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Modeling Fertility Patterns in Canada

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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Date 14 October 1983

Abstract

In fertility analysis a complete schedule of age-specific fertility rates is important because it reveals important information about the childbearing activity of a population at any given time. Statistics Canada publishes age-specific fertility rates for Canada and nine provinces (except Newfoundland) annually. Age-specific fertility rates for Newfoundland are not available because of lack of information on the age of mother. Moreover, age-specific fertility rates are also not available for ethnic and religious groups in Canada.

In this thesis, a system of model fertility tables for Canada is developed. Linear regression is used to obtain age-specific fertility rates from four indices, namely crude birth rate, general fertility rate, child-woman ratio and percentage of total population aged 0-4 years. The model tables are then used to estimate the age-specific fertility rates for Newfoundland, and major ethnic, religious and mother tongue groups in Canada.

Conventionally, births projection is obtained by directly projecting age-specific fertility rates. Mitra and Romaniuk recognized the potentials of the Pearsonian Type I curve for births projection. A procedure used by these authors for estimating the parameters of the Pearsonian Type I curve is particularly adaptive to factors influencing the

pattern of fertility. With this procedure, the number of parameters required for the graduation of fertility rates can be reduced to three, namely the total fertility rate, mean and variance of the distribution. The reduction in the number of parameters offers considerable operational and analytical advantages, and makes the Pearsonian Type I curve appropriate for the construction of a parametric model for fertility projections. The use of Type I curve for birth projection in the Canadian and Quebec contexts is investigated. It is seen that the Type I curve provides satisfactory results in this area.

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Table of Contents

List of Tables

List of Figures

1. Introduction

Fertility concerns the actual reproductive behaviour of women. A fertility rate refers to the relative frequency with which births occur within a population. As it is a major expansionary force in human populations and a major counteracting force to population attrition from mortality, fertility is a critical branch of study in the field of demography.

In addition to its importance in determining the number of inhabitants of a geographic region, their distribution and the rate at which the population is changing, fertility also has important effects on many aspects of the social, cultural and economic life of a population. The replacement of the population is essential to the continuation of family and societal traditions and culture. Moreover, changes in the rate of reproduction affect the education system, labour force, housing and other areas of concern to a country.

Fertility rate varies in time and space. Throughout human history the birth rate of a given population fluctuates widely; and at any one time there are likely to be differences between the reproductive behaviour of the various residential, racial, ethnic, religious, and socio-economic groups of which a population is composed. There is much interest in and importance attached to fertility differentials because these can bring about fundamental changes in the compositional make-up of the population (Smith and Zopf, 1976). Moreover, to analyze the level and changes in fertility of a population, it is important to identify the contributions of various groups in the population to the national level of fertility and to identify the groups that have contributed most to a change of birth rates in the total population.

Though the fertility level of a society is a result of decisions of thousands of individuals, many variables within a society or within the various groups of a population can influence the reproductive behaviour of its members. Broadly speaking, fertility is composed of two parts, biological and social. The social factor includes cultural, economic and socio-psychological influences. The biological component refers to the capacity to reproduce (fecundity), and while it is a necessary condition for parenthood, it is not sufficient in itself. Whether children will actually be born is largely a result of the social environment in which people live. In order to influence the level of fertility, social factors must operate through some intermediate variables. Davis and Blake (1956) elaborated eleven intermediate variables through which all social and biological factors can either enhance or depress fertility. A detailed discussion of the intermediate variables will be presented elsewhere in this thesis.

1.1 Aim Of The Study

This study investigates fertility patterns in Canada. To accomplish this task, a complete schedule of age-specific fertility rates by social statuses which reveal information about the childbearing activity of a population at any given time are analyzed. Besides looking at the present fertility situation, it is also worthwhile to predict future fertility patterns in Canada.

Statistics Canada publishes age-specific fertility rates for every province, except Newfoundland, annually. Age-specific fertility rates for Newfoundland are not available because the birth data by age of mother are not collected as a part of the vital registration system. This makes fertility analysis difficult for Canada as a whole and for this province in particular. Age-specific fertility rates by social statuses are also not available because the vital registration of births does not collect detailed data on the social characteristics of the parents, such as religion, ethnicity and mother tongue. One of the ways of obtaining age-specific fertility rates for Newfoundland and by religion, ethnicity and mother tongue is through model fertility tables.

Model fertility table provides estimates of fertility for groups with specified characteristics, when detailed data are inadequate. In the first half of this study a system of model fertility tables for Canada is developed which will provide probable sets of age-specif ertility rates (the number of births to 1000 women of a particular age) when some non-age-specific fertility indices such as crude birth rate (the number of births per 1000 mid-year population), general fertility rate (the total number of births per 1000 women of childbearing age), child-woman ratio (the number of children under five years of age per 1000 women of childbearing age), and percent of the total population aged 0-4 years (the number of children aged 0-4 years per 100 total population) are known. The model tables are then used to estimate the age-specific fertility rates for major ethnic, religious and mother tongue groups in Canada and for Newfoundland.

The second half of this study investigates the Pearsonian Type I curve's potential as a model for estimating age-specific fertility rates and as a parametric model for birth projections. The parameters of the Pearsonian Type I curve are estimated from the mean, the variance and the sum of the age-specific fertility rates. Canadian and Quebec data of fertility are used to derive the parameters of the Type I curve. Besides looking at Canada as a whole, Quebec is examined separately because substantial socio-economic changes have been taking place there in the past years. These changes have made the fertility pattern and fertility level of Quebec different from those of other provinces (eg., Quebec has an older age-pattern of childbearing and a lower level of fertility than other provinces).

1.2 Demographic Models

Demographic models try to present an idealized portrayal of a population phenomenon. The use of demographic models as a tool of estimation becomes particularly important when the available data are limited and defective. Even in situations when relevant demographic data are easily available, models are useful in evaluating and adjusting data, in filling gaps in the available records, and in deriving reliable estimates from fragmentary pieces of evidence, each of which may be defective if taken separately (Shryock and Siegel, 1975, p. 717).

Demographic models are generated to achieve different objectives. To mention a few, models are designed to present an idealized picture of reality, that is, demographic relationships measured with respect to a population at some point in time or during some period. Correspondingly, these relationships are introduced into a different population or at some other point in time with a specified set of assumptions. Models can also be used to express and measure the relationship between various events and characteristics of individuals in the population. In addition, models are often used as tools of estimation.

There are various types of demographic models such as deterministic; stochastic; static; dynamic; demographic-economic; explorative and predictive. Deterministic models define functional relationships between variables which are solved by specific or definite values.

On the other hand, stochastic models contain variables which are defined in terms of probability distributions. These distributions reflect the variability about the underlying value that is being estimated. Static models are intended to portray constant conditions while dynamic models allow for change over time in the rates representing the levels of the different components.

Demographic-economic models incorporate both economic and demographic data within a modeling framework. These models also examine the influences of the interrelations of the economic and demographic factors on the underlying process that is being studied. As the name itself implies, an explorative model is generated to examine a particular demographic process or phenomenon and a predictive model is used to estimate the future trend of demographic processes.

1.3 Life Table Model

The life table is a mathematical model that portrays mortality conditions of a population at a particular time and provides a basis for measuring longevity (Bogue, 1969, p.551). It is based on age-specific mortality rates observed for a population for a particular year or other fixed span of time. A life table sets up a "hypothetical cohort" of 100,000 persons and assumes that this cohort is subjected throughout the lifetime of its members to the probabilities of dying that were observed in the actual population during the current period. Life tables are constructed separately for each sex because in most populations females have a lower mortality rate than males.

The first sketch of what later came to be called a life table was constructed by John Graunt (1662) in the middle of the seventeenth century. He developed the life table as a means to show the different patterns of mortality in London. Though the contents of the life table were mostly conjectural, its form set the precedent for the death and survivors columns of all future life tables. About forty years later, prompted by Graunt's table, Halley (1693) constructed the first modern life table for the city of Breslau for the years 1687-1691. Thereafter more attempts were made to obtain measures of mortality, and the life table gradually came to occupy a central place in population studies as a device for description and as an analytical tool.

The life table plays a significant role in population studies because it has many important uses in demographic analysis. First, the terms of a life table are clear and unambiguous, therefore they are an efficient medium of communication. In addition, the life table is a good summary of the mortality experience by age of a population. Second, one of the terms, the expectation of life at birth is widely accepted as a superior measure of the overall impact of mortality on a population. For this reason it is used in international and other comparisons.

Third, the life table provides the basis for a "stable population", which is closed to migration and has unchanging fertility and mortality rates. Fourth, the computation of survival ratios is important for calculating insurance premiums and for generating population projections. Fifth, the life table is important in examining the impact of various causes of death and the part they play in bringing about a particular level of mortality.

Sixth, the life table has many applications in situations where the force of mortality needs to be included such as the computation of net reproduction rate. Seventh, the life table can be used to furnish data on net migration in the computation of survival ratios between two consecutive censuses. Eighth, the life table is useful in making population estimates by age, for it shows the approximate effects of mortality in an actual population. Ninth, the life table is a basic demographic tool and has a wide range of applications beyond the study of mortality. The life table technique has been used to study other phenomena such as divorce, nuptiality and migration.

In recent years, as mortality has declined almost all over the world, there is a growing interest in constructing mortality tables by causes of death (Preston, Keyfitz and Schoen, 1972). Krishnan <u>et al.</u> (1982) constructed life tables by causes of death for Canada, 1975 to 1977. In these tables, they examine the causes of death individually, so that one can infer the increase in life expectancy, when a particular cause of death is eliminated.

1.4 Model Mortality Tables

The construction of a life table relies on the knowledge of the age pattern of mortality; however, in less developed countries information on age-specific mortality may be deficient to such an extent that a reliable description of the pattern of mortality is not feasible. In order to estimate the approximate mortality of such a population, use has often been made of a life table computed for the population of another country where mortality levels and living conditions are presumed to resemble those of the population under consideration. Thus, model life tables are being constructed to reflect generalized experience.

The theoretical rationale of model life table is based on the regularities in the age-specific mortality pattern in almost all societies and the high correlations between successive age-specific mortality rates. Therefore reasonable estimates of age-specific mortality rates can be made if the mortality rate for one of the age groups is known. The first set of model life tables was published by the United Nations (1955). The United Nations set of model life tables, first published in 1955 and made available in a more elaborate form in 1956 were based on a collection of 158 tables for each sex, and computed by using regressions between q_x values of adjacent age groups starting from a specified value of infant mortality. In view of the distinct age patterns of mortality in many developing regions, United Nations (1982) has recently published a set of model life tables for developing countries.

Following the same theoretical rationale, the Princeton Office of Population Research (Coale and Demeny, 1966) developed a set of model life tables slightly different from the United Nations. They first collapsed the life tables into four families with different age pattern of mortality, they then regressed age-specific mortality rates on the expectation of life at age ten. Keyfitz and Cummings (see Keyfitz, 1968) have prepared three groups of life tables following the Princeton approach. Ledermann (1969) has also constructed a set of model life tables.

Brass' model life table systems (see Carrier and Hobcraft, 1971) is a two parameter system, say A and B, with a specific standard life table. Broadly speaking, parameter A fixes expectation of life at birth and the role of parameter B is to reduce mortality at some ages and to increase it at others, i.e. to 'tilt' the mortality pattern. The Brass' system provides a better fit than the United Nations model life tables to the mortality situation of a country that has recently started to experience a mortality decline.

Since age-specific survival ratios are good predictors of average life expectancy at birth, Krishnan <u>et al.</u> (1981) developed a simple system of model life tables from the Princeton life tables and used them to estimate the life expectancy of selected Canadian ethnic and cultural groups with the help of the 1971 census data.

1.5 Fertility Table

All fertility rates are a measure of childbearing and are expressed as a ratio of the number of births that occur in a population to the size of the population that bears the children. Demographers have devised five such rates, namely, crude birth rate, general fertility rate, age-specific fertility rate, total fertility rate and age-cumulative fertility rate. These rates are highly correlated with each other, and together they may be viewed as a system for fertility analysis. The computation of proper risk population is, however, not always easy in view of the continuous nature of the occurrence of births.

The core of the measurement problem lies in the calculation of the woman-years of exposure. The computation of conventional fertility measures do not take into account the non-fertile period. This period refers to the fact that all the females who give birth in one year may not conceive children in the next year because of biomedical reasons. Therefore, during the next year the woman-years of exposure are bound to be less than those of the initial year assuming that there are no new entrants to the childbearing ages by means of immigration. In order to solve this methodological problem, Kayani and Krishnan (1973) suggested the use of the life table approach to construct a fertility table.

The fertility table is based on three assumptions. First, a female who has delivered a child will not conceive another child for at least two months after birth, and a pregnant woman is infertile for nine months. Second, all live births are uniformly distributed over the twelve months of a year. Third, all females in the reproductive years do not die. Thus, using the age-specific fertility rates as probabilities, a fertility table, which is analogous to the life table can be constructed, and total fertility rate at any age can be computed. The computed fertility table values provide more information for a detailed analysis of fertility (eg., the study of fertility trends).

1.6 Model Fertility Table

Following the same theoretical rationale, demographers apply the technique of model life table to the area of fertility. In order to estimate the fertility rates of statistically less developed countries, demographers have to rely on the knowledge they have of nations with reliable data. The technique that demographers depend on is regression analysis. The general principle is to regress age-specific fertility rates on an index or indices (eg. crude birth rate) so that equations linking the age-specific rates to the index can be obtained. The derived equations reflect a generalized experience. This generalized model can then be used to derive the age-specific fertility rates from the index when only the latter is known.

The Brass model fertility table (1968) uses a two parameter polynomial function to describe age-specific fertility rates. The two parameters, which can be varied when the model is fitted to data for a population, are the constant which varies with the level of fertility and the earliest age of childbearing. The Brass two parameter polynomial method permitted estimates of fertility for Africa from sparse and less accurate information. Yet, the Brass model is appropriate only to a limited range of fertility patterns.

Bourgeois-Pichat (1965) made use of certain sociological and physiological variables in the preparation of model fertility tables. He initially classified the world into five regions based on five patterns of marriage, and then developed the different possibilities of natural fertility based on a combination of factors such as coital frequency, infertility, and foetal mortality.

Contributions by Mitra (1965), Bogue and Palmore (1964), Beaujot (1973) and Coale and Trussell (1974) merit attention. Mitra (1965) developed two sets of model tables by linearly regressing the age-specific female fertility rates on both the general fertility rate and on the sex-age adjusted birth rate. Bogue and Palmore (1964) used regression analysis to develop various equations whereby direct fertility measures can be estimated from indirect fertility measures. Supplementary indices, such as the median age at marriage, infant mortality rate, and the index of fertility age composition, were employed to improve predictive accuracy through multiple regression. In 1971, Bogue revised the system of multiple regression equations based on data for the same fifty nations. The revised system included observations for earlier years (as early as 1900) where data were available and appeared to have been valid.

Beaujot (1973) prepared four model male fertility tables based on crude birth rate and general fertility rate. Coale and Trussell's (1974) model fertility tables represent age patterns of fertility rather than the level of fertility. In the tables, the fertility in each year of age is calculated as the product of a number representing the proportion ever married at that age and a number representing marital fertility. By such combinations they are able to construct schedules that express essentially the full range of age structure of fertility likely to be found in most human populations.

1.7 Models In Other Demographic Areas

It is mentioned earlier that the life table technique has been used to study other phenomenon such as nuptiality, divorce, migration and labour force participation. Thus nuptiality, divorce or migration tables are similar to the life table. In a life table, a hypothetical cohort of 100,000 is subject to a given schedule of probabilities of dying, whereas in nuptiality, divorce or migration tables, the hypothetical cohort will be subject to a given schedule of probabilities of marrying, divorcing or migrating for the first time.

In the area of nuptiality, Coale (1971) pointed out the regularity of age-specific pattern of first marriage in populations under widely different social conditions. Many marriage decrement tables have been constructed with U.S. and Canadian data. In the United States, Grabill (1945) prepared the first-marriage decrement tables based on 1920-40 data and Jacobson (1959) with 1940 data. More recently, Bogue (1969, pp.627-630) constructed decrement tables for males and females by color based on 1950-60 data and Saveland and Glick (1969) incorporated 1958-60 data.

In Canada, Roberts and Krishnan (1973) estimated age-specific marriage rates from crude marriage rate, general marriage rate and total marriage rate. Mertens (1976) examined Canadian nuptiality patterns through the construction of nuptiality tables for Canada between the years 1911 and 1961, inclusively. A comparison of the nuptiality tables indicates that Canadians have been marrying younger and Canadian males have been marrying in greater proportions over time. Moreover, these changes have not been gradual and Canadian nuptiality resembled more the West European and not the American pattern. Laing and Krishnan (1977) constructed first-marriage decrement tables for males and females in Canada for the years 1961 and 1966. Basavarajappa (1978) prepared gross nuptiality tables for Canadian males and females for selected periods of time during 1941-71.

Besides using U.S. and Canadian data, Mertens (1965) computed nuptiality tables for several countries such as Norway and India. Expanding to the area of remarriage, Kuzel and Krishnan (1972) developed remarriage probability tables for males and females in Canada for 1961 and 1966. The remarriage tables were based on the widowed and divorced segments of the Canadian population.

There has not been much research in the area of divorce and migration. Krishnan (1971) prepared divorce tables using life table technique for the United States. Krishnan and Kayani (1978) constructed a set of model divorce tables based on expectation of married life at some age or divorce rate for 100 married persons. These tables have been applied to both U.S. and Canadian data to generate age-specific data on divorce rates. Based on the 1971 census data, Basavarajappa (1978) constructed divorce tables for Canadian males and females. In the area of migration, Rogers (1978) identified the persisting regularities in interregional migration. He then applied the method to estimate age-specific migration rates between urban and rural areas for the U.S.S.R. in 1970.

1.8 Pearson's System of Frequency Curves

Frequency distributions can be described by system of curves. In demography, several types of population data, such as age-specific birth rates and distributions of families by income, exhibit skewed bell-shaped patterns of distribution which can be approximated reasonably well by some frequency curves. Karl Pearson developed a whole system of curves to fit skewed bell-shaped patterns by modifying the equation for a normal curve and based on a criterion (the k criterion) for selecting the proper equation and formulas for computing the constants or parameters of the equations. The derivation of the formulas involves the use of moments about the mean.

The the k criterion is given by

$$\frac{B_1(B_2 + 3)^2}{4(2B_2 - 3B_1 - 6)(4B_2 - 3B_1)}$$

where $B_1 = U_3^2/U_2^3$, $B_2 = U_4/U_2^2$, in addition, U_2, U_3, U_4 are the second, third and fourth moments about the mean. The k criterion may have any value from $-\infty$ to $+\infty$, and the different types of Pearsonian curves cover all these possible values without overlap. If k is negative, we get one of the main types of curve called Type I; if k is positive and less than unity, we get the second main type, Pearson's Type IV; and if k is positive and greater than unity, we get the third main type, Pearson's Type VI.

These three main types of curve cover all the possible values of the criterion, but in the limiting cases when one type changes into another, simpler forms of transition curves can be reached.

Transition Types	Criterion
Normal curve	$k=0,\ B_1=0,\ B_2=3$
II	$k=0,\ B_1=0,\ B_2<3$
III	$2B_2=6+3B_1$
V	$k=1$

These Pearsonian curves can take varied forms besides the bell-shaped distribution, such as an S-shaped, J-shaped or U-shaped pattern.

1.9 Pearsonian Type I Curve

With the origin at the mode, the equation of the Pearsonian Type I curve is seen as:

$$y = y_0(1 + x/a_1)^{m_1}(1 - x/a_2)^{m_2} \qquad (1)$$

where y_0 is the modal ordinate, $-a_1 \leq x \leq a_2$ and $m_1/a_1=m_2/a_2$. The method most commonly used for fitting (1) to a frequency distribution is the method of moments. However, the number of moments used depends on the particular procedure followed. In the Elderton (1930) procedure, the parameters a_1, a_2, m_1 and m_2 are calculated from the first four moments of a frequency distribution, that is, from the mean, variance, and measures of skewness and kurtosis.

Statisticans and demographers have manifested considerable interest in Pearsonian Type I curve as a means of graduation of age-specific fertility rates. After fitting

Pearsonian Type III curve to the Swedish net fertility function, Wicksell (1931) suggested that a better fit might be obtained by using Pearsonian Type I curve. In a recent study, Luther (1982) used a special case of the Pearson Type III curve, the incomplete Gamma function, to estimate the age-specific fertility rates of seventy-nine countries. The data needed to employ the method are the mean age of childbearing, the ratio of age-specific fertility rates for the 20-24 and 15-19 age groups and the ratio of the fertility rates for the 35-39 and 40-44 age groups. Keyfitz (1968, p.161) presented a plot of empirical net maternity functions on the Pearson standardized moment plane. All empirical plots fell into the area of the plane corresponding to the Pearsonian Type I curve.

In a not so recent study, Avery (1970) performed tests on the basis of world-wide fertility data and concluded that the Pearsonian Type I function would fit the data better than other models tested. Chandrasekaran and Talwar (1968) used the Pearsonian system of curves to fit the distribution of the ages of women in an Indian community at different birth orders. They found that the forms of the age-specific birth rates of birth orders one, three and four were of Type VI; that of the seventh-birth order was of Type IV; and those of two, five, six, eight, and nine were Type I.

An important development in the use of Pearsonian Type I curve as a means of graduation is Mitra's (1967) work. Mitra used the Pearsonian Type I curve as a graduation equation for the pattern of age-specific fertility rates by five-year age groups on data from fifty countries having high, medium and low fertility rates. For purposes of simplicity, the parameters have been restricted to depend on the first two moments, instead of the first four. The number of independent parameters for the graduation of fertility rates has thus been reduced to only three, total fertility rate (the sum of all age-specific fertility rates), mean and variance of the distribution. The new procedure assumes a fixed age interval of fertility which is meaningful in fertility analysis, as children are rarely born before and after certain ages of the mother. The reduction in the number of parameters offer considerable operational advantages as higher order moments are usually less stable in repeated sampling. The details of the method will be discussed elsewhere in this thesis.

Romaniuk (1973) and Romaniuk and Mitra (1973) found that a three parameter Pearsonian Type I curve describes the age-specific fertility in Canada satisfactorily. The parameters were estimated from total fertility rates and the mean and modal ages of the distribution. They applied the method to fertility data by single years of age for Canada. The results also indicate that the annual number of births can be derived with high degree of accuracy from the three fertility measures. Hence instead of following the conventional procedure of obtaining the annual number of births by directly projecting age-specific fertility rates, it is more advantageous to obtain them by using the model.

2. Fertility Differentials In Canada

The opportunities and motivations for childbearing vary considerably from one social environment to another, and the result is great variability in the number of children that women have. The study of fertility of relatively small and socially homogeneous groups enables the student of demography to isolate the determinants of reproductive behaviour more easily than when he deals with such large and heterogeneous units as countries. Consequently, many demographers and sociologists have examined differentials in fertility according to types of residence, ethnicity, religion, education, income and social class. The presence of certain group fertility differentials provides clues for the possible future trend of fertility in the whole population (McVey, 1976).

What is the reason for fertility variation? This prompted Davis and Blake's (1956) attempt to set forth an analytical framework for the comparative sociology of fertility. They identify the means for regulating fertility as the intermediate variables. These are the variables through which social, cultural or biological factors influencing the level of fertility must operate. They point out that in any of the three phases of fertility: intercourse, conception, and gestation and parturition, the process of reproduction can be interrupted at any point

Table 2.1

Intermediate Variables through which Social Factors Influence Fertility

I. Factors Affecting Exposure to Intercourse ("Intercourse Variables").
   A. 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, or desertion.
         b. When unions are broken by death of husband.
   B. Those governiing the exposure to intercourse within unions.
      4. Voluntary abstinence.
      5. Involuntary abstinence (from impotence, illness, unavoidable but temporary separations).
      6. Coital frequency (excluding periods of abstinence).

