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Fertility and union dynamics in Brazil

by

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Thesis submitted for the fulfilment of the degree of Doctor of Philosophy

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May 2002

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SOCIAL SCIENCES

SOCIAL STATISTICS

Doctor of Philosophy

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There is evidence of an increase of union instability in Brazil and at the individual level women with more than one union are usually reported to have higher fertility. At the same time there has been an increase of consensual unions usually known for having a higher rate of dissolution than formal ones. The Brazilian total fertility rate fell from 6.5 in 1930 to 2.1 in 2000. The first evidence showed that the level of fertility is higher for those women with more than one union in any age group. Despite this, at a macro-level it is clear that Brazil showed a decline of fertility during a period of increase of union dissolution. The current literature stresses the attention on the role of sterilisation and abortion on dramatic fertility decline. However there are no recent studies that analyse the complex relationship between union dynamics and childbearing mainly due to the lack of data. Brazilian couples report serious lack of communication on reproductive matters and in particular for women of low-income status, reproductive choices are often dictated by the need to keep their partner. It is for this reason that to get a better understanding of the current fertility trends, there is a need to understand in depth the mechanisms that interact in union dynamics and reproductive decision-making.

The aim of this thesis is to analyse the union formation and dissolution behaviour and their interaction with fertility in Brazil. The second aim of this thesis is to utilise the Demographic and Health Surveys (DHS) calendar section to analyse union and reproductive histories. The DHS calendar, generally used for studies on contraceptive use, allows the simultaneous analysis of parallel event histories of union status changes and fertility, an analysis that has not previously been done for Brazil. The first part of the analysis is dedicated to the comparison of the modelling of the history of union status change as a single equation with the multiprocess modelling of union formation, dissolution and conception outcome using Lillard's model (1993). This type of analysis allows to study the relationships between union dynamics and their effect on fertility. Using the 1996 DHS it is demonstrated that union formation and union dissolution have a positive effect on the level of fertility. Furthermore it is shown that, in particular for women in their second or higher order union, childbearing could be used as a mean to strengthen their relationship.

Analysing in depth the relationship between the timing of sterilisation and union dynamics using discrete time modelling it is demonstrated that, women with a history of unstable relationships delay the timing of sterilisation. This could prove that the relationship between union instability and fertility is only one aspect of the overall relationship between union dissolution and reproductive matters.

The second part of the analysis is dedicated to the macro analysis of the actual effect of union instability on the level of fertility. The effects of three main components in the level of Brazilian fertility that have shown interesting trends in the last two decades have been decomposed: adolescent fertility, union instability and sterilisation.
In the absence of other methods, the fertility decline in Brazil is primarily due to the increased prevalence of female sterilisation. It is shown that the decline, powered by female sterilisation, would have been more rapid in the absence of the increase in teenage pregnancy and union instability.

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Acknowledgements

I would like to thank my supervisor Dr Andrew Hinde for his constant support and help throughout my PhD, most importantly for his ability to teach me how to do research. I acknowledge the supervision of Dr John 'Mc' McDonald. I would also like to thank Professor Diamond for being the first to suggest that I do a PhD.

I would like to thank all the colleagues with whom I have shared ideas and a collection of special moments. Most notably Juliet for sharing the 'thrills and spills' of the DHS calendar, Priscilla, Farah for the fun of living with her and the support she showed me in difficult times, Dulce, Felix, Zöe Matthews, Chiweni and Sarah 'Cheese'.

I would like to thank everyone at CEDEPLAR for being so helpful and make my staying in Belo Horizonte very pleasant, in particular Carminha for making me feel the 'saudade', Roberto, Eduardo, André and Paula.

I would like to thank Scott in particular for being very patient and supportive in very stressful times.

Finally and most importantly I am most grateful to my parents Umberto and Teresa for encouraging me and believing in my capabilities throughout these years, this work is dedicated to them.

Chapter 1
INTRODUCTION

1.1 Fertility and union dynamics in Brazil

The Brazilian demographic literature has concentrated in particular in the last thirty years on the dramatic fertility decline that the country has experienced. The total fertility rate fell from 6.5 in 1930 to 2.1 in 2001 and the decline has been particularly dramatic since the 1960s. The literature on this topic is rich and many authors have tried to summarise the main reasons for the decline. However, there have been few studies of interactions between union dynamics and fertility. This is mainly because of the difficulty of obtaining adequate data and the fact that it is hard to determine to what extent union instability is a cause of changes in fertility, and to what extent it is an effect of those changes. There is evidence of an increase of union instability in Brazil (if we consider women that have experienced more than one union, their percentage has increased from 10% in 1986 to 13.8% in 1996, Demographic and Health Surveys (DHS) data) and at the individual level women with more than one union are usually reported to have higher fertility. There is evidence as well of an increase of consensual unions that in Brazil report a higher level of fertility than legal ones. Despite this, at a macro-level it is clear that Brazil showed a decline of fertility during a period of increase of union dissolution.
In this thesis the term union will be used to identify affective relationships of cohabiting couples regardless whether their union is formalised or not.

There is a rich literature on the fertility decline and in particular on the role of sterilisation. The high prevalence of sterilisation (27% of all women aged 15-49 years old) derives mainly from easy access and ease of use. Most likely it has been influenced by the lack of alternative methods. It has been highlighted (Potter 1999) that the increasing autonomy of the woman and her will to keep her partner out of her reproductive choices, has played a major role in establishing sterilisation as the main contraceptive method. Furthermore, particularly striking is the lack of communication between the partners on reproductive matters (98% of the women do not talk about family planning to their partner according to the latest DHS figure, 1997). The stability of the union could play an important role not only on the fertility

outcome but on each aspect of the reproductive life of a couple. It is therefore important to highlight the relationship between union dynamics and reproductive matters. There are only few attempts to study this relationship in Brazil and in particular there is none relating to data of the last decade (Greene 1991; Henriques 1989; Lazo 1994).

The mechanisms that are behind childbearing and relationship decisions are particularly linked to the position of the woman inside the household. The position of the woman inside the Brazilian family is not strong in particular for lower economic classes. It is common in fact for Brazilian women to use childbearing as an instrument for keeping a relationship. This phenomenon is particularly frequent for women in consensual unions that have a weaker position in terms of decisional power.

The bargaining power of the Brazilian woman is fundamental to an understanding of the trends in the level of fertility and in particular the level of sterilisation. Sterilisation represents the main method of contraception with a prevalence of 40% among married women aged 15 to 49 years old. Most of the attention of the studies on fertility in Brazil in the last decade has concentrated on the peculiarity of the Brazilian case in respect to the percentage of sterilisation. However there is no study that relates the increase of sterilisation to changes in union dynamics or to the peculiarity form of Brazilian unions.

Thus the mechanism that link union formation and dissolution to contraceptive dynamics and in particular to non-reversible methods are not yet clear. It is therefore important to stress on the relevance of analysing the interaction between union dynamics and fertility to get a better understanding of couples' behaviour. It is possible that the increase in female sterilisation might be linked to changes in union dynamics and couples' communication.

1.2 Fertility and union dynamics

The relationship between fertility and union dynamics is commonly defined as a 'two way relationship' because of the nature of the interaction between union dynamics and childbearing decisions. These decisions are usually taken jointly and reflect an intense process of decision-making of the couple. The relationships between fertility

and union dynamics are complex and may vary in direction as well as magnitude with the stage of the union.

It is undeniable that there is a strong relationship between union formation and childbearing. Almost universally childbearing is culturally more acceptable if inside a union: in some societies the acceptance is limited to formalised unions, usually formalised religious unions. Couples tend to bear a child immediately after the beginning of a union or if conception occurs outside a union they might formalise their relationship to legitimise the birth. For this reason there is notably a positive relationship between union formation and childbearing.

The relationship is less clear in the case of union dissolution. Union instability could be defined as the tendency of a woman to experience more than one union of shorter durations during her life. Using this definition the relationship between union instability and childbearing may vary in extent as well as in direction.

The classical literature on the topic considers union instability as a depressant for fertility considering that the higher the level of instability the higher the time spent outside the union. However there are factors that should be accounted when considering the relationship between fertility and union instability that go beyond the simple time-exposure analysis. Women in unstable unions or that experience more than one union during their fertile life might have a higher fertility than those who go through only one stable relationship. Women with a history of unstable unions usually experience unions of shorter durations. If this aspect is linked to the fact that the frequency of coitus is usually found to be negatively correlated with the union duration, it follows that women who have several, shorter unions might be more exposed to the risk of conception due to a higher average frequency of coitus. Furthermore it has been found that couples in a union which is under threat of dissolution, tend to conceive a child in each new relationship due to the desire to have a child in each new union. At the same time couples experiencing an unstable union tend to bear a child to keep the relationship more stable. It is unclear though whether women in unstable unions use more ineffective contraceptive methods than women in stable unions. All these factors could affect positively the level of fertility. This topic has so far been unexplored and the few results available refer to United States data.

1.3 Data and methods

One of the reasons for the lack of in depth analysis of union dynamics and their relationship with reproductive matters in particular in developing countries, is a lack of data (Henriques 1989). There is the need of complete histories on union dynamics and reproductive life for both men and women.

The data that are used for this study come from the 1996 Brazil Demographic and Health Surveys (DHS). This dataset includes information on demographic and socio-economic characteristics of women aged 15-49 years. In particular the calendar section is used to model union and reproductive histories. The DHS calendar consists in a database that recalls information on union history, reproductive life and contraceptive use for each month in the five years preceding the survey. The potentiality of the information given by the DHS calendar is far from being fully exploited. Thus a second aim of this study is to utilise a dataset that is commonly used to analyse contraceptive dynamics and that to our best knowledge has never been used to analyse union dynamics.

Considering the nature of the longitudinal data event history techniques will be applied. In particular being the relationship between union dynamics and fertility a mutual relationship, a multiprocess model for hazard models developed by Lillard (1993) will be applied. It is becoming particularly evident the relevance of accounting for simultaneity of life events when modelling parallel histories. The technique developed by Lillard is relatively new and in particular the software (aML) that applies it has been newly created. The potentiality of this application is still to be fully explored in relation to the DHS calendar data.

1.4 Objectives of the study

The objectives of this project are therefore two. The first aim of this research is to analyse the dynamics that link the process of childbearing with union dynamics in Brazil in the way to shed a light on one of the aspects of the relationship between reproductive matters and union dynamics. Because this is a two-way relationship the effects of fertility on union dynamics and vice versa are studied. In particular the study

is aimed to analyse the fertility outcome of women who enter in more than one union. Furthermore an insight into the relationship between contraceptive use and union dynamics is given by the analysis of the timing to sterilisation and the impact if union status changes.

The use of the DHS calendar is a new approach to the study of the relationship between union dynamics and fertility. This becomes the second aim of this study: to derive all the possible information that could be deduced from the calendar and to study the limits and ways in which it could be improved.

1.5 Structure of the thesis

The thesis is structured in six substantive chapters. Chapter 2 describes the background for a study on union dynamics and fertility in Brazil. A history of the Brazilian unions and of the fertility trends in the last fifty years is reported. Chapter 3 highlights the conceptual framework: the hypotheses underlying a project on union dynamics and fertility are stated. Chapter 4 describes the DHS calendar data and the recoding work that has been done to render it suitable for the final models. In Chapter 5 the methodology is described. Starting with event history analysis, continuing with the importance of accounting for unobserved heterogeneity and for endogeneity, the description of multiprocess modelling is reported. Chapter 6 illustrates the results of the model describing the differences between discrete time and continuous models and between fixed effects, random effects and joint models' estimates. Chapter 7 gives a description of the results of the modelling of the timing of sterilisation and the effect of union instability on the timing. The second part of the chapter is dedicated to a macro-level analysis on the effect of union instability on the overall level of fertility. Linking the micro approach to the macro analysis this study will measure the actual impact of union instability on the level of fertility in Brazil and how it compares to other features of the Brazilian fertility such as sterilisation or adolescent fertility. The final Chapter 8 is a summary with the main findings and concluding thoughts on the overall project. The last part of the chapter is dedicated to ideas for future work.

Chapter 2

Fertility and marriage in Brazil

Latin America, in particular Brazil, is characterised by a high number of informal unions, usually described as consensual unions. In Brazil there has been an increase of consensual unions in the last three decades and this increase is likely to be the reason of an increase of union instability that occurred in the same period. Some authors suggest that this increase of union instability might have been one of the causes of the steep fertility decline that Brazil has faced in recent decades. Most of the ones that treat the effect of union instability (based on Bongaart's proximate determinants model) on the level of fertility have dismissed it as negligible (Carvalho and Wong 1996; Goldani 2001; Martine 1996). However, the literature lacks of an analysis of union dynamics (in terms of formation and dissolution) and their effect on fertility in Brazil, mainly because of a lack of complete data (Greene 1991; Henriques 1989; Lazo 1994).

The aim of this chapter is to analyse in depth the decline of the fertility that has occurred in the last century in Brazil and the characteristics of the Brazilian unions. In particular the stress is on the lack of interest on the effect of union dynamics on the level of fertility. In this chapter, therefore, the Brazilian context is described in order highlight the major debates of the Brazilian demography in the last decades and to understand better the results that will be presented in Chapters 6 and 7.

This chapter will introduce a general description of the recent demographic trends in Brazil in particular by region and by ethnic groups. It will describe then, the history family planning policy in Brazil in the last fifty years and how its interaction with the steep fertility decline in Brazil, described in the third section, leads to perceive the Brazilian case an anomalous one. Most of the literature recognises the fact that the Brazilian fertility decline occurred in absence of a government sponsored family planning programme; the third section will tackle this issue. The final section then will describe more in detail the characteristics of the Brazilian unions and how they are a

good set up for an analysis on union dynamics and fertility. This chapter is fundamental to lay out the Brazilian background that is required to understand the conceptual framework in the next chapter.

2.1 Brazilian demographic indicators

Brazil is the fifth largest country in the world with a population of 172,860 inhabitants and a growth rate equal to 1.4% per year. There is a high rate of urbanisation: 81% of the population lives in urban areas (Population Reference Bureau 1999) in particular in the south-east of the country in the triangle between Rio de Janeiro, Belo Horizonte and São Paulo. The Demographic and Health Surveys (DHS) data reports 51% of the female population is of mixed race, whereas 43.8% is white and the rest black (BEMFAM 1997). Considering the strong import of black slaves from Africa in the XVII and XVIII centuries, the high percentage of mixed groups shows a high rate of integration. The prevalence of Catholicism is undeniable, with Catholics forming 76.5 percent of the population, followed by the evangelic group linked to a protestant tradition (13.1%) (BEMFAM 1997). Spiritual and Umbanda religions that consist in a series of rites and myth believes from the slavery tradition, often mixed with Christianity are only 3% of the female population.

In economic terms there is a big gap between the north and the south of the country with the south being the leading region. This gap is reflected in the demographic indicators: fertility is higher in the north; in particular in the Northeast region the TFR is 3.1 compared with 2.1 in the state of Rio de Janeiro. A similar gap is reported in the infant mortality rate, which is equal to 89 per thousand in the Northeast compared with 29 per thousand in the South.
Medical improvements that occurred, in particular, during the 1940s have steeply reduced the level of mortality, bringing the current level of the life expectancy at birth to 67 years (Population Reference Bureau 1999).

The Total Fertility Rate (TFR) fell from 6.16 in 1940 to 2.0 in 2001. The decline in fertility has been particularly dramatic since 1960 (Table 2.1). Among the developing countries Brazil has one of the highest percentages of women in union using any type of contraceptive method (77%), in particular modern methods (70%) (BEMFAM 1997).

This rapid fertility decline has caused an increase in the proportion of the population aged 15-64 year and a decrease in the proportion at younger ages.

Table 2.1 Brazilian total fertility rates, 1940-2000

Year	TFR
1940	6.13
1950	5.93
1960	6.06
1970	5.32
1980	4.09
1990	2.56
2000	2.10

Source: (US Bureau of the census 2001)

The data for the statistics on contraceptive use and union status are taken from the 1986 and 1996 Brazilian DHSs that interviewed samples of women aged 15-49 years. If considering the changes in contraceptive use it is possible to see (Table 2.2) that the percentage of women in union using any method has increased steeply in 10 years, in particular there has been a dramatic increase in the percentage of sterilised women. Female sterilisation is a very important issue at the moment for the Brazilian demographers; Brazil reports one of the highest rates of female sterilisation (40% of the female population aged 15-49) in the world and definitely the highest rate of Caesarean section deliveries. A peculiarity of the Brazilian women is their almost complete reliance on two main contraceptive methods: pill and sterilisation (Table 2.2).

Table 2.2 Percentage of women aged 15-49 in union using various contraceptive methods, Brazil 1986, 1996

Contraceptive method	1986	1996
No method	35.5%	23.3%
Pill	23.3%	20.7%
Withdrawal	4.4%	3.1%
Female sterilisation	27.9%	40.1%
Male sterilisation	0.7%	2.6%
Periodic abstinence	4.2%	3.0%
Other methods	2.6%	1.9%
Condom	1.4%	4.4%

Source: BEMFAM 1989, 1997

If the statistics on union status are taken into consideration (Table 2.3) there has been an increase in the proportion of women in union and at the same time the proportion of legally married is decreased. There has been an increase in union instability with an increase in the number of divorces (BEMFAM 1997) that may be caused by the increase in the number of cohabitating unions.

Table 2.3 Percentages of women by type of union, Brazil 1986 and 1996

Type of union	1986	1996
Never in union	34.3%	30.6%
Married	49.5%	45.6%
Living together	9.3%	13.7%
Widowed	1.4%	1.6%
Divorced	4.1%	7.7%
Not living together	1.4%	0.8%

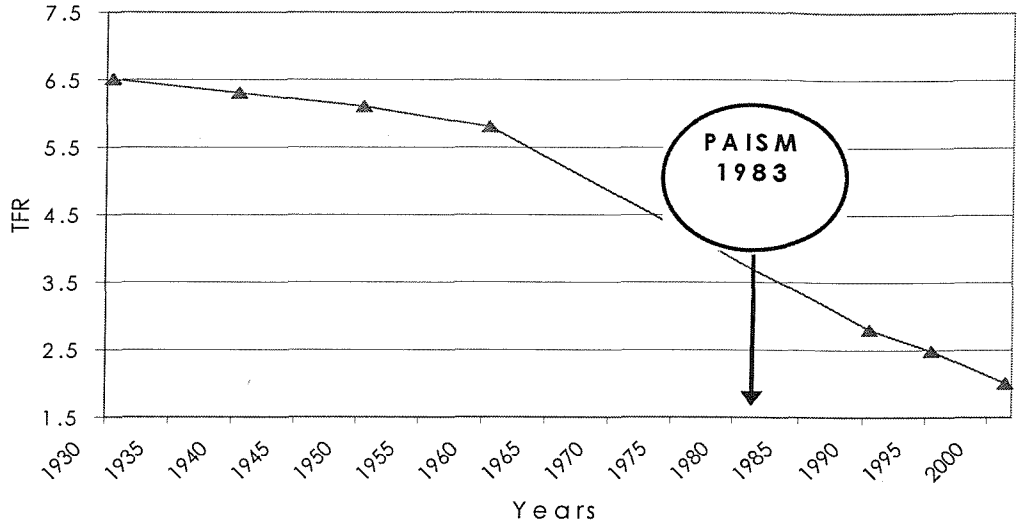
Source: BEMFAM 1989, 1997

2.2 Family planning programmes and demographic policies in Brazil

The Brazilian decline of fertility has always been considered anomalous compared with the rest of the Latin American countries (Carvalho and Wong 1996; Faria and Potter 1990; Goldani 2001; Merrick 1983; Potter 1990; Rutemberg et al. 1987; Sobrinho 1993), principally because of the lack of a government-sponsored national family planning programme. Its decline in such a short period is surprising if compared with the experience of countries like Mexico and Colombia where there has been a strong intervention of the government (Mundigo 1990). Brazil is a vast country, with a numerous and heterogeneous population, without an official demographic policy.

The first real family planning programme (that is, one not simply included in a programme for the health of the woman) was introduced in 1983 (PAISM: Programa de Assistencia Integral a Saude da Mulher). As it is possible to see from Figure 2.1, the decline in fertility started well before that moment. The PAISM though did not intend to decrease the level of fertility. The government at that time had only the intention of giving the right to women to have access to family planning services (Potter 1999).

Figure 2.1 TFR Brazil 1930-2001



Source: (Sobrinho 1993)

The distinctive evolution of Brazilian family planning policy up to 1983 is explained by considering the stages that the nation faced in terms of government attitude towards fertility issues. There have been three main periods. The first lasted from the XIX century to 1964 and was a eugenic and *pronatalist* phase. The second, from 1964 to 1974, is the phase of *antinatalism* against *'opposition to control'*. The third one from 1974 to 1983 is the period that brought the birth of PAISM, a period characterised by an increasing interest in family planning and by greater efforts being made to solve several problems linked with the health of the women (Sobrinho 1993).

The first period was characterised by a strong pronatalism. During this phase the 1930s revolution brought a new organisation of the state in Brazil with the creation of new ministries for the defence of the workers. In this period, due to the enormous amount of European migration, there was an increase of eugenic policies designed to protect the 'Brazilian race'. It is in this context that the pronatalist campaign started.
Among the major actions taken by the government were the stimulation of eugenic education, care of motherhood and childhood and help for large families (Sobrinho 1993).

The second period is seen as the period of the contrast between opposition to birth control and antinatalism. In 1964 a military regime took power. On the one hand this led to a strengthening of the conviction that a large population provides security for a nation that needs to be defended. On the other hand there was an increase of the

influence of the United States (US) over Brazilian politics due to the fear that the north east of Brazil could have been a second Cuba. The hegemony of the US was mainly focused towards Brazilian development policies. It was their conviction that population growth as it was at that time would slow down the economy. In 1965, an important year for the increase of policies aimed to reduce population growth, the US started to work with the United Nations (UN) to limit the demographic explosion. Several organisations for population planning were created, among these the United Nations Population Fund (UNFPA). One of the targets of this new interest on population growth was Latin America.

Following the continuous pressure from both UN and US in 1967, surely an important year in the history of Latin American population policies, Latin American governments organised a meeting in Caracas on population and development. This meeting signalled a change in view of the relationship between population and development. The conference was the result of strong pressure from the industrialised countries that considered the high fertility in Latin America an obstacle to development. Up to that moment the growth of the population was considered as a positive aspect for economic growth. None of the family planning programmes was well developed and none had the aim of decreasing fertility. Mundigo (1990) points out that during the 1950s and 1960s governments for the most part believed that 'to govern is to populate'. It is in this context that the decline of fertility, especially in Brazil, where these pronatalist pressures were stronger, looks anomalous. Only a few Latin American politicians were aware that productivity increases more with a rise in the skills of each worker than with the expansion of the number of workers.

Thus, despite this strong effort of the American government and of the UN, the Brazilian policy could still be summarised by the words ' Security and development', because these were the two main targets of the government (Sobrinho 1993). According to the generals in command at that time, the power of a nation was directly proportional to the size of the population. At the same time the first private attempts at a family planning programme began with the foundation of Service of Family Orientation (SOF) that started with the distribution of IUDs to families, and the creation of BEMFAM, the most important Brazilian private family planning organisation. In the meantime the Brazilian government was completely silent.

At that time (the end of the 1960s, the beginning of the 1970s) abortion was the main method of fertility control that accelerating the decline of fertility. However it is not possible to see the real impact of abortion due to the fact that it is illegal in Brazil and

therefore there are no official statistics. The other contraceptive methods used were the rhythm method and the pill (Martine 1996). Due to the lack of knowledge and deficiencies of the distribution system the practical effectiveness of these two methods was really low. The activity of BEMFAM started in 1966 (strongly influenced by the American government) and was mainly aimed at promoting women's health by trying to reduce the number of abortions rather than decreasing the level of fertility. All attempts at family planning were directed through maternal and childcare.
In this period, the Catholic Church and leftist groups were united in condemning the use of contraceptive methods though for different reasons. On one hand the Catholic Church reaffirmed that contraceptive use aimed at reducing the level of fertility could not be tolerated. On the other hand to the leftist groups, usually established inside hospitals and clinics, and who were strongly against the intervention of the US government in Brazilian politics, family planning was seen as a product of foreign domination. Among these leftist groups were also those who believed in the concept of free will: according to them childbearing is a couple's choice and nobody has the right to interfere.

The third period (1974-1983) represents the real turning point for the Brazilian family planning: both the Catholic Church and leftist groups reconsidered their positions and the role of the existing family organisations changed. Public assistance to mothers and children starts in this period with the Centre of Research and Assistance to the Mother and Child (CPAIMC). This centre created a big network of links between doctors to improve technology and knowledge of methods to promote mothers' health. At the same time there was an increase in the number of family planning bodies that resulted in the creation of Brazilian Association Family Planning Agencies (ABEPF) in 1981, an association that includes most Brazilian Family Planning institutions. The increase of family planning initiatives did not increase the participation of the government; the only step forward was taken in 1971 when the Ministry of Health finally declared that the higher the number of children the higher the probability of death for both mother and child (Sobrinho 1993). In 1974 the government declared that family planning was a human right and should be defended, but at the same time it stated that demographic politics was strictly a matter for the Brazilian government and there should not be any interference from outside.

Only in 1983, under pressure from the International Monetary Fund, did the Brazilian president speak to the Congress emphasising the importance get free access to contraception. Following this, the PAISM was created as the first form of public family planning in Brazil. PAISM was a big step forward in setting up the first programme that

would consider public intervention on reproductive matters. However, if the Brazilian government recognised the need to fund the right to have access to contraception, in contrast to what happened in Mexico and other Latin American countries, it did not act towards a population growth policy (Potter 1999). In particular the Brazilian government did not recognise the need for a fertility decline despite the international pressure.

