table 5.5: Probability of Having Child in a Given Interval Length of a Family

Table 5.5a : North-west

| Interval Length in Years | Birth Order | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| < .45 | .0016 | .0026 | .0129 | .0281 | .0465 | .0778 | .1587 |
| .45-1.45 | .1255 | .1585 | .2385 | .2840 | .3167 | .3469 | .3970 |
| 1.45-2.45 | .2536 | .2636 | .2606 | .2436 | .2316 | .2159 | .1865 |
| 2.45-3.45 | .2086 | .2084 | .1724 | .1566 | .1409 | .1236 | .0943 |
| 3.45-4.45 | .1431 | .1342 | .1095 | .0828 | .0862 | .0747 | .0549 |
| 4.45-5.45 | .0935 | .0835 | .0704 | .0614 | .0517 | .0480 | .0329 |
| 5.45-6.45 | .0611 | .0524 | .0423 | .0484 | .0353 | .0293 | .0170 |
| > 6.45 | .1130 | .0968 | .0934 | .0951 | .0918 | .0838 | .0594 |

Table 5.5b: Central

| Interval Length in Years | Birth Order | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| < .45 | .0014 | .0017 | .0045 | .0110 | .0132 | .0300 | .0618 |
| .45-1.45 | .1300 | .1594 | .2074 | .2599 | .2577 | .3000 | .3279 |
| 1.45-2.45 | .2583 | .2951 | .2921 | .2848 | .2729 | .2532 | .2167 |
| 2.45-3.35 | .2129 | .2210 | .2014 | .1767 | .1752 | .1525 | .1325 |
| 3.45-4.45 | .1460 | .1334 | .1184 | .1065 | .1048 | .0907 | .0797 |
| 4.45-5.45 | .0903 | .0743 | .0687 | .0608 | .0631 | .0566 | .0522 |
| 5.45-6.45 | .0573 | .0470 | .0407 | .0477 | .0382 | .0362 | .0341 |
| > 6.45 | .1038 | .0681 | .0668 | .0526 | .0749 | .0808 | .0951 |

one and largest possible interval length. This is because probability of having a child by an interval of more than 78 months is very low in rural community. This is observed in the empirical findings above.

For reasons already stated we shall emphasize in the first, second and third birth intervals. The others will be in aggregate. We shall use the modal approach, that is , we shall identify the birth interval length with highest probability.

Some interesting and consistent results seem to prevail. In other words, in each of the three regions and each of the first three birth intervals, the common birth interval length seems to

Table 5.5c : South

| Interval Length in Years | Birth Order | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| < .45 | .0021 | .0045 | .0110 | .0104 | .0274 | .0250 | .0901 |
| .45-1.45 | .1715 | .2252 | .2871 | .3052 | .3471 | .3457 | .3979 |
| 1.45-2.45 | .2985 | .3101 | .3045 | .3175 | .2809 | .2847 | .2243 |
| 2.45-3.45 | .2158 | .1991 | .1797 | .1775 | .1524 | .1524 | .1141 |
| 3.45-4.45 | .1307 | .1142 | .0947 | .0874 | .0791 | .0829 | .0643 |
| 4.45-5.45 | .0739 | .0616 | .0522 | .0461 | .0450 | .0438 | .0371 |
| 5.45-6.45 | .0432 | .0348 | .0281 | .0237 | .0254 | .0254 | .0217 |
| > 6.45 | .0642 | .0505 | .0427 | .0322 | .0427 | .0401 | .0505 |

Table 5.5d: Overall

| Interval Length in Years | Birth Order | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| < .45 | .0028 | .0030 | .0094 | .0166 | .0274 | .0409 | .1003 |
| .45-1.45 | .1441 | .1837 | .2452 | .2815 | .3062 | .3298 | .3758 |
| 1.45-2.45 | .2583 | .2894 | .2852 | .2772 | .2612 | .2472 | .2083 |
| 2.45-3.45 | .2127 | .2083 | .1826 | .1701 | .1538 | .1432 | .1151 |
| 3.45-4.45 | .1370 | .1289 | .1065 | .0984 | .0927 | .0850 | .0648 |
| 4.45-5.45 | .0889 | .0736 | .0655 | .0559 | .0531 | .0501 | .0406 |
| 5.45-6.45 | .0542 | .0423 | .0375 | .0348 | .0348 | .0330 | .0264 |
| > .45 | .1020 | .0708 | .0681 | .0655 | .0708 | .0708 | .0687 |

be in the range of 1.45-2.45 years. Taking the class mid-point as the representative of the interval length, the common birth interval length is about 24 months or 2 years. Hence, one may say that on the average rural community in Ethiopia give birth to their children in the interval of 2 years at least for the first four children. The probability of having a child within this interval length is highest in the South and lowest in the North-west with Central region in between. This is true for first, second and third intervals. The implication is that there is high fertility rate in South relative to the other two regions.

As we move to higher parity intervals, more probable interval length is .45-1.45 years, which is practised at lower parities in the North-west compered to the other two regions. The probability is higher for the South relative to North-west and Central regions.

The conclusion that one may reach is that households may desire a given number of children and the tempo of birth increased as women get older.

The interval length of less than .45 years ( less than about 6 months) is included to represent the length of age difference between twins. For the first two birth intervals the probability of having twin is highest in South and smallest for Central region. For higher parities the probability is highest for North-west.

Taking .45-1.45 as a lowest birth interval length Southern region seems to exhibit higher probability compared to the other regions. Also taking 5.45-6.45 as highest interval length, North-west region seems to exhibit higher probability and Southern region smaller probability.

The consistent result that one can see in Table 5.5 is that high probability for Southern region for shorter birth interval length, less than about 42 months, and small probability for large interval lengths. The opposite result is noted for the North-west region. Hence, it seems reasonable to say that Southern region exhibit high fertility pattern and North-west low fertility rate with Central part in between relative to each other.

Table 5.5d shows an over all fertility pattern. As it can easily be seen, the probability of having twins among the first four children is very low. The most common birth interval length seems to be about 2 years for the first 5 children and then about 1 year for higher parities for over all regions. Hence, the previous conclusions seems to be consistent.

## 5.2 SOCIO-ECONOMIC DETERMINANTS OF BIRTH INTERVALS

So far we considered birth interval for the three regions without taking into consideration other socio-economic variables. In the following we shall consider if there is a variation in the length of birth intervals among various demographic, socioeconomic and religious groups.

Table 5.6: Mean , Standard Deviation and Coefficient of Variation of Some Birth Intervals for all the Regions by Family Size.

| REGION | MEAN, S.D & C.V | SMALL FAMILY 1 | 2 | 3 | 4 | LARGE FAMILY 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|
| NORTH-WEST | MEAN, | 1.103 | 1.03 | .820 | .744 | 1.061 | .957 | .887 | .760 |
| | S.D | .646 | .679 | .765 | .972 | .627 | .623 | .773 | .768 |
| | C.V | .586 | .659 | .933 | 1.306 | .591 | .651 | .871 | 1.101 |
| CENTRAL | MEAN, | 1.065 | .975 | .858 | .746 | 1.072 | .941 | .903 | .781 |
| | S.D | .639 | .627 | .740 | .840 | .576 | .560 | .527 | .541 |
| | C.V | .600 | .643 | .862 | 1.126 | .537 | .595 | .584 | .693 |
| SOUTH | MEAN | .963 | .889 | .755 | .810 | .908 | .774 | .673 | .676 |
| | S.D | .580 | .606 | .691 | .657 | .618 | .661 | .688 | .590 |
| | C.V | .602 | .682 | .820 | .811 | .681 | .854 | 1.022 | .873 |
| OVERALL | MEAN | 1.052 | .975 | .828 | .769 | 1.009 | .882 | .810 | .731 |
| | S.D | .639 | .660 | .756 | .847 | .618 | .628 | .669 | .632 |
| | C.V | .607 | .677 | .913 | 1.101 | .612 | .712 | .826 | .865 |

### 5.2.1 FAMILY SIZE

Ethiopian rural community are predominantly farmers where children of the latter are considered as assets. They should work to subsidize their life and the family with their parents.

