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**Fertility, birth intervals,  
and their proximate determinants in Zimbabwe**

**by**

**Takudzwa S. Sayi**

Submitted in partial fulfillment of the requirements for a  
Master of Philosophy in Demography  
at the  
Centre for Actuarial Research, University of Cape Town

August 2009

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## Abstract

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Whilst there is consensus that fertility has been declining in Zimbabwe over the past four decades, little is known about the changes in birth spacing that has accompanied this decline.

Using indirect techniques suggested by Brass and Juárez for projected parity progression ratios and truncated pairwise measures of parity progression; Aoun for projected median birth intervals; and Moultrie and Timæus for secular time-location of median birth intervals, the dissertation uses Demographic and Health Survey data to investigate fertility patterns and their proximate determinants, and finds a relationship between these and changes in birth intervals. The comparative impact of the proximate determinants on the length of birth intervals is determined using a Poisson regression analysis, which gives hazard and survival functions, and these are compared between children borne to women of differing marital status, and contraceptive use status, respectively.

It is found that birth intervals have increased from about 28 months in the 1960s to about 51 months by the year 2000, with the greater part of this increase occurring after 1985. Fertility fell from 5.4 to 3.8 children per woman between 1985 and 2005. The changes in fertility and birth intervals are congruent with each other, in terms of timing and tempo. Of the two main proximate determinants identified; marital status and contraceptive use, the latter is found to be the more dominant force behind changes in birth spacing. Differentials by marital status are not significant.

The research adds to a growing body of studies on the nature of fertility transitions in sub-Saharan Africa, and would particularly be useful in explaining observed differences in fertility transitions between countries in the region.

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## Acknowledgements

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I extend my utmost gratitude to Associate Professor Tom Moultrie who supervised this study and provided helpful suggestions. I am grateful to the Andrew Mellon and Hewlett Foundations for funding my studies and the programme, and to the staff at the Centre for Actuarial Research for their support. Many thanks to my family and friends for all the inspiration and encouragement.

Last but not least, I acknowledge collaboration with Professors Tom Moultrie and Ian Timæus on the statistical modelling section of this study.

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## Chapter 1. Introduction

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Since Muhwava and Timæus' study of 1996 (Muhwava and Timæus 1996), there has not been any major, comprehensive study of fertility and parity progression in Zimbabwe. Prior to it (with the exception of Cohen's study of 1993), and since it, studies have tended to focus on total fertility and broad issues that affect fertility. Very little attention was paid to birth intervals until Moultrie (2008) extracted patterns and trends of birth intervals for countries in the sub-Saharan African region, including Zimbabwe. In recent years, researchers (such as Rafalimanana and Westoff 2000; Moultrie 2008; Timæus and Moultrie 2008) of fertility in sub-Saharan Africa have shown a heightened interest in studying birth intervals. This interest has arisen because birth spacing affects patterns of family formation, and patterns of family formation and childbearing are central to explaining and/or understanding fertility changes. Birth intervals might differ for women at different parities; for instance between first and second births, and between third and fourth births. Understanding the determinants of birth interval length at each parity therefore might be a useful way of gaining more insight into observed fertility patterns and their determinants.

This research seeks to add to our knowledge about birth intervals by determining projected median birth intervals using a technique put forward by Aoun (1989), and to locate them in time using an approach proposed by Moultrie and Timæus (2002). Locating them in calendar time allows secular trends to be drawn from the data. The observed time trends in the birth intervals can be explained by disaggregating the birth intervals at each point in time into their proximate determinants, so as to examine how parallel changes and trends in the proximate determinants impact on birth interval length, both in terms of direction of operation and extent of the effect. Of course the fragmentation of data in investigating the proximate determinants might result in small sample sizes or proportions, which would compromise the reliability of the results for inferential purposes. Not much can be done to rectify this, and where it is felt that the sample sizes or proportions are too small, the respective variables will be excluded from the analyses. Once these proximate determinants have been determined, regression analysis is used to investigate the relative influence of each of them on birth intervals.

In order to understand the relationship between fertility and birth spacing, it is important to establish the link between the start and pace of fertility change and the

corresponding traits in birth interval dynamics. In an effort to achieve this, as well as to bridge the gap with the study by Muhwava and Timæus (1996), this research establishes parity progression dynamics using the methods for parity progression ratios, and truncated pairwise measures of parity progression suggested by Brass and Juárez (1983). The fertility patterns implied by the parity progression investigations can then be analysed in parallel to the changes in projected median birth intervals and their determinants.

An exercise of this nature, if done across many countries, could help explain observed differences in fertility patterns, both on a regional and an international level. The availability of Demographic and Health Survey data in many of the developing countries means that the data for the processes should be available. This would also aid in determining how much behavioural change affects birth intervals, and consequently affects fertility, which information would be useful to governments mostly, and for the assessment of family planning programs. Understanding birth interval dynamics might also be useful for studying child mortality because the length of the interval between births is an important determinant of the survival of those children.

The thesis is presented in five chapters. The next chapter looks at the existing literature on fertility, birth intervals and their proximate determinants in Zimbabwe and/or in other countries in the sub-Saharan African region. The methods used in related studies are highlighted and critiqued in that chapter. Chapter 3 gives a tour of the datasets before outlining the methods used in this study. The results from using these methods are displayed, analysed and interpreted in Chapter 4. The prologue to Chapter 4 is in the form of a discussion on the implications of these results. Chapter 5 concludes the thesis by summarising the findings and reflecting on the work presented in the thesis.

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## Chapter 2. Literature Review

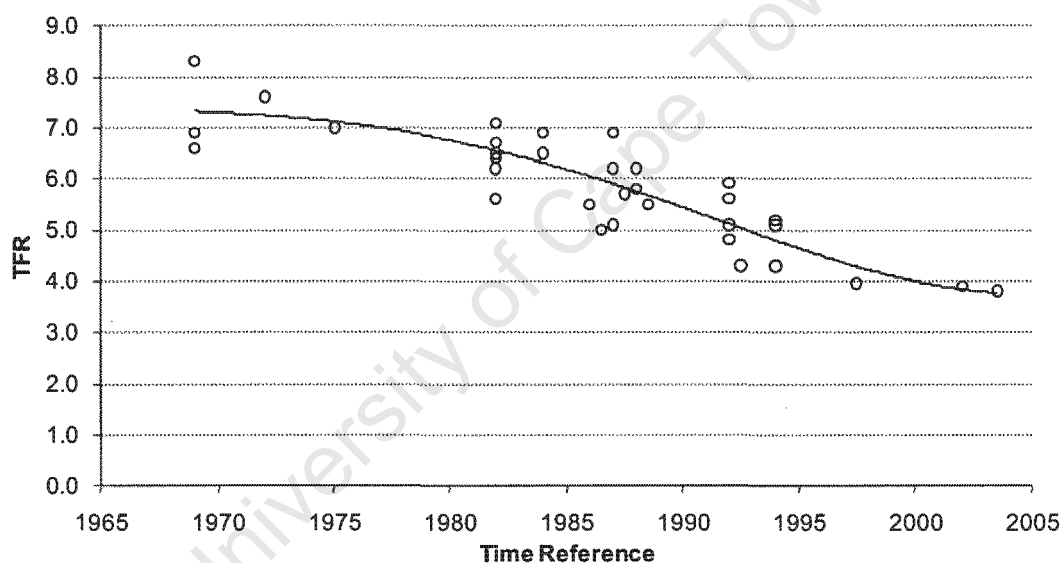
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### 2.1 Fertility in Zimbabwe

Many authors have documented a fertility decline since the 1980s in countries in sub-Saharan Africa, in particular in Botswana, Kenya, South Africa, and Zimbabwe (Mturi and Hinde 2001; Potts and Marks 2001; Caldwell and Caldwell 2002). With the exception of South Africa, the decline in fertility in Zimbabwe has been fairly rapid relative to other countries in the region (Kirk and Pillet 1998; Hinde and Mturi 2000). The fertility trends in Zimbabwe obtained from different sources are shown in Figure 2.1.

Figure 2.1 Total fertility in Zimbabwe, from different sources



Source: Derived from Cleland, Onuoha and Timæus (1994); Cohen (1993); Kirk and Pillet (1998), Muhwava and Timæus (1996)

The estimates show that a decrease in fertility in Zimbabwe commenced around 1970. A rather steep decline followed between the mid 1980s and the mid 1990s. After that period, the decline was only gradual. It is interesting to note the period between 1997 and 2003 when fertility seems to have stalled, before continuing to decline.

In reality, not all estimates are of equal quality. The multitude of estimates of the total fertility rate (TFR) result from the use of different data sources and different methods of estimation by different authors. Table 2.2 shows the TFRs displayed in Figure 2.1,

showing the data and method used to derive them, the time to which they refer, and the author from whom they are obtained.

**Table 2.1 TFRs from different sources**

TFR	Time Reference	Data	Method	Source
6.6	1969	Census 1969	Direct	Muhwava and Timæus (1996)
8.3	1969	Census 1969	P/F ratios	Muhwava and Timæus (1996)
6.9	1969	Census 1969	Relational Gompertz	Muhwava and Timæus (1996)
7.6	1970-74	Census and DHS	Birth History	Tabutin and Schoumaker (2004)
7.0	1975	Census 1982	Coale method	United Nations (1990)
6.7	1980-84	Census and DHS	Birth History	Tabutin and Schoumaker (2004)
6.5	1980-84	DHS, 1988-1989	P/F ratios	Cleland, Onuoha and Timæus (1994)
7.1	1982	Census 1982	P/F ratios	Thomas and Muvandi (1992)
5.6	1982	Census 1982	Direct	Muhwava and Timæus (1996)
6.4	1982	Census 1982	P/F ratios	Muhwava and Timæus (1996)
6.2	1982	Census 1982	Relational Gompertz	Muhwava and Timæus (1996)
5.5	1984-88	DHS, 1988-1989	Birth History	Central Statistical Office (1989)
6.5	1984	RHS 1984	Birth History	Central Statistical Office (1989)
6.9	1984	RHS 1984	P/F ratios	Muhwava and Timæus (1996)
6.9	1984	RHS 1984	Relational Gompertz	Muhwava and Timæus (1996)
5.7	1985-90	DHS, 1988-1989	P/F ratios	Cleland, Onuoha and Timæus (1994)
5.0	1985-88	DHS, 1988	Birth History	Muhwava and Timæus (1996)
5.1	1987	ICDS 1987	Birth History	Central Statistical Office (1989)
6.9	1987	ICDS 1987	P/F ratios	Muhwava and Timæus (1996)
6.2	1987	ICDS 1987	Relational Gompertz	Muhwava and Timæus (1996)
5.5	1988-89	DHS, 1988-1989	Bongaarts Model	Kirk and Pillet (1998)
6.2	1988	DHS, 1988	P/F ratios	Muhwava and Timæus (1996)
5.8	1988	DHS, 1988	Relational Gompertz	Muhwava and Timæus (1996)
5.1	1990-94	Census and DHS	Birth History	Tabutin and Schoumaker (2004)
4.3	1991-94	DHS, 1994	Birth History	Central Statistical Office (1995)
4.8	1992	Census 1992	Direct	Muhwava and Timæus (1996)
5.9	1992	Census 1992	P/F ratios	Muhwava and Timæus (1996)
5.6	1992	Census 1992	Relational Gompertz	Muhwava and Timæus (1996)
4.3	1994	DHS, 1994	Bongaarts Model	Kirk and Pillet (1998)
5.1	1994	DHS, 1994	P/F ratios	Muhwava and Timæus (1996)
5.2	1994	DHS, 1994	Relational Gompertz	Muhwava and Timæus (1996)
4.0	1996-99	DHS, 1999	Birth History	Central Statistical Office (2000)
3.9	2000-04	Census and DHS	Birth History	Tabutin and Schoumaker (2004)
3.8	2002-05	DHS, 2005-06	Birth History	Central Statistical Office (2007)

Source: Derived from Cleland, Onuoha and Timæus (1994); Cohen (1993:21); Cohen (1998:1457); Kirk and Pillet (1998), Muhwava and Timæus (1996). RHS is the Reproductive and Health Survey, and ICDS is the Intercensal Demographic Survey.

In some earlier studies, there was a lack of consensus on the relative magnitude of the fertility decline in Zimbabwe and Botswana (Blanc and Rutstein 1994; Thomas and Muvandi 1994). These disagreements were linked to the quality of the data that were used in deriving the fertility estimates. Thomas and Muvandi attributed some of the observed differences in fertility to differences in the composition of the women in the Demographic and Health Survey (DHS) and the Contraceptive Prevalence Survey (CPS), while Blanc and Rutstein objected to the statistical significance of the differences in the educational attainment of the women in the samples. The ZDHS of 1994 showed an even greater decline than had previously been estimated (Cohen 1998). Muhwava and Timaeus (1996) used more data, including censuses and other surveys which had been gathered since 1969 up to the time of their study; and they showed that although the ZDHS understated fertility, the decline was greater than suggested by Thomas and Muvandi.

Different time trends and levels of total fertility have been observed between rural and urban areas (Bongaarts 2003). The urban fertility transition in Zimbabwe started around the 1970s and the rural transition in the 1980s (Garenne and Joseph 2002). Table 2.2 shows the actual TFRs by residence from the four DHSs consulted.

**Table 2.2 TFR for rural and urban areas in Zimbabwe.**

ZDHS	Time reference	Urban	Rural
1988	1985-88	3.9	6.1
1994	1991-94	3.1	4.9
1999	1996-99	3.0	4.6
2005-06	2002-05	2.6	4.6

Source: Derived from the ZDHS 1988, 1994, 1999, and 2005-06

At all survey times, the fertility in urban areas has been much lower than that in the rural areas. Rural fertility fell by about 24.6 per cent in the period between 1985 and 2002-3, while the urban TFR declined by roughly 33.3 per cent – off a much smaller base - in the same period. In both urban and rural areas, the decline in total fertility was greatest between 1988 and 1994.

The disadvantage of analysing fertility by area of residence is that it is a current status variable, and current status variables present characteristics at the time of the survey rather than when the events of interest occur. Hence, if a woman has recently moved, then her fertility history will be recorded under the new area and not the place where it happened,

i.e. the present status may not apply to the data. This would inflate fertility in the receiving area whilst deflating fertility in the sending area. As such, some of the fertility in the urban areas might be incorrectly ascribed if the woman migrated from the rural areas but had her fertility history recorded in the urban areas, and vice versa.

The TFR, although it is one of the most used measures of fertility, has shortcomings associated with being a period measure of fertility. Bhrolcháin (1992), for example, has written extensively on this subject. TFRs are used to simulate the experience of actual cohorts using synthetic cohorts taken from a cross-sectional view of the data because following actual cohorts of women would have to span decades, and hence yield outdated estimates. The main shortfall that many analysts have associated with the TFR, as mentioned in that paper, is that the TFR fluctuates greatly when changes in fertility occur for women in the actual cohorts. More precisely, the level of period fertility (the quantum) increases when the pace (tempo) of cohort fertility increases, and decreases with decrease in pace (Bhrolcháin 1992). Therefore the use of the period TFR to estimate the fertility associated with cohorts leads to distortions (Bongaarts and Feeney 1998). It is important to understand these shortcomings so that caution can be used when interpreting fertility levels from studies of fertility.

Accurate studies of fertility trends in sub-Saharan Africa have been marred by a lack of reliable, or even adequate, data (Cohen 1993). With the exception of South Africa, there are no vital registration systems to speak of, and this has necessitated the use of indirect techniques of estimation. Much of the analyses that have been conducted have used data from the World Fertility Surveys (WFS), and more recently, from the DHS. WFS were conducted between 1974 and 1986 to collect fertility data from 62 countries across the globe (Cleland 1996). However, these surveys did not cover Africa at all, save for Kenya and Lesotho. The DHS surveys followed thereafter, from 1986, and these surveys pay greater attention to less developed countries. To date, four DHS surveys have been conducted in Zimbabwe (ZDHS) - in 1988, 1994, 1999, and 2005-06. Although most of the DHS data suffer from distortions caused by conscious and unconscious misrepresentation of births, the ZDHS datasets are regarded as some of the better samples (Kirk and Pillet 1998). Earlier studies have also used or included census data in the analyses, as the fertility surveys were not adequate for the studies at hand (Thomas and Muvandi 1994), and because ideally, the census should give one of the better estimates.

Census counts produce large datasets, and these are better than smaller samples in reducing the level of uncertainty surrounding estimates. However, the main limitation of using census data is that they do not contain full birth histories, or they may be of poor quality; hence they cannot be used with any of the indirect techniques of estimating fertility based on women's birth histories. Censuses were done in Zimbabwe in 1969, 1982, 1992, and 2002. The datasets are, however, not made available to the general public by the Zimbabwe Central Statistical Office.

## **2.2 The proximate determinants of fertility and birth interval length in sub-Saharan Africa**

Studies have been done to account for the differences in fertility levels in different populations. Davis and Blake (1956) suggested eleven factors which affect fertility. As an extension to the work of Davis and Blake, Bongaarts (1978) condensed the eleven factors into seven, and then into four (Bongaarts and Potter 1983) because some of the variables suggested by Davis and Blake were not easily measureable, and/or not variable across populations. Bongaarts put forward a proximate determinants framework in which he identified four factors as the variables which immediately affect fertility (Bongaarts and Potter 1983). Figure 2.2 shows the development of the framework as the original eleven variables suggested by Davis and Blake (1956) were condensed into the four well-known determinants.

According to this framework, the changes in these four factors directly result in changes in fertility. These channel the effects of the background variables such as economic, cultural, environmental, social, institutional, psychological, and health related variables. However, the variables which Bongaarts fixed in his model (in order to calculate the indices of marriage, abortion, contraception, and infecundability) were argued to account for most of the variation in fertility between populations.

Determinants of fertility are not necessarily those that determine birth intervals, although they are largely similar (Moultrie and Timæus 2002). The decline in fertility has resulted in smaller family sizes. Falling fertility and changing birth intervals are, however, conceptually, and often practically independent. Smaller family size does not necessarily result from or imply lengthening of birth intervals. Family size represents the quantum, and birth interval length the tempo effects of fertility. The same quantum can be reached via

different temporal scenarios. Women might have the same number of children in a short space of time, or they might have them far apart.

**Figure 2.2 Determinants of fertility change**

	<b>Variables</b>	
<b>Davis and Blake (1956)</b>	<b>Bongaarts (1978)</b>	<b>Bongaarts and Potter (1983)</b>
Age at entry in sexual unions		
Permanent celibacy	→ Proportion married	→ Marriage
Reproductive period spent after or between unions		
Use or non-use of contraception	→ Contraception	→ Contraception
Foetal mortality from voluntary causes	→ Induced Abortion	→ Induced Abortion
Voluntary abstinence	→ Lactational Infecundability	→ Lactation
Involuntary abstinence	→ Frequency of Intercourse	
Coital frequency		
Fecundity or infecundity (involuntary)	→ Sterility	
Fecundity or infecundity		
Foetal mortality from involuntary causes	→ Spontaneous Intrauterine Mortality	

Source: Adapted from Davis and Blake 1956:212; Bongaarts 1978:106

Studies in African fertility transitions have identified the proximate determinants of birth interval length. These are described below.

### 2.2.1 Contraceptive use

Whether a woman uses contraception between births might affect the length of the birth interval (Moultrie and Timæus 2002; Timæus and Moultrie 2008). Women who use contraception before a birth will generally have longer inter-birth spacing between the births in question than those who do not, because they prevent conception. Earlier studies on contraceptive use as a proximate determinant of birth intervals, however, concluded that contraceptive use was not an important factor. This is because the modern forms of contraception would merely take the place of the traditional methods of birth control (Cohen 1998).

There are modern and traditional forms of birth control which have been used to regulate fertility choices. Widespread modern forms of contraception include condoms (both male and female), the pill, intra-uterine device (IUD), sterilization, and implants. Traditional methods include abstinence and withdrawal. While South Africa has the highest contraceptive use prevalence in sub-Saharan Africa, contraceptive use in Zimbabwe is also high (Guilkey and Jayne 1997; United Nations Population Division 2008). The statistics from the ZDHS are shown in Table 2.3.

**Table 2.3 Per cent distribution of contraceptive use by survey, women aged 15-49**

ZDHS	Any method	Modern methods
1988	43.1	36.1
1994	48.1	42.2
1999	53.5	50.4
2005-06	60.2	58.4

The use of both modern and any form of birth control has been increasing over time. The increase in contraceptive use was similar in the intervals between consecutive surveys, ranging from 16 per cent between the 1999 and 2005-06 surveys to 19 per cent between the 1994 and 1999 surveys, for modern contraception.

Some authors have attributed the high use of contraception in Zimbabwe to the high levels of education amongst women, which boosts awareness of effective methods of birth control (Lloyd, Kaufman and Hewett 2000; Kravdal 2002).

The history of birth control in Zimbabwe is not without its politics – domestic and at a national level (Kaler 1998). Birth control as a national policy began in 1965 when the Rhodesian government formed the Family Planning Association of Rhodesia (FPAR). The program was initially only available to women in urban areas. Many of the black population viewed the program with skepticism because they feared that the white government was trying to eradicate future generations of natives. As Kaler (1998) relates, Depo Provera was introduced in 1969 at which point it was welcomed by most women because it provided long-term protection, and because women could use it without alerting their partners. Prior to this, many women used the IUD and the pill. The FPAR was succeeded by the Zimbabwe National Family Planning Council (ZNFPC) in 1980. After attaining independence from the British, the government of Zimbabwe banned the use of Depo Provera on two grounds; the first being that it was an experimental method which had

negative side effects; and second, because it was seen as an imperialist way, by the former colonial masters, of controlling the black majority (Kaler 1998). However, these reasons were spurious and they attempted to disguise and advance men's desire to control women's fertility (Kaler 1998). Men felt that patriarchy was being threatened by women's ability to use a birth control method that men could not see.