What is clear from this short history of the demographic policies in Brazil in the last 40-50 years is that several issues and developments at the macro level acted towards influencing the demographic policies of the country. However as we will see in the following paragraphs the attitude of single individuals made the difference.

2.3 The fertility decline

The TFR in Brazil fell from 6.16 in 1940 to 2.1 in 2001. The patterns are, however different in different regions and the decline had a different speed before and after 1960. In fact it is often held that 1960 was the start of the fertility decline in Brazil. However 1960 was only a turning point from which the fertility started to decline faster. For the country as a whole, the decline in fertility throughout the 1960s was less than 10%; during the 1970s it was 25% and during the 1980s the decline was approximately 20% in the first five years alone. This decline was concentrated in two main periods: the first half of the 1970s when the TFR decreased from 5.8 to 4.3, and the second during the first five years of the 1980s when the TFR dropped to 3.5 (Carvalho and Wong 1996). It should be noted that there is a strong regional difference, mainly between the northern and the southern regions: the former have higher fertility and sometimes showed an increase in the TFR, the latter, with lower fertility, had a continuous decline.

The strong overall decline of the first half of the 1970s was mainly due to a decline in the low income rural and urban sectors, the decline had in fact been under way for some time among the upper classes. The second period of rapid progress in the first half of the 1980s began in the large cities and then spread to the whole country. This period is characterised by a strong economic recession destroying all the progress made during the economic miracle of the 1970s. The recession reached not only the poorest sectors but also the middle class that was investing in long-term credit. The increase of education and the progressive rise of number of women in the labour

market meant that children started to be seen in terms of psychological and monetary costs. The role of mass media, as it will be discussed in more depth below, was undeniably important: soap operas brought new social behaviour and aspirations.

As pointed out in the preceding section, the government did not have a direct family planning policy that could have influenced the trend of fertility, but there was still an indirect effect through modernisation and increase of the power of the mass media. The changes made in the health sector increased the number of physicians and public sector health workers, mainly in the urban areas. These groups were highly politicised by leftist groups strongly against the family planning as it was conceived at that time. Only in the late 1970s did the increase of demand for contraceptive methods raise fertility assistance in the public sectors. The role of the government was especially important in increasing the pharmaceutical sector that ended up in promoting the use of the pill. The production of the pill started in the 1960s and has increased steeply since then (Potter 1999).

The major decline happened in marital fertility through the increase of contraceptive use inside unions. There was also, it should be said, increase of the mean age at marriage (Merrick 1983). From an analysis of the proximate determinants of fertility marital instability did not come out as a depressing factor for fertility in the 1970s. Most of the studies so far dismiss the role of union instability on the level of fertility as negligible (Carvalho and Wong 1996; Goldani 2001; Martine 1996). Most of the authors blame the lack of complete data by cohort that does not allow a complete analysis of the Brazilian fertility history. However because of the lack of a systematic study on the effect of union instability on the level of fertility it is not possible to be sure that union instability did not have an effect on fertility (Carvalho and Wong 1996; Martine 1996).

Some gaps in the knowledge of the steep decline of the Brazilian fertility have not been filled yet despite the rich literature. Goldani (2001) clearly highlights in a recent paper that demographers have concentrated for too long on the peculiarity of the Brazilian case stressing on the lack of a government sponsored family planning programme. The condition of anomaly for the Brazilian case stands as long as we consider the 'traditional' demographic transition theory (Goldani 2001).
If the fertility decline is considered as a broad historical change, accompanied by ideological change, by which ideological change it is meant the everyday social

interactions and experiences, we can see that the Brazilian case is not that anomalous (Goldani 2001).
The government did not intervene directly as in other Latin American countries. However modernisation, homogenisation of the experiences at national level and the increasing availability of contraceptive technologies have played a major role.

2.3.1 The role of contraception

The role of contraception is undeniable in decreasing the level of fertility. The two methods that had the main impact in Brazil were abortion and sterilisation (Martine 1996). In particular, abortion was relevant in the first stages of the decline: the lack of knowledge of contraceptive use that characterised the 1960s and the lack of availability of major contraceptive methods apart from the pill and rhythm, made abortion the most popular mean of birth control (Frejka and Atkin 1990). Even abstinence and withdrawal seem to have been rare. Because abortion is illegal there are no official data. However Frejka and Atkin (1990) estimated that a quarter of deliberate fertility control in Latin America at the beginning of the 1980s was achieved with abortion. Perhaps more striking is the estimate that 1.4 million abortion were reported to have been procured in Brazil in 1985, corresponding to half of the total number of abortions in six Latin American countries (Brazil, Chile, Colombia, Dominican Republic, Mexico and Peru) (Sigh and Wulf 1991).

Although abortion played an important role, as time progressed the increase of contraceptive prevalence in every part of the country played a major part. Two methods, in particular, have dominated: the pill and female sterilisation. For example among all married women using a contraceptive method 26% use the pill and 52% sterilisation (BEMFAM 1997).

The popularity of the pill is mainly due to its low cost and easy availability. Pharmacies are the main source of pills and in most cases they are used without medical prescription. The popularity of these methods may be related to the absence of a national family planning programme.
The practice of female sterilisation came only after 1975. Since then there has been a dramatic increase in the proportion of sterilised women, who now form 27% of all women between 15 and 49 years old, (BEMFAM, 1997) that has made of Brazil a country with one of the highest percentages of sterilised women in the world. The

main reason for the increase in the demand for surgical sterilisation in Brazil lies in the fact that many women found the pill a very unsatisfactory contraceptive method in the long term (Potter 1999). At the same time IUDs have never been promoted - indeed have been obstructed by the government- because they are thought to be an abortificient (Perpetuo and Aguirre 2000).

Female sterilisation is common and spread all over the country in Brazil. There is evidence of a culture of sterilisation from the fact that sterilised women are daughters or sisters of sterilised women (Perpetuo and Aguirre 2000). What is interesting is that sterilisation was illegal in Brazil until 1997 but there are no records of doctors being convicted for sterilisation (Rutemberg and Landry 1993).
In order to overcome the illegality, prior to 1997 Caesarean sections were widely used. For after two Caesareans sections a woman was allowed to undergo surgical sterilisation. This is almost certainly the reason that the proportion of births delivered by Caesarean sections increased from 15 to 37 per cent between 1971 and 1996 (Merrick 1983; Potter 1999). The frequency of Caesarean sections is even higher in private clinics, reaching 71.5%. This phenomenon has led to Brazil having the highest percentage of Caesarean sections in the world (Hopkins and Potter 1997). The 1996 DHS shows that 60% of all sterilisations had been performed after a Caesarean section (BEMFAM 1997).
Caesarean deliveries have become so common that they are not used solely to justify surgical sterilisation. Desire to get sterilised made them common, being common made them normal and a sign of progress. It is an increasing phenomenon for educated women to rely on Caesarean sections being a sign of civilisation (Perpetuo et al. 1997). It is therefore difficult to highlight how much of the increase in caesarean sections was due to the desire to get a sterilisation, and how much of the increase of sterilisation was due to the abuse of caesarean deliveries.

In 1997 a law that would finally allow men and women the right to free reproductive choice has been issued (Potter et al. 2001). Men and women are now allowed to undergo voluntary sterilisation as long as the individual is over 25, is competent, has at least two children and, if married, has his or her spouse's consent. However the law specifies that the sterilisation should not be performed at the time of the delivery. There should be a 65-day wait before applying for the operation. The Ministry of Health reimburses hospitals and clinics if this condition has been met and if counselling of alternative methods has been given. This law was meant to limit the number of Caesarean sections. At the same time it was meant to create awareness of different methods. However according to Potter et al (2001) considering the few resources that

the public system has, and the strong sterilisation culture that there is in Brazil, it is unlikely that this law will have an impact on the medical practice in the short run.

The other reason for such a high prevalence of female sterilisation might be the increase of private family planning programmes that could be using health facilities to perform sterilisation. The debate on the topic is open at the moment among Brazilian demographers and it is not clear yet whether the motivation is women asking for a Caesarean section or doctor convincing women to get sterilised (Hopkins and Potter 1997; Perpetuo et al. 1997). However it is undeniable that women rely greatly on medical advice, in particular in the private sector. Brazilian women completely trust the doctors and it is often said that a woman would talk more to her doctor than to her husband about reproductive choices (Potter 1999). There is no doubt that doctors, at least in the first stages of the diffusion of sterilisation, have played an important role in the increase of the number of sterilisations performed.

Nevertheless Brazilian women also use sterilisation because they control it. They have, in this way, full control over their reproductive life. The lack of inter-spousal communication that comes out the DHS data (98% of the women do not talk about family planning with their partner) shows a strong individualism within the couple. Furthermore it shows a strong lack of confidence of the women in their partner.

The high reliance on sterilisation creates an ethical issue on the public health community. Brazilian women have not received full information on the range of contraceptive methods. The reluctance of the Brazilian government to promote IUDs has *de facto* deprived Brazilian women of a fundamental right to choose their contraceptive method. This issue has been raised only in the last few years, however, and, as analysed in depth in Chapter 7, there is the need for an increasing awareness on the matter.

What is particularly striking in Brazil, but that is common all over the world apart from South Asia, is the low incidence of male sterilisation (2%, 1996 DHS). The main reason for this is the low availability of the service, which may reflect Brazilian men's 'macho' attitude. The idea that reproductive control is a woman's matter might also prevail amongst Brazilian men (Greene 1991).

2.3.2 The role of women's autonomy

There is evidence that female education and female religiosity are fundamental in influencing fertility control behaviour. While the role of education is clear, the role of income and labour participation is less certain. Several works cited by Martine (1996) showed a strong effect of the increase of education on the decline of fertility in Brazil, but it does not seem to be enough to explain the strong decline in fertility if compared with the results in other countries with a higher level of schooling. The increases in schooling should be interpreted as substantial improvements in the social and economic status of the women, improvements that have induced large declines in fertility (Lam et al. 1994).

Brazilian women have seen a progressive improvement of their autonomy over the last 30 years. The increasing influence of feminist groups in the 1970s certainly played a very important role. With the increase in years of schooling and female employment, more and more women have seen their position inside the family raising. At the same time the male chauvinistic attitude have started to change.

The main effect that female autonomy has had on the level of fertility has probably been through the increase use of surgical sterilisation as above quoted.
One other effect has been the quasi exclusion of the man from reproductive matters. This fact is increasingly worrying and should be considered in more depth.

2.3.3 Economic development

Authors disagree on the influence of economic development and rapid urbanisation on fertility. The passage from a subsistence economy to a waged one completely reversed the advantages of having a large family. Expectations increased steeply and ended up in stimulating fertility control (Martine 1996). However, Potter (1990) stresses that even with the strong evidence of the influence of the economic growth on fertility the decline persisted in a period of economic crisis. Most of the authors agree that the fertility decline during a period of economic crisis has been continuous due to a strong increase of female sterilisation. This suggests that economic growth is not the only reason for fertility decline and that the increase in education and labour female participation had an important role as well.

Urbanisation is another explanation for the unusual Brazilian fertility decline: it started earlier and in a faster way than in other countries and it reached a stage that is not comparable to any other developing nation. This factor has been ignored for a long time when considering the causes of the fertility decline. It is likely that a country experiencing rapid urbanisation will face a stronger fertility decline principally because of the change in the labour organisation. Urbanisation contributed to the acceleration of the fertility decline in Brazil because it is associated with a wide range of social, economic, and political changes that transformed the country during the last half-century (Martine 1996). The problem in considering urbanisation as an autonomous factor in the fertility decline is in the difficulty in disentangling the socio-economic improvements and new labour organisation that increased the level of urbanisation and the effect of the urbanisation itself. In other words, it is unclear whether urbanisation is an intervening variable or one important in its own right.

Linked with urbanisation is the effect of migration: the area surrounding São Paolo attracted a substantial segment of all migratory movements during the 1940-80 period. The migrants assumed the fertility behaviour of their destination place (urban areas) and return migration could have influenced values in their places of origin.

A second effect arose through the expansion of Brazil's huge agricultural frontier (Martine and Carvalho 1992). The redistribution of the population across the country meant changing economic opportunities but also led to instability in the sexual life of couples. Selectivity of migration, particularly by sex, may have produced in various regions unbalanced sex ratios that favoured lower birth rates. The spousal separation, a consequent reduced exposure of the couple to the risk of conception, might have played a role in the decline of fertility.

2.3.4 The role of the Brazilian government

Although most of the articles report the Brazilian government as ineffective in the early phases of fertility decline, Faria and Potter (1990) point out that significant institutional changes had a direct and immediate influence on the way people thought about sex and reproduction that facilitated the massive adoption of modern contraception. They argue that although Brazil did not enact a family planning or population control policy until 1983, many government decisions in the economic and social domain have functioned as an implicit population policy. The Brazilian military government

between 1964 and 1983 had important effects on the economics of childbearing, mainly through policies that accelerated the modernisation of the Brazilian economy after it assumed power. There were substantial commitments to expanding consumer credit, telecommunications, social security and health care and extremely rapid increases in coverage were achieved in the post-1964 period. The availability of credit made it possible for low-income classes to participate in markets. In this way they have increased the amount of technology and furniture in their household.

Another determinant of this fertility decline has been the shift toward specialised, high technology, hospital-based curative care. All these determinants had the power to increase expectations and to influence the behaviour of the population. What was important for example for the influence of the policies on fertility behaviour was the fact that the credit facilities were only available to purchase goods (like clothes and cars) which are consumer items rather than subsistence goods and services (food, rent, transportation, education, medical services) that are more critical for the reproduction of the family (Martine 1996).

2.3.5 Media

The economic progress that has been made after the military coup in 1964 not only enhanced the Brazilian economic growth but also unintentionally influenced the fertility decline though telecommunications. As Martine (1996) underlines, television did not have an explicit reproductive message but has strongly influenced the trend of fertility. One consequence for example, of television (especially Rede Globo the main national TV channel), has been a progressive homogenisation of the culture at national level (Rios-Neto 2001; Rios-Neto et al. 2001). People from different regions have been exposed to the same kind of message that changes their perception of social roles. Consumerism encouraged the entire nation to mimic the upper classes and to change its way of life.

All these messages have been diffused through television messages mainly in the form of *telenovelas*. These *telenovelas* presented a stereotyped family that is usually small, unstable and egalitarian, and the values underpinning such a family entered into daily discussion and influenced traditional social values. Families started to aim at luxury goods, to improve their life style. Women would start to identify themselves with the telenovelas' heroine and would try to be as independent and as strong as her. In general there is a tendency towards emancipation in every field that has had strong

repercussions on the reproductive life of the couples. Topics such as female pursuit of pleasure even through adultery, displays of homosexuality, criticism of machismo, and emphasis on individualism are only some of the new values that have been imputed into Brazilian's families creating changes in the demographic behaviours (Rios-Neto 2001).

2.4 Unions in Brazil

What characterises nuptiality in Latin America and in particular in Brazil and makes its study particularly interesting is the complexity and variety of types of union. This variety often leads to a problem of reporting mistakes in the official statistics due to the confusion that there is between the different types of unions. For example, in Brazil it is possible to have *only civil* marriages: these are the marriages that are celebrated in the municipality only. There are also *civil and religious* marriages that are celebrated in both municipality and church.

Brazil reports a high incidence of *consensual unions*, which are characteristic of Brazilian society. These differ from the normal *cohabitation* because the couple refers to itself as husband and wife, whereas in a normal cohabitation the partners define themselves as singles. Finally there used to be until 1978 *only religious* marriages that were celebrated in the church only and had no legal value (Greene 1991).

Brazil legalised divorce in 1977. Up to that year, separations could be legalised under the form of *desquite* (perpetual separation by mutual consent) but remarriages were illegal.

2.4.1 Data availability

The main problem in studying union dynamics in Brazil is the lack of data. It is for this reason that there has not been a systematic study of the role of marital instability on fertility decline in Brazil (Martine 1996).

Henriques (1989) reports it as even very difficult to study nuptiality in Brazil. Not only do women report themselves single when they are in a consensual union, furthermore it is difficult to differentiate between consensual unions and legal unions, or between

legal and religious marriages. To ease the classification task, cohabitation is therefore included among the condition for being in the married status.

The Brazilian 1986 DHS defines marital status similarly to the census or the Pesquisa Nacional por Amostra Domiciliar (PNAD) a national household survey: it includes cohabitation as a necessary condition for being classified as in union. Both in the calendar data of the five years preceding the survey on union history status, and in questions on the current and first unions, the DHS explicitly mentions living together or being married as sufficient conditions. Important other sources are censuses that have asked the same questions in the last 40 years. One of the best sources has been the PNAD in 1984 that included a section on union and marital childbearing. This has been one of the chief sources used in most of the studies of this topic, but unfortunately the same section has not been included in any of the subsequent PNADs. A shortcoming of the data is that the PNAD does not provide the same marital history for men. Another problem facing those who work with this kind of data is that while unions that are currently surviving have complete information on both husbands and wives, doing an analysis only on currently surviving unions would introduce a strong selectivity bias as consensual unions have a high probability of dissolving.

2.4.2 Statistics

Looking at some statistics, it is possible to see that considerable stability has been found in the more aggregated nuptiality indicators: for example the mean age at marriage remained quite stable at the level of 22 years over the period 1960-80. In 1980 legalised unions represented 80.1% of all unions while consensual unions where close to 12%. Religious-only marriages declined from 20.2% in 1960 to 8.1% in 1980 for the whole country with the relative decline being bigger in the rural areas. The proportion of women aged 20-29 years who are in consensual unions has doubled in these 20 years. However legal unions are still considered advantageous because they provide economic and psychological security to the family.

Very young women and old women are more likely to enter a consensual union (Greene 1991), the latter because it is easier to enter in an informal union after being divorced. In general, second or higher order unions are more likely to be informal.

In Brazil, there has been an increase of the union instability in the last decades and for this reason Martine (1996) has raised the question whether part of the fertility decline in Brazil is due to union instability. It is possible to this from Table 2.4. This would be even

more evident if a longer period and a wider age sample were considered. There is evidence of a decline of union durations too (Lazo 1992).

Table 2.4 Percentage of women by number of unions, DHSs 1986-1996 Brazil

	1986	1996
One union	90.2%	86.1%
More than a union	9.8%	13.9%

Source: DHSs 1986,1996

If considering the tendency of women to have more than one union it is possible to see from Figure 2.2 that the older the women the more likely it is she has experienced more than one union.

The Northeast and centre east regions report the highest percentages of women that have experienced at least two unions (Figure 2.3). The Northeast in particular is characterised by a high incidence of consensual unions usually thought to be more unstable.

Figure 2.2 Number of unions for Brazilian women aged 15-49 by age group. 1996 DHS

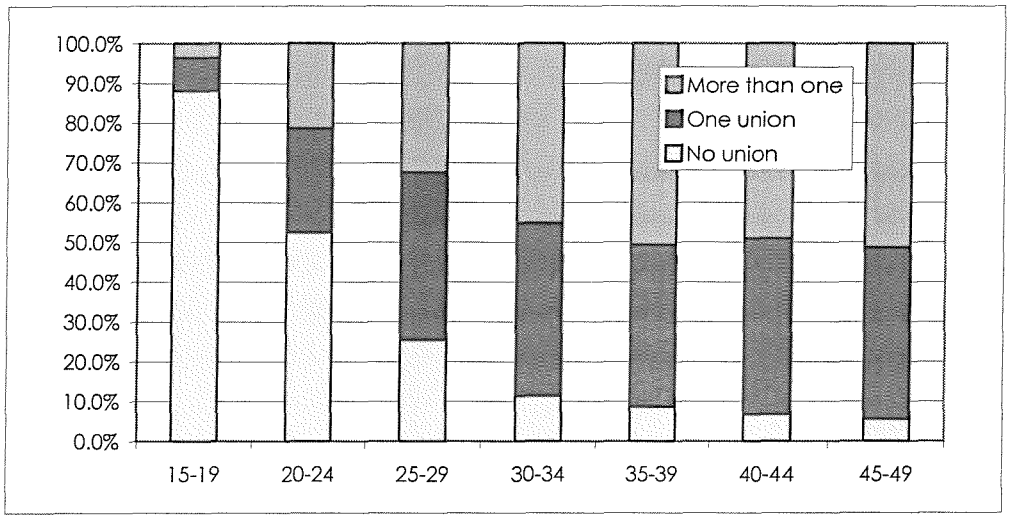
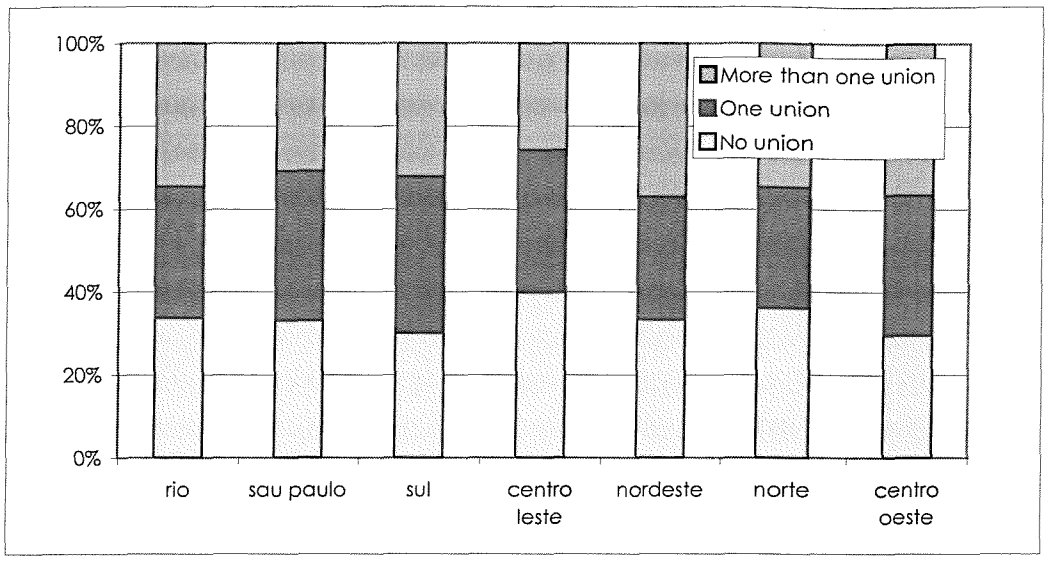


Figure 2.3 Number of unions for Brazilian women aged 15-49 by region. 1996 DHS



Mixed and black women are more likely than white to have experiences more than union (Figure 2.4). This racial difference in terms of type of marriage and stability of unions with black or mixed race couples having a higher change of union disruption compared with white couples was also observed by Greene (1991).

Women with lower levels of education are also more likely to have experienced at least two unions (Figure 2.5).

Figure 2.4 Number of unions for Brazilian women aged 15-49 by ethnicity. 1996 DHS

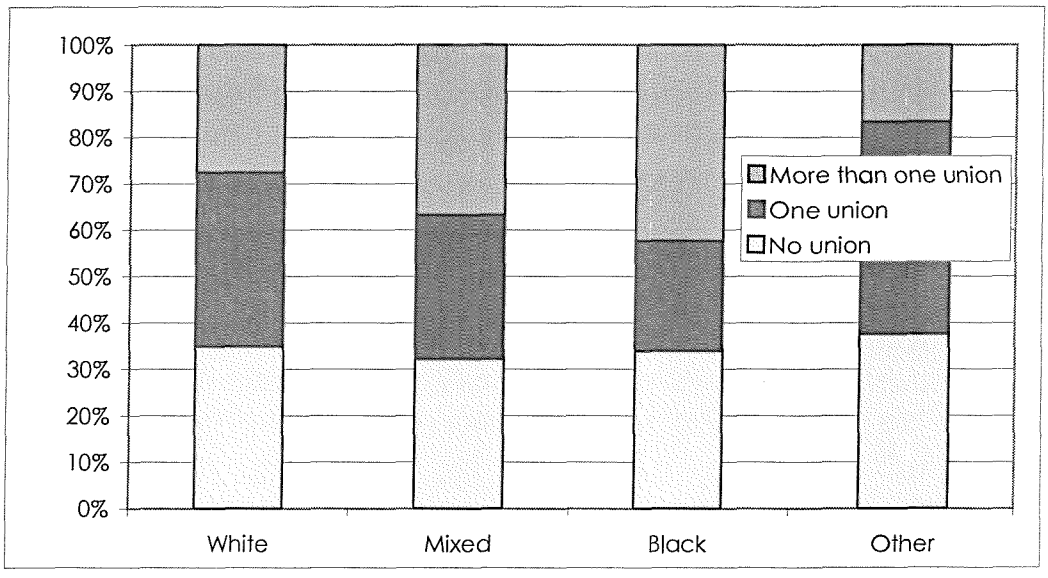
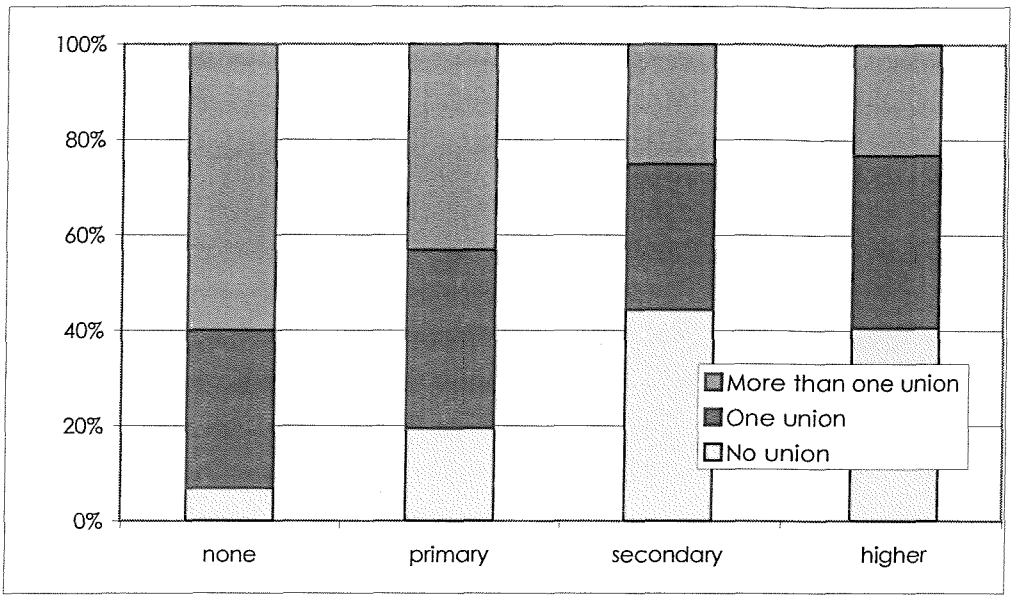


Figure 2.5 Number of unions for Brazilian women aged 15-49 by level of education. 1996 DHS



2.4.3 Incidence of consensual unions

As pointed out earlier, a common alternative in Brazil to marriages sanctioned by the church and the state is consensual or informal marriage, the formation of a conjugal union through living together and creating a shared life that in many respects includes the basic elements of formal marriage (Greene and Rao 1995). The reason for this high rate of consensual unions in Brazil should be searched for in the colonial history of the country. At the beginning of the colonisation in the XVI-XVII centuries it was common for Portuguese men to start a new union with indigenous women even though they were married in Portugal. In 1603 the Law of Realm promulgated that publicly recognised consensual unions would have had the same status as marriage (Greene 1991). This, together with other initiatives to make marriage procedures easier, was aimed at reducing concubinage. Subsequently during the XVIII century and the beginning of the XIX century, inheritance laws made the marriage custom more universal. The increase of legal marriages was originated by the fear, in particular among upper classes, of loosing part of their property.