Table 5.7: Probability of Bearing a Child in Different Possible Interval lengths

Table 5.7a: Small Family

| REGION | INTERVAL LENGTH IN YEARS | BIRTH ORDER 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| NORTH-WEST | < .45 | .0016 | .0036 | .0017 | .0559 |
| | .45-1.45 | .1255 | .1624 | .2606 | .2961 |
| | 1.45-2.45 | .2512 | .2547 | .2622 | .2116 |
| | 2.45-3.45 | .2049 | .2010 | .1690 | .1314 |
| | 3.45-4.45 | .1425 | .1300 | .1018 | .0844 |
| | 4.45-5.45 | .0955 | .0848 | .0623 | .0571 |
| | 5.45-6.45 | .0598 | .0542 | .0402 | .0384 |
| | > 6.46 | .1190 | .1093 | .0869 | .1251 |
| CENTRAL | < .45 | .0017 | .0023 | .0126 | .0329 |
| | .45-1.45 | .1362 | .1662 | .2420 | .2934 |
| | 1.45-2.45 | .2595 | .2798 | .2653 | .2450 |
| | 2.45-3.45 | .2090 | .2145 | .1651 | .1510 |
| | 3.45-4.45 | .1422 | .1339 | .1101 | .0909 |
| | 4.45-5.45 | .0903 | .0782 | .0657 | .0575 |
| | 5.45-6.45 | .0555 | .0473 | .0423 | .0374 |
| | > 6.56 | .1056 | .0778 | .0869 | .0918 |

Cont.



| | | | | | |
|---|---|---|---|---|---|
| SOUTH | < .45 | .0012 | .0027 | .0122 | .0071 |
| | .45-1.45 | .1527 | .1950 | .2790 | .2443 |
| | 1.45-2.45 | .2983 | .3063 | .2881 | .3003 |
| | 2.45-3.45 | .2286 | .2150 | .1787 | .1905 |
| | 3.45-4.45 | .1378 | .1223 | .0997 | .1086 |
| | 4.45-5.45 | .0776 | .0669 | .0554 | .0607 |
| | 5.45-6.45 | .0432 | .0381 | .0332 | .0337 |
| | > 6.45 | .0606 | .0537 | .0537 | .0548 |
| OVERALL | < .45 | .0019 | .0036 | .0158 | .0322 |
| | .45-1.45 | .1404 | .1778 | .2585 | .2870 |
| | 1.45-2.45 | .2629 | .2708 | .2616 | .2404 |
| | 2.45-3.45 | .2089 | .2032 | .1695 | .1492 |
| | 3.45-4.45 | .1498 | .1269 | .1052 | .0935 |
| | 4.45-5.45 | .0889 | .0798 | .0643 | .0598 |
| | 5.45-6.45 | .0542 | .0494 | .0398 | .0394 |
| | > 6.45 | .1020 | .0885 | .0853 | .0985 |

Therefore, one may possibly hypothesize that large number of the population desire to have more children and it make sense to examine if there is any difference between birth pattern of "large and small" families.

In our analysis we shall take large family as a household with more than 5 children and the other one as small family. We considered the two categories of families separately in fitting

Table 5.7b: Large Family

| REGION | INTERVAL LENGTH IN YEARS | BIRTH ORDER 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| NORTH | < .45 | .0015 | .0024 | .0146 | .0212 | .0484 | .0694 | .1539 |
| | .45-1.45 | .1342 | .1712 | .2368 | .2838 | .3260 | .3396 | .2944 |
| | 1.45-2.45 | .2617 | .2866 | .2526 | .2664 | .2319 | .2203 | .2939 |
| | 2.45-3.45 | .2129 | .2134 | .1696 | .1610 | .1390 | .1287 | .0967 |
| | 3.45-4.45 | .1446 | .1315 | .1087 | .0965 | .0835 | .0760 | .0536 |
| | 4.45-5.45 | .0889 | .0779 | .0708 | .0599 | .0521 | .0490 | .0311 |
| | 5.45-6.45 | .0559 | .0448 | .0431 | .0363 | .0337 | .0317 | .0216 |
| | > 6.45 | .1003 | .0722 | .1038 | .0749 | .0853 | .0853 | .0548 |
| CENTRE | <.45 | .0008 | .0010 | .0006 | .0017 | .0094 | .0233 | .0594 |
| | .45-1.45 | .1030 | .1529 | .1533 | .2219 | .2615 | .3103 | .3342 |
| | 1.45-2.45 | .2745 | .3142 | .3421 | .3596 | .2927 | .2651 | .2281 |
| | 2.45-3.45 | .2358 | .2338 | .2429 | .2191 | .1850 | .1593 | .1300 |
| | 3.45-4.45 | .1532 | .1370 | .1297 | .1043 | .1045 | .0905 | .0798 |
| | 4.45-5.45 | .0926 | .0726 | .0646 | .0479 | .0584 | .0566 | .0515 |
| | 5.45-6.45 | .0563 | .0390 | .0324 | .0227 | .0337 | .0330 | .0317 |
| | > 6.45 | .0838 | .0495 | .0344 | .0228 | .0548 | .0655 | .0853 |

Cont.



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SOUTH | < .45 | .0029 | .0087 | .0162 | .0062 | .0287 | .0281 | .0901 |
| | .45-1.45 | .1893 | .2622 | .3138 | .2953 | .3458 | .3502 | .3939 |
| | 1.45-2.45 | .3038 | .3005 | .2955 | .3428 | .2772 | .2808 | .2248 |
| | 2.45-3.45 | .2059 | .1866 | .1684 | .1846 | .1534 | .1515 | .1150 |
| | 3.45-4.45 | .1270 | .1041 | .0891 | .0873 | .0798 | .0801 | .0631 |
| | 4.45-5.45 | .0691 | .0556 | .0489 | .0420 | .0457 | .0425 | .0382 |
| | 5.45-6.45 | .0414 | .0328 | .0263 | .0196 | .0258 | .0259 | .0223 |
| | > 6.45 | .0606 | .0495 | .0418 | .0222 | .0436 | .0409 | .0526 |
| OVERALL | < .45 | .0017 | .0037 | .0082 | .0078 | .0281 | .0401 | .0934 |
| | .45-1.45 | .1498 | .2053 | .2464 | .2765 | .3055 | .3306 | .3588 |
| | 1.45-2.45 | .2771 | .2990 | .2971 | .3183 | .2612 | .2472 | .2069 |
| | 2.45-3.45 | .2157 | .2077 | .1872 | .1855 | .1538 | .1463 | .1173 |
| | 3.45-4.45 | .1380 | .1183 | .1072 | .0988 | .0903 | .0843 | .0697 |
| | 4.45-5.45 | .0842 | .0692 | .0605 | .0501 | .0555 | .0495 | .0446 |
| | 5.45-6.45 | .0497 | .0374 | .0364 | .0263 | .0334 | .0326 | .0285 |
| | > 6.45 | .0838 | .0594 | .0570 | .0367 | .0722 | .0694 | .0808 |

different pdfs. Measures of 'goodness of fit' is presented in Tables 1a and 1b in appendix .

Lognormal distribution seems best approximating distribution for the first two birth intervals in both categories (see Tables 1a and 1b in appendix ). This is true for all the regions. Higher birth intervals seems to be best approximated by gamma distribution and some of them by normal distribution. However, we shall consider lognormal distribution in probability generation recalling previous reasoning.

Result in Table 5.6 shows decreasing pattern of mean birth interval as women becomes older irrespective of family size. The variability of mean birth interval also increases in the same direction. This is true for all the region.

Degree of variability in mean birth interval is high for Southern region at low parities and for Central region at higher parities in small families. In case of large families inconsistency is observed in South followed by North-west for the first four birth intervals. The pattern is in the reverse order for large parities.

For all possible birth intervals probability of having a child with a given interval length is given in Table 5.7. The probability is generated using fitted lognormal probability density function. The result shows 1.45-2.45 years as the most probable interval length for both categories of the family to have a child at least for the first four births.

At higher parities most probable interval length is .45-1.45 years. The other common interval length at low parities is 2.45-3.45 years. For all the regions and for both categories of family probability of having twins is very low and having a child with interval length more than about 54 months is also not very large.