Contraceptive use has been labeled the most overriding proximate determinant of all the proximate determinants of fertility and median birth intervals, (Moultrie and Timæus 2002; Timæus and Moultrie 2008). The effect of the banning of Depo Provera can be seen from Figure 2.1, which shows that there was barely any change in the TFR between 1982 and 1985. After this period, fertility started falling again as women might have found alternative effective methods of birth control.

### **2.2.2 Marital status**

Studies have also suggested that differential birth intervals exist between women who have ever been married versus those who have never been married at the time of birth of a particular child. Moultrie and Timæus (2002) and Heckman, Holtz and Walker (1985) suggest that women who have ever been married tend to have shorter birth intervals than never married women. This is attributed to greater coital frequency by women who have regular partners, compared to women in less steady, short term, relationships. However, the concept of marriage in Zimbabwe is hazy due to the different types of marriage, and even then the multiplicity of the processes involved, and the extended time over which the marriage process occurs (Barbieri, Hertrich and Grieve 2005). This creates a problem in the definition of marital status, as one would not know at what point a person would be said to be married. The ZDHS define a married person as one who has ever lived with a man "as if married" (Central Statistical Office 2007).

Studies have shown that the age at first marriage has only risen slightly in Zimbabwe, and the proportions of women getting married has only recently declined (Jensen and Thornton 2003). They show that the proportion of women marrying by age 18 was fairly constant, ranging from 37 to 40 per cent for cohorts of women born between 1950 and 1965, before declining to about 29 per cent for women born between 1965 and 1970. That fewer women are marrying has been attributed to the greater participation by

women in the labour force as more women become educated. Table 2.4 shows median age at marriage by year of survey.

**Table 2.4 Median age at first marriage in Zimbabwe**

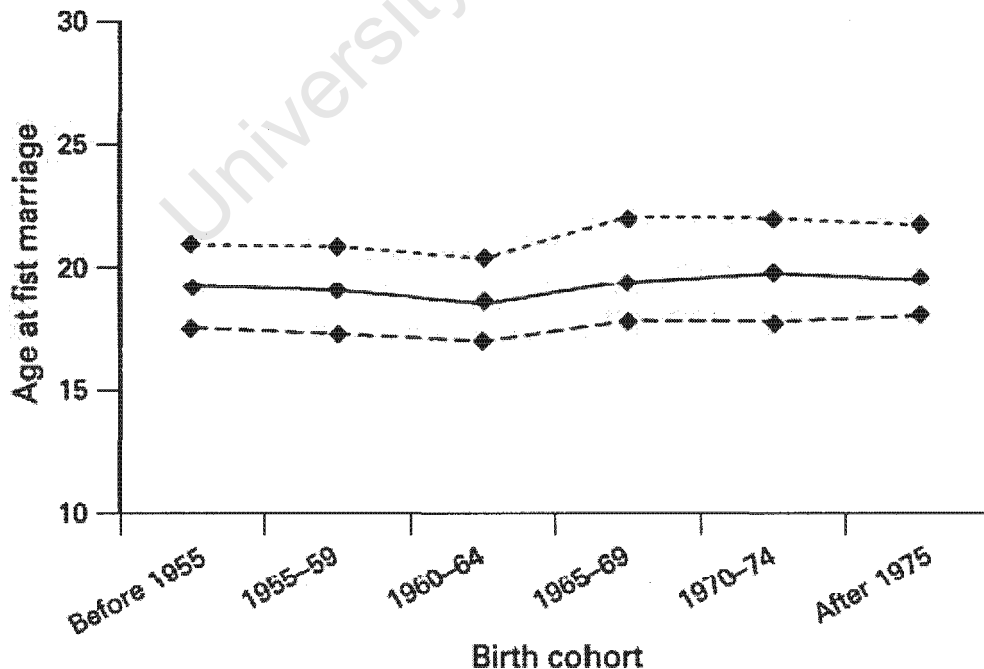
Age	Survey Date			
	1988	1994	1999	2005-06
20-24	19.7	19.8	19.7	19.5
25-29	18.8	19.3	19.9	19.6
30-34	18.5	18.7	19.7	19.4
35-39	19.0	18.8	18.6	19.7
40-44	18.1	18.9	18.9	18.5
45-49	18.6	18.9	18.8	18.8

Source: Derived from the ZDHS Reports for 1988, 1994, 1999, and 2005-06.

There has not been much shift in the age at which women first marry from the older to the younger cohorts, nor across time.

Figure 2.3 shows the median age at first marriage and the interquartile range obtained by Cremin, Mushati, Hallett, Mupambireyi et al. (2009) in a study in Manicaland province in Zimbabwe.

**Figure 2.3 Median age and interquartile range at first marriage in Manicaland province, Zimbabwe**



Source: Adapted from Cremin, Mushati, Hallett, Mupambireyi et al. (2009)

Again, changes in age at first marriage over time were only marginal. It is interesting to note that although by about age 17 only 25 per cent of women have married, 75 per cent would have done so by ages 21 to 22, roughly. This shows that first marriage, once it commences for these cohorts of women, is concentrated between these ages.

According to the DHS, levels of premarital sexual activity in Zimbabwe are quite low, with twelve per cent of single 15-19 year old women engaging in premarital sex in 2006. The corresponding statistic for South Africa is 43 per cent. Adolescent fertility is moderately high; about 20 per cent of women will have had a child by the age of 18.

### **2.2.3 Other proximate determinants**

The literature also identifies other proximate determinants of birth intervals, namely abortion, duration of breastfeeding and postpartum infecundity, and infecundability. Abortion is directly linked to birth interval length (Moultrie and Timæus 2002). It has been argued that, on average, when three abortions occur, they prevent the birth of one child (Keyfitz 1977). This tends to make complex the relationship between abortion and the length of the birth interval, because if only one abortion occurs, it only averts a fraction of a birth, which does not mean anything since births cannot be in part. This makes it difficult to find the exact relationship between abortion and birth interval length. The measurement of the abortion variable is made immensely difficult by the inadequacies of the accuracy of data. It has not been easy to obtain information on abortion from surveys and censuses because of the stigma attached to aborting (Cleland, Onuoha and Timæus 1994; Rossier 2003). Abortion can be natural or induced, and in many countries induced abortion is illegal (Brookman-Amisshah and Moyo 2004). In Zimbabwe, abortion is not legal, except when the mother is at risk of dying, the child is at risk of birth defects, or if the conception is a result of rape or incest (Johnson, Ndhlovu, Farr and Chipato 2002). As a result most abortion statistics are not captured in clinic and hospital databases. Any rates calculated directly from these data would therefore be an understatement of the actual experience.

Another determinant of fertility and birth interval length is breastfeeding. Breastfeeding as a form of birth control and as a source of nutrition for newborns is widespread in sub-Saharan Africa (Tabutin and Schoumaker 2004). If women extend the period that they breastfeed, then the period of infecundity also increases as a result of

lactational amenorrhea. The longer is this period of infecundity, the longer are birth intervals, because women will not be able to conceive in that period (Bracher and Santow 1982; Kirk and Pillet 1998; Moultrie and Timæus 2002; Blacker, Opiyo, Jasseh, Sloggett et al. 2005). In Zimbabwe, the duration of breastfeeding has been more or less constant over time. Duration of breastfeeding over time is given in Table 2.5 below.

**Table 2.5 Duration of the period of breastfeeding in Zimbabwe**

ZDHS	Mean Months
1988	19.3
1994	18.8
1999	19.0
2005-06	18.8

Source: Derived from the ZDHS Reports (1988, 1994, 1998-99, 2005-06)

Breastfeeding, and consequently infecundity is not much of a determinant of birth interval length because the period of breastfeeding has been relatively constant.

## 2.3 Methods

### 2.3.1 Pairwise comparison methods

Perhaps the most recent detailed work on birth interval analysis has been carried out in South Africa by Moultrie (2008). He used the pairwise comparison methods suggested by Brass and Juárez (1983) to derive projected parity progression ratios (PPPRs) and projected truncated pairwise measures of parity progression (projected  $B_t$ s); and the method suggested by Aoun (1989) to derive projected median birth intervals. Prior to that, Muhwava and Timæus (1996) had calculated fertility estimates, and  $B_{60}$ s for Zimbabwe using all the available datasets since 1969, and using various estimation methods for the TFR. The other major study is that by Cohen (1993), who calculated TFRs for 38 African countries, and  $B_{60}$ s for 8 countries for which DHS data were available – including Zimbabwe.

Parity progression ratios represent the proportion of women who will have a child, conditional upon already having one or more, and  $B_t$ s represent the proportion of women who will have another child, but with a time constraint of  $t$  months after the last birth in which she may do so. The approach by Aoun (1989) was derived from the method for pairwise measures of parity progression described above, and it uses the same data

requirements as  $B_s$ . The methods used in both studies are applicable when the data used include detailed birth histories of the mothers, such as information on age of the women, numbers of women at every parity, numbers of births to each woman by year, and time of death of children. This kind of information cannot be obtained from census data. Hence data from DHS surveys were used in both studies.

The  $B_{60}$ s derived by Cohen (1993) for Zimbabwe using the 1988 DHS are presented in Table 2.6 below.

**Table 2.6 Censored parity progression ratios**

Women's Age	Censored Parity Progression Ratios ( $B_{60}$ s) by Age Group			
	1-3	3-5	5-7	7-9
20-24	0.622			
25-29	0.664	0.500	0.237	
30-34	0.682	0.598	0.518	0.481
35-39	0.741	0.666	0.559	0.504
40-44	0.733	0.689	0.616	0.560
45-49	0.765	0.709	0.605	0.518

Source: Derived from Cohen (1993:44)

In this table, the  $B_{60}$ s have been combined across the parities. This was done by multiplying the values of  $B_{60}$  for consecutive parities for the parities which were grouped together. Hence, for instance, the 1-3 censored parity progression ratio is the product of  $B_{60}$  for women at parity 1-2 and women at parity 2-3, showing the proportion of women who are expected to progress from the first to the second or the second to the third birth within 60 months of the previous birth.

For women at all ages, the censored parity progression ratios ( $B_{60}$ s) declined with increasing parity, which shows that fewer and fewer women were having large numbers of children. Fertility was declining. Up to parity seven, the decline was steeper the greater the parity, i.e. it was greater at parities 5-7 than at parities 1-3. The ratios increased with age; an indication of a fall in the fertility trends in the period. This is consistent with assertions that the fertility decline in most of the sub-Saharan Africa region has been occurring at all ages, unlike what has been observed in other regions of the world (Caldwell, Caldwell and Orubuloye 1992; Caldwell and Caldwell 2002).

The  $B_{60}$ s for the 1988 and 1994 survey from Muhwava and Timæus (1996) are shown in Table 2.7 below. The parities are shown on top, with 1/2 indicating moving from parity one to the second.

**Table 2.7 The proportion of women progressing to the next birth within five years**

	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9
<b><math>B_{60}</math> Adjusted 1988 ZDHS</b>								
20-24	0.8112	0.7998	0.6809					
25-29	0.8393	0.7988	0.7504	0.7003				
30-34	0.8471	0.8134	0.8019	0.7676	0.7622	0.755	0.6765	
35-39	0.8858	0.8413	0.8294	0.825	0.7581	0.7419	0.6921	0.7803
40-44	0.8613	0.8557	0.8477	0.8337	0.7837	0.7973	0.766	0.7566
45-49	0.8786	0.8679	0.8635	0.8217	0.8182	0.7585	0.7655	0.6663
<b><math>B_{60}</math> Adjusted 1994 ZDHS</b>								
20-24	0.7368	0.6613	0.7403					
25-29	0.7440	0.7078	0.6437	0.5317				
30-34	0.8235	0.7756	0.7082	0.6137	0.6025	0.6142	0.5475	
35-39	0.8687	0.8265	0.8254	0.7287	0.6405	0.6221	0.5285	0.5418
40-44	0.8772	0.8368	0.8509	0.8113	0.7046	0.6737	0.6209	0.5472
45-49	0.8881	0.8647	0.8556	0.7910	0.804	0.7362	0.7084	0.6005

Source: Muhwava and Timæus (1996:41)

The values from Muhwava and Timæus' study are consistent with those from Cohen's study for the 1988 ZDHS; multiplying the equivalent  $B_{60}$ s in Table 2.7 gives very similar figures to those in Table 2.6.

At most parities and ages, parity progression decreased from the 1988 survey to the 1994 survey. Fewer women were moving to higher parities. The ratios decrease with age in both surveys, indicating a fall in fertility.

### 2.3.2 Means and medians of birth intervals

The need to use projected median birth intervals as a measure of the length between women's births stems from the inadequacy of the mean. Mean birth intervals are problematic because the last birth interval of every woman is technically never closed (Moultrie and Timæus 2002). As a result it is not possible to determine a mean of the failure function of such a distribution. The other problem with using the mean is that women's distribution of birth intervals is heavily skewed towards the right, rendering the

mean not very useful as a descriptive measure. As a result of their shortfalls, mean birth intervals have generally been abandoned as measures of birth spacing in the past few decades. Moultrie and Timæus (2002) include a section on mean birth intervals (and highlight their shortfalls) for South African women in their study of fertility patterns in South Africa.

A measure of central tendency commonly used in these analyses is the median birth interval. DHS reports present median birth intervals. Table 2.8 below gives these figures.

**Table 2.8 Median birth intervals in months for Zimbabwean women, using ZDHS**

<b>Year of survey</b>	<b>Median birth interval (months)</b>
1994	37.0
1999	40.0
2005-06	41.6

Source: Derived from ZDHS reports for 1994, 1999, and 2005-06

From these figures, the periods between births have been increasing with time. However, median birth intervals do not cater for temporal differences in childbearing. They are greatly affected by the pace at which women bear children; therefore when period changes in childbearing have been occurring, they fluctuate greatly and give distorted figures for cohort analysis. Projected median birth intervals are more useful for mapping the experience of all women.

The next chapter looks at the methods and data used in this study.

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## Chapter 3. Data and Methods

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This chapter starts by examining the characteristics of the ZDHS data used in the analyses with the view to interrogating the quality of the data, and to explaining some of the outcomes given in the next chapter. Latter sections describe the methods employed in carrying out the research.

### 3.1 Description of the Datasets

The analyses are done using data on women obtained from the Demographic and Health Surveys conducted in Zimbabwe in 1988, 1994, 1999, and 2005-06 (available from [www.measuredhs.com](http://www.measuredhs.com)). Because Demographic and Health Surveys collect detailed birth histories, they are useful for investigating parity progression and birth spacing. The need for the detailed birth histories precludes the use of census data for these analyses. DHS surveys in Zimbabwe are conducted by the Central Statistical Office in conjunction with Macro International (Central Statistical Office 2005-06). The respective numbers of women and households involved in the surveys over the years are shown in Table 3.1.

**Table 3.1 Zimbabwe Demographic and Health Survey sizes**

Survey	Number of Women	Number of Households
1988	4201	4107
1994	6128	5984
1999	5907	6369
2005-06	8907	9285

Source: Derived from the Demographic and Health Survey Reports (1988, 1994, 1998-99, 2005-06)

By 2005-06, there had been a doubling of the sample since the first ZDHS, both in terms of numbers of women and of households, and this should imply that the uncertainty surrounding results based on these data should have lessened over time.

### 3.2 Background Characteristics

This section takes a look at the background characteristics of the interviewed women in all four surveys.

Table 3.2 Background characteristics of the women interviewed in the 1988, 1994, 1999, and 2005-06 surveys

Background Characteristic	1988		1994		1999		2005-06					
	Weighted percent	Weighted	Unweighted	Weighted percent	Weighted	Unweighted	Weighted percent	Weighted	Unweighted			
<b>Age</b>												
15-19	24.3	1021	1021	24.0	1472	1486	24.5	1447	1468	24.2	2152	2130
20-24	20.0	840	840	20.7	1269	1231	21.9	1294	1232	21.9	1952	1945
25-29	16.2	679	679	14.9	915	911	17.5	1034	1011	16.5	1466	1439
30-34	14.0	589	589	14.2	871	876	11.3	668	650	13.6	1216	1212
35-39	11.0	464	464	10.8	661	666	10.8	637	672	9.4	834	843
40-44	7.6	318	318	8.7	532	542	7.9	466	492	7.8	699	719
45-49	6.9	290	290	6.6	407	416	6.1	361	382	6.6	589	619
<b>Education</b>												
No Education	13.5	566	566	11.1	682	712	6.7	396	437	4.3	380	380
Primary	55.9	2349	2349	47.3	2898	2961	40.2	2377	2518	32.6	2902	2971
Secondary	29.7	1249	1249	40.0	2451	2377	50.2	2965	2803	60.1	5355	5297
More than secondary	0.9	37	37	1.6	96	78	2.8	168	149	3.0	270	259
<b>Contraceptive Use</b>												
Ever Used	60.4	1249	1249	61.7	3781	3743	63.6	3754	3735	67.1	5971	5978
Never Used	39.6	1665	1665	38.3	2347	2385	36.4	2153	2172	33.0	2936	2929
Currently Using	32.2	1352	1352	35.1	2152	2101	37.7	2226	2166	40.2	3576	3547
Currently Not Using	67.8	2849	2849	64.9	3976	4027	62.3	3681	3741	59.9	5331	5360
<b>Marital Status</b>												
Ever Married	73.0	3068	3068	73.2	4482	4465	72.3	4270	4224	73.0	6503	6455
Never Married	27.0	1133	1133	26.9	1646	1663	27.7	1637	1683	27.0	2404	2452

Background Characteristic	1988		1994		1999		2005-06					
	Weighted percent	Weighted	Unweighted	Weighted percent	Weighted	Unweighted	Weighted percent	Weighted	Unweighted	Weighted percent	Weighted	Unweighted
<b>Residence</b>												
Rural	33.5	2794	2794	32.2	1975	1745	38.6	2279	1809	39.3	3502	3203
Urban	66.5	1407	1407	67.8	4153	4383	61.4	3628	4098	60.7	5405	5704
<b>Province (de facto)</b>												
Manicaland	12.5	527	527	13.7	839	550	14.9	882	556	11.7	1043	1039
Mashonaland Central	6.9	288	288	8.3	510	627	8.1	477	567	9.3	825	751
Mashonaland East	12.9	543	543	9.4	579	580	7.8	461	464	8.0	714	696
Mashonaland West	11.8	495	495	10.3	632	589	9.5	559	491	9.3	829	777
Matabeleland North	4.5	189	189	6.0	366	681	5.1	302	601	6.0	536	672
Matabeleland South	6.7	282	282	5.0	305	587	5.4	321	631	4.9	439	630
Midlands	15.6	656	656	13.2	810	716	12.5	741	673	13.4	1193	1128
Masvingo	11.8	497	497	10.6	652	604	10.7	629	633	12.8	1137	974
Harare	8.2	345	345	17.1	1048	608	18.2	1077	562	16.8	1492	1395
Bulawayo	9.0	379	379	6.3	388	586	7.7	457	729	7.8	697	845

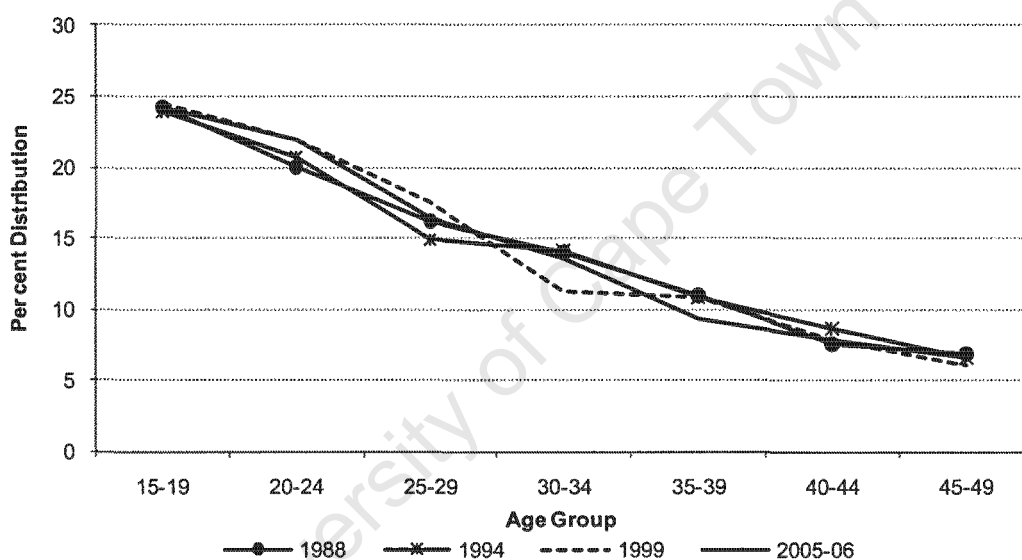
Note: The weights in the 1988 ZDHS are all equal to one because the sample was presumed to be self-weighting, and no weights were supplied.

First, Table 3.2 presents weighted and unweighted figures for some basic background characteristics of the women. Subsequent sections describe the background characteristics in more detail.

### 3.2.1 Age Distribution

In the ZDHS, women aged between 15 and 49 are interviewed to obtain information on their birth histories. The age distribution of women in the four surveys is given in Figure 3.1.