II. Factors Affecting Exposure to Conception ("Conception Variables").
      7. Fecundity or infecundity, as affected by involuntary causes.
      8. Use or non-use of contraception.
         a. By mechanical and chemical means.
         b. By other means.
      9. Fecundity or infecundity, as affected by voluntary causes (sterilization, subincision, medical treatment, etc.).

III. Factors Affecting Gestation and Successful Parturition ("Gestation Variables").
      10. Foetal mortality from involuntary causes.
      11. Foetal mortality from voluntary causes.

Source: Kinsley Davis and Judith Blake (1956). "Social Structure and Fertility: An Analytic Framework." Economic Development and Cultural Change 4, 211-235.

through the operation of one, or more of the eleven intermediate variables (Table 2.1).

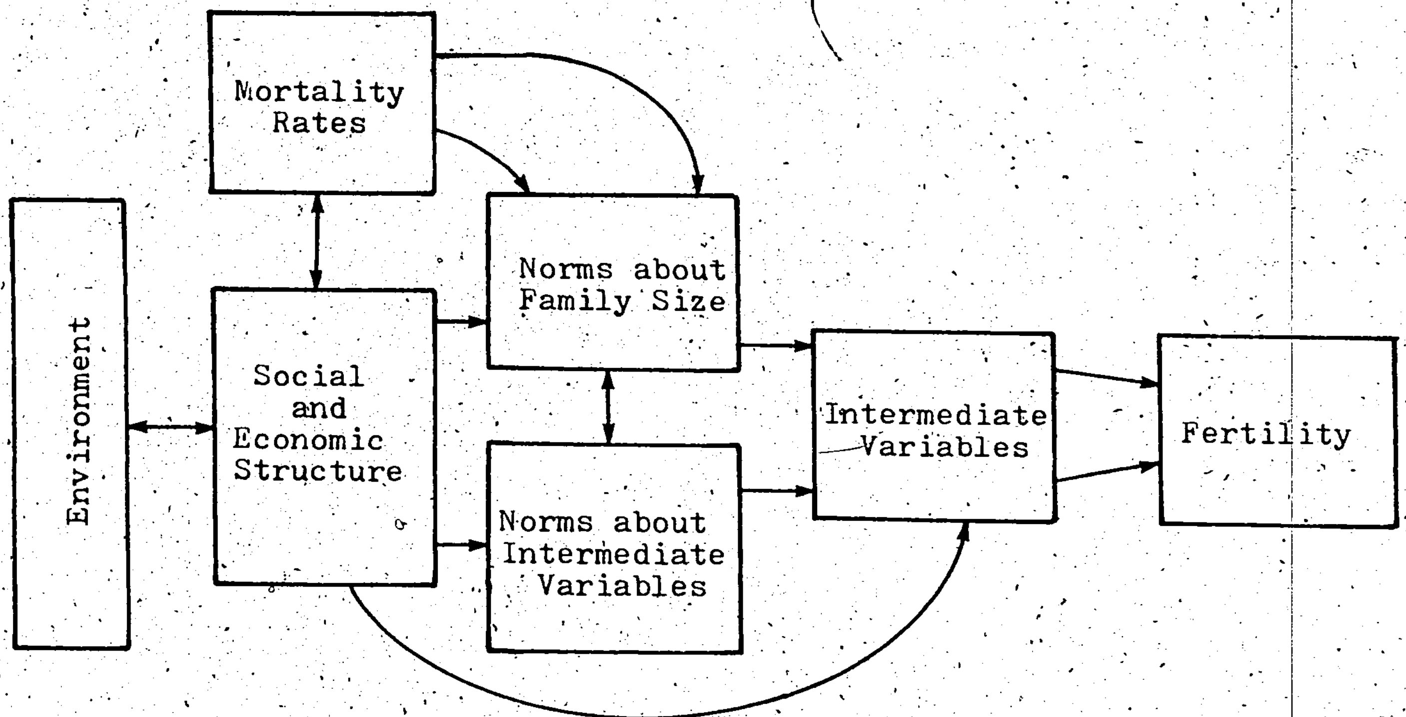
All the intermediate variables described in Table 2.1 vary in influence and are present in every society. Each variable can operate either to reduce or to enhance fertility. Even the absence of a particular practice such as abortion does not imply that this variable is not affecting fertility in one society, as its very absence is a form of influence. Therefore the position of any society must be stated on all the eleven variables.

Freedman (1961-62) incorporates Davis-Blake model within a broader sociological context. Working outward from the intermediate variables toward more encompassing societal concepts, Freedman discusses ways in which social norms, aspects of social organization and environmental factors operate through the intermediate variables to affect fertility. A simplified representation of Freedman's analysis of fertility levels is shown in Figure 2.1 (Freedman, 1967).

The following sections will try to discuss fertility differentials by various socioeconomic factors in Canada. These sections will examine variations in fertility by religion, ethnicity, mother tongue and education as are well-documented in two recent analytical studies done by Henripin (1972) and Balakrishnan, Ebanks and Grindstaff (1979). There is an earlier study on Canadian fertility patterns based on 1941 census data done by Charles (1948),

Figure 2.1

Schematic Diagram of Factors Affecting Fertility - Freedman Model



Source: Ronald Freedman, 1967, "Applications of the Behavioral Sciences to Family Planning Programs," Studies in Family Planning 23, 5-9.

however, the number of variables and the classification of variables used in the study are limited because of the nature of the census data collected. Three fertility surveys were carried out in Quebec (Lapierre-Adamcyk and Marcil-Gratton, 1975), Toronto (Balakrishnan, Kantner and Allingham, 1975) and Edmonton (Krishnan and Krotki, 1976) in the late sixties and early seventies. The conclusions reported concerning fertility differentials in these studies were consistent with the 1961 and 1971 census studies. Therefore the following sections will concentrate mainly on the two analytical studies as they have extensively examined fertility differentials in Canada.

2.1 Fertility Variations By Religion

Religion has always been an important explanatory factor in fertility studies. Many studies have concluded that religion is the single most important socio-cultural factor in accounting for differences in fertility (Westoff and Ryder, 1971). For many decades, there is a persistent excess in fertility among Catholic couples when compared to couples of Protestant faith. This differential is mainly due to the fact that Catholic women desire and do have larger families than do Protestant women. The higher Catholic fertility has been attributed to the Catholic Church doctrine that forbids the use of contraception and to its strong pronatalist position. In addition, Hutterite, Mennonite and Mormon doctrines are also pronatalist. Women of these faiths usually have large families as most of them do not use effective contraception.

Analyzing child-woman ratios between 1931 and 1961, Henripin (1972) commented that one of the rare elements resisting convergence in fertility was religion. Based on the 1961 census data, Henripin (1972, p.197) concluded that for all types of residence, the Hutterites and Mennonites recorded the highest fertility, followed by Catholics, Mormons and Greek Orthodox women, respectively. Women of Protestant and Judaic faiths manifested the lowest fertility rates.

Changes in the influence of religious affiliation has been documented in a study by Krotki and Lapierre (1968) which focused on the fertility differential between Catholics and non-Catholics. By comparing the child-woman ratios of the Catholics and non-Catholics in the decennial censuses between 1931 and 1961, they concluded that there was a convergence between the fertility of Catholics and Protestants, at least for those generations who were older than 45 in 1961. They found that among women aged 65 and over, Catholics had 80 per cent more children than Protestants, whereas among women aged 45-49, the difference was only 54 per cent.

There was also an indication in Henripin's study that the fertility rates by age of woman and for different types of residence dropped rapidly among the Hutterites and Mennonites, the Catholics and the Greek Orthodox women. For the Hutterites and Mennonites, women between 45 and 50 years of age had on the average 4.7 children while those over 65 had 6.0 children. On the other hand, Catholic women aged 65 and over had 5.7 children whereas women aged 45-49 had 4.0 children (Henripin, 1972, p.197). The Greek Orthodox women had the most rapid change: the proportion of women who had seven children or more was 29 per cent for those aged 65 and over, 4 per cent for those aged 45-49 and only 2 per cent for those aged 35-39 (Henripin, 1972, p.201). Regardless of age and residence, there was a relatively low proportion of Protestant and Judaic women that bore many children. They were characterized by their high concentration in the categories corresponding to one, two or three children.

Based on the 1971 census data, Balakrishnan, Ebanks and Grindstaff (1979) concluded that although the Mennonite and Hutterite women continued to have the highest fertility rates and the Jewish women the lowest, there seemed to be a convergence among all the religious groups. This convergence was most marked between young Catholic and Protestant women (Kalbach and McVey, 1979). Balakrishnan, Ebanks and Grindstaff (1979, p.58) found that Catholic-Protestant differences did not exist in the younger cohorts up to age 30. For the age group 25-29, mean number of children per 1,000 ever-married Catholic women was 1,728 compared to 1,713 for Protestant women.

After examining the fertility of Protestant and Catholic women, Balakrishnan, Ebanks and Grindstaff concluded that lower Catholic fertility among younger cohorts was largely due to the rapid decline in fertility taking place in Quebec in recent years. Those couples in the childbearing ages who both spoke French and were Catholic had lower fertility than couples who both spoke English and were Catholic. However, at the older ages, this pattern was reversed with the English-speaking Catholic couples having fewer children.

2.2 Variations In Fertility By Ethnic Origin

Prior to 1981, Canadian censuses identified ethnic origin in terms of the ethnic or cultural background traced through the father's side. In the 1981 census, however, ethnic origin refers to the ethnic or cultural group to which the respondent's ancestors belonged on first coming to North America. Ethnic origin may be an ambiguous variable as it does not represent an individual's self-identification with a particular cultural group. Henripin's study (1972), however, indicated that this factor permitted the differentiation between segments of Canadian society whose attitudes and values affect fertility.

Regardless of age and type of residence, Henripin found that Indian and Eskimo women manifested higher fertility than women of other groups. At the age of 50, these women had borne, on the average, 6.5 children, followed by the French women with 6.2 children. French women who were 65 and over were as fertile as the Indian and Eskimo women. In decreasing order of fertility; the Asiatics followed the French, at least after the age of 45. Before the age of 40, the Asiatics had a relatively low fertility rate that was scarcely higher than the Jews. The Jews had the lowest fertility rate when compared to other ethnic groups. Between the Asiatics and Jews, were the ethnic groups coming from north-western European countries, the Irish and the British (Henripin, 1972, p. 175).

The different levels of fertility among the various ethnic groups can be associated with their types of residence. Jews are characterized by low fertility because almost all Jewish people live in urban centres and the Asiatics are also heavily concentrated in these areas. On the other hand, a large proportion of women of north-western European origin live on farms in rural sectors. The Indian and Eskimo women, comprising the high fertility group, live mainly in the rural non-farm environment. For each type of residence, there are different social, cultural or biological factors that influence fertility through the intermediate variables. Broadly speaking, people living in urban centres have lower fertility than rural dwellers because they tend to marry at a later age, and they rely more on the effective use of contraception.

In the 1971 census analytical study, Balakrishnan, Ebanks and Grindstaff (1979) argued that ethnicity might be losing its significance for the vast majority of Canadians. They postulated that ethnicity might be a meaningful explanatory variable for recent arrivals and for the Indians and Inuit but for a tenth- or fifth-generation Canadian, ethnicity would not have any effect on fertility. After analyzing the 1971 census data, they concluded that the Jewish people had the lowest fertility, followed by Asians, 'Other and Unkown', Italians, Poles, British, Scandinavians, Ukrainians, Germans, Dutch (Netherlands), French and Indians and Inuit (Balakrishnan *et al.*, 1979, p.110). The fertility of the Indian and Inuit was more than double that of the Jewish group.

Balakrishnan, Ebanks and Grindstaff also found that the difference in fertility between the French and the British was smaller among those younger women who were in the childbearing ages (15-44). Therefore the French overall high fertility level reflected more on past fertility than the current levels of childbearing. For Asians who had completed their childbearing (45 and over), their fertility level was higher than the recently arrived, highly educated professional group. Moreover, older Italian women had higher fertility in comparison to the younger, more mobile Italians. In summary, they concluded that the introduction of a second control variable modified the relationship between ethnicity and fertility, with the overall associations maintained among older women but had little relevance for the younger cohorts.

2.3 Variations In Fertility By Mother Tongue

According to census definition, mother tongue refers to the language first learned in childhood and is still understood. Henripin (1972) identified this as the single characteristic that could be chosen to identify cultural groups. In analyzing the fertility performance of the two major linguistic groups in Canada, English and French, Henripin noted that the fertility of English-speaking women was just about identical with that of British ethnic group and the same was true with French-speaking women and women of French ethnic origin. In both cases, however, the fertility of the linguistic group is slightly higher than the fertility of the ethnic group. Since the difference is very small, further examination is not warranted.

The 1961 census data indicated that for all age groups, except the 20-24 age group, there were more English-speaking women than French-speaking women having smaller number of children (one to three children). Among the French-speaking women, the proportion of women that had seven or more children was very high but had decreased rapidly: 46 per cent for women 65 years and over and 23 per cent for those in the 45-49 age group (Henripin, 1972, p.183). For these two age groups, the proportion of English-speaking women was only twelve and six per cent, respectively. For women who were neither English-speaking nor French-speaking, there was also a marked decrease in fertility level. Henripin concluded that there was a convergence in fertility with regard to different mother tongue groups.

Balakrishnan, Ebanks and Grindstaff (1979) had also examined the relationship between mother tongue and fertility with the 1971 census data. In terms of rank order from low to high fertility, the 'other' category which included the Asians, Eastern Europeans, and Jews had the lowest number of children born per 1,000 women. These were followed by the English, the Italians, and the Poles, whose fertility levels were close to each other but distinctly lower than the German and the Ukrainians. The next mother tongue groups were the French and the Dutch. At the top of the rank order were the Indians and Inuit who had the highest fertility (Balakrishnan et al., 1979, p.96).

Looking at fertility by mother tongue in different age groups, Balakrishnan, Ebanks and Grindstaff found that fertility was dropping for all groups among those still in the childbearing ages, in particular for the Italians. Moreover, the decline in fertility rates among young French-speaking women, who were 15-34 years old, was more rapid than the English-speaking women. From age 35 on, French origin fertility was higher than the English with the divergence between the two rates became progressively larger as the cohorts got older.

2.4 Fertility Variations By Education

In almost all modern societies, an inverse relationship has been found between schooling and fertility. Schooling affects attitudes toward sex roles, trains and certifies for participation in the labour force, shapes attitudes toward children as well as the use or non-use of contraception. Schooling reinforces and/or de-emphasizes inherited traditions and religious values, in particular the latter that imply moral precepts which are likely to influence family size. Women who plan to go on to higher levels of education may purposely delay marriage and childbearing, while less educated women may give up the opportunity of furthering their education for marriage and/or childbearing.

Examining the distribution of women by level of schooling, Henripin observed that there was a higher proportion of women who had either high school or university training living in urban centres than in rural environment. Among rural women, those from a non-farm environment had had more high schooling and university training than those living on farms. The percentage of university graduates was five times higher (2 per cent) among urban women than those in the farm environment (0.4 per cent) (Henripin, 1972, p.238).

For all types of residence, Henripin (1972) noted a consistent inverse relationship between schooling and fertility. The difference in fertility between the elementary and secondary levels was most marked. The difference was appreciable between the secondary and the university level, but there was very little difference between women who had attended university but not graduated and those who graduated. Generally speaking, the differences in fertility rates by level of schooling were higher among older than among younger women.

After examining the relationship between fertility and education, Balakrishnan, Ebanks and Grindstaff(1979) concluded that education was the strongest of the socio-demographic variables in its relation to fertility. For all age groups, the inverse relation of education to fertility was evident. Moreover, the inverse relationship between fertility and education remained fairly constant where factors such as ethnicity, religion, labour force experience of women and migration status were controlled.

Similar to the results derived by Henripin, Balakrishnan, Ebanks and Grindstaff observed that the differences in fertility level were most pronounced for the less-than-thirty age cohorts which was partially explained by the later age at marriage of more educated women. For the older cohorts, however, education also had a negative effect on fertility. The differences were most notable between elementary and secondary levels for the later cohorts. Even for the high fertility baby-boom cohort of women aged 40-44, the mean number of children was 3.9 for those who had below Grade 9 schooling and 2.8 for those who had gone to university (Balakrishnan _et al._, 1979, p.73).

The preceding sections clearly demonstrate that differences in fertility are evident by religion, ethnic origin, mother tongue and education. These factors influence the level of fertility through the intermediate variables, by affecting attitudes toward childbearing, work, marriage, and the effective use or non-use of contraception.

Meaningful interpretations of these differentials are difficult due to the interrelations between these variables. In order to make clear the nature of the relationship among the various factors in trying to explain fertility, Balakrishnan, Ebanks and Grindstaff devised a theoretical framework and methodology that can handle many variables simultaneously. In their model, primary ascribed characteristics such as religion, ethnicity and nativity are treated as exogenous variables and achieved characteristics such as education, income and work status as endogenous variables.

It is found that ascribed characteristics have a considerable direct influence on fertility and an indirect effect through the endogenous variables. In addition, the ascribed characteristics seem to have more influence on the fertility of women who have completed their family size. For younger women, achieved characteristics seem to have more significance on fertility. This may indicate a trend where fertility is less influenced by traditional values and norms and more by individual desires and constraints of income and costs of childbearing.

3. Data And Methodology

This chapter consists of two parts. The first part deals with the data used in the analysis and part two discusses the methodology of constructing model fertility tables. The equations for generating the four model fertility tables are also presented in the last part.

3.1 Data

The data used for the first part of this study have been taken from the vital statistics published by Statistics Canada and the 1921-1976 censuses. Information on the age-specific fertility rates of all the provinces in Canada (except Newfoundland) from 1921 to 1979 are utilized[1]. Women in the quinquennial age groups 15-49 are taken into consideration. Together with the age-specific fertility rates, the four indices namely, crude birth rate, general fertility rate, child-woman ratio and percent of the total population aged 0-4 years which are taken from the 1921 to 1979 vital statistics and the nine censuses respectively are used to derive the four model fertility tables.

The quality of the data is known to be good as the vital registration and census collection systems throughout Canada are quite reliable. Statistics Canada conducted a quality assessment study on a sample of 1976 birth records.

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[1]The age-specific fertility rates for Quebec from 1921 to 1925 are not available

The results of the study revealed that the quality of birth data was generally high. The total error rate measured on the basis of adjudicated mismatches for the core characteristics was 2.7 per 100 records, with none of the individual characteristics exceeding an error rate of one per cent (Statistics Canada, 1979). On the other hand, a typical census is estimated to contain a 2.5 per cent error which means 97.5 per cent completeness (Overbeek, 1980).

The means and ranges of crude birth rate, general fertility rate, child-woman ratio and percent of the total population aged 0-4 years are recorded in Tables 3.1 and 3.2. Among the four indices, child-woman ratio has the largest standard deviation of 98.4 points while percent of the total population aged 0-4 has the smallest, a standard deviation of 2.0 points. Yet, the coefficients of variation of these four indices are all close to 0.2 points which means that they have similar relative range of variation. On the other hand, the age-specific fertility rates of the 20-24 age group has the largest range of values as the fertility rates of this age group have gone through considerable changes in the past decades. During World War II and the baby boom years, women were marrying and having children in their early twenties, but in the seventies women were delaying marriage and postponing childbearing to their late twenties and early thirties. The 45-49 age group has the least variation in the fertility rates as their contribution to the total number of births is considerably

Table 3.1

Means and Ranges of Crude Birth Rate, General Fertility Rate and Age-Specific Fertility Rates, Canada, 1921-1979

Rate	Mean	Minimum	Maximum	S.D.
Crude Birth rate	22.7	13.4	36.4	4.8
General Fertility Rate	95.8	52.6	155.2	22.1
Age-Specific Fertility Rates				
15-19	44.4	15.7	86.2	16.5
20-24	167.5	90.3	278.4	47.2
25-29	178.8	100.1	278.7	36.3
30-34	130.2	54.0	210.4	37.8
35-39	82.2	14.3	179.7	35.7
40-44	31.9	2.6	80.0	17.7
45-49	3.6	0.0	11.9	2.6

Number of Cases: 526

Table 3.2

Means and Ranges of Child-Woman Ratio, Percent Population 0-4 Years and Age-Specific Fertility Rates, Canada, 1921-1976

Rate	Mean	Minimum	Maximum	S.D.
Child-Woman Ratio	456.8	262.9	679.2	98.4
Percent Population, 0-4	10.7	7.0	14.9	2.0
Age-Specific Fertility rates				
15-19	47.7	19.8	84.5	16.3
20-24	178.0	100.1	278.4	46.1
25-29	183.8	119.0	278.7	36.6
30-34	127.9	59.4	194.7	38.1
35-39	78.7	18.1	154.5	35.7
40-44	29.9	3.2	72.3	17.4
45-49	3.4	0.0	11.9	2.8

Number of Cases: 80

Footnote: Child-woman ratio is defined as the number of children under five years of age per 1000 women age 15-49.

small especially in recent years.

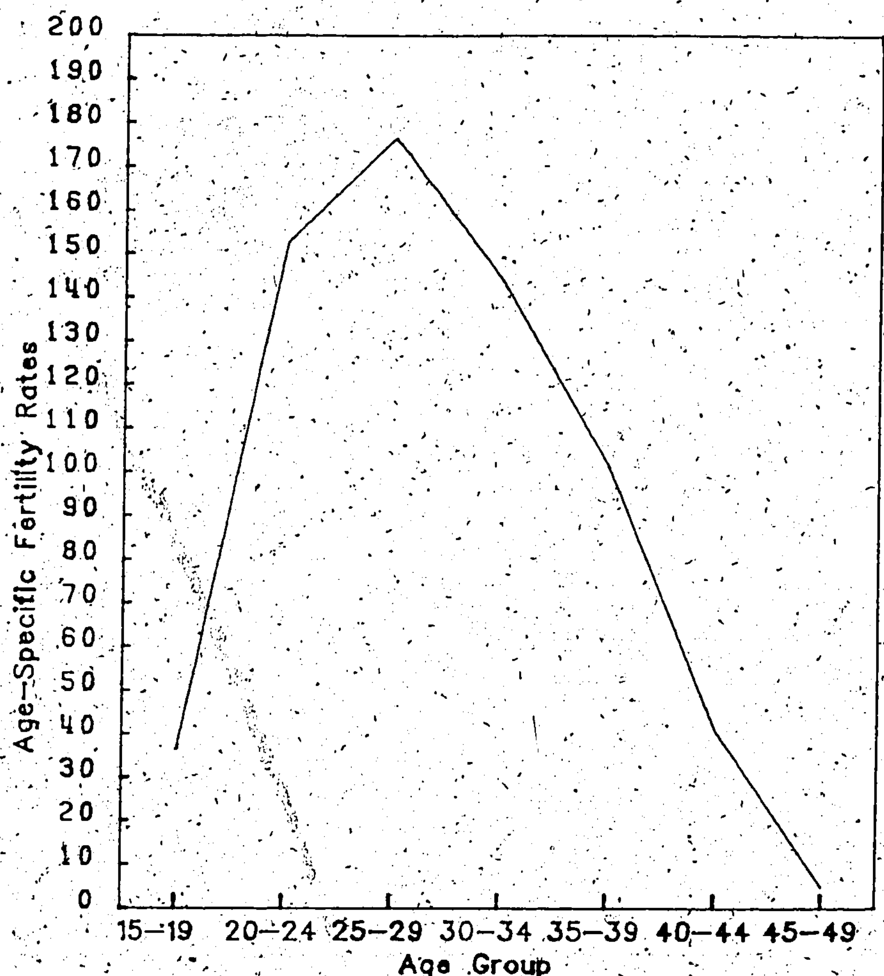
3.2 Tables Of Model Fertility

The theoretical rationale of the model fertility table technique is based on the persistent regularities of age-specific rates of birth all over the globe. Thus model tables can be used to summarize the identified regularities. And as the pattern is consistent, it is very probable that it will continue to remain so in the future. In addition, for nations with reliable data, there are several direct and indirect measures of fertility. Direct measures of fertility refer to fertility measures derived from the combination of vital statistics and census data such as crude birth rate, age-specific fertility rates. On the other hand, indirect measures refer to fertility measures derived from census data alone such as child-woman ratio, percent of the total population aged 0-4 years. And if the correlations between these different measures are high, then any given measure can be used to develop the other measures.

