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PROPORTIONS UNDER AGE 15 IN HUMAN POPULATIONS: THE APPLICATION OF THE STRAITJACKET CONCEPT

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled PROPORTIONS UNDER AGE 15 IN HUMAN POPULATIONS: THE APPLICATION OF THE STRAITJACKET CONCEPT submitted by ROBERT COLIN REID in partial fulfillment of the requirements for the degree of Master of Arts in Demography.

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ABSTRACT

The relative size of any age/sex group of a human population is constrained by the relative size of the other age/sex groups in the population. The straitjacket effect is a term used to describe figuratively the arithmetical relationship between proportions of children aged 0-14 and women aged 15-49 in populations with very high levels of fertility. The straitjacket concept means in the simplest terms that, when the proportion under age 15 reaches a certain size (roughly 50 percent), the proportion of females aged 15-49 can be no smaller than about 21 percent. Each proportion acts as a brake on the growth of the other, and thus a sort of straitjacket prevents the further growth of young proportions and shrinkage of females in the reproductive ages. This is primarily a fertility question because fertility is normally the most potent demographic force in determining the shape of the age/sex distribution. The methods used to determine the existence of the straitjacket include bivariate regression and stable population models. Of the three hypotheses tested, two receive support. It is determined, with qualifications, that the straitjacket effect does come into play among populations sustaining very high fertility over a number of years. A discussion of the uses and abuses of the proportional age distribution, in the light of the understanding provided by the straitjacket concept, follows.

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Chapter 1

Introduction

1.1 Statement of the problem

The relative size of any age/sex group in a human population is constrained by the relative size of the other age/sex groups in the population. Nowhere is this more apparent than between the proportion of women of childbearing ages (15-49) and the proportion of children under 15 years of age in the population: The more children born per woman, the larger the proportion under 15 in relation to the proportion of all other age groups, including women aged 15-49 years. The reason for this is the fact that the area under the curve of the proportionate age distribution of any population must add up to 100 percent. The question that arises is this: How large can the proportion under 15 become, and how small can the corresponding proportion of women aged 15-49 become, before no further growth or shrinkage (respectively) in the size of either proportion is possible? The term 'straitjacket' is intended to describe figuratively this arithmetic relationship, and is discussed further below.

1.2 Purpose

The purpose of this thesis is to illustrate and, if feasible, to establish the validity of the concept of the straitjacket operating between age group 0-14 for both sexes (hereafter called bst0-14[1]) and age group 15-49 for females (hereafter called ft15-49[2]). The straitjacket concept is, as currently formulated, restricted to the consideration of bst0-14 and ft15-49 and no attempt will be made to analyse its interplay among the other age/sex groups of the age structure.

It would be simplistic to think of the thesis as limited to the finding of the highest proportions possible bs0-14. This is only part of the problem at issue. In itself, the problem is more complex than just finding the highest percentage ever reported. This is due to differences between vital rates as reported and corresponding intrinsic rates and

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[1] 'bs' for 'both sexes' and 't' for 'total population'.

[2] 'f' for 'female' and 't' for 'total population'.

due to special circumstances of a given population, such as age and sex selective migration.

1.3 Concepts

The central concept introduced is the straitjacket. The word straitjacket was chosen to give a sense of the restriction of movement that such a device is intended to effect. In this thesis its meaning is adopted and applied to the age distributions of human populations. Clearly, the straitjacket concept is applicable only to populations experiencing high fertility. This is because it is only countries experiencing very high fertility that can have proportions bst0-14 and ft15-49 close to the maximum and minimum size, respectively. One can usefully think in terms of a proportionate population pyramid, the base of which is unusually wide, and which tapers off regularly and rapidly. From there, one can imagine an expansion of the base (in this case, the age groups under 15 years) and the consequent shrinking of the older age groups. The pyramid is soon transformed from extremely young, to speculatively young and finally into an impossibly youthful population pyramid. At some point in that transformation, the straitjacket comes into play and stops any further expansion of the base, as well as any further shrinkage of the other age groups. To repeat, the straitjacket effect is a two-way phenomenon, with bst0-14 dictating the size of ft15-49, and vice versa.

The entire issue rests essentially on the potential fertility performance of the women in the reproductive ages because it is the fertility performance of each woman in a population that determines that population's approximate form (Coale 1957; Keyfitz 1975; Lorimer 1951). The second chapter will therefore provide a review of literature showing why humanity has never reproduced at biologically maximum levels. The discussion deals with the relative contributions of both biological and sociological factors to fertility. Explanations of reported high levels of fertility are given in the literature in terms of why a particular population **did not** attain some predetermined empirical or speculative upper limit (Coale 1956; Bongaarts 1975, 1978). The literature review, while introducing the fundamental concepts of natural fertility (Henry 1961) and the intermediate variables (Davis and Blake 1956), shows that the speculative biological maximum level of human fertility is much higher than that which has been observed empirically.

Even in populations with natural fertility regimes, the biological maximum is not attained for behavioural reasons such as breastfeeding (an important factor in postpartum infecundibility) and social customs governing childspacing. Each model discussed in this chapter (Bourgeois-Pichat, 1967; Henry, 1953, 1961; Davis and Blake, 1956; Bongaarts, 1975, 1978; Coale, 1956, 1967) addresses specifically the varying contributions of biological and social determinants of fertility.

The discussion involves observations made of the highest human fertility yet recorded (Henry, 1961). However, populations such as the Hutterites of the early 20th century were relatively small and therefore not likely to be representative of the national populations studied in this thesis. Since fertility is primarily responsible for the proportionate size of any age group, it is only through an understanding of the mechanisms that determine the fertility level of a population that the operation of the straitjacket concept can be understood.

An important observation arising from the literature review is the lack of agreement concerning the precise upper limit of human fertility. Because this is an unknown quantity, its influence on the age structure of a human population becomes that much more difficult to specify.

The third chapter therefore does not deal with fertility directly, but shows the general relationship between bst0-14 and ft15-49, using empirical data for 142 countries for seven points in time between 1960 and 1990. Bivariate regression is employed to illustrate this relationship, and to determine the need for further analysis based on the scatterplot obtained. Subsequent regressions are performed separately on high and low fertility populations. The intent is to determine the distribution that the populations experiencing the straitjacket are a part of, as well as the nature of the relationship between the variables.

Having determined the **general** relationship between the two variables, bst0-14 and ft15-49, the fourth chapter focuses on those populations potentially experiencing the straitjacket. A review of the empirical data led to a decision to include only those countries with both a maximum proportion ft15-49 of .22 and a minimum proportion bst0-14 of .48. To avoid the complexities of a combined treatment of the sexes, the data used in this chapter are for females only.[3] It is important to note, in this respect, that in the fourth chapter, the proportions ft15-49 and bst0-14 are used only as

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[3] Coale (1957:83), Keyfitz (1971:652) and Pressat (1972:334) warn of the complexities of a combined treatment of the sexes when working with stable population models.

a convenient means of selecting those populations experiencing the straitjacket. Because a one-sex (female) model is being used, all calculations are done for females only. The notation changes to accomodate this fact, with the proportion female aged 0-14 now referred to as ff0-14[4] and the proportion female aged 15-49 now referred to as ff15-49.[5]

The purpose of the chapter is to compare these empirical proportions to proportions obtained from stable population models as a means of determining how far the empirical proportions depart from the stable proportions. This is accomplished first by constraining the empirical proportion ff0-14 to equal the stable proportion ff0-14, and then observing the deviation of the empirical proportion ff15-49 from the stable proportion ff15-49. The exercise is subsequently repeated the other way around, with empirical and stable proportions ff15-49 constrained to be equal and the deviation between empirical and stable proportions ff0-14 recorded. These calculations will result in either positive or negative differences. The smaller the differences, the more similar the empirical and theoretical proportions. A

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[4] The first 'f' for 'female' and the second 'f' for 'total female population'.

[5] See footnote 4.

determination of the existence of the straitjacket is made based on the patterns observed among the deviations of the empirical from the theoretical proportions.

1.4 Data[6]

Three data sources are utilized, these being,

1) Keyfitz and Flieger (1990) World Population Growth and Aging: Demographic Trends in the Late Nineteenth Century.

2) United Nations (1991a) The Age and Sex Distributions of Population: The 1990 Revision.

3) Coale and Demeny (1983) Regional Models Life Tables and Stable Populations.

The first source is used in chapter 3 and all three sources are used in chapter 4.

[6] Full bibliographic details for these sources are found in the reference list at the end of the thesis.

1.5 Hypotheses

Three hypotheses are tested in this thesis. They are,

1) The straitjacket effect occurs only among those populations with the most youthful populations. The less pyramid-shaped and more vase-shaped the age-sex distribution of a population, the less that population is influenced by the straitjacket effect (Chapter 3).

2) Among those populations experiencing the straitjacket effect, none will have larger proportions ff0-14 than would be expected in the the Coale and Demeny (1983) stable population models (Chapter 4).

3) Among those populations experiencing the straitjacket effect, none will have smaller proportions ff15-49 than would be expected in the the Coale and Demeny (1983) stable population models (Chapter 4).

Hypotheses 2) and 3) are complementary in that for one to be true, the other is necessarily true.

1.6 Implications

Proportions or percentages of a population's age distribution are routinely reported in the news media, in public statement by societal leaders, in academic literature and elsewhere. The percentage of the population that is under age 15 (children), 15-64 (working age) and 65 and over (the 'old') are reported to give the reader a sense of the overall age distribution of that population. There is often little understanding, however, that to mention the size of one proportion is to make an indirect statement about the size of the other proportions in the age distribution. It is not uncommon to come across reported proportions (particularly under age 15) that are impossibly large. Chapter 5 reviews several example of the correct and incorrect uses of such proportions, in light of the understanding provided by the straitjacket concept.

Chapter 2:

Literature Review of Fertility Determinants

2.1 Introduction

Of the three demographic forces of mortality, fertility and migration, it is fertility that normally has the greatest influence on the proportionate distribution of a human population (Coale 1957; Keyfitz 1975; Barclay 1958). It is true that in the short run, mortality or migration can significantly alter the shape of an age/sex distribution. Qatar, Kuwait and the United Arab Emirates, for example, exhibit distorted age distributions due to large-scale immigration of foreign workers (Taryam 1987:259; Zahlan 1979:120; Hassan 1974:311; Abu-Lughod 1978:232; El-Badry 1965:185).

Short-term mortality changes can likewise cause impressive changes in the age/sex structure. Arriaga's (1970) study of mortality decline in 11 Latin American countries from 1930 to the 1960s, showed the following:

> ...of the 27 million people alive in all the eleven countries in the 1960s who would not have been alive if there had not been a mortality decline since the 1930s, 16 million --59 percent--were under 15. (Arriaga 1970:103 in Weeks 1986:219)

However, as Weeks points out,

> Note that the only time that a change in mortality generates a change in the age/sex distribution is when the mortality shifts are different at different ages. If there is a change in the probability of survival from one age to the next that is exactly equal for all ages and for both sexes, then the age/sex structure will remain unchanged. (Weeks 1986:219)

Usually, however, it is fertility that has by far the greatest impact on the age/sex distribution. Shryock and Siegel (1976:138) provide an example of the relative effects of fertility and mortality on the age sex structure of a national population. The deficit of births in France during World Wars I and II are shown to have caused much more distortion of the 1967 population pyramid than did the massive war losses sustained by France during those wars.

While the effects of mortality are spread throughout the age structure, fertility adds only to the number of infants (age zero). The effects of fertility therefore stay with the population age after age. According to Barclay (1958:230),

> ...the effects of fertility changes are directly transmitted to the age structure of the population, whereas the typical changes of mortality have a very limited influence.

This fact was first brought to light by Lorimer (1951). Since then, several demographers have refined the techniques required to give a good estimation of the relative effects of fertility and mortality on age structure (for example, United Nations 1954; Keyfitz 1971, 1975; Keyfitz and Flieger 1971; Coale 1957). The techniques invariably are based on the stable population model.

For example, Keyfitz and Flieger (1971) show the relative effects of fertility and mortality on the age distribution of a human population. They compare the age distributions of Sweden, 1805, with Venezuela, 1965. Sweden had 31.3 percent of its population under age 15, and Venezuela had 47.7 percent under age 15. They concluded,

> We can say that, in this instance, the effect of fertility in determining what percentage of a population is less than 15 years old is three or four times as important as the effect of mortality (Keyfitz and Flieger 1971:33).

This relationship holds for any given section of the age/sex distribution. Keyfitz and Flieger (1971:33-34) write,

> Evidently the proportion at any age in the two countries, including the proportion of old people, differs in the long run mainly because they differ in birth rates.

The closer the age distribution of the empirical population is to the stable model, the more accurate is this technique of decomposition.

Because fertility is the primary determinant of the age structure, and the straitjacket concept consists of the relationship between selected proportions in the age structure, the straitjacket concept relies implicitly on fertility. Moreover, the straitjacket concept is intertwined with the factors that determine exceptionally high levels of fertility. For example, cultural factors governing birth-spacing are an important determinant of fertility in populations with a natural fertility regime (Jain et al 1980). Those researchers interested in measuring exceptionally high levels of human fertility tend to tackle the problem by comparing the fertility of any given population to an empirical or speculative upper limit. Explanations of given high levels of fertility tend to be in terms of why a particular population **did not** attain the empirical or speculative upper limit. Of particular importance are those explanations given by Coale (1967) and Bongaarts (1975; 1978). These models are discussed below.

The purpose of this chapter is to provide a review of literature showing why humanity never reproduced at biological maxima. Variables will be indicated that have been identified as determining Henry's concept of natural fertility. Importantly, these variables are both cultural and biological. The operation of all these variables results in given proportions of bst0-14. None of these traditional variables will be taken up in this thesis. The chapter will also, incidentally, show that few if any of the contributions to world literature used the availability of women (ft15-49), a demographic factor par excellence, as a variable limiting or influencing the proportions bst0-14.

In order to come to an understanding of what is meant by 'maximum possible fertility' it is necessary to review the basic concepts employed by demographers to study high fertility population data at the macro-level. It is not the simple matter that it may intuitively appear at first. As will be shown, factors such as marriage patterns, contraceptive use, birth intervals and sterility (pathological, primary, secondary and final) intervene to influence the level of fertility of any given population. These and other factors have led to much speculation by demographers concerning the level of fertility that could be achieved under optimum (ie. fertility maximizing) conditions in a human population.

The chapter will therefore consist of the following. Some basic and widely held demographic assumptions regarding maximum fertility (prior to Henry's (1953) concept of 'natural fertility') are outlined (Bourgeois-Pichat 1967). The obvious lack of theoretical sophistication in this area of demography at that time was remedied to a large extent by Henry (1953, 1961). His concept of natural fertility is then discussed and subsequently illustrated by way of an examination of data for high fertility historical populations compiled by Henry (1961). Davis and Blake's (1956) 'proximate determinants' will be indicated, since they represent an improvement in the organization and measurement of the biological and social factors (many of which are dealt with by Henry) that interact to produce each society's level of fertility. This leads logically to Bongaarts (1978) work, in which he determines which of the proximate determinants are important in reality.

Having discussed the proximate determinants of fertility, the concept of natural fertility and the methods of measuring fertility, three levels of maximum fertility will be outlined. These are, the theoretical maximum, the anomalous population 'real' maximum and the maximum national-level. In other words, it will be determined what the fertility level of a human population might be when conditions are such that females are having children at the maximum possible biological rates (theoretical); what the fertility level would be when a small historical population reproduces at unprecedented rates (anomalous 'real'), and; what the maximum fertility levels are for national populations in the last 40 years (maximum national-level).

2.2 Demographic assumptions prior to 'natural fertility'

Bourgeois-Pichat (1967) has outlined the demographic assumptions regarding fertility in non-industrial societies commonly held before Henry (1953) developed the idea of natural fertility. It was assumed that before birth control began, in the modern sense, fertility was entirely uncontrolled. From this it was believed that fertility was everywhere high and at the same level. A crude birth rate of 45 per 1,000 was the figure widely considered to represent the level of fertility in a population where no controls were in place. The following conclusions, suggests Bourgeois-Pichat, were typically made by demographers when a population subject to no modern birth control was recorded to have a crude birth rate of less than 45 per 1,000:

> a) If the data could be considered as accurate, one concluded that fertility was controlled and the difference between the recorded rate and 45 per 1,000 gave a rough estimate of the effect of the control.
>
> b) If the data could not be considerd as accurate, it was generally the case of a developing country where birth control was not practiced. The difference between 45 per 1,000 and the observed rate gave a rough estimate of the under-registration of births. (1967:160)

This is, of course, now seen as overly simplistic reasoning.