From the tables one can observe that in the interval lengths less than about 42 months Southern region seems to exercise high fertility pattern and North-west relatively low fertility pattern. If we observe interval length 2.45-3.45

probability is larger for central region than that of the other two regions for the large family. This is the only difference in the pattern of the two categories one can observe from the empirical results.

From the above discussion one may state that family size has no significant role in determination of fertility pattern in rural community. It may also be possible to conclude that both categories follow the same statistical distribution in their fertility pattern.

### 5.2.2 SEX PREFERENCE AND BIRTH INTERVAL

We have already indicated that in rural Ethiopia children are assumed to be assets. A farmer need help in farm activities and mothers need help in taking care of child and house activities. In other words, rural life is so hard which cannot be handled by a single person but co-operatively by hard working. Hence, labourers are needed in this community. Starting from this point one expects, and empirical data also supports, that large proportion of families to be in a group of large families. However, is there any sex preference? To answer this question at least roughly we considered sex of the first two children. One category is families with both children of females and other category is the compliment of this.

Different statistical distributions are fitted to birth interval for both categories and the results in Tables 2a and 2b

Table 5.8: Mean , Standard Deviation and Coefficient of Variation of Some Birth Interval for all the Regions Considering Sex of First Two Children in a Family

| REGION | MEAN, S.D & C.V | BIRTH ORDER OF FAMILY WITH FIRST TWO CHILDREN FEMALES | | | | BIRTH ORDER OF FAMILY WITH FIRST TWO CHILDREN NOT BOTH FEMALES | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| NORTH-WEST | MEAN, | 1.03 | 1.001 | .604 | - | 1.114 | 1.005 | .882 | .792 |
| | S.D | .678 | .637 | .636 | - | .643 | .671 | .793 | .855 |
| | C.V | .604 | .837 | 1.386 | - | .577 | .668 | .899 | 1.080 |
| CENTRAL | MEAN, | 1.047 | .914 | .810 | .709 | 1.071 | .982 | .908 | .782 |
| | S.D | .538 | .577 | .640 | .727 | .640 | .611 | .639 | .043 |
| | C.V | .514 | .631 | .790 | 1.025 | .598 | .622 | .704 | .822 |
| SOUTH | MEAN | .841 | .827 | .723 | .544 | .966 | .825 | .688 | .712 |
| | S.D | .648 | .653 | .643 | .684 | .574 | .625 | .686 | .605 |
| | C.V | .771 | .790 | .889 | 1.257 | .594 | .758 | .997 | .850 |
| OVERALL | MEAN | .971 | .910 | .779 | .718 | 1.052 | .942 | .831 | .748 |
| | S.D | .626 | .628 | .675 | .696 | .631 | .649 | .726 | .697 |
| | C.V | .645 | .690 | .866 | .969 | .600 | .689 | .874 | .932 |

are presented as measures of 'goodness of fit' in appendix. There is an indication of lognormal distribution at least for the first

Table 5.9: Probability of bearing a child in given interval length by region

Table 5.9a: First two children in a family are both females

| REGION | INTERVAL LENGTH IN YEARS | BIRTH ORDER 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| NORTH-WEST | < .45 | .0035 | .0024 | .0465 | - |
| | .45-1.45 | .1625 | .1587 | .3432 | - |
| | 1.45-2.45 | .2547 | .2753 | .2471 | - |
| | 2.45-3.45 | .2010 | .2079 | .1396 | - |
| | 3.45-4.45 | .1300 | .1351 | .0790 | - |
| | 4.45-5.45 | .0848 | .0827 | .0478 | - |
| | 5.45-6.45 | .0542 | .0494 | .0313 | - |
| | > 6.45 | .1093 | .0885 | .0655 | - |
| CENTRAL | < .45 | .0003 | .0015 | .0060 | .0192 |
| | .45-1.45 | .1035 | .1721 | .2391 | .3036 |
| | 1.45-2.45 | .2859 | .3144 | .3066 | .2798 |
| | 2.45-3.45 | .2509 | .2243 | .1969 | .1647 |
| | 3.45-4.45 | .1561 | .1290 | .1091 | .0926 |
| | 4.45-5.45 | .0902 | .0702 | .0585 | .0532 |
| | 5.45-6.45 | .0488 | .0390 | .0343 | .0310 |
| | > 6.45 | .0643 | .0495 | .0495 | .0559 |

Cont.

| | | | | | |
|---|---|---|---|---|---|
| SOUTH | < .45 | .0057 | .0064 | .0089 | .0250 |
| | .45-1.45 | .2301 | .2356 | .2823 | .3763 |
| | 1.45-2.45 | .3001 | .3018 | .3152 | .2937 |
| | 2.45-3.45 | .1932 | .1919 | .1817 | .1511 |
| | 3.45-4.45 | .1147 | .1104 | .0968 | .0716 |
| | 4.45-5.45 | .0628 | .0621 | .0496 | .0358 |
| | 5.45-6.45 | .0364 | .0359 | .0271 | .0197 |
| | > 6.45 | .0570 | .0559 | .0384 | .0268 |
| OVERALL | > .45 | .0023 | .0033 | .0096 | .0146 |
| | .45-1.45 | .1662 | .1916 | .2647 | .2939 |
| | 1.45-2.45 | .2837 | .2971 | .2932 | .2941 |
| | 2.45-3.45 | .2142 | .2065 | .1842 | .1708 |
| | 3.45-4.45 | .1303 | .1253 | .1037 | .0931 |
| | 4.45-5.45 | .0803 | .0706 | .0577 | .0527 |
| | 5.45-6.45 | .0466 | .0626 | .0332 | .0202 |
| | > 6.45 | .0764 | .0643 | .0537 | .0606 |

two birth intervals which is true for all the regions. In some regions even up to fourth birth intervals are best approximated by lognormal distribution. From this one may conclude that sex of the first two children do not have significant role in determination of statistical distribution of birth intervals in rural community.

From results in Table 5.8 we observe decreasing trend of

Table 5.9b: Sex of the first two children in a family are not both females

| REGION | INTERVAL LENGTH IN YEARS | BIRTH ORDER 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| NORTH-WEST | < .45 | .0015 | .0036 | .0170 | .0314 | .0505 | .0668 | - |
| | .45-1.45 | .1236 | .1700 | .2441 | .2807 | .3164 | .2964 | - |
| | 1.45-2.45 | .2418 | .2628 | .2469 | .2357 | .2318 | .2043 | - |
| | 2.45-3.45 | .2084 | .2004 | .1656 | .1507 | .1370 | .1240 | - |
| | 3.45-4.45 | .1471 | .1305 | .1058 | .0954 | .0829 | .0819 | - |
| | 4.45-5.45 | .0935 | .0512 | .0691 | .0615 | .0543 | .0555 | - |
| | 5.45-6.45 | .0631 | .0335 | .0440 | .0390 | .0353 | .0397 | - |
| | > 6.45 | .1210 | .1003 | .1075 | .1056 | .0918 | .1314 | - |
| CENTRAL | < .45 | .0017 | .0018 | .0038 | .0069 | .0170 | .0314 | .0708 |
| | .45-1.45 | .1362 | .1569 | .1967 | .2542 | .2606 | .2878 | .3189 |
| | 1.45-2.45 | .2557 | .2856 | .2915 | .3103 | .2622 | .2404 | .2090 |
| | 2.45-3.45 | .2090 | .2185 | .2065 | .1897 | .1690 | .1527 | .1270 |
| | 3.45-4.45 | .1428 | .1367 | .1227 | .1054 | .1018 | .0928 | .0794 |
| | 4.45-5.45 | .0911 | .0795 | .0695 | .0557 | .0643 | .0592 | .1297 |
| | 5.45-6.45 | .0560 | .0461 | .0425 | .0313 | .0398 | .0389 | .0353 |
| | > 6.45 | .1075 | .0749 | .0668 | .0465 | .0853 | .0968 | .1093 |

Cont.