The data used in the analysis can be further grouped into the 1930's depression low fertility period, post-war baby boom high fertility period, and the baby bust low fertility period. Thus, there is a considerably wide range of fertility experience for a country within 59 years. However, the data exhibit a consistent inverted U-shaped pattern with the peak at the 25-29 age group before and during the war, peak at the 20-24 age group during the baby

Figure 3.1

Age-Specific Fertility Rates, Canada, 1921-1953

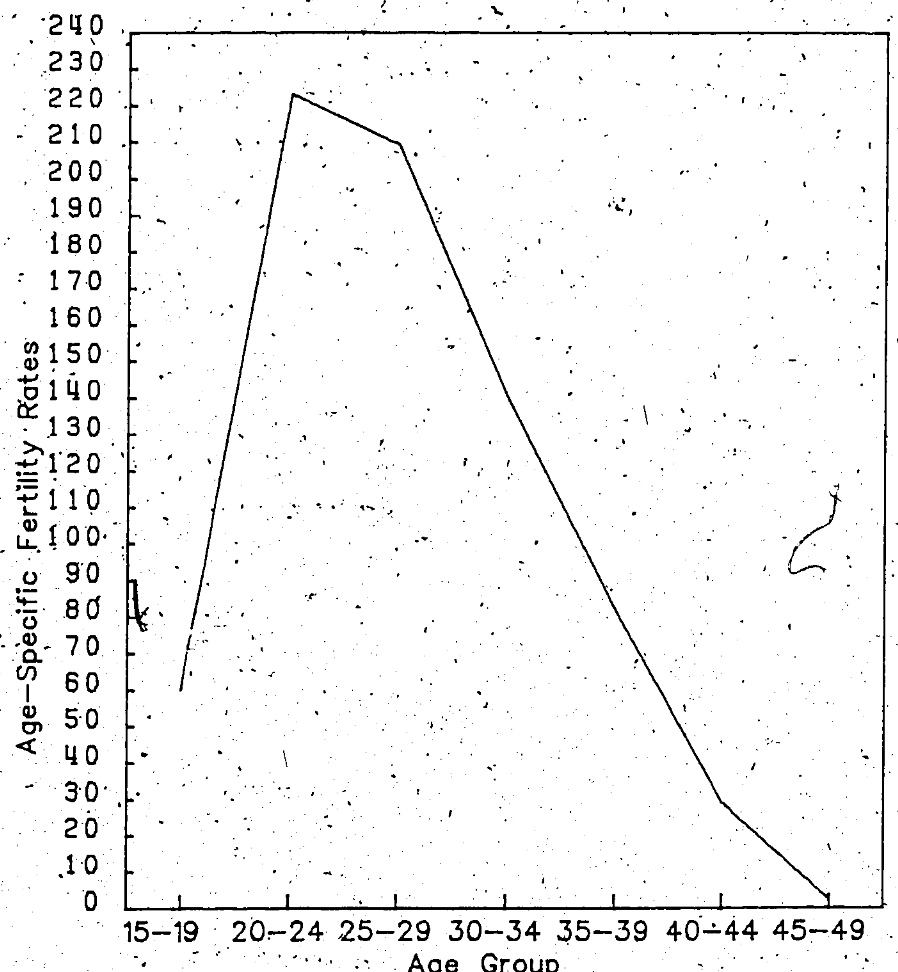


This figure is based on the means of age-specific fertility rates of Canada, 1921-1953.

Source: Statistics Canada (formerly Dominion Bureau of Statistics), Vital Statistics, 1921-1953.

Figure 3.2

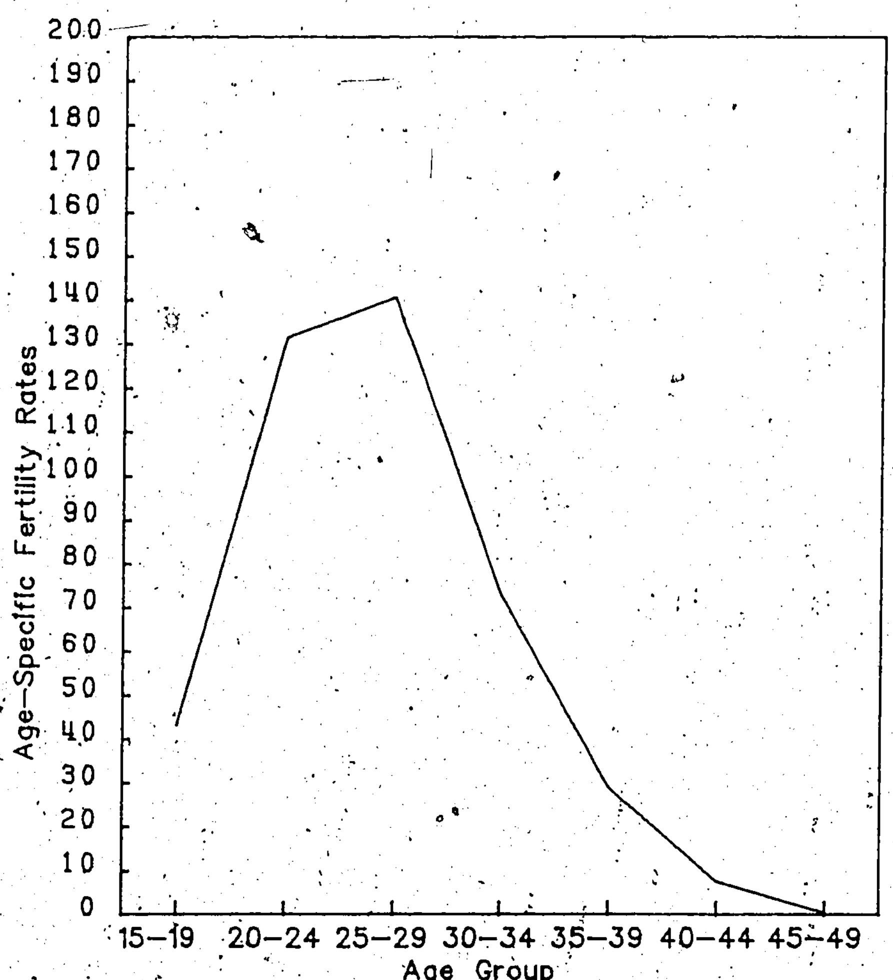
Age-Specific Fertility Rates, Canada, 1954-1968



This figure is based on the means of age-specific fertility rates of Canada, 1954-1968.
Source: Statistics Canada (formerly Dominion Bureau of Statistics), Vital Statistics, 1954-1968.

Figure 3.3

Age-Specific Fertility Rates, Canada, 1969-1979



This figure is based on the means of age-specific fertility rates of Canada, 1969-1979.
Source: Statistics Canada (formerly Dominion Bureau of Statistics), Vital Statistics, 1969-1979.

boom years, and then peak at the 25-29 age group again in the 1970's (Figures 3.1 to 3.3). Because of the consistent pattern of fertility behaviour among the provinces, the fertility experience of a province or a set of provinces can be used to represent a generalized experience of the whole country.

The correlation matrices among age-specific fertility rates are shown in Tables 3.3 and 3.4. The predictability decreases as the gap separating the age groups increases along the age-axis with two exceptions. The high correlation between successive age groups indicates that plausible estimates of age-specific rates can be made, if the fertility rate for one of the age groups is known or can be estimated *a priori*.

It can be seen from Table 3.5 that the correlations of age-specific fertility rates and the indices are generally high except for the first age group (15-19) and the last two age groups (40-44, 45-49). The correlation of age-specific fertility rate and crude birth rate is also low for the 20-24 age group. This reflects that the contribution to the total number of births by these terminal age groups is relatively small, especially the two oldest age groups. Moreover, there may be greater variability in the youngest group due to various social factors such as age at marriage and childbearing practices. Generally, women who marry at an early age tend to have a higher level of fertility and have children at an earlier age than those who marry at older

Table 3.3

Correlation Martrix of Age-Specific Fertility Rates from Vital Statistics Data, Canada, 1921-1979

Age Group	15-19	20-24	25-29	30-34	35-39	40-44	45-49
15-19	1.0	0.81	0.51	0.08	-0.11	-0.20	-0.32
20-24		1.0	0.85	0.49	0.28	0.16	0.00
25-29			1.0	0.80	0.64	0.54	0.38
30-34				1.0	0.95	0.90	0.78
35-39					1.0	0.98	0.89
40-44						1.0	0.93
45-49							1.0

Number of Cases: 526

Table 3.4

Correlation Matrix of Age-Specific Fertility Rates from Census Data, Canada, 1921-1976

Age Group	15-19	20-24	25-29	30-34	35-39	40-44	45-49
15-19	1.0	0.79	0.46	0.08	-0.09	-0.18	-0.27
20-24		1.0	0.87	0.58	0.40	0.28	0.14
25-29			1.0	0.86	0.73	0.64	0.50
30-34				1.0	0.97	0.92	0.80
35-39					1.0	0.98	0.89
40-44						1.0	0.94
45-49							1.0

Number of Cases: 80

Table 3.5

Correlation Coefficients of Age-Specific Fertility Rates with Crude Birth Rate, General Fertility Rate, Child-Woman Ratio and Percent Population Aged 0-4 Years, Canada, 1921-1979

Age Group	CBR	GFR	CWR	% Pop. 0-4
15-19	0.35	0.46	0.49	0.42
20-24	0.68	0.78	0.84	0.79
25-29	0.88	0.94	0.91	0.90
30-34	0.88	0.89	0.82	0.86
35-39	0.77	0.77	0.73	0.76
40-44	0.69	0.68	0.66	0.69
45-49	0.55	0.53	0.54	0.58

ages.

Bogue and Palmore (1964) indicated that any given measures of fertility could be used to develop other measures of fertility because of the high correlation between the different measures. The Bogue-Palmore contention seems to hold true for our four sets of data, as revealed by the high correlation between age-specific fertility rates of the 20-24, 25-29, 30-34 and 35-39 age groups and the four indices. These correlation coefficients are all greater than 0.70 except for the correlation coefficient between crude birth rate and age-specific rates for the group 20-24, which is 0.68.

A comparison of our results with those derived by Bogue and Palmore reveals that the correlation coefficients between age-specific fertility rates and crude birth rate and general fertility rate follow the same pattern. The highest value of the correlation coefficients between the age-specific fertility rate and the two indices is obtained at the 25-29 age group, then closely followed by the 30-34 age group and the lowest value is obtained at the 45-49 age group. The correlation coefficients in our data are relatively lower. Therefore it is appropriate to use crude birth rate and general fertility rate to predict age-specific fertility rates.

Since crude birth rate, general fertility rate, child-woman ratio and percent of the total population aged 0-4 years perform reasonably well as predictors of the

Table 3.6

Linear Regression Equations for the Seven Age-Specific Fertility Rates Based on Crude Birth Rate, Canada, 1921-1979

Age Group	Simple R	R Square	B	Constant
15-19	0.34604	0.11974	1.186890	17.47671
20-24	0.67766	0.45922	6.658247	16.26938
25-29	0.87990	0.77422	6.649216	27.75099
30-34	0.87601	0.76739	6.884988	-26.19710
35-39	0.77126	0.59484	5.733674	-48.02103
40-44	0.68599	0.47058	2.534000	-25.64344
45-49	0.54665	0.29882	0.291067	-3.02068

Table 3.7

Linear Regression Equations for the Seven Age-Specific Fertility Rates Based on General Fertility Rate, Canada, 1921-1979

Age Group	Simple R	R Square	B	Constant
15-19	0.45841	0.21014	0.342335	11.65545
20-24	0.77836	0.60584	1.665119	8.06563
25-29	0.94227	0.88787	1.550345	30.33418
30-34	0.88779	0.78817	1.519228	-15.27735
35-39	0.76786	0.58961	1.242894	-36.79280
40-44	0.68169	0.46470	0.548266	-20.58236
45-49	0.53098	0.28194	0.061557	-2.30349

Table 3.8

Linear Regression Equations for the Seven Age-Specific Fertility Rates Based on Child-Woman Ratio, Canada, 1921-1976

Age Group	Simple R	R Square	B	Constant
15-19	0.49088	0.24096	0.081262	10.60782
20-24	0.83898	0.70389	0.393156	-1.55667
25-29	0.90986	0.82784	0.338625	29.09727
30-34	0.82427	0.67942	0.318744	-17.74276
35-39	0.72842	0.53059	0.263956	-41.89003
40-44	0.65601	0.43035	0.116025	-23.07889
45-49	0.53800	0.28944	0.015205	-3.55440

Table 3.9

Linear Regression Equations for the Seven Age-Specific Fertility Rates Based on Percent Population Aged 0-4 years, Canada, 1921-1976

Age Group	Simple R	R Square	B	Constant
15-19	0.41544	0.17259	3.453597	10.74509
20-24	0.78954	0.62338	18.57932	-20.92312
25-29	0.90132	0.81238	16.84491	3.39458
30-34	0.85576	0.73233	16.61772	-50.09374
35-39	0.75867	0.57557	13.80530	-69.15105
40-44	0.69358	0.48105	6.160023	-36.04384
45-49	0.57992	0.33631	0.823058	-5.42236

age-specific fertility rates, regression technique can be applied. Linear regression, E(Y) = A + BX, is employed with X being one of the four indices and Y being one of the seven age-specific fertility rates. Thus a total of seven equations are derived empirically for each set of data. The equations and relative measures of relationship are shown in Tables 3.6 to 3.9. It can be seen from the tables that the four indices account for a good proportion of variance in the age-specific fertility rates of the 25-29 age group. The variance explained by the indices for the oldest and youngest age groups is generally low.

Since the correlation coefficients between crude birth rate and age-specific fertility rates for age groups 15-19, 20-24, 40-44 and 45-49 are not as high as those for the others and since the adjacent age groups predict these quite satisfactorily, fertility rates for these age groups are predicted from the rates for the age groups 20-24, 25-29, 35-39 and 40-44 after the latter have been predicted from crude birth rate. The same procedure has been executed on the 15-19, 40-44 and 45-49 age groups of the other sets of data. The resulting equations and relative measures of relationship are reproduced in Tables 3.10 to 3.11. It can be observed that there are significant improvements in predictability when adjacent age groups are used instead of the indices.

Therefore the process of generating age-specific fertility rates from the four indices is as follows:

Table 3.10

Linear Regression Equations for ASFR 15-19, 20-24, 40-44 and 45-49 Based on Adjacent Age Group, Canada, 1921-1979

Age Group	Simple R	R Square	B	Constant	Predictor ASFR
15-19	0.81392	0.662461	0.284127	-3.160437	20-24
20-24	0.85396	0.72924	1.110318	-31.002840	25-29
40-44	0.97554	0.95167	0.484727	-7.938580	35-39
45-49	0.93399	0.87234	0.134630	-0.706195	40-44

Footnote: These equations based on vital statistics data are different from the equations of model tables where the predictors are crude birth rate or general fertility rate.

Table 3.11

Linear Regression Equations for ASFR 15-19, 40-44, 45-49 Based on Adjacent Age Group, Canada, 1921-1976

Age Group	Simple R	R Square	B	Constant	Predictor ASFR
15-19	0.78772	0.62050	0.278278	-1.814741	20-24
40-44	0.97927	0.95897	0.477964	-7.686829	35-39
45-49	0.94313	0.88950	0.150712	-1.118056	40-44

Footnote: These equations based on census data are different from the equations of model tables where the predictors are child-woman ratio or percent population aged 0-4 years.

ASFR 15-19 = 0.2841 (ASFR 20-24) - 3.1604

ASFR 20-24 = 1.1103 (ASFR 25-29) - 31.0028

ASFR 25-29 = 6.6492 (CBR) + 27.7510

ASFR 30-34 = 6.8850 (CBR) - 26.1971

ASFR 35-39 = 5.7337 (CBR) - 48.0210

ASFR 40-44 = 0.4847 (ASFR 35-39) - 7.9386

ASFR 45-49 = 0.1346 (ASFR 40-44) - 0.7062

ASFR 15-19 = 0.2841 (ASFR 20-24) - 3.1604

ASFR 20-24 = 1.6651 (GFR) + 8.0656

ASFR 25-29 = 1.5503 (GFR) + 30.3342

ASFR 30-34 = 1.5192 (GFR) - 15.2774

ASFR 35-39 = 1.2429 (GFR) - 36.7928

ASFR 40-44 = 0.4847 (ASFR 35-39) - 7.9386

ASFR 45-49 = 0.1346 (ASFR 40-44) - 0.7062

ASFR 15-19 = 0.2783 (ASFR 20-24) - 1.8147

ASFR 20-24 = 0.3605 (CWR) - 6.6976

ASFR 25-29 = 0.3037 (CWR) + 28.1579

ASFR 30-34 = 0.2788 (CWR) - 15.0120

ASFR 35-39 = 0.2278 (CWR) - 38.0467

ASFR 40-44 = 0.4780 (ASFR 35-39) - 7.6868

ASFR 45-49 = 0.1507 (ASFR 40-44) - 1.1181

ASFR 15-19 = 0.2783 (ASFR 20-24) - 1.8147

ASFR 20-24 = 18.5793 (C(0-4)) - 20.9231

ASFR 25-29 = 16.8449 (C(0-4)) + 3.3946

ASFR 30-34 = 16.6177 (C(0-4)) - 50.0937

ASFR 35-39 = 13.8053 (C(0-4)) - 69.1511

ASFR 40-44 = 0.4780 (ASFR 35-39) - 7.6868

ASFR 45-49 = 0.1507 (ASFR 40-44) - 1.1181

One should be aware that errors are cumulated both in predicting age-specific fertility rates from the indices and from adjacent age groups. These errors may be small as the correlations between the indices and the age-specific rates and the correlations between successive age groups are high. Therefore no attempts have been made to correct for the errors.

3.3 Evaluation Of The Model Fertility Tables

Model fertility tables for Canada are constructed in Appendix A for different levels of crude birth rate, general fertility rate, child-woman ratio and percent population aged 0-4 years. Crude birth rates ranging from 10 to 40, at an interval of five are used to generate the first set of the model tables. As for the other three indices, the range of general fertility rate is frorm 45 to 165 at a spacing of twenty, child-woman ratio ranges from 250 to 700 at an interval of fifty, and the range of percent population 0-4 years is from 6 to 16 at a spacing of two.

An evaluation of the values estimated by the four model tables is done by comparing the derived total fertility rates to the actual rates. The total fertility rate is employed in the empirical test because most of the analyses in this study are based on this measure. Table 3.12 shows the ratios of actual total fertility rates to derived total fertility rates for the census years, 1921 to 1976.

It can be seen from Table 3.12 that the ratios of observed to derived total fertility rates are moderately high for most of the years which indicate that the model fertility tables provide satisfactory estimates of total fertility rates. The ratios of the actual rates to those generated by the four indices are similar within the nine years except for those values derived from child-woman ratio which tend to under-estimate total fertility rates. Between the two direct measures of fertility, general fertility rate seems to be a better predictor than crude birth rate because the total fertility rates estimated by this index is closer to the actual values. As to the two indirect measures of fertility, percent population aged 0-4 provides better estimates of total fertility rates than child-woman ratio especially for the years before 1961. After 1961, child-woman ratio seems to provide better estimates.

It is worth to mention that the ratios of actual to derived total fertility rates presented in Table 3.12 can be used as correction factors to adjust for the under-estimation or over-estimation of total fertility

Table 3.12

Ratios of Observed to Derived Total Fertility Rates for Canada, 1921-1976

Year	CBR	GFR	CWR	% pop. 0-4
1921	0.8333	0.9752	1.1314	0.9383
1931	0.9783	1.0271	1.2367	1.0298
1941	0.9025	0.9880	1.3138	1.0766
1951	0.9805	0.9538	1.1145	0.9051
1956	0.9559	0.9799	1.1738	0.9927
1961	1.0287	1.0226	1.1291	0.9846
1966	1.0554	1.0475	0.9570	0.8387
1971	0.9720	0.9973	1.0555	0.9320
1976	0.8794	0.9461	1.0651	0.9133

rates. A correction factor is developed for every year and for each set of model tables as the discrepancies of the observed to derived total fertility rates vary from year to year and from one predictor to another predictor. A corrected total fertility rate is obtained by multiplying the estimated value from any of the four indices by a correction factor of the corresponding year and index, such as the correction factor of 0.9805 will be used if the adjusted value is needed for the year 1951 and using crude birth rate as the predictor. In the following analyses, correction factors will not be used because the improvements in the adjusted values are not significant and the use of correction factors does not alter the pattern of fertility.

4. Application Of Model Fertility Tables To Major Religious, Ethnic And Linguistic Groups In Canada

It is known that in order to investigate fertility patterns in Canada it is important to have a complete schedule of age-specific fertility rates by various social economic statuses. However the vital registration of births does not collect detailed data on the socio-economic characteristics of the parents, such as religion, ethnicity and mother tongue. One of the ways of obtaining such information is the application of mathematical models to census data, such as model fertility tables.

In the preceding chapter, model fertility tables for Canada were constructed on the basis of the experience of all the provinces in Canada (except Newfoundland) between the years 1921 and 1979. Linear regression was employed with the independent variable being either child-woman ratio or percent of the total population aged 0-4 years and the dependent variable being one of the seven age-specific fertility rates. Thus a total of seven equations were derived empirically for each set of independent indicators.

In this chapter, age-specific fertility rates by major religious, ethnic and mother tongue groups in Canada for 1951, 1961 and 1971 will be estimated using these model fertility tables based on child-woman ratio and percent population aged 0-4 years. A comparison of our results with those presented in the two census analytical studies will be made. A direct comparison cannot be done because these studies employed cohort measures, while age-specific fertility rates and total fertility rates are period measures,

4.1 Estimating Age-Specific Fertility Rates And Total Fertility Rates By Religion

Estimated age-specific fertility rates and total fertility rates for six major religious groups are shown in Tables 4.1 and 4.2. These results are obtained by feeding into the regression equations (the equations are shown in chapter three, section 3.2) values of child-woman ratio or percent population aged 0-4 years in the different religious groups. Age-specific fertility rates for the age groups 15-19, 40-44 and 45-49 are predicted from that of age groups 20-24, 35-39 and 40-44 after the latter have been predicted from either one of the two indices. In the two tables, Protestants include Baptist, Lutheran, Pentecostal, Presbyterian, Salvation Army and United Church. On the other hand, Catholics refer to both Roman and Ukrainian Catholics. Prior to 1971, Canadian censuses did not differentiate between Hutterites and Mennonites as two separate religious groups. Both groups were coded as Mennonites and treated as a single religious category.