Based on a) and b) above, if uncontrolled fertility produced everywhere the same high levels, then one could expect accurately measured CBRs of over 45 per 1,000 to be at least similar. This is clearly not the case. Table 2.1 shows a list of high reported CBRs from developing countries. It can safely be assumed that none of these populations consciously limits its fertility. Yet the range of CBRs in table 2.1, which were included only if they were 54.0 or higher, is quite wide. The possibility that some of the higher figures are inflated is a real one. However, if we extend the lower end of the range to 45 as suggested in a) and b) above, a large amount of variation over 45 per 1,000 remains unaccounted for by this explanation.

Table 2.1 Table of high reported/estimated CBRs

Country/Region	Year	CBR
Guinea(6)	1950-1955	54.7
Ivory Coast(4)	1957-1958	55.0
Kenya(4)		
Nyanza	1962	55.0
Western	1962	55.0
Malawai(6)	1960-1965	54.7
	1965-1970	55.8
	1970-1975	56.6
	1975-1980	57.2

	1980-1985	56.8
	1985-1990	56.3
Nicaragua(6)	1950-1955	54.1
Niger(6)	1950-1955	54.4
Niger(4)		
Stratum 4	1960	54.0
Nigeria(2)	1952-1953	54.0
Nigeria:Eastern Region(4)		
Calabar	1953	57.0
Owerri	1953	55.0
Rivers	1953	54.0
Nigeria:Western Region(4)		
Benin	1952	55.0
Ibadan	1952	66.0
Ondo	1952	57.0
Oyo	1952	58.0
Northern Rhodesia(1)		
(African population)	1950	56.8
Pakistan(3)	1951	60.3
Moslems		62.2
non-Moslems		50.7
Sudan(4)		
Central Southerners	1955-1956	58.0
Eastern Southerners	1955-1956	60.0
Sudan(5)		
Gezira	1961/1962	56.8
Togo(4)	1961	56.0
Yemen(6)	1965-1970	54.1
	1970-1975	54.8
	1975-1980	55.6
	1980-1985	54.4

Sources:

(1) Shaul, J.R.H. 1961. "Demographic features of Central

Africa." Pp.31-48 in K.M. Barbour and R.M. Prothero (Eds.) Essays on African Population. London: Routledge and Kegan Paul
(2) Ramachandran, K.V., K. Venkatacharya and Tesfay Teklu. 1979. "Fertility and mortality levels, patterns and trends in some English-speaking African countries." Pp.190-218 in United Nations Economic Commission for Africa. Population dynamics: Fertility and mortality in Africa. Proceedings of the Expert Group Meeting on Fertility and Mortality Levels and Trends in Africa and Their Policy Implications. Monrovia, Liberia, 26 November - 1 December 1979
(3) Petersen, William. 1972. Population. 2nd Edition. London: The Macmillan Company, Collier-MacMillan Limited
(4) Coale, Ansley and Frank Lorimer. 1968. "Summary of estimates of fertility and mortality." Pp.151-167 in William Brass, Ansley J. Coale, Paul Demeny, Don F. Heisel, Frank Lorimer, Anatole Romaniuk and Etienne Van De Walle (Eds.) The Demography of Tropical Africa. Princeton: Princeton University Press
(5) Henin, R.A. 1968. "Fertility differentials in the Sudan." Population Studies, 22(1):147-164
(6) United Nations. Department of International Economic and Social Affairs. 1991b. World Population Prospects 1990. Population Studies No. 120. New York: United Nations

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There are a number of social and biological factors which in combination determine the fertility level of any one population, even in those populations who do not consciously limit their fertility. It is worth noting these factors as summarized by Bourgeois-Pichat because of their centrality in the concept of natural fertility (discussed in more detail below).

The first factor he discusses is marriage. Fertility takes place largely within marriage (or its equivalent). The pattern of marriage in each population or country is therefore of primary demographic significance. Bourgeois-Pichat calculates a 'gross expectation of marital life below the age of 50 years for a girl 15 years old' (1967:160). If all women lived to the age of 50 and were married at the age of 15, a value of 35 years of marital life would be the result. The empirical extremes he lists are 30 for Black Africa and 21 for Europe (1967:160), with every other region or country falling somewhere in between. The intervening social factors are those which regulate the formation of the couple and reduce exposure to effective reproductive relationships.

The second factor he treats is fecundity. Between the ages of 15 and 49 women as a group are subject to declining fecundability, with a small percentage sterile through the entire period. By age 49 most women are no longer fertile. Similar to the expectation of marital life, a 'gross expectation of fecund life for a 15 year old girl' (1967:161) can be calculated. He notes a wide range of values across populations, with the French Canadians of the early eighteenth century showing the highest value at 29 years.

Marriage patterns in combination with increases of infecundity with age produce a given fertility regime. The French Canadians of the early eighteenth century are given as a rare example of a population combining very high fecundity and high nuptiality. They are again cited as the upper limit in the empirical literature, with a girl of 15 expecting a marital fecund life of 20 years, the world average being 15 years.

Whether birth control prevails or does not, this means that the number of children a woman bears is determined by the interval between successive births. This is broken down by Bourgeois-Pichat into three partial intervals:

> i) the length of the pregnancy
>
> ii) the period of temporary infecundity which follows each confinement
>
> iii) the conception delay, which is the average interval between the time when ability to procreate returns and the time when conception occurs (1967:160)

These factors are dealt with more fully by Henry (and others), to whose work we now turn.

2.3 Natural fertility

Henry (1953) proposed the concept of natural fertility to describe and analyse populations in which contraceptive use and induced abortion (ie. deliberate controls) are not employed in response to the number of children already born (parity). "Control can be said to exist when the behavior of the couple is bound to the number of children already born and is modified when this number reaches the maximum which the couple does not want to exceed." (Henry 1953 in Leridon and Menken 1980: 23). In the absence of such control, Henry proposed that fertility was determined by several factors including fecundability (the probability of conception during a menstrual cycle); post-partum infecundability or the "dead" time (pregnancy is not possible during the period following a conception and before ovulation resumes); intrauterine mortality, and; sterility (Henry 1980:37). There are obvious difficulties involved in assigning a numerical value to each of these factors.

These factors are in turn affected by a great number of other factors that vary widely between populations (cultures). To mention only a few, nutrition can affect age at menarche and at menopause (Bongaarts and Delgado 1980; Mosely 1980), fecundability (Frisch 1975), and length of postpartum amenorrhea (Chen et al 1974). Infant and child mortality can affect fertility by cutting short the breastfeeding behaviour of the mother, which brings about a more rapid return of ovulation (Knodel 1980; Gille 1985), although this relationship is not well-established (Cleland 1985). Diseases such as venereal syphilis and malaria can cause spontaneous abortion and even sterility (Gray 1980).

Natural fertility is studied only within marriage or stable unions (Henry 1953). Since fertility is determined by such factors as the marriage rate and illegitimate and legitimate birth rates, cross-cultural comparisons are difficult. By restricting the study to legitimate birth rates, or the equivalent, however, it is possible to analyse and compare "the fertility of women who have formed a union which is stable enough for them to be considered as exposed to the same risk as married women" (Henry 1961:82). Henry (1961) therefore concentrated on age patterns of fertility and on birth intervals within marriage. He was able to demonstrate that although the level of fertility varied among populations, there was in fact a typical age pattern for natural fertility within marriage. Works by Coale (1967; 1971) and Coale and Trussell (1974), in particular, have advanced the understanding of the effects of age patterns of marriage on fertility. "Coale and Trussell characterized age-specific fertility rates of any population by two parameters as deviations from a set of standard natural fertility rates" (Xie 1990:656). Ohadike (1980) shows that in many natural fertility societies marriage is early and almost universal.

Marriage rates therefore tend to be high. Since high proportions of women in the child-bearing ages are married, birth rates tend to be high (1980:290).

The more important question for this thesis is the outcome of this combination of factors as it is measured by fertility performance among the various populations experiencing, or very nearly experiencing, natural fertility. It is only among those populations experiencing maximum marital fertility that the very high proportions under fifteen years of age can come into being. However, maximum marital fertility may result in a level of fertility in one population that is remarkably higher or lower than the level of fertility experienced in another population also exhibiting maximum marital fertility.[7]

To illustrate the wide differences in fertility among populations meeting these conditions, table 2.2 provides a list of historical populations showing mean number of children per completed family of women married at age 20. The accompanying columns--mean fertility rate for 20-29 age group and indices of mean fertility rates--are provided to give a rough idea of the age distribution of births. Such a breakdown

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[7] In a review of total fertility rates (TFR) among populations with natural fertility, Leridon (1977) found the highest TFRs were double the lowest.

is necessary, according to Henry (1961), in order to facilitate a valid comparison among the legitimate birth rates of different populations.

A number of observations, aside from the extraordinarily high levels of fertility reported, can be made. First, it is clear from the declining fertility performance by age, that age of the woman is an important factor affecting fecundity and therefore fertility. This fact is not surprising, given that all reproducing human populations exhibit a similar curve, with a sharp rise in fertility rates into the early to mid-twenties from the mid-teens, with a distinct decline until about age 45-50 (Coale and Demeny 1983:27). The populations in table 2.2 have relatively gradual declines from their peak levels in the twenties, to the effective cessation of fertility at age 49. French Canadian women married between 1700 and 1730 maintained a remarkably consistent level of fertility between the ages of 20 and 39, the 30-39 years old reproducing at a reported 89 percent of the 20-29 year olds. Still, their overall fertility (10.8 children per completed family) was slightly below that of the Hutterites married between 1921 and 1930 (10.9 children per completed family), whose 30-39 year olds reproduced at a lower but still very high 81 percent of the 20-29 year olds.

This appears from the table to be due to the fact that the Hutterite women outperformed the French Canadian women in the 20-29 year age group by 24 births per thousand women (526 per thousand compared to 502 per thousand). Note also that the mean fertility rate for the 20-29 year age group for the Bourgeoisie of Geneva, 505 per thousand, is slightly higher than that of the French Canadians (502 per thousand). Yet the mean number of children born per completed family is substantially higher for the French Canadians (10.8) than for the Geneva Bourgeoisie (9.4). This is explained by the more rapid decline in fertility performance for the Bourgeoisie of Geneva into the 30-39 year age group (71 percent compared to 89 percent) and, even more so, into the 40-49 year old age group (15.5 percent compared to 26 percent).

It is clear from this discussion that maximum reproduction and therefore maximum proportions under age 15 are found only in populations whose women maintain high levels of fertility over the course of the reproductive years. Thus, since the fecundity of 20-29 year olds exceeds that of 30-39 year old women, the former have higher levels of fertility than the latter. Likewise, fecundity of 40-49 year olds declines to close to zero around age 49, and they therefore give birth to far fewer children than the two younger age

Table 2.2

Fertility indices of historical high fertility populations

Population	Mean No. of children per completed family of woman married at 20	Mean fert. rate (per 1,000) for the 20-29 age group	Indices of mean fertility rates (base 100: mean rate 20-29) 20-29 years	30-39 years	40-49 years
Hutterites marriages from 1921-30	10.9	526	100	81	27
Canada marriages from 1700-30	10.8	502	100	89	26
Hutterites marriages before 1921	9.8	463	100	86	25
Bourgeoisie of Geneva, wives of men born between 1600-49	9.4	505	100	71	15.5
Europeans of Tunis (notabilities excluded) marriages from 1840-59	9.15	449	100	81	22.5
Sotteville-lès-Rouen (Normandy) marriages and births from 1760-90	8.95	465	100	78	14.5
Crulai (Normandy) marriages from 1674-1742	8.3	430	100	76	17
Norway marriages from 1874-76	8.1	388	100	81	28.5
Iran (villages) marriages from 1940-50	7.5	382	100	76	19.5
Bourgeoisie of Geneva, wives of men born before 1600	7.5	376	100	80	19

Taiwan (rural region of Yunlin) women born about 1900	6.95	350	100	81	17
India (Hindu villages of Bengal) marriages from 1945-46	6.2	306	100	80	22
Guinea (villages of Fouta-Djalon) marriages from 1954-55	6.2	339	100	67	16
Average	8.42	421	100	79.5	20.5

Source: Henry, Louis. 1961. "Some data on natural fertility." Eugenics Quarterly, 8(2):84

groups. If it is assumed that each woman in such a population is subject to a natural fertility regime, then the level of fertility is determined not by conscious attempts to limit fertility, but by other potent intermediate variables. It is logical to assume that biological variables play a greater role in such populations than do behavioural variables. Davis and Blake (1956) proposed the intermediate variables as a means of delineating behavioural from biological determinants of fertility.

2.4 The intermediate variables

Davis and Blake (1956), working independently of Henry

(Leridon and Ferry 1985:139), proposed the intermediate variables, which combine to determine the fertility level of any and all populations (Table 2.3). They proposed eleven intermediate variables in all, both behavioural and biological. In their model, fertility occurs in three phases, each of which is represented by a category of intermediate variables. These are the intercourse, conception and gestation variables. It is important to note at this point that it is through these intermediate variables, and only through them, that cultural factors act to produce a given fertility level. The variables are arranged into four categories according to their expected values in pre-industrial societies. These are, usually high values, high or low values, usually low values and the indeterminate.

Table 2.3: The Intermediate Variables

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 governing 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 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 Parturation ("Gestation Variables").

10. Foetal mortality from involuntary causes.

11. Foetal mortality from voluntary causes.

Source: Davis, Kingsley and Judith Blake. 1956. "Social structure and fertility: An analytic framework." Economic development and cultural change, 4:213

They stress that all these variables are present in every society, and that they exert either positive or negative effects on fertility. They write,

> One cannot say, as is frequently implied in the literature, that some of these variables are affecting fertility in one society but not in another. All of the variables are present in every society. This is because, as mentioned before, each one is a variable--it can operate either to reduce or to enhance fertility. If abortion is not practiced, the fertility value of variable 11 is "plus". In other words, the absence of a specific practice does not imply "no influence" on fertility, because this very absence is a form of influence. It follows that the position of any society, if stated at all, must be stated on all eleven variables (Davis and Blake 1956:213).

This prescription has not been followed by many subsequent researchers, who select the variable(s) they are interested in, without giving due consideration to the other variables (Leridon and Ferry 1985:139). Moreover, Davis and Blake (1956:213) do not attempt to classify the social factors or "conditioning variables" which affect fertility through the intermediate variables. Their intermediate variables "offer a means of approach to selecting and analyzing these factors" (Davis and Blake 1956:213).[8]

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[8] For example, age of entry into sexual union has an obvious effect on fertility (Coale 1971; Coale and Trussell 1974). The reasons for early or late entry into a marital unions, however, are in the realms of sociology, economics and social psychology (Hoppe 1980:261). These factors, while beyond the scope of this thesis, are the starting point for numerous analyses of fertility (for example, DelVecchio Good et al 1980; Hirschman and Rindfuss 1980).

2.5 The proximate determinants and fertility according to Bongaarts

Bongaarts (1978) has developed a widely used model which is used to quantify, relatively simply, the relationships between intermediate fertility variables and the level of fertility. While the Davis and Blake model includes all possible determinants of fertility, Bongaarts has found which variables are important in reality by quantifying them. He collapses Davis and Blake's 11 variables into eight, and groups them into three categories:

I. Exposure factors

1. Proportion married

II. Deliberate marital fertility control factors

2. Contraception
3. Induced abortion

III. Natural marital fertility factors

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

While the first two categories are self-explanatory, the third encompasses factors that are independent of parity and can therefore be considered natural fertility factors. It is because of differences in the five factors in this category that fertility is neither the same nor at the biological maximum among natural fertility populations. Of the first three factors, among natural fertility populations, marriage is early and almost universal, and contraception and induced abortion are absent or minimal.