In the XIX century, 40% of the trans-Atlantic slave was to Brazil compared with 4% to the United States. The common thought at the time was that the slaves were sexually promiscuous and usually they would build up families without structure or norms. At the

same time these groups were not allowed to marry formally. Among these groups free unions were common. Racial mixing was much more common than in United States and intermarriage took place almost entirely through free or consensual unions (Greene 1991).

At present legal marriages in Brazil are expensive in terms of ceremony and documents, it is for this reason that many people, especially among the low income classes, are in informal unions. Legalised unions are more common among women who marry after their teens or those who have some education. Consensual unions in Brazil, therefore, end up in being useful in two kinds of situations. First, they are optimal for low-income classes that cannot afford the expenses of ceremonies and of eventual legal separations. At the same time low-income men lack a stable job that gives psychological security. Second, the legalisation of divorce has made consensual unions more likely for people with already one union; they might go into cohabitation before committing themselves in another union. For these reasons, it is likely therefore that the increase in consensual unions will continue. The growth of consensual unions might lead to more liberal habits that would affect all groups (Henriques 1989).

Greene (1991) shows that different kinds of marriage have widely different levels of stability. Consensual unions are more fragile than civil and religious ones, which are by far the most durable of all marriages. Furthermore consensual unions are more prevalent among second and higher order unions.

The increase of union instability is linked to the increase of consensual unions but it is also related to the increase of the woman status. Union instability is common among highly educated, young, economically independent women usually living in richer areas (Lazo 1992). The legalisation of divorce in 1977 might have been the impetus for a lot of women to get out of unhappy relationships. It might be interesting to see whether this trend will continue in the future with the increase of economic wealth and in particular with the rise in women's status. It is possible that the number of separations will decline due to a different approach to marriage: women might rely less and less on the men as source of economic security and therefore rely less on marriage as a source of economic stability. This would lead to a decline of marriages started for convenience and therefore less stable. However it is not possible to foresee this happening in the immediate future.

The legalisation of divorce and the overall increase in the number of separations from legal marriages might also have led people to start out in a consensual union to test

their compatibility before moving on to legalise their union (Henriques 1989). What is interestingly underlined by Henriques (1989) are differences in the characteristics of women in each type of union: women in consensual unions are on average less educated than those in legal unions; family income differs as well. At every age group a much higher proportion of women in consensual unions is poor compared to those in legal unions. The women in consensual unions show a lower level of fertility compared to the legally married. On the other hand more women in consensual union have never used contraceptive methods than married ones. If you consider the timing more than the level of fertility, the consensually married have a higher percentage of women starting their first union before the age of 20 and even higher for those who have had their first child before the age of 20.

2.5 Conclusions and summary

Several papers stress the peculiarity of the Brazilian case, most of them without reaching a satisfactory conclusion on the causes of the steep fertility decline. Probably the peculiarity resides in the tendency of most authors to compare the Brazilian case with the rest of Latin America. If considering Brazil under a macro perspective, grouping the main features into main categories, it is probably possible to talk of an anomalous case. Brazil did experience a fertility decline in a period when the government was aimed towards a pronatalist policy, in a period without a government sponsored family planning programme. However in stressing that it is an anomaly we forget that the decline started well before 1960. At the same time it should be remembered that the demographic transition in Europe happened without the help of the governments, and certainly in absence of a family planning programme.

If the Brazilian case is considered under another perspective, specifically, the perspective that considers individualism and the changes in ideology that can happen in each country, it could probably be seen that Brazil is simply different from the rest of Latin America and not anomalous. Brazil is different from the Latin America not only in the demographic patterns but also in the language and culture. As it has been stressed in other papers (Basu and Amin 2000), language can play a fundamental role. If anything the main peculiarity of Brazil stands in the homogeneity

of behaviours at national level. The influence of the mass media has played a major role in this and their effects are identifiable in the couple's lives.

The study of union dynamics in Brazil is not an easy task, not least because of the lack of data. Furthermore, union dynamics have had far less attention than fertility in Brazil. In this respect the analysis of fertility lacks a fundamental component that could explain a big part of the reproductive behaviour. The lack of data underscores part of the difficulty of a complete study of both union dynamics and reproductive life. The challenge lies in exploiting the data that are currently available. In the next chapter the two processes will be linked, considering their mutual relationship.

Chapter 3

Fertility and union dynamics: two-way relationship

This chapter describes the basic hypotheses that lie behind the analysis that is presented in Chapter 6 and 7. The interaction between union dynamics and childbearing patterns is complex and has been approached differently from economic, demographic and sociological perspectives.
Economists see childbearing and marriage as the outcome of a cost-benefit analysis. Demographers have for long seen union instability as depressing the level of fertility (Bongaarts 1978).

Most of the literature reviewed in Chapter 2 considers the impact of union instability on the level of fertility as negligible if not negative. However, there have been few studies that have truly attempted to analyse the relationship between fertility and union dynamics as opposing to making general assertions without much evidence, and only one has analysed the impact of union instability on the level of fertility.

In this chapter the hypothesis that is at the base of the study is described: that union instability has a positive effect on the level of fertility in Brazil.
The main literature on the topic will be reviewed and it will be explained why it is believed that women in unstable unions could have a higher level of fertility. In this analysis the single components that could affect fertility will not be studied in depth, however this review will help in strengthening the initial hypothesis.

3.1 The two-way relationship

Family building behaviours show that decisions about childbearing, marriage and divorce are interrelated and commonly simultaneous events. The relationship between fertility and union dynamics should, in fact, be seen as a two-way relationship, in which it is by no way clear which one is cause and which is effect. The ultimate fulfilment of a marriage is in most cases the birth of a child and it is not uncommon to get married because of a birth of a child. Numerous factors interact in the couple's complex life bargaining and the presence of children plays a relevant role. Desired fertility can be considered as a function of perceived cost and benefits of children to women and men. Entering in the union and deciding to have a child is the result of a bargaining process and is influenced by the role played by each partner inside the union.

Childbearing is the result of a series of decisions taken most of the time simultaneously and that influence each other. Deciding to have a child is the result of the decision not to use any contraceptive method, the decision not to abort a pregnancy, and thereby to start a new family or make the existing one bigger. This may also involve working within budget constraints, taking decisions about the career and about education if the woman is still studying. All these decisions take into account the cost and benefits of a new child (Becker 1960).

Entering in a union involves deciding first of all whether to cohabit or to get married formally. It may involve changing residence if the couple is not cohabiting yet. Involves deciding about childbearing and it might affect the decision to continue or not to pursue education. If the potential partners have children from previous unions, the decisions to entering a new union could be affected by the impact that it could have on the children. At the same time, previous children might have a negative effect on the ability of the woman to look for a new partner as they might restrict the time available to start a new relationship (Becker 1973).

Leaving a union involves the decision to move out of the current residence or to remain on one's own in the current one. It involves the decision not to bear children anymore with that partner, and decisions about the location of the children born to that relationship. In this case as well, separation is the result of a cost benefit analysis that considers the separation more beneficial for at least one member of the couple than staying together. More importantly, people dissolve their union if their combined

wealth when dissolved exceeds their combined wealth of when together (Becker et al. 1977).

The classical economic analysis of entering and leaving unions reduces union formation and childbearing to the mere outcome of a cost-benefit analysis. Although the literature on the topic is particularly rich, it is believed that to restrict the analysis of union dynamics to the economic approach is limited. These types of decisions involve the psychology of the couple and their level of affection. Furthermore it should not be underestimated the influence of social norms and the effect that the environment could have on these type of decisions. Finally it is important to stress the simultaneity of the life course events and the effect that each decision might have on various aspects of a couple's life.

3.2 Fertility influences union dynamics

Almost universally childbearing is socially accepted inside a union. In many cultures it is not tolerable to have an out of wedlock birth. In certain religions, in particular Islam and, to a lesser extent, Catholicism, it is not accepted.
Cultural bindings can be very strong and one way to create less 'friction' with the rest of the community is to have children within a union. An out of wedlock conception could therefore lead to starting a new union to legitimise the newborn. It has been found that in some cases women get pregnant to force the man into a formal relationship in particular in cases of economic deprivation (Glaser 1999; Greene 1994). Thus women take advantage of the social situation to make gains economically.

It is more likely for couples without children to divorce. The increased stability of unions following the arrival of children is evidence that children do add something positive to the union or that children increase the costs of dissolution.
Couples without children do not have problems of having to arrange for child custody, support and visitation and therefore may divorce more quickly than couples with children (Koo et al. 1984). In fact lack of financial support and children are often cited as a reason for not divorcing (Heaton 1990). In particular low-income women have to face the high financial dependence on men when they have children and might not divorce because they are unable to afford to live on their own.

Children can also influence the probability of remarrying. Women with children might have financial problems to raise them and might look for a new partner to provide economic security. On the other hand women with offspring could deter a possible husband for the high commitment that the children involve. At the same time a woman with children from a previous marriage has less time to dedicate to search for a potential husband and could therefore have less chances of remarrying than a woman with no children (Becker 1973). In general the probability of divorce is lower for women with a large number of children and these women will take longer to divorce than those with smaller numbers of children (Koo et al. 1984).

There is evidence from several studies that the number and the age of children have an impact on union instability (Heaton 1990). Couples with young children believe that they should stay together for the benefit of the children, even when they do not get along. It is important in particular to look at the age of the youngest child: union disruption declines steeply by the time the youngest child reaches adulthood. It has been shown for example that union disruption increases up to the child age of 3 years and then it declines (Heaton 1990). Couples with young children are usually at the early stages of the union when it is more likely to split up. The arrival and ageing of children is an important dynamic with strong implications for union instability (Heaton 1990).

3.2.1 Union dynamics influence fertility

The decision about whether to have a child or not depends as well on the stability of the union. Some couples might avoid having a child if they are not sure about their relationship in order not to involve the child in a possible trauma after the separation of the parents. Some other couple instead might want a child to strengthen their union. It is common to have a child in each new union to fulfil the idea of having a proper family. It is also common among low-income women to bear children in order to keep their relationship. Women, particularly those in consensual union, are aware of the weakness of their relationship and, in particular in the early years of their relationship, having a child might be a rational strategy for keeping the husband with them. Husband and wife may wish any way a child together regardless of the number of children either of them had before. This is particularly true for men who leave their previous children with the previous partner (Greene 1994).

3.3 Fertility and union instability

3.3.1 Conceptual framework

In the study of the proximate determinants of fertility the proportion of married women is considered as an exposure variable (Bongaarts 1978): women are considered at risk when they are in a union.
Onaka (1973) cites numerous articles that have found that the time lost due to sexual union dissolution is inversely related to the level of fertility. The amount of fertility loss is then related to the type of sexual union: for women in consensual unions the time lost is usually higher than for those formally married (Onaka and Yaukey 1973).

However, in countries with high contraceptive prevalence and where family planning decisions are the result of a complex bargaining between the two partners, it is difficult to predict how union type and union stability will be related to fertility. The following statement of the United Nations explains clearly the problems encountered when studying the relationship between fertility and union instability:

> "The tendency of women to start their conjugal life in less formal unions creates a pattern in which many women find themselves, during their peak reproductive years, in unions which are, on the one hand, less conductive to effective fertility control and, on the other hand less stable. This lack of stability can be a factor in ultimate fertility outcomes because, while it may lead to a loss of exposure time, it also leads to a greater chance of multiple partners. The number of partners a woman has had has been shown to be positively related to fertility regardless of union type. This is because of men's desire to father children with each partner." (United Nations 1988)

This quotation gives a clear idea of the complexity of a study of the relationship between fertility and union instability. The idea that comes out clearly is that the effect of union instability on fertility is confounding. On one hand it can have a negative effect due to the loss of exposure to the risk of conception. On the other hand it can have a positive effect for various reasons that will be analysed in more depth later in this section: couples often want a child in each union, and women might have a less effective use of contraceptive methods. There is also the additional point that the frequency of coitus is higher at the beginning of a union, at short union durations, so women with more, but shorter, unions might have more frequent intercourse over their reproductive lives than women with fewer, longer, unions (Chen et al. 1974).

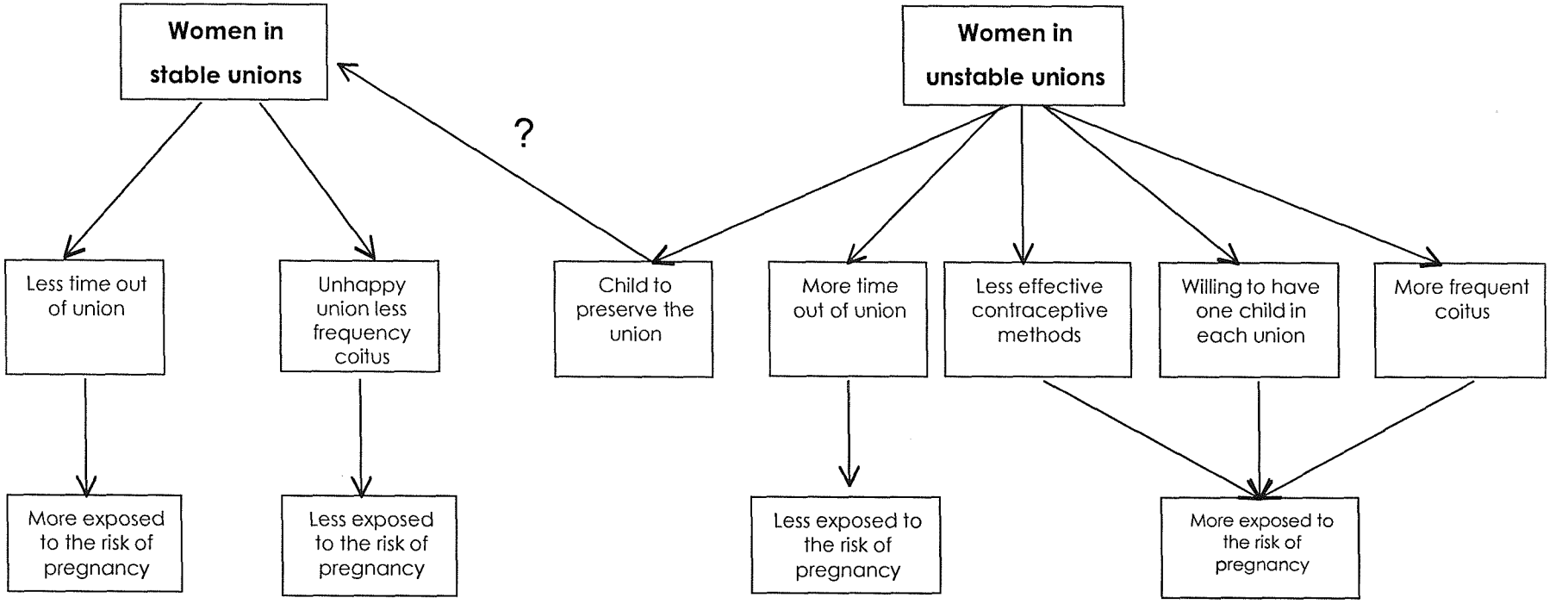
Opinions on the topic differ and are often linked to the culture that is analysed. Ebanks et al. (1974), for example, agree with Bongaarts' framework in contrast with the United Nations (1988): they hypothesised that the instability of unions would

depress fertility in the Caribbean islands. Therefore a reduction in instability would lead to higher levels of fertility. This hypothesis was derived from the observation that the higher the instability the higher the period a woman spends outside the union, as so there is a decrease in the amount of exposure to the risk of pregnancy. It is logical to suppose, therefore, according to the authors, that the larger the number of partnerships the lower the level of fertility.

Using the data of the Caribbean Islands, they found out instead that as the number of partnerships increases so does the average number of live births (Ebanks et al. 1974). The reason lies in the fact that many Caribbean women enter into a new relationship when they have not yet finished the last one, leaving no gaps between the two relationships. One of the most interesting findings of this analysis is that one of the most likely times to break a sexual relationship in a Caribbean country is when the woman becomes pregnant.

As shown in Figure 3.1, therefore, there are different effects that should be taken in consideration in a study of this type. The main point to emerge from the diagram is that for women in unstable unions the outcome is less clear and not always foreseeable. Generalisations in this case might not work as the outcome is too much linked to the individuals' behaviour.
In the following sections some aspects of the effect of union instability on fertility are considered in more detail.

Figure 3.1 Effects of union instability on fertility



3.3.2 Effectiveness of contraceptive use

Type of method

The effect of union instability on contraceptive use could be confounding: women in a stable relationship are more likely to use an effective family planning method and this could result in a lower level of fertility.
Women in stable unions are those who are constantly at risk of conception and there is no loss of exposure. However women in stable unions could be more likely to use more effective contraceptive methods and to use them more effectively. A woman in a stable union is more likely to use Intra Uterine Devices (IUDs) or sterilisation after having reached the desired family size. Women in stable unions can rely on the fact that it is easier for them to plan their family size with their partner. On the other hand women in unstable unions or women who believe themselves likely to have several partners are less motivated to use a contraceptive method that involves a high commitment like sterilisation, or a method like the IUD that is not easily available and that needs to be inserted by specialised hospital based personnel. Women in an unstable union are more likely to use less effective methods like condoms or, among the highly effective ones, the pill.

The literature on the topic is rather thin and one of the main studies by Bumpass and Rindfuss (1982) contradicts this point of view. Using monthly contraceptive histories collected by the National Surveys of Family Growth in the US, they show that women that have experienced unstable unions are less likely to use coital dependant methods (condoms, diaphragm) when they are about to split up. The reason for this might be in the fact that when there is a crisis the couple tends to have more problems in communication, therefore they might be less willing to use contraceptive methods that involve collaboration. This is even more evident when looking at the fact that these types of methods are less likely at the end of the union as well. However marital dissolution does not have a big impact on contraceptive usage and despite this effect, contraceptive use patterns following separations are very similar to those of women who remain in the same union (Bumpass and Rindfuss 1982).

Godecker, Thompson and Bumpass (2001) analysed the effect of union histories on the timing of sterilisation using a Cox proportional hazards model. One of their main results was that cohabiting partners, generally known for having less stable unions, do not show different patterns of sterilisation timing from formally married ones. Women in unstable unions seem to take the decision to get sterilised more often than women in

stable unions as the alternative of male sterilisation is usually not available, as their partners are unable/unwilling to offer it. It is likely that the sterilisation decision is taken individually rather as couple. In this respect the authors foresee an increase in the gap between sterilisation rates of cohabiting partners at gender level: cohabiting men might be less prone to get sterilised because of the greater likelihood of changing partners and a consequent desire to have another child with a consequent partner.

Bailey et al. (2001) conducted quantitative and qualitative analysis among men aged 15-40 in Jamaica. They show that men in casual relationships are less likely to encounter women that use permanent or at least safer methods such as the pill, IUD and sterilisation. One of their most important findings is that women's ability to control their fertility depends not only on their knowledge but also on their dependence on men and males 'macho attitude'. Men exhibit a different contraceptive behaviour according to the type of sexual relationship they are in. Men in general had a strong disapproval for permanent methods as it could affect their virility. On the other hand most of men in stable unions would not use condoms as they considered them disrespectful to their partner (if the woman is faithful there is no need for condoms). However this behaviour often shows a double standard as Jamaican men often feel the need for more than one sexual partner (Bailey et al. 2001). In general the study concluded that young men and in particular men in casual relationships preferred no permanent or semi-permanent contraceptive method.

The mechanisms behind the relationship between contraceptive use and union duration are influenced by the culture and contraceptive tradition of the country, therefore it is possible to generalise from the results above discussed. It is in the author's belief that for Brazil women that are in less stable relationships and might want to get pregnant to keep the relationship, might be more likely to rely on reversible methods rather than sterilisation.

Effectiveness

If considering the effectiveness of use rather that the type of method, the UN's statement (United Nations 1988) about a less effective use of contraceptive methods for the women in unstable unions is questionable. First of all there is no clear evidence that an effective use of contraceptive method is linked with the number of unions a woman had. Secondly the effectiveness of the use is influenced by the availability, price and knowledge of the method, by the woman's characteristics such as education, social background and not by the stability of the union. The stability of the union is influenced by the characteristics of the partners. If there is a difference in

terms of higher risk of conception this difference might be in the use of less effective contraceptive methods rather than in a less effective use. Therefore much more emphasis should be given to the type of method that is used by union duration and by union history.

3.3.3 Frequency of coitus

A simple analysis of time exposure to the risk of pregnancy cannot explain the complexity of the relationship between fertility and union instability. It is possible for example that a woman in a long stable union has a lower level of fertility than one who has lost more reproductive time for the fact that she stays in a unhappy union where sexual intercourse becomes infrequent (Chen et al. 1974).
Bongaarts' model has demonstrated that fecundability increases with the increase of coital frequency (Weistein et al. 1990). Obviously the exposure to the risk of pregnancy is highly related to the frequency of sexual intercourse, what is less obvious is the relationship between the frequency of coitus and the 'happiness' of the union. Studies have shown that the frequency of sexual intercourse is inversely related to the union duration (Rao and Demaris 1995; Weistein et al. 1990). Frequency of sexual intercourse has been found to be negatively related to husband and wife's age and to the union duration.
The possible reasons for this negative correlation could be physiological factors, 'boredom' of the couple, staying together for the sake of the children, or increasing familiarity with the partner, or simply strong influence to social norms that consider divorce as culturally not acceptable.

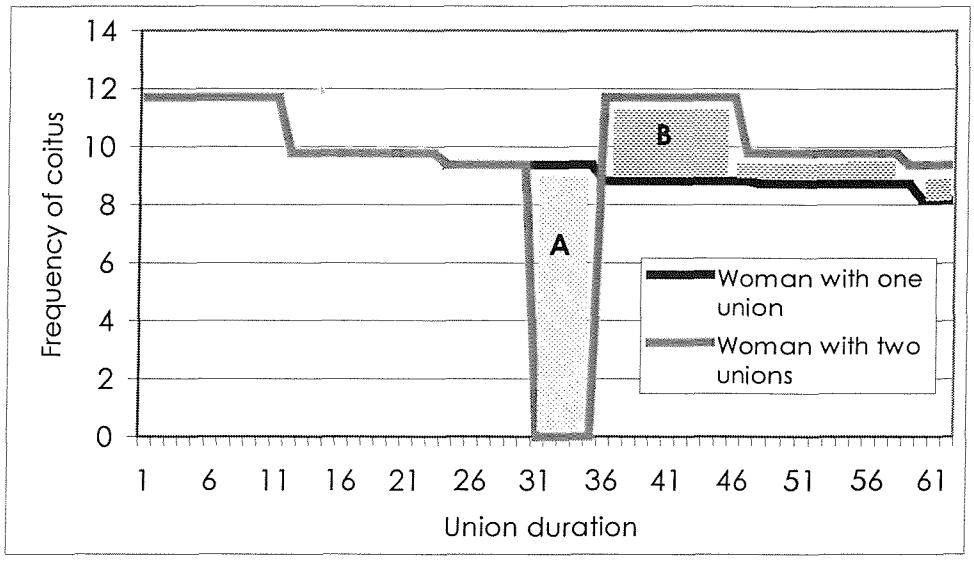
In order to show that women who enter into more than one union have a higher exposure due to the higher frequency of sexual intercourse, two women's union history have been considered. These women were taken from the 1996 Brazil DHS. As explained in more depth in Chapter 4, it is possible to deduce whether the woman is in a union for each month of the calendar period. Two women who started their first union on January 1991 that corresponds to the beginning of the calendar period have been chosen. One woman is in one union only throughout the calendar period, whereas the other one is in two unions and has a gap between them.