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SOUTH | < .45 | .0011 | .0047 | .0150 | .0062 | .0336 | .0322 | .0985 |
| | .45-1.45 | .1481 | .2280 | .3078 | .2815 | .3447 | .3537 | .3855 |
| | 1.45-2.45 | .3030 | .3111 | .2951 | .3302 | .2660 | .2732 | .2145 |
| | 2.45-3.45 | .2286 | .2016 | .2702 | .1899 | .1467 | .1460 | .1148 |
| | 3.45-4.45 | .1404 | .1123 | .0091 | .0937 | .0819 | .0798 | .0637 |
| | 4.45-5.45 | .0768 | .0600 | .0502 | .0469 | .0463 | .0443 | .0377 |
| | 5.45-6.45 | .0426 | .0338 | .0272 | .0229 | .0282 | .0253 | .0247 |
| | > 6.45 | .0594 | .0485 | .0436 | .0287 | .0526 | .0455 | .0606 |
| OVERALL | < .45 | .0017 | .0037 | .0126 | .0132 | .0116 | .0436 | .0901 |
| | .45-1.45 | .1384 | .1857 | .2517 | .2814 | .2970 | .3309 | .3505 |
| | 1.45-2.45 | .2612 | .2827 | .2716 | .2886 | .3055 | .2434 | .2111 |
| | 2.45-3.45 | .2166 | .2051 | .1764 | .1748 | .1740 | .1432 | .1186 |
| | 3.45-4.45 | .1401 | .1251 | .1063 | .0997 | .0949 | .0827 | .0710 |
| | 4.45-5.45 | .0881 | .0747 | .0644 | .0554 | .0489 | .0506 | .0436 |
| | 5.45-6.45 | .0554 | .0452 | .0392 | .0321 | .0272 | .0321 | .0313 |
| | > 6.45 | .0985 | .0778 | .0778 | .0548 | .0409 | .0735 | .0838 |

mean birth interval in moving from relatively low parities to higher one. This is true for all the regions. Increasing in variability of mean birth interval as birth order becomes large is also observed for both categories. In all the regions for both categories small interval length is observed in South and generally large interval length in North- west. This is to agree with the result under overall analysis. Hence, one may conclude possibility of high fertility pattern in south and relatively low pattern in North-west irrespective of the sex of the first two children in a family.

Table 5.9 shows small probability of having twins and almost similar probability (small) of having a child with interval length of about more than 54 months. Most probable interval length seems to be 1.45-2.45 years for small parities which shifts to .45-1.45 years at higher parities. Taking interval 1.45-2.45 years and

comparing the probability for all birth intervals for the three regions show that high probability in families with first two children females for North-west and Central. The opposite is observed in the other region.

### 5.2.3 EDUCATION

Ethiopian rural community is known as family of farmers whose educational level is very low. During the past 17 years there was a massive literacy campaign. However, one is not sure as to the success of this venture.

In this paper we classified household into two categories, namely those whose household heads who are not literate and those who are. Tables 3a and 3b in appendix show that lognormal distribution may be considered as the best approximating distribution for birth interval in both categories. This is true for all the regions.

Mean birth interval and standard deviation are also presented in Table 5.10. Mean birth interval decreases as birth

Table 5.10: Mean , Standard Deviation and Coefficient of Variation of Some Birth Intervals for all the Regions by Educational Status of Head of a Family

| REGION | MEAN, S.D & C.V | BIRTH ORDER OF FAMILY WITH NON LITERATE HEAD | | | | BIRTH ORDER OF FAMILY WITH LITERATE HOUSEHOLD HEAD | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| NORTH-WEST | MEAN, | 1.115 | 1.046 | .929 | .788 | 1.089 | .956 | .769 |
| | S.D | .666 | .639 | .763 | .874 | .536 | .551 | .758 |
| | C.V | .597 | .611 | .823 | 1.109 | .492 | .576 | .986 |
| CENTRAL | MEAN, | 1.087 | .977 | .909 | .801 | .970 | .873 | .811 |
| | S.D | .642 | .646 | .622 | .647 | .531 | .489 | .564 |
| | C.V | .591 | .661 | .684 | .808 | .547 | .548 | .695 |
| SOUTH | MEAN | .973 | .876 | .762 | .701 | .867 | .748 | .585 |
| | S.D | .640 | .691 | .656 | .589 | .499 | .532 | .711 |
| | C.V | .658 | .789 | .861 | .840 | .576 | .711 | 1.215 |
| OVERALL | MEAN | 1.063 | .965 | .866 | .784 | .973 | .856 | .716 |
| | S.D | .664 | .670 | .686 | .539 | .546 | .528 | .690 |
| | C.V | .625 | .694 | .792 | .688 | .561 | .617 | .964 |

order becomes large for all the regions. This is true for both categories of families. The variability of mean birth interval length has increasing pattern as women becomes older for each

Table 5.11: Probability of bearing a child in given interval length by region

Table 5.11a: Non Literate Family

| REGION | INTERVAL LENGTH IN YEARS | BIRTH ORDER 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| NORTH-WEST | < .45 | .0021 | .0019 | .0119 | .0344 | .0582 | .1210 | - |
| | .45-1.45 | .1293 | .1427 | .2208 | .2812 | .3163 | .3670 | - |
| | 1.45-2.45 | .2393 | .2644 | .2513 | .2322 | .2203 | .1964 | - |
| | 2.45-3.45 | .2046 | .2089 | .1751 | .1507 | .1409 | .0071 | - |
| | 3.45-4.45 | .1404 | .1401 | .0109 | .0925 | .0749 | .1639 | - |
| | 4.45-5.45 | .0894 | .0881 | .1738 | .0598 | .0515 | .0408 | - |
| | 5.45-6.45 | .0635 | .0536 | .0469 | .0399 | .0359 | .0260 | - |
| | > 6.45 | .1314 | .1003 | .1093 | .1093 | .1020 | .0778 | - |
| CENTRAL | < .45 | .0016 | .0030 | .0030 | .0068 | .0041 | .0256 | .0630 |
| | .45-1.45 | .1319 | .1706 | .1919 | .2478 | .2107 | .2900 | .3191 |
| | 1.45-2.45 | .2486 | .2747 | .2971 | .3050 | .3012 | .2558 | .2166 |
| | 2.45-3.45 | .2127 | .2071 | .2099 | .1921 | .2030 | .1577 | .1270 |
| | 3.45-4.45 | .1409 | .1327 | .1245 | .1060 | .1199 | .0947 | .0821 |
| | 4.45-5.45 | .0932 | .0784 | .0698 | .0585 | .0660 | .0572 | .0521 |
| | 5.45-6.45 | .0580 | .0482 | .0420 | .0333 | .0369 | .0367 | .0363 |
| | > 6.45 | .1131 | .0853 | .0618 | .0505 | .0582 | .0823 | .1038 |

Cont.



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SOUTH | < .45 | .0028 | .0078 | .0084 | .0054 | .0394 | .0294 | .0869 |
| | .45-1.45 | .1708 | .2249 | .2659 | .2823 | .3542 | .3603 | .3971 |
| | 1.45-2.45 | .2786 | .2793 | .3050 | .3416 | .2618 | .2803 | .2248 |
| | 2.45-3.45 | .2069 | .1865 | .1880 | .1893 | .1441 | .1486 | .1176 |
| | 3.45-4.45 | .1319 | .1148 | .0092 | .0913 | .0795 | .0776 | .0640 |
| | 4.45-5.45 | .0798 | .0697 | .0557 | .0446 | .0446 | .0420 | .0374 |
| | 5.45-6.45 | .0469 | .0406 | .0313 | .0211 | .0259 | .0234 | .0227 |
| | > 6.45 | .0823 | .0764 | .0465 | .0244 | .0505 | .0384 | .0495 |
| OVERALL | > .45 | .0026 | .0043 | .0075 | .0016 | .0307 | .0436 | .0838 |
| | .45-1.45 | .1466 | .1824 | .2283 | .2190 | .2993 | .3309 | .3409 |
| | 1.45-2.45 | .2521 | .2735 | .2802 | .3626 | .2493 | .2434 | .2121 |
| | 2.45-3.45 | .2013 | .1989 | .1891 | .2163 | .1531 | .1432 | .1181 |
| | 3.45-4.45 | .1396 | .1261 | .1132 | .1071 | .0914 | .0827 | .0740 |
| | 4.45-5.45 | .0867 | .0769 | .0683 | .0479 | .0572 | .0506 | .0481 |
| | 5.45-6.45 | .0580 | .0478 | .0396 | .0227 | .0352 | .0321 | .0312 |
| | > 6.45 | .1131 | .0901 | .0735 | .0228 | .0838 | .0735 | .0918 |

region for the two categories. From this one may conclude that educational level of the household head has little effect on fertility pattern in rural community. Region wise comparison show low fertility pattern in North-west and higher one in South. Regarding the consistency of mean interval length vis a vis the level of education with no education show less consistent result.