Of the eight variables, Bongaarts suggests that the last four--frequency of intercourse, sterility, spontaneous intrauterine mortality and duration of the fertile period--are not very important determinants of fertility differences among populations.[9] The remaining four factors he assembles into a model. The equation that describes this model (ie, the relationships between the four variables) is:

$$TFR = C_m \text{ X } C_c \text{ X } C_a \text{ X } C_i \text{ X } TF$$

where,

TFR is the total fertility rate, excluding illegitimate births

TF is the total fecundity rate equal to the total natural marital fertility rate in the absence of lactation

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[9] The difference in fertility levels between populations with a natural fertility regime is therefore determined mainly by the fourth variable, lactational infecundity.

C_m is an index of age-specific proportions married and age specific marital fertility rates

C_c is an index of age- and method-specific proportions currently contracepting among married women, and age- and method-specific effectiveness levels of contraception

C_a is an index of the total induced abortion rate and the total fertility rate (excluding abortions and births to women not married)

C_i is an index of the average duration of lactational infecundability

Bongaarts calculates a TF of about 15, and expects the large majority of populations to fall within 2 births of this figure. A maximum total fecundity rate of 17 is the result. His analysis involves an explanation of why a population does not attain this high number of births. He compares a developing country (Korea 1960-1970) with a developed country (United States 1965-1973) and shows that the four important intermediate variables do not contribute equally to fertility levels and trends.

Korea's TF is calculated to be over 16. In 1960, lactation (C_i) accounts for a reduction to 9, and non-marriage (C_m) a further 3, which brings the total down to the observed TFR of about 6. Induced abortion (C_a) and contraception (C_c) play insignificant roles. By 1970, lactation is still the most important factor, but its effect is lessened. It accounts for a reduction of the TF to 11 from 16. Induced abortion and contraception each accounts for about 2 births and non-marriage still accounts for 3, which brings us to the observed TFR of about 4.

In comparison, a TF of under 16 in 1965 (and about 15 by 1973) for the United States is reduced by about one birth by lactation, 10 by contraception, and a further 2 by non-marriage, for an observed TFR of about 3. In 1973, lactation accounted still for one birth, induced abortion for one birth, contraception for about ten births and non-marriage for about one, for a TFR of about 2. Balakrishnan (1989) has calculated these indices for Canada using the same method. A TF of 16.43 in 1984 is reduced to the observed TFR of 1.592 by 0.82 births due to lactation, 0.62 births due to induced abortion, 11.54 births due to contraceptive use and 1.85 births due to non-marriage.

From this it might be inferred that in natural fertility populations, the main reason for the non-attainment of the biological maximum fertility is lactation. Since induced abortion and contraception are, it has been found empirically and contrary to expectations, unimportant or non-existent in these populations, it is non-fertility due to non-marriage and duration of postpartum sterility resulting from breastfeeding that reduces the fertility of a natural fertility population to its observed, from its potential, level (Romaniuc 1980:293; Lesthaeghe and Page 1980:143).

In an earlier paper, Bongaarts (1975) estimates that a typical thirty-month birth interval in a natural fertility population can be divided into the following: twelve months postpartum amenorrhea, four months waiting time to a conception before an intrauterine death, a one-month non-susceptible period associated with the intrauterine death, a further four month conception waiting time before a live birth, and a nine-month gestation period. Overall, the observed birth rates in natural fertility populations are much lower than the biological maximum because women spend much of their time in non-reproductive states: unmarried, sterile, postpartum anovulatory, ovulatory or non-susceptible states. Only one-sixth of their reproductive years is spent in the pregnant stage. All the children are produced during this relatively short proportion of the reproductive years.

2.6 Coale's indexes of fertility

Coale (1967) has devised four indexes of fertility that measure levels and trends of fertility over time and employ some of the variables that were to be used later by Bongaarts. An essential point for this thesis is that Coale used a standard schedule of age specific fertility that was fixed with reference to the concept of natural fertility. The standard schedule he used was that of Hutterite women who married between 1921 and 1930 (Woods 1979:118). This was the highest age-specific fertility schedule cited by Henry (1961, see table 2.2). However, because Hutterite women tended to marry some years after their 15th birthday--thereby reducing their exposure to conception--Coale states the following

> The average number of children born to a group of women passing through life, married at age 15 and subject to the Hutterite childbearing rates, would be 12.6 (Coale 1969:4).

While less than Bongaarts' (1978) TF of 16, it turns out that Coale's conception of maximum human fertility (12.6 children per woman) is in the realm of speculation as well.

The indexes are: (1) An index of overall fertility [I_f] that indicates the extent to which the women in a given population approach the births they would achieve if all were subject to the highest rates of age-specific fertility on record, that is, the fertility of married Hutterite women. (2) An index of marital fertility (I_g) that indicates how closely married women approach the births they would produce if subject to the Hutterite age-specific fertility rates. (3) An index of the fertility of non-married women (I_h) that indicates how closely the fertility of the unmarried approaches that of the married Hutterites. (4) An index of the proportion married among women in the child-bearing ages (I_m) that indicates the extent to which marriage contributes to the achievement of the highest potential fertility of the population being studied. (Coale 1967:4-5)

The interrelations between these four indices are shown by the following equation:

$$I_f = I_m \times I_g + (1-I_m) I_h.$$

In populations where I_h is less than 4 percent, the relationship is reduced basically to:

$$I_f = I_m \times I_g.$$

There are two advantages to using this model. First, the data requirements are not extensive, especially in the case of the reduced equation. Data requirements include the actual number of all births, of legitimate births, and of illegitimate births, and the distribution of women 15 to 50 by age and marital status. Second, for the purposes of this thesis, the fact that the fertility performance of a population is measured against the actual fertility performance of the highest recorded (rather than the highest theoretical) fertility level is of some value. Although this model will not be used in this thesis, it is noteworthy that it does not extend the measurement of fertility beyond observed fertility levels. That is, Coale seems to be acknowledging that a fertility measure based on anything but empirically verifiable limits (ie the Hutterite fertility of the 1930s) may not be practically useful.

2.7 Conclusion

This chapter may be usefully concluded by distinguishing between and summarizing the three levels of fertility discussed above. Bongaarts (1975) considers 40 births per woman to be the theoretical upper limit. This assumes a reproductive span of 30 years, and no time between births. His attempt to account for the difference between the highest observed fertility of Hutterites (8.9 births per woman, according to Bongaarts) and this theoretical upper limit recognises marriage as the principal demographic factor affecting the birth rate in populations with natural fertility. Sterility he recognises as "the biological factor primarily responsible for the age pattern in natural marital fertility" (293).

Three years later, Bongaarts (1978) gives a much lower, but still unrealistic, maximum figure of about 15 children per woman (and as high as 17 in some populations). Balakrishnan (1989), using Bongaarts model, comes up with a TF of 16.43 for Canada 1984. The variable primarily responsible for the non-attainment of these very high theoretical upper limits is, in developed countries, contraception. In developing countries it is lactation.

The anomalous population 'real' maximum belongs to the Hutterites married between 1921-1930 (see table 2.2). Not far behind are the French Canadians married between 1700-1730, whose TFR of 10.8 is very slightly below the 10.9 recorded for Hutterites. Other notable examples--Hutterites married before 1921, Bourgeoisie of Geneva and Europeans of Tunis (see table 2.2)--had TFRs of over nine, but were all populations of very small size. The word 'anomalous' is appropriate because small populations are much more likely to be subject to extreme demographic fluctuations.[10] The larger the population, the less likely it is to be subject to demographic extremes. The upper limits of fertility referred to above give us some insight into the demography of high-fertility populations, but they are not limits that can be expected to apply to modern national populations. The Rwandan TFR of 8.5 for the 1980-85 period is well below that of the Hutterites and French Canadians, but is nonetheless remarkable for a relatively large population. It is among just such national populations that the straitjacket is expected to be in operation.

[10] Pressat (1972:356-360) discusses the problems faced by demographers when dealing with small population groups.

Chapter 3:

The straitjacket in the empirical world

3.1 Introduction

The complex workings of the cultural and biological factors that create a given level of fertility, are given expression in the age distribution of a population. Of particular interest in this thesis are the proportions of the distribution that are female aged 15-49 and both sexes aged 0-14. The purpose of the chapter is primarily to describe the relationship between the two variables theorized to comprise the concept of the straitjacket. (It is the purpose of chapter 4 to make a determination of the *existence* of the straitjacket concept.)

Although the straitjacket is theorized to be in place only at the highest proportions aged 0-14 years accompanied by the lowest proportions female 15-49 years, it may be misleading to describe the relationship between the two variables only for extreme values of the variables. That is, before going on to isolate the populations of interest to the thesis, and analysing them separately, it makes sense to determine the form of the relationship between the variables when the variables are composed of their full range of values.

A further advantage of using data for all countries is realised since it will mean the addition of countries with demographic data known to be highly accurate. Countries potentially experiencing the straitjacket are less-developed countries, many of which have less than desirable demographic data collection methods and resources.[11] Including the data for the countries of Europe, North America and some others will add stability to the regression line (Preston 1986).

It is hypothesized that the straitjacket effect occurs only among those populations with the most youthful populations. The less pyramid-shaped and the more vase-shaped the age distribution of a population, the less that population is governed by the straitjacket effect.

3.2 Data

The data used in this chapter are from Keyfitz and Flieger (1990). The dataset constructed for the purposes at

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[11] Makannah (1985), for example, discusses the unsatisfactory state of vital registration in many African countries. The United Nations (1992:145-146) reports that in 1990, fertility rates were available for 63 percent of African countries and 61 percent of Western Asian countries.

hand consists of 1022 cases, which are comprised of the data for seven time periods for 146 countries[12]. Thus, 146 times seven equals 1022. The time frame is 1960 to 1990[13]. For example, data for Egypt for each of the years 1960, 1965, 1970, 1975, 1980, 1985 and 1990 have been entered into the data file. Each of these seven Egyptian populations is treated as a case. The fertility behaviour of any individual country's population can thereby be traced from 1960 to 1990 and be compared with the changes observed in other countries over the same period. The value of such an exercise lies in the discovery of a pattern over time of the countries experiencing the straitjacket. The absence of a unique pattern would likewise shed some light on the relationship between bst0-14 and ft15-49.

3.3 Methods

The method of analysis for this chapter is bivariate regression. It is a simple matter when using regression (should it be justified after checking the residuals) to see

[12] See Appendix for a list of the countries used in this analysis.

[13] The 1990 figures are projections.

whether the relationship is linear or otherwise by adding quadratic term(s) to the equation. The relationship is expected to be linear, however, with a proportional increase in bst0-14 heralding a corresponding decrease in proportions ft15-49 (in the absence of significant demographic disturbances, such as large-scale migrations).

An initial regression and scatterplot will be observed to place countries into categories. It is expected that the categories will fall roughly into a less developed country (LDC)/more developed country (MDC) dichotomy. In other words, a pre-transitional group and a post-transitional group should emerge. Borderline cases will be of interest, especially if they move from one category to the other over time. These would be the countries that have experienced a fertility transition sometime between 1960 and 1990. Other cases of interest will be the outliers. Potential outliers include countries with relatively small populations, experiencing massive in or out migration. Kuwait and Qatar, for example, experience major flows of incoming foreign workers (Abu-Lughod 1978;Hassan 1974). Such outliers may require special attention and possibly removal from the main data set, since their inclusion may adversely affect the location of the regression line.

A second set of regressions will be performed within each of these categories and will help in understanding the position of the straitjacketed populations in the larger picture. Outliers will again be a concern, and will be analysed separately. It is of some interest to see whether Canada (and other low fertility countries which have already passed through the demographic transition) show any of the effects of this straitjacket. It is expected, in accordance with the straitjacket concept, that the correlation between bst0-14 and ft15-49 will not be as strong in low fertility countries as in high fertility countries. This of course hinges on the expectation that LDCs and MDCs show up on the scatterplot as distinct groups.

Specifically, the argument of this chapter will proceed as follows. Data for all countries for the 1960 to 1990 period will be used in the following model:

$$(bst0-14) = a + b(ft15-49) + e \qquad \text{Equation [1]}$$

$$(ft15-49) = a + b(bst0-14) + e \qquad \text{Equation [2]}$$

where,

bst0-14 = proportion of each national population aged 0-14, both sexes

ft15-49 = female proportion of each national population aged 15-49

a = y intercept
For equation [1], the value of bst0-14 when ft15-49 = 0
For equation [2], the value of ft15-49 when bst0-14 = 0

b = correlation coefficient
For equation [1], this is the effect of a unit change of ft15-49 on bst0-14
For equation [2], the effect of a unit change in bst0-14 on ft15-49

e = error: anything other than the independent variable that affects the dependent variable, in each equation

Two equations are presented above to show the theoretical possibilities involved in an empirical treatment of the straitjacket concept. That is, the proportion bst0-14 acts to constrain the proportion ft15-49, and vice versa. Practically, however, only one equation need be considered for the purposes at hand. Equation [1] will therefore be used to demonstrate the relationship between the two variables. The reason for this is that causation is not assumed between the two variables; only a correlation is assumed. Moreover, a classification scheme for the countries in the analysis can be constructed using one or the other equation: both are not necessary. Equation [1] was selected over equation [2] because the independent variable, ft15-49, precedes the dependent variable, bst0-14, chronologically: mothers give birth to children.

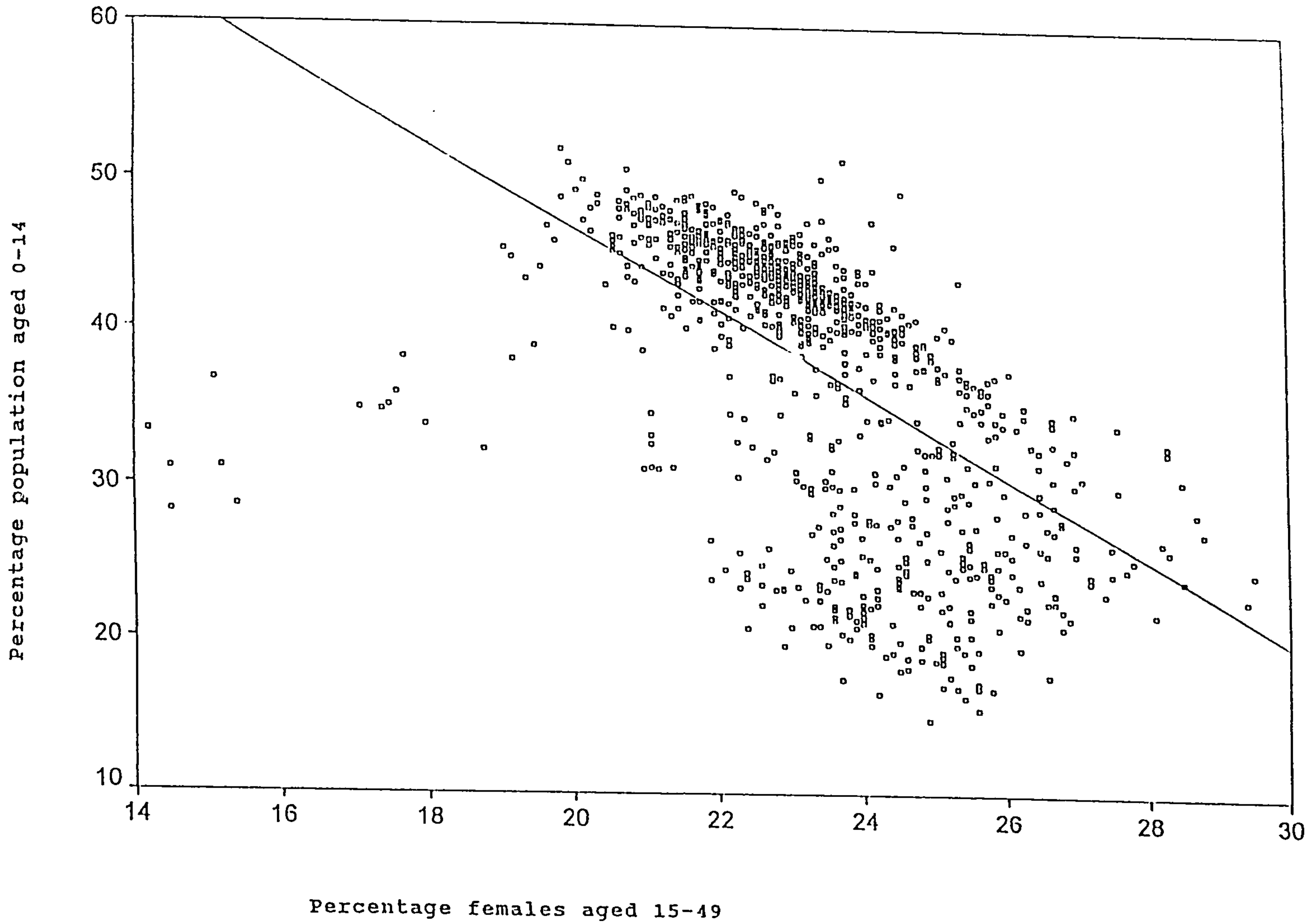
3.4 Results

Five bivariate regressions have been run. The first involved all cases (N=1022) and the second all cases minus the outliers (N=1009). The third (N=693) and fourth (N=675) regressions were run for high fertility populations, the former for all high fertility populations (minus the outliers identified in the first regression) and the latter for high fertility populations minus the outliers identified in the third regression. The fifth regression N=316) was run for low fertility populations, minus the outliers identified in the first regression. No outliers were identified among the low fertility populations. For each of these regressions, a scattergram and regression line is shown (Figures 3.1 to 3.5). All identified outliers are discussed separately.