Table 3.1 Monthly frequency of coitus by union duration. Application to two empirical cases extracted from the 1996 Brazilian DHS calendar

Year	Woman in one union			Woman in two unions		
	Union duration*	Union order	Frequency of coitus	Union duration*	Union order	Frequency of coitus
1	12	1	11.71	12	1	11.71
2	24	1	9.77	24	1	9.77
3	36	1	9.38	36	1	9.38
4	48	1	8.81	48	1	8.81
5	60	1	8.72	6	2	11.71
6**	62	1	8.15	8	2	9.77

*Union duration in months at the end of the year
**To conform the data to the 1996 DHS calendar data only the months reported in the calendar have been used

Figure 3.2 Monthly frequency of coitus by union duration. Application to two empirical cases extracted from the 1996 Brazilian DHS calendar



The 1991 Northeast of Brazil DHS asked a question of married women about the frequency of sexual intercourse in the last month preceding the interview, a question that is not available in the 1996 dataset. For those women in one union only the average frequency per month by union duration has been estimated. This frequency has then been applied to the two women that were chosen from the 1996 calendar hypothesising that there is no sexual intercourse when the woman is out of the union (Table 3.1). Although this is a rather extreme case, in which the second women spend only a short time between unions, it is still possible to see that the woman with more than one union has a higher exposure to the risk of conception in the overall period (Figure 3.2). This exposure would be even greater if considering a longer period. In particular if considering the amount of sexual intercourse by the area under the

curves it is obtained that if B>A then the woman in 2 or higher order union has more sexual intercourse than the woman with one union only.

3.4 Fertility and union instability in Brazil

3.4.1 Fertility levels and patterns by number of unions

An initial descriptive analysis of the Brazilian data is reported bearing in mind that the analysis does not control for age. There is an initial confirm of some of the findings of other Latin American countries (Bailey et al. 2001; Glaser 1999). Women in consensual unions report a lower age at first union and at first sex.

Table 3.2 Mean age at first sex and at first union by union type, 1996 Brazil DHS

	Married	Living together
Age at first union	20.29	19.19
Age at first sex	19.48	17.82

At the same time it is common for women who enter in more than one union to be in a consensual union when they enter in their second or higher order union. It is possible to see in Figure 3.3 that women in an unstable union history are more likely to be in a consensual union, whereas those who are in their first union are more likely to be formally married.

Figure 3.3 Percentage of women by union type and by number of unions, 1996 Brazil DHS

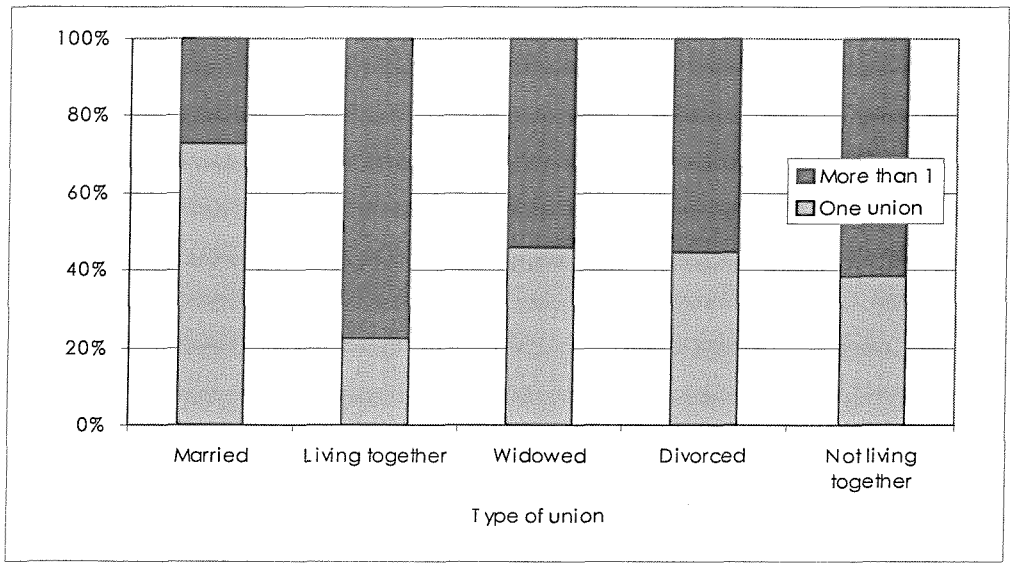


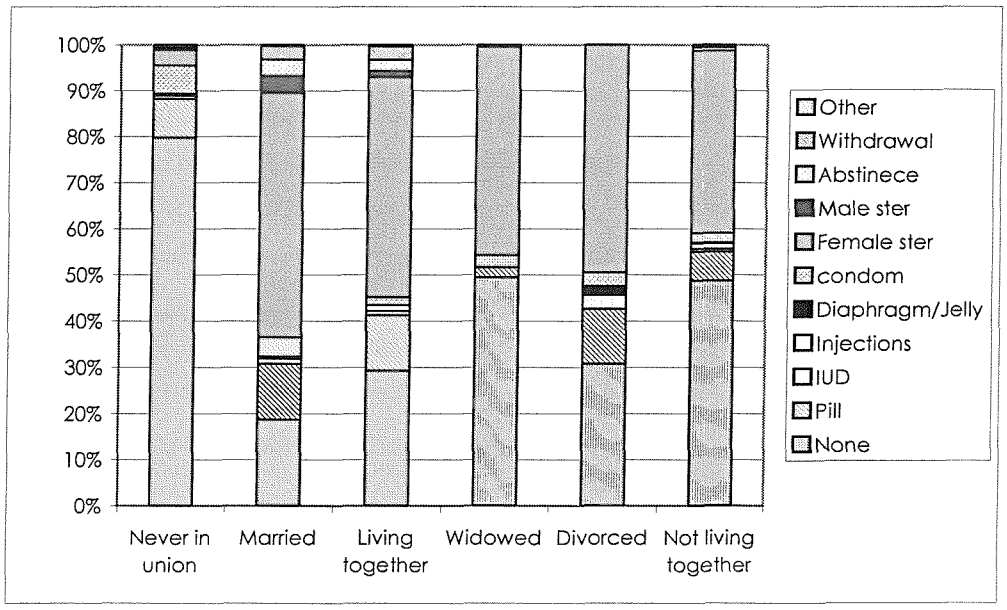
Table 3.3 Percentage of women using different contraceptive methods by union type, 1996 Brazil DHS

Union Status	Contraceptive Method										
	None	Pill	IUD	Inject.	Diaph/ Foam/ jelly	Condom	Fem. Sterilisation	Male sterilisation	Per. Absti	Withdrawal	Other
Never in union	86.1	6.5	0.1	0.9	0.0	4.4	0.6	0.1	0.5	0.7	0.0
Married	22.0	18.6	1.1	1.0	0.1	4.2	44.6	2.3	3.2	2.8	0.3
Living together	34.1	20.8	1.0	2.2	0.1	2.8	33.1	0.8	1.7	2.9	0.6
Widowed	46.8	3.9	0.5	-		2.4	45.9	-	0.5	-	-
Divorced	33.7	10.6	4.8	-	1.0	3.8	46.2	-	-	-	-
Not living together	52.8	9.0	0.8	1.8	0.2	2.9	30.8	0.1	1.2	0.3	0.1

Source BEMFAM, 1997

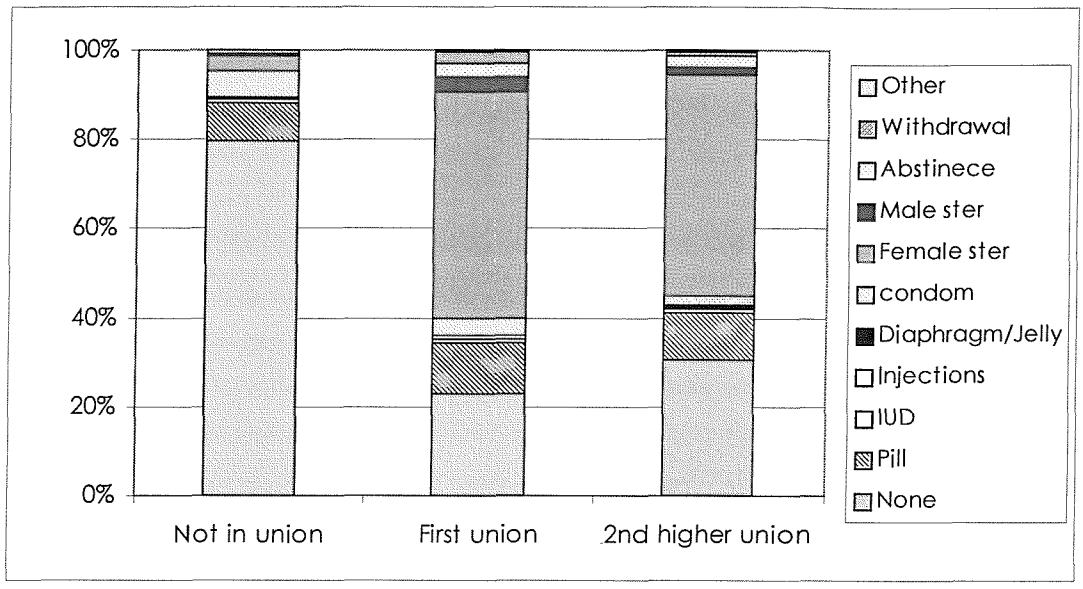
If considering the type of contraceptive method used (Table 3.3) women in consensual union report a higher level of no use and a lower level of sterilisation. The data are, however, obviously affected by the fact that married women are older and therefore more likely to be sterilised. For this reason in Figure 3.4 the percentages only for those women that are aged over 30 years old are reported. Married and divorced women report the highest percentages of female sterilisation. Whereas cohabiting women report a higher percentage of non-use compared with married ones. Interestingly women that are in a union but not cohabiting (not living together) have a high percentage of female sterilisation.

Figure 3.4 Percentage of women over 30 years old using different contraceptive methods by union type, 1996 Brazil DHS



If the same data but according to union status for women aged 30 and above is considered (Figure 3.5) it is see that women in their first union have a slightly higher percentage of sterilised women. Whereas women in second or higher order unions show a higher percentage of non-users.

Figure 3.5 Percentage of women over 30 years old using different contraceptive methods by union status, 1996 Brazil DHS



The actual level of fertility (Figure 3.6) by number of unions is considered. Unfortunately, as pointed out in Chapter 4, in the DHSs it is only possible to distinguish whether the woman has experienced one and more than one union. Comparing these two groups of women, the age-specific fertility rates (ASFRs) show that fertility is higher in almost all age groups for those women who have been in more than one union. This result gives a first indication that women with a less stable union history might have a higher level of fertility than monogamous women.

If analysing fertility by union type, it is possible to see (Figure 3.7) that women in consensual unions, that are usually known for being more unstable than marriages, have higher ASFRs at any age group except the 20-24 years old, confirming the findings of previous research (Greene 1991; Greene 1994).

Figure 3.6 ASFRs by number of unions, births in the 5 years preceding the survey Brazil 1996

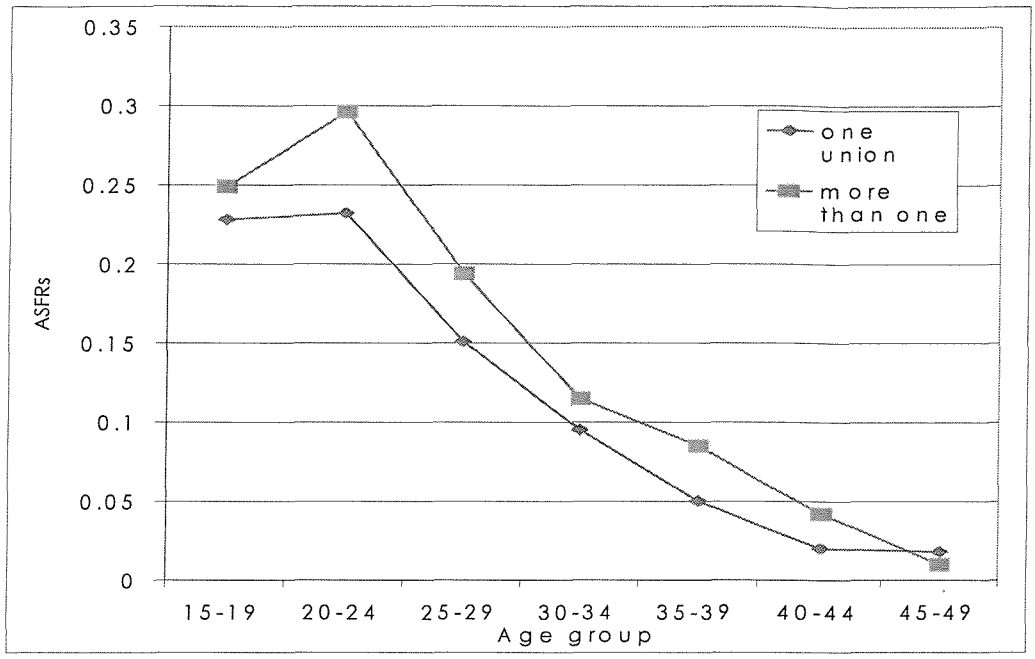
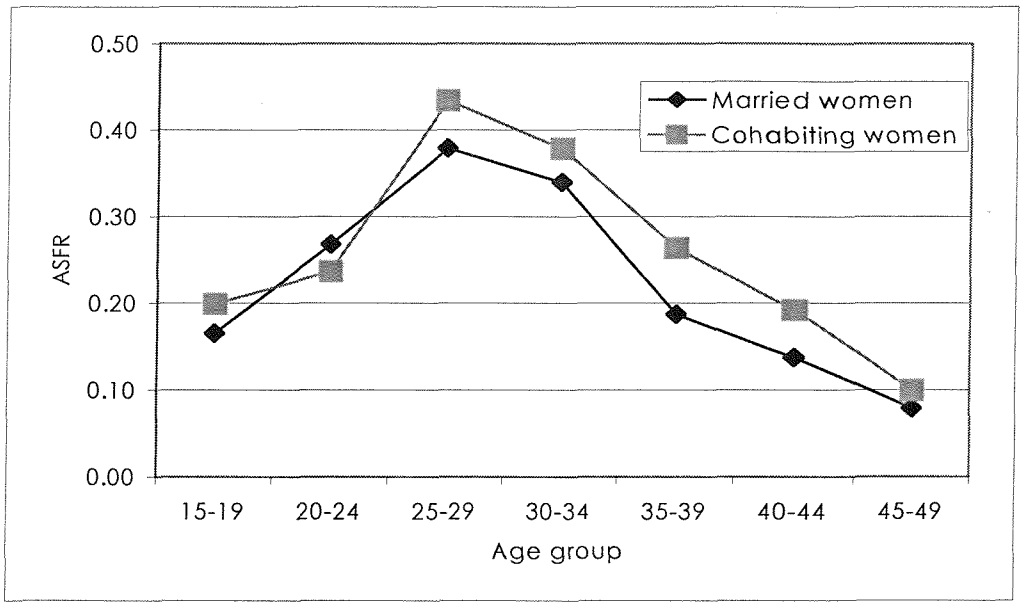


Figure 3.7 Age specific fertility rates by union type, 1996 Brazil DHS



3.4.2 Accounts of the relationship

In the analyses of the effect of nuptiality changes on the level of fertility, one idea that has arisen is that the recent increase of consensual unions and the increase of more liberal sexual customs might lead to earlier exposure to the risk of pregnancy. At the same time, however, increasing contraceptive knowledge and sterilisation at earlier ages might counteract the effect of an early exposure. Consensual unions are usually known as being more unstable and seem to have a higher level of fertility (Greene 1994). These women with 'unstable' union histories usually spend less time inside a union, but at the same time they have higher fertility when they are in union.

Interest in union dynamics in Brazil increased in the second half of the 1980s and the beginning of the 1990s because of the availability of the PNAD survey that offered complete union and fertility histories for almost 140,000 women. Since then there has been no attention to union dynamics in Brazil. Even with the PNAD dataset, the literature does not offer a particularly rich number of pieces of research on the topic. The most substantial contribution is that of Margaret Greene and Viajendra Rao (Greene 1991; Greene 1994; Greene and Rao 1995; Rao and Greene 1991). Their research made a fundamental contribution, both to the Brazilian context and to the study of union dynamics and their interaction with fertility in general. They were able to integrate ethnographic, economic and statistical techniques to analyse the complexity of the interaction of union choices and reproductive behaviour. Nevertheless their analysis concentrates on the effect of union instability on fertility without considering the effect of fertility on union dynamics, thus ignoring the endogeneity, although they point out that in Brazil women sometimes use pregnancies to stabilise their unions. Their interpretation focuses on the economic dependence of the woman on the man and how there is a direct relationship between women's autonomy and union stability.

In particular one of Greene's analysis (Greene 1994) concentrates on the importance of union type on the bargaining power of the woman and the consequent stability of the union. She stresses the tendency of Brazilian women in informal marriages to use childbearing to keep the relationship. However there is no reason to believe that women decide to enter in a consensual union or in a formal union according to the number of children they already have or according to whether they have conceived. It is reasonable to think that fertility is influenced by the type of union the woman is in rather then the choice of type of union being influenced by the fertility outcome.

From the 1984 PNAD and the 1986 DHS it seems that women in formal marriages have a slightly higher number of children. However, looking at the births in the 5 years preceding both surveys, women in informal unions consistently show a higher number of births. The explanation of this could be found in the fact that women in consensual unions are younger therefore have higher current fertility and at the same time because younger they are at the beginning of their union. As reported in the previous section, women in the early days of unions are more exposed to the risk of conception.
Women in informal marriages are less likely to use any contraceptive method (Greene 1994). There is no information, though, about which type of contraceptive methods is used by the women in informal unions.

Finally, women in informal marriages are more likely to have actual fertility that exceeds their desired fertility. It might be interesting to see how much of this gap between desired fertility and actual outcome is due to the use of childbearing as a means for keeping the partner in the relationship. However Greene (1994) highlights that this gap is mainly relevant at higher parities suggesting that it refers to older women who might have not benefited from modern contraceptive methods. At the same time older women will have had more relationships to keep and so more chances for the effect to occur.
The Brazilian case is particularly interesting because of the type of roles that men and women have in the household. As mentioned in the previous sections it is common to find among men the culture of 'machismo'. This attitude is reflected in the bargaining power of the women inside the household. Men in informal unions have fewer obligations and women are more vulnerable. As Greene (1994) found out in her fieldwork in two completely different areas of Brazil (Northeast and São Paulo), it is very common for women in informal unions, in particular for those of the lower classes, to use childbearing to keep their partner. At the same time men leave the children they have with previous relationships. As a rule, men from lower classes do not support children from previous unions. Regardless of the number of their previous children, they tend to start a new family once they get in a new union. It is a 'macho' attitude as well to have a child with each woman with whom they have a relationship. Women in consensual unions feel weaker, in particular when they do not have economic independence. For this reason they might use children to defend their relationship. What came out strikingly from her fieldwork is the difference in targets in terms of marriage choice and reproductive behaviour between men and women in Brazil. Men are more likely to enter consensual unions as it allows them to have more than one partner more easily, whereas women desire more to enter a formal union. At the same time men show more willingness to have more children as a sign of virility,

whereas women prefer to have fewer children, since Brazilian men do not look after them (Greene 1994).

Starting from the results of the Greene's fieldwork Rao and Greene (1991) develop a bargaining model based on economic theory. This model takes into consideration the bargaining power of men and women inside the household. They start from the concept of 'threat point'. A threat point is:

> 'The point at which a spouse, hypothetically faced with a locus of progressively worsening situations within the marriage and/or progressively improving possibilities outside it, considers herself better off quitting the marriage and becoming single.' (Rao and Greene 1991. pp: 3)

From this concept it follows that women who are economically independent have a higher threat point and therefore a higher bargaining power in the household. These women are more likely to be in control of their reproductive life. Whereas, as it came out clearly from the fieldwork, women with a lower threat point are more likely to conceive a child to stabilise their union and make sure that their partner takes care of them economically.

Rao and Greene construct a quantitative model using ordinary least squares regression in which fertility is a function of the wages of both wife and husband, unearned incomes, schooling of both husband and wife, external factors and a vector of variables that might affect the choice such as ethnicity, religion, residence. The effect of union instability inside the model is considered using expected probabilities of union duration for each child the couple has using life table techniques. These expected probabilities are then inserted in the model as one of the covariates.

The authors use the DRAT (Duration RATio), the ratio of actual to potential natural fertility, as the outcome variable using ordinary least square regression. The DRAT considers only the fertility of unions with a duration higher than five years. This measure controls for both marital duration and age at marriage and includes only the fertility that takes place within that marriage. Considering this outcome variable the authors want to model decision-making within the household in a situation where both husband and wife can potentially influence the level of fertility.

The results show that consensual unions have a negative effect on fertility. Woman's autonomy (as measured by labour force participation and independent income) also has a negative effect. The stability of the union lowers the level of fertility, so the higher the expected union duration the lower the level of fertility. Having children from previous marriages also reduces fertility, contrasting somehow the hypothesis

that couples do tend to bear a child in each union. Female earnings as well as the level of female education have a negative relationship with the level of fertility.

The problem of this analysis is that it restricts the effect to the fertility inside the last union. The other problem of using the DRAT as the outcome variable is that it controls by union duration, partly by excluding fertility, the experience of unions of short durations. At the same time it implies that the couple's decisions are made on an economic basis of bargaining power inside the house. It does not consider that couples might take decisions in perfect agreement based on love and respect. Furthermore it does not take into account the endogeneity of the events. However it does capture some aspects of the effect of union instability on fertility and it is the only work that has attempted to do this. Furthermore the model refers to both men and women whereas most of the analyses refer to the woman's behaviour only.

Another interesting analysis of marital fertility differential in Brazil is the research conducted by Lazo (1994). The author analyses the effect of union type on the level of fertility in Brazil using Rodríguez and Cleland (1988) simplified version of a model previously developed by Page (1977). This model considers the marital fertility at a certain age and a certain marital duration as a function of the age pattern of natural fertility multiplied by a parameter representing the level of natural fertility and a parameter that considers the extent to which marital fertility at a given time-period departs from natural fertility as a function of increasing duration of first marriage (Rodriguez and Cleland 1988). A simplified version of it consists in counting births and exposure time for a fixed period using a Poisson regression model. Starting from this function Rodríguez and Cleland (1988) have used the model to estimate the total fertility rates: one as the percentage reduction from maximum natural fertility (spacing index) and the other as a measure if marital fertility control after ten years of marriage (limiting index). This type of model is suitable with a large sample for a long period.

Using the 1976 and 1984 PNADs and the 1986 and 1991 DHS, Lazo (1994) shows that consensual unions have higher fertility than informal unions. Looking at the limiting index (that shows the level of control of fertility), women in formal unions have a higher marital fertility control than those in informal unions. Comparing civil/religious unions with the consensual ones the latter have a total marital fertility rate (TMFR) one child higher than the former. This result somehow clashes with the obtained by Henriques (1989) that does not find particular differences between the fertility of consensual and formal unions. This is mainly due to the fact that consensual unions have a higher fertility in the short run but due to the instability of the union in the long run this gap is shortened by the loss of exposure the woman faces. In Henriques's view

women in consensual unions are in general bad planners with non-effective contraceptive use. For this reason, at short durations women in consensual unions might report a higher fertility. However their fertility reaches the level of women in formal unions due to the long break ups they usually go through and consequent loss of exposure to the risk of conceiving (Henriques 1989).
Another result of Lazo's analysis worthy of note is the increase of the limiting index for the consensual unions in one of the periods that was taken into consideration (1976-1984). It is therefore interesting to see whether in the future an increase of fertility control of the consensual unions would decrease even more the level of fertility in Brazil. The limit of this analysis though is that it does not take in consideration fertility for those not in unions at all. Regarding birth spacing the main difference is between civil and civil/religious unions. The former show an index of spacing that is half the one of civil/religious unions (Lazo 1994).

All of these studies concentrate their attention on the fertility differentials by union type. The effect of union instability is considered for consensual unions assuming that formal ones are stable by definition. Rao and Greene (1994) somehow account for union duration by calculating the expected probabilities of union duration with any added child. However they do not account for the simultaneity of the processes of childbearing and union dynamics and the interaction of the life course events.

3.4.3 Woman's role

In analysing the dynamics of union changes in Brazil it is fundamental to look at the position of the woman inside the union. In the 1800s the Brazilian women had a lower status than men in law and custom. Some feminist movements tried to elevate the position of the woman, in particular through the enhancement of the level of education. However in the 1930s they were encouraged to return to the traditions and to the old ways of being. Until 1962 the Civil Code gave the husband full power on family decisions, electing him as head of the family. After that the man was still head of the household but the woman could collaborate (Greene 1991). Women who wanted to start a business needed to have had the authorisation of the husband. Among the signs of low female status the law used to consider it, until the second half of the 1990s, as an offence against custom and not against the person that means that rape was a crime against society, not against the victim.

Domestic violence against the women is not uncommon and not declining in Brazil. Most cases of husbands murdering their wives which are brought to court are justified in defence by the claim that the husband was engaged in a "legitimate defence of honour", meaning that if the wife attacked the integrity of the husband he is justified to react physically to this offence. In 80% of these cases this defence succeeds (Greene 1991).
The importance and prevalence of the culture of 'machismo' is common in Brazil consequences for the nature of the unions. Men with this attitude are often in favour of casual sexual unions with no or little commitment. It is not uncommon for them to enter in more than one union and leave the children they had with the previous partner behind.