Figure 3.1 Age distribution of women by year of survey



The composition of the four samples are similar in terms of age distribution. There is great consistency in the age distribution of the women who have been sampled over the years. Similar proportions at all ages over time show a consistency in the overall age distribution, as would have been expected. There, however, appears to be a cohort effect of the deficit of births incurred around 1967 to 1969. This manifests as dips in the 25-29 age group of the 1994 survey, the 30-34 age group of the 1999 survey, and the 35-39 age group of the 2005-06 survey; all of which represent the same cohort of women followed over time. Further investigations (not shown here) indicate a consistent pattern of a decrease in births in the late 1960s relative to other years, and thus that this shortfall is

real and not an artifact of the samples. The reasons for this curious pattern require further attention, but are beyond the scope of this thesis.

### 3.2.2 Marital Status

In order to investigate the effect of a woman's marital status on parity progression and birth spacing, it is worthwhile investigating the marriage data. Table 3.3 shows the changes in marriage patterns in Zimbabwe as recorded in the DHSs.

**Table 3.3 Per cent distribution of women by marital status, age and year of survey**

	Ever Married			
	1988	1994	1999	2005 - 06
15-19	19.8	20.6	21.4	21.8
20-24	71.5	72.0	70.0	70.8
25-29	93.2	91.4	89.5	90.9
30-34	97.5	96.1	96.6	96.1
35-39	98.5	98.9	97.2	96.6
40-44	99.1	97.2	98.4	99.3
45-49	98.6	99.0	99.0	98.9

The percent distribution of the never married women is the complement of that of the ever married.

Amongst the older women, marriage (at least once) is almost universal, shown by the small percentages of women who have never married at these ages. All in all, the changes in marital status are very small over the whole period. Changes in proportions marrying over time for each cohort of women are roughly seen by following the diagonals which span across the different surveys, as are changes in proportions not marrying. For example, women aged 15-19 in 1988 are roughly aged 20-24 in 1994 and 25-29 in 1999. Tracing these changes for all women does not yield differences by cohort. The singulate mean age at marriage (SMAM) implied by the 1988, 1994, 1999, and 2005-06 ZDHS further confirms this stagnation, as shown in Table 3.4.

**Table 3.4 Singulate mean age at marriage by year of survey**

Year of Survey	SMAM
1988	21.0
1994	21.1
1999	21.3
2005-06	21.2

Up until the 2005-06 survey, the SMAM was increasing, albeit only marginally. Women were still getting married at relatively young ages. The SMAM is not a very useful measure of age at first marriage if there has been a shift in the nature of marriage patterns. This is because the SMAM as a period measure uses synthetic cohorts, and when marriage patterns change, the proportions of single older women might become greater than that of younger women. This would imply an increase over time, in the proportion of women who have not had a first marriage for the same cohort of women, which is not feasible. There were no notable changes in marriage patterns over the years as shown in Table 3.3.

### 3.2.3 Contraceptive Use

So as to investigate the time trends of ever use and never use of modern contraception, Table 3.5 shows the distribution of women who have ever used contraception for each survey.

**Table 3.5 Per cent distribution of women by ever use of modern contraception, age and year of survey**

	Ever Used			
	1988	1994	1999	2005 - 06
15-19	11.5	12.9	15.4	16.5
20-24	53.3	61.0	63.6	66.0
25-29	68.9	80.6	83.8	88.7
30-34	71.5	76.8	84.8	90.5
35-39	63.6	73.1	81.8	89.3
40-44	52.8	66.4	75.4	84.1
45-49	40.3	49.3	64.4	73.3

Note: The percent distribution of the never used is the complement of that of the ever used.

The proportion of women who have never used contraception decreases with time. The changes occur for women at all ages, although the decline is more rapid after ages 15-19. For the most part, the greatest shift in contraceptive use status occurs between the 1988 and 1994 surveys, with the decline becoming less steep afterwards. Older cohorts of women show only marginal increases in the rates of contraceptive use as they aged. However, the proportions of older women who have ever used contraception increase with time, as the older generations of women who did not use contraception were phased out of the surveys. For the cohorts of women aged between 15 and 19, and 20 and 24 in

the 1988 survey, greater changes in their contraceptive use status occurred when they were younger, i.e. the rate of uptake of contraception diminished with age.

The distributions of women using contraception at the time of survey are given in Table 3.6, which shows that with every successive survey, there were greater proportions of women using contraception at the time of the survey.

**Table 3.6 Per cent distribution of current contraceptive use of women, by age and year of survey**

	Currently Using			
	1988	1994	1999	2005 - 06
15-19	7.1	7.5	10.4	10.0
20-24	32.7	36.2	38.2	42.5
25-29	41.5	47.9	51.2	59.3
30-34	41.6	41.0	50.3	55.5
35-39	31.3	38.7	46.3	48.4
40-44	25.5	32.1	33.7	40.3
45-49	14.5	18.5	24.1	27.8

The percent distribution of the currently not using is the complement of that of the currently using.

At all ages, the proportions of women who were currently using contraception at the time of survey were smaller than the proportions that had ever used. The differences are greater the later the survey and the older the women. This shows that there have been reductions in the uptake of contraception with time.

### 3.2.4 Educational Attainment

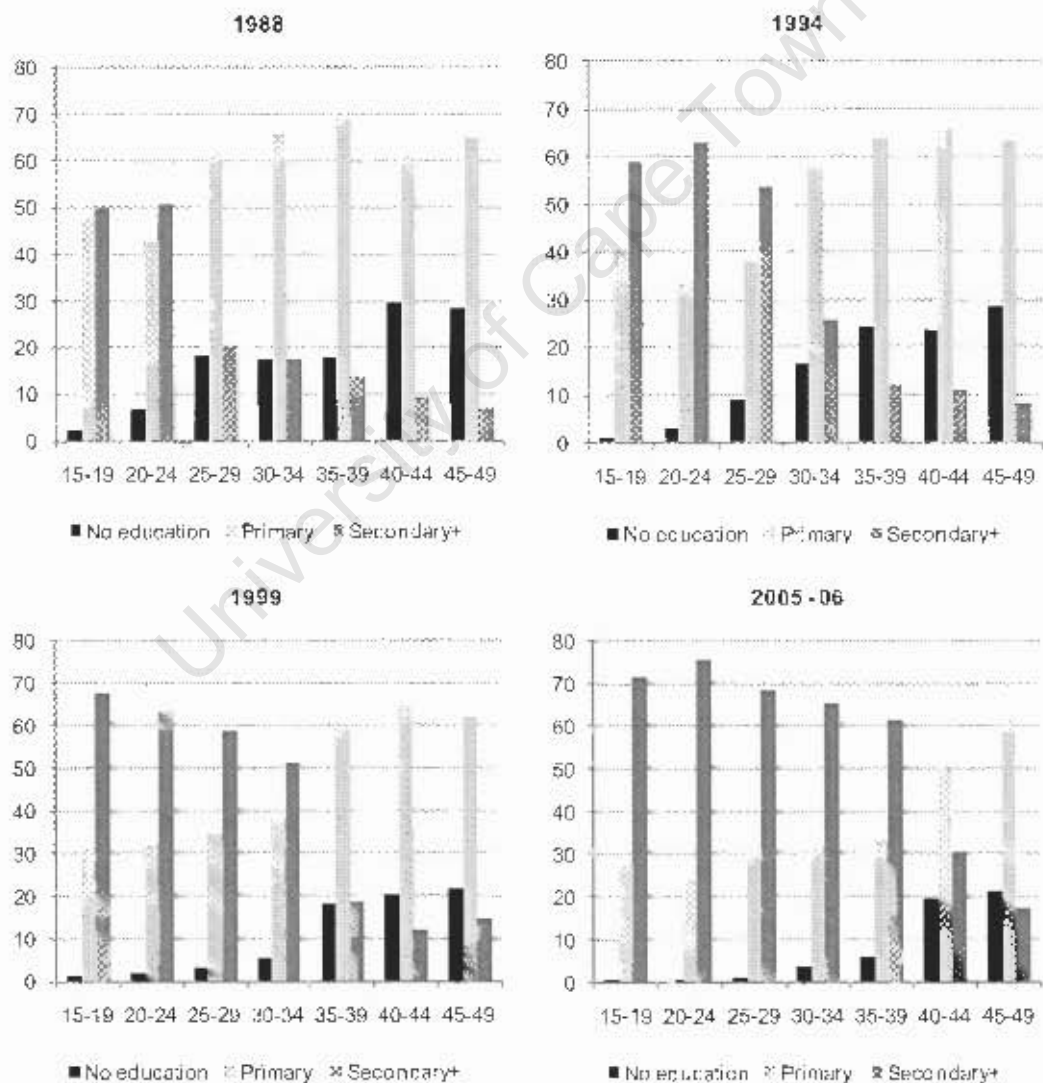
Because the literature has highlighted that the level of education attained plays an influential part in marriage and contraceptive use decisions, we examine the levels of education to women in the four surveys. Figure 3.2 presents the distribution of women across the educational spectrum by year of survey. The secondary and tertiary education groups were combined because of very small proportions of women with tertiary education.

Over time, progressively greater proportions of younger women have received primary, secondary and tertiary education. The proportions of uneducated women decreased over time as more and more of the uneducated older women were phased out

of the surveys as they outgrew the survey age range in the later surveys. The proportions of uneducated women also dropped off amongst the younger women.

It would appear that at younger ages, women were more educated and low proportions of these women were married. In terms of contraceptive use, both current and ever use, the peaks between contraceptive use and educational attainment did not seem to coincide. So education had a greater relationship with marriage than with contraceptive use. Women in Zimbabwe used contraception irrespective of their educational attainment.

Figure 3.2 Per cent distribution of level of education attained by age and survey



### 3.2.5 Residence

The samples of women drawn up in all four surveys contain more urban than rural interviewees. The majority of these women were drawn from the four provinces – Harare, Manicaland, Midlands, and Masvingo. These are amongst the largest and more urbanized provinces in Zimbabwe.

This distribution of women will likely cause the derived TFR to be lower than if there were equal proportions, because fertility has been shown to be lower in urban than rural areas (in Table 2.2). Women in urban areas will likely be more educated and have greater knowledge of, and means to control their childbearing using modern forms of contraception.

### 3.2.6 Fertility

Having looked at the proximate determinants of fertility and birth intervals in the previous sections, this section investigates fertility implied by the four ZDHS surveys. In the ZDHS interviews, women are asked to recall, among other things, the number of live births they have had, the number of births in the last five years and births that occurred in the past year. The responses to these questions are useful for deriving the different fertility estimates for these women.

The most common measure of fertility is the TFR, the number of children a woman is expected to have if she were to live to the end of her reproductive life span and have children at the fertility rates observed in that time period. The age specific fertility rates (ASFRs) and TFRs for all the surveys in the ZDHS are shown in Table 3.7.

There has been a decline in fertility over the years, with the decline being sharpest between 1985<sup>1</sup> and 1994. After 1994, there has been a much slower fertility decline, possibly due to the decrease in the uptake of contraceptive use with time shown in Table 3.5. However, because the TFR is a synthetic cohort measure of fertility, it is affected by changes in the timing of fertility. Hence, if birth interval lengths have greatly changed, then the period TFR is not the best measure to use. Changes in birth intervals are presented in section 4.2 in the next chapter.

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<sup>1</sup> The TFR estimate from the 1988 survey refers to the period 1985-88, 1994 survey to 1991-94, 1999 survey to 1996-99, and the 2005-06 survey to 2002-05.

**Table 3.7 ASFR and TFR by year of survey for women aged 15-49**

	Survey Time			
	1988	1994	1999	2005-06
<b>ASFR</b>				
15-19	0.102	0.099	0.112	0.099
20-24	0.251	0.210	0.199	0.205
25-29	0.250	0.194	0.180	0.172
30-34	0.212	0.172	0.135	0.144
35-39	0.158	0.117	0.108	0.086
40-44	0.080	0.052	0.046	0.042
45-49	0.032	0.014	0.015	0.013
<b>TFR</b>	<b>5.4</b>	<b>4.3</b>	<b>4.0</b>	<b>3.8</b>

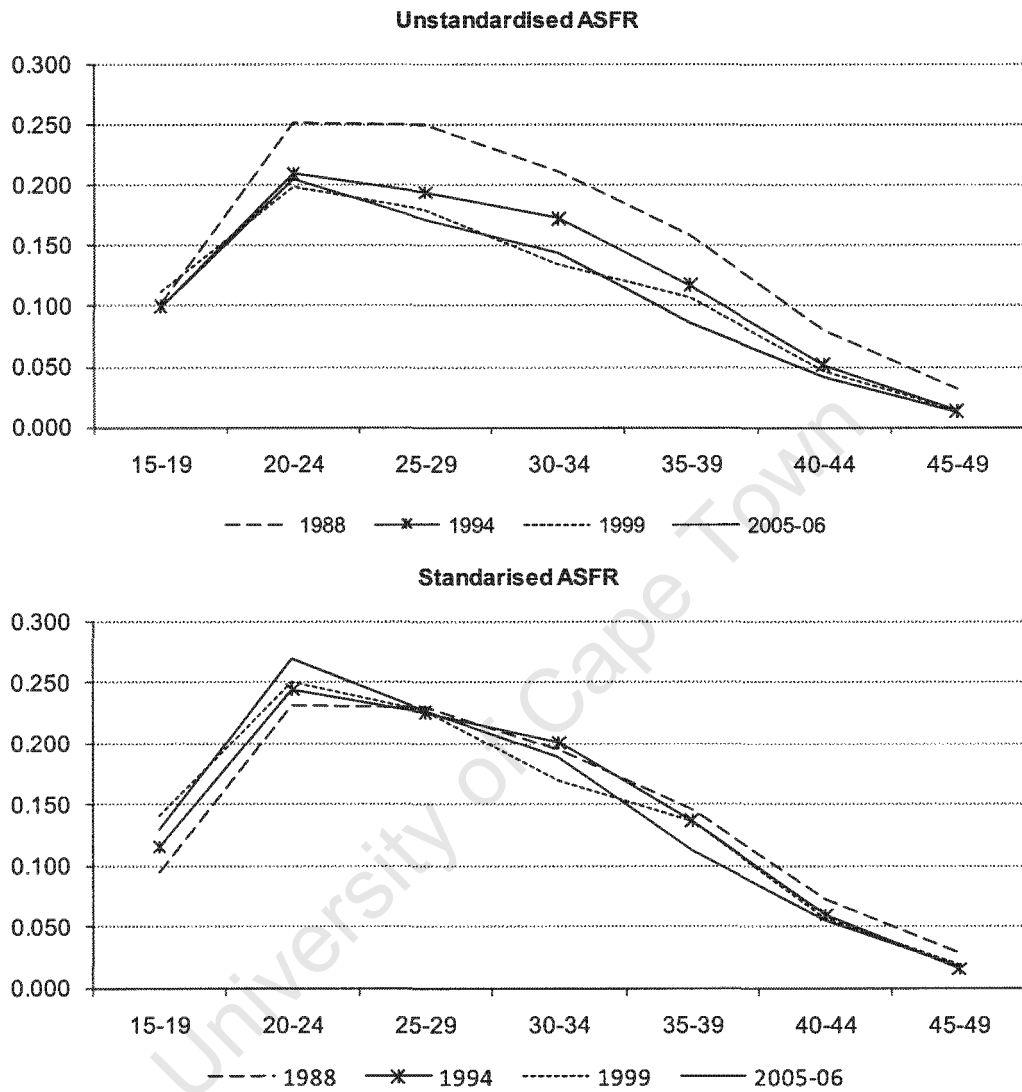
Note: The estimates from the 1988 survey refers to the period 1985-88, 1994 survey to 1991-94, 1999 survey to 1996-99, and the 2005-06 survey to 2002-05.

Furthermore, the TFR, being an overall measure of fertility for all women in the childbearing age range, masks differences in fertility by age. ASFRs give a better picture of these differentials, as they show the fertility attributable to each age band.

Figure 3.5 presents ASFRs for the different surveys in Zimbabwe. The ASFRs refer to a time period which is on average 18 months prior to the survey date. The ASFRs were standardised to a TFR of one, in order to facilitate comparison between the shapes of the fertility distributions.

In general, the age patterns of fertility over time are very similar. Most of the fertility is concentrated in the 20-24 age band, increasingly more so with time. These women aged, 20-24, also have the highest fertility, which decreases over time. At all ages, fertility levels are lower the later the survey date. Before ages 20-24, with the exception of the 1988 survey, the fertility of women was similar in the different surveys. The proportion of fertility attributed to these women however increased with time. In fact, as time progressed, fertility became less concentrated in the older ages and shifted to the younger ages. This resulted in flatter plateau shaped distributions in the earlier surveys, with the distributions becoming less spread out and slightly shifted upwards and to the left with time.

Figure 3.3 Standardised and unstandardised ASFRs in the three years before the survey, by survey and age at survey



### 3.3 Methods

After investigating the basic demographic and social characteristics of women in the four DHSs in the previous sections, this section starts out by describing the way in which the variables useful in the analysis were created, before outlining the methods used in deriving PPPRs, Bt's and projected median birth intervals.

### 3.3.1 Creating the variables

According to the reviews set out in section 2.2, differentials in birth interval length are likely to be found between women who have ever been married by the time of a particular birth, and those who have never been married; and between those who have ever used contraception prior to a specific birth versus those who have never used it. The ZDHS data do not contain these variables, but they can be derived from information contained in the data. The ZDHS has variables pertaining to the date of marriage of the mother, and comparing this with the date of birth of each child the woman has given birth to will determine the marital status of the mother at birth of each child. The resulting variable is used for generating projected B<sub>s</sub> and projected median birth intervals in the children's file - a file which contains the birth history of every child to every woman in the survey. The code for generating this variable is presented in Appendix A4.

Creating the contraceptive use variable for mothers at the time of birth of the child in the children's file is more complex because ZDHS data only give the number of children who were alive when the mother first used contraception. The variable of interest had to be derived from this variable by considering if the child's birth order, adjusted to consider only the living children, was of a higher parity than the parity at which the mother first used. The code for generating the ever use variable is presented in Appendix A5.

The obvious limitation in using this variable is that the results will, in essence, refer only to first use rather than use before each birth because the behavior of women at parities higher than the parity of first use is not taken into consideration. This might result in the incorrect classification of mother by ever use status if she did not use contraception prior to subsequent births. In fact, this would increase the numbers of times women have used contraception whilst depressing the numbers of times they did not. The variable derived for ever use also does not make a distinction between regular users of contraception and those who only used contraception a few times for experimentation. This would inflate the number of women classified as having ever used contraception for controlling births. However, despite the unfortunate consequence of having no better proxy, the results should still be useful for birth interval and parity progression analyses by contraception.

The variables derived in this section were then used with the methods described in subsequent sections of this chapter.

### 3.3.2 Parity progression ratios

Parity progression ratios are a measure of the proportion of women at a particular parity who go on to have a subsequent birth

i.e. 
$$PPR(i, i + 1) = \frac{W_{i+1}}{W_i}$$

where  $W_i$  is the number of women at parity  $i$ .

This measure is generally more accurate for women at older ages because these women are closer to the end of their reproductive life spans, and therefore their PPRs represent actual experiences. Measures of parity progression of women at younger ages are distorted mainly by selectivity bias. Selectivity bias arises from some women having children at a faster pace than others, and hence contributing more to the data. Another weakness of parity progression ratios is the truncation bias, which affects all women. Truncation bias results from the open last birth interval, which makes it impossible to know what happens after a survey date. Parity progression ratios are therefore not an adequate measure of fertility dynamics at younger ages.

The Brass and Juárez (1983) method produces projected parity progression ratios (PPPRs), which deal with the selectivity effect through cohort comparison. PPPRs show the proportion of women at a particular parity who are expected to go on to have the next child by the end of their reproductive lifespan. The data requirements for their computation are simple – tabulations of parity by age of the mother at the time of the survey. The method uses a comparison of fertility to women attained at the same age but at different times. Births in the last five years are excluded in the older cohort of women, and the resulting births refer to births to these women when they were the same age as that of the younger women at the time of survey. Parity progression ratios are then calculated for both sets of women. For the younger age groups, mostly, the parity progression ratios could still be relatively small because some women will only be starting the childbearing process. It would not be accurate to use these small parity progression ratios to extrapolate the PPPRs. Moultrie and Timæus (2002) suggest ignoring data points for which the parity progression ratios are less than 0.65 (i.e. less than 65 per cent of

women have progressed to the next birth), and to treat with caution those for which the actual parity progression ratios lie between 0.65 and 0.8. The data points used are those for which the actual parity progression ratios are greater than 0.8.

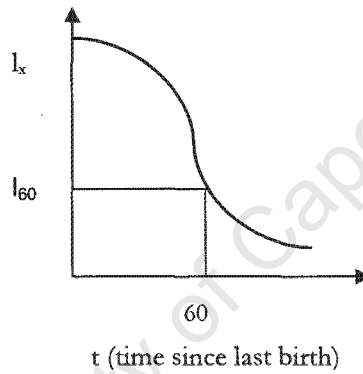
The ratio of the observed parity progression ratios of the women whose experience is untruncated to that of the women with truncated births in the adjacent cohorts is known as the index of relative change. This index shows the comparative change in fertility between the two groups of women. An index which is less than unity shows that the fertility of the older cohort of women was lower than that of the younger women. Indices of relative change greater than one show that fertility has decreased over the last five years. The indices are then used to adjust the parity progression ratios of the younger women by a multiplicative process in which the base parity progression ratio is that for women aged 45–49. The adjusted ratios are estimates of the completed parity progression ratios, or PPPRs, i.e. the ratios that the women are expected to have at the end of their reproductive life spans.

The PPPRs were created for all women in the dataset. They were not generated for women by contraceptive use and marital status because contraceptive use and marital status are time-varying variables, which also vary by parity. As such, the women of a particular contraceptive use or marital status at parity  $(i+1)$  at time  $(t+1)$  might not necessarily be the same women at parity  $n$  at time  $t$ , because at parity  $n$  they might have been of a different status. PPPRs are therefore not meaningful when derived according to ever use of contraception or marital status.