3.4.1 Bivariate regression results: All cases

The initial regression was run using all cases (N=1022), the scatterplot of which is presented in Figure 3.1. Overall, there appears to be a negative linear relationship between the

Figure 3.1: Scattergram of percentage of females aged 15-49 with percentage of population under age 15 (All cases: N=1022)



two variables, and a correlation coefficient of -.543 provides some indication that this is indeed the case. The other possiblity is that the relationship is curvilinear, with the association becoming positive at high levels of the independent variable ft15-49. The relationship is somewhat more complex than the correlation coefficient might suggest, however, a fact which is apparent from the observation that more than one group emerges on the scatterplot.

There appear to be three groups, two of which are fairly distinct. The most tightly clustered group is the one composed of data from high fertility populations. These countries have high proportions under 15 years of age and low proportions female 15-49. There appears to be a strong negative correlation between the two variables for these countries. The dividing line is clearly about 35 percent for bst0-14, below which the pattern appears to fall apart. Below 35 percent, a second group emerges. These are primarily, but not exclusively, the more developed countries. During the period 1960-1990, 26 countries--most of them less developed--saw their proportions under age 15 decline from above 35 percent to below 35 percent. These countries are listed in table 3.1 and are discussed later in this chapter.

3.4.2 The outliers: All cases

A third group is composed of the outliers. An analysis of the residuals reveals 13 outliers. As expected, these are small Middle Eastern, oil-producing countries with high rates of immigration. They tend to have very low proportions of females 15-49 and moderate to high proportions under 15. They are, Kuwait (1960), Qatar (1960-1990) and United Arab Emirates (1970-1990). Qatar and United Arab Emirates are the only countries to register proportions female (15-49) under 15 percent, the mean for all countries being 23.3 percent. These three countries have in common a small population prior to the discovery of oil. The transition from nomadism to industrialism required the importation of foreign skilled and unskilled workers.

In Kuwait, the population before the discovery of oil is estimated at 100,000 (Abu-Lughod 1978:232). By 1978, the population had grown to over 800,000, only 360,000 of whom were Kuwaiti citizens (Abu-Lughod 1978:232). As early as 1961, the masculinity ratio among foreigners was as high as 388:100 for some age groups (El-Badry 1965:185). The magnitude of the influx of foreign workers is all the more remarkable when one considers that the native Kuwaiti population was reproducing itself rapidly: the estimated crude birth rate for native Kuwaitis was 52.8 in 1965 (Zaghloul and El-Ghamry 1971:20). Despite this rapid natural increase, however, by 1991 60 percent of Kuwait's population, and 83 percent of its workforce, were foreigners (Looney 1992:175).

Similar situations existed in the United Arab Emirates and Qatar. The population of the United Arab Emirates grew from 180,000 to 1,015,000 between 1968 and 1979 (Taryam 1987:259). The increase was due largely to the immigration of foreigners, who made up 37 percent of the population in 1968 and 78 percent in 1979 (Taryam 1987:259). In Qatar, a masculinity ratio of 181.9:100 in 1970 was largely accounted for by immigration of male workers from Oman, India, Pakistan and Iran (Hassan 1974:311). The masculinity ratio among the working age groups (15-59) in 1970 was 280.0:100 (Hassan, 1974:311). In 1977, 64 percent of the Qatari population was composed of foreigners (Zahlan 1979:120). The immigration of male foreign workers to these small countries has had the effect of decreasing both the proportion of females 15-49 and the proportion of children under 15. Distortions of the age/sex structure of this magnitude make them unsuitable candidates for inclusion in the analysis.

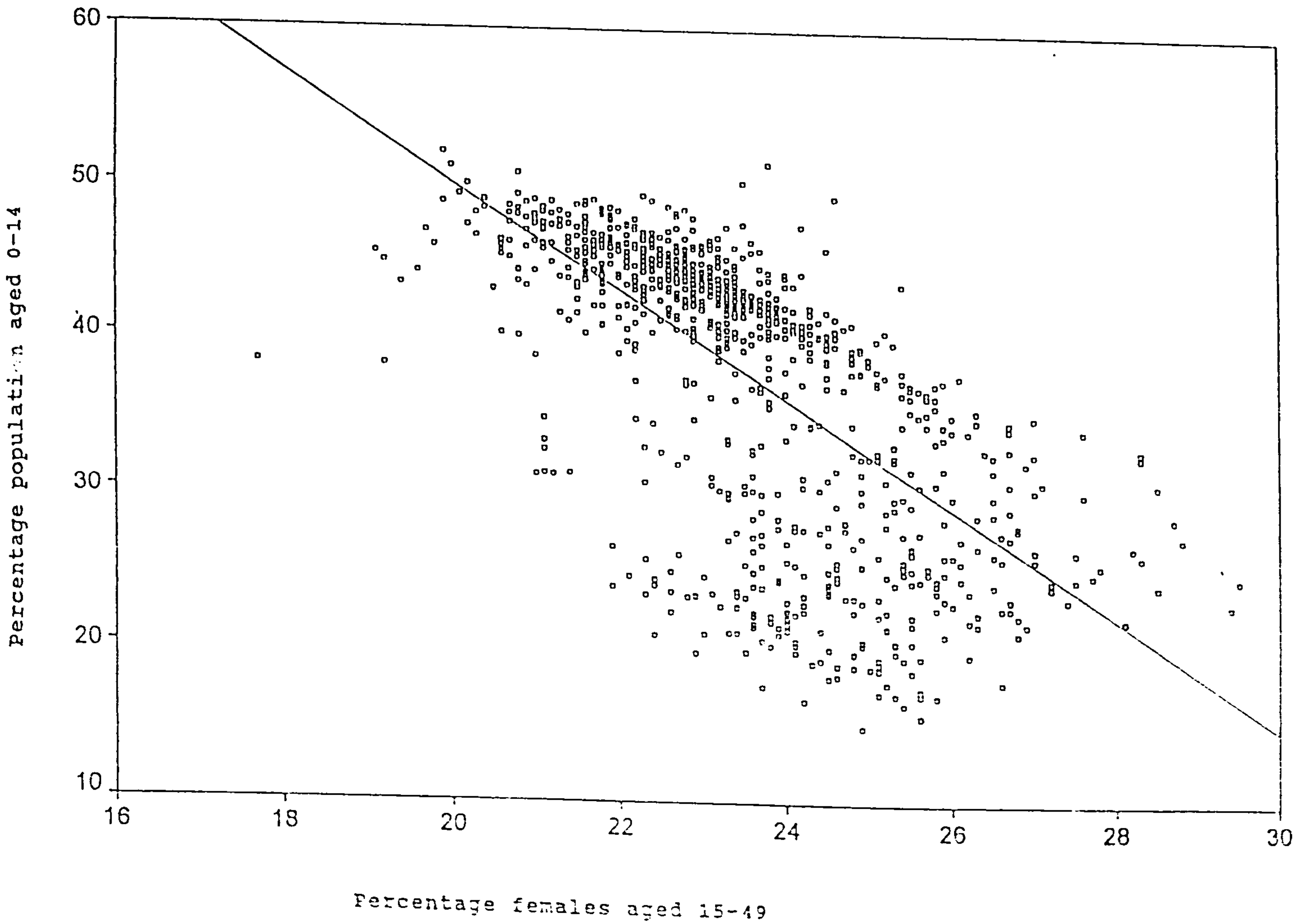
3.4.3 Bivariate regression results: All cases, outliers removed

Figure 3.2 shows the same variables, with the outliers identified above r[illegible] from the data (N=1009). The fit is slightly better, t[illegible]re having increased from .30 to .42, and the cor[illegible] coefficient having increased to -.646. Still, the [illegible] appear to fall into the two groups discussed above (divided by the 35 percent mark of the bst0-14 variable), and have been divided at the 35 percent mark. Thus, countries who have over 35 percent of their populations under 15 are assigned to one group, and those with 35 percent or less are assigned to the other group. Regressions were subsequently run for each group for the same variables, and the following results were obtained.

3.4.4 Bivariate regression results: High fertility populations

Dividing the original dataset (minus the outliers) into two groups produced groups of 693 cases (the "high" proportions under 15 group) and 316 cases (the "low" proportions under 15 group). Figure 3.3 shows the results of

Figure 3.2: Scattergram of percentage of females aged 15-49 with percentage of population under age 15 (All cases, minus outliers: N=1009)

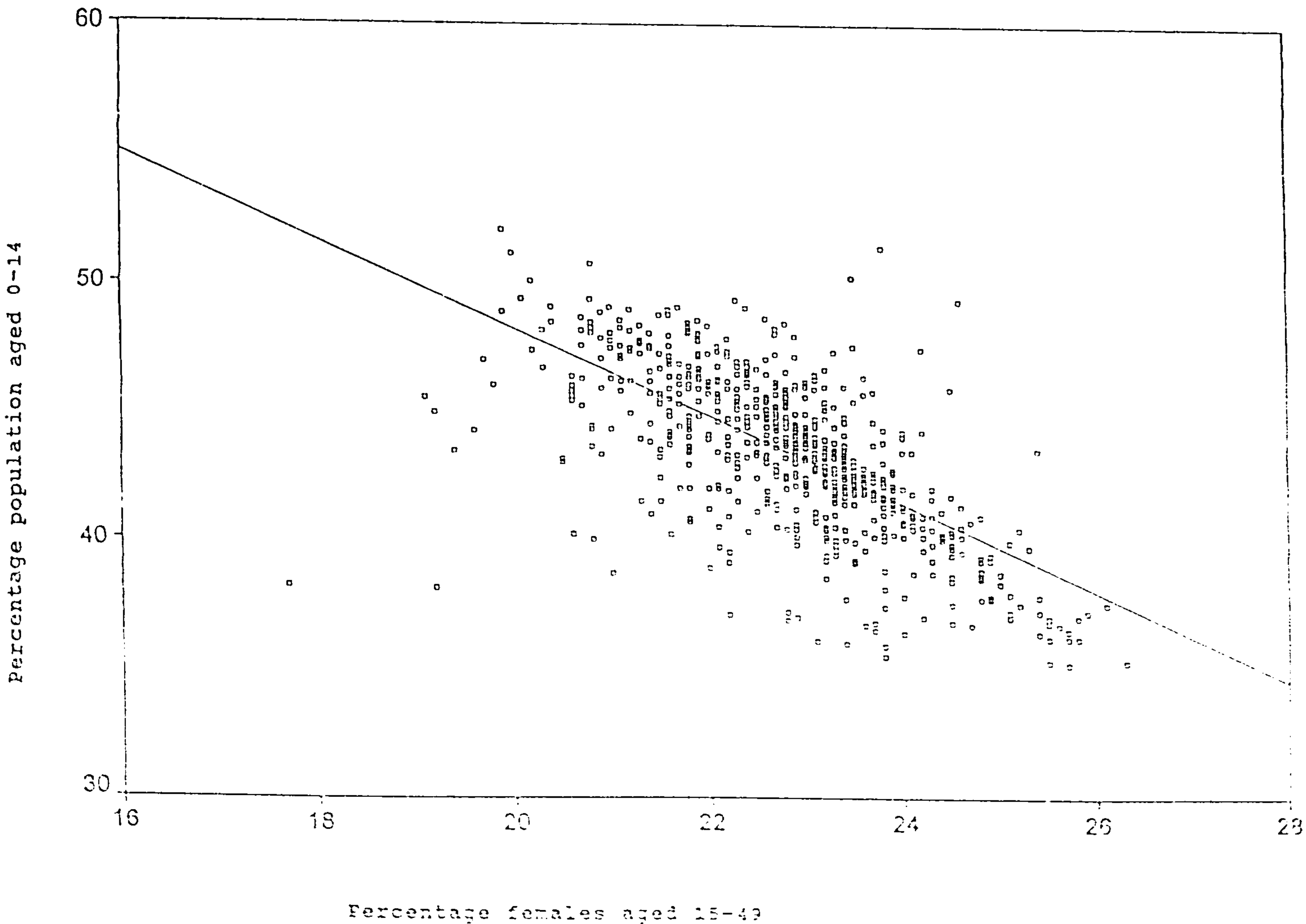


the regression performed on the "high" proportions. A clear pattern is revealed, although outliers probably distort the relationship between the two variables. Note that the correlation coefficient (-.649) and the R-square statistic (.42) are the same as they were for the entire dataset minus the outliers, despite the apparently distinct pattern on the scatterplot. To improve the fit, the outliers were identified, removed and are treated separately below. Their exclusion is necessary in light of their exceptional migration.

3.4.5 The outliers: High fertility populations

The 18 outliers were identified as Botswana (1960-1975), Barbados (1970), Cuba (1965-1975), Kuwait (1965-1990), Israel (1960), and United Arab Emirates (1965). The remarks made previously for Kuwait and United Arab Emirates apply here and will not be repeated. Botswana is the one country identified as an outlier for some years because of its extraordinarily high proportions female aged 15-49. Botswana's proportions under 15 for 1960, 1965, 1970 and 1975 were 47.5, 49.4, 51.5 and 50.3, respectively. This places them among the highest ever recorded. Yet at the same time the proportions female 15-49 were between 23.5 and 24.6 for the same period. Thus,

Figure 3.3: Scattergram of percentage of females aged 15-49 with percentage of population under age 15 (High fertility populations: N=695)



proportions under 15 were exceptionally high, and female proportions 15-49 were above the world national average. This anomaly can be explained by the high rates of emigration of male labourers from Botswana (mainly to South Africa) that began in the 1950s and continued into the 1960s and early 1970s (Cortin 1978:183).

Cuba's position as an outlier for the years 1965-1975 can be explained largely in terms of official American concern for the welfare of Cuban refugees. Between the years 1953 and 1965, an average of 11,000 Cubans per year emigrated to the United States (Keely 1971:164). By 1966 the number rose to 17,000, by 1967, 33,000 and by 1968, 99,000 (Keely 1971:164). Rosberg (1978:369, footnote) explains that the reason so many Cubans emigrated to the United States during the 1965-1975 period was because of

> special provisions for Cuban refugees whose entry into the United States was sought and encouraged by the United States Government for political and humanitarian reasons outside the field of immigration policy.

The effect was to push the under 15 proportions just above .35 and into the "high" proportions under 15 group.

Israel is similarly situated on the scatterplot, but for very different reasons. 36.1 percent of Israel's 1960 population was composed of children under 15. When the

British mandate in Israel ended in 1948, Israel began "encouraging, stimulating, and assisting immigrants in all stages of the immigration process" (Friedlander and Goldscheider 1979:83). The goal was to populate Israel with Jewish people from any part of the Earth Thus, in the 1950s the share of immigrants from Asia and Africa grew from very small numbers to almost half of all immigrants by 1960 (Ben-Porath 1988:14). Their birth rates soon converged with the already-settled Israelis. The already-settled Israelis, meanwhile, were experiencing a shortage of females aged 15-29 because of the reduced fertility in the late 1930s and early 1940s in Israel (Friedlander 1975:598). The shortage of females and the fact that proportions under 15 were slightly over .35 combined to place Israel (1960) in an outlying position on the scatterplot.