It is very common in Brazil and in other Latin American countries to choose the type of union (consensual or formal) according to the 'bargaining power' of the woman inside the couple (Glaser 1999; Greene 1991). Where the position of the woman is weaker it is more likely that the male's choice would prevail and the woman is more likely to enter in a consensual union with fewer financial and legal obligations. Both Greene (1991) and Glaser (1999) have shown with their fieldwork, in Brazil and Costa Rica respectively, that Latin American men often impose their will over that of the woman. This situation is particularly dramatic for women with a low or no income that depend financially from the men. These women show a tendency to bear children to formalise their union. As Greene (1991) found in her study, Brazilian women only very rarely fail to give importance to marriage. It is for this reason that some women use pregnancy to create an obligation for the man to be loyal to the family. On the other side the 'macho' attitude that many Brazilian men show brings them to have children in each union they are in. If the woman is pregnant the bond for the man might not be so strong. Eventually he will leave the union if he wants to be with another woman. At the same time Brazilian women have become more aware of the fact that a child would not necessarily assure the stability of their union and even more would not assure financial help.

Men's and women's reproductive goals have been shown to clash in Latin American cultures (Oppenheim Mason and Taj 1987). Women find themselves more and more involved in the labour market and less willing to be dependent on the man. However, they also have to face the onerous task of bringing up the children as men are not so involved in child rearing. Men's willingness to have several children could clash with the women's willingness to limit the size of the family as it limits women's freedom. These mechanisms that interact in couple's decision making linked with an increase of female autonomy might influence women's decision to get sterilised relatively

early. As stressed several times, the majority of the Brazilian women do not speak about family planning with their partner. The choice of sterilisation highlights women's desire to be in full control of their reproductive lives and might be driven by the fear that childbearing could interfere with their autonomy. Even more importantly, it might be driven by the determination to exclude men from family planning decisions.
It is therefore clear that the status of the Brazilian women is fundamental to understand the family dynamics that interact in the fertility decisions.

3.5 Summary

The relationship between fertility and union dynamics is complex and may vary in magnitude as well as in direction with the stage of the union. Union instability has been for a long time considered as a depressant of the level of fertility, however confounding factors that interact in this relationship can affect the level of fertility positively.

There is a negative relationship between the frequency of sexual intercourse and the duration of the union. Women with a history of unstable unions might have a higher exposure to the risk of conception due to a higher frequency of coitus. At the same time couples do tend to bear children in each new relationship regardless of the number of children they had in previous unions.

The outcome of an analysis on the relationship between union dynamics and fertility is not foreseeable and the current literature does not show many systematic studies in particular in Brazil on the relationship between union dynamics and fertility. However considering the current literature on the topic in Latin America, there is evidence that the loss of exposure to the risk of conception might not play a fundamental role in influencing the level of fertility. On the contrary casual relationships and change of unions may have a positive effect on fertility.

Chapter 4

DATA

The potential of the Demographic and Health Surveys (DHS) calendar data is still to be fully exploited. Because of the structure of the data and that it is difficult to handle, there are only few studies that have analysed the calendar (Curtis 1997; Goldman et al. 1989; Leite 1998; Magnani et al. 1996; Steele and Curtis 2001; Strickler et al. 1997; Westoff et al. 1990). In particular, to the best of the author's knowledge there is only one study that has considered the Brazilian 1991 DHS calendar (Leite 1998), and no study that has considered the 1996 calendar. Discussions with Brazilian demographers have highlighted the difficulty in handling the data and their unwillingness to analyse the calendar data as opposed to ad hoc surveys (surveys made for specific purposes as different to general surveys that are recurrent in time). For this reason there is no current research on the 1996 calendar. Furthermore, adjusting some of the variables that can be deduced from the calendar for demographic modelling could be very cumbersome. In some cases the amount of information that is obtained could be not enough to conduct the desired analysis. In those cases the effort put into the recoding could not be corresponded by sufficient information. It is, therefore, important to highlight further utilisations of the calendar data and the possible recoding the type of information that could be extracted from it. For this reason this entire chapter will be dedicated to a description of the Brazilian DHS and in particular to the calendar section. The methods that will be applied to the data will be discussed in the next chapter.

Surveys carried out in developing countries have sometimes been 'accused' of producing data of poor quality (Goldman et al. 1989; Hobcraft et al. 1982; Jameson 2000; Meekers 1991; Strickler et al. 1997). The first part of this chapter will describe the data quality checks that researchers have undertaken for the 1996 Brazilian DHS showing that it is one of the most successful DHSs and that the quality of the data is very good. The second part will describe the structure of the calendar and the recoding that has been undertaken to transform it into Bernoulli format for the discrete time model and into a woman-episode file for the continuous time model.

The third part will describe the sample bias problems that have been encountered when using the DHS calendar to create analysable union and fertility histories.

4.1 Demographic and Health Surveys

The Demographic and Health Survey (DHS) project started in the mid-1980s as a continuation of the World Fertility Survey project. DHSs are nationally representative surveys that collect data on reproduction, maternal and infant health in developing countries in a common format with the aim of providing a large amount of data that allow the comparison of different regions, and the same regions or countries at different points in time. They are particularly important, not only for the amount of the data they contain, but also for the fact that in some countries they represent the only source of information on health and demographic topics.

There have been three phases of the DHS: the first started in the mid-1980s, the second at the beginning of the 1990s and the third in the mid-1990s. In successive phases there have been improvements in the quality of the survey and of the questionnaire. In particular the calendar data that will be analysed later on more in depth, were introduced in the second phase.

4.1.1 Sample design

In an effort to collect data that suit the contraceptive characteristics of the country there are two DHS questionnaires: Model 'A' is for countries with a high (over 40% of married women use a contraceptive method) contraceptive prevalence, Model 'B' is for countries with a low contraceptive prevalence. For Brazil the Model 'A' questionnaire has been used. The survey is composed of three questionnaires, one for the household, an individual questionnaire for each woman and an individual questionnaire for each man.

The household questionnaire includes questions about the characteristics of the people living in the household, access to services like water and electricity supply, floor material and the characteristics of the head of the household. A major aim of this questionnaire is to identify inside the household the women that are eligible for the individual questionnaire: specifically all women aged 15-49. The individual

questionnaire asks about the characteristics of the women being interviewed, reproduction, contraceptive use, family planning, union history and sexual activity, maternal and child mortality, immunisation and characteristics of the husband (BEMFAM 1997).

The male sample is selected from the household questionnaire as well. A sub-sample equal to the 25% of the households selected in the first sample is chosen and all men aged 15-59 who are in this sub-sample of households are eligible. In this questionnaire information about each man's characteristics is sought as well as questions on reproduction, contraceptive use, sexually transmitted diseases and AIDS, union history and maternal mortality. The information collected is more limited than in the woman's individual questionnaire.

The 1996 DHS sample is based on the results of the 1995 PNAD (Pesquisa Nacional por Amostra de Domicilios), a national household survey. The DHS is a sample survey with random selection in two stages: the first stage involved the selection of the primary sampling units with a probability proportional to the number of households in each unit. In the second stage there was the selection of the households considering the representation of urban and rural areas in each sector as obtained in the PNAD survey (BEMFAM 1997). A total of 16,451 households was selected for the DHS and for 13,283 complete information was obtained. From these households 12,612 women and 2,950 men were interviewed. The data were collected between 1 March and 30 June 1996 by 29 different teams.

For this analysis the individual women's recode dataset will be used. The men's file has been excluded, as it does not give enough information on union formation. The main source of information relates to that given in the calendar section that is missing in the male recode.

4.1.2 Data quality

The 1996 Brazilian DHS has been recognised as being one of the most successful DHS datasets in terms of data quality (Becker et al. 2000; Jameson 2000). Becker et al. (2000) for example demonstrated that there is the best matching of contraceptive reporting between men and women. Comparisons between 32 countries on age misreporting in DHS (Jameson 2000) have shown that the Brazilian one has the lowest level of age misreporting.

The experience gained with two previous DHSs by one of the most important population organisations in Latin America (BEMFAM), linked with the high level of education of the Brazilian women, is thought to be the reason for its high quality. In addition to the above-cited checks further checks to make sure that the information provided on fertility and unions was internally consistent have been undertaken.

As a first check the data on the mean and median age at first union for the 1991 and 1996 datasets have been compared. The analysis has been restricted to the Northeast region because the 1991 DHS only relates to this region. Table 4.1 shows that there are no major inconsistencies: the mean and the median age at first union are always higher in the 1996 dataset for the same cohort as expected. A gap of five years has passed and in the meantime other women of the same generation have married at a later age. This has increased the mean age at first union. The gap is consistently higher at young cohorts as expected more women of younger cohorts to enter in a union in the five-year gap. Whereas for older cohorts only a small number of additional women will enter in a union for the first time. At the same time, if by the age of 44-49 women have never entered a union it is unlikely they will ever do so.

For the fertility variables external and internal validation checks have been undertaken. Table 4.2 reports the same check as Table 4.1 for the age at first birth: there are no inconsistencies. For the same reasons reported for Table 4.1 it could be expected that the values of the mean and the median age at first birth are higher for the 1996 data.

Table 4.1 Age at first union by birth cohort, Northeast 1991-1996 DHS

Birth cohort	Northeast 1991				% never in union	Northeast 1996				% never in union
	Mean	95% Conf. Int.	Median	95% Conf. Int.		Mean	95% Conf. Int.	Median	95% Conf. Int.	
1977-1981	-	-	-	-		15.55	(15.32, 15.78)	16	(16, 16)	80.8
1972-1976	15.86	(15.66, 16.06)	16	(16, 16)	82.9	17.72	(17.49, 17.96)	18	(18, 18)	43.3
1967-1971	17.69	(17.47, 17.90)	18	(18, 18)	48.2	19.20	(18.99, 19.55)	19	(19, 19)	20.3
1962-1966	19.05	(18.81, 19.29)	18	(19, 19)	23.1	19.99	(19.64, 20.34)	19	(19, 19)	13.8
1957-1961	19.89	(19.57, 20.21)	19	(19, 19)	12.6	20.67	(20.27, 21.08)	20	(19, 21)	11.1
1952-1956	20.44	(20.05, 20.84)	19	(19, 19)	8.8	20.84	(20.35, 21.33)	20	(20, 20)	5.4
1947-1951	20.93	(20.51, 21.34)	20	(20, 20)	6.4	21.91	(21.33, 22.45)	21	(20, 22)	7.2
1942-1946	20.75	(20.24, 21.25)	19	(18, 20)	6.3	-	-	-	-	-
Total	19.53	(19.33, 19.68)	19	(19, 19)	35.1	19.72	(19.56, 19.88)	19	(19, 19)	32.6

Table 4.2 Age at first birth by birth cohort. Northeast 1991, 1996 DHS

Birth	Northeast 1991				Northeast 1996			
cohort	Mean	95% Conf. Int.	Median	95% Conf. Int.	Mean	95% Conf. Int.	Median	95% Conf. Int.
1977-1981	-	-	-	-	16.15	(15.93, 16.36)	16	(16, 16)
1972-1976	16.59	(16.39, 16.79)	17	(17, 17)	18.50	(18.27, 18.72)	18	(18, 18)
1967-1971	18.55	(18.35, 18.75)	19	(19, 19)	19.86	(19.59, 20.12)	20	(20, 20)
1962-1966	19.98	(19.75, 20.21)	20	(20, 20)	21.11	(20.76, 21.45)	20	(20, 20)
1957-1961	21.09	(20.78, 21.40)	20	(20, 20)	21.63	(21.26, 22.00)	21	(21, 21)
1952-1956	21.63	(21.27, 22.00)	21	(21, 21)	22.10	(21.63, 22.56)	21	(21, 21)
1947-1951	22.16	(21.77, 22.56)	21	(20, 22)	23.09	(22.53, 23.65)	22	(21, 23)
1942-1946	22.19	(21.72, 22.65)	21	(20, 22)	-	-	-	-
Total	20.74	(20.60, 20.88)	20	(20, 20)	20.72	(20.56, 20.88)	20	(20, 20)

Table 4.3 Average parity by birth cohort. Northeast 1991, 1996 DHS

Birth cohort	Northeast 1991	Northeast 1996
1977-1981	-	0.23
1972-1976	0.14	0.93
1967-1971	0.91	1.94
1962-1966	2.03	2.78
1957-1961	3.19	3.67
1952-1956	4.26	4.44
1947-1951	5.04	4.96
1942-1946	6.03	-

A similar check may be carried out for the average parity by age group (Table 4.3). Comparing the data longitudinally there are no major inconsistencies. The only inconsistency is reported for the birth cohort 1947-1951 where the average parity in 1996 is higher than in 1991 probably due to recall lapses.

A final check is done with the help of the P/F ratios using 'method B' described by Hobcraft et al. (1982). The P/F ratios estimate recent fertility by combining data on the number of children ever born (P) with estimates of cumulative age-specific fertility (F) for the recent years. These ratios were initially estimated to obtain estimates of current fertility, recently they have been used to estimate the quality of data in particular of the World Fertility Survey. The application of the ratios is the same if one wants to check the level of current fertility or the data quality, what changes is the interpretation (Hobcraft et al. 1982). The ratios compare the level of actual with the cohort fertility and closer the value to the unity the lower the level of misreporting. If the fertility remains constant and reporting is accurate, the series of F-values should agree with the corresponding P-values. Should the P-values be higher than the F-values a decline in fertility has occurred. P/F ratios have an identification problem in the presence of recent fertility decline. They cannot simultaneously detect under-reporting and decline of fertility. However with careful interpretation they can still be used even with this problem. The conventional procedure involves analysis of fertility rates by age. The age-specific fertility rates for the past year are defined as f_i, where i=1, ..., 7 is the age group at the time of the survey. The cumulation of these rates is equal to $F_i = \sum_{j=1}^{i} f_j$

Similarly the reported average number of children ever born to women in the *i*th age group is defined as P_i. The P/F procedure combines the best information available in order to obtain estimates of age- specific fertility from the recent past. Once the estimates of F_i and P_i have been calculated the P/F ratio can be obtained, by simple division P_i / F_i.

The values in Table 4.4 are close to unity apart from the older age groups in the period 0-5 years prior the survey where there is a sign of fertility decline. The fact that the P/F ratios values are close to the unity in particular at young age groups is a sign of good data quality in which the cumulative fertility values have not been affected by misreporting. The deviation from the unity is much more likely in older age groups as these are the groups who have been more exposed to fertility trends and therefore the F-values are more likely to differ from the P-values.

Table 4.4 Cohort period rates by age, 1996 Brazil DHS

Age cohort at the end of each period	Years prior to survey						
	0-5	5-10	10-15	15-20	20-25	25-30	30-35
P/F ratios							
15-19	1.004	1.000	1.004	1.002	0.994	1.004	1.002
20-24	0.949	1.051	0.952	1.004	0.963	1.022	
25-29	1.060	1.003	0.980	0.995	0.941		
30-34	1.079	1.052	0.991	0.959			
35-39	1.164	1.050	0.983				
40-44	1.171	1.067					
45-49	1.202						

4.2 DHS calendar

4.2.1 The development of the calendar

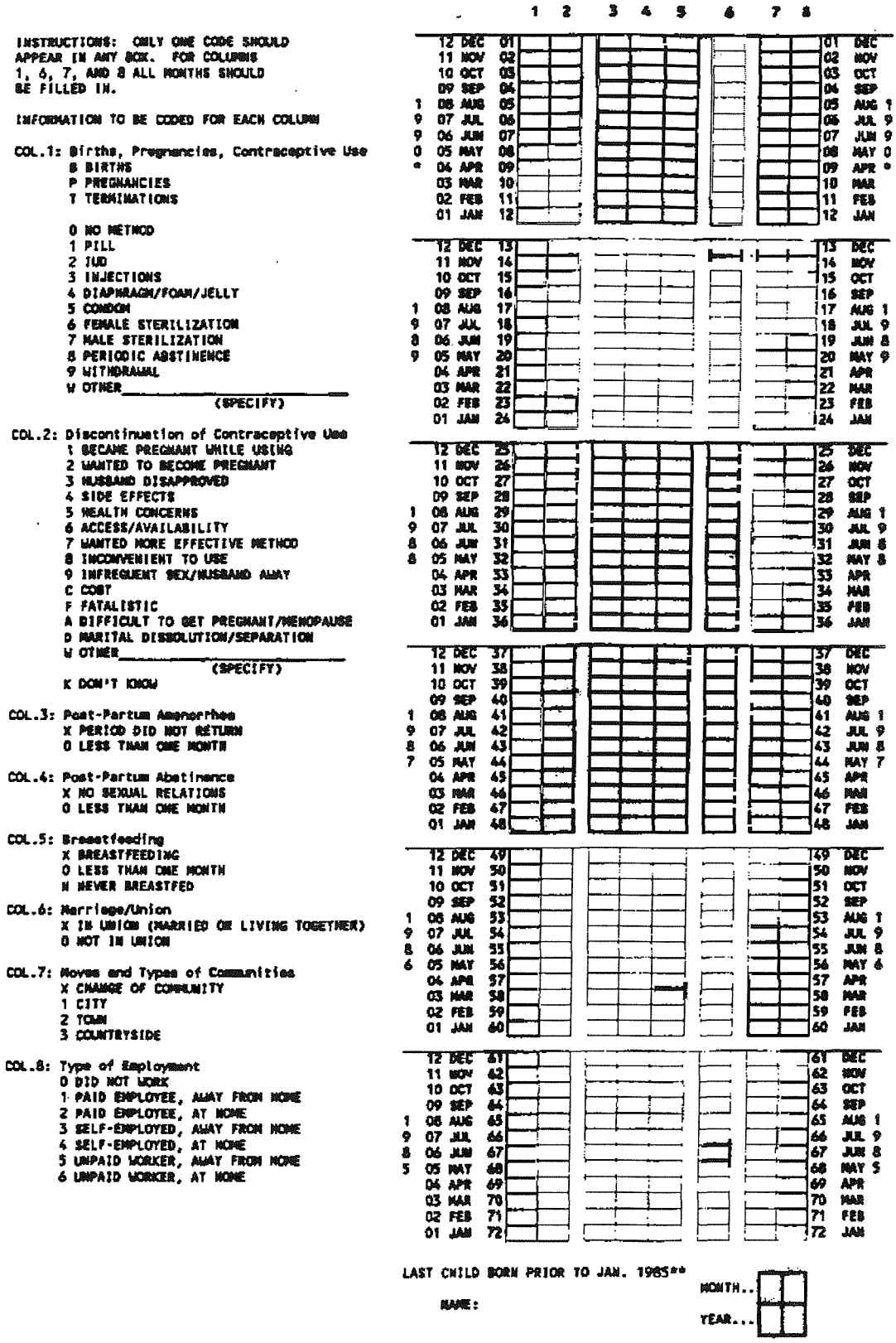
In the second phase of the DHS the calendar has been introduced as a means of studying contraceptive adoption, contraceptive continuation, contraceptive switching and contraceptive failure (Curtis 1997). The calendar is only used in countries with relatively high contraceptive prevalence (approximately 40% or more). It collects retrospective data on contraceptive use, pregnancies, union status,

reasons for contraceptive discontinuation, migration and other subjects specific to each country in the five years preceding the survey (e.g. postpartum amenhorrea, breastfeeding, employment). The calendar has been used in 24 DHSs and a general example is reported in Figure 4.1 (DHS 1990). When measuring union status all women who are married or in a cohabiting relationship are considered to be in union (Figure 4.1 column 6).

The main goal of this instrument is to provide longitudinal data on contraceptive use. However, the improvement of the data quality and the availability of a cross-sectional dataset, along with the longitudinal data, have made the calendar an important source of data for other subjects such as migration, breastfeeding, change of type of employment and postpartum amenorrhea (Curtis 1997; Goldman et al. 1989). Yet, hitherto the calendar has been used only for studies on contraceptive use dynamics (Curtis 1997; Leite 1998; Strickler et al. 1997) and the full potentiality of the information has not been exploited.

The calendar consists of a matrix of rows and columns in which each row represents a month and the columns are used to record a particular type of information for each month (Figure 4.1). In the Brazilian case there are only four columns: reproductive history, migration, union history and contraceptive discontinuation.
At the end of the birth history section the interviewers insert relevant births in the calendar and add eight months of gestation before each birth. At the same time pregnancies that did not result in live birth are entered. The contraceptive entries are therefore checked with the pregnancies that are already inserted in the calendar. The interviewer is allowed to insert only one code in each cell. In this way it is possible to record the type of contraceptive method that has been used, for how long and the reason why it has been discontinued, along with changes in union status. In some DHS information on breastfeeding, postpartum amenhorrea, postpartum abstinence, employment and community migration has been included as well.

Figure 4.1 General structure of the DHS calendar



* For fieldwork beginning in 1991, 1992, or 1993, the years should be adjusted.
** For fieldwork beginning in 1991, 1992, or 1993, the year should be changed to 1986, 1987, or 1988, respectively.

Source: DHS, 1990

4.2.2 Advantages of calendar data

The type of information provided by the calendar allows cross-sectional and longitudinal analysis. The follow up clinic surveys instead collect data on different points in time following the same group of people for a period. The calendar data give information that is usually missing in follow up clinic surveys, such as reason for discontinuation of use of contraception. The problem with the clinic surveys is that part of the information is lost because methods like pill or condom are often obtained from pharmacies (Curtis 1997), so users of these methods are under-represented in the clinical studies as are users of 'traditional methods' (e.g. periodic abstinence, rhythm). The DHS calendar includes women who obtain their contraceptive method from any kind of supplier. This type of study is definitely cheaper than a follow up and it does not suffer from the problem of loss of data, as it is collected like a cross-sectional survey.

Experiments in Peru (Goldman et al. 1989) and the Dominican Republic (Westoff et al. 1990) have demonstrated that the calendar is more powerful instrument than a cross sectional type of survey (the information refers to the time of the survey only or to the last 3-6 months before the survey) in recording women's contraceptive histories. The fact that the interviewer is able to reconcile the contraceptive history with other events makes it easier for the woman to reconstruct events. Inserting several events like pregnancies, births and contraceptive use in the same column avoids inconsistencies in the information. The standardised form of the calendar allows easier comparison among countries (Curtis 1997).

In the Peruvian case a standard DHS (with no calendar) along with an experimental survey was undertaken. The difference in the surveys was mainly in the inclusion of the contraceptive calendar. The experiment found that reported contraceptive use was 13 percent higher when the calendar was used for both traditional and modern methods.

The use of the calendar has been criticised as being too time-consuming but the experimental survey in Peru demonstrated that it takes only few minutes more than in the standard survey (Goldman et al. 1989). The interviewers reported that they preferred the calendar section as a more suitable data collection method than the one that refers to the woman's behaviour in the 3-6 months previous the survey date. The Peruvian experience has shown that the calendar data obtain more complete reports of contraceptive use than the cross sectional survey for periods prior to the survey.

In the Dominican Republic 400 women were reinterviewed several months after the original DHS interview to determine the reliability of the DHS calendar information (Westoff et al. 1990). Unfortunately this experiment failed, as it did not have enough cases to reach the initial target.

A further experimental study has been done in Morocco to test the reliability of the DHS calendar (Strickler et al. 1997). The 1995 Morocco Panel Survey gave a unique opportunity to observe the level of reliability of the DHS calendar. This survey included a sub-sample of the women interviewed in the 1992 DHS survey and both surveys included a calendar that overlapped in the 1990-92 period. Results suggested that at aggregate level the data are reliable. However at individual level the data in particular for women with complex contraceptive histories, were less reliable and therefore advanced modelling of contraceptive-use dynamics with individual data could be less stable than aggregate measures. However the bias of the individual data appeared to be random rather than systematic.

In general the data on contraceptive use or non-use were reported to be very reliable. The one with most problems is the one of reason for discontinuation and contraceptive switching (Curtis 1997; Strickler et al. 1997). The main problem comes from the impossibility to report more than one reason for discontinuation (one woman might discontinue the pill because she did not feel comfortable with it and because she has been suggested that IUD is more reliable). Furthermore the reasons or the timing of contraceptive switching can be more difficult to remember and more affected by heaping. The analysis in the following chapters is based on the most reliable information that is collected in the DHS calendar: births and union status (Curtis 1997). These events are most reliable as they are considered important dates and easier to remember for the respondent.

4.2.3 Limitations of calendar data

The main problem of the calendar is recall: the interviewee is asked to recall for the five years preceding the survey events that might be not very memorable for the respondent (Curtis 1997). Omissions might be frequent, in particular for contraceptive spells that lasted a short time. The Moroccan experiment showed some of the limits of the calendar. The analysis of the surveys showed that while the data were reliable at

aggregate level they were unreliable at individual level, in particular the reason for discontinuation (Strickler et al. 1997).

Another limitation of the calendar information lies in the impossibility of having information on dual contraceptive use and multiple reasons for contraceptive discontinuation, as the calendar allows one value only.

4.2.4 Calendar data quality in the 1996 Brazilian DHS

Internal checks on the quality of the Brazilian calendar have been carried out, in particular on reported number of unions, starting dates of the first union, pregnancies that report a gestation of less than eight months and date at sterilisation. A total of 10 cases have been reported of short pregnancies and five for misreported sterilisations were identified by cross checking the dates at sterilisation in both cross-sectional and calendar sections. These cases have been reported to Macro International (the organisation that co-ordinates all the DHSs) and eliminated from the analysis.

To check the quality of the calendar data at aggregate level it is possible to compare the current status of contraceptive use and union status in the 1991 Brazilian DHS with the information obtained from the 1996 calendar for the corresponding months (Curtis 1997). For those months the union status and the contraceptive use frequency information has been considered. This information has been compared with the current status information taken from the 1991 DHS assuming that no migration has occurred in the meantime. Furthermore women from the Northeast region only have been selected as the 1991 survey refers to the Northeast of Brazil only. The analysis has been limited to the women aged 15 to 44 years for an easier comparison. If the calendar information is reliable the prevalence of use of specific contraceptive methods obtained from the calendar data should not show large differences in relation to the levels estimated on the basis of current status data, allowing for sampling errors (Curtis 1997). The results (Tables 4.5, 4.6, 4.7) reported values from the calendar very close to the 1991 current status data. The few differences that are reported in the percentages of sterilised women and nonusers are likely to be due to sampling errors rather than to systematic underreporting of contraceptive use in the calendar data of the 1996 DHS.