The assumption of the method is that changes in marriage and contraceptive use patterns are small in the five years over which the births are excluded, such that the experience of older women can be assumed to be fairly homogeneous to that of women five years younger. This is why truncation is done using a five year period, which is considered to be small enough for no significant changes to occur. Indeed section 3.2.2 highlights that patterns of marriage did not change much over time, while section 3.2.3 shows that from the 1990s, contraceptive use patterns for women in the middle age groups changed only marginally over time.

### 3.3.3 Truncated pairwise measures of parity progression

The method for PPPRs, even after adjusting for selectivity, does not eradicate the truncation bias because there is still no knowledge of women's experience after they are censored by the survey. Another common measure of parity progression is  $B_t$  – the proportion of women at a particular parity who go on to have a subsequent child within  $t$  months of the last birth. Brass and Juárez (1983) suggested using life table analysis to generate  $B_t$ s, based on techniques similar to those suggested by Hobcraft and Rodríguez (1992). This entails deriving a failure function, which shows the proportion of women having a birth within  $t$  months of the last one. A standard life table with a radix  $l_0$  is used, and using a cumulative failure function, the failure function for women who fail at time 60, say, can be obtained as shown below.



The  $B_t$  is then calculated as

$$B_t = 1 - l_x \equiv 1 - {}_n p_x = {}_n q_x$$

where  $t$  is the time since last birth,  $x$  is the age of the women, and  $n$  is the time interval under investigation. The  $B_t$  is the failure function at time  $t$ . The failure function is derived as

$${}_n q_x = \frac{{}_n E_x}{N_x^*}$$

where  ${}_n E_x$  is the number of subsequent births in the time interval  $n$ , and  $N_x^*$  is the exposed to risk, such that if  ${}_n C_x$  is the number of censored cases in time interval  $n$ , then

$$N_x^* = N_x - \frac{1}{2} {}_n C_x, \text{ and}$$

$$N_{x+n} = N_x - {}_n C_x - {}_n E_x$$

Censored cases result from death or outmigration before the end of the survey, of women involved in it. The measure of exposure covers the time between successive births, or the time from birth until censoring occurs at the time of the interview.

$B_{t,s}$ , however, suffer the same inadequacies in catering for the selection bias as do parity progression ratios because they do not adjust for differences in childbearing tempo. A pairwise comparison procedure similar to that used in calculating PPPRs can be used to produce a measure which is free of both selectivity and truncation biases – projected  $B_{t,s}$ .  $B_{t,s}$  are obtained for truncated data, where births in the past five years have been excluded, and untruncated data. Indices of relative change are then computed as ratios of untruncated to truncated  $B_{t,s}$  for corresponding age and parity. These are used to project the  $B_{t,s}$  of the younger women through an iterative procedure which starts at the  $B_{t,s}$  for women aged 45-49 and goes backwards in age. The resulting values are the projected  $B_{t,s}$ . Projected  $B_{t,s}$  show the proportion of women who are expected to go on to have the next child in  $t$  months of the previous child by the time they reach the end of childbearing. In truncating by  $t$  months ( $t= 60, 72, 84$ ), the assumption is that if a woman has not had a child in  $t$  months after the previous one, then it is likely that she will not ever have one. As such it is important to use values of  $t$  such that the period is neither too long nor too short.

Similarly to PPPRs,  $B_{t,s}$  were generated first for all women; and then for the women after they had been split by contraceptive use and marital statuses, respectively.

### 3.3.4 Median birth intervals

Aoun (1989) extends Brass and Juárez's work on parity progression to birth interval analysis. Aoun's approach uses the life table analysis described above to generate projected median birth intervals. In order to obtain the median, there will normally be a need to use interpolation between successive values of the failure function centred around 50 per cent. The method for projected median birth intervals is similar to that for calculating PPPRs and  $B_{t,s}$ . First indices of relative change are generated as the ratios of untruncated to truncated median birth intervals. Using an iterative method which starts at the median birth intervals of women aged 45-49, the indices are used to adjust the untruncated median birth intervals. Median birth intervals fail to cater for selection bias because they are still affected by the differences in the rate of childbearing of women,

hence the need for projection. The adjusted sets of values are the projected median birth intervals, and they estimate the median time between births for women by the end of their reproductive lifespan. This procedure is done for a large number of life tables ( $\pm 140$ ), which cover the history of seven cohorts of women who may have reached up to ten or more parities, and for the truncated and untruncated data.

In this study, the process of projecting median birth intervals was done first for the aggregate groups of women in the surveys, and then for women based on their marital status and contraceptive use status. There are fewer life tables when the women are fragmented by the proximate determinants than when the whole samples are considered.

### **3.3.5 Time location of median birth intervals**

The projected median birth intervals obtained in section 3.3.4 are not located in time. Time referencing is useful because it allows time trends in birth intervals to be analysed. One method for locating the birth intervals is that suggested by Moultrie and Timæus (2002). In this method, the time to which the median birth intervals refer is the average time of birth of children to women of a particular age who are at a particular parity. This is done by tabulating the average date of birth of the children by parity and age of mother at the time of survey. Children of a given parity borne to women of a given age are viewed as having been born at the same time, given by the average time of birth. The assumption that this method makes is that the mean date of birth is a fair average time when these took place.

### **3.3.6 Statistical Modelling**

A more mathematical way of investigating the relative effects of contraceptive use and marital status as proximate determinants of birth intervals is through fitting a regression model. The regression was fitted to the ZDHS, aimed at finding the rate of closing a birth interval within given time intervals ranging from zero to 108 months; and defined from the time at which the last birth occurred. The length of these intervals was chosen such that they would be neither too small to not contain the event of interest, nor to long to mask any emergent patterns of occurrence.

The progression from one birth to the next was modelled as a counting process, namely a Poisson process, by considering the number of progressions in a given interval of time, i.e.

$$X_t \sim \text{Poisson}(\lambda t)$$

where  $t$  represents the length of time intervals created at 9, 18, 24, 30, 36, 42, ..., 72, 84, 96, 108 months since last birth, and created to describe the hazard function; and  $\lambda$  represents births per unit time.

A Poisson process with rate  $\lambda$  assumes that only one birth to each mother can occur within a particular time interval, that consecutive births are independent of each other, and that these parity progressions occur at a constant rate  $\lambda$ . In order to restrict the events to one occurrence at within time  $[t, t+1]$ , twins are counted as a single birth. The waiting time between births in a Poisson process with rate  $\lambda$  follows an exponential distribution with parameter  $\lambda$ .

Assuming that the hazard is constant implies that the 'risk' of failing, or moving to the next parity, was assumed to be the same for all women and at all stages of childbearing. This feature is termed the 'memoryless property' of the exponential distribution. This assumption is strictly only reasonable for smaller values of  $t$ . In fact, one is modelling piecewise hazard models, and hence one needs to look at the hazard in fairly narrow time intervals.

In this model, failure was taken to imply moving from one parity to the next within a specified time. Censored observations were those in which the progression to the next birth, or failure, did not occur within that specified time. In other words, the birth intervals for these women were closed after the period of observation had ended. The dependent variable in the regression was therefore the occurrence of a failure. The predictors that were fitted into the model to try and explain any variation were parity, age of the mother, mother's contraceptive use status, marital status of mother, survey date, the length of the interval, as well as interaction terms between these variables. The best model for the regression was taken as the one for which the likelihood function was maximised, and the F-statistic was greatest.

The predicted output from the model were hazards at each of the time segments spanned by the interval  $[0, 120]$ . A hazard is the chance of a subsequent birth occurring within an infinitesimally small time period. A hazard function shows the instantaneous propensity to fail at each time  $t$ , conditional upon non-failure before time  $t$ . Having

derived the hazard functions for each category of women (ever used, never used, ever married, never married), these were converted into central failure rates by multiplying the hazard per time interval in each of the intervals by the length of the particular interval:

$$m_t = h_t \times t,$$

assuming the hazard rate is piecewise constant.

The central rates ( $m_t$ ) were then converted into q-type probabilities used in life table analysis using the formula

$$q_t = \frac{m_t}{1 + m_t(1 - a_t)}$$

where the  $a_t$  values represent the time spent, in months, before failing, between time  $[t, t+1]$ , by those who fail within this interval, and these were adopted from Moultrie (2002).

These probabilities were then used to derive a cumulative survival function, starting with a radix ( $l_0$ ) of one and applying the cumulative probability of failing by a certain time to determine survival up to that point.

Guilkey and Rindfuss (1987) suggest the computation of a summary measure,  $g_0^s$ , generated such that no assumptions would be made to cater for the women not progressing to the next parity, and for the small proportions progressing at the longest intervals.  $g_0^s$  is calculated as

$$g_0^s = \frac{[\sum_0^s L_x] - [l_{s+1}] \times (s + 1)}{l_0 - l_{s+1}}$$

where  $l_s$  and  $L_x$  are the usual life table quantities derived using the probabilities derived above,  $l_0$  is the radix, and  $s$  is the cut-off time for which hazard rates were determined (108). This quantity is analogous to Hajnal's SMAM (Hajnal 1953), which is given by

$$SMAM = \frac{[\sum_0^t S_x] - [S_t + S_{t+1}]/2 \times (t + 1)}{1 - [S_t + S_{t+1}]/2}$$

where  $S_x$  is the proportion of women who are single at age  $x$ . The SMAM is an estimate of the number of years lived single by those who marry by a certain age, normally age 50.  $g_0^s$  therefore shows the time at which women who close their birth intervals within the interval  $[0, 120]$  or within ten years of the previous birth are expected to close them. The focus is on ten years because within ten years, the assumption can be made that all the women who will ever progress to the next parity would have done so.  $g_0^s$ , like the SMAM

is a period measure, and it is sensitive to changes in the timing of childbearing. When there are rapid changes in birth intervals, it therefore does not capture accurately the time taken to close birth intervals.

This summary measure was separately computed for the ever used, never used, ever married, and never married categories of women.

The methods of this chapter generated PPPRs,  $B_s$ , and projected median birth intervals. The statistical model compared the relative impact of each of the determinants of birth intervals. The results of the application of these methods are presented in Chapter 4.

University of Cape Town

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## Chapter 4. Analysis and Interpretation of Results

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This chapter presents the results for parity progression, birth intervals, and the statistical modelling, obtained from implementing the methods described in Chapter 3. In all sections, results are first given for all women in the survey then by contraceptive use and marital status respectively. A discussion of the results follows at the end of the chapter.

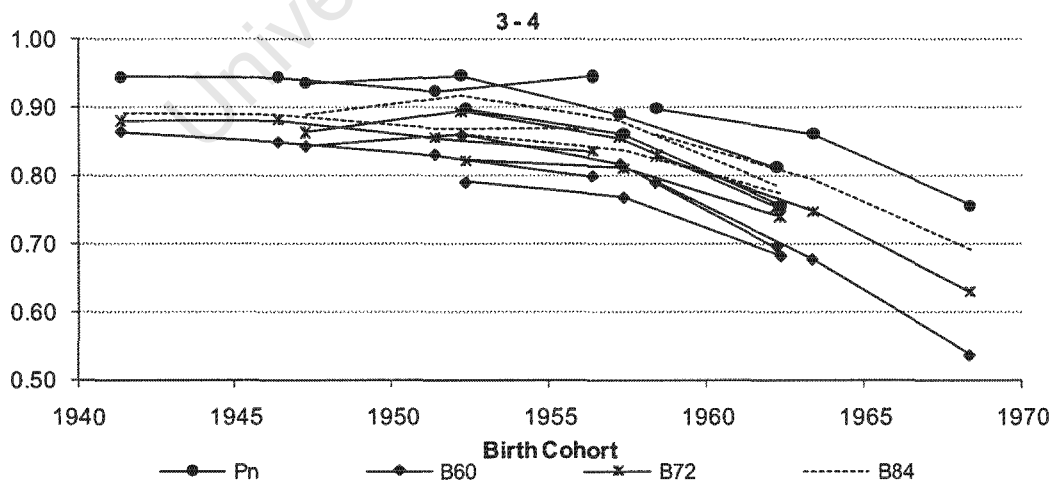
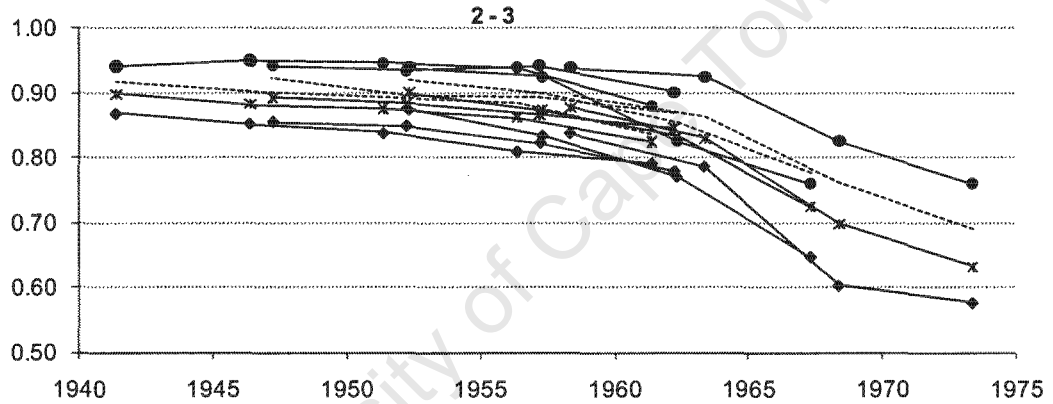
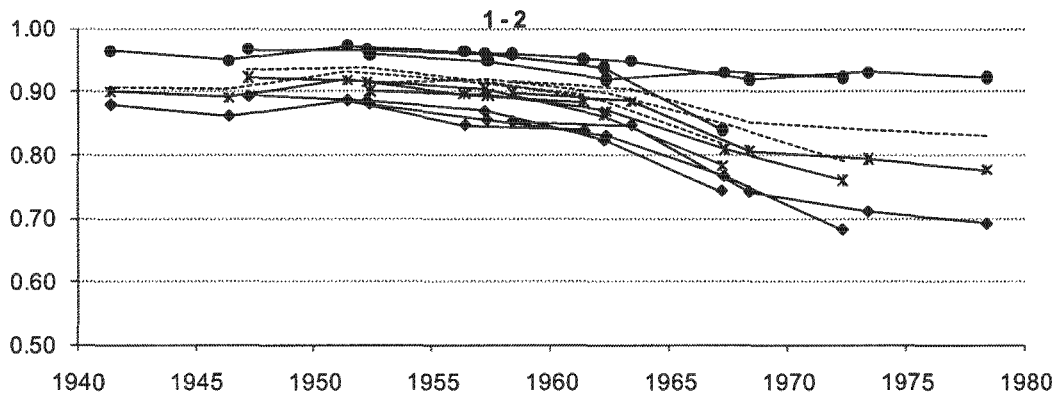
### 4.1 Parity Progression

Results for the measures of parity progression are presented in this section. These are the projected parity progression ratios (PPPRs) and the  $B_s$ s (B60s, B72s, and B84s). Only the first four parities are shown because fertility is fairly low in Zimbabwe, which means there are random fluctuations in these measures after the fourth parity caused by small sample sizes. The horizontal axes in the parity progression curves represent the date at which women at the different ages in the different surveys were born, on average. The assumption for each survey was that women in the five year age band  $[x, x+5]$  were on average  $x+2.5$  years old. The average date of birth to these women was computed by subtracting  $x+2.5$  from the average time of occurrence of each of the surveys for all values of  $x$ . The results therefore show parity progression by age for women at different parities, where age decreases from left to right.

#### 4.1.1 Aggregate Results

Figure 4.1 shows the results for parity progression and  $B_s$  for all women based on all four surveys, and for the first four birth orders. For the first two parities, there is evidence of falling fertility for the cohort born between 1960 and 1965, indicated by the downward sloping nature of the PPPR and the  $B_s$  curves. For the third to fourth parities, fertility decline commenced with the cohort of 1955-60. The slope becomes steeper with time, implying an increase in the decline in fertility for the younger cohorts of women. Progressively smaller parity progression measures with parity, accompanied by steeper slopes imply that fewer and fewer women are having large numbers of children. Prior to that, parity progression was fairly constant.

Figure 4.1 PPPRs,  $B_{60}$ s,  $B_{72}$ s and  $B_{84}$ s by birth cohort for all women in the 1988, 1994, 1999, and 2005-06 surveys



A measure of the quality of data used is the relationship between the measures of parity progression. The limiting value of  $B_t$  for a given parity  $n$  as  $t$  increases is the  $P_n$ , i.e.

$$\lim_{t \rightarrow \infty} B_t = P_n$$

where  $P_n$  is the proportion of women at parity  $n$  who are expected to progress to parity  $(n+1)$  by the end of their reproductive lifespan (PPPR).

As expected, Figure 4.1 generally shows that

$$P_n > B_{84} > B_{72} > B_{60}$$

for all parities, where  $P_n$  represents PPPRs. This gives confidence that the data are of good quality, because the longer is the period of truncation used, the greater are the numbers of women who are expected to progress to the next parity. Another factor which works to increase the confidence in the data and the methods of estimation is that for the different surveys, the PPPRs and  $B_s$ s for the same cohort of women are very similar. Generally, these estimates lie sufficiently close to each other to be considered as similar.

The following sections look at parity progression by contraceptive use and marital status respectively.

#### 4.1.2 Contraceptive Use

Parity progression was investigated separately for women who had ever used contraception prior to a birth against those who had not. Figure 4.2 shows the for women who had ever used in the 1988, 1994, 1999, and 2005-06 surveys, whilst Figure 4.3 shows the corresponding results for women who had never used. As discussed in section 3.3.2, PPPRs are not presented by contraceptive use. Evidence of good data quality for women who ever used contraception is shown by the general pattern of the parity progression measures, where  $B_z > B_x$  for  $z > x$ . For women of the same birth cohort, the  $B_s$ s generated from the four surveys are quite similar.

For the first two parities of women who had ever used, all of the measures seem to be declining, starting from the 1955 cohort, possibly indicating a fertility decline starting with this cohort of women. For the third parity, the decline started with the cohort born between 1950 and 1955. The rate of decline increased the higher the parity, implying that women were having fewer children.

Figure 4.2  $B_{60}$ s,  $B_{72}$ s, and  $B_{84}$ s by birth cohort for women who had ever used contraception in the four surveys