3.4.6 Bivariate regression results: High fertility populations, outliers removed

Re-running the regression after removal of these outliers produced the scatterplot shown in Figure 3.4. The variables are highly correlated (-.75), with 56 percent of the variation in bs0-14 explained by f15-49.

3.4 Bivariate regression results: Low fertility populations

A regression performed on the "low" proportions (see figure 3.5) shows a very low correlation (-.02114) between bst0-14 and ft15-49, with ft15-49 explaining less than 1 percent of the variation in bst0-14.

The regression line is close to horizontal, indicating no relationship between bs0-14 and f15-49. It is worth noting, however, that while the slope obtained from the equation is not statistically significant (p=.7100), it is negative (-.06514). This might be taken, with some reservations, as confirmation of the overall negative slope observed in figures 3.1 and 3.2. More important, however, is the lack of a statistically significant correlation between the proportions bst0-14 and ft15-49.

3.5 Discussion

The straitjacket does not appear to operate in populations that have entered a certain phase of the

Figure 3.4: Scattergram of percentage of females aged 15-49 with percentage of population under age 15 (High fertility populations, minus outliers: N=675)

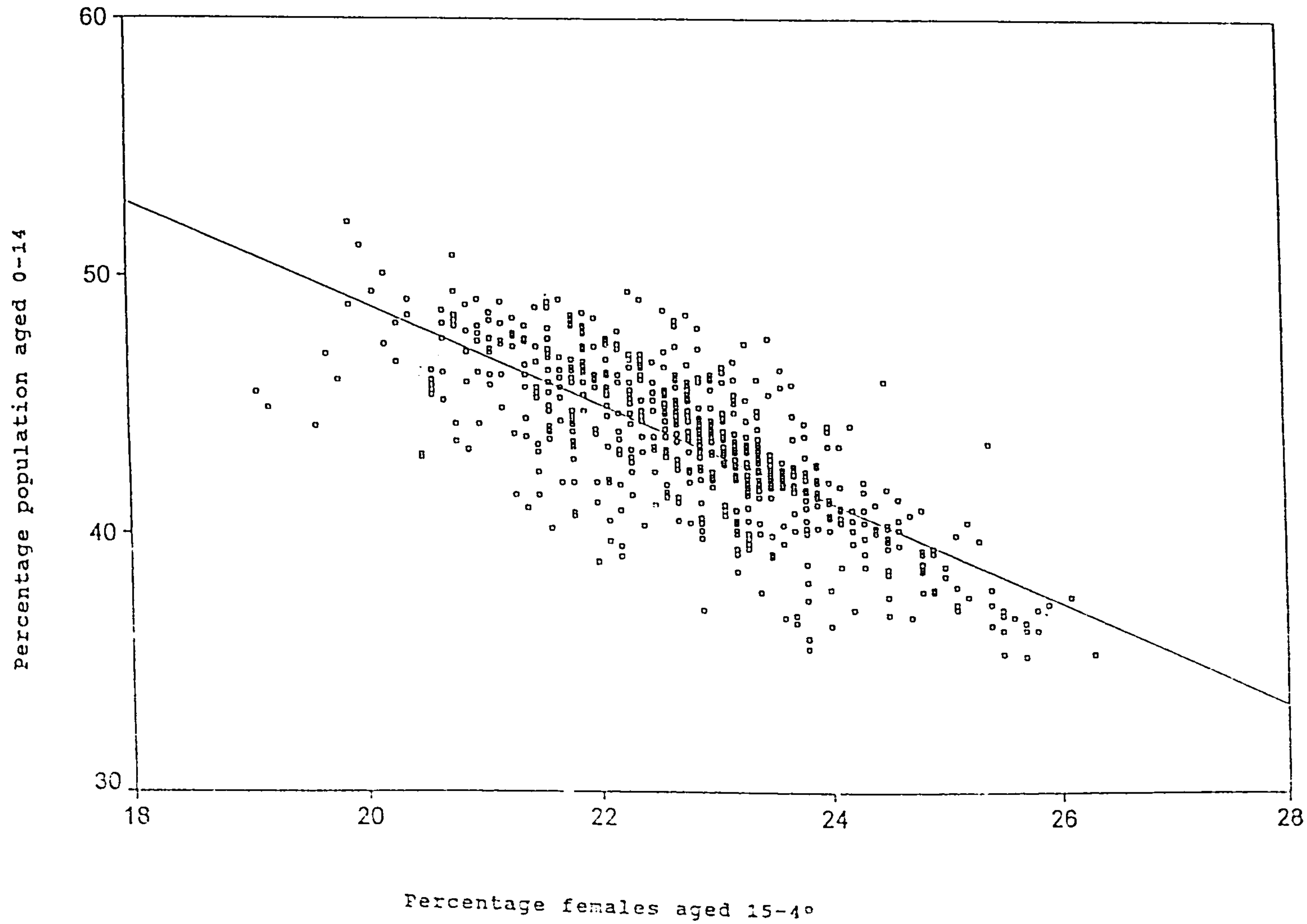
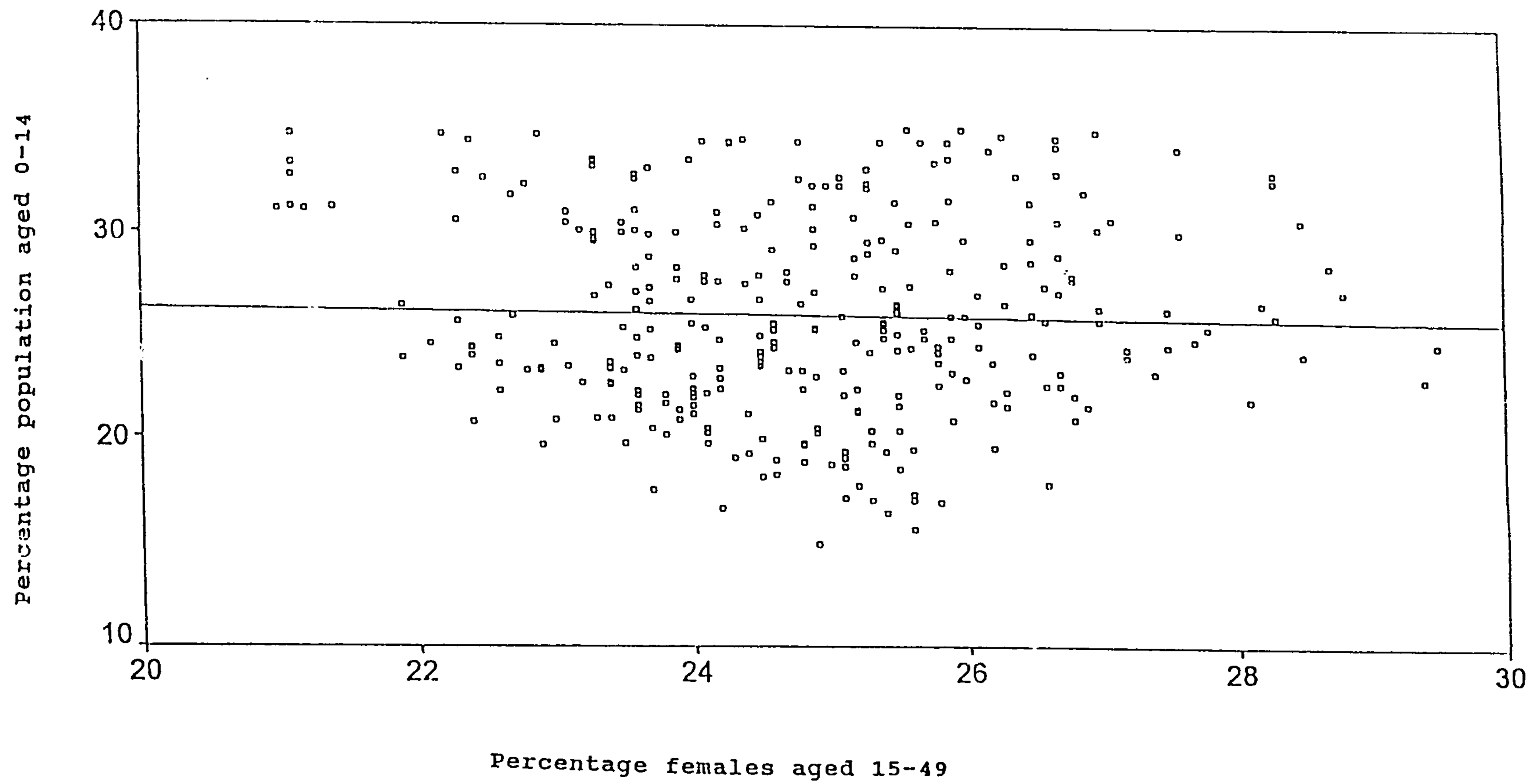


Figure 3.5: Scattergram of percentage of females aged 15-49 with percentage of population under age 15 (Low fertility populations: N=316)



demographic transition. Some light may be shed on this possibility by looking at those countries that have moved from the high proportion under 15 group to the low during the period under observation.

Most countries (116 of 142) during the period under observation had either high proportions under age 15 (over 35 percent), or low proportions under age 15 (equal to or less than 35 percent). They did not cross the line from high to low, or vice versa, during the period under observation. The distribution is a bimodal one. Conspicuous among the group of countries maintaining high proportions under age 15 are the African countries, and of the group with low proportions under age 15 (Table 3.1), the European countries. Of the 24 countries that moved from high to low proportions under age 15, the large majority are less developed. With the exception of Israel and Bahrain[14], each of these countries has experienced the beginning or the continuation of a fertility decline.

Most of these populations are recent arrivals to the

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[14] Israel's high levels of migration in her early years, and Bahrain's continued high rates of immigrating foreign labour are special cases. Israel proportions under age 15 would probably have remained below 35 percent in the absence of mass immigration, and Bahrain would likely have remained above 35 percent, given the high fertility of their natives.

low group and if classified by the timing of their fertility transitions, are primarily 'late-initiation

Table 3.1
Countries moving from high (>35%) to low (<35%) proportions under 15 and the year they appeared in the low group

Country	Year
Mauritius	1980
Barbados	1975
Chile	1980
Cuba	1980
Guadaloupe	1980
Guyana	1990
Jamaica	1990
Martinique	1980
Panama	1990
Peurto Rico	1975
Suriname	1990
Trinidad & Tobago	1980
Bahrain	1980
China	1985
Cyprus	1965
East Timor	1980
Hong Kong	1975
Indonesia	1990
Israel	1965
Kampuchea	1980
Rep of Korea	1980
Singapore	1975
Turkey	1990
Albania	1985

countries' (United Nations 1992:11). Eighteen of the 24 countries moved from high to low proportions under age 15 since 1980. Mostly Latin American, Caribbean and newly industrializing Asian countries appear in the table. The

Table 3.2: Summary of correlations between bst0-14 and ft15-49 for five samples

Sample	Corr. coeff.	p-value
All cases (N=1022)	-.54339	.0000
All cases minus outliers (N=1009)	-.64621	.0000
High fertility sample (N=693)	-.64945	.0000
High fertility sample minus outliers (N=675)	-.74804	.0000
Low fertility sample (N=316)	-.02114	.7100

Source: Statistical output

important common observation among these countries is the fact that their proportions female aged 15-49 have begun to disperse by the time their proportions bst0-14 fall to 35 percent of the total population. The effect of the straitjacket is felt to a remarkably lesser degree by those populations with low proportions under age 15 (See table 3.2 for a summary of the correlations obtained for the different samples).

3.6 Conclusion

It can be said with some confidence, therefore, that hypothesis 1 is supported by these findings. Populations with both high proportions under age 15 and low proportions female aged 15-49 are subject to the straitjacket. As proportions bst0-14 decrease, and ft15-49 increase, the correlation between the variables decreases. Eventually, as fertility declines to the levels of the modern Western countries, the correlation disappears altogether. Two distinct groups emerge, with the critical dividing line being 35 percent of bst0-14.

Chapter 4:

The straitjacket among theoretical populations

4.1 Introduction

It is clear from the analysis in Chapter 3 that the straitjacket effect occurs only among those populations experiencing high fertility.[15] It appears that the higher the fertility, the more restrictive is the hold of the straitjacket. The populations with the highest proportions bst0-14 and the lowest proportions ft15-49 are populations subject to natural fertility. As we have seen, however, not all populations experiencing natural fertility will have such extreme proportions. Only a select few natural fertility populations have the appropriately young and universal age at marriage, and the short period of post-partum infecundability (due to short duration of lactation), to allow for long exposure to intercourse and short birth spacing (Bongaarts 1987). It is these select few that this chapter will focus on.

A determination of whether these proportions have indeed attained the arithmetic maximum and minimum possible in a

[15] In the timing of their fertility transition, they are classified as 'pre-transition countries' by the United Nations (1992:10).

human population can be accomplished with the help of stable population models (Coale and Demeny 1983). By using the technique of adjusting the stable proportion to the empirical proportion in question, and then observing the deviation of the other proportion from the stable, a reasonably accurate assessment of the existence of the straitjacket concept can be made.

Since the stable population is assumed to be closed to migration (Barclay 1958:133), we assume the same for the empirical populations. In the absence of migration, it is solely births and deaths that affect the age distribution. Empirical populations whose age/sex structures are found to be seriously affected by migration will be removed from the analysis.

The stable population is a theoretical population in which fertility (defined by a series of age-specific fertility rates) and mortality (defined by a life table) have not changed over a long period of time, and have therefore resulted in fixed proportions at each age (eg. Pressat 1972:334). It is possible to compare empirical with stable populations under some conditions. Pressat writes,

> If there is reason to think that real populations have retained the same life table as well as the same rate of natural increase for a long period of time, we may seek to

compare them to corresponding stable populations (Pressat 1972:333).

The key is the similarity of the age/sex distribution of the empirical population at the time of observation to the distribution it would have if its age-specific rates of fertility and mortality remained constant for a long period of time. In some populations, the observed age/sex distribution may be very close to the one produced by its "intrinsic rate of natural increase" or its "Lotka rate".[16] In others, it would not be so close. The stable distribution that the population would eventually reach is independent of the original, or observed, age distribution (eg. Keyfitz 1971:651). Since the age distribution of the stable population is determined by the Lotka rate, it is "independent of disturbing influences on the present structure of the population studied, an inheritance from past history that masks current growth capacity of the population" (Pressat 1972:334). This means that, depending on how similar the empirical distribution is to the stable, the comparison of stable and empirical proportions will be more or less valid.

Keyfitz and Flieger (1971), for example, have calculated

[16] These are interchangeable expressions for the rate of natural increase that would result if the present fertility and mortality regime were maintained over a long period of time (Pressat 1972:334).

for 700 empirical populations the index of dissimilarity. The index is in this case a measure of the difference between observed age distributions and stable age distributions. Their analysis shows that comparisons among populations which involve stable models are most meaningful when the index of dissimilarity is low (Keyfitz and Flieger 1971:30). The results obtained in the present chapter will obviously be affected by this fact, depending on how similar the stable populations are to the empirical.

Two complementary hypotheses are tested in this chapter.

1) The proportion of females aged 15-49 in the empirical population will be larger than the corresponding proportion in the theoretical population, when holding female proportions aged 0-14 constant.

2) The proportion of females aged 0-14 in the empirical population will be smaller than the corresponding proportion in the theoretical population, when holding female proportions aged 15-49 constant.

In essence, the expectation in both hypotheses is that mothers will have fewer children than would be expected in the corresponding stable population. This is because the stable population is a limiting population, and any empirical population tends towards the limiting stable state (Pressat 1972:334,476).

4.2 Data

The data for this chapter are from three sources.

1) United Nations 1991a The Age and Sex Distributions of Population: The 1990 Revision.

2) Keyfitz and Flieger 1990 World Population Growth and Aging: Demographic Trends in the Late Twentieth Century.

3) Coale and Demeny 1983 Regional Model Life Tables and Stable Populations.