It is evident from the two tables that Hutterite and Mennonite, Mormon, and Catholic were the high fertility

Table 4.1

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Selected Religious Groups Based on Child-Woman Ratio, Canada, 1951, 1961, 1971

Religion And Year	TFR	Age-Specific Fertility Rates 15-19	20-24	25-29	30-34	35-39	40-44	45-49
Catholic								
1951	3526	51.7	192.4	195.9	139.0	87.8	34.3	4.0
1961	3816	55.9	207.4	208.5	150.6	97.2	38.8	4.7
1971	2170	32.2	122.4	136.9	84.9	43.5	13.1	0.9
Protestant								
1951	2831	41.8	156.6	165.7	111.3	65.1	23.4	2.4
1961	3076	45.3	169.2	176.3	121.0	73.1	27.3	3.0
1971	1855	27.7	106.2	123.2	72.3	33.3	8.2	0.1
Greek Orthodox								
1951	2004	29.9	113.9	129.7	78.2	38.1	10.5	0.5
1961	2294	34.0	128.8	142.3	89.8	47.6	15.1	1.2
1971	2080	31.0	117.8	133.0	81.2	40.6	11.7	0.6
Mormon								
1951	3703	54.3	201.6	203.6	146.1	93.6	37.0	4.5
1961	4074	59.6	220.7	219.7	160.9	105.7	42.8	5.3
1971	2426	35.9	135.6	148.1	95.1	51.9	17.1	1.5
Jewish								
1951	2424	35.6	138.5	147.1	94.2	51.2	16.8	1.4
1961	2109	31.4	119.3	134.3	82.4	41.6	12.2	0.7
1971	1399	21.1	82.4	103.2	53.9	18.2	1.0	0.0
Hutterite and Mennonite								
1951	3332	49.0	182.4	187.5	131.3	[illegible]	31.2	3.6
1961	4138	60.4	223.5	222.1	163.0	[illegible]	43.7	5.5
1971	3079	45.4	169.6	176.5	121.0	73.0	27.2	3.0

Tables 4.2

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Selected Religious Groups Based on Percent Population Aged 0-4 Years, Canada, 1951, 1961, 1971

Religion and Year	TFR	Age-Specific Fertility Rates 15-19	20-24	25-29	30-34	35-39	40-44	45-49
Catholic								
1951	4450	63.6	234.9	235.3	178.7	120.9	50.1	6.4
1961	4505	64.3	237.5	237.7	181.1	122.9	51.0	6.6
1971	2568	38.8	145.9	154.7	99.1	54.8	18.5	1.7
Protestant								
1951	3405	49.8	185.5	190.5	134.5	84.2	32.6	3.8
1961	3428	50.1	186.6	191.6	135.5	85.1	33.0	3.9
1971	1985	31.1	118.4	129.7	74.5	34.4	8.7	0.2
Greek Orthodox								
1951	2395	36.5	137.7	147.9	91.8	48.7	15.6	1.2
1961	2532	38.3	144.2	153.1	97.6	53.6	17.9	1.6
1971	2332	35.7	134.8	144.6	89.2	46.5	14.6	1.1
Mormon								
1951	4631	65.9	243.5	243.1	186.4	127.3	53.2	6.9
1961	4710	67.0	247.2	246.5	189.7	130.1	54.5	7.1
1971	3035	44.9	168.0	174.7	118.9	71.2	26.4	2.9
Jewish								
1951	3216	47.3	176.6	182.5	126.6	77.6	29.4	3.3
1961	2253	34.7	131.1	141.2	85.8	43.8	13.2	0.9
1971	1369	22.8	88.5	102.6	47.8	12.2	0.0	0.0
Hutterite and Mennonite								
1951	4148	59.6	220.6	222.4	165.9	110.3	45.0	5.7
1961	4730	66.7	246.1	245.5	188.7	129.2	61.8	8.2
1971	3054	45.2	168.9	175.5	119.7	71.9	26.7	2.9

groups, and their total fertility rates were similar to each other. On the other hand, women of Greek orthodox faith had the lowest fertility level in 1951 and were replaced by Jewish women in 1961 and 1971. This is similar to the results presented in the 1961 census analytical study though the rank order of the religious groups according to fertility is not exactly the same. For all types of residence, Henripin (1972, p.197) observed that the Hutterites and Mennonites recorded the highest fertility, followed by the Catholics and Mormon women. Yet in most circumstances, fertility preformance of these groups did not differ greatly from each other. On the other hand, the fertility of Protestant and Jewish women was the lowest among all the religious groups.

The 1961 census analytical study indicated that Greek Orthodox women had an intermediary level of fertility rates that was closer to the high fertility religious groups than to the Protestant or Jewish women. The total fertility rates of Greek Orthodox women seemed to be exceptionally low in Tables 4.1 and 4.2, in particular in 1951 and 1961 as the rates closely resembled those of Jewish women. This may be explained by the radical decrease in fertility among women of Greek Orthodox faith as mentioned by Henripin (1972, pp. 200-202).

The age-specific fertility rates generated by the percent population aged 0-4 years as predictor are generally higher than those generated by child-woman ratio. It is believed that the model table based on child-woman ratio under-estimates the fertility rates for Hutterite and Mennonite, Catholic and Mormon, especially in 1951, as the total fertility rates of these groups should far exceed the Canadian average of 3503 children per 1000 women.

From 1961 to 1971, fertility rates had dropped for all the religious groups, in particular the high fertility groups, consequently a convergence in fertility rates among the various groups can be observed (Figure 4.1)[2]. Figure 4.1 shows that Catholics had the most rapid drop in total fertility rates, from 4505 to 2568 children per 1000 women, a difference of 1938 children per 1000 women in ten years. A similar downward trend in fertility rates among Catholic was observed by Balakrishnan, Ebanks and Grindstaff from the 1971 census data. They concluded that this change was largely related to the radical decrease in fertility among French Canadian Catholic since 1960's.

It can also be seen from Figure 4.1 that the total fertility rates of Jewish women dropped between 1951 and 1971, despite the fact that the fertility rates of other religious groups recovered slightly in 1961. This rise in fertility in the late fifties was primarily due to the making up of postponed births and marriages and early timing of births. The total fertility rate of Jewish women declined from 3216 children per 1000 women in 1951 to 1369 children per 1000 women in 1971, a decline of 57 per cent over a

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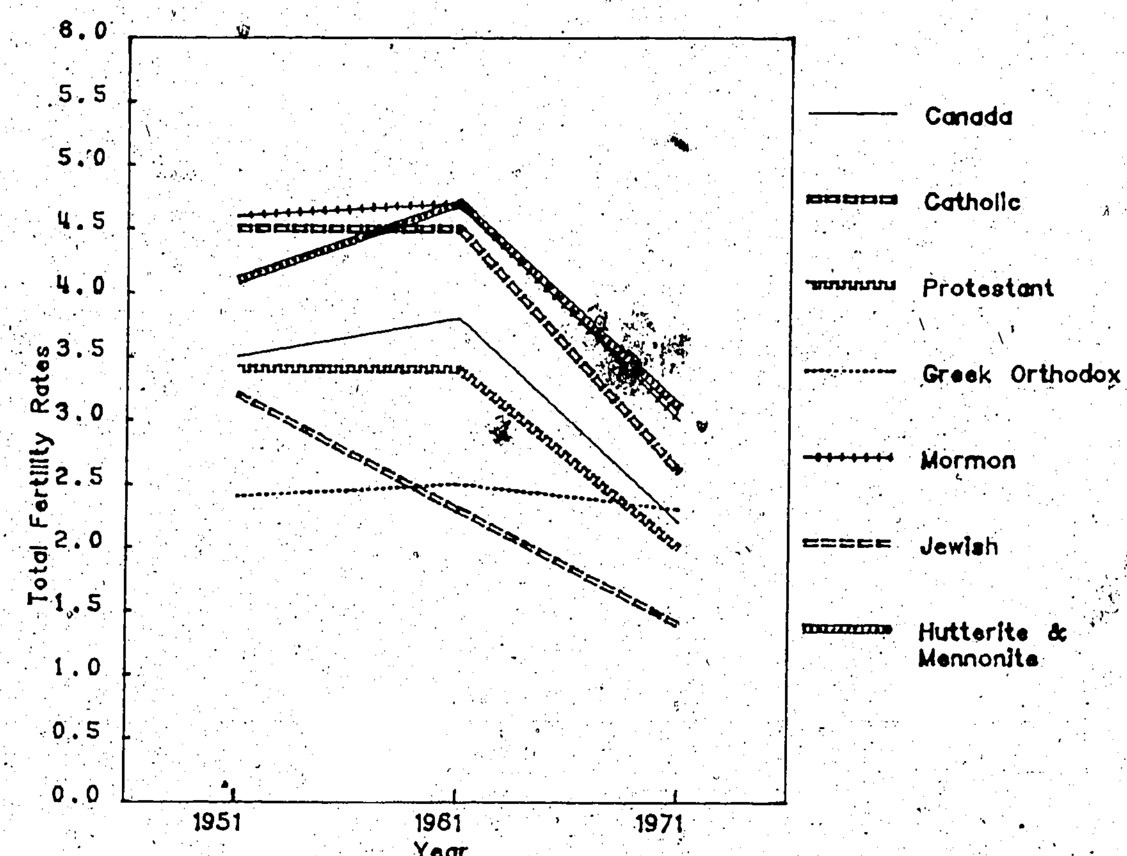
[2]This figure is based on Table 4.2.

Figure 4.1

Total Fertility Rates for Selected Religious Groups, Canada, 1951, 1961 and 1971



period of twenty years.

4.2 Estimates Of Age-Specific Fertility Rates And Total Fertility Rates For Selected Ethnic Groups

Canada is an ethnic mosaic where different ethnic groups are permitted to preserve their culture and traditions. Many researchers have exploited the ethnicity data from Canadian censuses to point out the differentials in fertility. Based on the former two sets of equations, age-specific fertility rates and total fertility rates for various ethnic groups are generated in Tables 4.3 and 4.4. These rates are obtained by using ethnic group specific child-woman ratio and percent of the population aged 0-4 years as predictors.

Ethnicity is a vague variable as it does not represent an individual's self-identification with a particular cultural group. And the definition of ethnicity of a Canadian resident does not indicate the generation to which that person belongs. In addition, it does not give any weightage to the ethnicity on the female's (mother's) side and to the possibility of miscegenation. The dimensions of acculturation and assimilation are also ignored in the census definition. In spite of all these, researchers continue to identify fertility differentials among various ethnic groups.

It can be seen from Tables 4.3 and 4.4 that in terms of rank from high to low fertility, for the same year the

Table 4.3

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Selected Ethnic Groups Based on Child-Woman Ratio, Canada, 1951, 1961, 1971

Ethnic Group, Year	TFR	Age-Specific Fertility Rates						
		15-19	20-24	25-29	30-34	35-39	40-44	45-49
British Isles								
1951	2994	44.1	165.0	172.8	117.8	70.4	26.0	2.8
1961	3148	46.3	172.9	179.5	123.9	75.4	28.4	3.2
1971	2095	31.2	118.6	133.7	81.9	41.1	12.0	0.7
French								
1951	3616	53.0	197.1	199.8	142.6	90.7	35.7	4.3
1961	3662	53.7	199.5	201.8	144.4	92.2	36.4	4.4
1971	1923	28.6	109.4	126.0	74.8	35.3	9.2	0.3
German								
1951	2913	42.9	160.8	169.3	114.5	67.8	24.7	2.6
1961	3476	51.0	189.9	193.7	137.0	86.2	33.5	3.9
1971	1985	29.6	112.7	128.9	77.5	37.5	10.2	0.4
Italian								
1951	2585	38.2	143.8	155.0	101.4	57.1	19.6	1.8
1961	3850	56.4	209.2	210.0	151.9	98.4	39.3	4.8
1971	2696	39.8	149.6	159.8	105.8	60.7	21.3	2.1
Jewish								
1951	2516	37.2	140.3	152.0	98.7	54.8	18.5	1.7
1961	2271	33.7	127.6	141.3	88.9	46.8	14.7	1.1
1971	1444	21.8	84.7	105.2	55.7	19.7	1.7	0.0
Netherlands								
1951	3208	47.2	176.0	182.1	126.3	77.4	29.3	3.3
1961	4347	63.5	234.8	231.6	171.8	114.6	47.1	6.0
1971	2387	35.4	133.6	146.4	93.5	50.6	16.5	1.4
Polish								
1951	2450	36.3	136.9	149.1	96.0	52.7	17.5	1.5
1961	3058	45.0	168.3	175.5	120.3	72.5	27.0	2.9
1971	1401	21.1	82.5	103.3	53.9	18.3	1.1	0.0
Scandinavian								
1951	3022	44.5	166.4	174.0	118.9	71.4	26.4	2.9
1961	3287	48.3	180.1	185.5	129.4	80.0	30.5	3.5
1971	1838	27.5	105.3	122.5	71.6	32.7	8.0	0.1

Table 4.3 (continued)

Ethnic Group, Year	TFR	Age-Specific Fertility Rates 15-19	20-24	25-29	30-34	35-39	40-44	45-49
Ukrainian								
1951	2432	36.0	135.9	148.3	95.3	52.1	17.2	1.5
1961	2983	43.9	164.4	172.3	117.3	70.1	25.8	2.8
1971	1631	24.5	94.5	113.4	63.2	25.9	4.7	0.0
Indian and Inuit								
1951	5112	74.5	274.3	264.9	202.3	139.5	59.0	7.8
1961	5999	87.3	320.1	303.5	237.7	168.5	72.8	9.9
1971	4573	66.8	246.5	241.4	180.8	121.9	50.6	6.5
Asian								
1951	2684	39.6	149.0	159.3	105.4	60.3	21.1	2.1
1961	4150	60.7	224.7	223.1	163.9	108.2	44.0	5.5
1971	2529	37.4	141.0	152.5	99.2	55.3	18.7	1.7

Table 4.4

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Selected Ethnic Groups Based on Percent Population Aged 0-4 Years, Canada, 1951, 1961, 1971

Ethnic Group, Year	TFR	15-19	20-24	25-29	30-34	35-39	40-44	45-49
		Age-Specific Fertility Rates						
British Isles								
1951	3574	52.0	193.5	197.8	141.7	90.2	35.4	4.2
1961	3452	50.4	187.7	192.6	136.5	85.9	33.4	3.9
1971	2261	34.8	131.4	141.5	86.2	44.1	13.4	0.9
French								
1951	4604	65.6	242.2	241.9	185.2	126.3	52.7	6.8
1961	4368	62.5	231.0	231.8	175.2	118.0	48.7	6.2
1971	2269	34.9	131.8	141.9	86.5	44.3	13.5	0.9
German								
1951	3621	52.7	195.7	199.8	143.7	91.8	36.2	4.3
1961	4277	61.3	226.7	227.9	171.4	114.9	47.2	6.0
1971	2292	35.2	132.9	142.9	87.5	45.2	13.9	1.0
Italian								
1951	3177	46.8	174.7	180.8	124.9	76.2	28.7	3.2
1961	4910	69.6	256.7	255.1	198.2	137.1	57.8	7.6
1971	3283	48.2	179.7	185.3	129.4	79.9	30.5	3.5
Jewish								
1951	3342	49.0	182.5	187.8	131.9	82.0	31.5	3.6
1961	2402	36.6	138.1	147.6	92.2	49.0	15.7	1.3
1971	1440	23.8	92.2	106.0	51.1	14.9	0.0	0.0
Netherlands								
1951	3979	57.4	212.6	215.1	158.8	104.4	42.2	5.2
1961	5071	71.7	264.3	262.0	205.0	142.8	60.5	8.0
1971	2701	40.5	152.2	160.4	104.8	59.5	20.8	2.0
Polish								
1951	3255	47.8	178.4	184.1	128.2	79.0	30.1	3.4
1961	3387	49.2	183.4	188.7	137.7	82.7	31.8	3.7
1971	1496	24.6	95.0	108.5	53.6	17.0	0.4	0.0
Scandinavian								
1951	3405	49.8	185.5	190.5	134.5	84.2	23.6	3.8
1961	[illegible]	53.0	196.8	200.8	144.7	92.6	36.6	4.4
1971	[illegible]	30.9	117.5	128.9	73.7	33.7	8.4	0.2

Table 4.4 (continued)

Ethnic Group, Year	TFR	Age-Specific Fertility Rates 15-19	20-24	25-29	30-34	35-39	40-44	45-49
Ukrainian								
1951	3279	48.1	179.5	185.2	129.2	79.8	30.5	3.5
1961	3598	52.3	194.6	198.9	142.7	91.0	35.8	4.3
1971	1744	27.9	106.9	119.3	64.2	25.8	4.7	0.0
Indian and Inuit								
1951	5653	79.4	291.8	286.9	229.6	163.2	70.3	9.5
1961	6412	89.4	327.6	319.4	261.7	189.8	83.0	11.4
1971	5197	73.4	270.2	267.4	210.3	147.2	62.7	8.3
Asian								
1951	2351	35.9	135.7	145.4	90.0	47.2	14.9	1.1
1961	4438	63.4	23[illegible].4	234.8	178.2	120.5	49.9	6.4
1971	3279	48.1	179.5	185.2	129.2	79.8	30.5	3.5

ordering is not the same in both tables. Broadly speaking, Indian and Inuit, Italian and Netherland people exhibit high fertility levels while Jewish, Ukrainian and Polish people are characterized by low fertility rates. The two census analytical studies also found that the Indian and Inuit women recorded the highest and the Jewish women the lowest fertility. Balakrishnan, Ebanks and Grindstaff concluded that the fertility of the Indian and Inuit was more than double that of the Jewish group. This phenomenon can also be detected in tables 4.3 and 4.4.

In 1951, Indian and Inuit women were remarkably more fertile than women of other ethnic groups. On the other hand, Ukrainian women (Table 4.3) and Asian women (Table 4.4) were the least fertile. The Asian people had very low fertility rate in 1951 because many of the small number of Asians in Canada were highly educated professionals. For the other low fertility groups, such as Jewish, Ukrainian, Polish and Italian, their ordering in terms of fertility was not very meaningful because they had very similar total fertility rates.

In 1961, the highest fertility group was the Indian and Inuit while the group that had the lowest fertility rate was the Jew. It can be seen from Tables 4.3 and 4.4 that in the post-war baby boom years the Jewish people were still characterized by a low fertility level of having a total fertility rate of about two children while other ethnic groups had completed family size of three or more children.

The rank order of ethnic groups in terms of fertility did not manifest any drastic change in 1971. Indian and Inuit women still had the largest completed family size while Polish and Jewish people had the lowest. A point worth mentioning is the rapid decline of fertility rates among French women. Between 1961 and 1971, the total fertility rate of French ethnic group dropped by about two children. In the latter year, French fertility level was either very similar to or lower than the fertility level of British women. This convergence in fertility rates between the French and the British is also mentioned in the 1971 census analytical studies.

4.3 Estimates Of Age-Specific And Total Fertility Rates For Mother Tongue Groups

Mother tongue is considered by many demographers as an important variable to identify cultural groups. However, for a Canadian of second or higher order generation, his own mother tongue is usually replaced by English because of the overpowering influence of the English language in Canada. This phenomenon is becoming more obvious in recent years because many new arrivals can speak and understand English fluently. In addition, for many mixed marriages, English is usually selected as the mother tongue for the children.

Following the same procedures two sets of fertility estimates by mother tongue were generated based on the regression equations (Tables 4.5 and 4.6). Eight mother tongue groups were selected initially but the percentage of 0-4 children is so low in some groups that the estimated age-specific fertility rates and total fertility rates of such groups are not meaningful. Therefore the following analysis will concentrate on only four mother tongue groups which are English, Italian, French and Indian and Inuit.

It can be seen from the two tables that Italian had very low fertility in 1951. In view of the small number of cases, these estimates do not seem to be realistic. From then on, the total fertility rates are within reasonable limits as many Italians immigrated to Canada starting from 1951.

For all the three years, the Indian and Inuit population had the highest fertility rate, and the Italian speaking group had the lowest fertility levels in 1951 and 1961. French speaking women had the lowest fertility level in 1971. In 1951, French speaking population experienced higher fertility than the English speaking group which reflected the past high fertility performance of French people. Starting from 1961, French-speaking group had similar but lower fertility than English-speaking group. In the 1971 census analytical study, Balakrishnan, Ebanks and Grindstaff also observed a rapid decline in fertility rates among young French-speaking women between the ages of 15 and 34. They also found that their fertility was lower than that of the English-speaking women. The difference in fertility rates between the two groups is larger in 1971 which is

Table 4.5

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Selected Mother Tongue Groups Based on Child-Woman Ratio, Canada, 1951, 1961, 1971

Mother Tongue, Year	TFR	Age-Specific Fertility Rates						
		15-19	20-24	25-29	30-34	35-39	40-44	45-49
English								
1951	3368	49.5	184.3	189.0	132.7	82.6	31.8	3.7
1961	3848	56.4	209.0	209.9	151.8	98.3	39.3	4.8
1971	2368	35.1	132.6	145.5	92.8	50.0	16.2	4.3
Italian								
1951	941	14.0	56.7	84.6	34.0	2.0	0.0	0.0
1961	3105	45.7	170.7	177.6	122.2	74.1	27.7	3.1
1971	2144	31.9	121.1	135.8	83.8	42.7	12.7	0.8
French								
1951	3478	51.0	189.9	193.8	137.1	86.2	33.5	3.9
1961	3409	50.1	186.4	190.8	134.3	84.0	32.5	3.8
1971	1815	27.2	104.1	121.5	70.7	32.0	7.6	0.0
Indian and Inuit								
1951	4938	72.0	265.4	257.3	195.4	133.9	56.3	7.4
1961	5214	76.0	279.6	269.3	206.4	142.9	60.6	8.0
1971	4611	67.3	248.5	243.1	182.3	123.2	51.2	6.6

Table 4.6

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Selected Mother Tongue Groups Based on Percent Population Aged 0-4 Years, Canada, 1951, 1961, 1971

Mother Tongue, Year	TFR	15-19	20-24	25-29	30-34	35-39	40-44	45-49
		Age-Specific Fertility Rates						
English								
1951	4073	58.6	217.1	219.2	162.8	107.7	43.8	5.5
1961	4238	60.8	224.9	226.3	169.8	133.5	46.6	5.9
1971	2627	39.6	148.7	157.2	101.6	56.9	19.5	1.8
Italian								
1951	905	15.5	62.3	78.9	24.4	0.0	0.0	0.0
1961	4093	58.9	218.0	220.0	163.6	108.4	44.1	5.5
1971	2729	40.9	153.5	161.6	105.9	60.5	21.2	2.1
French								
1951	4431	63.3	234.0	234.5	177.9	120.3	49.8	6.4
1961	4101	59.0	218.4	220.4	163.9	108.7	44.2	5.6
1971	2143	33.2	125.9	136.5	81.2	39.9	11.4	0.6
Indian and Inuit								
1951	5437	76.5	281.5	277.6	220.4	155.6	66.7	8.9
1961	5345	80.0	294.0	288.9	231.6	164.8	71.1	9.6
1971	5064	71.6	263.9	261.6	204.7	142.5	60.4	8.0

about 500 children per 1000 women. On the other hand, the difference in total fertility rates between people of British and French ethnic origin was about 172 children per 1000 women. The difference between the two groups is more pronounced by mother tongue than by ethnicity indicates that the drastic decline in fertility rates of the French population is mainly attributable to the French-speaking group, who are mostly resided in Quebec.

Between 1961 and 1971, all mother tongue groups experienced a drop in their fertility rates but the French had the steepest decline (Figure 4.2)[3]. The total fertility rate of French speaking women dropped from 4101 children per 1000 women in 1961 to 2143 children per 1000 women in 1971, a decline of 48 per cent in a period of ten years. As a result the total fertility rate of French speaking people was even lower than the Canadian average in 1971. Figure 4.2 also shows that the Indian and Inuit had little variation in their fertility rates within the twenty years. Although the total fertility rates of other mother tongue groups were converging to the Canadian average in 1961 and 1971, the Indian's and Inuit's rates remained high as compared to those of Canada as a whole.