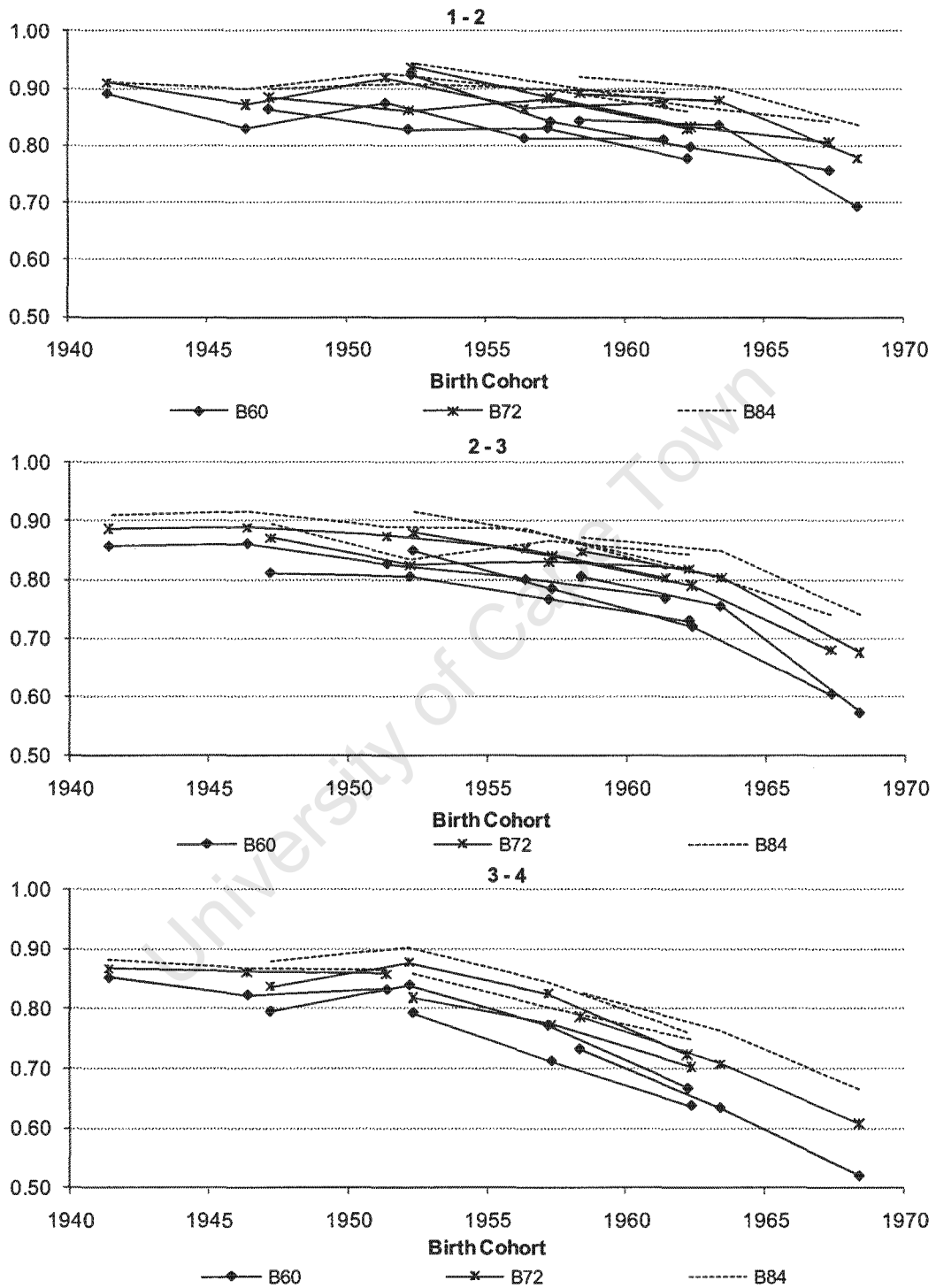
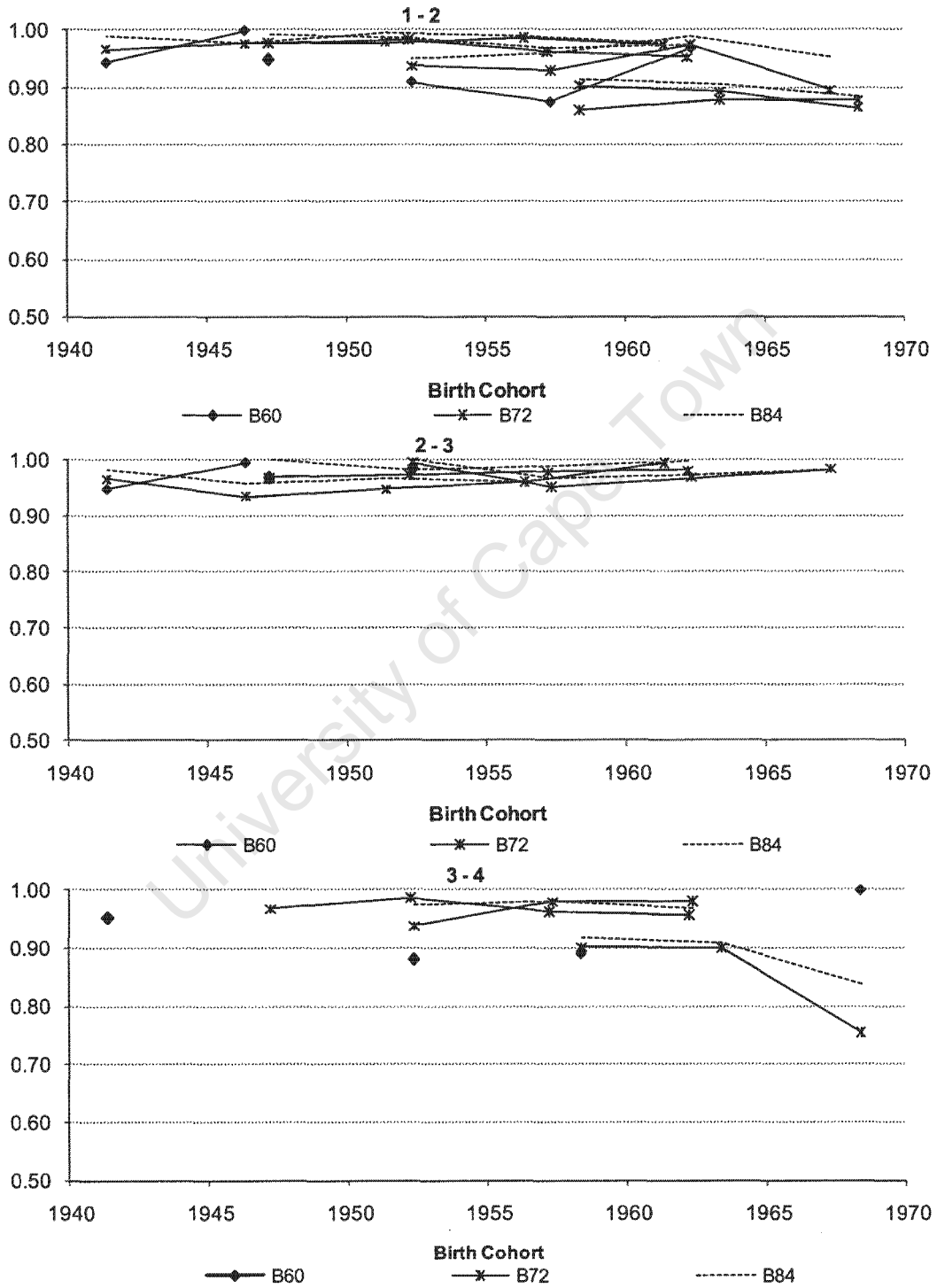


Figure 4.3  $B_{60}$ s,  $B_{72}$ s, and  $B_{84}$ s by birth cohort for women who had never used contraception in the four surveys



Doubts are cast about the quality of data for women who have never used contraception because the pattern of  $B_s$  is erratic in terms of size relative to each other; although the  $B_s$  of women born around the same time from different surveys are very close to each other. In analysing the measures for women who had never used, there did not seem to be much evidence of falling parity progression beyond the first parity.

Women who had never used generally had greater  $B_s$  than those who had ever used. This was true for all values of  $t$ . Depending on the failure rate of the birth control method, by using contraception, women prevent conception, resulting in smaller proportions progressing to the next parity.

### 4.1.3 Marital Status

The  $B_s$  based on the marital status of women are shown in Figure 4.4 and Figure 4.5 respectively. For the first two parities for ever married women, parity progression started decreasing with the cohort born between 1960 and 1965. Prior to that, it was fairly unchanging. The decrease was greater for women at the second parity than those at the first. Fertility decline thus probably started with the women of this birth cohort. For women at the third parity, parity progression, and hence possibly fertility decline would have started with the birth cohort of 1950-1955. The decline became steeper for younger women, i.e. those born after 1955.

Many of the data points in Figure 4.5 were lost to the analysis as a direct consequence of random fluctuations resulting from small sample sizes brought on by the near-universality of marriage in Zimbabwe (as shown in Table 3.3). Beyond the second parity, the number of data points was too small to warrant inclusion in the analysis. However, for the remaining data points for ever-married and never-married women, the  $B_s$  for women of the same age in different surveys are very similar, showing that the data quality is good.

Because of the sparsity of data points, it is difficult to decipher a coherent pattern in the  $B_s$  of never-married women in Zimbabwe.

Figure 4.4  $B_{60}$ s,  $B_{72}$ s, and  $B_{84}$ s by birth cohort for women who had ever married in the four surveys

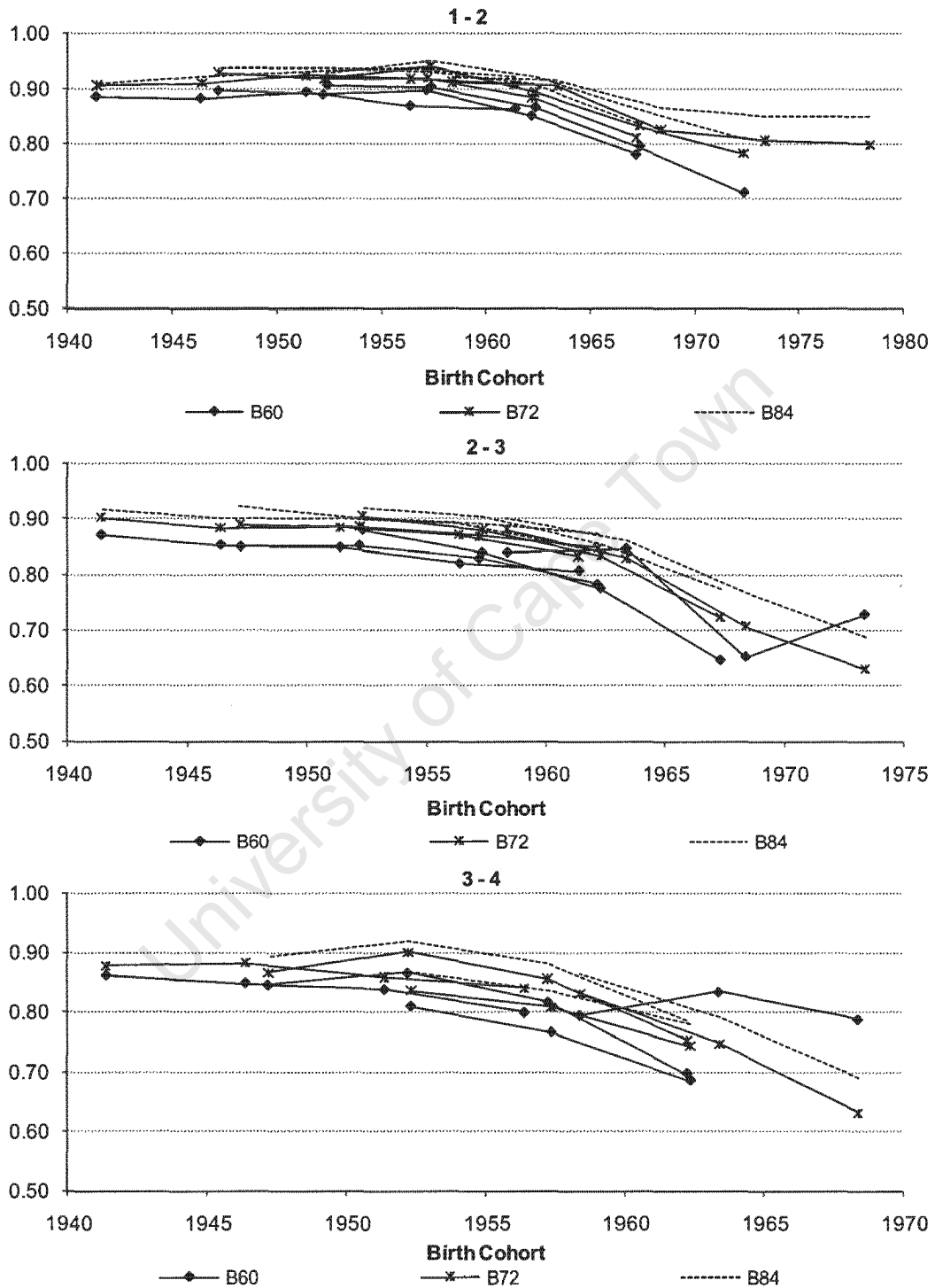
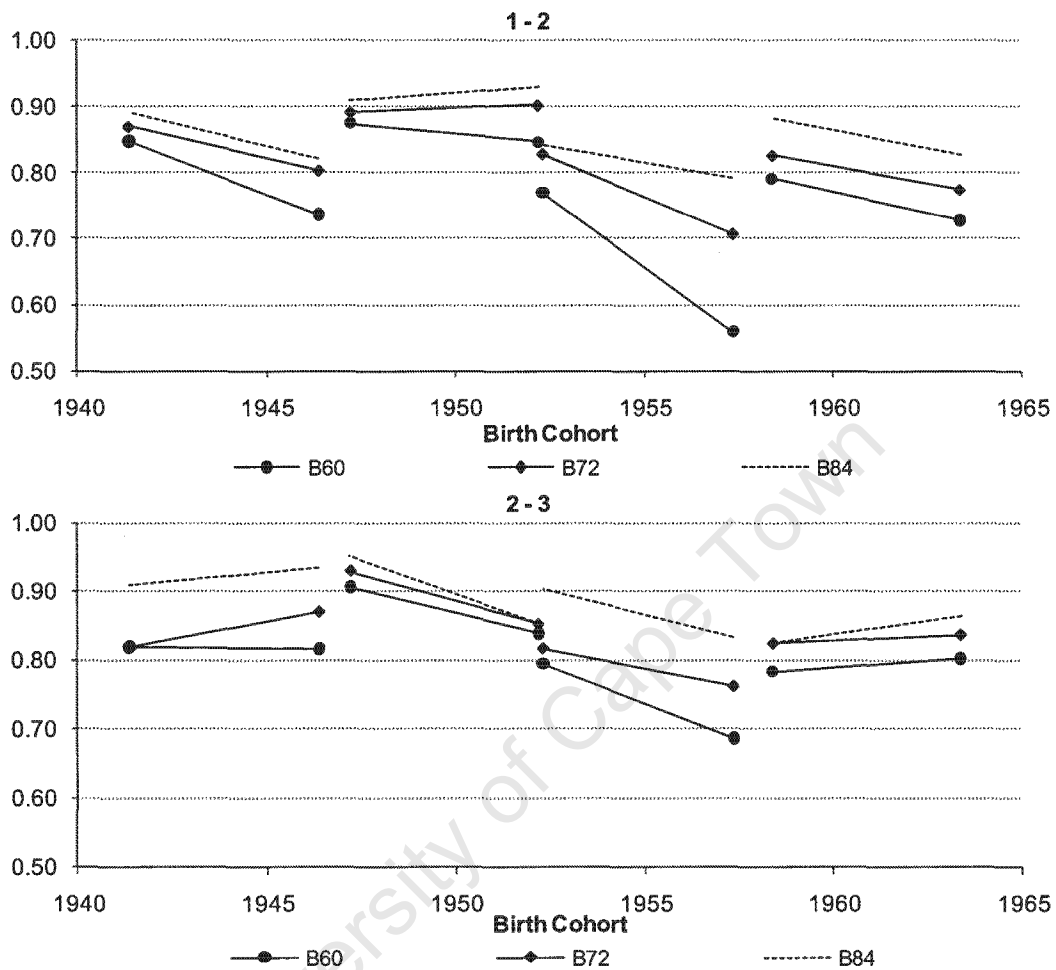


Figure 4.5  $B_{60}s$ ,  $B_{72}s$ , and  $B_{84}s$  by birth cohort for women who had never married in the four surveys



## 4.2 Projected Median Birth Intervals

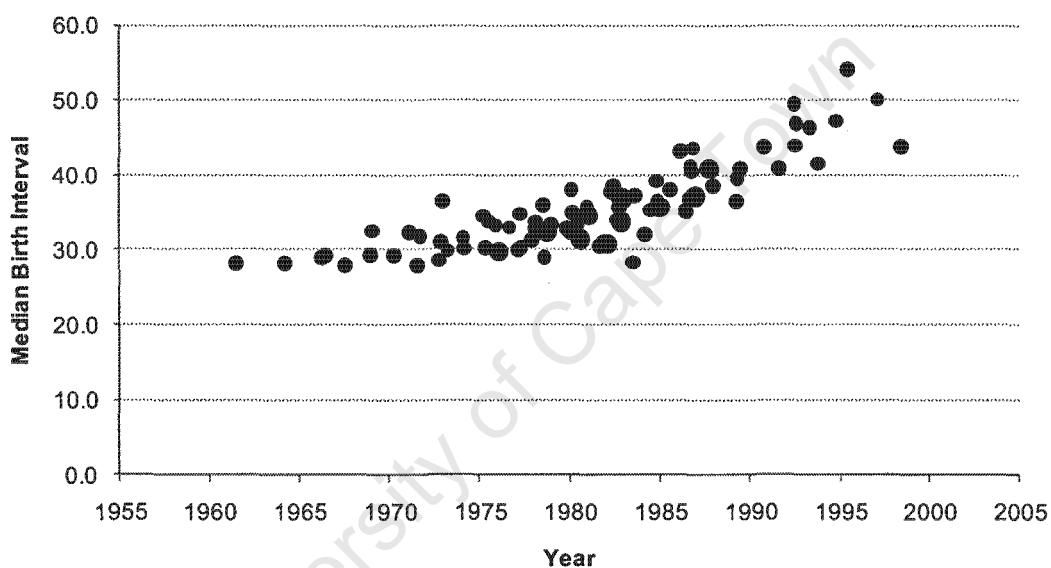
The results of the method for projected median birth intervals suggested by Aoun (1989) are presented in this section. First, results for all women are given, followed by results by contraceptive use and marital status, respectively. In all of the presentations, the projected median birth intervals have been plotted on one curve, irrespective of the age of the women at the time of survey, or the parity they are at. The horizontal axis represents the secular time to which the projected median birth interval apply, where the right hand side represents more recent dates. The results for women who have ever used contraception prior to a birth do not necessarily apply to the same time period as those of women who have never used, because the average age at birth of children borne to women in the two

categories may not coincide. The time trends are therefore slightly shifted to the left or right of each other. The same applies to the results by marital status.

#### 4.2.1 Aggregate Results

The time trend of projected median birth intervals for all women aged 15-49 in the surveys are displayed in Figure 4.6.

**Figure 4.6 Projected median birth intervals in months for all women - 1988, 1994, 1999, and 2005-06**

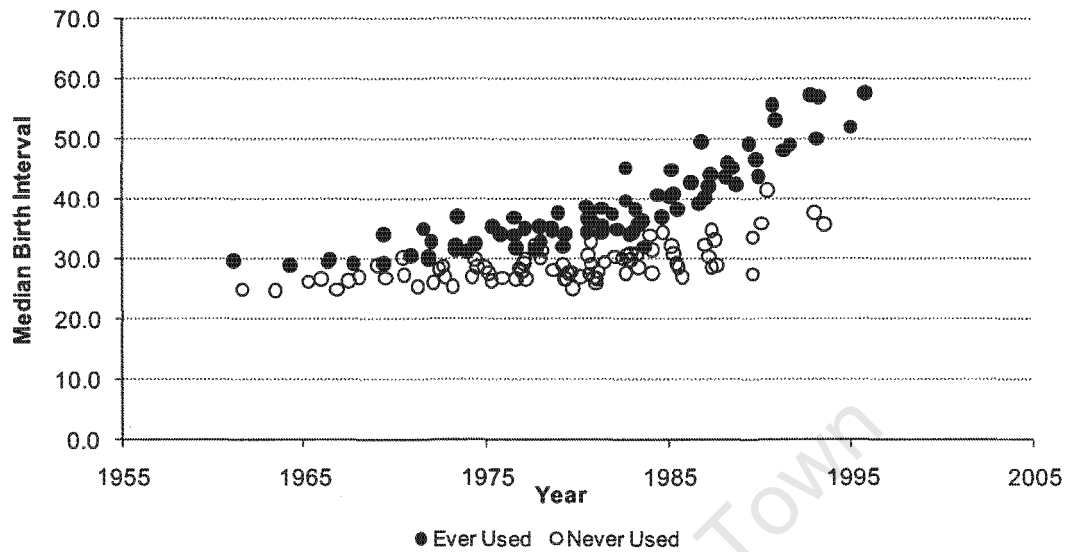


Projected median birth intervals have increased with time, as shown by the upward drift over the years. Birth spacing nearly doubled in the four decades spanning from the 1960s to 2000. However, at any point in time, the lengths of the median birth intervals were similar, irrespective of the age of the woman, her parity and the survey. This is shown by the clustering of dots at a particular point in time. This shows that birth interval length has only been dependent upon time.

#### 4.2.2 Contraceptive Use

Figure 4.7 shows projected median birth intervals for women depending on whether they had ever used contraception prior to a birth, or not.

**Figure 4.7 Projected median birth intervals in months, by contraceptive use - 1988, 1994, 1999, and 2005-06**



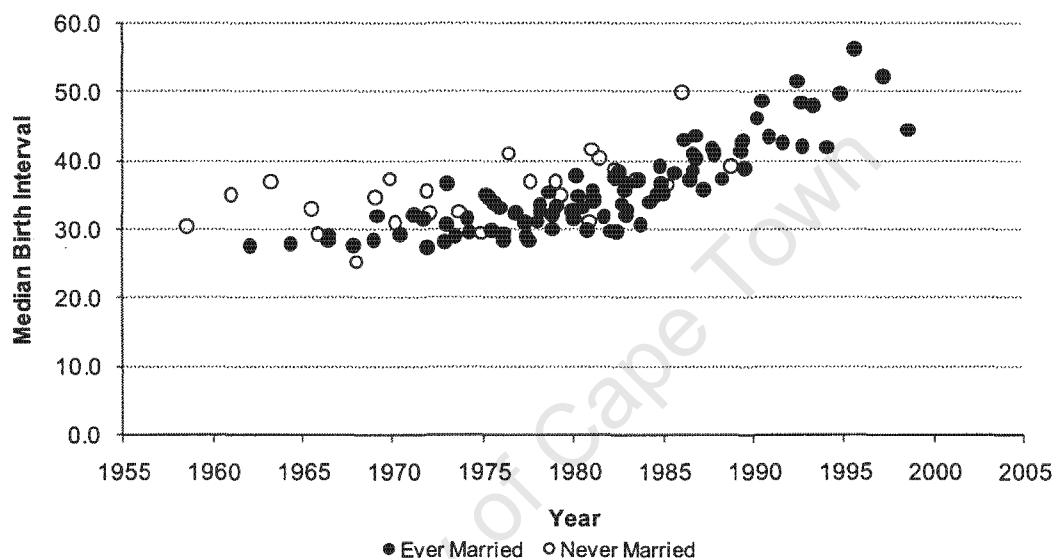
In all four surveys, women who had practiced birth control before the subsequent birth had longer inter-birth spacing than those who did not. This occurred irrespective of age and parity. Projected median birth intervals for women who had never used contraception have been relatively stable over time, ranging mostly between 25 and 35 months for women at all ages and parities. On the other hand, the intervals between consecutive births for women who have ever used contraception increased steadily with time, and more so after 1985. This coincides with the launch of the ZNFPC. An increase in birth intervals, albeit smaller, is also notable between 1970 and 1980 - the period of the FPAR. The national family planning program clearly had an impact on the way women are shaping their families. Again, similar median birth intervals occurred at the same point in time to women of different cohorts and at different parities, only now being dependent on contraceptive use status.

### 4.2.3 Marital Status

Results of the investigation of differences in projected median birth intervals for women of differing marital status prior to the birth of a child are shown in Figure 4.8. The results shown in Figure 4.8 show more data points for ever married women than for never

married women. This is an unfortunate consequence of data loss because data points in which the proportions of women progressing from parity (n) to parity (n+1) (parity progression ratios) are less than 65 per cent were excluded from the analysis (see section 3.3.2).