The data from Keyfitz and Flieger (1990) have two purposes in this chapter. The first is to provide data for the selection of those populations subject to the straitjacket concept. Proportions bst0-14 and ft15-49 are conveniently aggregated, allowing for easy identification of the relevant populations. These are presented in table 4.1 and are discussed further below. The second purpose of the Keyfitz and Flieger data is to provide life expectancies at birth. Life expectancies at birth are convenient for selecting the appropriate stable populations, and are necessary for interpolations between mortality levels (discussed in the methods section).

The proportions ft15-49 and bst0-14 are needed in chapter 4 only for the purpose of selecting populations potentially subject to the straitjacket. The denominator for these two proportions is of course the total population, males and females combined. Once the selection of these populations has been made, the proportions used in the subsequent analysis will be based on the total female population. This is necessary because when using stable populations for comparison, a combined treatment of the sexes leads to unnecessary complexity (Coale 1957; Pressat 1972; Keyfitz 1975). This will require a change in notation.

The United Nations (1991a) provides data for proportions female aged 0-14 years (hereafter called ff0-14) and proportions female aged 15-49 years (hereafter called ff15-

49).[17] These are proportions of the total **female** population, and are not available in Keyfitz and Flieger (1990). As discussed earl , a combined treatment of the sexes using stable populations is a complexity beyond the scope of this thesis, and has been undertaken by few analysts.

The stable populations were obtained from Coale and Demeny (1983).

Because this chapter compares stable and empirical data, there is some concern that for some countries for some years, the population estimates may be based on estimates that make use of the stable populations. Many developing countries did not have reliable demographic data until recently, yet the data sources above provide data for individual countries beginning in 1950. In some cases, life expectancy at birth, for example, was estimated from model life tables. Keyfitz and Flieger (1990:12) write,

> These figures [life expectancy at birth] were either taken from official national life tables or, in cases where no reliable mortality information was available, estimated with the help of UN or Coale and Demeny model life tables.

Any such adjustments, however, were made by the United Nations Population Division in its eleventh round of demographic

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[17] See chapter 1, footnotes 3 and 4 for an explanation of this notation.

assessments. In Keyfitz and Flieger "no further adjustments on the data or estimates were made; they are reproduced or are used in calculations as given by the United Nations" (Keyfitz and Flieger 1990:8). This of course raises a question about the validity of comparing empirical estimates (that are possibly derived from the Coale and Demeny model life tables) with stable populations that are based on the same model life tables.

A similar consideration exists for the United Nations (1991a) data, which are from the twelfth round of demographic assessments of the Population Division (United Nations 1991a:1). They provide a brief discussion of data quality, including the following.

> Most of the estimates presented are derived from available national data that have been evaluated and, whenever necessary, adjusted for deficiencies and inconsistencies. For those countries for which data are lacking or insufficient, the estimates adopted are those that are believed to be reasonable for the population in question and are in agreement with any **existing reliable information** (United Nations 1991:1) (emphasis added).

Possibly and probably, "existing reliable information" may include Coale and Demeny stable populations. From this, it appears likely that the same potential problem mentioned above exists with this dataset. Since no other data are available, however, it is a potential problem that will have to be tolerated.

4.3 Methods

The first problem that requires attention is the selection of countries potentially experiencing the straitjacket. A large number of countries have experienced exceptionally high fertility over the last 40 years (Keyfitz and Flieger 1990). Reports of crude birth rates in excess of 50, and even 60 are common in the literature.[18] It could therefore be expected that a number of populations have produced exceptionally high proportions under age 15 and accompanying small proportions female aged 15-49. In fact, an extensive review of available data that provides proportional breakdowns of age/sex distributions has revealed that it is not uncommon for 45 percent of a population to be under the age of 15. By almost anyone's standards, this is an exceptionally high proportion of children.

Populations with more than 45 percent of their total under age 15 become increasingly rare as the proportion under age 15 increases from 45 percent to 46 percent and so on. A benchmark of 48 percent is warranted because there are almost

[18] See table 2.1 for national and sub-national examples.

no populations with reported proportions under age 15 of 49 percent or higher, and a large number with reported proportions under age 15 between 47 and 48 percent. Thus, populations with 48 percent or more under age 15 were considered candidates for the operation of the straitjacket. This is, however, a necessary but not sufficient condition. An extensive review of available population data revealed that there are a great number of countries whose proportion of females aged 15-49 is as low as 23 percent (Keyfitz and Flieger 1990). A decision based on similar considerations to the ones used in the selection of a benchmark for proportions under age 15 was employed in the selection of the benchmark for proportions female aged 15-49. In other words, 21 percent was too low, and 23 percent was too high. In short, populations subject to the operation of the straitjacket concept have, by definition, extreme distributions. A decision was therefore made to include for analysis only those populations whose proportions bst0-14 and ft15-49 were, respectively, both 48 percent and higher, and 22 percent and lower.

Because the straitjacket concept relies on comparisons of empirical populations with stable populations, some method of controlling for migration must be implemented. That is, stable population theory assumes that a population is closed to migration (Barclay 1958:133). Meaningful comparisons with the stable populations can be made only if it can be assumed that the age structures of the empirical populations have not been altered by migratory tendencies of one or more segments of the population. It therefore becomes necessary to remove from the analysis those populations which are known to have had their age/sex structures altered significantly by mass migrations.

A final criterion for selection involves population size. Some countries will be omitted because of their small population size, even though they satisfy the other three conditions. Small populations are subject to demographic changes not normally seen in larger populations. Explanations for the inclusion or non-inclusion of a population shown in table 4.1 are given in the results section.

From those populations meeting the criteria set out above, the number of females aged 0-14 (ff0-14) and 15-49 (ff15-49) are then calculated as a percentage of all females. These "potential candidates" for the probable operations of the straitjacket have been read off the printouts of the regional stable populations; first, proportions at f0-14 in the empirical population were matched (via interpolation) with an identical proportion in the theoretical population for each given population. Then the disagreement between the corresponding two proportions ff15-49, that is empirical and theoretical, was established. This can be expressed mathematically, and applied to each population separately:

When T(ff0-14) = E(ff0-14), then,

Equation [3] T(ff15-49) - E(ff15-49) = g

where,

E(ff0-14) = empirical proportion ff0-14 (females aged 0-14 years as a proportion of all females)

T(ff0-14) = theoretical (as per Coale and Demeny "West" stable female populations 1983) proportion ff0-14

E(ff15-49) = empirical proportion ff15-49 (females aged 15-49 years as a proportion of all females)

T(ff15-49) = theoretical (as per Coale and Demeny "West" stable female populations 1983) proportion ff15-49

g = deviation of the empirical proportion (ff15-49) from the theoretical proportion (ff15-49) when proportions ff0-14 are held constant

Secondly, the exercise will be repeated 'the other way round': match empirical ff15-49 with theoretical ff15-49, then search for disagreement between empirical ff0-14 and theoretical ff0-14. This can be expressed mathematically, and applied to each population separately:

When T(ff15-49) = E(ff15-49), then

Equation [4] T(ff0-14) - E(ff0-14) = h

where,

E(ff15-49) = empirical proportion ff15-49 (females aged 15-49 years as a proportion of all females)

T(ff15-49) = theoretical (as per Coale and Demeny "west" stable female populations 1983) proportion ff15-49

E(ff0-14) = empirical proportion ff0-14 (females aged 0-14 years as a proportion of all females)

T(ff0-14) = theoretical (as per Coale and Demeny "West" stable populations 1983) proportion ff0-14

h = deviation of the empirical proportion (ff0-14) from the theoretical proportion (ff0-14) when proportions ff15-49 are held constant

The selection of the appropriate stable population involves four important considerations. The first of these involves the selection of one of the four families of stable populations. Of the four, the "South" and "West" families appear to contain stable populations most similar to the empirical populations subject to the straitjacket concept. The "West" family affords the greatest generality, since "...the tables underlying the "West" models are a residual collection after the "East", "South" and "North" tables have been removed" (Coale and Demeny 1983:12). Coale and Demeny (1983:33) also suggest that the "West" "stable is the most likely choice at...a high level of mortality". While the "West" stable populations appear to be the most appropriate choice, both "South" and "West" stable populations have been tested in the above equations. The "West" stable populations proved to have a closer fit to the empirical populations, and have therefore been deemed the more appropriate.

The second consideration is which set of stable populations to use, the "growth rate" set or the "GRR" set? According to Coale and Demeny (1983), this is a matter of which set the user finds more convenient. They write,

> The user will find the "growth rate" set of tables more convenient in exploring the implications (for example) of different recorded intercensal rates of increase and the "GRR" set more convenient in analyzing the effects of different levels of fertility (Coale and Demeny 1983:30).

Since it is primarily a matter of convenience, not one of substantive import, the "GRR" set was selected for use in this chapter.

Having selected the "West" family of stable populations and the "GRR" set, the third consideration is the selection of a unique stable population for comparison with each of the selected empirical populations. The following advice is given by Coale and Demeny (1983:30):

> In the universe of stable age distributions associated with any one of the four families of model life tables, it is possible to locate a unique stable population from knowledge of two non-redundant parameters, such as the birth rate and e_0^0, the rate of increase and e_0^0, the proportion under 20 and the rate of increase, or the average age and the death rate.

Since life expectancy at birth is readily available in Keyfitz and Flieger (1990) for each of the selected empirical populations, and the proportions ff0-14 and ff15-49 are also known, the selection of a stable population becomes a relatively simple matter.

The final step in the selection of a unique stable population involves multiple interpolation (Coale and Demeny 1983:30). This is required because the unique stable population almost always lies somewhere between two of the twenty-four mortality levels on neighbouring pages, and between two of thirteen given fertility levels on each page. In each case, three interpolations are required: two "horizontal" (fertility adjustments) and one "vertical" (mortality adjustment).[19] In the example below, the method just reviewed[20] is illustrated employing first equation [3] and then equation [4] for Cote d'Ivoire (1985). In other words, for equation [3], the empirical and stable proportions ff0-14 will be held constant, and the deviation of the empirical proportion ff15-49 from the stable proportion ff15-49 will be calculated. For equation [4], the empirical and stable proportions ff15-49 will be held constant, and the deviation of the empirical proportion ff0-14 from the stable proportion ff0-14 will be calculated.

Example: Calculation of equation [3]

for Cote d'Ivoire, 1985

Equation [3] When T(ff0-14) = E(ff0-14), then,

T(ff15-49) - E(ff15-49) = g

Empirical information required:

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[19] The term "horizontal" refers to interpolations conducted between columns in a single table (ie between fertility levels). The term "vertical" refers to interpolations that are conducted between tables (ie between mortality levels). For an example, see Coale and Demeny (1983:30).

[20] This method is based on the method presented in Coale and Demeny (1983:30), and upon the suggestions made by them for the selection of non-redundant parameters.

Female life expectancy at birth (1985): 53.2 (Keyfitz and Flieger, 1990:136)

Proportion female aged 0-14 years: 48.3 (United Nations, 1991a:142)

Proportion female aged 15-49 years: 42.5 (United Nations, 1991a:142)

Procedure:

Step 1:

Using two non-redundant parameters, life expectancy at birth and the proportion female aged 0-14 years, locate the two mortality levels among the West female stable populations in Coale Demeny (1983) (in the GRR set) between which the life expectancy, 53.2, lies[21]. These are mortality levels 14 (p.93) and 15 (p.94). Mortality level 14 has a life expectancy at birth of 52.5, and mortality level 15 has a life expectancy at birth of 55.0.

Step 2:

Locate in the cumulative age distribution of mortality level

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[21] "The expectation of life at birth is indicated directly on the first set of age distributions as Pop. size, B(0) = 1, r = 0, because of the well-known fact that in a stationary population, expectation of life at birth is the reciprocal of the birth rate" (Coale and Demeny 1983:30, footnote no.2).

14 the two proportions under 15 years of age between which the empirical proportion ff0-14 falls. In this case, the empirical proportion 48.3 falls between the columns headed GRR = 3.500 and GRR = 4.000. The stable proportions are 48.10 and 51.33, respectively.

Step 3:

Determine the horizontal interpolation factors first by subtracting the lower from the higher stable proportion ff0-14, that is, 51.33 - 48.10 = 3.23, and then by subtracting the lower stable proportion ff0-14 from the empirical proportion ff0-14. That is, 48.30 - 48.10 = 0.20. Divide this difference by the difference between the stable proportions, that is, 0.20/3.22 = 0.06. This is the first horizontal interpolation factor. The second horizontal interpolation factor is arrived at simply by subtracting 0.06 from 1.0, that is, 1.0 - 0.06 = 0.94.

Step 4:

The proportions fema. 15-49 are then cumulated for the same GRRs. For GRR = 3.50 the stable proportion ff15-49 = 44.00. For GRR = 4.000, the table proportion ff15-49 = 42.21.

Step 5:

The interpolation factors are then applied in the following equation: (0.94)44.00 + (0.06)42.21 = 43.8926.

Step 6:

This exercise is repeated using mortality level 15, the final equation being: (0.05)45.60 + (0.95)43.74 = 43.833.

Step 7:

Vertical interpolation between the stable proportions ff15-49 obtained from mortality levels 14 and 15 is now required. The vertical interpolation (between the values obtained from level 14, 43.8926, and level 15, 43.833) is based on life expectancy at birth. That is, 53.2 - 52.5 = 0.7, which is then divided by the difference between the life expectancy at birth for mortality levels 14 and 15: 0.7/2.5= 0.28. The second vertical interpolation factor is obtained in the same manner that the second horizontal interpolation factor was arrived at, namely, 1.0 - 0.28 = 0.72.

Step 8:

The vertical interpolation is then completed by way of the following equation, which uses the values obtained in step 7: (0.72)43.8926 + (0.28)43.833 = 43.875912

Step 9:

Based on the West female GRR set of stable populations, when holding empirical and stable proportions ff0-14 constant, one could expect 43.875912 percent of all females in Cote d'Ivoire in 1985 to be in the age group 15-49. Applying equation [3], for Cote d'Ivoire, 1985,

When T(ff0-14) = E(ff0-14), then,

T(ff15-49) - E(ff15-49) = g

= 43.875912 - 42.50 = +1.38 (rounded)

The positive sign is an indication that the stable proportion ff15-49 is larger than the empirical proportion ff15-49. The interpretation and implications of this result are discussed below.

Example: Calculation of equation [4]

for Cote d'Ivoire, 1985

Equation [4] When T(ff15-49) = E(ff15-49), then,

T(ff0-14) - E(ff0-14) = h

Empirical information required:

Female life expectancy at birth (1985): 53.2 (Keyfitz and Flieger, 1990:136)

Proportion female aged 15-49 years: 42.5 (United Nations, 1991a:142)

Proportion female aged 0-14 years: 48.3 (United Nations, 1991a:142)

Procedure:

Step 1:

Using two non-redundant parameters, life expectancy at birth and the proportion female aged 15-49 years, locate the two mortality levels among the West female stable populations in Coale and Demeny (1983) (in the GRR set) between which the life expectancy, 53.2, lies. These are mortality levels 14 (p.93) and 15 (p.94). Mortality level 14 has a life expectancy at birth of 52.5, and mortality level 15 has a life expectancy at birth of 55.0.

Step 2:

Locate in the cumulative age distribution of mortality level 14 the two proportions aged 15-49 between which the empirical proportion ff15-49 falls (by subtracting proportions ff0-14 from the cumulative total for ages 0-49). In this case, the empirical proportion 42.50 falls between the columns headed GRR = 3.500 and GRR = 4.000. The stable proportions are 44.00 and 42.21, respectively.

Step 3:

Determine the horizontal interpolation factors first by subtracting the lower from the higher stable proportion ff15-49, that is, 44.00 - 42.21 = 1.79, and then by subtracting the lower stable proportion ff15-49 from the empirical proportion ff15-49. That is, 42.5 - 42.21 = 0.29. Divide this difference by the difference between the stable proportions, that is, 0.29/1.79 = 0.162. This is the first horizontal interpolation factor. The second horizontal interpolation factor is arrived at simply by subtracting 0.162 from 1.0, that is, 1.0 - 0.162 = 0.838.

Step 4:

The proportions female 0-14 are then located in the cumulative distributions for the same GRRs. For GRR = 3.500, the stable proportion ff0-14 = 48.10. For GRR = 4.000, the stable proportion ff0-14 = 51.33.