From these results we see that fertility differentials exist among the various social groups in Canada. Overall, the differences among the various ethnic, religious and mother tongue groups seem to be narrowing. Since 1961 the

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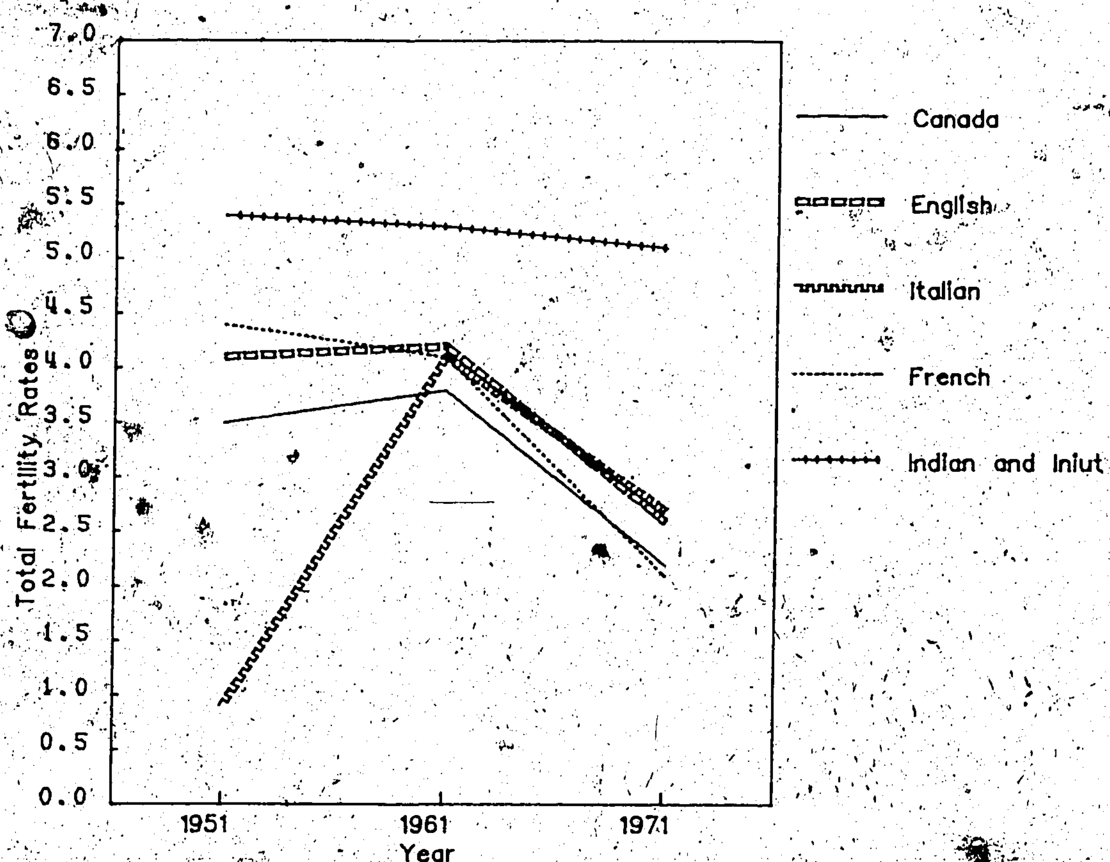
[3]This figure is based on Table 4.6

Figure 4.2

Total Fertility Rates for Selected Mother Tongue Groups, Canada, 1951, 1961 and 1971



fertility rates of some of the high fertility groups (eg., Catholic, Mormon, French ethnic origin and French-speaking groups) are moving down to the national level. Yet, the fertility rates of some cultural and religious groups like the Indian and Inuit and the Jews are basically unchanged in the past twenty years. Therefore cultural variables do seem to be important for fertility analysis in Canada.

5. Age-Specific Fertility Rates in Newfoundland: Results From Model Fertility Tables

Unlike other provinces in Canada, age-specific fertility rates for Newfoundland are not available because the birth data by age of mother are not collected as a part of the vital registration system. This makes fertility analysis difficult for Canada as a whole and for this province in particular. Crude birth rates and general fertility rates are the fertility indices that are readily calculated from vital statistics. In order to obtain more refined fertility measures, appropriate indirect estimation procedures have to be employed. One procedure is to apply model fertility tables to Newfoundland and generate the necessary estimates.

In chapter three, two model fertility tables based on crude birth rate and general fertility rate were constructed using Canadian data between the years 1921 and 1979. These two sets of equations are utilized to estimate age-specific fertility rates and total fertility rates for Newfoundland in this chapter. An evaluation of the results is also done by comparing the estimated age-specific fertility rates and total fertility rates with those estimated from administration records by Statistics Canada (Perreault, George and Duclos, 1982).

5.1 Estimates Of Age-Specific Fertility Rates

Estimated age-specific fertility rates and total fertility rates for Newfoundland of the census years from 1921 to 1976 are shown in Tables 5.1 and 5.2 based on the two sets of equations. Table 5.2 does not include estimates for 1921, 1931 and 1941 because Newfoundland was not included in the Canadian census prior to 1951. It is because Newfoundland had not joined the Confederation until 1949. Hence, general fertility rates for Newfoundland before 1951 cannot be computed. Yet crude birth rates of the earlier years are available because the registration of vital events are the responsibility of the separeate provinces and territories.

Results in Tables 5.1 and 5.2 are generated by feeding into the two sets of regression equations values of crude birth rates or general fertility rates for Newfoundland for selected years. Age-specific fertility rates for the age groups 15-19, 20-24, 40-44 and 45-49 are predicted from that of age groups 20-24, 25-29, 35-39 and 40-44 after the latter have been predicted from crude birth rates. The same procedures are employed to generate age-specific fertility rates for the age groups 15-19, 40-44 and 45-49 in Table 5.2. On the whole, the values estimated by the latter set of equations are higher than those estimated by the first one, especially in the post-war baby boom years. However, the fertility rates in the two tables are becoming more similar in 1970's.

Table 5.1

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Newfoundland Based on Crude Birth Rate, 1921-1976

		Age-Specific Fertility Rates						
Year	TFR	15-19	20-24	25-29	30-34	35-39	40-44	45-49
1921	3909	53.8	200.6	208.6	161.1	107.9	44.4	5.3
1931	3287	45.7	171.8	182.7	134.2	85.6	33.5	3.8
1941	3925	54.1	201.4	209.3	161.8	108.5	44.7	5.3
1951	4754	65.0	239.7	243.9	197.6	138.3	59.1	7.3
1956	5153	70.2	258.2	260.5	214.8	452.7	66.1	8.2
1961	5009	68.3	251.6	254.5	208.6	147.5	63.6	7.9
1966	4116	56.6	210.2	217.3	170.0	115.4	48.0	5.8
1971	3478	48.2	180.7	190.7	142.5	92.5	36.9	4.3
1976	2760	38.7	147.5	160.7	111.5	66.7	24.4	2.6

Table 5.2

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Newfoundland Based on General Fertility Rate, 1951-1976

		Age-Specific Fertility Rates						
Year	TFR	15-19	20-24	25-29	30-34	35-39	40-44	45-49
1951	5118	70.0	257.3	262.4	212.2	149.3	64.4	8.0
1956	5724	78.0	285.6	288.8	238.0	170.4	74.7	9.3
1961	5617	76.6	280.7	284.1	233.4	166.7	72.8	9.1
1966	4543	62.3	230.5	237.5	187.7	129.3	54.7	6.7
1971	3666	50.7	189.6	199.3	150.3	98.7	39.9	4.7
1976	2749	38.5	146.8	159.5	111.3	66.7	24.4	2.6

Similar to the pattern of the age-specific fertility rates of Canada, the estimated values in the two tables exhibit the same inverted U-shaped pattern with the peaking of fertility at 25-29. In both tables, there is a sharp increase in the age-specific fertility rates from ages 15-19 to 20-24 then a steady decrease from the age group 30-34 onwards. The fertility rates of the age groups 20-24 and 25-29 are very similar with an average difference of about six points.

Changes in fertility behaviour throughout the years can be observed in Figure 5.1. The age-specific fertility rates for all the age groups were moderately high in 1921; they dropped to a low level in 1931, the depression years; the rates reverted to high levels during the war and the post war years; and then they declined consistently after 1961.

In order to examine the fertility trends in Newfoundland more closely, the total fertility rates derived by crude birth rates are compared with those of Canada as a whole and other Atlantic provinces (Table 5.3). This table is used instead of the one based on general fertility rates because information prior to 1951 can also be obtained by this table. Table 5.3 shows that the total fertility rates of Newfoundland were greater than those of Canada as a whole and of the other Atlantic provinces except in 1921 and 1931. In 1921, New Brunswick's total fertility rate was higher than that of Newfoundland. Among the Atlantic provinces, Newfoundland had the lowest total fertility rate in 1931

Figure 5.1

Age-Specific Fertility Rates for Newfoundland Based on Crude Birth Rate, 1921-1971

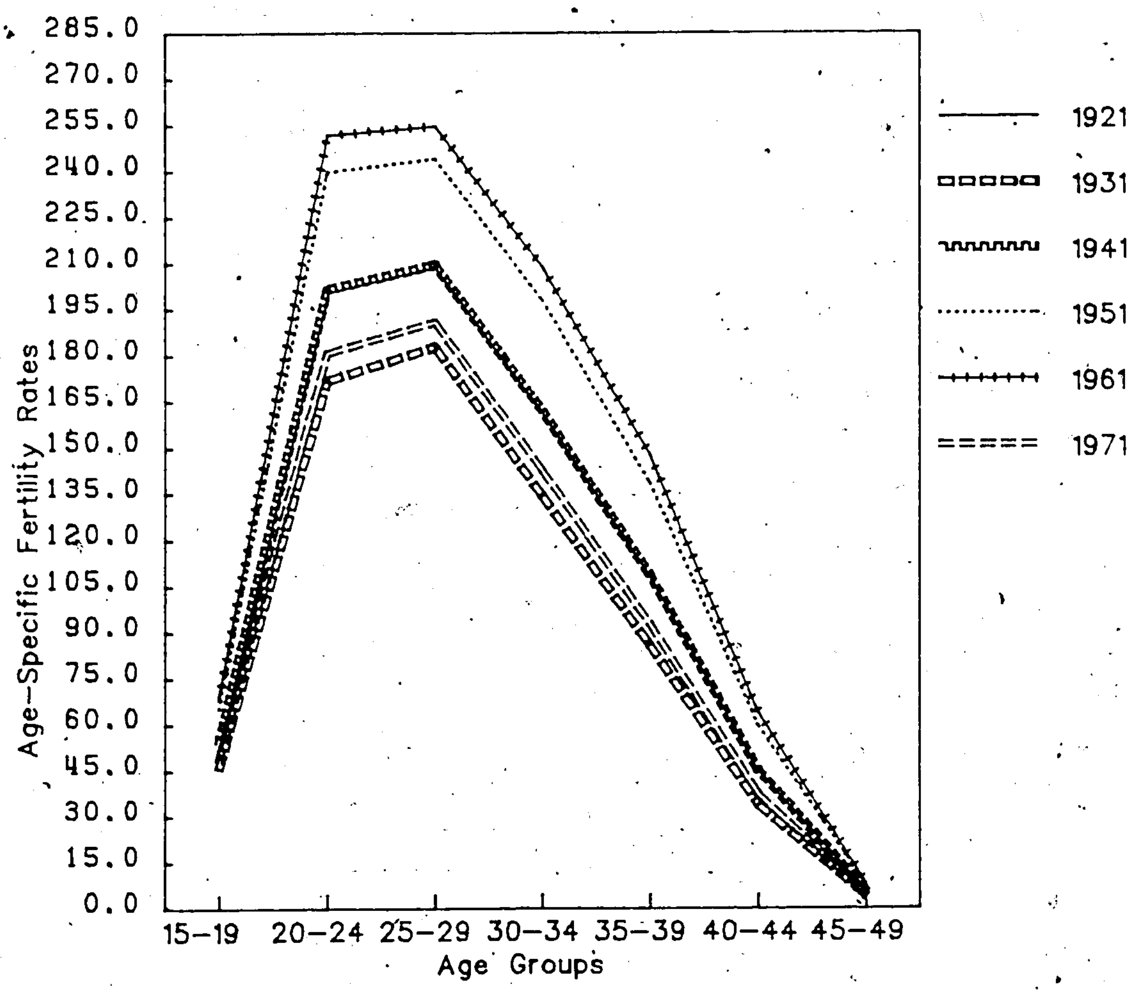


Table 5.3

Crude Birth Rates and Total Fertility Rates for Newfoundland, Canada, Prince Edward Island, Nova Scotia and New Brunswick, 1921-1979

Year	Nfld. CBR	Nfld. TFR	Canada CBR	Canada TFR	P.E.I. CBR	P.E.I. TFR	N.S. CBR	N.S. TFR	N.B. CBR	N.B. TFR
1921	27.2	3909	29.3	3536	24.3	3779	24.9	3585	30.2	4269
1931	23.3	3287	23.2	3200	21.3	3521	22.6	3397	26.5	3990
1941	27.3	3925	22.4	2832	21.6	3228	24.1	3097	26.8	3688
1951	32.5	4754	27.2	3503	27.1	4189	26.6	3682	31.2	4378
1956	35.0	5153	28.0	3858	26.8	4542	27.5	4092	29.9	4576
1961	34.1	5009	26.1	3840	27.1	4881	26.3	4159	27.7	4543
1966	28.5	4116	19.4	2812	20.3	3578	20.1	3150	20.6	3312
1971	24.5	3478	16.8	2187	18.8	2909	18.1	2503	19.2	2667
1976	20.0	2760	15.7	1825	16.4	2140	15.5	1882	17.4	2070
1977	19.8	2728	15.5	1806	16.4	2076	14.8	1771	16.8	1958
1978	18.4	2505	15.3	1757	16.3	2043	14.9	1765	15.5	1781
1979	17.7	2393	15.5	1764	15.7	1968	14.6	1708	15.5	1758

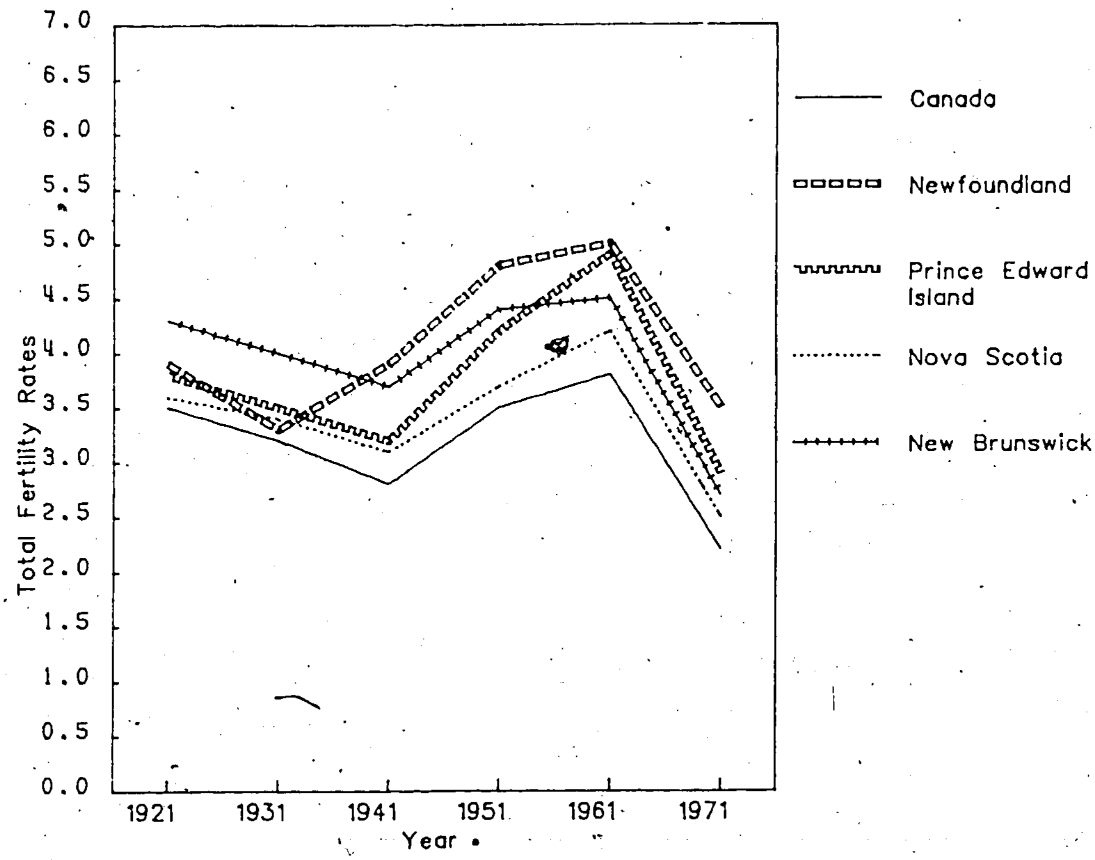
although it was still slightly larger than that of Canada as a whole.

Table 5.3 and Figure 5.2 show that throughout the years, the maritime provinces have higher total fertility rates than those of Canada as a whole (with three exceptions). The total fertility rates of Newfoundland are consistently closer to Prince Edward Island than to other provinces. Since 1939, the crude birth rate of Newfoundland is among the highest within Canada. These may suggest that the maritime provinces have a slightly different pattern of fertility when compared with the other provinces in Canada. Therefore it may be worthwhile to examine the fertility behavior of the Atlantic provinces separately. In Appendix B, model fertility tables for the maritime provinces are constructed on the basis of the experience of the maritime provinces between the years 1921 and 1979. These model tables are utilized to estimate the fertility rates for Newfoundland.

Similar to Canada, there has been a steady downward trend in Newfoundland's fertility rates starting from 1961. A similar trend can also be detected in the crude birth rate (Table 5.3). The total fertility rate of Newfoundland declined from 5009 in 1961 to 2393 in 1979, a decline of 52 per cent over a period of eighteen years. During the same period, Canada's rate declined by 54 per cent. Therefore, Newfoundland's fertility decline is similar to that of Canada in this span of time.

Figure 5.2

Total Fertility Rates for Canada, Newfoundland, Prince Edward Island, New Brunswick and Nova Scotia, 1921-1971



Source: Statistics Canada (formerly Dominion Bureau of Statistics), Vital Statistics, 1921-1971.

A convergence of Newfoundland's fertility rates to the national level can also be observed in Table 5.3. In 1961, the difference in total fertility rate between Canada and Newfoundland was 1.2 children while it was 0.6 in 1979. This rapid convergence between the national and the provincial fertility rates can also be detected in the crude birth rates. A difference in the crude birth rates of 8 points between Canada and Newfoundland in 1961 has dropped to 2.2 points in 1979.

5.2 Comparison With Statistics Canada's Study

In view of the ever present footnote noting that fertility rates are not available for Newfoundland, Statistics Canada (Perreault, George and Duclos, 1982) used administrative records to estimate fertility rates for Newfoundland, 1966 to 1979. The data were derived from the province's hospital morbidity file, which contained "information on the number of deliveries by province of residence and age of mother at the time of delivery." After evaluating the data by comparing it with registered births, Perreault, George and Duclos concluded that the coverage of the data on births based on hospital records were complete.

The fertility rates were generated by using the distributions of deliveries by age of mother. However minor adjustments were required because the total number of deliveries based on the administrative records did not correspond with the registered number of births from vital statistics. The adjustments were made by "multiplying the age-specific deliveries for each year by the corresponding ratio of the total registered births to the total deliveries according to the hospital records." The adjusted age-specific births for each year were then divided by the corresponding mid-year female population to produce the age-specific fertility rates for the ages 15 to 49. The total fertility rates and mean age of fertility are also presented in the Perreault-George-Duclos paper.

In order to evaluate fertility rates estimated by the two model tables in the previous section, total fertility rates derived from crude birth rates are compared with those calculated from administrative records. It can be seen from Table 5.4 that the ratios of the two total fertility rates are close to unity between the years 1968 and 1973 inclusively. Within the fourteen years, the two series of data indicate the same yearly fertility fluctuations except for 1971. Starting from the latter half of 1970's, the difference between the two rates seems to increase. This is because Newfoundland is undergoing a more rapid decline in fertility than is indicated by crude birth rates. Consequently the age-specific fertiltiy rates generated from crude birth rates tend to overestimate the fertility levels especially for the age groups 25-29 and over.

The estimated values from Statistics Canada indicate a younger age pattern of childbearing in Newfoundland than in the other maritime provinces. The peak age of fertility is

Table 5.4

Estimated Total Fertility Rates for Newfoundland Based on Crude Birth Rate and Administrative Data, 1966 to 1979

Year (1)	Estimated CBR (2)	TFR Based On Admin. Data (3)	Column(2)/Column(3) (4)
1966	4.12	4.55	0.905
1967	3.67	3.98	0.922
1968	3.61	3.80	0.950
1969	3.61	3.68	0.981
1970	3.45	3.46	0.997
1971	3.48	3.40	1.024
1972	3.43	3.27	1.049
1973	3.08	3.11	0.990
1974	2.95	2.67	1.105
1975	2.82	2.49	1.133
1976	2.76	2.37	1.165
1977	2.73	2.32	1.177
1978	2.51	2.14	1.173
1979	2.39	2.07	1.155

at the 20-24 age group in Newfoundland rather than the 25-29 age group as in the other Atlantic provinces. This younger age pattern of childbearing is not reflected in the values estimated by the model tables as among the provinces in Canada, only Saskatchewan has similar age pattern of fertility as Newfoundland. The administrative records, however, are unpublished and not readily available. Therefore the construction of model tables to derive the fertility rates for Newfoundland is useful even though there are minor variations in the results.

6. Pearsonian Type I Curve And Its Potential As A Model

In this chapter another mathematical model, namely the Pearsonian Type I curve will be examined as a means of graduation of age-specific fertility rates. In the first section, data source and methodology for generating the parameters of the model are discussed. Section two deals with the empirical verification of the curve as a means of graduation and its potential as a model. Then the Pearsonian Type I curve's potentials for birth projections are described in the final section.

6.1 Data Source and Methodology

It was mentioned elsewhere in the thesis that Mitra and Romaniuk (1973) have utilized Canadian data on fertility by single years of age from 1926 to 1969 to derive the parameters of the Type I curve. Age-specific fertility rates for Canada from 1970 to 1979 taken from the births section of vital statistics are utilized in this study.

With the origin at the mode, the equation of the Type I curve is:

$$y = y_0(1 + x/a_1)^{m_1}(1 - x/a_2)^{m_2} \qquad (1)$$

where

$$-a_1 \leq x \leq a_2 .$$

Also,

$$m_1/a_1 = m_2/a_2 \qquad (2)$$

In formula (1), y_0 is the modal fertility rate, which in human populations occurs between 20 and 30 years of age. The constants a_1 and a_2 jointly determine the reproductive interval and m_1 and m_2 determine the shape of the fertility curve. When m_1 and m_2 are approximately equal, the curve approaches a normal distribution, and it is positively skewed when $m_1 < m_2$.

The selection of a particular curve from the whole system of Pearsonian curves is based on the value of a criterion called k, given by:

$$\frac{B_1(B_2 + 3)^2}{4(2B_2 - 3B_1 - 6)(4B_2 - 3B_1)}$$

Pearson recommends that the Type I curve should be used when k has a negative value. It can be seen in Table 6.1 that for Canada from 1970 to 1979 k has a negative value, and therefore it is appropriate to use the Type I curve.