Table 4.5 External validation check: percentage women 15-44 by union status 1991 Northeast DHS, 1991-92 Northeast 1996 DHS calendar

Union status	1991-Cross-sectional	1996 Calendar
In union	58.6	60.6
Not in union	41.4	39.4

Table 4.6 External validation check: percentage contraceptive use, currently married women 15-44 years old 1991 Northeast DHS, 1996 Brazil DHS

Contraceptive use	Northeast 1991 DHS Current status	Northeast 1991 (1996 DHS) Calendar	Difference
None	39.3	41.4	2.1
Pill	14.7	14.7	0
IUD	0.4	0.6	0.2
Injection	1.0	1.0	0.0
Diaphragm/foam/jelly	0.0	0.0	0
Condom	1.5	1.7	0.2
Female sterilisation	37.1	34.2	2.9
Male sterilisation	0.1	0.3	0.2
Periodic abstinence	2.6	3.4	0.8
Withdrawal	3.1	2.4	0.7
Other	0.2	0.2	0

Table 4.7 External validation check: percentage contraceptive use, all women 15-44 years old 1991 Northeast DHS, 1996 Brazil DHS

% Contraceptive use	Northeast 1991 DHS Current status	Northeast 1991 (1996 DHS) Calendar	Difference
None	61.3	57.9	3.2
Pill	9.6	12.1	2.5
IUD	0.3	0.4	0.1
Injection	0.8	0.8	0
Diaphragm/foam/jelly	0.0	0.0	0
Condom	1.1	1.8	0.7
Female sterilisation	23.3	23.4	0.1
Male sterilisation	0.1	0.2	0.1
Periodic abstinence	1.6	1.9	0.3
Withdrawal	1.8	1.2	0.6
Other	0.1	0.1	0

In addition to the external and internal checks conducted, discussions with fieldworkers and the field coordinator have been held. Most of the detractors of DHS calendar types of data collection claim that this type of information causes further stress to women who cannot remember well the events of the last five years, in particular regarding contraceptive dynamics. However most of the Brazilian interviewers stressed the fact that women did not report particular stress when asked to fill the calendar. The calendar was not visible to them but only to the interviewer. This meant a further memory exercise for the woman that could not fill the cells of the questionnaire on her own.

4.2.5 Heaping

A problem commonly associated with data collection in developing countries, and in particular for the calendar data due to the way it is collected, is data heaping. Heaping is the tendency of interviewees to round ages or durations to the next value ending with 5 or 0. Alternatively, it arises from the tendency of subjects to remember durations in years instead of a precise number of months. The calendar might be affected by this problem, particularly the contraceptive use durations (Curtis 1997). Problems have been reported, especially in Asian or African countries where the concept of time is relative and not comparable with the Western idea of time (Singh 1987). These problems have been reported for breastfeeding durations, durations of postpartum amenhorrea, birth intervals. For the Brazilian case it has been highlighted in the preceding sections that the high level of education among women and the experience of most of the interviewers render the quality of the data high. Birth intervals are usually less affected by heaping problems as they are calculated using the day of births. The quality of duration variables in the calendar plotting the number of cases by duration has been examined and as it is possible to see from Figure 4.2 (for union durations) and Figure 4.3 (for birth interval durations) that there is no evident heaping.

Figure 4.2 Union status duration frequency expressed in months, 1996 Brazilian DHS calendar

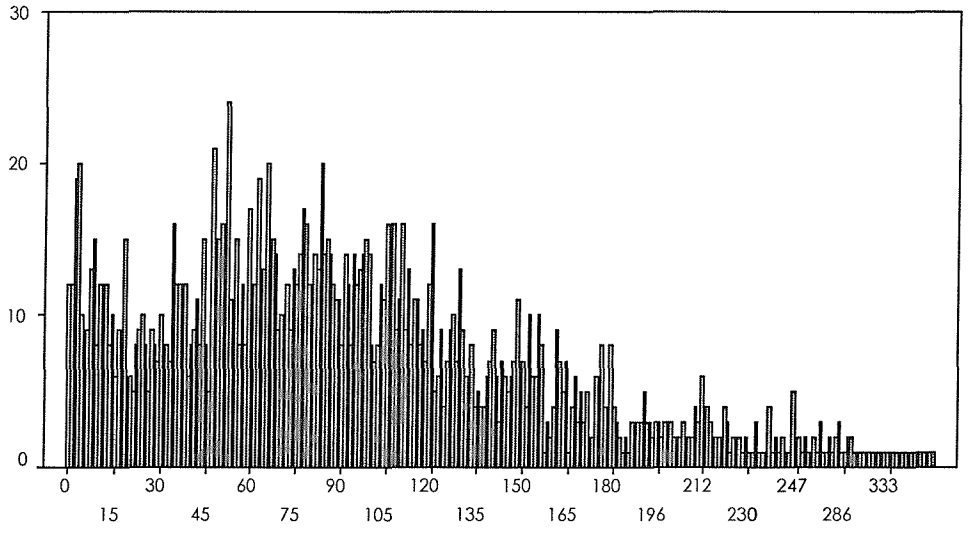
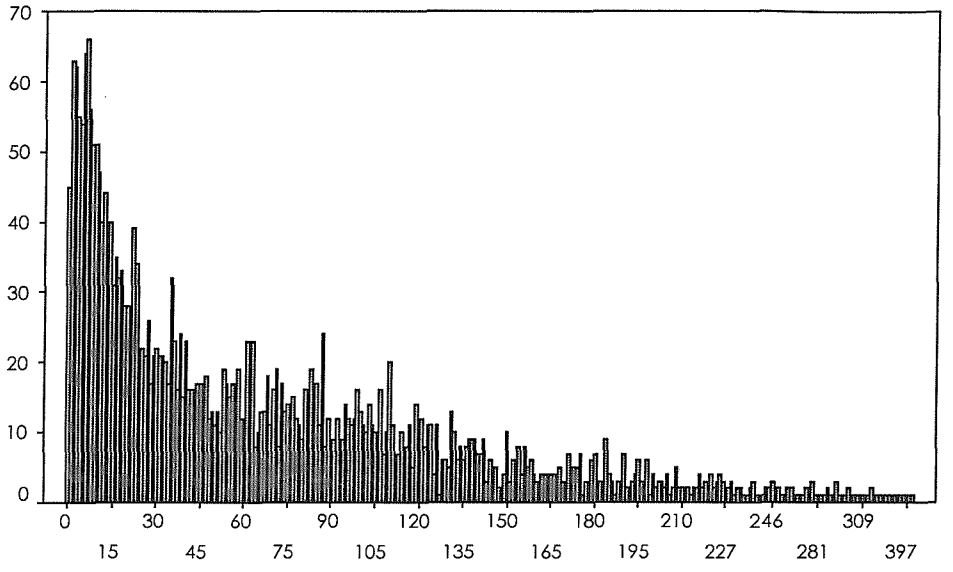


Figure 4.3 Birth interval durations frequency expressed in months, 1996 Brazilian DHS calendar



4.3 Union status censoring

4.3.1 Censoring

Analysing longitudinal data there are issues of censoring due to the availability of data in a restricted period only. Event history analysis techniques will be described in depth in the next chapter. However it is important to stress the censoring issue, as it is important to take into account of it when setting up the data for the modelling.

Censoring and truncation occur when information is affected by the fact the period of observation is limited. Censoring exists when incomplete information is available about the duration of the risk interval because of a limited observation period. If the event occurs after the period of observation, the observation is right censored. In this case the situation is easily manageable. Typical cases of right censoring are observations lost to follow up, withdrawals from a study, events running after the end of a study and, as in the DHS case, after the interview date.

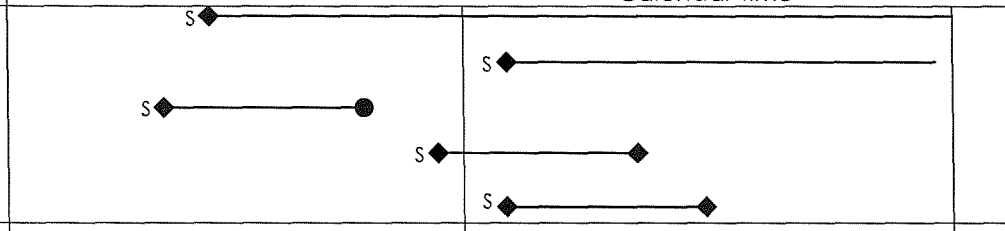
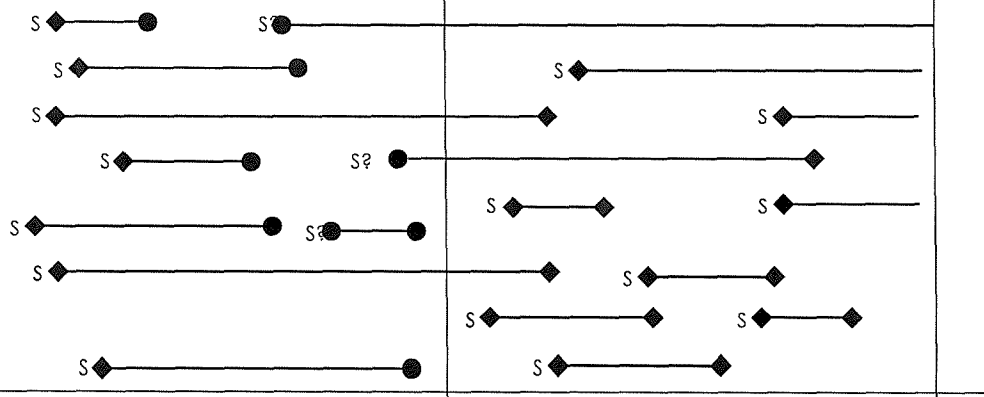
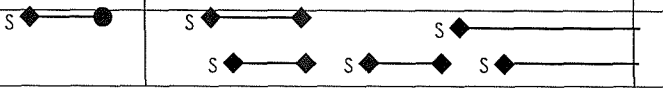
Instead if the event occurs before the period of observation, the observation is left censored. The analysis of this type of data is more complex and the observation is usually removed from the analysis. Left censoring occurs when the spell (interval of time) of the event started before the period of observation and there is no

information about the starting date. In the case under consideration those women that are reported to have experienced more than one union, and that started their first spell before the beginning of the calendar period are considered left censored.

It is possible to have an idea of the difference between censoring and truncation looking at the figure 4.4. The cases of the DHS calendar have been divided according to the union history of the woman whether she had experienced one union or more. The data have been broken down by type of union histories that are available in the Brazilian calendar.

In the case of the DHS union calendar data for example all the women that have experienced more than one union and started both their unions before 1 January 1991 are left censored (code 3). For these women the information about the ending date of the first union and the starting date of the second one are lacking therefore it is not possible to know the duration of each union. This information, as described in depth later in the chapter, is usually removed from the analysis for the sake of simplicity. For women with one union starting and ending before the calendar period and one starting after (code 4) the information is truncated as only part of the woman's information is usable. The information that is used starts from the moment the second union begins, as it is possible to know the duration starting from that point onwards.

Figure 4.4 Combinations union histories found in the 1996 Brazil DHS calendar

	1 January 1991 — Survey Calendar time	CODE	Number of women
Only one union		1	5070
		1	1620
		2	425
		1	342
		1	2
TOTAL			7459
At least two unions		3	557
		4	227
		4	167
		4	99
		1	74
		3	65
		4	3
		1	3
		4	1
TOTAL			1196
At least 3 unions		4	7
		1	1
TOTAL			8
Missing= no relationship information			38

-=right censored s◆=starting date known s?●=starting date unknown ◆ =known ending value ● =unknown ending value

4.3.2 Calendar censoring

The only information available in the DHS data is about the starting date of the first union and whether the woman has experienced no, one, or more than one union. No information is known for the period before 1 January 1991 apart from the starting date of the first union, therefore for those women who reported more than one union and who are in their most recent union at the beginning of the calendar period two unions at least are estimated not knowing the exact number of unions. For those who started a union before the beginning of the calendar it is possible to know the duration of that union only if they have been in one union only and finished the union inside the calendar time. In this case the period related to the unions of which the starting date has been taken into consideration is known.

It is evident that the main problem of the DHS data on union history is that many of the durations are left censored, meaning that most of the durations lack the starting date. As it will affect the union formation and union dissolution model it has been a serious concern to try to get the most of the information from the calendar considering that part of the sample should have been eliminated due to left censoring. For this reason the structure of the calendar data has been analysed to assign a code to each of the possible combinations of union histories and exclude or truncate those cases that would not fit in the model that will be applied to the data.

The structure of the data is reported in Figure 4.4. The lines are approximations of the possible combinations of union histories that have been found in the 1996 DHS calendar.

Therefore there are 4 possible cases:

1. Women for whom there is full knowledge of starting and finishing dates of all spells.
2. Women for whom the number of unions is known, but the duration of all union spells and of the spells out of the union is unknown.
3. Women for whom neither the number of previous unions nor the duration of the current union is known as it started before the calendar period and there is no information on the starting date.
4. Women for whom the duration of the current union is known, or even the most recent two unions but lack of any information about the history before the calendar period, and so how many unions the women had is unknown.

To summarise it is possible to have

	Code			
Type of information	1	2	3	4
No. of unions	◆	◆	●	●
Dates of recent unions in the calendar				
Plus spells out of union	◆	●	●	◆
Dates of less recent unions	◆	●	●	●

Where ◆=known ●=unknown

4.4 Recoding

4.4.1 The raw calendar data

In the DHS dataset a single columns from the calendar is presented as a single variable string between 64 and 67 digits, according to the date of the interview.

Consider the following examples, taken from the Brazilian DHS calendar.

The union calendar cell contains the following string:

XXXXXXXXXX0000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

End of interview Start calendar

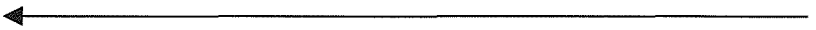
Time

The reproductive history calendar cell contains the following string:

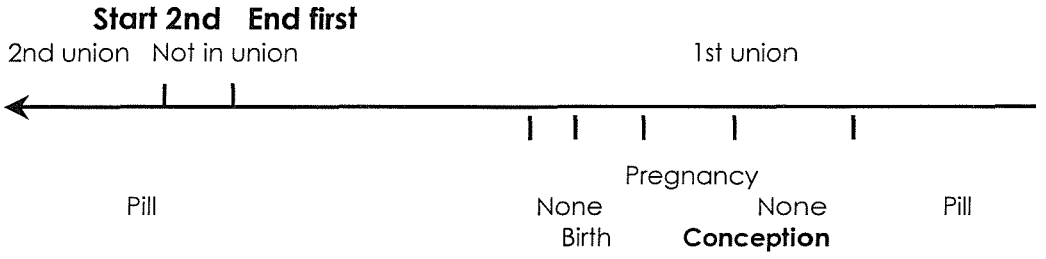
11111111111111111111111111111111111100BPPPPPPPP0000111111111111111

End of interview Start calendar

Time



Setting both the reproductive and union events on a timeline they would appear as follow (events in bold are the events of interest):



Each digit represents a month and the last digit represents January 1991. For this woman it is possible to see that she was in a union at the beginning of the calendar ('X'). She remains in this union for the first 52 months of the calendar. She comes out of the union ('0') for 4 months and then she starts a union until the end of the period. The problem about the union history is that it is not known whether the woman re-entered the union she was in during the first spell or whether it is a new one. The only check that can be done is to note whether she reported one or more than one union in the current status variable. In this example the woman reported having been in more than one union in the cross-sectional section. It is therefore possible to conclude that the second spell refers to a second union, the difficulty remains for those who had

more than one union before the calendar period and re-entered in the same union during the calendar period as described in the previous section.

Looking at the reproductive history calendar it is possible to see that the woman was using the pill ('1') at the beginning of the calendar and she continued for another 16 months. She then ceased using any contraceptive method ('0') for 4 months. She became pregnant ('P') and nine months later she gave birth ('B'), starting to use the pill again two months after parturition.

4.4.2 Discrete-time file structure

The descriptions of the data settings that will follow describe the structures that have been utilised to fit the data to the type of softwares and models that have been used. This first structure is the one obtained for the initial discrete time analysis in SPSS. Two files have been created structuring them to allow a model for the timing of union change (from not in a union to being in a union and vice versa) and a model for timing to conception.

For the purposes of the longitudinal analysis from the format described in the previous section for both calendar topics a variable for each month has been created. Each variable represents a calendar month in which is reported either the union status or the reproductive history. The file has been then transformed into a Bernoulli format where each case represents a month. Each woman has between 64 and 67 months that are reported in ascending order as shown in Table 4.8 (PG 74) that shows the final format of the file as suggested by the example above. Starting with the 12,612 women available in the initial sample a file in Bernoulli format of over 800,000 woman-month cases was obtained. As suggested in other DHS reports (Curtis 1997), the last three months of the calendar have been removed, as the woman may have become pregnant shortly before the survey and not realise it.

For those women that had left censored or left truncated information for the union duration, the periods in which there was no information about the duration length have been removed. Next, transition variables and duration variables were created. A variable denoting a conception that has as an outcome a life birth has been created. The event conception is assumed to occur at the end of the month, therefore it is reported in the month before the woman reports the pregnancy in the reproductive history calendar. The conceptions that do not have a life birth as an outcome have been excluded because abortion is illegal in Brazil and the quality of the data on terminations is poor (Sigh and Wulf 1991). The other difficulty of the

Brazilian data is that in the calendar data there is no distinction between miscarriages and abortions. An attempt to estimate induced abortions and terminations from the DHS calendar (Magnani et al. 1996) has shown the difficulty of obtaining accurate estimates in countries where abortion information is sensitive. The estimates obtained from the 1993 Turkey DHS have been shown to be weak. Considering the risk of modelling an outcome variable that is potentially biased, and the fact that most of the models on fertility and union status consider life births only, the analysis has been restricted to life births only.

The variable union status change has been recoded along the same lines. It reports the value '1' whenever there is a change in a woman's union status regardless of whether she is starting a union or leaving it. Duration variables for the union status duration and for the birth intervals have been built. The former counts the time since the last transition from one status to the other. The latter considers the interval since last birth, for all birth intervals except the first. For the first birth interval, duration is measured as the time since menarche. The DHS dataset does not report the age at menarche, so the age at menarche at 12 years for all women. Existing data on age at first menarche in Brazil report that the average age at menarche is reported to be around 12.5 years (Ministerio da saude 1999). In the past it has been common to take entry into first union as the start event for the first birth interval. For the purposes of this analysis and due to the characteristics of the Brazilian women this would not have been a sensible choice. As described in Chapter 2, marriage is not universal in Brazil, consensual unions are considered as legitimate as marriage, and often women enter unions only after they have conceived. Furthermore the interest is in the women's reproductive behaviour both within and outside unions. The 1996 DHS data shows that 8% of the women have their first birth before their first union. Furthermore that 16% of all conceptions, in the five years previous to the survey, occur outside a union. Only seven women reported a pregnancy before the age of 12 and these have been removed from the analysis for the sake of simplicity. Therefore the sample includes five years' histories of women between their 12th to their 50th birthdays only.

The other time varying variables included in the model are age of the woman at each month of the calendar and the 'calendar month' that is used to define the time variation inside the model. This last variable is usually inserted in longitudinal models to measure any historical event that might influence the events. In our case being the time-span relatively short, we do not foresee any major changes. These variables were not originally in the dataset and were constructed from the Bernoulli format file.

Table 4.8 Structure of the calendar after recoding the dataset, Bernoulli format

Calendar month	Union status Calendar	Union status change	Union status duration	Repr. History calendar	Birth interval	Conception	Age	Number of children
1	1	0	15	1	28	0	18	1
2	1	0	16	1	29	0	18	1
3	1	0	17	0	30	0	18	1
4	1	0	18	0	31	0	18	1
5	1	0	19	0	32	0	19	1
6	1	0	20	0	33	1	19	1
7	1	0	21	P	34	0	19	1
8	1	0	22	P	35	0	19	1
9	1	0	23	P	36	0	19	1
10	1	0	24	P	37	0	19	1
11	1	0	25	P	38	0	19	1
12	1	0	26	P	39	0	19	1
13	1	0	27	P	40	0	19	1
14	1	0	28	P	41	0	19	1
15	1	0	29	B	1	0	19	1
16	1	0	30	0	2	0	19	2
17	1	0	31	0	3	0	20	2
18	1	0	32	1	4	0	20	2
19	1	0	33	1	5	0	20	2
20	1	0	34	1	6	0	20	2
21	1	0	35	1	7	0	20	2
22	1	0	36	1	8	0	20	2
23	1	0	37	1	9	0	20	2
24	1	0	38	1	10	0	20	2
25	1	0	39	1	11	0	20	2
26	1	0	40	1	12	0	20	2
27	1	0	41	1	13	0	20	2
28	1	0	42	1	14	0	20	2
29	1	0	43	1	15	0	21	2
30	1	0	44	1	16	0	21	2
31	1	0	45	1	17	0	21	2
32	1	0	46	1	18	0	21	2
33	1	0	47	1	19	0	21	2
34	1	0	48	1	20	0	21	2
35	1	0	49	1	21	0	21	2
36	1	1	50	1	22	0	21	2
37	0	0	1	1	23	0	21	2
38	0	0	2	1	24	0	21	2
39	0	0	3	1	25	0	21	2
40	0	1	4	1	26	0	21	2
41	1	0	1	1	27	0	22	2
42	1	0	2	1	28	0	22	2
43	1	0	3	1	29	0	22	2
44	1	0	4	1	30	0	22	2
45	1	0	5	1	31	0	22	2
46	1	0	6	1	32	0	22	2
47	1	0	7	1	33	0	22	2
48	1	0	8	1	34	0	22	2

Another time varying variable reports whether the woman is in a union or not for each calendar month. To overcome the lack of data as described in section 4.3, the information in the cross sectional variables 'number of unions' and date of first union with the union status information available in the calendar section has been combined. Following the analysis of the type of union reported in Figure 4.4 a variable that records the union status for each calendar month has been constructed.

The new variable reports whether the woman was in a union or not. Furthermore if she has more than one union according to the union history reported (Figure 4.4, pg 68) the hypothesis that has been made is whether it was the first or second union. As pointed out earlier, it is not possible to work out the exact number of unions for those women whose first union started before the calendar and who reported more than one union. If a woman had one union that started and ended before the calendar time and just one during the calendar period, it is not possible to know whether this woman had one or more than one union before the beginning of the calendar. However it was clear apart from 38 cases, which one was the first one or the following union. All cases have been crosschecked using the information on the number of unions and the information on the starting of the first union. For 38 cases the information on number of unions was missing and cross-checking with the calendar information it was not possible to derive whether the woman had one or more than one union. One example could be of a woman that has experienced two unions before the calendar period and is not in a union during the calendar period.

For the variable change of union status, as well, a duration variable that records the duration since the last union status change has been created. For the first interval, as in the birth interval variable, the age of 12 has been chosen assuming that when the woman is first at risk of conception she is first at risk of entering a union as well.

In the original dataset the variables of age and parity give current status information. These have been recoded so as to be time varying, in the case of parity with the help of the birth history reported in the section of the DHS.

4.4.3 Continuous time file structure

The analysis in SPSS presented some limits in particular for the analysis of the time varying variables and when accounting for the simultaneity of the events. The software aML allows a more advanced analysis. In particular it allows the multiprocess analysis of the events and to break down the analysis of union status change into two

components: union formation and union dissolution. The file has been created to allow the analysis of four outcomes: timing to union formation, timing union dissolution, timing to conception when in a union and timing to conception when not in a union.
In order to adapt the file to the needs of the software aML, the structure of the discrete-time file has been recoded into a continuous time one. AML does not handle a large dataset as the one obtained from the recoding into a Bernoulli format. Furthermore the computation of the joint model with this software is facilitated if time is continuous. The file for a continuous model is considerably smaller but more difficult to construct. There is no need to express the data in a woman-month structure. Each line considers a spell in which the durations at the time of the event are reported. The file that will be illustrated in this section has been constructed according to the needs of the software aML that will be described in the next chapter (Lillard and Panis 2000).
In particular the file has been constructed with a data structure format to include all the information of the union formation, union dissolution and conception data in one file and to allow aML to recognise which part of the data to take into consideration for each model (i.e. time to union formation or time to union dissolution). At this stage the analysis has been advanced differentiating between union formation and union dissolution and between conception when in or out of unions. The advantage of using aML lies in the fact that it allows to gather more information by the way the data are structured.
Each model considers different spells and different censoring. For this reason there is the need to structure the data in three different ways according to the event it is considered. In this way the data are unbalanced and might consider different timing for the same woman (e.g. in the union dynamics data the pregnancy months have been included whereas they have been excluded from the conception data). It is, therefore, clearer and more straightforward to have the data separated for each model in the way to ease the readability of the file.

The variables themselves are built up and the censoring principles are exactly the same as in the discrete-time model. In this case, though, each observation represents a woman's spell for each event.

In aML the data can be organised in structures, meaning that for each event or dataset it is possible to assign a data structure value that the programme would recognise, when running a model, to which particular section of the file it should refer. This option is particularly useful when running multiprocess models for hazards. It allows to group in one unique file all information needed for the single models.