Table 5.11 presents probability of bearing a child within

Table 5.11b: Literate Family

| REGION | INTERVAL LENGTH IN YEARS | BIRTH ORDER 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| NORTH-WEST | < .45 | .0002 | .0007 | .0192 | .0548 | - |
| | .45-1.45 | .0916 | .1439 | .2823 | .3659 | - |
| | 1.45-2.45 | .2676 | .3116 | .2660 | .2421 | - |
| | 2.45-3.45 | .2509 | .2388 | .1649 | .1339 | - |
| | 3.45-4.45 | .1631 | .1390 | .0991 | .0741 | - |
| | 4.45-5.45 | .0974 | .0759 | .0573 | .0454 | - |
| | 5.45-6.45 | .0557 | .0406 | .0363 | .0268 | - |
| | > 6.45 | .0735 | .0495 | .0749 | .0570 | - |
| CENTRAL | < .45 | .0004 | .0003 | .0022 | .0102 | .0418 |
| | .45-1.45 | .1288 | .1420 | .2155 | .3090 | .3750 |
| | 1.45-2.45 | .3151 | .3617 | .3419 | .3176 | .2640 |
| | 2.45-3.45 | .2507 | .2571 | .2168 | .1765 | .1378 |
| | 3.45-4.45 | .1439 | .1296 | .1105 | .0899 | .0739 |
| | 4.45-5.45 | .0758 | .0588 | .0549 | .0442 | .0407 |
| | 5.45-6.45 | .0388 | .0272 | .0275 | .0226 | .0241 |
| | > 6.45 | .0465 | .0233 | .0307 | .0300 | .0427 |

Cont.



| | | | | | | |
|---|---|---|---|---|---|---|
| SOUTH | < .45 | .0004 | .0018 | .0256 | .0099 | .0495 |
| | .45-1.45 | .1607 | .2371 | .3565 | .2951 | .3712 |
| | 1.45-2.45 | .3628 | .3714 | .2879 | .3167 | .2529 |
| | 2.45-3.45 | .2464 | .2109 | .1512 | .1778 | .1370 |
| | 3.45-4.45 | .1241 | .0980 | .0785 | .0930 | .0724 |
| | 4.45-5.45 | .0571 | .0433 | .0409 | .0469 | .0421 |
| | 5.45-6.45 | .0257 | .0196 | .0235 | .0254 | .0254 |
| | > 6.45 | .0228 | .0179 | .0359 | .0352 | .0495 |
| OVERALL | < .45 | .0006 | .0009 | .0143 | .0132 | .0268 |
| | .45-1.45 | .1351 | .1779 | .2942 | .3096 | .3553 |
| | 1.45-2.45 | .3086 | .3531 | .2941 | .3065 | .2843 |
| | 2.45-3.45 | .2436 | .2358 | .1738 | .1730 | .1495 |
| | 3.45-4.45 | .1410 | .1227 | .0944 | .0902 | .0972 |
| | 4.45-5.45 | .0777 | .0572 | .0514 | .0457 | .0251 |
| | 5.45-6.45 | .0418 | .0278 | .0293 | .0251 | .0234 |
| | > 6.45 | .0516 | .0281 | .0485 | .0367 | .0384 |

given interval length by region considering education of household head. It is clear from Tables 5.11a and 5.11b that 1.45-2.45 is more probable interval length of having a child at low parities for both categories. This is true for all the regions.

Comparison by region show that South is more probable to experience the common interval length relative to Central and

North-west followed by Central region. As women becomes older more probable interval length is about 12 months. Considering first birth interval probability is larger in the interval length .45-1.45 for households of non literate head over that of the other category. The same is true as interval length increases for all the regions. However, the reverse is true in the interval length 1.45-3.45 years. For higher order parities almost similar pattern is observed.

In general probability of having twins is very low eventhough Southern region is more probable to have it. The probability increases at large parities.

For almost less than 32 months of interval length probability to have a child within given interval length is maximum for south relative to other regions and minimum for North-west. As interval length increases Central region takes maximum and South minimum. This may give some evidence to say Southern region have high fertility pattern and North-west lower one at low parities.

### 5.2.4 RELIGION

In Ethiopia two main religions are Christian and Moslems. The former are the followers of the Ethiopian Orthodox Church. A stronger religious affiliation is expected to increase fertility and reduce the use of contraceptives. It is then expected to have a positive effect in population growth.

We considered Orthodox and non Orthodox families independently for each region. Religion of the family is taken the same as that of head of household. In our sample we could not get enough proportion of non orthodox families for consideration of birth interval in model building in North-west and Central region. The same is true for orthodox families in Southern region. Hence, we only consider orthodox in North-west and

Table 5.12a: Mean , S.D and C.V Of Some Birth Intervals

| RELIG-ION | BIRTH ORDER | NORTH | | | CENTRAL | | | OVERALL | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | X | S.D | C.V | X | S.D | C.V | X | S.D | C.V |
| ORTHO-DOX | 1 | 1.11 | .633 | .570 | 1.057 | .621 | .588 | 1.07 | .637 | .594 |
| | 2 | 1.04 | .623 | .600 | .955 | .606 | .635 | .983 | .617 | .628 |
| | 3 | .880 | .768 | .873 | .885 | .625 | .706 | .883 | .690 | .781 |
| | 4 | .737 | .851 | 1.16 | .762 | .642 | .843 | .770 | .764 | .992 |

Table 5.12b: Mean , S.D and C.V Of Some Birth Intervals

| RELIGION | BIRTH ORDER | SOUTH | | | OVERALL | | |
|---|---|---|---|---|---|---|---|
| | | X | S.D | C.V | X | S.D | C.V |
| NON ORTHODOX | 1 | .951 | .599 | .630 | .958 | .611 | .638 |
| | 2 | .829 | .639 | .771 | .827 | .651 | .787 |
| | 3 | .687 | .693 | 1.009 | .700 | .710 | 1.014 |
| | 4 | .689 | .588 | .853 | .695 | .584 | .840 |

Table 5.13: Probability of bearing a child in given interval length By Religion

Table 5.13a: Orthodox Family

| REGION | INTERVAL LENGTH IN YEARS | BIRTH ORDER 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| NORTH-WEST | < .45 | .0013 | .0016 | .0143 | .0359 | .0559 | .0668 | .1515 |
| | .45-1.45 | .1197 | .1407 | .2403 | .2977 | .3262 | .3345 | .2968 |
| | 1.45-2.45 | .2459 | .2667 | .2534 | .2417 | .2282 | .2242 | .2906 |
| | 2.45-3.45 | .2124 | .2165 | .1728 | .1471 | .1351 | .1262 | .0976 |
| | 3.45-4.45 | .1464 | .1418 | .1073 | .0909 | .0810 | .0798 | .0542 |
| | 4.45-5.45 | .0981 | .0858 | .0673 | .0575 | .0506 | .0495 | .0329 |
| | 5.45-6.45 | .0592 | .0535 | .0443 | .0358 | .0345 | .0321 | .0216 |
| | > 6.45 | .1170 | .0934 | .1003 | .0934 | .0885 | .0869 | .0548 |
| CENTRAL | < .45 | .0014 | .0019 | .0036 | .0075 | .0102 | .0281 | .0630 |
| | .45-1.45 | .1343 | .1666 | .2025 | .2634 | .2674 | .3019 | .3306 |
| | 1.45-2.45 | .2617 | .2917 | .3019 | .3123 | .2938 | .2532 | .2243 |
| | 2.45-3.45 | .2167 | .2206 | .2077 | .1871 | .1835 | .1557 | .1307 |
| | 3.45-4.45 | .1439 | .1325 | .1183 | .1026 | .1005 | .0926 | .0778 |
| | 4.45-5.45 | .0905 | .0755 | .0692 | .0536 | .0577 | .0554 | .0504 |
| | 5.45-6.45 | .0547 | .0444 | .0386 | .0308 | .0332 | .0353 | .0329 |
| | > 6.45 | .0968 | .0668 | .0582 | .0427 | .0537 | .0778 | .0901 |