In order to determine the relative distribution of fertility by age by means of the Pearsonian Type I curve, values for the constants a_1, a_2, m_1 and m_2 are needed. The most commonly used procedure is the method of moments. In the Elderton (1930) procedure, the constants are calculated from the first four moments of the frequency distribution, that is, from the mean, variance, measures of skewness and

Table 6.1

Parameters Of Canadian Fertility Distribution
By Five Year Age Group, 1970-1979

Year	TFR	Mean Age	Variance	Measure of Skewness B_1	Measure of Kurtosis B_2	Criterion k
1970	2331	27.16	33.64	0.312	2.905	-0.226
1971	2187	27.05	32.05	0.296	2.944	-0.240
1972	2024	26.99	31.09	0.264	3.008	-0.273
1973	1931	26.82	29.85	0.265	3.021	-0.283
1974	1875	26.79	28.67	0.241	3.068	-0.327
1975	1852	26.69	27.93	0.239	3.105	-0.375
1976	1825	26.74	27.31	0.204	3.040	-0.303
1977	1806	26.78	26.62	0.169	2.999	-0.260
1978	1757	26.87	26.27	0.158	3.026	-0.293
1979	1764	26.95	25.57	0.133	2.985	-0.241

kurtosis. Recently, Mitra (1967) has developed a procedure that utilizes only the first two moments of the observed distribution and the sum total of the age-specific fertility rates to estimate the four parameters. But this procedure assumes a fixed age interval of fertility. This assumption is realistic as children are rarely born before and after certain ages of the mother. For all practical purposes, the range of fertile ages may be taken as 15-50 years. Thus,

$$a_1 + a_2 = 50 - 15 = 35 . \tag{3}$$

With equations (2) and (3), the required number of independent parameters is reduced to two, and the solutions are obtained from the following equations:

$$m_1 + m_2 = \frac{U_1'(a_1 + a_2 - U_1')}{U_2} - 3 \tag{4}$$

and

$$m_1 = \frac{m_1 + m_2 + 2}{a_1 + a_2} U_1' - 1 , \tag{5}$$

then

$$m_2 = (m_1 + m_2) - m_1 . \tag{6}$$

In equations (4) and (5), u_1' represents the mean counted with the starting point at age 15 and u_2, the variance. Furthermore, equations (2) and (3) can be used to determine a_1 and a_2. Equation (2), that is,

$$\frac{m_1}{a_1} = \frac{m_2}{a_2}$$

also equals to

$$\frac{m_1 + m_2}{a_1 + a_2} = \frac{m_1 + m_2}{35} .$$

Then,

$$a_1 = \frac{35}{m_1 + m_2} m_1 ,$$

and

$$a_2 = 35 - a_1 .$$

Finally, the expected value of the age-specific fertility rate for any age group can be obtained through incomplete Beta function.

The reduction in the number of moments may entail some loss in the goodness of fit, however, it presents some definite analytical and operational advantages. The use of a less sophisticated graduation formula means a significant reduction in computation. In the original formula of the Type I curve, there are several parameters therefore it is extremely difficult to relate, for example, the effect of a reduction in the total fertility rate on the modal age, the fertile age span, etc. The restriction on the fertility interval makes the interpretation of the remaining parameters relatively simple and perhaps more meaningful.

Mitra and Romaniuk (1973) further simplified the procedure for calculating the constants by using the first moment of the distribution, the mean and the mode. This method, however, is appropriate only when the age-specific fertility rates are available by single year.

In this study, Mitra's procedure is used to derive the constants in the equation of the Type I curve as age-specific fertility rates are available by five year age groups only. The constants are also derived by the method of the four moments for the purpose of comparison. As grouped data are used to calculate the moments, Sheppard's corrections are used to correct any distortion introduced by the approximation that the frequencies are assumed to be concentrated at the mid-points of the intervals[4].

6.2 Empirical Verifications Of The Model

In order to decide on the suitability of the Pearsonian Type I curve as a means of graduation of age-specific fertility rates, the model has to be submitted to some empirical tests. Since the main concern is with the model's potential for birth projections, that is, the annual number of births at any year, this variable is employed in the empirical tests. To calculate the number of births in any given year, one merely multiplies the number of women at

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[4]Refer to Appendix C for the estimates parameters without Sheppard's corrections.

Table 6.2

Model's Output Obtained by Elderton's Procedure for Canada, 1970-1979

Year	a_1	a_2	m_1	m_2	Derived Number Of Births B	Actual Number Of Births B'	Ratio of B/B'
1970	8.67	30.88	1.42	5.06	370,850	371,988	0.9969
1971	9.33	32.26	1.77	6.12	356,318	362,187	0.9838
1972	10.91	36.94	2.61	8.85	341,962	347,319	0.9846
1973	10.85	37.11	2.72	9.30	338,376	343,373	0.9854
1974	12.16	42.59	3.71	12.99	342,095	350,650	0.9756
1975	12.67	46.87	4.27	15.80	352,416	359,323	0.9808
1976	12.96	42.62	4.36	14.34	354,113	359,987	0.9837
1977	13.73	41.28	4.88	14.67	358,652	361,400	0.9924
1978	14.85	46.34	5.96	18.60	355,758	358,852	0.9914
1979	15.29	43.22	6.27	17.71	363,423	366,064	0.9928

Table 6.3

Model's Output Obtained by Mitra's Procedure for Canada, 1970-1979

Year	a_1	a_2	m_1	m_2	Derived Number Of Births B	Actual Number Of Births B'	Ratio Of B/B'
1970	10.03	24.87	1.52	3.74	375,540	371,988	1.0095
1971	10.11	24.89	1.63	4.00	359,457	362,187	0.9925
1972	10.12	24.88	1.70	4.18	342,185	347,319	0.9852
1973	9.98	25.02	1.76	4.42	338,366	343,373	0.9854
1974	10.05	24.95	1.88	4.67	340,951	350,650	0.9723
1975	9.98	25.02	1.93	4.83	350,928	359,323	0.9766
1976	10.10	24.90	2.02	4.98	352,355	359,987	0.9788
1977	10.21	24.79	2.12	5.15	356,653	361,400	0.9869
1978	10.36	24.64	2.20	5.25	353,790	358,852	0.9859
1979	10.53	24.47	2.34	5.44	361,464	366,064	0.9874

each age by the fertility rate of the corresponding age, and then sums the products which are obtained. Thus the annual number of births for the period 1970-1979 are generated from ~~the model and compared with the actual number of births for~~ the same period.

Table 6.2 shows the ratios of derived number of births obtained from Elderton's procedure to actual number of births. Eldertion's method can be set as a standard against which estimates obtained by other methods can be compared because the closeness of fit improves as the number of moments used is increased. Table 6.3 shows the ratios of derived births obtained from Mitra's procedure to the actual number.

It can be seen from Table 6.2 and 6.3 that the ratios of derived to actual number of births are close to unity and the values are very similar in the two tables. This shows that the reduction in the number of moments does not entail a great loss in the goodness of fit. In Table 6.3, the deviations are mostly around one per cent, only three of them are over two per cent. The close resemblance of the derived to actual number of births indicates that the age-specific fertility rates generated from the model are close to the actual fertility rates

In order to obtain some indication of the differences between the derived age-specific fertility rates and the observed ones, age-specific fertility rates generated by Mitra's procedure is plotted against the observed ones for

Figure 6.1

Derived and Observed Age-Specific Fertility Rates for Canada, 1971

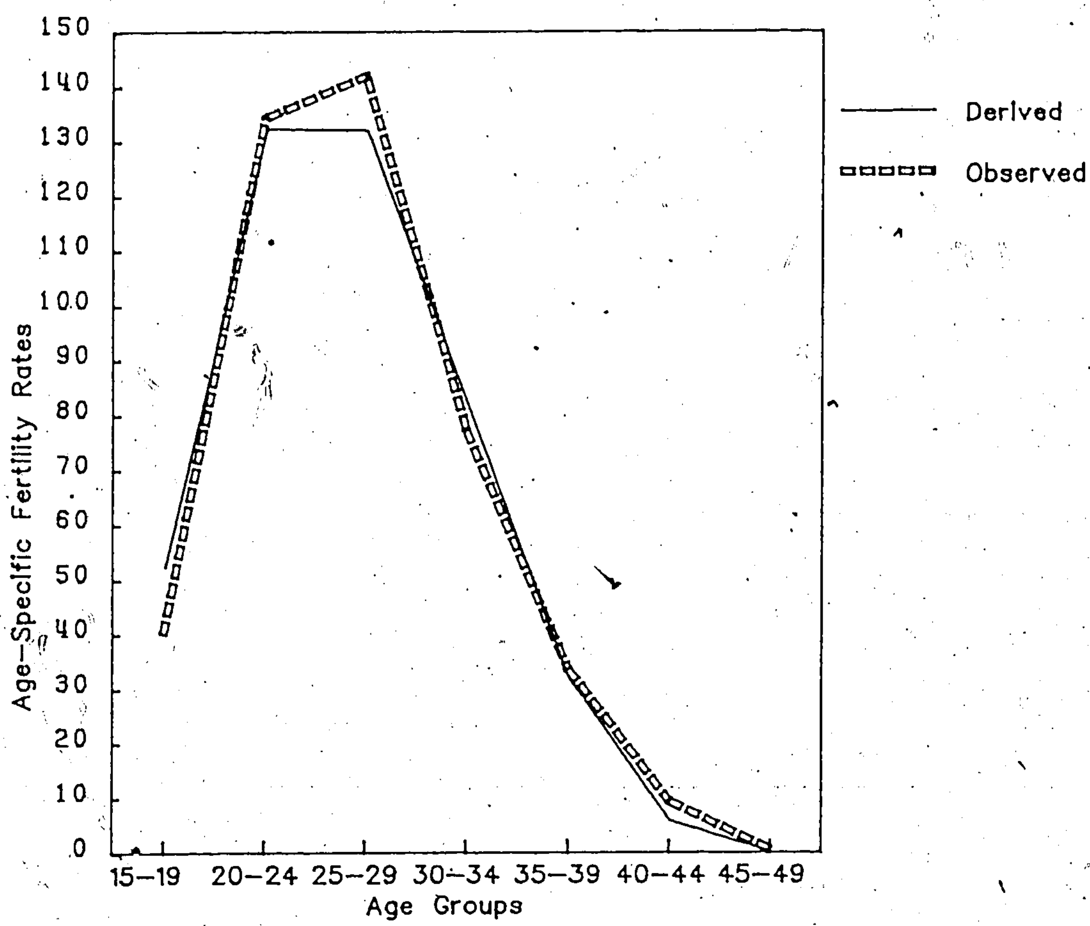


Figure 6.2

Derived and Observed Age-Specific Fertility Rates for Canada, 1976

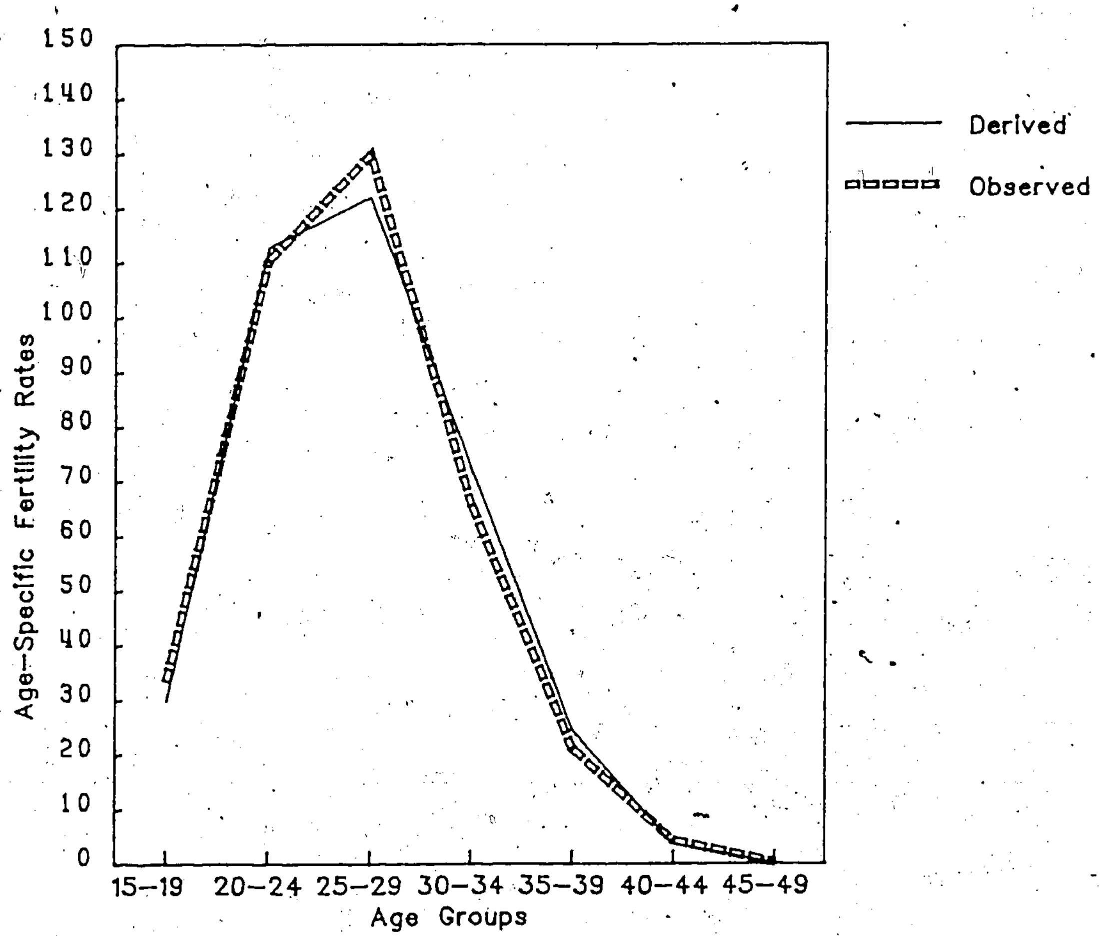
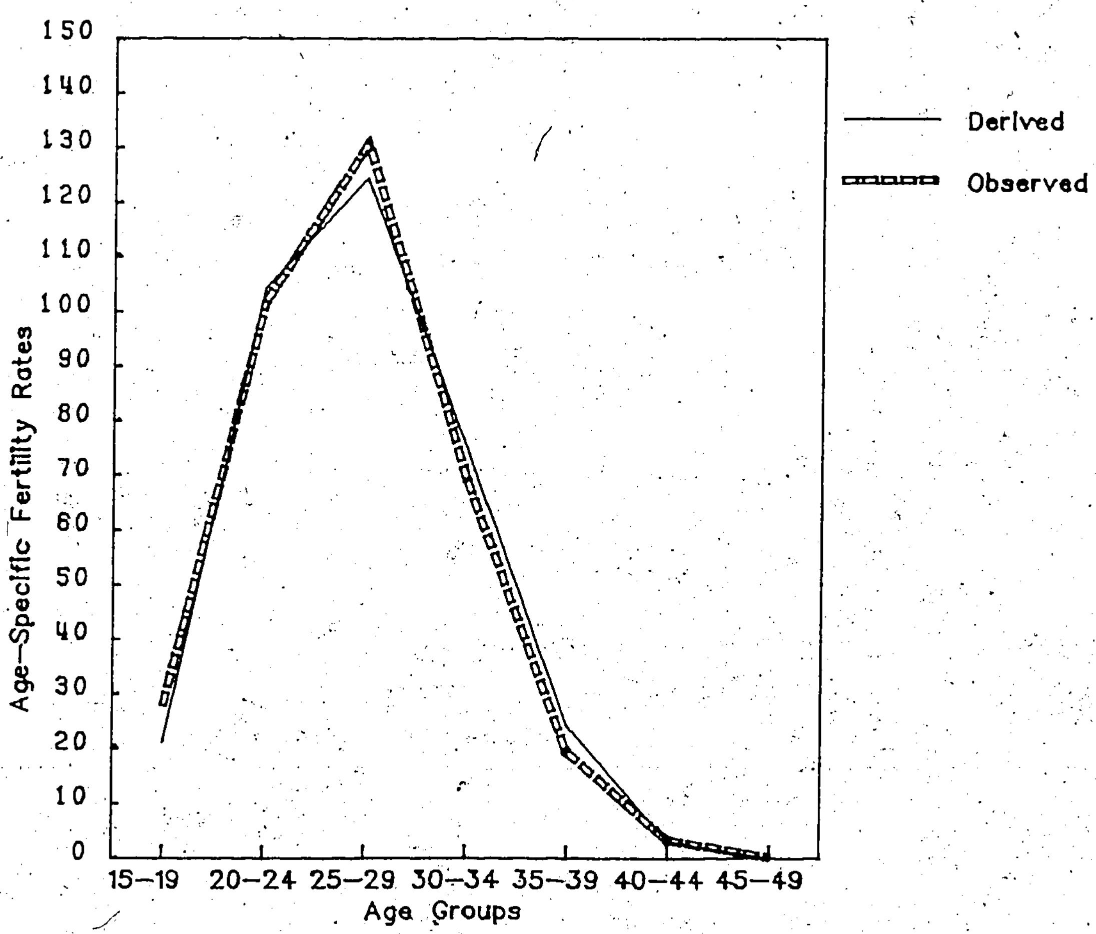


Figure 6.3

Derived and Observed Age-Specific Fertility Rates for Canada, 1979



the years 1971, 1976 and 1979 (Figures 6.1 to 6.3). It can be seen from the three figures that the derived and observed age-specific fertility rates are of the same pattern with a low value for the 15-19 age group, rises rapidly to the 20-24 age group, reaches a maximum at 25-29, and then declines steadily thereafter.

On the whole, the differences between the derived and observed values are not large, the average difference is about 4.07 points. Among the seven age groups, the largest deviation is obtained at the 25-29 age group. Throughout the period under consideration, the model tends to under-estimate the fertility rates for the 25-29 age group by about 6.3 to 11.1 points.

The traditional approach of measuring goodness of fit is to calculate X^2, the magnitude of which depends in part upon the relative difference between the observed and graduated values. The fit is good when the observed values are within random fluctuations of the expected values and the computed X^2-value is relatively small, that is, less than the critical value of X^2 for the appropriate degrees of freedom. Thus, a X^2 is computed for each year from 1970 to 1979, with the recorded age-specific fertility rates correspond to the observed values and those derived from Mitra's procedure the expected values (Table 6.4).

For each year, there are four degrees of freedom associated with the statistic and with the level of significance set at .05 , the critical value of X^2 is

Table 6.4

Calculated X^2-values for the Age-Specific Fertility Rates, Canada, 1970-1979

Year	X^2	DF	Remarks
1970	12.5886	4	significant
1971	6.9414	4	not significant
1972	3.5090	4	not significant
1973	3.2221	4	not significant
1974	3.1019	4	not significant
1975	3.3452	4	not significant
1976	2.6052	4	not significant
1977	2.9638	4	not significant
1978	3.6363	4	not significant
1979	3.8323	4	not significant

9.4877[5]. Since the calculated values of X^2 are all less than the critical value, except for 1970, it can be concluded that the differences between the observed and the expected values in nine of the ten year can be attributed to sampling fluctuations. As there is no evidence against the null hypothesis, we conclude that the model is appropriate to be used as a graduation formula for age-specific fertility rates.

6.3 Potential As A Model

The results of the tests presented in the above section lead to the conclusion that Pearsonian Type I curve can be used to graduate fertility rates. In this section, the possibility of developing the Type I curve into a model for estimating age-specific fertility rates for Canada will be discussed. To accomplish this task, the four parameters of the equation, namely a_1, a_2, m_1 and m_2, are assigned to specific values, while the total fertility rate is needed for the year that age-specific fertility rates will be estimated. With the parameters of the equation being fixed and a specific total fertility rate, the values of age-specific fertility rates for the corresponding year can be obtained through incomplete Beta function.

It can be seen from Table 6.3 that the values of a_1 are very similar within the ten years. This is also true for the

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[5]The degress of freedom is computed as (n-1-p) where n stands for the number of categories, and p stands for the number of parameters estimated.

values of a_2, m_1 and m_2. The values of a_1 are centered around 10, 24.8 for a_2, 1.9 for m_1 and 4.6 for m_2. These indicate that a certain value of the four parameters, such as the average value of the ten years, can be used to approximate the parameters for any specific year. The average value of a_1 for the ten years, 1970-1979 is 10.147, 24.843 for a_2, 1.910 for m_1 and 4.666 for m_2. Thus a fertility model for Canada based on the Pearsonian Type I curve can be generated using the above values for the four parameters. This model can be used to estimate age-specific fertility rates for Canada in future years assuming that the fertility pattern of the 1970's will continue to exist. Moreover, it can be used to estimate fertility rates for those years that have fertility pattern similar to the 1970's.

Based on the model, age-specific fertility rates for Canada for the years 1980 and 1981 are generated and compared to the actual values (Table 6.5). The results in Table 6.5 show that the derived and observed values are quite close to each other expecially for the age groups 30-34, 40-44 and 45-49. The differences between the derived and actual values range from 0.1 to 16 points, and the average difference of the two years is 4.8 points.

Among the seven age groups, the largest deviation is obtained at the 25-29 age group. For both years, the model tends to under-estimate the fertility rates for this particular age group. This problem is also encountered in

Table 6.5

Derived and Observed Age-Specific Fertility
Rates for Canada, 1980, 1981

Age Group	1980 Derived	1980 Observed	1981 Derived	1981 Observed
15-19	31.6	27.6	30.9	26.4
20-24	106.9	100.1	104.3	96.7
25-29	113.6	129.4	110.9	126.9
30-34	68.7	69.3	67.0	68.0
35-39	24.4	19.4	23.8	19.4
40-44	3.9	3.1	3.8	3.2
45-49	0.1	0.2	0.1	0.2

the previous section when the parameters are generated from the first two moments of the observed distribution.

As the preliminary estimates of the total population of Canada by age groups for 1980 is available, total number of births can be computed. The derived number of births is 367,416 while the actual number is 370,709. Therefore the ratio of derived to actual number of births is 0.9911. In general the model can be used to estimate age-specific fertility rates for Canada when only the total fertility rate is known, or conjectured.

6.4 Potentials For Birth Projections

In the preceding section, the Pearsonian Type I curve has been examined as a device for the graduation of age-specific fertility rates. In this section, an attempt will be made to expand its application to the field of projections. Conventionally, birth projection is obtained by directly projecting age-specific fertility rates. Using the Pearsonian Type I curve, projection of births can be derived from only three relatively simple fertility measures, namely, total fertility rate, mean age of fertility, and variance of the distribution of age-specific fertility rates.

The procedure of utilizing the model to do projection is: first, obtain the three parameters required for the model i.e. total fertility rate, average age of fertility and variance of the distribution based on specific assumptions. The second step is to generate the age-specific fertility rates from the above three parameters. The final step is to calculate the number of births in any projected year which is done by merely multiplying the number of women at each age by the fertility rate of the corresponding age and then summing the products which are obtained. As for the number of women, it is provided independently by applying projected survival ratios to an initial population of women by age.

In order to perform empirical tests on the model as a device for birth projections, the number of births derived from the model for Canada is compared with those obtained by the conventional procedure of directly projecting age-specific fertility rates. These projections are based on three fertility assumptions, representing high, medium and low alternatives. The medium series assumes a continuation of the total fertility rate of 1976, 1.83 children per woman; the high series assumes a rise in the rate to 2.55 children per woman; and the low series a decline to 1.66 children per woman. The initial population is being projected for a period of 25 years, from 1976 to 2001. During this period, migration is assumed to be negligible and mortality levels remain unchanged.

The results of the tests are shown in Table 6.6. It can be seen that, on the whole, the values derived from the model almost coincide with the values obtained by the conventional procedure. All the deviations are less than one

Table 6.6

Ratio of the Number of Births derived by the Model to the Number of Births Obtained by Conventional Projections, Canada, 1981-2001

Year	Low Series	Medium Series	High Series
1981-1986	1.0021	0.9973	1.0069
1986-1991	0.9986	1.0003	1.0019
1991-1996	0.9970	1.0027	0.9996
1996-2001	0.9984	1.0035	1.0022

per cent and of the twelve deviations, only one is larger than 0.5 per cent.

The results of the tests lead to the conclusion that fertility projections can be performed by the model as accurately as by directly projecting age-specific fertility rates.

The conventional method involves projecting each of the seven age-specific fertility rates to obtain population pojections by five year age groups, however, the model utilizes only three parameters. This constitutes an important operational advantage of the model. Moreover, the use of three simple and demographically significant parameters offers more analytical advantages than the conventional method. Since an age-specific fertility rate has little meaning in itself, it is difficult to relate it to those factors which determine a woman's actual reproductive behaviour. Therefore projections which are made in terms of period age-specific fertility rates are mostly based on vague assumptions about future trends in fertility.