The software also allows setting the data on different levels to allow multilevel modelling in general and, more specifically, for hazard models, to distinguish between cross sectional and time varying variables. aML sets at level one the variables that are specified at woman level, at level two the variables that are specified at episode level (e.g. duration) and at level three the variables that vary within the episode (e.g. conceptions within the union duration spell).

The main variables of the file are here described:

- *Data structure* refers to the section of data that has been considered for each model: 1 refers to the structure of data of women not in union. This structure has been used for the union formation model. Number 2 refers to the conception structure. Number 3 refers to the union dissolution structure.

- *Censor* is the censoring variable that in aML is defined as 1 is the event occurs and 0 otherwise. In this case it refers to either union formation, or union dissolution or conception.

- *Number of spells* records the number of spells of union status changes occurred within the conception spell (i.e. how many times the woman has changed union status between two conceptions). Similarly it detects the number of conception spells within a union status spell. In practice it detects the number of level 3 events within a spell.

- *Lower* and *upper* define the duration window in which the event has occurred. aML requires at least a 0.5 lag of time in which the event has occurred. If the event did not occur lower and upper have the same values and refer to the last value observed.

- *Duration* refers to the duration of the conception interval at the time the union event occurred or the union duration at the time the conception has occurred.

- *Age* refers to the calendar age at the time of the event.

- *Union status* records the union status at the time of the occurrence of the event (0 not in union, 1 in first union, 2 in second or higher order union). This variable is useful for the conception events.

- *Time1... time3* are the level 3 variables that define the simultaneity of the events. In structure 1 this variables define the timing of conception inside the union duration interval. Similarly in the conception structure they define the union status event timing inside the conception duration. The last event is always reported equal to the *upper* value. If there is no event occurring during the spell the time variable is reported to be as the upper value.

- *Status1...status2* define the type of event that has occurred and it can be set according to the needs of the model. In the union status structure 99 defines when the women was pregnant, *0,1,...n* define the parity. Similarly in the conception structure 0 defines when the woman is entering in a union, 1 is leaving the first union, 2 is leaving the second union. If there is no event occurring the status variable is equal to the value of the current union status one. The *time* variable helps in understanding that there was no event occurring.

Table 4.9 Continuous file data structure

Woman	Data structure	Censor	Number of spells	Lower	Upper	Duration	Age	Union status	Time1	Event1	Time2	Event 2	Time3	Event 3
1	3	1	3	50	50.5	22	21	1	20	99	29	2	50.5	2
1	2	1	1	33	33.5	20	19	1	33.5	0	-	-	-	-
1	2	0	3	34	34	8	22	0	22	0	26	1	34	1
1	1	1	1	4	4.5	26	22	0	4	2	-	-	-	-
1	3	0	1	8	8	34	22	2	8	2	-	-	-	-

4.5 Sample selection bias

One of the limits of working with the DHS union histories as described in paragraph 4.2 is the left censoring. The dataset does not collect enough information on union histories to be able to use complete histories. The main problem with this type of data is the difficulty in handling it. In our case the main bias is for those women that have experienced more than one union.

Several authors report the treatment of left censored cases to be computationally difficult to handle (Allison 1984; Blossfeld et al. 1989; Kalbfleisch and Prentice 1980; Yamaguchi 1991). The main reasons for left censoring being a problem are, first if the censored sample is a function of the unknown values of the outcome variable, and, second, when there is no pattern of the missing-data mechanism (Yamaguchi 1991). This implies that it is not possible to identify easily a criterion to rebuild the missing cases. To facilitate the analysis it is usually suggested to exclude the cases that are left censored even if it might lead to a biased sample.

There are few studies (Flinn and Heckman 1982) that try to find possible solutions for left censored data, but they are computationally intensive and frequently heavily dependent on arbitrary assumptions. As these assumptions will not assure accurate estimation in the final model, it was felt that the left censoring techniques were not achieving a better result.

Sample composition of the women that have been excluded

Three types of women that have been completely excluded as reported in Figure 4.4 PG 68 from the analysis:

1. Women that experienced only one union that ended before the beginning of the calendar (425 women, 6% of the women who experience only one union).
2. Women with more than one union that have all their relationships before the beginning of the calendar (65 women, 5% of the women that experience more than one union).
3. Women with more than one union who started the last union before the beginning of the calendar period (557 women, 46% of the women that experience more than one union).

It is clear that the main bias is given by the fact that women that experience more than one union are more likely to be excluded from the analysis and therefore more likely to be underrepresented.
In cases of evident bias, censored data could be treated as missing data in the same manner as other type of missing data like non-response, measurement errors or non-coverage. If data are missing randomly the problem does not exist and it is possible simply to exclude the cases from the analysis as they would not create a serious bias. However if there is a clear pattern to the missing cases there are two possible ways to overcome the problem: weighting or imputation.

Weighting is usually used when the information on the subject is completely missing (unit missing) (Kalton and Kasprzyk 1986). In this case the information refers to woman-months units where some of the women are simply truncated, therefore part of the information is known. It is therefore possible to have a woman completely missing in the sample that is being considered, as in the case of women that reported two unions before the start of the calendar period. In that case we do not have any information about the ending dates of the unions and no information about the starting date of the second union. Otherwise it is possible to have women that have a first union before the starting of the calendar period but that start a second union after the beginning of the calendar, in this case the information is partial. It is only possible to use the complete information for the second union. Weighting being a technique for completely missing information, it was not found to be an appropriate technique for reconstructing missing cases.

A better option is then imputing the value of the unit missing cases. A variety of imputation methods have been developed for assigning values for missing values (Kalton and Kasprzyk 1986). Imputation techniques can range from simple ad hoc procedures to ensure complete records in data entry, to sophisticated procedures that involve regression techniques. Most of these techniques refer to 'non-response' missing values that are not appropriate in the case under consideration.

There are also techniques that consider ad hoc algorithms to substitute values of censored data in particular of right-censored data.
The main problems linked with this type of technique are that not many packages can handle it. The computation of the values can be long and work intensive as in most cases the packages need to be programmed for the appropriate imputation method. If the type of imputation method does not fit the data perfectly it could

actually add a further bias to the analysis (Sande 1982). Finding an appropriate imputation method could therefore, be cumbersome and the result not be the appropriate one. It is considered to be a task that goes beyond the target of this study and that could be very time consuming. For these reasons and for the fact that it adds further complexity and possibly even additional bias to the analysis, it was felt that imputation would not add further value to the analysis.

A third option that could show the actual impact of left censoring on the results is to select the cases that start their union during the calendar period only (Yamaguchi 1991). In this way a very small sample that is not affected by left censoring is obtained. The results can be then used to analyse the differences and bias of the actual models. This final option has been chosen to tackle the problem under study for being straightforward and easy to handle. As an initial approach to the problem the women that have been excluded are analysed and the possible effects on the results are considered in the next section.

4.5.1 Composition of the sample

To ease interpretation of the results that will be presented in Chapter 6, some basic socio-economic and demographic characteristics of the women that have been excluded from the analyses have been explored to see if there are any patterns and how these may affect the results. In choosing the characteristics that could influence significantly the final results are selected. The codes refer to those defined in Figure 4.4 pg 68.
The women that refer to code '2' are much older than the rest of the sample. The composition in terms of race, religion, residence is very similar to the rest of the sample. Code '2' differs from the rest of the sample for childbearing as well. Almost none of the women have had a child during the calendar. The percentage of sterilised women is higher as well. For the second group it can be seen that they are only slightly older than the average of the population. Most of the women with code '2' are not at risk of experiencing the event conception during calendar period as they are in general older than the overall sample. The main bias is determined by the exclusion of women with the code '3' as they are more at risk of conceiving.

In this case the behaviour of women that experience more than one union could be underrepresented. In particular those women show a fertility that is higher that the

average of the sample during the calendar period. However it is possible to see that the sample of the excluded women is very similar to the overall sample of women that have experienced more than one union. This shows that there is not a particular pattern of the women that have been excluded from the analysis and consequently the bias could be negligible.

Table 4.10 Composition of the sample of women excluded from the analysis

	Code 2*	Code 3**	Sample women with 2+union	Total sample
% of over 30	75	60	55	33
% of mixed ethnicity	61	63	63	56
% of Catholics	77	74	75	77
% of urban resident	89	80	82	81
% sterilised at the beginning of the calendar period	35	32	36	20
% of those with last child before beginning calendar period	91	66	59	69
% those who has two children during calendar period	1	12	13	5

*Women for whom the number of unions is known, but the duration of all union spells and of the spells out of the union is unknown. **Women for whom neither the number of previous unions nor the duration of the current union is known as it started before the calendar period and there is no information on the starting date.

4.6 Summary and conclusions

The data recoding and strategy of analysis is one of the main targets of this study. There is a lack of utilisation of the DHS calendar mainly due to difficulties in managing this type of data. It is for this reason, and to facilitate the task for future users, that a detailed description of the steps that have been undertaken to arrive at the final file has been included. Despite few gaps in the sample, most of the information it is

possible to extract from this type of data for an analysis of union dynamics and fertility has been obtained.

It is important to explore new ways to exploit a big source of information such as the DHS calendar. Many developing countries lack of analysis on union dynamics mainly for the lack of data. The DHS calendar could be the only source of information in these cases.

Chapter 5
Methods

Interest in life course events and how to model them has been growing. Particular stress has been put on the analysis of failure time data. Starting from the basic principles of the life table, new statistical techniques have been developed.
This chapter will stress in particular on the need of modelling life course events jointly. The simultaneity and correlation of the events is a fundamental factor that should be taken in consideration when modelling decision-making.
This chapter describes one of the possible applications that can be done studying life course events. Starting with the description of discrete and continuous time modelling the importance of accounting for unobserved heterogeneity in event history models is highlighted. Even if the final multiprocess model will be in continuous time, the stages experienced to get to the final model will be shown. The last part of the chapter is completely dedicated to the technical description of multiprocess modelling.

5.1 Multiprocess modelling

Researchers have stressed on the need to incorporate multiple life course processes in order to better understand the ways in which people actually live their lives. The simultaneity of the events and their correlation has highlighted the need for more flexible techniques that would incorporate multiple life events.
In particular union dynamics and childbearing has a rich literature of attempts to model the decision–making behaviour of a couple. Preliminary attempts (Upchurch 1993, Ribar 1991, cited in (Lillard and Brien 1994)) have tried to model the simultaneity of the trajectories such as adolescent childbearing and educational attainment, using multinomial logistic models. However these models are not applicable to every type of event (i.e.: hazards of marrying or remarrying are not competing risks) and

they take into account only of a small variety of trajectories and do not include important time-varying covariates (Lillard et al. 1994).

Life course study highlights the different trajectories that interact in a woman's life: when a woman is at risk of entering in a union she is at risk of conceiving as well. During this time other events occur in her life that interact and could be at the same time endogenous effects themselves. Educational attainment, family formation and childbearing for example are strictly correlated (Lillard et al. 1994). Entry into employment and childbearing could be considered two other endogenous effects. Childbearing, for example, is the result of the decision of not to take any contraceptive method, of building up a family or not aborting. All these events can be modelled jointly to account for the endogeneity of each effect (Upchurch et al. 2001). Results are called multiprocess models.

As Lillard has pointed out in several papers (1993, 1994, 1998) it is important to consider the endogeneity of each event when considering life course trajectories. In the case of the union formation women are at risk of entering a union in the same moment they are at risk of childbearing. Union formation could often be the consequence of a pregnancy. It is clear that conception is an endogenous effect inside the union formation equation. In the union dissolution equation the woman is at risk of splitting up as it is at risk of conceiving.
Consider the case that is studied in this project. The woman is at risk of conceiving when she reaches the age of 12. At the same time she is at risk of entering in a union. If the woman enters in a union it is likely that after a while she will conceive. The case could be that she gets pregnant not being in a union and decides with her partner to start a new union. From that moment onwards the woman is at risk of conceiving again and at the same time to exit the union. These processes are running in parallel and decisions on two processes may be made jointly, mutually influencing each other. The information available on the calendar data is limited and does not permit to consider other potentially endogenous processes such as that described in employment histories or educational histories. However, using cross sectional information they could still be included as covariates.

Multiprocess models are fundamental in event history analysis because they allow the analysis of different life course sub-areas (marriage and conceptions) simultaneously. Furthermore simultaneous models allow the analysis of multiple spells along one process accounting for the endogeneity of the others by capturing the

unobserved heterogeneity from the full life history of each woman. Joint models allow time to be measured across several temporal dimensions simultaneously.
The heterogeneity terms of related processes determining the current or lagged values of explanatory variables may be correlated with the one in the process that is being considered.
This type of modelling allows taking into account of lagged events. It therefore takes into account of the fact that events of one phenomenon might depend on past events of another phenomenon. More specifically conceiving a child is directly dependent on entering in a union few months earlier (Upchurch et al. 2001).

Multiprocess modelling is useful when one outcome may affect the other one. In that case a simple one-equation model might not explain the variation fully. In these type of models the simultaneity of the events is considered by correlating the unobserved heterogeneity of the different processes. Fully simultaneous models, in which there is a reciprocal relationship between the outcomes, are a specific subclass of multiprocess models. In these models the simultaneity is expressed by the inclusion of one hazard in the other equation and using econometric techniques to reduce the system from multiple equations to one equation. In particular, recent literature (Lillard 1993; Lillard and Panis 1998; Lillard and Waite 1993) has concentrated its attention on simultaneity in hazard processes. Simultaneous models are useful when the hazard rate of one process depends on the hazard of another process or on the actual current state or prior outcomes of a related multi-episode process.

Simultaneous equation modelling is usually associated with econometric analysis, and there is a wide literature on the topic (Griffiths and al 1993; Maddala 1988). However its use has been extended in the last ten years to other areas, and has found application in several demographic models.

From now onwards it will be referred to the response variable and the covariates with different terminology. In simultaneous models outcome variables are referred as *endogenous* variable. These are variables that are determined by the model; whereas the *exogenous* variables are determined externally. The endogenous variables are also defined as jointly determined and the exogenous ones as predetermined (Maddala, 1988).

5.2 Event History analysis

Event history analysis can be defined either as the study of the duration of non-occurrence of an event or as the analysis of the rates of the occurrence in a period of risk (Yamaguchi 1991). The aim of event history analysis is to analyse the timing, patterns and causes of an event. Event history analysis is concerned with the study of the occurrence of an event. It is usually used by demographers for the study of vital events such as births, marriages, and deaths.

If conception is considered as the event of interest then the period at risk is the time between the menarche and the menopause. If union status change is considered as the event of interest the time of risk is the time between menarche and the union formation or between union formation and union dissolution.
More in general the event analysis describes the passage from one state to another (i.e. healthy versus ill).
In social sciences event history analysis is used to analyse the length of time before a subject experiences marriage, conception, entry into the labour force, first sex. In medical science there is wide spread use of event history analysis. Particular examples of uses of failure time data in medical sciences are the timing of death or the risk of contracting a certain disease.

The analysis of the DHS calendar in this thesis concerns events related to union status and childbearing during the five years preceding the survey. The events of interest will be the conceptions and changes of union status.

Event history analysis has different approaches according to the type of event that is taken into consideration. It is possible to have repeated against unrepeated events, the second being more widely studied and usually linked to simpler models. Examples of unrepeated events are the birth of the first child, or sterilisation, first marriage or death. With repeated events there are multiple episodes for each subject for the same type of event. Examples of repeated events are: conceptions, entries into a union, and exits from a union. The subject has multiple spells defining spell as the interval duration of an episode.
It is possible to have single or multiple kinds of events. To clarify the difference the example of entering in a union can be taken: considering it as a single event it is simply considering the start of a new union regardless of the type of union.

Considering it as a multiple kind of event it is to take into account that the subject can either enter in cohabitation or in a formal marriage.

Event history analysis may be carried out in both discrete and continuous time. If the time of event occurrence is measured exactly in small units a continuous model is usually used. If the number of intervals of possible events is small, discrete approach is preferred (Allison 1984).

Two issues that are usually considered in the analysis of duration data are censoring (the date of the occurrence of the event is unknown), that have been described in detail in the previous chapter, and the inclusion of variables that change value during the observation period (i.e. age) (Allison 1984). Time varying variables are fundamental in models that consider the simultaneity of the events and the fact that changing one type of status might affect the other.

5.2.1 Continuous time

Concepts that are highly related are the *hazard rate, probability density function, risk period* and *survivor function*. The hazard rate *h(t)* is the risk of an event occurring at time t given that the event did not occur before time t. The function can also be defined as the ratio of two probabilities: the unconditional density of the event *f(t)* divided by the survival probability *S(t)* (Yamaguchi 1991).

The hazard rate for the occurrence of the event is defined as the probability density of the occurrence of the event, conditional on the non-occurrence of the event through the current time *t*. In the models considered the hazard is given by the product of a baseline hazard h(t) and proportional shifts in the hazard due to both measured covariates and latent variables.
Density f(t) and distribution F(t) function of the duration $T(T \geq 0)$ are defined as

$$F(t) = P(T < t) = \int_0^t f(u)du$$

and

$f(t) = F'(t)$.

The *survivor function* as

$S(t) = P(T \geq t)$

that expresses the probability that an individual remains in the state until time t, that means that the event has not occurred and the episode is still continuing.

$$h(t) = \lim_{t \to 0} \frac{P(t + \Delta t > T \geq t \mid T \geq t)}{\Delta t} = \frac{f(t)}{S(t)} \qquad \textbf{5.1}$$

where $P(t + \Delta t > T \geq t \mid T \geq t)$ is the probability that the event occurs between time t and time t+Δt given that the event did not occur prior to time t.

In the models considered here the hazard is given by the product of a baseline hazard $h_0(t)$ and the positive proportional shifts in the hazard due to both measured covariates and the outcome variable:

$$h(t) = h_0(t) e^{\alpha + \beta' X + \gamma' X_t(t) + \varepsilon} \qquad \textbf{5.2}$$

or

$$\ln h(t) = \ln h_0(t) + \alpha + \beta' X + \gamma' X_t(t) + \varepsilon .$$

Where *X* is the vector of the covariates, $X_t(t)$ is the vector of time varying variables and ε is a random effect.

The duration distribution (baseline hazard) can follow different patterns according to the model that is being used and according to the phenomenon is studied. It is possible to have logistic, exponential or Weibull distribution for examples (Blossfeld et al. 1989).

The duration model that will be used for the modelling analysis is based on the Gompertz-piecewise linear distribution. The Gompertz (Makeham) hazard function is defined as

$$h(t) = h_0 c^t$$

where h_0 is the hazard at time 0, c is a constant and *t* is time.

5.2.2 Discrete time hazard model

The common approach to event history analysis is to consider time as a continuous variable. Discrete-time models assume that the event of interest occurs only at particular time points. When the time units are few but frequently occurring it is reasonable to consider the discrete approach.

The interest of this analysis is in the event "conception" and in the event "change of union status". To simplify the analysis the data is structured in a Bernoulli format and each observation is a woman-month exposure as described in section 4.4. The hazard rate will be the probability of conceiving a child or changing the union status given that the woman is at risk. In both cases the explanatory variables of the model are binary: 1 if the event occurs, 0 otherwise. Among the explanatory variables there are time varying variables such as duration, age, parity, etc. having on average 65 possible event-times and several thousands of cases, the discrete time approach is straightforward.

Having written formula 5.1 for continuous time we have its discrete time analogue (Allison 1982):

$$h_t = P(T = t \mid T \geq t) = \frac{f_t}{S_t} \qquad \textbf{5.3}$$

h_t is a function of time to indicate that the event may vary with time.

f_t is the probability function for T

$$f_t = P(T = t) \qquad \textbf{5.4}$$

and the survivor function can be expressed as

$$S_t = [1 - F_t] \qquad \textbf{5.5}$$

where F_t is the cumulative distribution function for T

To model the hazard as a smooth function of time the fitting is obtained using the logistic model. In this way it is assumed that all the unobserved heterogeneity is accounted by the inclusion of the covariates. Creating the logistic link the model will therefore be a logistic model expressed as:

$$\log \frac{h_t}{1 - h_t} = a + b_1 x_1 + b_2 x_2(t) \qquad \textbf{5.6}$$

where h_t is the hazard function, x_1 is the vector of variables constant over time, $x_2(t)$ is the vector of the time varying variables, b_1 and b_2 are the vectors of the coefficients.

Applying the exponent to both sides of the equation we obtain the hazard function

$$h_t = \frac{\exp(a + b_1 x_1 + b_2 x_2(t))}{1 + \exp(a + b_1 x_1 + b_2 x_2(t))} \quad \textbf{5.7}$$

or

$$h_t = \frac{1}{1 + \exp^{-[a + b_1 x_1 + b_2 x_2(t)]}} \quad \textbf{5.8}$$

Limits of the discrete time approach

The main problem linked with the discrete time approach emerges when there is the analysis of a large sample for a long period. In that case the Bernoulli format file becomes extremely large and unmanageable. One solution could be to group the intervals of time. It has been argued that in this way there would be a loss of information but it has been shown (Diamond et al. 1986) that little precision is lost when observations are aggregated.

It is also possible to estimate the model with log linear analysis instead of logistic regression. The only condition is that all the covariates should be categorical (Allison 1984).

In general though if the sample is not extremely large the discrete time approach will give results similar to the continuous one in particular when there are time varying variables.

5.2.3 Discrete versus continuous time

Discrete time approach is more appropriate and definitely easier to apply in several models. In a continuous time model, time is assumed to be a continuous variable that does not take any negative value. However more often events are recorded in discrete time (nearest year or nearest month) even if the underlying process operates in continuous time. In those cases discrete time is a better option. An advantage of

discrete time is that the dataset setting up is more straightforward and more readable. However discrete time is not the best approach for simultaneous modelling, in particular for the difficulty of packages to handle the big datasets. At the same time the type of dataset that are constructed for a discrete time model creates problems with most software. The computation is longer and sometimes the software is not able to handle the whole dataset. This is the case of AML the software that will be used for the analysis. For this reason after a preliminary analysis in discrete time that helped in setting up the variables to be included in the final model, the continuous time approach to analyse the more advanced models and in particular the joint model has been chosen.

5.2.4 Repeatable events

Many of the events studied by social scientists are repeatable. In this case both conception and union status change are repeatable events. Other example can be contraceptive use intervals, employment spells. The main problem associated with repeated events is that some individuals might contribute with more than one event in the sample. The main methodological problem of recurrent events derives from the fact that most statistical models imply independence between observations. However it would be expected that repeated observations on the same individual to be correlated. Considering the example of the analysis of birth intervals a woman with a high fecundity will contribute with a short series of birth intervals.
With repeated events there are two sets of factors: those it is possible to control by including process history, and those it is not (unobservable). There is therefore a range of solutions that could take into account these factors.
One approach that could be suggested is to analyse every single event separately but that could result computationally tedious and statistically inefficient as in many cases the occurrence of subsequent events could vary very little in the same individual (Yamaguchi 1991).

Another approach is to consider covariates that include previous events to take into account possible dependencies. In the analysis of birth intervals a possible covariates is the number of preceding births, or in the analysis of union dissolution the number of preceding unions. However it is still likely to be some unobserved factors that it is not possible to control, and therefore the correlation between durations would still be there.

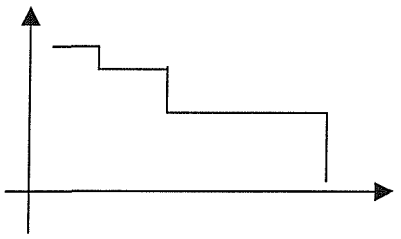
An alternative could be to insert the order of the events and interact with the rest of the variables in the model and in particular with time. The problem with this solution is that the order is meaningful only when the history of the individual is complete. In the case under study, for example, there is not complete information on the order of the unions.

Another solution is to include covariates that include the order of the event, including time. The order is meaningful in the model only if the complete event history is known. One solution can therefore be to insert the duration variables in the list of covariates.

5.3 A methodological note: splines

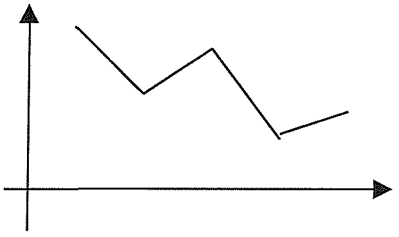
The inclusion of time varying duration variables in the event history analysis creates the restriction of a linear relationship between the log hazard ratio and the time varying variable. To remove this restriction it is possible to transform the continuous variable with various transformations, among these splines, polynomials or piecewise constant or linear.
Splines are usually defined as piecewise polynomials of degree n whose function values and first n-1 derivatives agree at the points where they join. The abscissas of these joint points are called knots (Smith 1979). Polynomials may be considered a special case of splines with no knots. Piecewise constant technique is the simple transformation of the continuous variable into several dummy variables, equal to n+1 knots.
Their shape and suitability varies according to the type of model and to the type of duration.

Piecewise constant splines are the simplest and the less flexible ones as well.
Their shape could look like this.

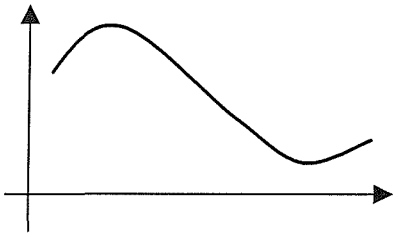


With this type of splines it is assumed that the hazard is constant between each knot.

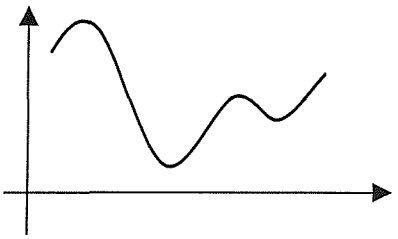
An advanced version of spline is *Piecewise linear* that assumes linear trends between each knot.