CONT.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OVERALL | < .45 | .0016 | .0019 | .0073 | .0202 | .0268 | .0465 | .0869 |
| | .45-1.45 | .1341 | .1592 | .2224 | .2813 | .2960 | .3204 | .3338 |
| | 1.45-2.45 | .2540 | .2832 | .2783 | .2699 | .2525 | .2357 | .2048 |
| | 2.45-3.45 | .2129 | .2148 | .1905 | .1577 | .1571 | .1396 | .1199 |
| | 3.45-4.45 | .1428 | .1376 | .1121 | .0998 | .0940 | .0842 | .0732 |
| | 4.45-5.45 | .0911 | .0782 | .0704 | .0580 | .0585 | .0526 | .0479 |
| | 5.45-6.45 | .0560 | .0487 | .0412 | .0367 | .058 | .0341 | .0332 |
| | > 6.45 | .1075 | .0764 | .0778 | .0764 | .0793 | .0869 | .1003 |

Central, and non orthodox in South.

'Measures of goodness of fit' are also given (see appendix Tables 4a and 4b). It seems that best approximating distribution for the first two birth intervals is lognormal which is true for all the regions.

Mean birth interval and standard deviation for some birth intervals are given in Table 5.12. It seems that there is a decreasing trend in mean birth interval length in all the regions. The variability of this result does not show significant difference which is not observed previously.

Probability generated and given in Table 5.13 also supports conclusions arrived previously. As interval length becomes smaller (less than about 42 months) probability of having a child within a given interval length is larger in Central region relative to North-west. Probability of bearing twins in all the regions seems to be very small.

Table 5.13b: Non Orthodox Family

| REGION | INTERVAL LENGTH IN YEARS | BIRTH ORDER | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| SOUTH | < .45 | .0017 | .0054 | .0162 | .0057 | .0322 | .0256 | .0968 |
| | .45-1.45 | .1643 | .2304 | .3066 | .2889 | .3575 | .3451 | .3952 |
| | 1.45-2.45 | .2981 | .3040 | .2951 | .3422 | .2767 | .2810 | .2168 |
| | 2.45-3.45 | .2203 | .1991 | .1702 | .1870 | .1469 | .1561 | .1124 |
| | 3.45-4.45 | .1315 | .0770 | .0580 | .0532 | .1014 | .0847 | .0676 |
| | 4.45-5.45 | .0766 | .0972 | .0817 | .0794 | .0198 | .0407 | .0334 |
| | 5.45-6.45 | .0432 | .0340 | .0276 | .0208 | .0246 | .0250 | .0230 |
| | > 6.45 | .0643 | .0529 | .0446 | .0228 | .0409 | .0418 | .0548 |
| OVERALL | < .45 | .0021 | .0062 | .0174 | .0052 | .0307 | .0274 | .1003 |
| | .45-1.45 | .1664 | .2358 | .3054 | .2860 | .3476 | .3358 | .3917 |
| | 1.45-2.45 | .2917 | .3018 | .2875 | .3419 | .2771 | .2774 | .2168 |
| | 2.45-3.45 | .2170 | .1919 | .1661 | .1907 | .1469 | .1533 | .1124 |
| | 3.45-4.45 | .1334 | .1104 | .0922 | .0909 | .0826 | .0851 | .0618 |
| | 4.45-5.45 | .0763 | .0621 | .0506 | .0417 | .0443 | .0461 | .0377 |
| | 5.45-6.45 | .0437 | .0359 | .0303 | .0208 | .0253 | .0274 | .0234 |
| | > 6.45 | .0694 | .0559 | .0505 | .0228 | .1455 | .0475 | .0559 |

# CHAPTER 6

## CONCLUSIONS

The aim of this study was to consider one of the most important demographic variable - interbirth interval- and see the magnitude of such interval as well as its effect on fertility. The approach was to fit in some commonly known statistical pdfs namely the gamma, lognormal and normal distribution.

A survey based demographic data on age at marriage and detailed information on consecutive birth intervals was assembled; the data was cleaned, checked for internal consistency and the already mentioned pdfs were tried. There were nine consecutive intervals extracted from the data. However, in each region number of observations for the last two birth intervals were very small to fit models from the data. Hence, the first seven birth intervals were considered except in case of large family in South and overall regions. The data for the study was from Northwest, Central and Southern Ethiopia. Once fitted the best fit was selected using the norm approach (see chapter 4). Three types of norms were used in this selection.

While non of the pdfs fitted perfectly to each consecutive interval, the lognormal distribution was found to be relatively better for the first and second intervals. For the next 3 intervals the model which fitted better depends on how the norm is defined, without being consistent. There was relatively less satisfactory fit for intervals of order greater than 5. The main reason for poor fit is the relatively small sample size at these higher intervals.

preliminary results show that the inter birth interval had a wider variability that it was not easy to identify a reliable mean. More specifically first birth interval, which is usually taken as an indicator of subsequent birth intervals shows different results for the three regions. In other words, Northwest Ethiopia has a wider mean first interval while the Southern Ethiopia had smallest. This suggests voluntary birth control in the relatively over populated area of Northwest while the opposite seems to be true in the South. Similar results is observed for subsequent birth intervals.

An analysis of the generated probabilities of bearing a child at a given interval length shows that the most common interval length is 1.45-2.45 years which shifts to .45-1.45 years at higher parities. At lower parities the second common birth interval length is 2.45-3.45 years. For a given interval length and birth order probability of having a child is higher in South and smaller in Northwest indicating relatively high fertility in South and lower in the Northwestern region.

When we estimated mean birth interval and the corresponding pdf by family size, education, sex of the first two children in a family and religion similar results are obtained as those based on aggregate results. In other words, classifying households by socioeconomic groups did not make significant difference. The reason is that differences in education, religion and family size are so thin that it is difficult to distinguish one from the other.

The overall conclusion is that in overpopulated, overgrazed and famine prone areas there is the need to voluntarily control fertility through widening birth intervals. If government could encourage households to widen birth intervals chances are that the higher rate of fertility in the country in general and in Southern regions in particular will be controlled.

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**APPENDIX**

**MEASURES OF 'GOODNESS OF FIT'**

Table 1a: Small Families.

| REGION | BIRTH ORDER | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|---|
| NORTH-WEST | 1 | .14 | .35 | .097 | .17 | .45 | .101 | .24 | .67 | .153 |
| | 2 | .10 | .29 | .085 | .17 | .37 | .144 | .17 | .50 | .114 |
| | 3 | .22 | .43 | .157 | .14 | .31 | .109 | .14 | .33 | .084 |
| | 4 | .21 | .45 | .157 | .20 | .43 | .167 | .22 | .45 | .187 |
| CENTRAL | 1 | .1 | .25 | .077 | .14 | .36 | .122 | .24 | .57 | .207 |
| | 2 | .14 | .31 | .082 | .14 | .39 | .118 | .26 | .61 | .207 |
| | 3 | .17 | .34 | .144 | .14 | .35 | .114 | .22 | .47 | .187 |
| | 4 | .24 | .44 | .198 | .17 | .35 | .130 | .20 | .41 | .139 |
| SOUTH | 1 | .17 | .40 | .144 | .24 | .53 | .200 | .35 | .78 | .302 |
| | 2 | .14 | .31 | .108 | .17 | .39 | .145 | .28 | .55 | .237 |
| | 3 | .17 | .33 | .145 | .10 | .23 | .084 | .17 | .34 | .124 |
| | 4 | .14 | .29 | .111 | .08 | .15 | .057 | .089 | .21 | .051 |
| OVERALL | 1 | .14 | .33 | .089 | .17 | .46 | .138 | .28 | .69 | .229 |
| | 2 | .10 | .28 | .081 | .14 | .39 | .106 | .24 | .61 | .201 |
| | 3 | .17 | .35 | .144 | .14 | .34 | .108 | .20 | .45 | .175 |
| | 4 | .22 | .43 | .182 | .14 | .34 | .115 | .14 | .34 | .112 |