Step 5:

The interpolation factors are then applied in the following equation: (0.162)48.10 + (0.838)51.33 = 50.80674.

Step 6:

This exercise is repeated using mortality level 15, the final equation being: (0.311)48.49 + (0.689)51.71 = 50.70858.

Step 7:

Vertical interpolation between the stable proportions ff0-14 obtained from mortality levels 14 and 15 is now required. The vertical interpolation (between the values obtained from level 14, 50.80674, and level 15, 50.70858) is based on life expectancy at birth. That is, 53.2 - 52.5 = 0.7, which is then divided by the difference between the life expectancy at birth for mortality levels 14 and 15: 0.7/2.5= 0.28. The second vertical interpolation factor is obtained in the same manner that the second horizontal interpolation factor was arrived at, namely, 1.0 - 0.28 = 0.72.

Step 8:

The vertical interpolation is then completed by way of the following equation, which uses the values obtained in step 7: (0.72)50.80674 + (0.28)50.70858 = 50.7792552.

Step 9:

Based on the West female GRR set of stable populations, when holding empirical and stable proportions ff15-49 constant, one could expect 50.7792552 percent of all females in Cote d'Ivoire in 1985 to be in the age group 0-14. Applying equation [4], for Cote d'Ivoire, 1985,

When T(ff15-49) = E(ff15-49), then,

T(ff0-14) - E(ff0-14) = h

= 50.7792552 - 48.30 = +2.48 (rounded)

The positive sign is an indication that the stable proportion ff0-14 is larger than the empirical proportion ff0-14. The interpretation and implications of this result are discussed below.

4.4 Results

4.4.1 Selection of populations subject to the straitjacket effect

The criteria set out in the methods section for the selection of populations potentially experiencing the straitjacket effect are applied to the populations listed in table 4.1. The four criteria are, <u>all</u> of which must be in operation:

1) 48 percent or more of the population is under age 15.

2) 22 percent or less of the population is female aged 15-49.

3) the age/sex structure has not been altered significantly by migration.

4) the total population is large enough to minimize the probability of significant short-term fluctuations in vital rates (500,000 total population is adopted as a minimum).

Initial consideration for inclusion in the final dataset was based on whether or not a country had at some point between 1955 and 1990, 48 percent or more of its population under age 15. Twenty countries meet this criterion and are listed in table 4.1. To give an illustration of the behaviour of bst0-14 and ft15-49 over time for these countries, bst0-14 and ft15-49 have been included for each year from 1955-1990,

Table 4.1

Percentage bs0-14 and percentage f15-49 for selected populations, 1955-1990

Country	Year							
	1955	1960	1965	1970	1975	1980	1985	1990
Alg-eria	41.3 22.6	43.8 22.5	46.5 21.9	48.4 21.3	47.6 21.4	46.5 21.8	45.6 22.1	44.4 22.7
Bah-rain	42.7 20.7	43.1 20.5	50.8 20.8	46.0 19.8	43.0 20.5	34.7 21.1	33.3 21.1	32.7 21.1
Bots-wana	45.8 23.4	47.5 24.2	49.4 24.6	51.5 23.8	50.3 23.5	47.3 22.7	48.3 22.7	48.5 22.8
Cote d'Iv.	43.7 23.4	45.1 22.7	46.8 21.8	47.3 21.5	47.8 21.3	48.3 21.1	48.9 20.9	49.4 20.8
Fiji	47.6 22.0	48.0 21.6	46.8 22.1	43.5 23.4	39.9 25.1	37.5 26.1	37.2 25.9	36.7 25.6
Guy-ana	45.2 21.8	48.5 20.8	47.1 21.1	47.6 21.1	43.8 23.1	39.4 24.9	37.0 25.8	34.6 26.7
Hond-uras	44.6 23.2	45.2 22.7	46.2 22.1	47.2 21.6	48.2 21.1	47.5 21.4	46.4 21.8	44.6 22.7
Jordan	45.1 20.9	44.4 21.7	44.8 21.8	45.9 21.6	47.2 21.1	49.4 20.1	48.1 20.8	47.9 20.9
Kenya	42.3 21.7	45.6 20.6	47.4 20.2	48.2 20.3	49.1 20.4	50.1 20.2	51.2 20.0	52.1 19.9
Nicar-agua	46.3 22.7	48.0 21.9	48.8 21.5	48.3 21.8	47.9 21.9	47.4 22.2	46.7 22.5	45.8 22.8
Niger-ia	45.4 22.7	45.4 23.2	45.9 22.9	47.0 22.4	47.6 22.1	48.1 21.9	48.3 21.8	48.4 21.8
Para-guay	45.4 22.5	47.7 21.3	48.7 20.7	46.4 21.7	44.3 22.3	42.1 23.3	41.0 23.8	40.4 24.1

Rwanda	45.2 23.2	45.2 23.2	45.6 23.0	47.2 22.2	48.2 21.8	48.8 21.6	49.0 21.6	49.0 21.6
Suri-name	43.2 21.6	47.6 20.7	48.2 20.7	48.3 20.8	47.6 21.1	39.8 24.5	37.2 25.4	34.4 26.4
Syria	42.8 22.2	44.4 21.8	48.9 19.9	48.9 19.9	48.5 20.4	47.5 21.0	48.1 21.0	48.1 21.4
Uganda	46.1 22.4	46.6 22.4	46.8 22.4	47.0 22.3	47.4 22.1	47.8 21.9	48.1 21.8	48.5 21.8
Tanza-nia	46.2 22.7	46.0 23.0	45.9 23.1	47.1 22.6	47.9 22.2	48.4 22.0	48.6 21.9	49.1 21.7
Yemen	42.2 22.7	42.4 22.8	42.5 22.9	43.0 23.8	46.4 23.6	47.4 23.3	48.0 22.9	48.1 22.7
Zambia	44.9 23.5	45.2 23.3	45.6 23.0	46.1 22.7	46.5 22.3	49.4 22.3	48.7 22.6	49.1 22.4
Zimb-abwe	44.7 22.5	46.5 21.9	48.6 21.1	49.1 21.0	49.0 21.2	47.8 21.9	46.2 22.7	44.8 23.4

Source:
Keyfitz, Nathan & Wilhelm Flieger. 1990. World population growth and aging: Demographic trends in the late twentieth century. Chicago: University of Chicago Press

for each country.[22]

Of the twenty countries meeting the first of the four criteria, only fourteen meet each of the remaining three. If we consider cases, then 39 cases of 53 potential cases were selected. Of the fourteen potential cases not included among

[22] The pattern observed among these countries are in themselves interesting, but their implications are beyond the scope of this thesis.

the cases, four were dropped due to the small size of their populations, even though they meet the other criteria. These are Bahrain 1965; Fiji 1960; Suriname 1965-70. The other ten had more than 22 percent females. These are Botswana 1965-75 and 1985-90; Yemen 1985-1990; Zambia 1980-90. Of the 39 cases selected, Syria (1980) does not meet the 48 percent under age 15 criterion. It has been retained as a case, however, because during the years leading up to 1980, as well as the years after, Syria's proportions under age 15 exceeded 48 percent. Its decline in 1980, to 47.5 percent, was not substantial. The value of retaining Syria (1980) is in the continuity it provides for a country that has maintained such extreme proportions bst0-14 and ft15-49 for an extended period of time. Tables 4.2 and 4.3 list the 39 cases selected for analysis via equations [3] and [4].

4.4.2 Results for equation [3]

As discussed, a determination of the existence of the straitjacket effect will be made in two stages. In table 4.2, the results for Equation [3] for each of the 39 selected cases is presented. The theoretical proportions ff15-49 obtained from the Coale and Demeny (1983) stable populations (by interpolation) and the empirical proportions ff15-49 from Keyfitz and Flieger (1990) are shown, as are the differences between them (g). It was hypothesized that the differences between empirical and theoretical proportions ff15-49, when holding constant theoretical and empirical proportions ff0-14, would be negative. That is, empirical proportions ff15-49 would be larger than theoretical proportions ff15-49. This is clearly not the case.

Of the 39 gs shown in table 4.2, 38 are positive. The empirical proportions ff15-49 are actually smaller than the theoretical proportions ff15-49. Because ff0-14 are held constant, this result means that fewer women than would be expected in the theoretical population gave birth to these children than expected. This will be discussed later.

The range of values of g is -3.35 to +6.69, both of which were recorded for Zimbabwe 1975 and 1965, respectively. Among the 38 positive values of g, the lower bound of the range is 0.42 (Syria 1990). For countries with more than one case on the table, several patterns over time emerge. Cote d'Ivoire (1980-1990), Nicaragua (1960-1970), Nigeria (1980-1990) and Uganda (1985-1990) each show a monotonic increase in the value of g over time. A monolithic decline towards zero is

Table 4.2: Results for Equation [3]

When T(ff0-14) = E(ff0-14), then, Equation [3]

T(ff15-49) - E(ff15-49) = g

Country	Year	Stable (ff15-49)	Empirical (ff15-49)	g
Algeria	1970	44.81	41.58	+3.23
Cote d'Ivoire	1980	44.30	44.05	+0.25
	1985	43.89	42.50	+1.38
	1990	43.50	42.00	+1.50
Guyana	1960	43.52	40.90	+2.62
Honduras	1975	44.02	42.56	+1.46
Jordan	1980	43.00	41.70	+1.30
	1985	44.34	44.13	+0.21
	1990	43.55	42.56	+0.99
Kenya	1970	44.13	40.70	+3.43
	1975	43.64	40.70	+2.94
	1980	43.04	40.40	+2.64
	1985	42.68	40.50	+2.18
	1990	43.09	41.70	+1.39
Nicaragua	1960	44.51	43.73	+0.78
	1965	44.02	42.80	+1.22
	1970	44.12	42.78	+1.34
Nigeria	1980	45.08	44.59	+0.49
	1985	44.86	44.20	+0.66
	1990	44.61	43.82	+0.79
Paraguay	1965	43.62	41.20	+2.42
Rwanda	1975	44.30	43.06	+1.24
	1980	44.02	42.60	+1.42
	1985	43.79	42.60	+1.19
	1990	43.75	42.70	+1.05

Syria	1965	43.96	40.90	+3.06
	1970	43.83	40.90	+2.93
	1975	43.68	41.70	+1.98
	1980	43.87	42.70	+1.17
	1985	43.50	42.70	+0.80
	1990	43.52	43.10	+0.42
Tanzania	1980	44.12	43.23	+0.89
	1985	44.82	43.24	+1.58
	1990	43.68	42.91	+0.77
Uganda	1985	44.08	42.80	+1.30
	1990	43.83	42.40	+1.43
Zimbabwe	1965	43.89	37.20	+6.69
	1970	43.59	41.50	+2.09
	1975	43.65	45.30	-3.35

Source:
Stable proportions:
Coale, Ansley J and Paul Demeny. 1983. Regional model life tables and stable populations. Second edition. New York: Academic Press (The tables used are female sex, from the 'West' family and the GRR set)
Empirical proportions:
see table 4.1

shown for Kenya (1970-1990) and Syria (1965-1990). Jordan (1980-1990), Rwanda (1975-1990) and Tanzania (1980-1990) show overall declines towards zero, but with fluctuations. Zimbabwe's (1965-1975) decline involves a drop in the value of g from the highest value in the column to the lowest.

4.4.3 Results for equation [4]

Results for Equation [4] are presented in table 4.3. In this equation, empirical and theoretical proportions ff15-49 are held constant, and the deviation of the empirical from the theoretical proportions f0-14 is recorded (h). The hypothesis that only positive resulfts would be obtained is supported, as 38 of the 39 hs are positive. Zimbabwe is again the extreme country, with values of h ranging from -3.35 to +10.68. The hs, while greater in magnitude than the gs, appear to be highly correlated with the gs. In fact, the correlation

Table 4.3: Results for Equation [4]

When T(ff15-49) = E(ff15-49), then, Equation [4]

T(ff0-14) - E(ff0-14) = g

Country	Year	Stable (ff0-14)	Empirical (ff0-14)	h
Algeria	1970	52.32	46.41	+5.91
Cote d'Ivoire	1980	48.07	47.58	+0.49
	1985	50.76	48.30	+2.48
	1990	51.60	48.90	+2.70
Guyana	1960	53.21	48.50	+4.70
Honduras	1975	50.58	47.78	+2.80
Jordan	1980	51.75	49.10	+2.65
	1985	46.93	46.55	+0.38
	1990	50.07	48.00	+2.07
Kenya	1970	53.75	47.90	+5.85
	1975	53.70	48.70	+5.00
	1980	54.11	49.70	+4.41

	1985	53.90	50.20	+3.70
	1990	51.86	49.40	+2.46
Nicaragua	1960	48.79	47.33	+1.46
	1965	50.33	48.10	+2.23
	1970	50.24	47.77	+2.47
Nigeria	1980	47.09	46.01	+1.08
	1985	47.76	46.41	+1.35
	1990	48.38	46.82	+1.56
Paraguay	1965	52.53	47.90	+4.63
Rwanda	1975	50.15	47.84	+2.31
	1980	51.08	48.30	+2.56
	1985	50.78	48.60	+2.18
	1990	50.52	48.60	+1.92
Syria	1965	53.40	48.10	+5.30
	1970	53.32	48.20	+5.12
	1975	51.94	48.30	+3.64
	1980	50.02	47.50	+2.52
	1985	49.92	48.10	+1.82
	1990	48.96	48.10	+0.86
Tanzania	1980	49.54	48.41	+1.13
	1985	49.46	48.00	+1.46
	1990	49.96	47.93	+2.03
Uganda	1985	49.51	48.00	+2.32
	1990	49.99	48.40	+2.77
Zimbabwe	1965	59.08	48.40	+10.68
	1970	52.46	48.90	+3.56
	1975	45.35	48.70	-3.35

Source:
Stable proportions: see table 4.2
Empirical proportions: see table 4.1

between g and h was found to be almost unity (.99). The conclusion to be drawn is that the exercise could be carried out with equal validity with either Equation [3] or Equation [4].

4.5 Discussion

Two observations among the gs and hs in tables 4.2 and 4.3 are of central importance in determining the existence of the straitjacket concept. These are, 1) the direction of the deviation of the empirical from the theoretical proportions (ie. positive or negative), 2) the patterns of change over time in gs and hs. These are discussed below.

4.5.1 The direction of the deviations of the empirical from the theoretical proportions

In each of the 39 cases but one, the gs (table 4.2) are positive. Substantively, this means that the empirical proportion ff15-49 is smaller than is expected in the theoretical age distribution, based on the proportion ff0-14. This is an unexpected result. Its unexpectedness is more clearly seen when we examine the other side of the coin.

Thirty eight of the 39 hs are also positive. As hypothesized, the empirical proportions ff0-14 are smaller than the theoretical proportions, based on proportions ff15-49. In simple terms, mothers in the fertile ages have given birth to fewer children than would be expected in the theoretical population. The opposite, however, is found in the solutions for Equation [3], namely, mothers in the fertile ages have given birth to <u>more</u> children than expected in the theoretical population.

Focusing on the hs, or the deviation of the empirical proportions ff0-14 from the theoretical proportions ff0-14, the consistently positive direction of the deviations supports hypothesis 2. The following explanation is offered, even though it does not appear to hold for the proportions ff15-49.

If the populations in question had maintained constant vital rates for the previous 50 to 100 years, it would be expected that their age distributions would be very similar to the stable age distributions. Fluctuations in mortality and particularly fertility would cause proportions at various ages in the empirical population to be sometimes smaller and sometimes larger than the corresponding stable age distribution. In terms of gs and hs, both positive and negative values would be expected.

The empirical populations, however, have not experienced constant vital rates for the necessary 50 to 100 years. Their current age distributions are the result of fertility and mortality changes of the last 40 or 50 years. During this time they have experienced rapid mortality declines, and have maintained or even increased their fertility. In short, their age distributions have departed from the stable because of significant changes in vital rates. Moreover, each of the populations in tables 4.2 and 4.3 have experienced a similar change in vital rates, namely, a large change in natural increase. The fact that each of the g's and h's is positive (except one) is a reflection of the similarity of the demographic changes taking place in these countries.