**Figure 4.8 Projected median birth intervals in months, by marital status - 1988, 1994, 1999, and 2005-06**

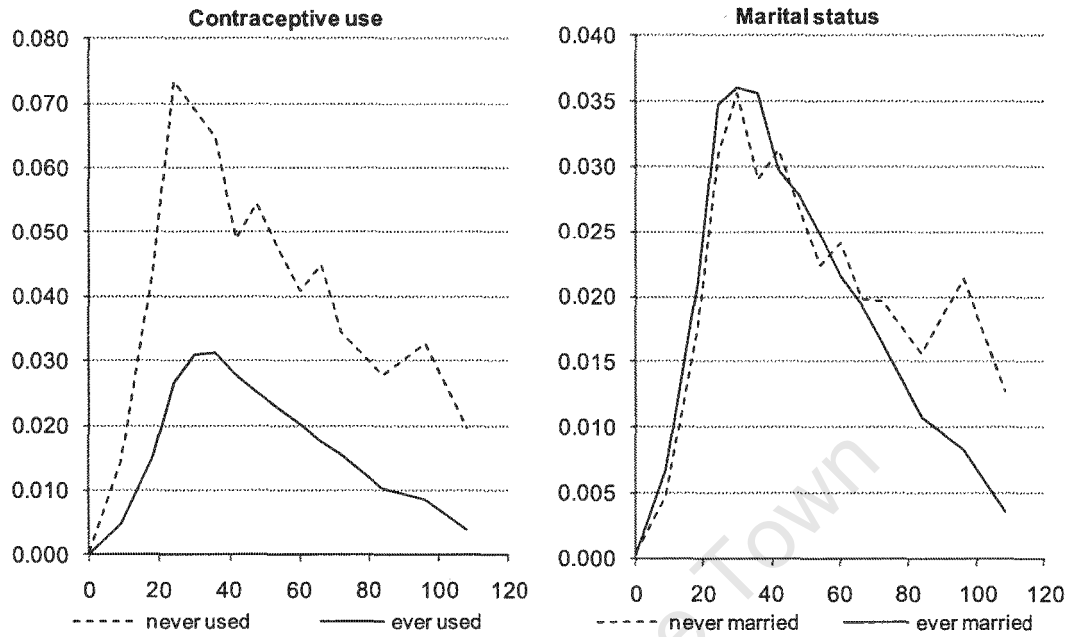


Based on marital status, projected median birth intervals have increased over time for both women who have never married and those who have ever married by the time of the subsequent birth. As is the case with the aggregate results and the results by contraceptive use, the median birth intervals are similar for the different surveys, parities and age groups at all times. The birth intervals for women who have never married are greater than those of women who had ever married. The distinction between the two sets of women is, however, not very pronounced. This implies that marital status is not a strong determinant of changes in birth spacing for Zimbabwean women.

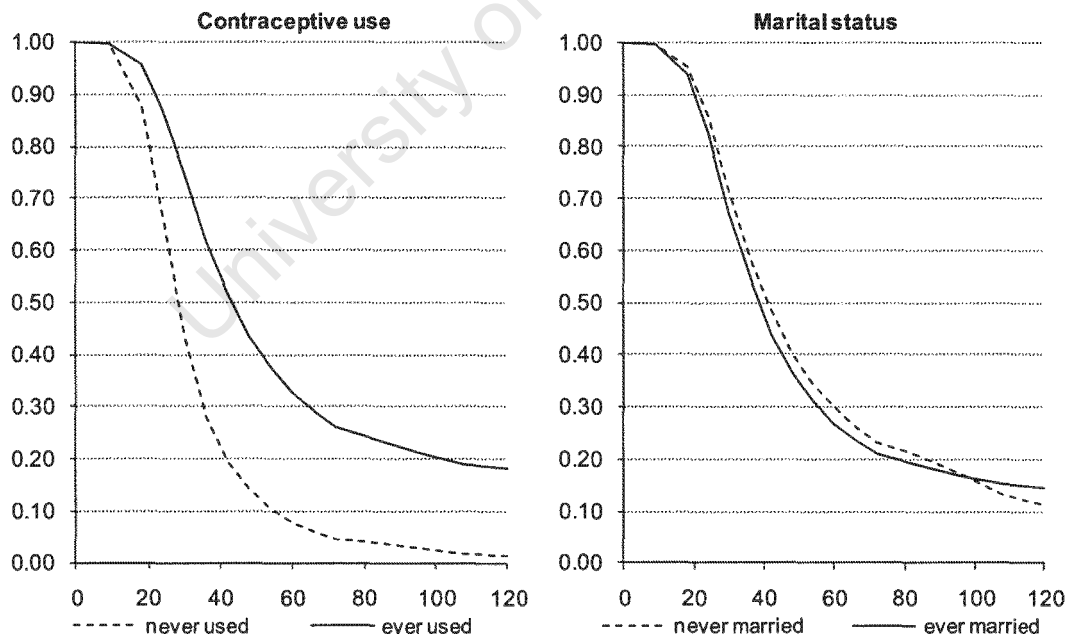
### 4.3 Statistical Modelling

The hazard functions and the cumulative survival functions for the four categories of women are presented in Figure 4.9 and Figure 4.10, respectively.

**Figure 4.9 Hazard function by contraceptive use and marital status by time since previous birth**



**Figure 4.10 Cumulative survival function by contraceptive use and marital status and time since previous birth**



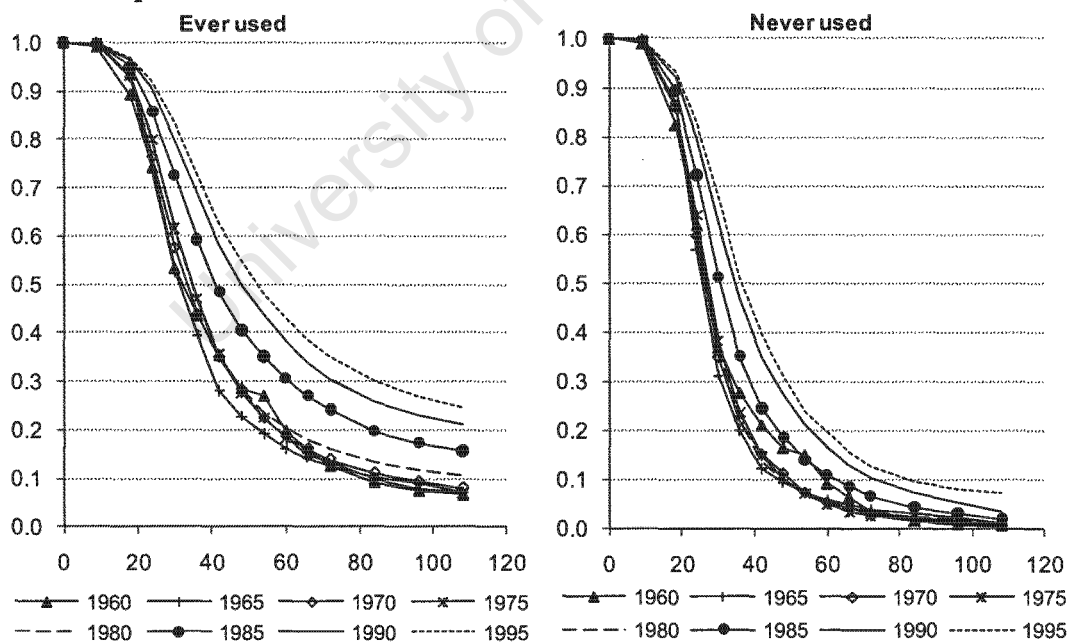
The horizontal axes in all four curves represent the time, in months, since the last birth, in which periods the chance of closing the birth intervals were investigated.

At all but the long durations, the hazard functions (and consequently survival functions) for ever married and never married women are very similar. The hazard for women who had ever used and never used a contraceptive method are different. Both modes are between 20 and 40 months from the previous birth, but the level of parity progression is greater for women who have never used contraception, as shown by a more rapidly declining survival function.

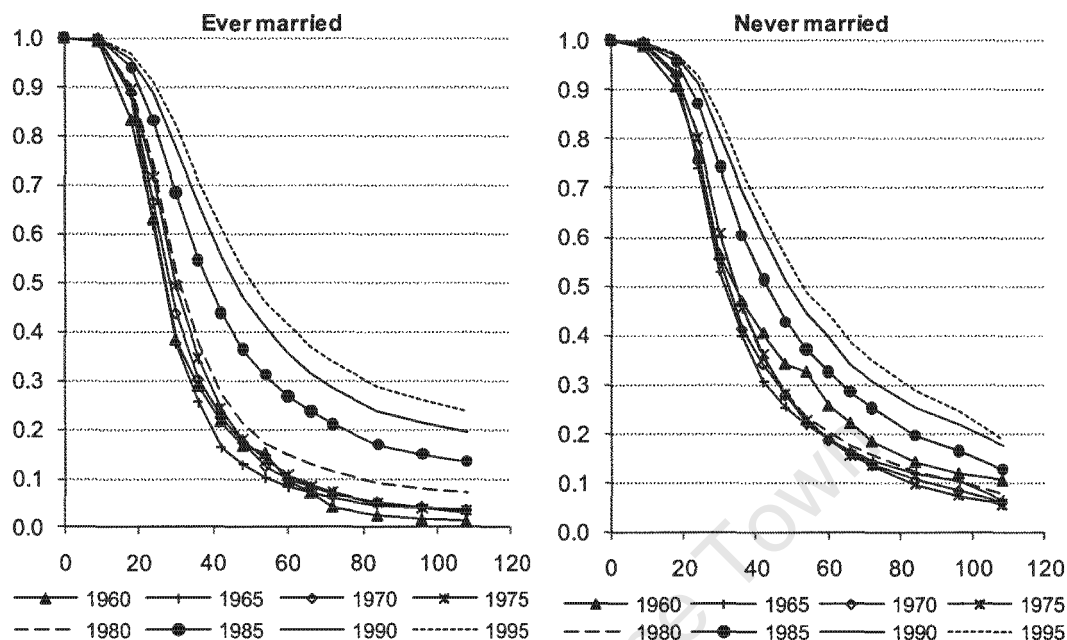
Within the first 20 months, all four survival functions remain relatively unchanged, which indicates that very small proportions of women went on to have a subsequent child within 20 months of the last one. After peaking, the hazard functions for never married women and for women who have never used contraception fall in a zigzag pattern, possibly due to heaping in some data.

Figures 14.11 and 14.12 show the cumulative survival function by time since last birth for women of different birth cohorts. This adds a time component to the hazards presented above.

**Figure 4.11 Cumulative survival function by contraceptive use, birth cohort and time since previous birth**



**Figure 4.12 Cumulative survival function by marital status, birth cohort and time since previous birth**



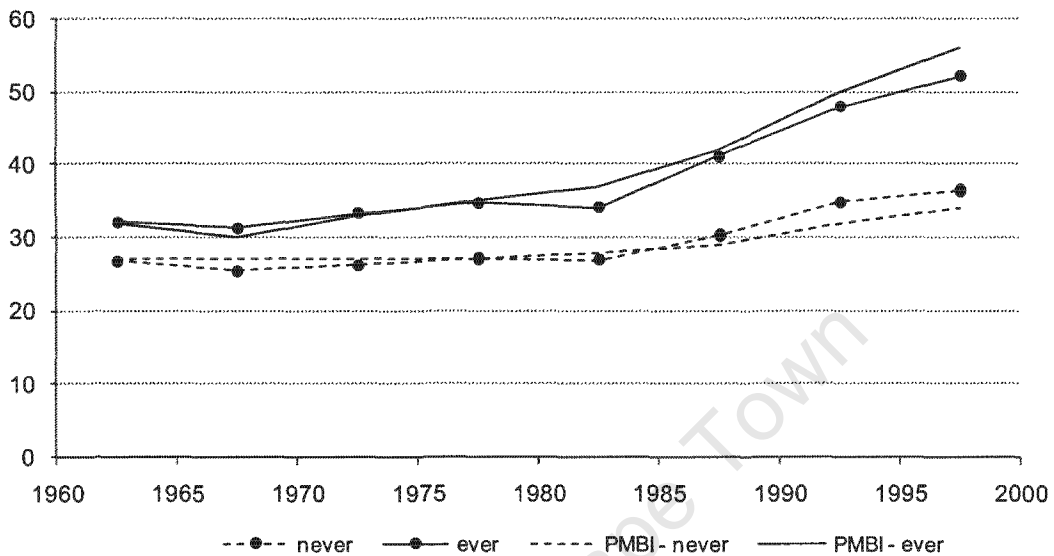
For women who have never used contraception and at all durations, survival is lower for older women i.e. for the birth cohort of 1995 than of 1960. This indicates that the propensity to progress to a subsequent birth has been decreasing with time for women who have never used contraception. For women born between 1960 and 1985, the survival functions are very similar, which indicates that there was not a great change in the hazard over this time.

The levels of the cumulative survival function for women who have ever used are greater the younger the women. Women born between 1960 and 1980 have similar survival functions, showing that parity progression over this period was fairly constant.

When women who have ever used contraception are compared with those who have never used, the survival function is greater at all durations and ages, for women who have ever used, implying that women who have ever used have a smaller propensity to close their birth intervals. The survival function falls faster for women who have never used contraception. While the hazard has increased over time at most durations for women who have never used a contraceptive method, it has decreased for women ever user.

Figure 14.13 shows a comparison of the median birth intervals implied by the model against the projected median birth intervals from Aoun's method.

**Figure 4.13 Median birth intervals by contraceptive use - projected and predicted**



Note: never and ever refer to the Poisson model results, and PMBI – ever and never refer to results from Aoun's method

The projected results in each time period were obtained by taking the average projected median birth intervals for women who had ever used (or never used) in that period. The timeline for the predicted values refers to the time at which children were born.

The projected and the predicted median births intervals are very similar at all time periods, although the median birth intervals from the Poisson model show a more parallel pattern than do the projected median birth intervals, which diverge in more recent periods. The smoothness is no doubt a function of the nature of the model fitted. The model therefore predicts that contraceptive use is a less dominant proximate determinant of birth intervals than does Aoun's method, because the predicted median birth intervals of those who have ever used and those who have never used contraception have more parallel trends.

The levels of the predicted values are slightly less, for both categories of women, than the projected values. A possible explanation for these differences lies in the assumptions implemented by the Poisson modelling process. For instance, assuming that

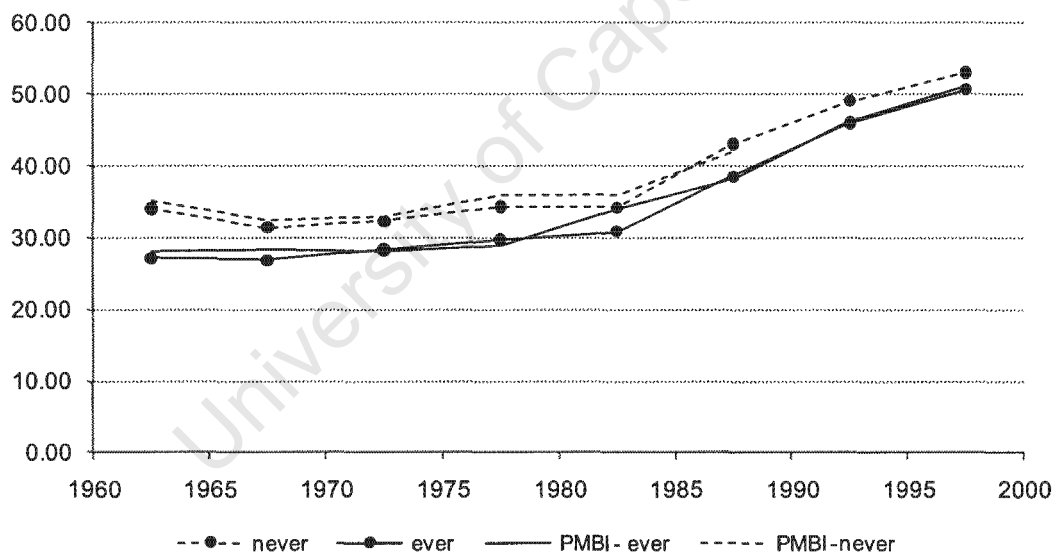
the parity progressions occur at a constant rate  $\lambda$  might mask fluctuations in the hazard in real life.

Never married women have cumulative survival functions which are greater for women born in more recent periods. For birth cohorts of 1960 to 1980, parity progression was fairly similar, such that the survival functions almost lie on top of each other.

Ever married women have a different pattern of parity progression in that the survival function falls much faster and more so for older cohorts of women. This means that women who have ever married are more likely than never married women to have another child at these durations.

Figure 14.14 shows a comparison of the median birth intervals implied by the Poisson model against the projected median birth intervals from the Aoun's method.

**Figure 4.14 Median birth intervals by marital status - projected and predicted**



Note: never and ever refer to the Poisson model results, and PMBI – ever and never refer to results from Aoun's method

The projected and predicted values of the birth intervals are similar to each other, although deviations occur around 1982. The model is a good fit to the data. The slight differences in level of the birth intervals are probably a result of approximating the projected intervals at each time. There are fewer data points in the later years for the

projected intervals as some of the points were for women who had not yet gone far with their childbearing.

When comparing between the women split by the two proximate determinants, the level of the propensity to close birth intervals is much greater for women who have never used contraception than it is for both ever married and never married women. This manifests in the lower proportions of women who had not had a subsequent birth within 120 months since the last birth.

Table 4.2 presents the estimates of  $g_0^s$ , the estimated time at which women closed their birth intervals, for those who closed them within 120 months of the previous birth. As expected, women who have ever used contraception closed their birth intervals at longer durations than those who have never used; and women who have never married had a subsequent birth at longer periods of the previous one than did ever married women. The difference between the estimated birth intervals in Table 4.2 by contraceptive use (24 per cent) are greater than those by marital status (2 per cent).

**Table 4.1 Estimates of the conditional expectation,  $g_0^s$ , by contraceptive use and marital status**

Proximate determinant	Status		Per cent difference
	Never	Ever	
Contraceptive use	31.3	38.8	24.0
Marital status	35.8	36.6	2.2

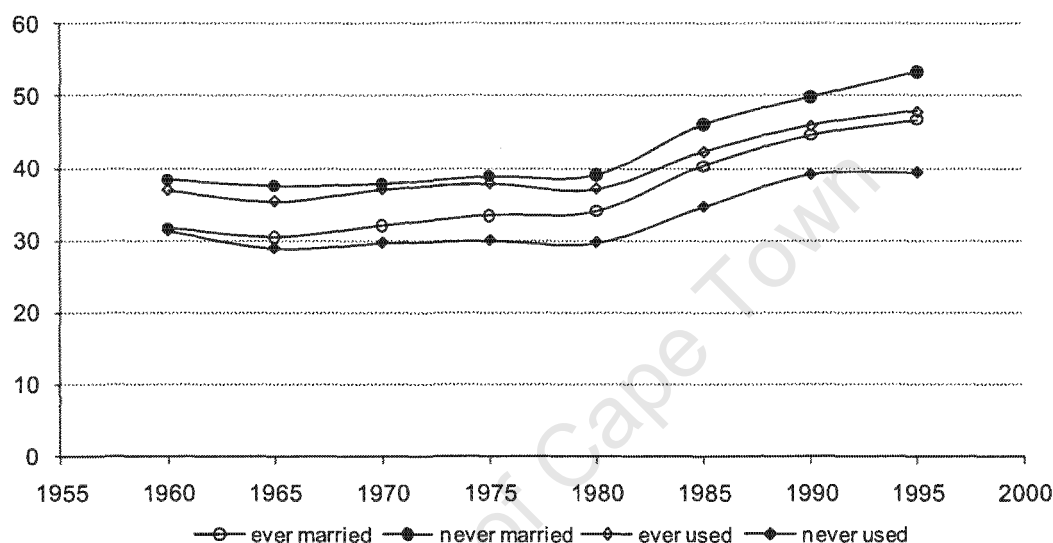
The time trends for  $g_0^s$  for women who have ever used, never used, ever married, and never married are shown in Figure 4.15.

With all birth cohorts, the conditional expectation is greater for women who have never married than ever married women; and for women who have ever used than never used. Up until the cohort of 1980, the conditional expectation was fairly constant, implying that the time in which women are expected to close their birth intervals did not change for those cohorts. Birth intervals were therefore fairly constant with time. For younger cohorts of women, the birth intervals increase with time.

All in all, greater differences in parity progression, and consequently birth interval length, as shown by the hazard and survival functions, exist more when women are fragmented according to ever use of contraception than by whether they had ever married prior to a particular birth. In the fitted model, marital status was not significant at the five

percent level of significance, as opposed to contraceptive use. Contraceptive use is a more dominant proximate determinant of birth intervals than is marriage. It is interesting to note that for cohorts born before 1980, they seemed to have similar birth intervals and parity progression. Changes in birth intervals started with the cohort of 1985.

**Figure 4.15 Time trends for estimates of the conditional expectation,  $g_0^*$ , by contraceptive use and marital status**



#### 4.4 Discussion

This section rounds off all the results presented in this chapter and puts forward hypotheses to explain the results, taking into account the background characteristics of the women, and the mechanisms in the methods that were presented in Chapter 3.

By looking at Figure 4.6, much of the change in the median birth intervals for all women started to occur after 1985. There were considerable increases in the proportion of women who used modern contraception, which occurred when the ZNFPC was launched in 1984. All through the period of investigation, the proportions of women who ever married and never married, respectively, did not fluctuate much (see Table 3.2). The changes in aggregate median birth intervals after 1985 can therefore be attributed mostly to the compositional changes in the proportions of women using contraception, supporting the findings by Moultrie (2008), that contraceptive use is the more dominant proximate determinant of birth interval length. The less notable increase in birth intervals

between 1970 and 1985 covers the period when women used Depo Provera, before its ban in 1982.