Table 1b: Large Families

| REGION | BIRTH ORDER | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|---|
| NORTH-WEST | 1 | .14 | .32 | .084 | .14 | .34 | .078 | .20 | .52 | .111 |
| | 2 | .17 | .42 | .106 | .20 | .47 | .094 | .26 | .68 | .176 |
| | 3 | .24 | .45 | .170 | .17 | .40 | .130 | .20 | .52 | .122 |
| | 4 | .24 | .46 | .196 | .17 | .32 | .130 | .14 | .31 | .082 |
| | 5 | .32 | .50 | .304 | .14 | .35 | .117 | .14 | .29 | .079 |
| | 6 | .24 | .47 | .199 | .17 | .37 | .133 | .14 | .31 | .108 |
| | 7 | .24 | .46 | .207 | .17 | .33 | .151 | .14 | .36 | .078 |
| CENTRE | 1 | .10 | .29 | .074 | .95 | .34 | .553 | .24 | .67 | .163 |
| | 2 | .032 | .24 | .060 | .14 | .34 | .107 | .24 | .58 | .203 |
| | 3 | .14 | .31 | .108 | .20 | .41 | .156 | .30 | .64 | .257 |
| | 4 | .14 | .29 | .110 | .14 | .32 | .116 | .22 | .47 | .185 |
| | 5 | .20 | .41 | .154 | .17 | .36 | .106 | .22 | .49 | .165 |
| | 6 | .24 | .51 | .205 | .17 | .40 | .137 | .20 | .44 | .146 |
| | 7 | .24 | .48 | .199 | .17 | .41 | .133 | .14 | .30 | .106 |

Cont.



| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SOUTH | 1 | .20 | .43 | .142 | .22 | .47 | .177 | .32 | .68 | .272 |
| | 2 | .24 | .47 | .185 | .24 | .50 | .199 | .32 | .62 | .279 |
| | 3 | .30 | .55 | .219 | .26 | .53 | .214 | .32 | .62 | .286 |
| | 4 | .26 | .48 | .190 | .22 | .45 | .180 | .28 | .57 | .235 |
| | 5 | .36 | .59 | .258 | .30 | .53 | .218 | .28 | .56 | .239 |
| | 6 | .30 | .51 | .206 | .24 | .48 | .178 | .26 | .52 | .214 |
| | 7 | .32 | .56 | .222 | .26 | .52 | .177 | .22 | .41 | .166 |
| | 8 | .28 | .56 | .175 | .22 | .50 | .134 | .20 | .45 | .132 |
| OVERALL | 1 | .14 | .35 | .087 | .17 | .43 | .112 | .26 | .65 | .202 |
| | 2 | .17 | .36 | .113 | .17 | .40 | .144 | .28 | .59 | .237 |
| | 3 | .22 | .46 | .164 | .20 | .42 | .152 | .26 | .56 | .236 |
| | 4 | .22 | .42 | .169 | .20 | .35 | .145 | .24 | .49 | .221 |
| | 5 | .26 | .49 | .198 | .22 | .45 | .164 | .26 | .51 | .233 |
| | 6 | .26 | .49 | .197 | .22 | .47 | .154 | .24 | .51 | .212 |
| | 7 | .26 | .54 | .195 | .20 | .46 | .130 | .17 | .41 | .133 |
| | 8 | .26 | .56 | .175 | .20 | .43 | .126 | .14 | .30 | .075 |
| | 9 | .20 | .44 | .133 | .17 | .38 | .150 | .22 | .53 | .140 |

Table 2a: Family With First Two Children of Both Female Sex

| REGION | BIRTH ORDER | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|---|
| NORTH-WEST | 1 | .22 | .51 | .159 | .24 | .56 | .156 | .32 | .76 | .242 |
| | 2 | .14 | .33 | .118 | .14 | .40 | .090 | .22 | .56 | .144 |
| | 3 | .20 | .37 | .177 | .61 | 1.5 | .349 | .14 | .32 | .084 |
| CENTRAL | 1 | .32 | .19 | .055 | .14 | .33 | .105 | .20 | .59 | .193 |
| | 2 | .32 | .29 | .085 | .14 | .35 | .070 | .22 | .56 | .145 |
| | 3 | .22 | .47 | .170 | .17 | .35 | .119 | .20 | .43 | .173 |
| | 4 | .20 | .37 | .60 | .14 | .29 | .093 | .17 | .35 | .122 |
| SOUTH | 1 | .30 | .56 | .218 | .30 | .56 | .234 | .36 | .70 | .318 |
| | 2 | .14 | .35 | .108 | .14 | .33 | .082 | .22 | .47 | .156 |
| | 3 | .20 | .41 | .140 | .20 | .40 | .140 | .26 | .55 | .198 |
| | 4 | .30 | .52 | .206 | .22 | .45 | .171 | .24 | .46 | .179 |
| OVERALL | 1 | .20 | .38 | .130 | .20 | .43 | .165 | .30 | .65 | .255 |
| | 2 | .32 | .30 | .071 | .14 | .36 | .081 | .22 | .59 | .170 |
| | 3 | .17 | .35 | .146 | .14 | .32 | .117 | .22 | .45 | .191 |
| | 4 | .17 | .37 | .148 | .14 | .29 | .101 | .20 | .44 | .168 |
| | 5 | .22 | .42 | .170 | .17 | .38 | .146 | .24 | .51 | .216 |
| | 6 | .22 | .46 | .170 | .17 | .41 | .115 | .20 | .45 | .144 |

Table 2b: Families With Sex of the First Two Children not Both Females.

| REGION | BIRTH ORDER | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|---|
| NORTH-WEST | 1 | .14 | .31 | .101 | .14 | .39 | .107 | .22 | .62 | .156 |
| | 2 | .14 | .31 | .117 | .14 | .34 | .108 | .22 | .55 | .140 |
| | 3 | .22 | .42 | .172 | .17 | .35 | .112 | .17 | .46 | .099 |
| | 4 | .24 | .48 | .206 | .17 | .38 | .140 | .17 | .42 | .093 |
| | 5 | .20 | .43 | .176 | .14 | .33 | .108 | .14 | .31 | .084 |
| | 6 | .17 | .33 | .153 | .14 | .36 | .089 | .20 | .49 | .143 |
| CENTRAL | 1 | .10 | .29 | .067 | .14 | .41 | .098 | .24 | .64 | .184 |
| | 2 | .14 | .29 | .084 | .17 | .39 | .131 | .26 | .62 | .224 |
| | 3 | .17 | .35 | .117 | .20 | .42 | .151 | .28 | .57 | .240 |
| | 4 | .22 | .45 | .163 | .46 | .83 | .413 | .26 | .57 | .228 |
| | 5 | .22 | .50 | .161 | .20 | .50 | .144 | .26 | .61 | .222 |
| | 6 | .24 | .53 | .199 | .20 | .47 | .133 | .24 | .51 | .200 |
| | 7 | .24 | .51 | .190 | .17 | .48 | .120 | .20 | .48 | .131 |
| SOUTH | 1 | .17 | .39 | .120 | .22 | .51 | .172 | .33 | .76 | .273 |
| | 2 | .22 | .43 | .169 | .24 | .48 | .194 | .32 | .64 | .281 |
| | 3 | .26 | .46 | .203 | .20 | .37 | .146 | .22 | .45 | .188 |
| | 4 | .24 | .42 | .169 | .26 | .38 | .262 | .26 | .53 | .221 |
| | 5 | .36 | .57 | .265 | .30 | .52 | .215 | .28 | .56 | .238 |
| | 6 | .28 | .48 | .205 | .22 | .43 | .155 | .22 | .45 | .184 |
| | 7 | .30 | .58 | .296 | .24 | .52 | .154 | .26 | .59 | .184 |

Cont. 