In contrast to the conventional method, the model has inherent analytical properties because assumptions about future fertility are formulated in terms of three parameters that are amenable to in-depth analysis and meaningful demographic interpretation. Among the three parameters, the total fertility rate is particularly suitable for in-depth analysis. By making assumptions about future fertility in terms of total fertility rate, the cohort approach can be employed to explain variations in total fertility rate by referring to changes in family size and changes in the timing of births of successive cohorts of women. Furthermore, assumptions about future fertility trends can be formulated upon parity distribution data and information from surveys about intended family size.

Assumptions about the other two parameters, mean and variance of the distribution of fertility rates are easier to formulate than period total fertility rate. Indications of future trends in the mean and variance can be obtained by examining within a period and/or by examining cohorts of women by such variables as age at marriage, parity distribution and child-spacing patterns. In addition, countries with high voluntary fertility control tend to have a smaller range of effective fertile period. This is due to the fact that under planned fertility conditions, pregnancies do not ordinarily take place at very early or very late fertile ages, therefore the distributions of age-specific fertility rates are expected to have smaller variances.

The above illustraions only show the potentials of the model for more in-depth analysis in fertility projections. This approach begins with three simple and demographically meaningful parameters, total fertility rate, mean age and variance of the distribution, then proceeds to examine the immediate and then the more remote variables that influence these parameters. The ultimate goal of the approach is to incorporate the three parameters into a more complete socio-economic model.

7. Application of Pearsonian Type I Curve for Graduation and for Birth Projections: Quebec

In the preceding chapter, Pearsonian Type I curve has been examined as a device for the graduation of age-specific fertility rates for Canada, 1970 to 1979. Moreover, the model's potential for birth projections has also been discussed. In this chapter, the model will be applied to Quebec fertility data from 1970 to 1979 to reproduce age-specific fertility rates and to perform birth projections. Quebec is selected because it has gone through substantial social and economic changes such as the radical decline in fertility during the 70s.

7.1 Data and Application of the Model as a Graduation Device

The data used for estimating the parameters of the model are age-specific fertility rates for Quebec from 1970 to 1979. Following the procedures outlined in the last chapter, the constants in the equation are derived by Mitra's procedure and by the method of the first four moments.

Before calculating the constants of the equation, the k criterion has to be computed for the selection of the appropriate form of the Pearsonian curve. It can be seen from Table 7.1 that for Quebec from 1970 to 1979, k has a negative value, leading to the selection of Type I curve. In

Table 7.1

Parameters of Quebec Fertility Distribution by Five Year Age Group, 1970-1979

Year	TFR	Mean Age	Variance	Measure of Skewness B_1	Measure of Kurtosis B_2	Criterion k
1970	1974	28.00	32.64	0.309	2.870	-0.213
1971	1878	27.93	31.49	0.300	2.927	-0.233
1972	1727	27.89	29.68	0.282	3.049	-0.304
1973	1683	27.72	28.06	0.274	3.087	-0.340
1974	1657	27.63	26.28	0.252	3.165	-0.472
1975	1753	27.48	25.99	0.253	3.279	-1.006
1976	1774	27.34	25.07	0.207	3.152	-0.516
1977	1755	27.36	24.34	0.178	3.126	-0.495
1978	1690	27.37	23.57	0.187	3.209	-1.025
1979	1748	27.40	22.71	0.146	3.130	-0.638

comparison to Canada during the same period, Quebec has a relatively older mean age of fertility and a smaller variance for the distribution of fertility rates. These indicate that the degree of fertility control is higher in Quebec than in Canada which can also be observed in the total fertility rates. It is worthwhile to mention here that the extent of fertility control can alter the shape of the fertility curve.

Tables 7.2 and 7.3 show the model's output and the derived number of births obtained by the two procedures. It can be seen that Mitra's procedure tends to slightly over-estimate the annual number of births in 1971, 1972, 1973 and 1977. In Table 7.3 eight out ten of the deviations are either less than or around one per cent.

In both tables, the ratio of derived to actual number of births is relatively low in 1974. This is also the year that has the lowest total fertility rates within the ten years. The relatively low ratio may be associated with the distortions in the distributions of the age-specific fertility rates which are brought about by the effect of fertility control. In order to verify this point, age-specific fertility rates derived by the model is plotted against the observed rates for 1974 in addition to 1971, 1976 and 1979.

Figure 7.2 indicates that the derived and observed age-specific fertility rates are very similar, there is no indication of any distortions or irregularities in the

Table 7.2

Model's Output Obtained by Elderton's Procedure for Quebec, 1970-1979

Year	a_1	a_2	m_1	m_2	Derived Number Of Births B	Actual Number Of Births B'	Ratio of B/B'
1970	8.24	29.28	1.29	4.60	92,394	91,757	1.0069
1971	8.94	31.11	1.64	5.69	88,589	89,210	0.9930
1972	10.60	37.81	2.66	9.49	83,491	83,603	0.9987
1973	11.06	40.60	3.16	11.59	83,650	84,057	0.9952
1974	12.77	52.99	4.84	20.10	85,249	89,364	0.9540
1975	15.16	98.12	7.83	50.71	93,434	93,597	0.9983
1976	14.54	61.31	6.68	28.17	96,265	96,342	0.9992
1977	15.52	62.97	7.78	31.55	96,990	95,690	1.0136
1978	17.37	110.68	11.24	71.62	94,163	94,860	0.9927
1979	17.90	82.51	11.54	53.20	98,320	98,646	0.9967

Table 7.3

Model's Output Obtained by Mitra's Procedure for Quebec, 1970-1979

Year	a_1	a_2	m_1	m_2	Derived Number Of Births B	Actual Number Of Births B'	Ratio Of B/B'
1970	11.44	23.56	1.88	3.88	94,698	91,757	1.0321
1971	11.42	23.58	1.98	4.08	90,477	89,210	1.0142
1972	11.50	23.50	2.17	4.43	84,803	83,603	1.0143
1973	11.37	23.63	2.31	4.79	84,465	84,057	1.0048
1974	11.38	23.62	2.52	5.23	85,649	89,364	0.9584
1975	11.20	23.80	2.50	5.31	93,523	93,597	0.9992
1976	11.07	23.93	2.58	5.57	96,210	96,342	0.9986
1977	11.15	23.85	2.71	5.79	96,861	95,690	1.0122
1978	11.21	23.79	2.84	6.03	94,094	94,860	0.9919
1979	11.31	23.69	3.02	6.32	98,170	98,646	0.9952

fertility rates. Therefore the large deviation is not due to a result of the internal defect of the model. Checking at the vital statistics of 1974 and 1979, we find that there is a discrepancy in the tables that record the number of live births. In 1974, the recorded number is 85,627, but in subsequent years, the number of live births is 89,364. The change was made because Statistics Canada tried to adjust for the undercount of births in 1974, however, the recorded age-specific fertility and total fertility rates for 1974 correspond to the unadjusted figure, that is 85,627. Subsequently, the ratio of derived to actual number of births (85,649/85,627) is 1.0003 rather than 0.9584.

Figures 7.1 to 7.4 indicate that the derived and observed age-specific fertility rates follow the same pattern and the values are similar. The figures also show that the largest deviation between the derived and observed rates happen at the 25-29 age group. The model tends to under-estimate the fertility rates for this age group quite substantially, with an average of 10.6 points. Yet the average deviations between the derived and observed rates of the remaining six age groups is about 3.5 points. A X^2 test is done for every year with the recorded age-specific fertility rates correspond to the observed values and those derived from Mitra's procedure the expected values (Table 7.4). For each year, there are 4 degrees of freedom associated with the statistic and with the level of significance set at .05, the critical value of X^2 is 9.4877.

Figure 7.1

Derived and Observed Age-Specific Fertility Rates for Quebec, 1971

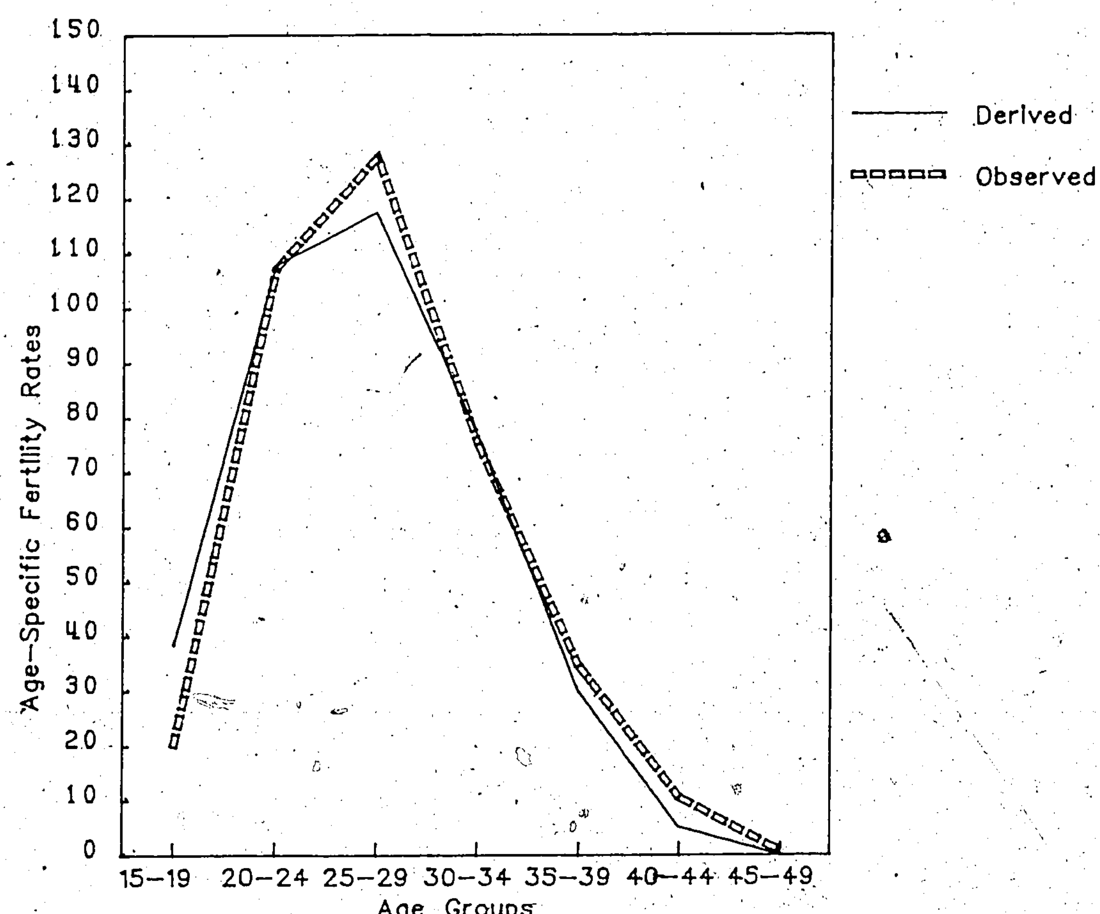


Figure 7.2

Derived and Observed Age-Specific Fertility Rates for Quebec, 1974

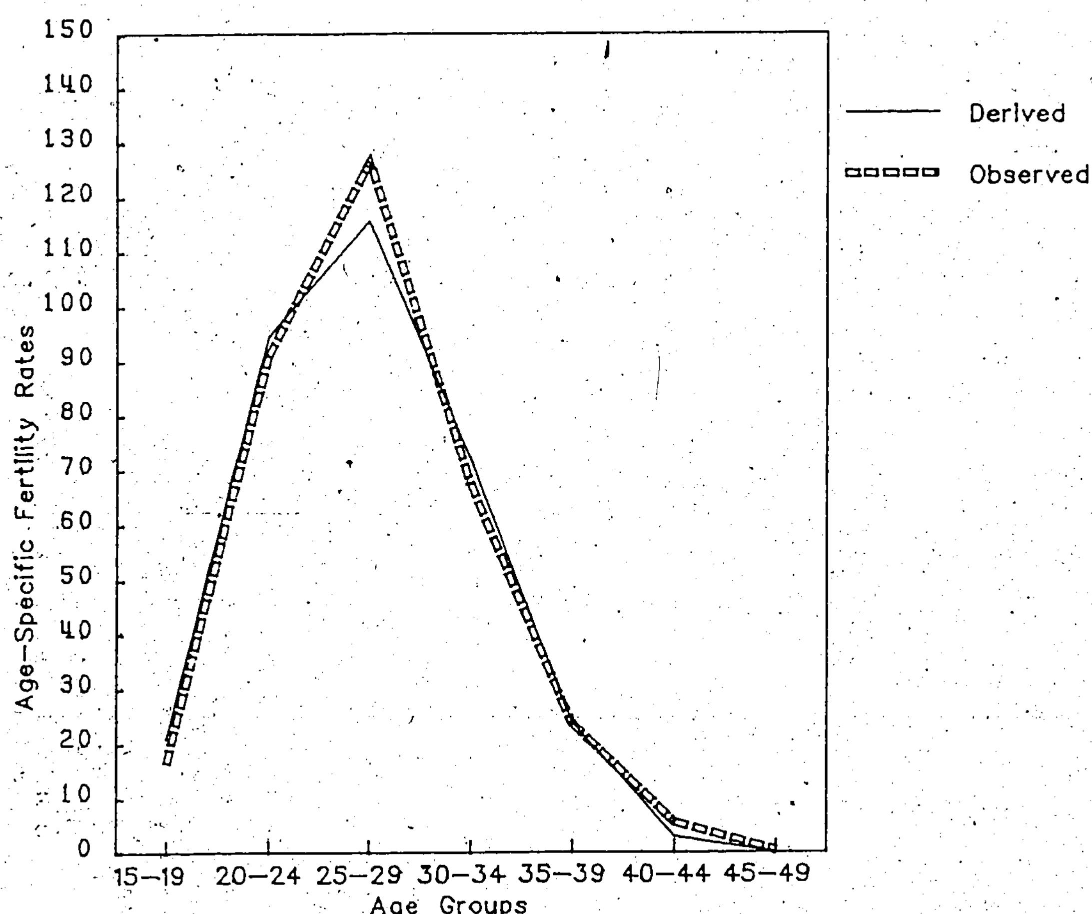


Figure 7.3

Derived and Observed Age-Specific Fertility Rates for Quebec, 1976

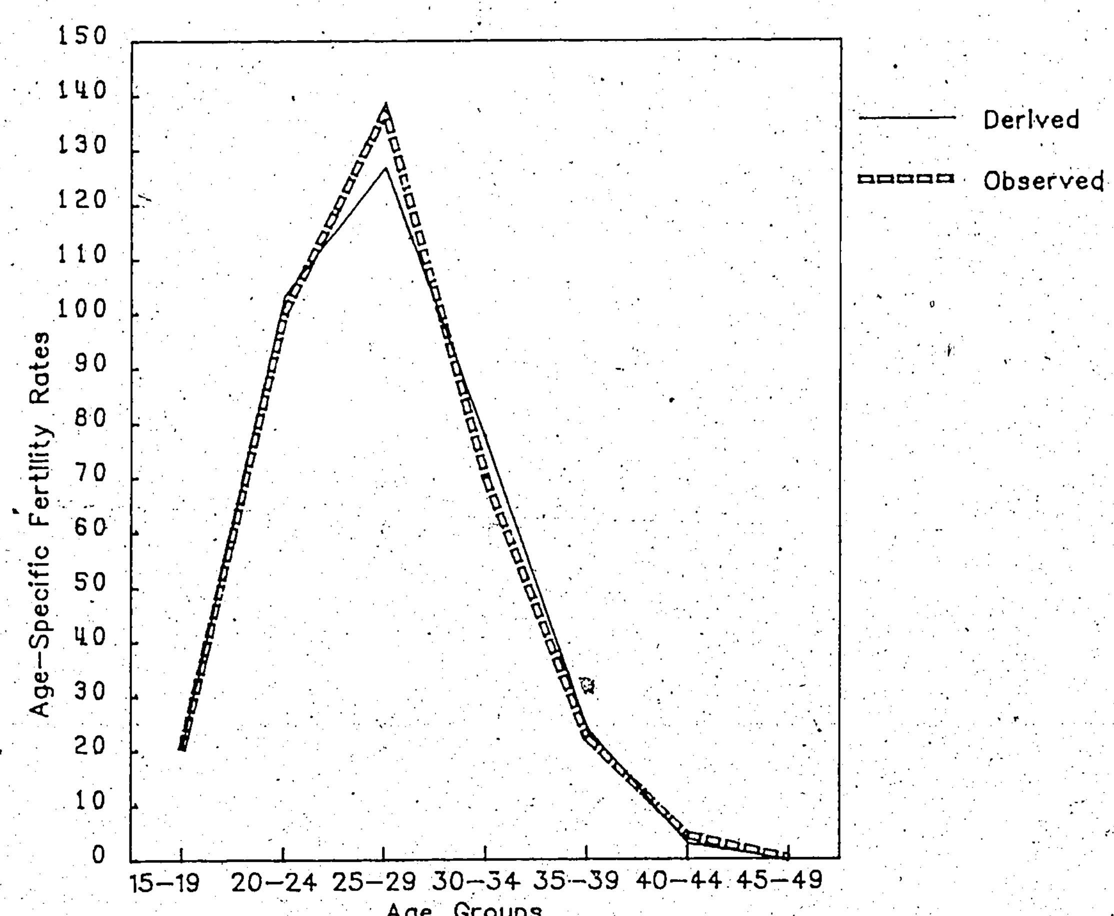
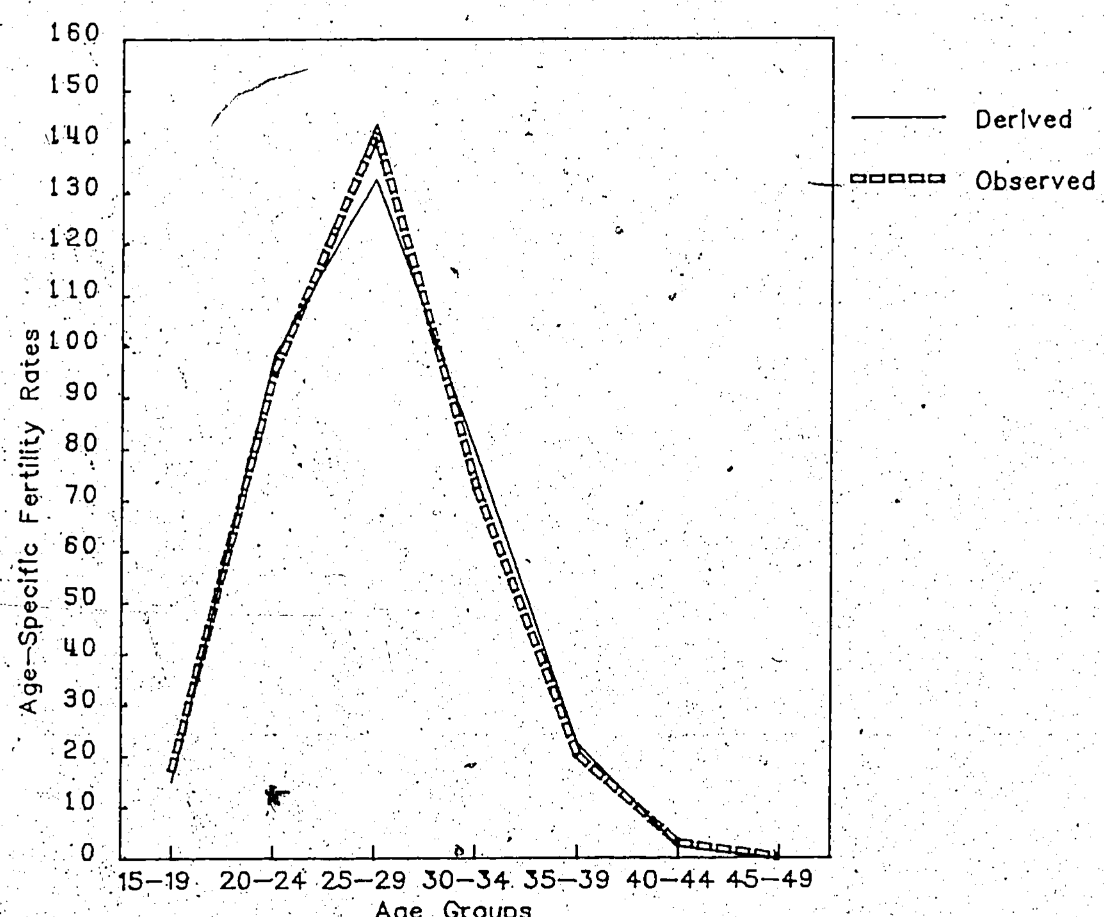


Figure 7.4

Derived and Observed Age-Specific Fertility Rates for Quebec, 1979



It can be seen from Table 7.4 that the calculated X^2 for the years 1973 to 1979, inclusively, are all less than the critical value. Yet, the X^2-values of the first three years exceed the critical value and it is concluded that the differences between the observed and expected values are too great to be explained by sampling fluctuations.

There are substantial changes in the age-specific fertility rates within these years because Quebec started its rapid fertility decline in late sixties. The model markedly over-estimates the age-specific fertility rates for the 15-19 age group and under-estimates the fertility rates for the 40-44 and 45-49 age groups for the years 1970, 1971 and 1972. Therefore, during this transitional period, the fertility rates are quite unpredictable by the model. On the whole, the model performs satisfactorily as a graduation device for reproducing age-specific fertility rates even though Quebec has gone through notable changes in fertility rates.

7.2 Birth Projections

In this section, the model is extended to the field of projection. It is used to predict future fertility under three assumptions representing low, medium and high alternatives. The medium series assumes a continuation of the total fertility of Quebec in 1976, that is 1.77 children per woman; the low series assumes a drop in the total fertility rate to 1.66 children per woman; and the high

Table 7.4

Calculated X^2-values for the Age-Specific Fertility Rates, Quebec, 1970-1979

Year	X^2	DF	Remarks
1970	31.4915	4	significant
1971	21.3011	4	significant
1972	12.1473	4	significant
1973	8.3527	4	not significant
1974	5.3772	4	not significant
1975	6.1264	4	not significant
1976	4.0896	4	not significant
1977	3.5971	4	not significant
1978	4.5098	4	not significant
1979	3.6260	4	not significant

Table 7.5

Ratio of the Number of Births Derived by the Model to the Number of Births Obtained by Conventional Projections for Quebec, 1981-2001

Year	Low Series	Medium Series	High Series
1981-1986	1.0011	1.0000	1.0057
1986-1991	0.9979	0.9990	1.0014
1991-1996	0.9967	0.9990	1.0000
1996-2001	0.9988	1.0023	1.0022

series a rise to 2.55 children per woman. The initial population is Quebec population in 1976 and is to be projected to 2001, a period of 25 years. During this period, migration is assumed to be negligible and mortality levels unchanged.

The number of births derived from the model for Quebec is then compared with those obtained by the conventional method of directly projecting age-specific fertility rates. The ratios are shown in Table 7.5. It can be observed that the values derived from the model almost coincide with the values obtained by the conventional procedure. There are two cases where the number of births generated by the two methods are the same, and all the other ratios are less than one per cent. This leads to the conclusion that fertility projections can be done by the model as accurately as by directly projecting age-specific fertility rates.

8. Summary and Conclusion

We summarize the major findings of this study and make recommendations for further investigation in the further.

8.1 Major Findings

Aggregate fertility in a country differs according to ethnicity, religion, occupation, education, income and residence. The aim of this study is to investigate fertility patterns in Canada.