The similarity in the trends and levels of projected median birth intervals between ever married and never married women can be explained on the basis of the similarity in the sexual behavior of ever married and never married women. Although small proportions of very young women (those less than 19) engage in premarital sex in Zimbabwe, a sizable proportion have children outside of the marriage institution (see section 2.3.2). It could also be that there are high levels of infidelity between the married couples, which cause similarity in the sexual behavior of married and unmarried women.

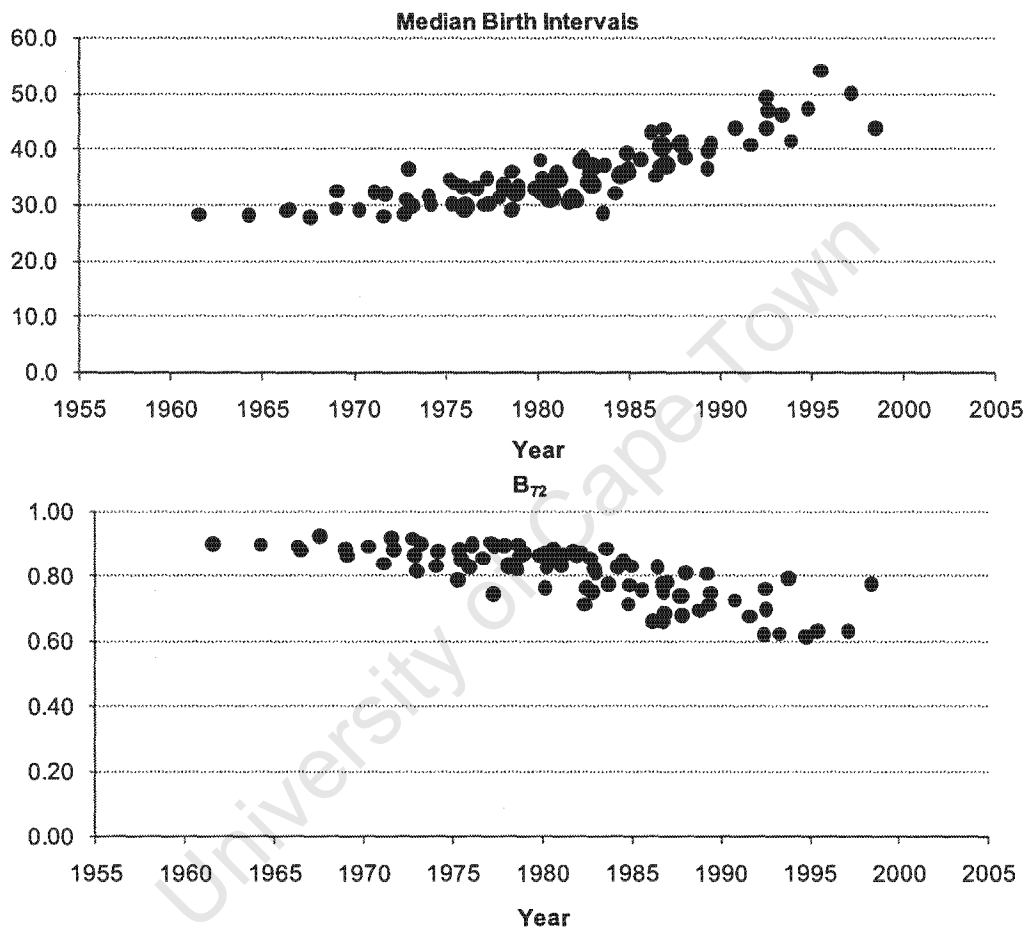
A question raised in this research is that of the coincidence of the timing and pace of fertility changes. Figure 4.16 shows the median birth intervals and the  $B_{72}$ s presented in previous sections when they are both plotted on the same time scale. The trends in the birth intervals and the trends in parity progression mirror each other when plotted on the same time line. Just as much of the increase in birth intervals commenced after 1980, so did most of the decline in  $B_{72}$ s. Prior to that, the  $B_{72}$ s were declining only marginally. Parity progression started to decline at a time when the spacing between births started to increase. This period also coincides with the time during which much of the rapid fertility decline started to occur in Zimbabwe. This suggests that the fertility decline in Zimbabwe was indeed accompanied, if not caused, by the lengthening of birth intervals. The lengthening of birth intervals occurred mostly due to an increase in birth control usage.

Section 2.1 looked at the fertility traits extracted from various studies done in Zimbabwe. Figure 4.16 shows that the decline in  $B_{72}$ s, and hence fertility, albeit slow, commenced around 1970, and was fairly rapid after 1980. The decline became less rapid in the late 1990s. The patterns of fertility observed in this study are fairly similar to those observed in historical studies in Zimbabwe. It is interesting to note, in the  $B_{72}$ s plot, that unchanging parity progression from around 1992 to 1997 coincides with the stall in fertility in the 1990s that was depicted in the curve fitted to TFRs in section 2.1. This implies that fertility stalled in the 1990s.

From the birth cohort of 1945, parity progression was lower for latter cohorts of women. This shows that fertility was declining by age. Over time, the decline in parity progression also occurred to women at all parities. Fertility thus declined in Zimbabwe

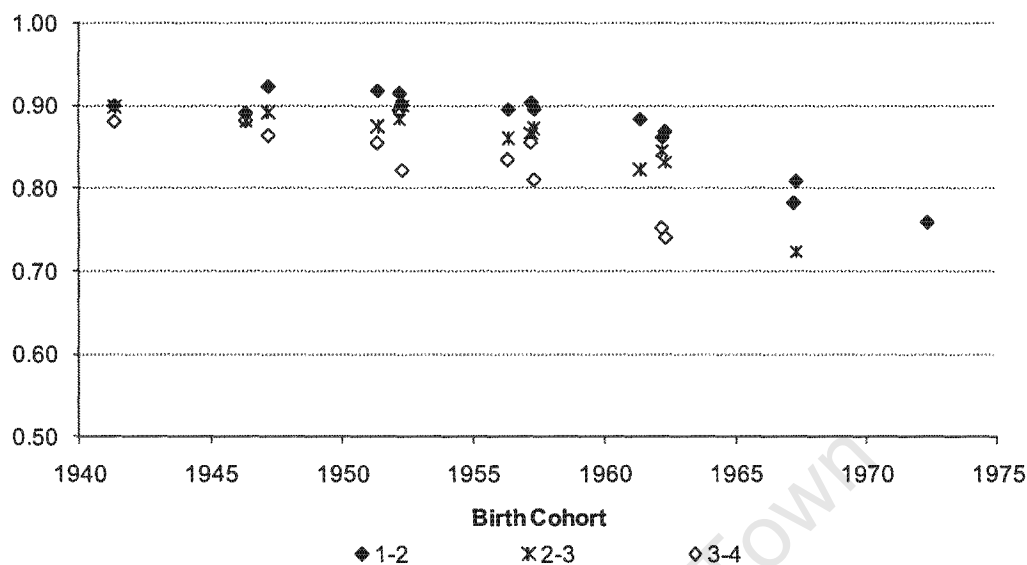
for women at all ages and parities. The decline was, however, greater for younger women and women at higher parities.

**Figure 4.16 Projected median birth intervals and  $B_{72}$ s plotted in secular time for women in all four surveys**



The nature of the changes in fertility and birth intervals is important to understand. There were suggestions by Caldwell, Caldwell and Orubuloye (1992) and Caldwell and Caldwell (2002) that the fertility decline in sub-Saharan Africa, once it commenced, would occur to women at all ages and parities. Figure 4.17 shows the  $B_{72}$ s for all women in the surveys, separated into the different birth cohorts and parities.

Figure 4.17  $B_{72}s$  by birth cohort and parity for women in the four surveys



Having determined that the fertility estimates are consistent with those from previous studies, the results from the Muhwava and Timæus (1996) and Cohen (1993) studies are revisited. One of the aims of this research was to complement the studies by Muhwava and Timæus (1996) and Cohen (1993). First, the estimates from Cohen's report are singled out here for comparison with the corresponding estimates from this research. Table 4.3 reproduces, for this study, a table derived in the Cohen (1993) study (Table 2.6). The censored parity progression ratios here were calculated by multiplying the values of  $B_{60}$  in consecutive parities, just as done by Cohen.

Table 4.2 Censored parity progression ratios by age group for the 1988 ZDHS

Women's Age	Censored Parity Progression Ratios ( $B_{60}s$ ) by Age Group			
	1-3	3-5	5-7	7-9
20-24	0.625			
25-29	0.664	0.506		
30-34	0.686	0.596	0.571	0.470
35-39	0.742	0.669	0.560	0.515
40-44	0.734	0.691	0.626	0.553
45-49	0.763	0.709	0.620	0.510

The results in both studies are fundamentally similar. They only differ mostly in the third decimal, a difference probably caused by rounding.

Table 4.4 shows the  $B_{60}$  results from this study extracted to correspond to the results obtained by Muhwava and Timæus. Again, the findings from both studies are fundamentally similar, and any differences in  $B_{60}$ s between the two studies do not exceed five per cent in magnitude.

**Table 4.3 The proportion of women progressing to the next birth within five years**

	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9
<b><math>B_{60}</math> Adjusted 1988 ZDHS</b>								
20-24	0.8054	0.7767	0.6802					
25-29	0.8384	0.7915	0.7428	0.6809				
30-34	0.8470	0.8095	0.7979	0.7471	0.7629	0.7489	0.6431	
35-39	0.8859	0.8380	0.8297	0.8061	0.7592	0.7380	0.6925	0.7434
40-44	0.8613	0.8524	0.8478	0.8147	0.7840	0.7984	0.7665	0.7219
45-49	0.8786	0.8679	0.8635	0.8215	0.8179	0.7580	0.7654	0.6665
<b><math>B_{60}</math> Adjusted 1994 ZDHS</b>								
20-24	0.7334	0.6101	0.7044					
25-29	0.7427	0.6785	0.6121	0.4872				
30-34	0.8232	0.7785	0.6952	0.6179	0.5864	0.5664	0.5320	
35-39	0.8694	0.8223	0.8169	0.7271	0.6337	0.6073	0.5090	0.5293
40-44	0.8860	0.8472	0.8594	0.8081	0.6966	0.6578	0.6124	0.5389
45-49	0.8935	0.8539	0.8434	0.7955	0.7921	0.7120	0.6891	0.5881

Because of the similarity of the estimates, this study can be deemed to complement or to be an extension to both Muhwava and Timæus' and Cohen's work on parity progression in Zimbabwe through exploring the other ZDHS data. Both of the earlier studies give summary estimates of fertility and parity progression measures in Zimbabwe, and sub-Saharan Africa respectively, which could be updated using the results of this study.

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## Chapter 5. Conclusions

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This study set out to determine the dynamics of birth interval length parallel to changes in the proximate determinants of the length of birth intervals. Patterns of contraceptive use and marital status were determined, as were patterns of birth interval length. The findings show that indeed behavioural change, in the form of changes in birth control and nuptiality patterns has an effect on family formation patterns. In particular, a regression analysis validated the central importance of contraception on birth interval length, where inter-birth spacing tended to be greater for women who used birth control between births. Never married women also exhibited longer inter-birth spacing than ever married women, although the difference was to a lesser extent than between women who have ever used contraception and those who have never used it.

These findings have significant implications for research in fertility and birth intervals. A link was shown to exist between the fertility decline and the changes in birth intervals, both in terms of the timing and the pace. On a national level, both transitions commenced around 1970, before gaining momentum around 1980. Birth intervals increased from about 28 months in the early 1960s to almost double that by the year 2000, with the majority of that increase starting around 1985. Fertility fell from about 5.4 to 3.8 children per woman between 1984 and 2005.

The fertility trends obtained from the analyses in this research suggest a stall in fertility in the mid-1990s, as did an analysis of the fertility estimates from various other authors (section 2.1). In recent fertility studies, the focus in fertility studies has been on investigating the reasons for stalls in fertility for countries where a decline has been occurring. If the stall occurred, it is likely to have been caused by the leveling off in the length of birth intervals brought about by reductions which occurred in the uptake of contraception by the 1990s. However, as Schoumaker (2008) argues, it is likely that the stall is spurious. He reviews that such apparent stalls are a result of many reasons such as problems in the quality of the data used, and the way in which stalls are defined, which classifies incorrectly cases as stalls.

Whilst the findings show that women who use contraception greatly lengthen the intervals between their births, they do not show why birth intervals for women who do not use contraception also increased, albeit marginally, over time. Rindfuss, Palmore and

Bumpass (1987) have suggested that there might be other proximate determinants fuelling changes in birth intervals, which have not yet been identified, or which have been excluded from the analysis because of measurement difficulties. Future studies need to find new ways in which to operationalise variables such as abortion and infecundability which are difficult to measure directly. Further studies need to be done to investigate if indeed any other proximate determinants that affect birth interval length and/or fertility can be identified. One such potential determinant is HIV/AIDS. The HIV/AIDS pandemic in Zimbabwe caused an increase in the numbers of women using condoms to protect themselves from infection. This increase in the numbers of women who use condoms would have resulted in longer birth intervals, since women will prevent conception. Second, HIV/AIDS reduces the fecundity of women, which would result in a direct decline in fertility. However, HIV/AIDS is not a particularly pertinent factor in this study because whilst the pandemic only peaked in the late 1990s, birth intervals for women who had ever used contraception were already lengthening from as early as 1980, as were those of women who had never used it prior to a birth. Furthermore, as Figure 4.7 showed, very few data points for median birth intervals after 1995, for both users and non-users of contraception.

A major limitation to careful study of marriage data was the small sample size when the data were split between the ever married and never married statuses. It would have been very useful to investigate the parity progression and birth interval patterns by factors such as province and ethnic group, but the fragmentation of data that would be required would result in even smaller sample sizes in each class. Hopefully, future research will use larger samples. The feasibility of this will depend on availability of financial resources, as well as on time constraints, and the availability and competence of the manpower to carry out surveys on large numbers of people.

The operationalisation of the ever use of contraception variables could, in the future, be improved in a number of ways. First, the DHS could adapt to more countries the contraceptive calendar module it has included in some countries. The module records, on a monthly basis and in the five years preceding the survey, when women started and stopped using contraception, if and when they got pregnant, and if the children are alive or dead. The other way would be adding more questions to the surveys, on the mother's status prior to the birth of each child. The DHS has already attempted this by adding

questions in their questionnaire on ever use at every parity for the DHS of 2005-06 in Zimbabwe, by asking women when they used a particular contraceptive method, the duration of use, and for how long after a particular birth. Of course the price to pay might be too high. Women, and in particular older women, tend to push births forwards or backwards in time because they cannot accurately recall the timing of these births. As Rindfuss, Palmore and Bumpass (1987) noted, it is doubtful that women would accurately recall whether they used birth control prior to a particular birth. The same applies to questions on their marital status, particularly if the women are asked about second and subsequent marriages.

In recent years, researchers have investigated the intentions behind the use of contraceptives among women. Classifying women in the broad classes of ever use and never use of contraception does not give account of the circumstances under which these methods were used. For instance, where women only ever used contraception in an experimental manner and not for periods not long enough to affect birth intervals, their inclusion in the class of ever users of contraception inflates proportions of women who have ever used. Hopefully this study inspires studies like that done by Timæus and Moultrie (2008) which challenge decades old theories that women use contraception for spacing births and family size limitation. Timæus and Moultrie (2008) achieved this by analysing the distributions of birth intervals, and used regression methods, similar to those used in this research, to investigate the differences in the hazard based on the motives behind women's use of contraception. Knowledge of the motives would go a long way in deciphering the nature of the fertility transition in Zimbabwe, and within and beyond the region of sub-Saharan Africa and in providing contraception suited to the needs of women.

Finally, a limitation of the data and methods used is that the latest estimates, of both fertility and birth intervals, which can be extracted from the data refer to a time roughly a decade ago, or to a time period which is five years before the latest survey. It would be interesting to see if future studies using data sources other than the ZDHS yield similar results. Even more significant would be having studies in the future to investigate if any such relationships between fertility and birth intervals, or between birth intervals and their proximate determinants as in Zimbabwe exist in other countries in and beyond the region. The point about using multiple DHSs was to see whether the evidence

corroborates itself, and the results have shown that it does. Even though we do not know about the changes which occurred in the last five years, the method has shown to be quite reliable.

University of Cape Town

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## References

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- Aoun, S. (1989). An Assessment of the Pairwise Comparison Procedure for Measuring Early Changes in Fertility in Syria, Tunisia and Yemen Arab Republic. Centre for Population Studies. London, London School of Hygiene and Tropical Medicine
- Barbieri, M., V. r. Hertrich and M. Grieve (2005). "Age Difference between Spouses and Contraceptive Practice in Sub-Saharan Africa." Population (English Edition, 2002-) **60**(5/6): 617-654.
- Bhrolcháin, M. N. (1992). "Period Paramount? A Critique of the Cohort Approach to Fertility." Population and Development Review **18**(4): 599-629.
- Blacker, J., C. Opiyo, M. Jasseh, et al. (2005). "Fertility in Kenya and Uganda: A Comparative Study of Trends and Determinants." Population Studies **59**(3): 355-373.
- Blanc, A. K. and S. O. Rutstein (1994). "The Demographic Transition in Southern Africa: Yet Another Look at the Evidence from Botswana and Zimbabwe." Demography **31**(2): 209-215.
- Bongaarts, J. (1978). "A Framework for Analyzing the Proximate Determinants of Fertility." Population and Development Review **4**(1): 105-132.
- Bongaarts, J. (2003). "Completing the Fertility Transition in the Developing World: The Role of Educational Differences and Fertility Preferences." Population Studies **57**(3): 321-335.
- Bongaarts, J. and G. Feeney (1998). "On the Quantum and Tempo of Fertility." Population and Development Review **24**(2): 271-291.
- Bongaarts, J. and R. G. Potter (1983). "Fertility, biology, and behavior: an analysis of the proximate determinants." In series: Studies in Population: xi, 230.
- Bracher, M. D. and G. Santow (1982). "Breast-Feeding in Central Java." Population Studies **36**(3): 413-429.
- Brass, W. and F. Juárez (1983). Censored Cohort Parity Progression Ratios from Birth Histories. Asian and Pacific Census Forum. **10**: 5 - 13.
- Brookman-Amisshah, E. and J. B. Moyo (2004). "Abortion Law Reform in Sub-Saharan Africa: No Turning Back." Reproductive Health Matters **12**(24): 227-234.
- Caldwell, J. C. and P. Caldwell (2002). "Africa: The New Family Planning Frontier." Studies in Family Planning **33**(1): 76-86.
- Caldwell, J. C., P. Caldwell and I. O. Orubuloye (1992). "The Family and Sexual Networking in Sub-Saharan Africa: Historical Differences and Present-Day Implications " Population Studies **46**(3): 385 - 410.
- Central Statistical Office (1989). Zimbabwe Demographic and Health Survey 1988-89. CSO and Macro International Inc. Calverton, Maryland.
- Central Statistical Office (1995). Zimbabwe Demographic and Health Survey 1994. C. a. M. I. Inc. Calverton, Maryland.
- Central Statistical Office (2000). Zimbabwe Demographic and Health Survey 1999. C. a. M. I. Inc. Calverton, Maryland.
- Central Statistical Office (2007). Zimbabwe Demographic and Health Survey 2005-06. C. a. M. I. Inc. Calverton, Maryland.
- Cleland, J. (1996). "Demographic data collection in less developed countries 1946-1996." Population Studies **50**(3): 433-50.