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| OVERALL | 1 | .14 | .33 | .072 | .17 | .46 | .115 | .26 | .69 | .206 |
| | 2 | .14 | .32 | .100 | .17 | .40 | .136 | .26 | .61 | .233 |
| | 3 | .20 | .42 | .161 | .17 | .41 | .137 | .26 | .55 | .225 |
| | 4 | .24 | .47 | .188 | .20 | .39 | .148 | .24 | .48 | .222 |
| | 5 | .24 | .45 | .201 | .22 | .46 | .158 | .24 | .50 | .220 |
| | 6 | .26 | .48 | .198 | .20 | .46 | .142 | .22 | .47 | .196 |
| | 7 | .20 | .43 | .162 | .17 | .41 | .095 | .20 | .51 | .117 |
| | 8 | .28 | .58 | .169 | .22 | .45 | .136 | .17 | .41 | .093 |

Table 3a: Family With Non literate Household Head

| REGION | BIRTH ORDER | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | .17 | .45 | .105 | .20 | .49 | .104 | .26 | .69 | .154 |
| NORTH- | 2 | .10 | .25 | .075 | .14 | .33 | .071 | .20 | .55 | .122 |
| WEST | 3 | .20 | .40 | .149 | .17 | .33 | .098 | .20 | .52 | .126 |
| | 4 | .24 | .47 | .205 | .79 | 1.68 | .564 | .14 | .39 | .082 |
| | 5 | .22 | .44 | .179 | .14 | .36 | .112 | .14 | .32 | .080 |
| | 6 | .22 | .15 | .149 | .17 | .35 | .121 | .14 | .34 | .073 |
| | 1 | .10 | .24 | .065 | .14 | .34 | .090 | .22 | .56 | .172 |
| CENTRAL | 2 | .14 | .38 | .088 | .17 | .47 | .115 | .26 | .67 | .207 |
| | 3 | .17 | .35 | .113 | .17 | .38 | .137 | .26 | .55 | .222 |
| | 4 | .20 | .42 | .164 | .17 | .34 | .111 | .20 | .45 | .160 |
| | 5 | .17 | .37 | .127 | .14 | .33 | .086 | .22 | .46 | .155 |
| | 6 | .26 | .59 | .207 | .22 | .52 | .140 | .24 | .53 | .170 |
| | 7 | .24 | .49 | .185 | .17 | .44 | .118 | .17 | .42 | .098 |
| | 1 | .22 | .48 | .171 | .26 | .58 | .217 | .36 | .79 | .312 |
| SOUTH | 2 | .20 | .38 | .141 | .20 | .44 | .170 | .28 | .57 | .256 |
| | 3 | .24 | .44 | .177 | .20 | .41 | .154 | .26 | .52 | .217 |
| | 4 | .20 | .32 | .151 | .14 | .29 | .111 | .20 | .39 | .154 |
| | 5 | .36 | .59 | .261 | .30 | .53 | .212 | .26 | .54 | .229 |
| | 6 | .30 | .52 | .213 | .22 | .40 | .204 | .22 | .47 | .176 |
| | 7 | .30 | .56 | .215 | .26 | .54 | .178 | .22 | .44 | .175 |

Cont.



| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | .14 | .36 | .096 | .17 | .27 | .137 | .28 | .69 | .224 |
| OVERALL | 2 | .14 | .34 | .095 | .17 | .42 | .117 | .26 | .60 | .207 |
| | 3 | .20 | .40 | .148 | .17 | .38 | .132 | .24 | .52 | .213 |
| | 4 | .14 | .25 | .109 | .20 | .43 | .133 | .24 | .53 | .215 |
| | 5 | .26 | .50 | .200 | .68 | 1.80 | .385 | .28 | .51 | .225 |
| | 6 | .26 | .53 | .194 | .20 | .52 | .141 | .26 | .51 | .200 |
| | 7 | .53 | .96 | .466 | .20 | .45 | .127 | .20 | .44 | .147 |
| | 8 | .24 | .50 | .154 | .20 | .44 | .128 | .20 | .45 | .122 |

Table 4a: Orthodox Family

| REGION | BIRTH ORDER | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | .14 | .35 | .097 | .17 | .44 | .095 | .24 | .67 | .151 |
| NORTH- | 2 | .10 | .26 | .091 | .14 | .36 | .095 | .22 | .59 | .137 |
| WEST | 3 | .20 | .37 | .155 | .14 | .33 | .098 | .17 | .44 | .103 |
| | 4 | .24 | .45 | .198 | .17 | .38 | .130 | .14 | .36 | .085 |
| | 5 | .22 | .44 | .185 | .17 | .38 | .117 | .14 | .32 | .088 |
| | 6 | .24 | .47 | .207 | .17 | .34 | .143 | .10 | .24 | .077 |
| | 7 | .24 | .48 | .213 | .17 | .32 | .159 | .14 | .34 | .079 |
| | 1 | .10 | .26 | .063 | .14 | .38 | .110 | .24 | .61 | .198 |
| | 2 | .14 | .31 | .077 | .17 | .41 | .123 | .26 | .63 | .219 |
| | 3 | .17 | .34 | .117 | .17 | .39 | .147 | .26 | .55 | .235 |
| CENTRAL | 4 | .22 | .39 | .169 | .17 | .36 | .124 | .22 | .47 | .178 |
| | 5 | .20 | .40 | .158 | .17 | .32 | .101 | .20 | .44 | .156 |
| | 6 | .24 | .50 | .193 | .20 | .46 | .129 | .22 | .49 | .194 |
| | 7 | .24 | .50 | .203 | .17 | .42 | .138 | .14 | .32 | .104 |
| | 1 | .10 | .30 | .074 | .14 | .42 | .098 | .24 | .65 | .186 |
| OVERALL | 2 | .10 | .29 | .066 | .14 | .39 | .090 | .24 | .61 | .183 |
| | 3 | .17 | .37 | .137 | .17 | .37 | .113 | .24 | .53 | .198 |
| | 4 | .22 | .48 | .186 | .17 | .49 | .121 | .22 | .43 | .195 |
| | 5 | .22 | .44 | .175 | .17 | .41 | .113 | .22 | .47 | .180 |
| | 6 | .24 | .49 | .204 | .20 | .46 | .132 | .20 | .44 | .176 |
| | 7 | .24 | .52 | .186 | .17 | .47 | .118 | .17 | .45 | .102 |

Table 4b: Non Orthodox Family

| REGION | BIRTH ORDER | $X_l$ | $Y_l$ | $Z_l$ | $X_g$ | $Y_g$ | $Z_g$ | $X_n$ | $Y_n$ | $Z_n$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | .20 | .43 | .150 | .24 | .52 | .197 | .35 | .75 | .296 |
| SOUTH | 2 | .22 | .41 | .174 | .22 | .44 | .178 | .30 | .59 | .268 |
| | 3 | .26 | .45 | .194 | .20 | .38 | .147 | .22 | .46 | .193 |
| | 4 | .22 | .40 | .155 | .20 | .36 | .149 | .24 | .49 | .206 |
| | 5 | .37 | .60 | .269 | .30 | .53 | .211 | .26 | .54 | .222 |
| | 6 | .28 | .49 | .250 | .22 | .46 | .180 | .28 | .51 | .252 |
| | 7 | .30 | .55 | .212 | .24 | .47 | .157 | .17 | .37 | .135 |
| | 1 | .20 | .44 | .153 | .24 | .55 | .203 | .35 | .78 | .305 |
| OVERALL | 2 | .20 | .38 | .149 | .20 | .43 | .175 | .30 | .58 | .266 |
| | 3 | .24 | .48 | .187 | .20 | .43 | .163 | .26 | .51 | .234 |
| | 4 | .22 | .38 | .153 | .17 | .35 | .144 | .24 | .48 | .201 |
| | 5 | .36 | .59 | .259 | .28 | .52 | .213 | .28 | .55 | .234 |
| | 6 | .28 | .52 | .202 | .24 | .53 | .195 | .30 | .61 | .259 |
| | 7 | .30 | .57 | .215 | .24 | .49 | .162 | .17 | .39 | .127 |