It has been established that fertility is by far the more important of the two vital rates in determining an age distribution. Thus, before a country's population first appears in tables 4.2 and 4.3, an abrupt change in fertility almost certainly took place.[23]

For example, Kenya's population first appears in tables 4.2 and 4.3 in 1970. Between 1950-55 and 1960-65, Kenya's TFR rose from 7.511 to 8.120, and remained constant until the

[23] Absolute certainty cannot be claimed because there were probably errors and adjustments in data for some of the populations at some point in time. This could artificially inflate or deflate fertility measures, resulting in a less than accurate assessment of the demographic changes taking place.

1985-1990 period when it was projected to decline (Keyfitz and Flieger 1990:137). The increase in fertility resulted in a more pronounced departure from stability than was the case in later years, when constant fertility allowed movement towards the stable state. Similarly, Rwanda's TFR rose from 7.077 in 1950-55 to 8.290 in 1970-75, at which point it rose slightly more and then levelled off (Keyfitz and Flieger 1990:152). Rwanda's population first appears in tables 4.2 and 4.3 in 1975. Such fertility changes probably account for the departure from stability of each of the 39 populations. The fact that the results are positive (that is, the empirical proportions f0-14 are smaller than the stable proportions ff0-14) is an indication that the populations in question have not reached the stable state, or rather have departed from the stable state.

To return to the mothers of these children (i.e. ff15-49), the same explanation does not hold. Coale (1993), using the Ivory Coast (1985) example discussed earlier, offers the following possibilities.

> I found the sable populations with the given ff0-14 and ff15-49 for Ivory Coast...The stable ff15-49 selected from ff0-14 is larger than the recorded, and the stable ff0-14 is larger than the recorded. A possible explanation is that the relation of ff15-49 to GRR is curvilinear; and a given value of ff15-49 can occur in two different stable

populations...Another possible source of the dilemma is that the proportions less than 15 and 15-49 may be systematically distorted by chronic patterns of age misreporting, and may differ from the stable because of recent declines in fertility and mortality (Coale 1993).[24]

4.5.2The patterns of change over time in g and h values

The patterns of change observed among those populations appearing more than once in tables 4.2 and 4.3 are useful in understanding the straitjacket concept. As discussed above, a change in fertility can bring about a departure from stablility. Kenya, for example, had a rise in its TFR of about 0.6 children per woman prior to 1970, the year its population first appears in tables 4.2 and 4.3. The g (3.34) and h (5.85) calculated for 1970 are relatively far from the expected stable proportions. Constant fertility from 1970 to 1990 caused movement towards stability, and this is reflected in the reduction in size of the g's and h's (g=1.39 and h=2.46 in 1990). The continuation of this level of fertility (TFR=8.120) into the indefinite future, combined with little or no alteration in mortality, would reduce the g's and h's even

[24] I have taken the liberty of changing Professor Coale's notation to conform with my own.

further. The 1990 Kenyan population, however, is already showing an age distribution that is quite close to stable, even after only 20-25 years of constant fertility and nearly constant mortality.

A crucial issue at this point is whether or not a national population can sustain a TFR of much more than the 8.120 of the Kenyans. This returns us to the discussion of chapter 2, which explores the boundaries between speculative and observed maximum human fertility. If the maximum observed TFR of a national population is accepted as the maximum possible, then the slightly over 50 percent of Kenyans under age 15 in 1990 is very close to the maximum proportion possible in a human population.

4.6 Conclusion

Determining the existence of the straitjacket effect is not a simple matter. The age structure of a human population is determined by fertility, mortality and migration, and data errors (recording, processing, etc.) add further complexities. In this thesis, the focus has been on fertility, while partially controlling for migration, and giving little attention to mortality and data problems. The focus on fertility was primarily because fertility has by far the strongest effect on the age distribution. This is not to deny that the other variables have any effect. Theirs are, however, generally second-order effects.

Migration was partially controlled for by removing from the analysis those populations that had been seriously affected by large-scale migration. This did not, however, remove the effects of migration in those populations included in the analysis. That is, every country still experiences some net balance of immigration and emigration. This may account for some of the deviation of the empirical proportions from the theoretical proportions. A more accurate assessment of the straitjacket effect might be arrived at by employing more stringent controls for migration, or incorporating migration into the model.

As mentioned earlier, the data for some high fertility populations are estimates, based on incomplete or non-existent empirical data. In populations where data are inadequate, estimates based on stable models and surveys have inherently some error. Comparisons of 'empirical' and theoretical proportions are in such cases bound to be flawed. In the first instance, because estimates based on stable populations are being compared to stable populations. In the second instance, because survey data cannot take the place of a complete vital statistics registration system, which records vital events more reliably than do surveys.

As for mortality, its effect may not be of the same order as fertility on the age structure, but it does have some effect. A more accurate assessment of the straitjacket effect would thus take into account these three influences in addition to fertility on the age distribution.

Nonetheless, the method used in this thesis to determine the existence of the straitjacket has provided a reasonably accurate first assessment of the straitjacket concept. The inclusion of the other variables just mentioned would simply tighten up the differences between the theoretical and empirical populations. It can be said with assurance that the straitjacket effect does take place in certain populations, and acts to limit the proportionate size of the proportions that make up the straitjacket.[25]

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[25] The more one looks at the Kenyan situation, the more one realizes that the straitjacket has been imposed on the Kenyan age structure. Coincidentally, a recent doctoral dissertation (Berrios Loyola 1992) also found Kenya to closely resemble a theoretical model that combined economic factors and a high fertility regime.

Chapter 5

Implications: The uses and abuses of the proportionate age distribution

5.1 Introduction

Proportions or percentages of a population's age distribution are routinely reported or merely used without complete understanding in the news media and elsewhere. Three proportions are most commonly reported. These are children, workers and the old. The children and old people are considered dependent on the working age groups, with a 'young age dependency ratio', an 'old age dependency ratio' and a 'total dependency ratio' being calculated by comparing the size of the young and/or old age groups to the working age group. The exact boundaries of the age groups are variable, although the standard age groups are 1) under age 15, 2) 15 to 64 years, and, 3) 65 years and older. Depending on the purpose of the researcher or writer, the boundaries of these age groups are shifted one way or the other.[26]

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[26] For example, The United Nations (1987, 1989, 1990) reports the proportions of each population under age 15 and 60+ to give a general impression of the age structure. France

The percentage of persons in an age group is also reported, for example, to give the reader an immediate sense of the overall age distribution of that population. However, as we have seen in chapters 3 and 4 of this thesis, making a statement about the proportionate size of one age group is to make an indirect statement about the proportionate size of the other age groups, especially among high fertility populations. This is not in general a well-understood fact. It is not uncommon to find references to 'almost half', 'half' or even 'more than half' of a population being under age 15. Journalistically, this is a dramatic and informative tactic, intended to provide a comprehensive demographic picture with a single figure. Technically, however, and in accordance with the straitjacket concept, such references are often used with more enthusiasm than understanding.

In this chapter, examples of both the uses and abuses of the proportionate age distribution will be discussed. In particular, instances of correct and incorrect uses of proportions under age 15, in light of the understanding provided by the straitjacket concept, will be presented. Where

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has begun to use since 1990 the proportion under age 20 as the young age dependents, and it is increasingly common for researchers studying the old age population to study the old' (65-74 years) and the 'old old' (75+ years).

appropriate, examples of proportions other than those using under age 15 will be included in the discussion.

5.2 Proportions under 15 as an illustration of a young age structure

Of the many uses of proportions under age 15, the most common is probably as an illustration of a young age structure. The use of a single number to indicate the youthfulness of a population is almost routine among journalists reporting on stories originating in developing countries. The demographic picture is complete for most readers when it is reported that half of the population are children. It is here that abuses of such proportions are most common. Numerous examples of both uses and abuses exist.

Some writers seem to appear unaware of what proportion of children actually constitutes a young age structure. For example, The Manchester Guardian Weekly reports that a third of the 1.8 million Turks living in Germany are under 18 (Fisher 1993). The implication is that the Turks are a young population[27] and the figure reported is reasonable. It is

[27] They certainly are young compared to the German population, but not so young when compared to many African and Middle Eastern countries.

reasonable in fact, as has been shown to report figures much higher than one third. For example, The Economist (1992a) reports that "45.5% of the population [of Iran] is under 15." Forty five percent is quite high, but is accurate and gives the picture of a youthful population. The Economist (1992b) reports, "The demographic bulge means that two fifths of black Africans are under 15." In contrast to most reporting errors, which are usually high, this example is low. The correct figure for the continent is closer to 45 percent (Keyfitz and Flieger 1990:109; United Nations 1992:16).

Examples of very high reported proportions of children, which are nonetheless probably reasonable, include this report from Popline (1993). It was reproted in Popline (1993), that Queen Noor of Jordan visited The Population Institute, and said "Jordan has slightly more than four million peple, about fifty percent of whom are under fifteen years old." Jordan is, as we have seen, one of the few countries about which such a statement can be made with confidence. Another example is found in Populi (1993) where it is reported that the the first popultation census of Oman will be conducted in December of 1993. Its estimated population of two million has about half under age 18 and grows at about 3.5 percent per year. The proportion under age 18 is high, but is certainly a real possibility.

Other writers are not so careful in quoting proportions of children. For example, Lacvillle (1992) claims in The Manchester Guardian Weekly that of Mali's eight million people "more thatn half are under 15." This is unlikely, since Mali has not recorded a TFR of more that 6.699 since 1950 (Keyfitz and Flieger 1990:143). Only after having had a TFR of over eight for 20 years did Kenya have over half its population under 18.

It is reported in CanadAid (1993) that almost half of Honduras' 5.1 million people are under the age of 15. This is not likely, since the TFR has fallen from 7.421 in 1965-70 period, when proportions under 15 were between 46.2 and 47.2, to 5.550 in the 1985-90 period.

In a letter to the editor of The Globe and Mail, The Executive Director of Canadian Physicians for the Preventions of Nuclear War determined that of the 20 million civilians in North Korea (20.8 million total population, the rest are soldiers), "at least one-half are children under 16, or 10 million" (Singleton 1993). Considering that North Korea's TFR has never exceeded six, and is in fact currently well under four (Keyfitz and Flieger, 1990:225), it is probable that North Korea's proportion under 16 is no more that forty percent (even with the military population excluded from the denominator).

5.3 Proportions under 15 as an illustration of the effects of war

While the reporting of proportions under age 15 is usually intended to give an indication of the youthfulness of a population, it has other uses as well. Wars can decrease the proportion of men (particularly), which can lead to an increase in the proportion under age 15. On the other hand, a war can lead to emigration of significant numbers of women and children, thereby reducing the proportion under 15.

An article in The Economist (1992c), for example, showed a table with the following figures:

	TFR	%0-14
Afghanistan	7.2	40.8
Pakistan	5.8	44.2

One would expect, other things being equal, that Afghanistan's %0-14 would be higher than Pakistan's, given that Afghanistan's fertility rate is so much greater. This is not the case, however, due probably in large part to mass migration of Afghanis to neighbouring countries of women and children. The primary effect in this case is on the numerator (children aged 0-14), while war losses would have some effect on the denominator (adult males especially).

Another example of a country's proportions under 15 being affected by war comes from Angola. Fritscher(1991) reports in The Manchester Guardian Weekly that "two thirds of the Angolan population are under 25 and half under 14." The mortality among males (and females, though probably to a lesser degree) aged 15+ would have to be very high due to war operations, and emigration of children very low to cause such high proportions under 14. This is most likely an overestimate of the true proportion. For a population to have half under age 15 is remarkable, but to have half under 14 is, unless special circumstances exist, impossible.

5.4 Proportions under 15 as an illustration of future economic or political potential

Proportions at young ages are often examined for their future economic or political potential. For example, The Manchester Guardian Weekly (1992) reports that by the year 2000, 46 percent of Saudi Arabians will be under 15 (the suggestion of an increase in this proportion of a stable population is probably unjustified). The decreased importance of oil on the world market, the consequent decline in the Saudi Arabian economy, and the high proportion under 15 will lead to a fall in future generations' welfare.

Popline (1991) reports that in the Middle East, where nearly half of all inhabitants are under 15 (a reasonably accurate statement, though slightly high if all Middle East countries are considered), Libya's Muammar al-Quadafi and Iraq's Saddam Hussein encourage population growth. They believe there is a correlation between national power and demographic size.

The Economist (1993a) reports that economically, it would make sense for the Asian countries "from the Indonesian archipelago in the south to Myanmar..., Laos and Vietnam in the north... and Singapore, Malaysia, Brunei and Cambodia" to get together. It is reported that of the 400 million people in the region, "most of them are under age 15." Two points should be made here. First, as the straitjacket concept has shown, the probability of any population being "mostly under age 15" is very low, and is probably impossible in this case. It is probably impossible because each of the countries would have to have fertility levels close to the maximum possible, for perhaps at least 20 years in a row, and all at the same time. Second, most of these countries have long since experienced a sustained fertility decline (United Nations 1992:11), and therefore could not possibly be subject to the straitjacket any longer.

5.5 Proportions under 15 and poverty

Finally, high proportions under 15 are commonly reported as though such proportions were a correlate of poverty. For example, The Economist (1993b) reports that of the nine million people in Burkina Faso, "...half of them [are] under 15, and the poverty remains..." It is the reference to the proportion under 15 that is troublesome here, since Burkina Faso has never had more that 44 percent of its population under 15 (Keyfitz and Flieger 1990:119). Their TFR has never exceeded seven (ibid:119), and, in accordance with the straitjacket concept it probably never could have reached 'half' under 15.

5.6 Conclusion

Proportions under 15 are used in a number of other ways, including for international comparisons (United Nations 1987, 1989, 1990) and as a reflection of fertility and linguistic retention (Statistics Canada 1992). Of course, any age group can be quoted, as long as they have some substantive meaning to the writer (and hopefully the reader). For example, Clements (1993) compares Canadian proportions under age 30 with seven East Asian countries, McMurdy (1992) compares Canadian proportions 65 and over (as well as their fertility rates), and Largaespada-Fredersdorff (1993:11) describes the female part of the population in Nicaragua.

Various proportions of the age distribution are a regular feature of journalists and other writers. The particular age group used is of course contingent only on the requirements of the writer. The size of the proportion, however, when it approaches the upper proportional limit for that age group, is limited by the straitjacket effect.

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Appendix

List of countries used in Chapter 3

Africa
Algeria
Angola
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Central African Republic
Chad
Congo
Egypt
Ethiopia
Gabon
Gambia
Ghana
Guinea
Cote d'Ivoire
Kenya
Lesotho
Liberia
Libya
Madagascar
Malawi
Mali
Mauritania
Mauritius
Morocco
Mozambique
Namibia
Niger
Nigeria
Rwanda
Senegal
Sierra Leone
Somalia
South Africa
Sudan
Swaziland
Tanzania
Togo
Tunisia

Uganda
Zaire
Zambia
Zimbabwe

South America
Argentina
Barbados
Bolivia
Brazil
Chile
Colombia
Costa Rica
Cuba
Dominican Republic
Ecuador
El Salvador
Guadaloupe
Guetemala
Guyana
Haiti
Honduras
Jamaica
Martinique
Mexico
Nicaragua
Panama
Paraguay
Peru
Puerto Rico
Suriname
Trinidad and Tobago
Uruguay
Venezuela

North America
Canada
United States

Asia
Afghanistan
Bahrain
Bangladesh
Bhutan
Burma
China

Cyprus
East Timor
Hong Kong
India
Indonesia
Iran
Iraq
Israel
Japan
Jordan
Kampuchea
Democratic People's Republic of Korea
Republic of Korea
Kuwait
Laos
Lebanon
Malaysia
Mongolia
Nepal
Oman
Pakistan
Philippines
Qatar
Saudi Arabia
Singapore
Sri Lanka
Syria
Thailand
Turkey
United Arab Emirates
Vietnam
Yemen
Democratic Yemen

<u>Europe</u>
Albania
Austria
Belgium
Bulgaria
Czechoslovakia
Denmark
Finland
France
German Democratic Republic
Federal Republic of Germany
Greece

Hungary
Iceland
Ireland
Italy
Luxembourg
Malta
Netherlands
Norway
Poland
Portugal
Romania
Spain
Sweden
Switzerland
United Kingdom
Yugoslavia

Oceania
Australia
Fiji
New Zealand
Papua New Guinea
USSR