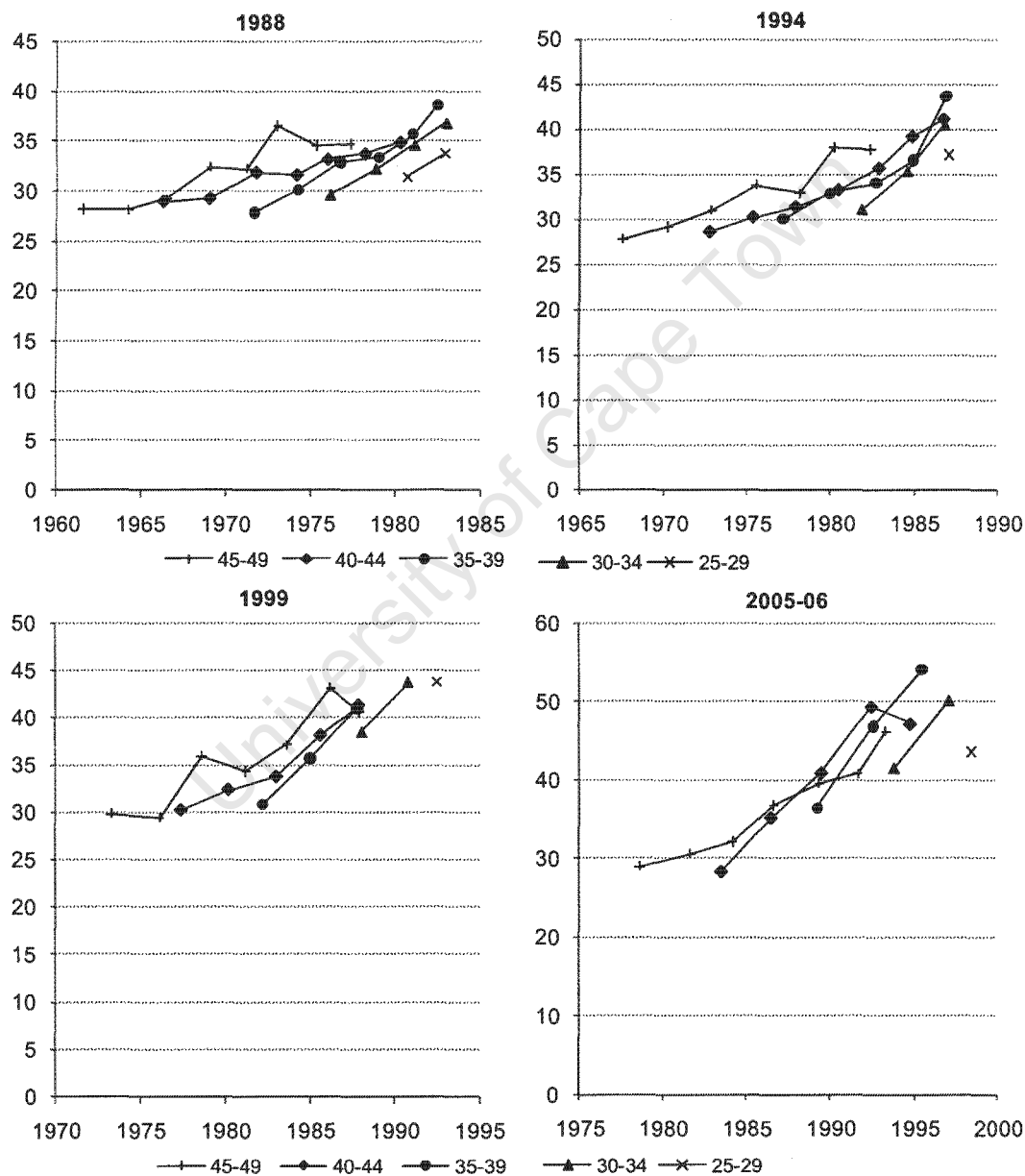
- Cleland, J., N. Onuoha and I. Timæus (1994). "Fertility change in Sub-Saharan Africa: a review of the evidence." The onset of fertility transition in Sub-Saharan Africa, edited by Therese Locoh and Veronique Hertrich.: 1-20.
- Cohen, B. (1993). Fertility levels, differentials, and trends. Demographic change in Sub-Saharan Africa, edited by Karen A. Foote, Kenneth H. Hill, and Linda G. Martin., Washington, D.C., National Academy Press, 1993.: 8-67.
- Cohen, B. (1998). "The Emerging Fertility Transition in Sub-Saharan Africa." World Development 26(8): 1431-1461.
- Cremin, I., P. Mushati, T. Hallett, et al. (2009). "Measuring trends in age at first sex and age at marriage in Manicaland, Zimbabwe " Sex Transm Inf: i34-i40.
- Davis, K. and J. Blake (1956). "Social Structure and Fertility: An Analytic Framework." Economic Development and Cultural Change 4(3): 211-235.
- Garenne, M. and V. Joseph (2002). "The timing of the fertility transition in sub-Saharan Africa." World Development 30(10): 1835-1843.
- Guilkey, D. K. and S. Jayne (1997). "Fertility Transition in Zimbabwe: Determinants of Contraceptive Use and Method Choice." Population Studies 51(2): 173-189.
- Guilkey, D. K. and R. R. Rindfuss (1987). "Logistic regression multivariate life tables: A communicable approach." Sociological Methods and Research 16(2): 276-300.
- Hajnal, J. (1953). "Age at Marriage and Proportions Marrying." Population Studies 7(2): 111-136.
- Heckman, J. J., V. J. Holtz and J. R. Walker (1985). "New Evidence on the Timing and Spacing of Births." The American Economic Review 75(2): 179-184.
- Hinde, A. and A. J. Mturi (2000). "Recent Trends in Tanzanian Fertility." Population Studies 54(2): 177-191.
- Hobcraft, J. and G. Rodriguez (1992). Methodological issues in life table analysis of birth histories. The analysis of maternity histories, edited by Allan G. Hill and William Brass., Liege, Belgium, Editions Derouaux-Ordina, 1992.: 53-95.
- Jensen, R. and R. Thornton (2003). "Early Female Marriage in the Developing World." Gender and Development 11(2): 9-19.
- Johnson, B. R., S. Ndhlovu, S. L. Farr, et al. (2002). "Reducing Unplanned Pregnancy and Abortion in Zimbabwe through Postabortion Contraception." Studies in Family Planning 33(2): 195-202.
- Kaler, A. (1998). "A Threat to the Nation and a Threat to the Men: The Banning of Depo-Provera in Zimbabwe, 1981." Journal of Southern African Studies 24(2): 347-376.
- Keyfitz, N. (1977). Applied Mathematical Demography. New York, John Wiley and Sons.
- Kirk, D. and B. Pillet (1998). "Fertility Levels, Trends, and Differentials in Sub-Saharan Africa in the 1980s and 1990s." Studies in Family Planning 29(1): 1-22.
- Kravdal, Ø. (2002). "Education and Fertility in Sub-Saharan Africa: Individual and Community Effects." Demography 39(2): 233-250.
- Lloyd, C. B., C. E. Kaufman and P. Hewett (2000). "The Spread of Primary Schooling in Sub-Saharan Africa: Implications for Fertility Change." Population and Development Review 26(3): 483-515.
- Moultrie, T. and I. Timæus (2002). Trends in South African fertility between 1970 and 1998: An analysis of the 1996 Census and the 1998 Demographic and Health Survey. Burden of Disease Research Unit, Medical Research Council.
- Moultrie, T. A. (2002). Why do women use contraception? Annual Conference of the Demographic Association of Southern Africa. Cape Town.

- Moultrie, T. A. (2008). Child spacing in Southern and Eastern Africa: Is there an "African" fertility transition underway? IUSSP International Seminar on Human Fertility in Africa: Trends in the last decade and prospects for change. Cape Coast, Ghana, 16-18 September 2008.
- Mturi, A. J. and A. Hinde (2001). Fertility levels and differentials in Tanzania. Workshop on prospects for fertility decline in high fertility countries. New York, Population Division, United Nations Secretariat.
- Muhwava, W. and I. M. Timaeus, Eds. (1996). Fertility decline in Zimbabwe. Research Paper No. 96-1, London, England, University of London, London School of Hygiene and Tropical Medicine, Center for Population Studies, 1996 Dec.
- Potts, D. and S. Marks (2001). "Fertility in southern Africa: the quiet revolution." Journal of Southern African Studies 27(2): 189-205.
- Rafalimanana, H. and C. F. Westoff (2000). "Potential Effects on Fertility and Child Health and Survival of Birth-Spacing Preferences in Sub-Saharan Africa." Studies in Family Planning 31(2): 99-110.
- Rindfuss, R. R., J. A. Palmore and L. L. Bumpass (1987). "Analyzing Birth Intervals: Implications for Demographic Theory and Data Collection." Sociological Forum 2(4): 811-828.
- Rossier, C. (2003). "Estimating Induced Abortion Rates: A Review." Studies in Family Planning 34(2): 87-102.
- Schoumaker, B. (2008). Stalls and reversals in fertility transitions in sub-Saharan Africa: Real or spurious? Paper presented at the IUSSP International Seminar on Human Fertility in Africa: Trends in the last decade and prospects for change. Cape Coast, Ghana, 16-18 September 2008.
- Tabutin, D. and B. Schoumaker (2004). "The Demography of Sub-Saharan Africa from the 1950s to the 2000s. A Survey of Changes and a Statistical Assessment." Population (English Edition, 2002-) 59(3/4): 457-555.
- Thomas, D. and I. Muvandi (1994). "The Demographic Transition in Southern Africa: Another Look at the Evidence from Botswana and Zimbabwe." Demography 31(2): 185-207.
- Thomas, D. and I. Muvandi (1994). "The Demographic Transition in Southern Africa: Reviewing the Evidence from Botswana and Zimbabwe." Demography 31(2): 217-227.
- Timaeus, I. and T. Moultrie (2008). "On Postponement and Birth Intervals." Population and Development Review 34(3): 483-510.
- United Nations Population Division (2008). World contraceptive use 2007. Wallchart. St/Esa/Ser.a/273, New York, New York, United Nations, Department of Economic and Social Affairs, Population Division
- [www.measuredhs.com](http://www.measuredhs.com). "Demographic and Health Surveys."

## Appendices

### Appendix A1. Projected median birth intervals for all women in each survey

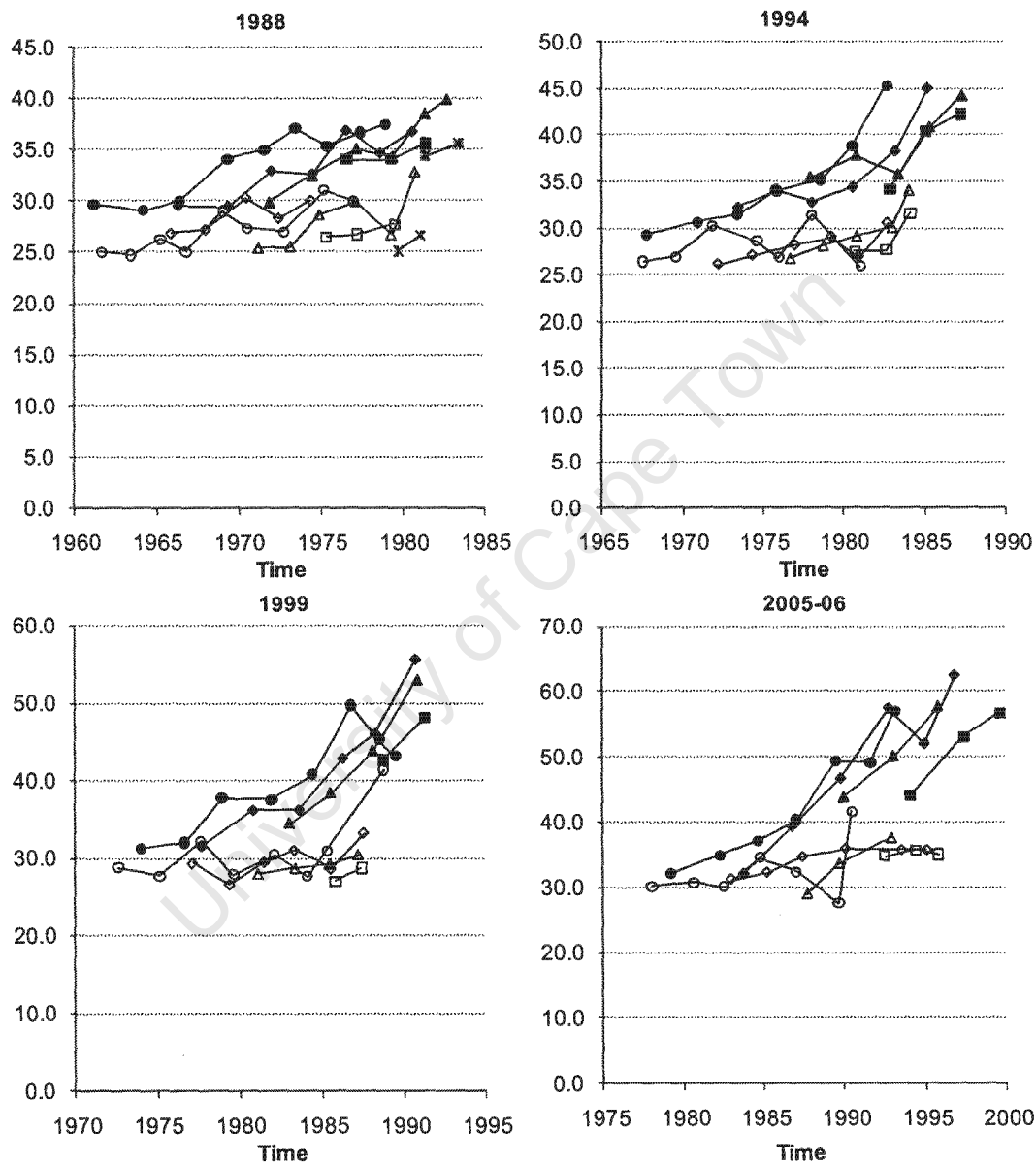
Figure A1. Projected median birth intervals for all women for each survey, by age and parity



Note: In all curves, parities increase from left to right.

## Appendix A2. Projected median birth intervals by contraceptive use in each survey

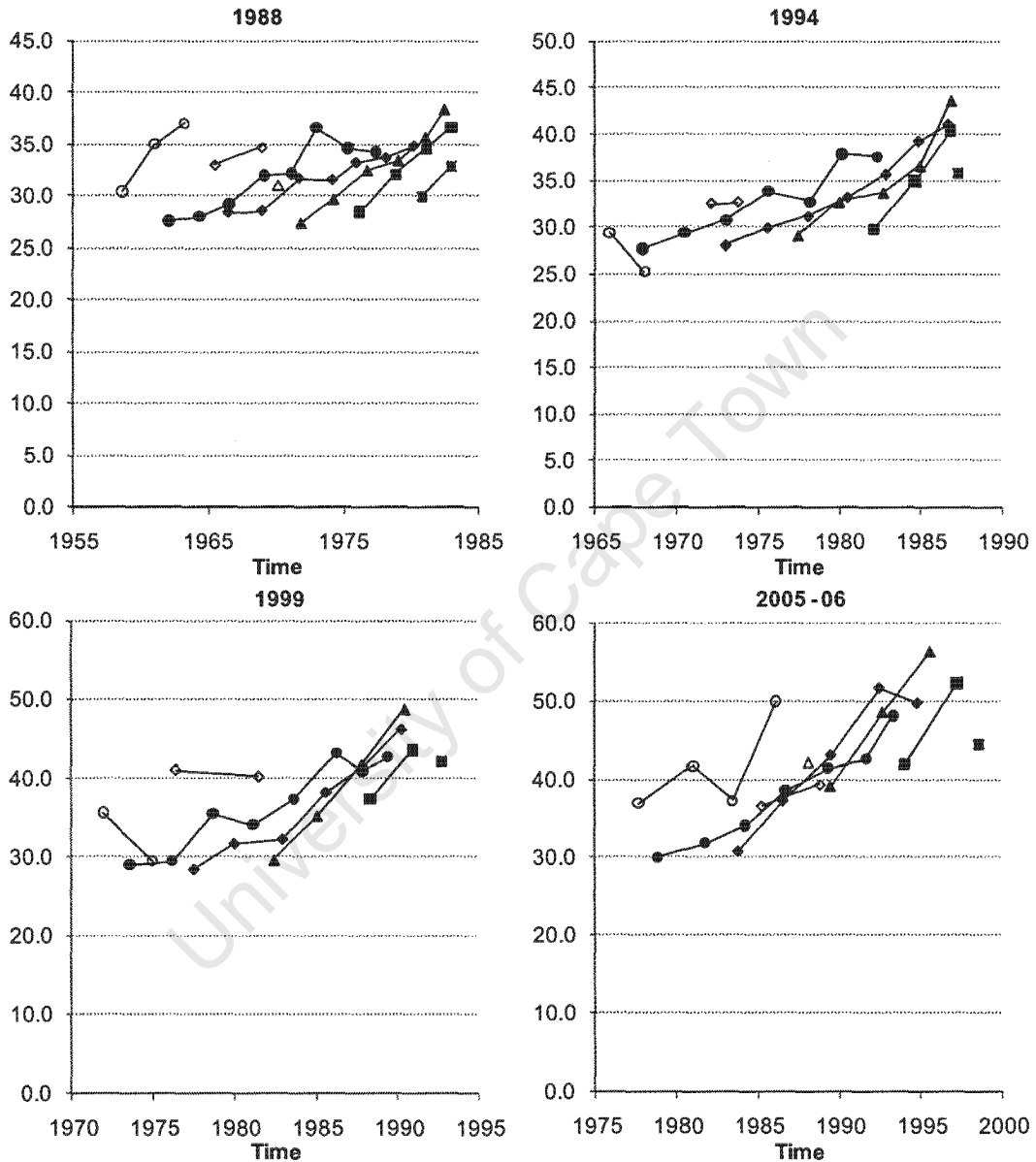
Figure A2. Projected median birth intervals by contraceptive use status for each survey, by age and parity



Note: Stars represent the 25-29 age group, squares 30-34, triangles 35-39, diamonds 40-44, and circles 45-49. The open shapes refer to the never used, and closed shapes to the ever used category. In all curves, parities increase from left to right.

### Appendix A3. Projected median birth intervals by marital status in each survey

Figure A3. Projected median birth intervals by marital status for each survey, by age and parity



Note: Stars represent the 25-29 age group, squares 30-34, triangles 35-39, diamonds 40-44, and circles 45-49. The open shapes refer to the never used, and closed shapes to the ever used category. In all curves, parities increase from left to right.

### Appendix A4. Stata do-file for generating the ever use variable in the children's file

\*generating a variable for number of dead children to each mother, and subsequently living children at birth of each child

```
gen cmcdeath=b3+b7 if b5==0
sort caseid bord
by caseid: egen maxbord=max(bord)
by caseid: egen countdeadchn = sum(b5)
gen deadchn=maxbord-countdead
drop countdeadchn maxbord
```

```
gen livingbord= bord if deadchn==0
```

\*\* 1 dead child in the family \*\*

```
gen temp1=cmcdeath if deadchn==1
recode temp1 .=0
by caseid: egen dk1 = sum(temp1)
gen howmanydeadchnatbirth = 1 if b3>= dk1 & deadchn==1
recode howmanydeadchnatbirth .=0 if deadchn==1
replace livingbord = bord-howmanydeadchnatbirth if deadchn==1
drop dk1 howmanydeadchnatbirth temp1
```

\*\* 2 dead child in the family\*\*

```
gen temp1 = cmcdeath if deadchn==2
recode temp1 .=9999
by caseid: egen rankdeadchn2=rank(temp1)
replace rankd=. if deadchn!=2
replace rankd=. if rankd-int(rankd)!=0
replace rankd=. if rankd>deadchn
```

```
by caseid: egen dk1= total(temp1) if rankd==1
by caseid: egen dkk1=max(dk1)
by caseid: egen dk2= total(temp1) if rankd==2
by caseid: egen dkk2=max(dk2)
drop dk1 dk2 temp1
```

```
gen count1= 0
gen count2=0
replace count1 =1 if b3>=dkk1
replace count2 =1 if b3>=dkk2
gen counttotal = count1+count2
replace livingbord = bord-counttotal if deadchn==2
drop rankd dkk1 dkk2 count*
```

\*this is done up to the maximum number of dead children to all women

\*creating a dummy variable for women who have ever used contraception and those who have never used contraception.

```
generate bthcontrol = .
replace bthcontrol = 0 if livingbord <= v310 & v310 != .
replace bthcontrol = 1 if livingbord > v310
```

```
label variable bthcontrol "Ever Used Contraception"
label values bthcontrol bthcontrollbl
label define bthcontrollbl 0 "Never Used" 1 "Ever Used"
```

### Appendix A5. Stata do-file for generating the ever married variable in the children's file

\*creating a dummy variable for women who had ever been married and those who had never been married when they had the child:

```
generate married = .
replace married = 0 if v509 > b3 & v509 != .
replace married = 1 if v509 <= b3 & v509 != .
recode married . = 0 if v502 ==0
```

```
label variable married "Ever Married"
label values married marriedlbl
label define marriedlbl 0 "Never married" 1 "Ever married"
```

### Appendix A6. Stata do-file for the poisson regression model

\*creating the dataset. This part of the do-file is run separately on the children's file for each survey.

```
gen DHS_wt = v005/1000000
svyset v021 [pw=DHS_wt], strata(v022) singleunit(centered)
gen bcohort=int(v011/60)*5
gen gp_bord=bord
recode gp_bord 3/4=2 6/7=5 9/10=8 12/max=11
gen fail = b12_!=.
egen survey = median(v007)
replace survey=survey-80
gen double id = (v001*(10000000)+v002*10000+v003*100 + bord)*100+survey
gen long id_mother = v001*(100000)+v002*100+v003
sort id
gen nextbt = b3+b12
replace nextbt = v008 if b12==.
replace nextbt= v008+0.5 if b3==v008
```

\* the datasets are then appended to each other.

\* the following commands are then run on the appended datasets:

```
stset nextbt [pw=DHS_wt] if b0<=1, id(id) failure(fail) exit(time .) enter(b3_)
```

\* generation of time-varying covariate giving time to age 50; based on age at the start of birth interval

```
gen timetoage50= (v011+600-_t0)
```

\* split on time intervals since birth

```
stsplit interval, at(0 9 18 24 30 36 42 48 54 60 66 72 84 96 108) after(time=b3)
```

```
* derivation of exposure in each interval slice
```

```
gen exposure = _t-_t0
```

```
char interval[omit] 36
```

```
gen birthyear = b2_
```

```
replace birthyear = b2_+1900 if b2_ < 150
```

```
gen childcohort = 1900+ 5*int((birthyear-1900)/5)
```

```
char childcohort[omit] 1990
```

```
char bcohort[omit] 70
```

```
drop if gp_bord==0
```

```
* the regression model is then applied to the dataset, followed by prediction of the  
incidence rate
```

```
xi: svy: poisson _d i.interval*i.married i.interval*i.bthcontrol i.interval*timetoage50
```

```
i.married*timetoage50 i.bthcontrol*timetoage50 i.bthcontrol*i.gp_bord
```

```
i.childcohort*i.interval i.bcohort ,e(exposure) irr
```

```
predict p_hat if e(sample),ir
```

```
table interval bthcontrol,c(m p_hat)
```

```
table interval married,c(m p_hat)
```

```
table interval child bthcontrol, c(m p_hat)
```

```
table interval child married, c(m p_hat)
```