In the first half of the thesis, four model fertility tables for Canada are developed in order to estimate the age-specific fertility rates for major ethnic, religious and linguistic groups in Canada and for Newfoundland in past years. The data used for generating the model tables have been taken from the births section of vital statistics published by Statistics Canada, and the 1921 to 1976 censuses. Information on the age-specific fertility rates of all the provinces in Canada (except Newfoundland) from 1921 to 1979 were utilized. Linear regression was used to obtain age-specific fertility rates from crude birth rate, general fertility rate, child-woman ratio or percent population aged 0-4 years.

The theoretical rationale underlying the model fertility table technique is the persistent regularities of the relationships of age-specific fertility rates with the general indicators of fertility. The model tables summarize the identified regularities. Moreover, if the correlations between the different measures of fertility are high, then any given measure can be used to develop the other measures.

The correlations of age-specific fertility rates and the indices were generally high except for the first age group (15-19) and the last two age groups (40-44, 45-49). The correlation between the age-specific rate and crude birth rate was also low for the 20-24 age group. Since crude birth rate, general fertility rate, child-woman ratio and percent of the population aged 0-4 years performed reasonably well as predictors of age-specific fertility rates, regression analysis was applied. Simple linear regression was employed with the dependent variable being one of the four indices and the independent variable being one of the seven age-specific fertility rates.

Since the correlation coefficients between crude birth rate and age-specific fertility rates for age groups 15-19, 20-24, 40-44 and 45-49 were low and since adjacent age groups predicted these quite accurately, fertility rates for these age groups were predicted from the age groups 20-24, 25-29, 35-39 and 40-44 after the latter had been predicted from crude birth rate. The same procedures were used to predict the fertility rates of the 15-19, 40-44 and 45-49 age groups of the other three sets of data.

The two model fertility tables based on child-woman ratio and percent children aged 0-4 years were then used to estimate age-specific fertility rates for six religious groups, eleven ethnic groups and four mother tongue groups in Canada. A comparison of the results with those presented in the 1961 and 1971 census analytical studies indicated that the fertility patterns observed in this study were similar.

The other two model tables based on crude birth rate and general fertility rate were used to estimate fertility rates for Newfoundland. A comparison of the results with those estimated from administrative records by Statistics Canada indicated a difference in the peak age of fertility. Statistics Canada estimated the peak age of fertility at the 20-24 age group rather than at the 25-29 age group as was predicted by the model tables. This younger age pattern of childbearing was not reflected in the values estimated by the model tables.

Pearsonian Type I curve was examined as means of graduation of age-specific fertility rates and of birth projections in the latter half of the study. Both the Elderton and the Mitra procedures were used to estimate the parameters of the equation. Fertility data for Canada and Quebec from 1970 to 1979 were used to test the performance of the model for graduating age-specific fertility rates and the results were found to be satisfactory. The model was also used to do birth projections and found to fare well.

8.2 Suggestions for Further Research

On the whole, the model fertility tables perform reasonably well as a device for predicting age-specific fertility rates. The estimated values could not be expected to correspond exactly to observed rates in view of variations in individual populations and over time periods. In order to improve predictability, it may be useful to employ multiple indicators such as infant mortality rate, median age at first marriage, the age composition of women in the reproductive ages, percentage of the married population that were sterile and other biological indicators.

Ethnic groups living in Canada may have fertility patterns that differ from their native countries and yet they may not have acquired the fertility pattern of Canada. Therefore further research is needed to investigate the similarities and dissimilarities of the fertility patterns of ethnic groups in Canada and those in their native countries. The construction of model fertility tables based on the fertility experience of ethnic groups in their native countries is recommended for comparison purposes.

Additional research is needed before a parametric model of fertility projections of the type outlined in this study can be made fully operational. Further research on the procedures of translating assumptions about the family size and mean age of fertility for different cohorts of women into period total fertility rate is needed. The procedures which are generally used to transform cohort to period measures have not been very successful in projection. Consequently, no model is as yet operationally capable of projecting directly in terms of cohort measures.

The tests of validity of the Pearsonian Type I curve were limited to data for only one country, namely, Canada, therefore it is difficult to speculate on the degree of universality of this model's applicability. In Appendix D, the method is applied to the fertility data of two different cultures in Asia, Hong Kong and India. Yet additional tests similar to those illustrated in this study with data from other nations is needed, before any definite statements can be made concerning the range of experience to which the model may be applicable.

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Appendix A: Model Fertility Tables For Canada

In this appendix, model fertility tables for Canada are constructed for different levels of crude birth rate, general fertility rate, child-woman ratio and percent population aged 0-4 years. The methodology of developing these tables are discussed in the main body of the thesis.

Table A.1

Age-Specific Fertility Rates Based on Crude Birth Rate

	Age-Specific Fertility Rates						
CBR	15-19	20-24	25-29	30-34	35-39	40-44	45-49
10	17.8	73.6	94.2	42.7	9.3	0.0	0.0
15	28.3	110.6	127.5	77.1	38.0	10.5	0.0
20	38.7	147.5	160.7	111.5	66.7	24.4	2.6
25	49.2	184.4	194.0	145.9	95.3	38.3	4.4
30	59.7	221.3	227.2	180.4	124.0	52.2	6.3
35	70.2	258.2	260.5	214.8	152.7	66.1	8.2
40	80.7	295.1	293.7	249.2	181.3	80.0	10.1

Table A.2

Age-Specific Fertility Rates based on General Fertility Rate

GFR	Age-Specific Fertility Rates						
	15-19	20-24	25-29	30-34	35-39	40-44	45-49
45	20.4	83.0	100.1	53.1	19.1	1.3	0.0
65	29.9	116.3	131.1	83.5	44.0	13.4	1.1
85	39.3	149.6	162.1	113.9	68.9	25.4	2.7
105	48.8	182.9	193.1	144.2	93.7	37.5	4.3
125	58.3	216.2	224.1	174.6	118.6	49.5	6.0
145	67.7	249.5	255.1	205.0	143.4	61.6	7.6
165	77.2	282.8	286.1	235.4	168.3	73.6	9.2

Table A.3

Age-Specific Fertility Rates Based on Child-Woman Ratio

	Age-Specific Fertility Rates						
CWR	15-19	20-24	25-29	30-34	35-39	40-44	45-49
250	21.4	83.4	104.1	54.7	18.9	1.3	0.0
300	26.4	101.4	119.3	68.6	30.3	6.8	0.0
350	31.4	119.5	134.4	82.6	41.7	12.2	0.7
400	36.4	137.5	149.6	96.5	53.1	17.7	1.5
450	41.5	155.5	164.8	110.4	64.5	23.1	2.4
500	46.5	173.5	180.0	124.4	75.8	28.6	3.2
550	51.5	191.6	195.2	138.3	87.2	34.0	4.0
600	56.5	209.6	210.4	152.3	98.6	39.5	4.8
650	61.5	227.6	225.5	166.2	110.0	44.9	5.6
700	66.5	245.6	240.7	180.1	121.4	50.3	6.5

Table A.4

Age-Specific Fertility Rates Based on Percent of the Population Aged 0-4

	Age-Specific Fertility Rates						
C(0-4)	15-19	20-24	25-29	30-34	35-39	40-44	45-49
6	23.4	90.6	104.5	49.6	13.7	0.0	0.0
8	33.7	127.7	138.2	82.8	41.3	12.0	0.7
10	44.1	164.9	171.8	116.1	68.9	25.2	2.7
12	54.4	202.0	205.5	149.3	96.5	38.4	4.7
14	64.7	239.2	239.2	182.6	124.1	51.6	6.7
16	75.1	276.3	272.9	215.8	151.7	64.8	8.7

Appendix B: Model Fertility Tables For The Maritime Provinces

It is mentioned in chapter five that in order to estimate the fertility rates for Newfoundland by a methematical model, it may be worthwhile to develop model fertility tables based on the experience of the three maritime provinces (Prince Edward Island, Nova Scotia and New Brunswick). This is because these provinces have a pattern of fertility different from those of the other provinces. Throughout the years, the maritime provinces have higher age-specific fertility rates and crude birth rates when compared with the other provinces in Canada. Since 1939, the crude birth rate of Newfoundland is among the highest within Canada. Here model fertility tables for the three maritime provinces are generated based on crude birth rate and general fertility rates.

The data used for deriving the model tables are taken from the births section of vital statistics published by Statistics Canada. Information on the age-specific fertility rates of the three maritime provinces from 1921 to 1979 are utilized. Thus two 177 sets of age-specific fertility rates for the seven quinquennial age groups relating to the three provinces are regressed linearly both on crude birth rate and general fertility rate to develop the two model fertility tables.

The correlation matrix of age-specific fertility rates and the correlation coefficients of age-specific fertility rates with crude birth rates and general fertility rates are shown in Tables B.1 and B.2. The highest value of the correlation coefficients between the age-specific fertility rates and the two indices is obtained at the 25-29 age group, then closely followed by the 30-34 age group and the lowest value is obtained at the 15-19 age group. As to the correlations between age-specific rates, the highest value is between 40-44 and 35-39, while the lowest value is between 30-34 and 25-29 age groups.

The correlation coefficients of age-specific fertility rates with crude birth rates and general fertility rates are slightly lower for the maritime provinces than those based on all the provinces in Canada. This is because only three provinces are taken into consideration and the fertility pattern of one of the provinces, New Brunswick, deviates from the other two provinces. New Brunswick has a younger age pattern of fertility than the other two Atlantic provinces. When compared with Prince Edward Island and Nova Scotia, New Brunswick has higher age-specific fertility rates for the age group 15-19. Between 1951 and 1977, the highest age-specific fertility rate for New Brunswick is obtained at the 20-24 age group instead of the 25-29 age group.

Since crude birth rate and general fertility rate perform reasonably well as predictors of age-specific

Table B.1

Correlation Matrix of Age-Specific Fertility Rates, the Three Maritime Provinces, 1921-1979

Age Group	15-19	20-24	25-29	30-34	35-39	40-44	45-49
15-19	1.0	0.84	0.49	0.01	-0.17	-0.29	-0.43
20-24		1.0	0.83	0.43	0.25	0.13	-0.07
25-29			1.0	0.78	0.64	0.53	0.34
30-34				1.0	0.95	0.90	0.75
35-39					1.0	0.96	0.85
40-44						1.0	0.90
45-49							1.0

Table B.2

Correlation Coefficients of Age-Specific Fertility Rates with Crude Birth Rate and General Fertility Rate, the Three Maritime Provinces, 1921-1979

Age Group	CBR	GFR
15-19	0.43	0.46
20-24	0.66	0.76
25-29	0.84	0.93
30-34	0.84	0.87
35-39	0.75	0.76
40-44	0.66	0.66
45-49	0.48	0.46

fertility rates, linear regression is employed to derive the necessary equations. Thus a total of seven equations are derived empirically for each set of data. The equations and relative measures of relationship are shown in Tables B.3 and B.4. Similar to the results generated by the model fertility tables for Canada, the two indices account for the greatest proportion of variance in the fertility rates of the 25-29 age groups. And the variance explained by the indices in the youngest and oldest age groups is generally low.

As the correlation coefficients between crude birth rate and age-specific fertility rates for the age groups 15-19, 20-24, 40-44 and 45-49 are not as high as the other and since the adjacent age groups predict these quite accurately, fertility rates for these age groups will be derived from the age groups 20-24, 25-29, 35-39 and 40-44 after the latter have been predicted from crude birth rate. The same procedure will be performed on the 15-19, 40-44 and 45-49 age groups of the other set of data. The resulting equations and relative measures of relationship are reproduced in Table B.5. The results show that there are significant improvements in predictibility when adjacent age groups are used instead of the indices.

The process of generating age-specific fertility rates from the two indices is as follows:

ASFR 15-19 = 0.2549 (ASFR 20-24) - 5.3468

Table B.3

Linear Regression Equations for the Seven Age-Specific Fertility Rates Based on Crude Birth Rate, the Three Maritime Provinces, 1921-1979

Age Group	Simple R	R Square	B	Constant
15-19	0.43078	0.18557	1.339268	18.10210
20-24	0.65649	0.43097	6.448887	21.65844
25-29	0.84165	0.70838	6.543908	31.59508
30-34	0.83634	0.69947	7.145127	-25.18910
35-39	0.75292	0.56688	5.924257	-42.87826
40-44	0.66376	0.44057	2.550147	-20.69819
45-49	0.48141	0.23176	0.266799	-1.894002

Table B.4

Linear Regression Equations for the Seven Age-Specific Fertility Rates Based on General Fertility Rate, the Three Maritime Provinces, 1921-1979

Age Group	Simple R	R Square	B	Constant
15-19	0.45851	0.21023	0.311762	17.51765
20-24	0.75570	0.57109	1.623580	6.13954
25-29	0.92932	0.86363	1.580272	22.82723
30-34	0.86740	0.75239	1.620722	-23.88917
35-39	0.76244	0.58131	1.312063	-38.50625
40-44	0.66433	0.44133	0.558214	-18.13371
45-49	0.46205	0.21349	0.056004	-1.376841

Table B.5

Linear Regression Equations for ASFR 15-19, 20-24, 40-44 and 45-49 Based on Adjacent Age Group, the Three Maritime Provinces, 1921-1979

Age Group	Simple R	R Square	B	Constant	Predictor ASFR
15-19	0.80555	0.64891	0.254942	5.346768	20-24
20-24	0.83163	0.69161	1.050716	-21.66968	25-29
40-44	0.96145	0.92439	0.469459	-6.051484	35-39
45-49	0.89607	0.80295	0.129257	-0.709479	40-44

$$\text{ASFR } 20\text{-}24 = 1.0507\ (\text{ASFR } 25\text{-}29) - 21.6697$$

$$\text{ASFR } 25\text{-}29 = 6.5439\ (\text{CBR}) + 31.5951$$

$$\text{ASFR } 30\text{-}34 = 7.1451\ (\text{CBR}) - 25.1891$$

$$\text{ASFR } 35\text{-}39 = 5.9243\ (\text{CBR}) - 42.8783$$

$$\text{ASFR } 40\text{-}44 = 0.4695\ (\text{ASFR } 35\text{-}39) - 6.0515$$

$$\text{ASFR } 45\text{-}49 = 0.1293\ (\text{ASFR } 40\text{-}44) - 0.7095$$

$$\text{ASFR } 15\text{-}19 = 0.2549\ (\text{ASFR } 20\text{-}24) + 5.3468$$

$$\text{ASFR } 20\text{-}24 = 1.6236\ (\text{GFR}) + 6.1395$$

$$\text{ASFR } 25\text{-}29 = 1.5803\ (\text{GFR}) + 22.8272$$

$$\text{ASFR } 30\text{-}34 = 1.6207\ (\text{GFR}) - 23.8892$$

$$\text{ASFR } 35\text{-}39 = 1.3121\ (\text{GFR}) - 38.5063$$

$$\text{ASFR } 40\text{-}44 = 0.4695\ (\text{ASFR } 35\text{-}39) - 6.0515$$

$$\text{ASFR } 45\text{-}49 = 0.1293\ (\text{ASFR } 40\text{-}44)\ 0.7095$$

Estimated age-specific fertility rates and total fertility rates for Newfoundland of the census years from 1921 to 1976 are shown in Tables B.6 and B.7 based on the two sets of equations. Newfoundland was not included in the Canadian census prior to 1951 therefore Table B.7 does not include estimates for 1921, 1931 and 1941. On the whole, the estimated values based on the two model fertility tables for the maritime provinces are higher than those based on the model tables for Canada. However the average differences in total fertility rates between corresponding tables are small: a difference of 126.3 children per 1000 women for the two tables that based on crude birth rate and 17.4 children per 1000 women for the two tables that based on general

Table B.6

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Newfoundland Based on Crude Birth Rate, 1921-1976

		Age-Specific Fertility Rates						
Year	TFR	15-19	20-24	25-29	30-34	35-39	40-44	45-49
1921	4033	56.0	198.5	209.6	169.2	118.3	49.5	5.7
1931	3456	49.1	171.7	184.1	141.3	95.2	44.7	5.1
1941	4049	56.1	199.2	210.2	169.9	118.9	49.7	5.7
1951	4865	65.3	235.0	244.3	207.0	149.7	64.2	7.6
1956	5257	69.6	252.2	260.6	224.9	164.5	71.2	8.5
1961	5116	68.1	246.0	254.7	218.5	159.1	68.7	8.2
1966	4237	58.2	207.5	218.1	178.4	126.0	53.1	6.2
1971	3610	51.2	180.0	191.9	149.9	102.3	42.0	4.7
1976	2904	43.3	149.0	162.5	117.7	75.6	29.4	3.1

Table B.7

Estimated Age-Specific Fertility Rates and Total Fertility Rates for Newfoundland Based on General Fertility Rate, 1951-1976

		Age-Specific Fertility Rates						
Year	TFR	15-19	20-24	25-29	30-34	35-39	40-44	45-49
1951	5152	68.9	249.2	259.4	218.7	157.9	68.1	8.1
1956	5730	74.4	270.7	286.3	246.3	180.3	78.6	9.4
1961	5664	74.7	271.9	281.5	242.4	176.3	76.7	9.2
1966	4540	56.8	223.0	233.9	192.6	136.7	58.1	6.8
1971	3677	52.0	183.1	195.1	152.8	104.5	43.0	4.8
1976	2745	41.4	141.4	154.4	111.1	70.8	27.2	2.8

fertility rate.

Appendix C: Sheppard's Corrections

When moments are calculated from a grouped distribution, there is an assumption that the frequencies are concentrated at the mid-points of the intervals. In some circumstances, it is possible to make corrections for any distortions introduced thereby.

If the distribution is continuous and has high order contact with the variate-axis at its extremities, i.e. if it tails off slowly, then Sheppard's corrections should be employed. The mean and the third moment do not need any adjustments. The crude second moment calculated from grouped frequencies should be corrected by subtracting from it $h^2/12$, where h is the width of the interval. And the crude fourth moment should be corrected by subtracting from it $(h^2U_2/2)+(7h^4/240)$, where U_2 is the corrected second moment (Elderton and Johnson, 1969, p.29).

Table C.1 shows the parameters of the Canadian fertility distribution without employing Sheppard's corrections. It can be seen that the second moment of the uncorrected values are about 2 points larger than the corrected. Moreover, the uncorrected B_1-values are smaller than those of the corrected. But the pattern is reversed for the B_2-values.

Tables C.2 and C.3 present the ratios of derived number of births to actual number of births obtained by Elderton's and Mitra's procedures respectively. The ratios of derived to actual number of births are close to unity, when the corrections are applied. But these ratios are not as close as the corresponding values generated by the uncorrected moments.

Table C.1

Parameters of Canadian Fertility Distribution by Five Year Age Group, 1970-1979, Without Sheppard's Corrections

Year	TFR	Mean Age	Variance	Measure of Skewness B_1	Measure of Kurtosis B_2	Criterion k
1970	2331	27.16	35.72	0.260	2.911	-0.218
1971	2187	27.05	34.13	0.245	2.946	-0.232
1972	2024	26.99	33.17	0.217	3.002	-0.266
1973	1931	26.82	31.93	0.216	3.013	-0.276
1974	1875	26.79	30.75	0.195	3.053	-0.321
1975	1852	26.69	30.01	0.193	3.085	-0.372
1976	1825	26.74	29.40	0.164	3.028	-0.295
1977	1806	26.78	28.70	0.135	2.993	-0.251
1978	1757	26.87	28.36	0.126	3.016	-0.282
1979	1764	26.95	27.65	0.105	2.981	-0.229

Table C.2

Model's Output Obtained by Elderton Procedure, Canada, 1970-1979, Without Sheppard's Corrections

Year	a_1	a_2	m_1	m_2	Derived Number Of Births B	Actual Number Of Births B'	Ratio Of B/B'
1970	10.55	33.87	1.98	6.35	370,732	371,988	0.9966
1971	11.27	35.69	2.43	7.68	355,961	362,187	0.9828
1972	12.98	41.27	3.47	11.05	340,896	347,319	0.9815
1973	12.97	41.70	3.64	11.70	337,336	343,373	0.9824
1974	14.48	48.38	4.91	16.41	340,824	350,650	0.9720
1975	15.13	53.80	5.68	20.18	350,928	359,323	0.9760
1976	15.41	48.44	5.74	18.04	352,647	359,987	0.9796
1977	16.26	46.76	6.36	18.30	357,197	361,400	0.9884
1978	17.56	52.60	7.72	23.13	354,325	358,852	0.9874
1979	18.02	48.75	8.05	21.77	362,054	366,064	0.9890

Table C.3

Model's Output Obtained by Mitra's Procedure, Canada, 1970-1979, Without Sheppards's Corrections

Year	a_1	a_2	m_1	m_2	Derived Number Of Births B	Actual Number Of Births B'	Ratio Of B/B'
1970	9.93	25.08	1.35	3.42	370,921	371,988	0.9971
1971	9.91	25.09	1.45	3.66	355,004	362,187	0.9802
1972	9.92	25.08	1.51	3.81	338,461	347,319	0.9745
1973	9.78	25.22	1.56	4.02	334,682	343,373	0.9747
1974	9.86	25.14	1.66	4.24	337,591	350,650	0.9628
1975	9.78	25.22	1.70	4.38	347,549	359,323	0.9672
1976	9.91	25.09	1.78	4.51	349,133	359,987	0.9698
1977	10.03	24.97	1.87	4.66	353,708	361,400	0.9787
1978	10.18	24.82	1.94	4.74	351,151	358,852	0.9785
1979	10.36	24.64	2.06	4.90	359,016	366,064	0.9807

Appendix D: Application Of Pearsonian Type I Curve To The Fertility Data of Hong Kong And India

It has been demonstrated earlier in the study that the Pearsonian Type I curve performs satisfactorily as a graduation formula for Canadian fertility rates. In order to test the universality of this model's applicability, the method is applied to the fertility data of two cultures different from Canada, namely, Hong Kong and India. The data are taken from the 1976 census of Hong Kong and the 1969 sample vital registration in India.

Following the procedure outlined in chapter 6, section 6.1, the constants in the equation are derived by Mitra procedure. The parameters and k criteria of Hong Kong and Indian fertility distributions are shown in Table D.1. Since k has a negative value for both countries, the Type I curve is selected.

Age-specific fertility rates for Hong Kong and India are then generated and compared to the actual values (Table D.2). In the same table, a X^2 is computed for each country, with the recorded age-specific fertility rates correspond to the observed values and those derived from Mitra procedure the expected values. For each country, there are 4 degrees of freedom associated with the statistic and with the level of significance set at .05, the critical value of X^2 is 9.4877. It can be seen from Table D.2 that the calculated X^2

for both countries are all greater than the critical value, therefore it is concluded that the differences between the observed and expected values are too great to be explained by sampling fluctuations. The results generated by Mitra procedure are not very satisfactory. It may be useful to employ Elderton procedure to estimate the parameters as the increase in the number of moments can improve the goodness of fit. Moreover, data for several years have to be taken into consideration before making a firm statement as to the applicability of the Mitra method to any culture.

Table D.1

Parameters of Hong Kong (1976) and India (1969) Fertility Distributions by Five Year Age group

Nation	TFR	Mean Age	Variance	Measure of Skewness B_1	Measure of Kurtosis B_2	Criterion k
H.K.	2519	28.72	28.68	0.222	3.098	-0.375
India	5618	29.54	55.49	0.176	2.439	-0.855

Table D.2

Derived and Observed Age-specific Fertility Rates for Hong Kong (1976) and India (1969)

	Hong Kong		India	
Age Group	Derived	Observed	Derived	Observed
15 - 19	25.6	17.4	164.6	97.9
20 - 24	122.3	109.7	248.2	261.9
25 - 29	170.2	192.1	256.3	266.9
30 - 34	124.6	119.6	216.4	226.0
35 - 39	50.3	48.9	146.9	158.3
40 - 44	8.5	14.6	68.2	77.1
45 - 49	0.2	1.5	9.0	35.5

Calculated X^2, Hong Kong: 18.5117

Calculated X^2, India: 109.4153