Another type of spline is the *Polynomial* that can be considered at whichever degree is needed.



A particular case that will be analysed in more depth in the next section is the natural cubic spline that gives more flexibility that a simple polynomial.



Splines will be included in each of the models described in the next chapters. In particular the attention will be focused on the piecewise constant and the natural cubic splines.

5.3.1 Piecewise linear splines

For the continuous model a different type of splines is used: piecewise linear splines with Gompertz intercept. These types of splines give a better fit to the data when considering continuous time hazard models (Lillard et al. 1994; Lillard 1993).

The piecewise linear duration is convenient because the sum of several piecewise linear dependencies is again piecewise linear, so multiple 'clocks' (the meaning of clocks will be described in the next section) may be running during a particular spell (Lillard & Panis, 1998). Furthermore a log-hazard with piecewise linear duration can be substituted easily inside multiprocess models into another latent variable to obtain the system of equations.

It is possible to consider the generic time dependence *D(t)* of the single hazards. With piecewise linear spline transformation the duration variable becomes a vector of $N_T + 1$ spline variables where T represents the calendar time. In practice the duration is decomposed in $N_T + 1$ linear durations that add up together form the trend of the hazard by duration. Each new variable represents the original variable on a specific segment of its range, so that the estimated effect is no longer linear but piecewise linear. The spline variable for the *kth* interval between the knots μ_{k-1} and μ_k is given by

$$D_k(t) = \max[0, \min(t - \mu_{k-1}, \mu_k - \mu_{k-1})]$$

Therefore for example for the whole variable it would become

$$\alpha_1' D(t) = \sum_{K=1}^{N_T+1} \alpha_{1k} D_k(t) \qquad \textbf{5.9}$$

Considering the example of a variable with 3 knots: 12, 60,120. Therefore the variable can be defined into the four piecewise segments as

$$D(t,12\ 60\ 120) = \begin{pmatrix} \min[t,12] \\ \max[0,\min[t-12,60-12] \\ \max[0,\min[t-60,120-60] \\ \max[0,t-120] \end{pmatrix}$$

these single segments added up will form the duration variable.

5.3.2 Natural cubic splines

The attention is concentrated on the cubic splines as well as they are very popular because they are of low degree, fairly smooth assuming continuity restrictions up to the second derivative, and they have the power to incorporate several different trends simply by increasing the number of knots. These splines have been used for the discrete time models only as they are more suitable for this type of models.

Cubic splines are defined as

$$Spline(a_i) = \gamma_0 + \gamma_1 a_i + \gamma_2 a_i^2 + \gamma_3 a_i^3 + \sum_{j=1}^{q} \varphi_j (a_i - \tau_j)_+^3 \qquad \textbf{5.10}$$

where $(a_i - \tau_j)_+ \equiv a_i - \tau_j$, if $a_i > \tau_j$

$\equiv 0$ otherwise.

The value of the continuous variable for the *i*th individual is a_i, q is the number of knots, τ_j is the location of each knot and γ_0, γ_1, γ_2, γ_3 and φ_j are the parameters to be estimated (Grummer-Strawn 1993).
It has been demonstrated (McNeil et al. 1977) that there is a unique cubic spline that can be shown to be the smoothest in the sense that minimises the integral

$$\int_o^t \{Spline''(a)\}^2 da$$

and assuming for the sake of simplicity when q=5 this integral is minimised by the conditions:

1. $\gamma_2 = 0$
2. $\gamma_3 = 0$ **5.11**
3. $\varphi_1\tau_1 + \varphi_2\tau_2 + \varphi_3\tau_3 + \varphi_4\tau_4 + \varphi_5\tau_5 = 0$
4. $\varphi_1 + \varphi_2 + \varphi_3 + \varphi_4 + \varphi_5 = 0$

When these conditions are satisfied the fitted curve is called *natural cubic spline*.

It has been demonstrated (Grummer-Strawn 1993) that the natural cubic spline fits the data better compared to model schedules such as polynomials or piecewise constant transformations, in particular for discrete time models.
Considering the model in formula 5.6 (PG 89) with the inclusion of splines it is obtained that

$$\log\frac{h_t}{(1-h_t)} = a + b_1x_1 + b_2x_2(t) + b_3S(t). \qquad \textbf{5.12}$$

where $x_1(t)$ is the vector of the covariates, $x_2(t)$ is the vector of the time varying variables, b_1 *and* b_2 are the vectors of the coefficients and $b_3S(t)$ is the vector of the spline variables.

The main problem about splines is the choice of the knots. There is no fixed rule about it and the choice is usually related to the trend of the variable. It is commonly suggested not to use too many knots, as this makes the computation more difficult. It is usually sensible to choose the knots at points that are considered, on the basis of previous literature, to be crucial turning points in the trend of the variable.

For each of the time varying variables (age, duration since preceding birth, calendar month and union status duration) natural cubic splines have been calculated and introduced into the discrete time model. Piecewise constant, piecewise linear and polynomial transformations have also been tried but the best fit was obtained with the natural cubic spline. The fit of the variable has been deduced graphically plotting the log-hazard against the splines. Furthermore natural cubic splines assure continuity on the knots' points.
However this type of splines are not available in the software aML.

5.4 The importance of accounting for unobserved heterogeneity

Statistical and economic models make often the assumption that the population of interest is homogeneous. Usually the models that account for the covariates effects only are called 'fixed-effects' models. These types of models analyse the fixed (observed) effects of the covariates on the outcome, in the case of this study on the hazard of the event. In other words they assess the observed heterogeneity of a population at risk of experiencing an event. These types of models assume a priori that the population observed is homogeneous.

In reality individuals are different and even though it is possible to recall a common behaviour expressed by most covariates included in the model, there are still unobserved factors that are not described by the variables included in the model and that belong to each individual. Assuming that the population we are studying is homogeneous when instead it is heterogeneous would introduce a bias. In a situation where there is limited information on the factors that determine union status change, accounting for unobserved heterogeneity can improve the model. For example, the lack of information for women in second or higher order unions about the order of the actual union could be important in determining the hazard of splitting up. At the same time including union duration could not be enough to consider the boredom that some couples might experience in their union. Similarly the bargaining power of the woman to keep the relationship is not measurable with the only 'standard' covariates that will be introduced in the model. Despite education and socio-economic conditions different women represent different characters and different strengths. The same reasoning applies to the hazard of conception. A fixed-effects model could never catch the discussion and negotiation that goes in a couple's life when childbearing decisions must be taken. Considering the target of this thesis, it is possible to say that there is an unobserved variability in women's fertility that it is not possible to measure with the standard fixed-effect model.

Several authors have highlighted the importance of including this heterogeneity in the model in both economic and demographic analysis (Heckman et al. 1985; Heckman and Singer 1982; Heckman and Singer 1984; Lewis and Raftery 1995; Lillard et al. 1994; Lillard 1993; Weistein et al. 1990). They demonstrated that if we fail to account for unobserved heterogeneity biased results could be obtained. Vaupel & Yashin (1985), for example, demonstrated that not accounting for unobserved heterogeneity decreases the hazard of the event. Considering that there are

individuals with a higher hazard of experiencing the event, those individuals will be out of the observation earlier and therefore the rest of the survival distribution will be influenced by their early absence. Heckman et al. (1985) analysed the influence of early fertility on subsequent births comparing models with and without the random effect. They demonstrated that accounting for unobserved heterogeneity a longer birth interval predicts a shorter subsequent interval in particular when including marital status as a covariate, contradicting most of the literature on the topic.

Considering repeated events instead, it is possible to say that they are not independent. In the case of conception, for example, the hazard of the event depends on the number and timing of the previous events. Including random effect measures allows the events to be correlated.

Models that include unobserved heterogeneity are usually called random effect models or frailty models. It derives from the fact that the standard procedure to consider for unobserved heterogeneity is to include a random effect estimator in the model. The random effect estimator is then implemented assuming a functional distribution of the unobservable. The distribution can be normal, gamma or any parametric distribution (Heckman and Singer 1982). As Heckman and Singer (1982) demonstrate it is important as well to identify the right type of distribution. It could be useful sometimes to use a mixture of distributions to obtain the best estimations is considered. The standard procedure to account for unobserved heterogeneity. The normal distribution is used following Lillard's (1993) model that will be described in the next section.

However the identification of the distribution could be one of the main limits of the inclusion of unobserved heterogeneity. As Trussell and Rodriguez (1990) have demonstrated, the wrong identification of the distribution of the unobserved could lead to estimates that do not add any information to the model. The authors claim that the same amount of information in an event history model could be reached with the simple inclusion of duration variables and time varying covariates (Trussell and Rodriguez 1992). In the case that will be analysed in the next chapter the information available is limited and there are several gaps to be filled in particular for time varying covariates. The inclusion of unobserved heterogeneity in the model is fundamental to account for these gaps.

Unobserved heterogeneity is fundamental as well for this model as it allows correlating the unobserved factors of two equations when modelling two outcomes

jointly. The model that will be used to estimate the risk of conception and union status change will be based on the joint distribution of the unobserved heterogeneities. In particular, as reported in the next paragraph, Heckman and Singer (1985) estimation for the unaccounted heterogeneity factor will be considered.

5.5 Multiprocess hazard models, failure time

A latent variable is defined as a variable that is not directly observable not even in the population. These variables are usually hypothetical constructs invented by the analyst to understand a certain behavioural area and for which there is not a direct estimation method (Everitt 1984). This definition will be useful to understand most of the multiprocess procedures that will be described in this section.

Section 5.1 stressed the importance of accounting for endogeneity when modelling events that are highly correlated and interdependent. The main techniques refer to econometrics techniques. However in the last twenty years there has been a particular interest in developing multiprocess techniques to apply to demographic modelling, in particular to binary outcomes and multilevel data. In this section some of the main methods that have been developed to be applied to demographic methods will be reviewed.

There can be four basic types of multiprocess models: correlated processes; non-randomly missing data; self-selection and endogenous outcomes from related processes; and index functions from related processes (Lillard and Panis 1998). The first one considers the case in which the *correlation* is determined by the correlation between the latent variables. The two processes have their own set of latent variables and are simply correlated. Apart from substantive correlations, these kind of processes can be estimated separately and the correlation can be estimated pairwise (Lillard and Panis 1998). An example of correlated latent variables could be the earnings of brothers or sisters where it would be expected that the level of earnings to be correlated. In this case it is possible to consider each process (the earnings of each brother or sister) parallel.

The multiprocess model that involves *nonrandomly missing data* includes the non-random selection into sub sample of the data where the outcome of some other

process is observed. One example could be the observation of marital fertility timing or total number of children born to a woman only for sisters who have married in a family unit of observation. Another example is the observation of earnings only for siblings who have completed their schooling and begun work. In this type of models the events (in the first case to have a child, in second example the level of earnings) are correlated and subsequent events are subject to selectivity with respect to earlier events (only those sisters that got married, only those siblings that completed their schooling). The fact that the correlation is introduced among either the sisters or the siblings makes the computation of this type of multiprocess modelling more technically advanced[1].

The last two methods are more relevant for the type of analysis that is considered in this study as they are both applicable to the type of data that is used in this analysis.

The third type considers the multiprocess model in which the index function from a related process is an explanatory variable. An example of this model is the paper by Lillard (1993). The author considers the hazard of marital disruption and the hazard of conception. The first hazard is a function of the potentially endogenous variable marital fertility. The second hazard is a function of the hazard of divorce.
Considering the example of the joint model of conception and union dissolution, Lillard (1993) builds up a model in which union dissolution is an index function of conception. The equations of the model could be expressed as

$$\ln h_l^d(t) = \alpha_0 + \alpha_1 T(t) + \alpha_2 A(t) + \alpha_3 D_l(t) + \alpha_5 X^d(t) + \alpha_7 C_l(t) + \varepsilon^d$$

and

$$\ln h_l^{cd}(t) = \beta_0 + \beta_1 T(t) + \beta_2 A(t) + \beta_3 C_j(t) + \beta_5 X^{cd}(t) + \beta_6 D_l(t) + \lambda \ln h_l^d(t) + \varepsilon^{cd}$$

where $\ln h_l^d(t)$ is the hazard of union dissolution for the *l-th* time at time t. $T(t)$ is the vector of the time varying variables. $A(t)$ is age at time *t*. $D_l(t)$ is the union status duration variable of being in union status at time *t* in spell *l*. $X^d(t)$ is the vector of the

[1] For more details see Lillard, L. A., and Panis, S.(1998) "Multiprocess multilevel modelling." *Annual meeting Population Association of America*, Chicago, USA..

exogenous variables for the union status model. $C_l(t)$ is the duration of the birth interval at time *t* in spell *l*. ε^d is the woman specific residual (heterogeneity) affecting the hazard of entering in a union and it is normally distributed $\varepsilon^d \sim N(0,\sigma^2_{\varepsilon^d})$.

$\ln h_l^{cd}(t)$ is the hazard of conception for women in a union for the *l-th* time at time t. $X^{cd}(t)$ is the vector of the exogenous variables for the conception model. ε^{cd} is the woman specific residual (heterogeneity) affecting the hazard of conception and it is normally distributed $\varepsilon^{cd} \sim N(0,\sigma^2_{\varepsilon^{cd}})$

The index function in this case is given by the presence of $\ln h_l^d(t)$ in the second equation. The estimation of λ is given by solving the model with econometric techniques (Lillard 1993).

Lillard develops estimation techniques using Full Information Maximum Likelihood (FIML). This is the most advanced simultaneous model ever used for hazard equations. This type of estimation has led to a series of other studies on the endogeneity of the outcomes that have developed numerous models that consider the simultaneity of the latent variables (Brien et al. 1999; Lillard et al. 1994; Lillard and Waite 1993; Upchurch et al. 2001).

This model will not be used for the study that will be presented in the next chapter as the hypotheses at the base of this study is of mutual relationship between conception and union dynamics and the current methodology does not provide an estimation of a joint model that consider both outcomes as index functions of the other as in Lillard's model.

The methodology that will be used refers to the fourth case in which a milder assumption on the correlation of the latent variables is made.

The simultaneity of the outcomes to hazard models can be applied. More specifically the simultaneity of the outcomes considering the correlation of the heterogeneity components can be taken into consideration. The estimation of the parameters follows Lillard's model (1993) using FIML. Lillard has been the first to consider the simultaneity of two hazard models in which the hazard of dissolution influences the hazard of conception but not vice versa. The endogeneity of union formation and union dissolution in the conception model is not as strong as the endogeneity of conception inside the union status change model. At the same time there is so far no study that considers the fully simultaneous model of hazard equations. Lillard incorporates the effect of different time varying variables that affect simultaneously

the outcome variable. Defining these time related variables as 'multiple clocks', he models the simultaneity of the events considering that one process might depend on the duration of a related process.
Union formation and dissolution are affected by a series of time-related factors such as woman's age, parity, union status duration and a set of exogenous variables. At the same time conceiving is affected by the same set of time-related variables, by the duration since the previous birth and another set of exogenous variables.

The last type of multiprocess modelling is *self selection and endogenous outcomes from related processes* that is strictly related to the previous approach. This is the case in which one or more of the explanatory variables in the equation(s) for one process are themselves outcome of other processes. The explanatory variable is then said to be endogenous effect of the outcome that it is to explain. As explained in the previous section, failure to account for endogeneity will result in estimates that are biased. The correlation across processes is represented by the heterogeneity components specific to each process. In practice in this model the multiprocess is considered with the correlation of the unobserved heterogeneity.
This type of model considers the same techniques of estimation of the previous model in a more simplified approach. The difference from the previous example is that in this case the assumption is milder. In the previous case it was assumed that the index function of an outcome was the explanatory variable of a related process, in this last case instead it is simply the explanatory variable to be the outcome of a related process. There have been an increasing number of applications of this model to various examples in the last decade as it is more straightforward and easily applicable than the previous one (Brien et al. 1999; Lillard et al. 1994; Lillard and Brien 1994; Steele and Curtis 2001; Upchurch et al. 2001). This model has been applied to the outcomes of this analysis. The description of the models that will be used follow.

Union formation model

The union formation model considers the hazard of entering in a union for the first time or re-entering a union in general. It specifies the log-hazard of getting married as a function of time-varying covariates, duration dependencies and unobserved heterogeneity.
The equation is

$$\ln h_l^f(t) = \alpha_0 + \alpha_1' T(t) + \alpha_2' A(t) + \alpha_3' F_l(t) + \alpha_4' \Pr eg_l(t) + \alpha_5' X^u(t) + \alpha_6' Kid_l(t) + \alpha_7' C_l(t) + \varepsilon^f$$

5.13

Where $\ln h_l^f(t)$ is the hazard of union status formation for the *l-th* time at time t.

$T(t)$ is the vector of the time varying variables.

$A(t)$ is age at time *t*

$F_l(t)$ is the union status duration variable of single status at time *t* in spell *l*

$\Pr eg_l(t)$ is the pregnancy status at time *t* in spell *l*

$X^u(t)$ is the vector of the exogenous variables for the union status model

$Kid_l(t)$ is the number of children at time *t* in spell *l*

$C_l(t)$ is the duration of the birth interval at time *t* in spell *l*

ε^f is the woman specific residual (heterogeneity) affecting the hazard of entering in a union and it is normally distributed

$\varepsilon^f \sim N(0, \sigma^2_{\varepsilon^f})$

Union dissolution model

$$\ln h_l^d(t) = \alpha_0 + \alpha_1'' T(t) + \alpha_2'' A(t) + \alpha_3'' D_l(t) + \alpha_4'' \Pr eg_l(t) + \alpha_5'' X^d(t) + \alpha_6'' Kid_l(T) + \alpha_7'' C_l(t) + \varepsilon^d$$

5.14

where $\ln h_l^d(t)$ is the hazard of union dissolution for the *l-th* time at time t.

$T(t)$ is the vector of the time varying variables.

$A(t)$ is age at time *t*

$D_l(t)$ is the union status duration variable of being in union status at time *t* in spell *l*

$\Pr eg_l(t)$ is the pregnancy status at time *t* in spell *l*

$Kid_l(t)$ is the number of children at time *t* in spell *l*

$X^d(t)$ is the vector of the exogenous variables for the union status model

$C_l(t)$ is the duration of the birth interval at time *t* in spell *l*

ε^d is the woman specific residual (heterogeneity) affecting the hazard of entering in a union and it is normally distributed

$$\varepsilon^{d} \sim N(0,\sigma^{2}_{\varepsilon^{d}})$$

Conception model with the union formation spells

$$\ln h_l^{cf}(t) = \beta_0^{'} + \beta_1^{'}T(t) + \beta_2^{'}A(t) + \beta_3^{'}C_l(t) + \beta_4^{'}X^{cf}(t) + \beta_5^{'}F_l(t) + \beta_6^{'}Kid_l(t) + \varepsilon^{cf} \quad \textbf{5.15}$$

$C_l(t)$ is the conception duration at time *t* in spell *l*

$F_l(t)$ is the union status duration variable of being in union status at time *t* in spell *l*

$X^{cf}(t)$ is the vector of the exogenous variables for the conception model

$Kid_l(t)$ is the number of children at time *t* in spell *l*

ε^{cf} is the woman specific residual (heterogeneity) affecting the hazard of conception and it is normally distributed

$$\varepsilon^{cf} \sim N(0,\sigma^{2}_{\varepsilon^{cf}})$$

Conception model with the union dissolution spells

$$\ln h_l^{cd}(t) = \beta_0^{''} + \beta_1^{''}T(t) + \beta_2^{''}A(t) + \beta_3^{''}C_j(t) + \beta_4^{''}Unsta_l + \beta_5^{''}X^{cd}(t) + \beta_6^{'}D_l(t) + \beta_7^{''}Kid_l(t) + \varepsilon^{cd} \quad \textbf{5.16}$$

$C_l(t)$ is the conception duration at time *t* in spell *l*

$Unsta_l$ is the time dependent variable that recodes the union status in spell *l*

$D_l(t)$ is the union status duration variable of being in union status at time *t* in spell *l*

$X^{cd}(t)$ is the vector of the exogenous variables for the conception model

ε^{cd} is the woman specific residual (heterogeneity) affecting the hazard of conception and it is normally distributed

$$\varepsilon^{cd} \sim N(0,\sigma^{2}_{\varepsilon^{cd}})$$

5.5.1 Estimation: marginal maximum likelihood

The estimation for this kind of model uses Full Information Maximum Likelihood (FIML) developed by Lillard (1993) for the estimation of simultaneous models and is used by the software aML (Applied Maximum Likelihood).

The correlation is accounted for through the heterogeneity components for each process. Conditional on the vector of the εs it is assumed that the probabilities are independent of the current outcome. To account for unobserved heterogeneity of the covariates in the unconditional distribution, the marginal likelihood is obtained by integrating over a full range of unobserved heterogeneity components.

For the joint model of union formation and conception the vector of the heterogeneity components is distributed as follows:

$$\begin{pmatrix} \varepsilon^{f} \\ \varepsilon^{cf} \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^{2}_{\varepsilon^{f}} & \sigma_{\varepsilon^{f}\varepsilon^{cf}} \\ \sigma_{\varepsilon^{f}\varepsilon^{cf}} & \sigma^{2}_{\varepsilon^{cf}} \end{pmatrix} \right)$$

where

$$\sigma_{\varepsilon^{f}\varepsilon^{cf}} = \rho_{\varepsilon^{f}\varepsilon^{cf}} \sigma_{\varepsilon^{f}} \sigma_{\varepsilon^{cf}}$$

and $\rho_{\varepsilon^{f}\varepsilon^{c}}$ is the correlation coefficient of the heterogeneity components.

Similarly for the joint model of union dissolution and conception

$$\begin{pmatrix} \varepsilon^{d} \\ \varepsilon^{cd} \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^{2}_{\varepsilon^{d}} & \sigma_{\varepsilon^{d}\varepsilon^{cd}} \\ \sigma_{\varepsilon^{d}\varepsilon^{cd}} & \sigma^{2}_{\varepsilon^{cd}} \end{pmatrix} \right)$$

where $\sigma_{\varepsilon^{d}\varepsilon^{cd}} = \rho_{\varepsilon^{d}\varepsilon^{cd}} \sigma_{\varepsilon^{d}} \sigma_{\varepsilon^{cd}}$

Lillard's estimation of the marginal likelihood that form the joint model is described. The joint model for union formation and conception only is reported; the one that includes union dissolution follows the same criteria.

For any observation, conditional on measured covariates and on the heterogeneity components the survival function is:

$$S_{0u}^{f}(t)=\exp\left(-\int_{t_{0u}}^{t}\exp(\alpha_0+\alpha_1^{''}T(t)+\alpha_2^{''}A(t)+\alpha_3^{''}D_l(t)+\alpha_4^{''}\Pr eg_l(t)+\alpha_5^{''}X^{d}(t)+\alpha_6^{''}Kid_l(T)+\alpha_7^{''}C_l(t))dt\right)$$

5.17

for $t > t_{0u}$ where t_{0u} is the date of the union *u* start.

$$S_{0b}^{cf}(t)=\exp\left(-\int_{t_{0b}}^{t}\exp(\beta_0^{'}+\beta_1^{'}T(t)+\beta_2^{'}A(t)+\beta_3^{'}C_l(t)+\beta_4^{'}X^{cf}(t)+\beta_5^{'}F_l(t)+\beta_6^{'}Kid_l(t))dt\right)$$

5.18

for $t > t_{0b}$ where t_{0b} is the date when conception *b* occurred.

Following this notation the conditional (on the heterogeneity component) survivor function is:

$$S^{f}(t,\chi(t_{l*}^{f}),\varepsilon^{f})=\prod_{i}^{I}\left[\frac{S_0^{f}(t_{i+1})}{S_0^{f}(t_i)}\right]^{\exp(\alpha_0+\alpha_1^{'}T(t)+\alpha_2^{'}A(t)+\alpha_3^{'}U_l(t)+\alpha_4^{'}\Pr eg_l(t)+\alpha_5^{'}X^{u}(t)+\alpha_6^{'}Kid_l(t)+\varepsilon^{f})}$$

5.19

where *I* is the number of subintervals within which the time varying covariates are constant, $\chi(t)$ denotes the full history of the time varying covariates since the spell began, and $t_{I+1}=t$.

The conditional density function for completed duration t_{l*} is given by

$$f^{f}(t_{l*}^{f},\chi(t_{l*}^{f}),\varepsilon^{f})=S^{f}(t_{l*}^{f},\chi(t_{l*}^{f}),\varepsilon^{f})h(t_{l*}^{f},\varepsilon^{f}).$$

The conditional likelihood represents the density function for the observed duration, for each time of each process, conditional on the measured covariates and on the heterogeneity terms of the unmeasured factors. The joint conditional likelihood is calculated as the product of the single conditional likelihood as the censored durations are independent (Brien et al., 1999).

In the aggregate the outcomes are not independent. Furthermore the variation of the heterogeneity induces no independence across the occurrence of the outcome.

At the same time, correlation in the heterogeneity terms across processes induces in the aggregate no independence of the endogenous effect. At the individual level the outcomes are not independent because the heterogeneity terms are unknown for the individual.

The approach that will be used to estimate the likelihood includes these correlations. To account for the correlation in the estimation the joint conditional likelihood is integrated over a range of possible values of the heterogeneity vector weighted by their joint density function, to obtain the marginal likelihood function.

The vector of the heterogeneity components $\varepsilon' = (\varepsilon^f, \varepsilon^c)$ is assumed, as above stated, to be normally distributed: $\varepsilon' \sim N(0, \Sigma_{\varepsilon\varepsilon})$.

The joint likelihood is given by

$$L = \int_{\varepsilon^f}\int_{\varepsilon^c} \prod_{l=1}^{F} L_l^f(\chi(t_l^f), \varepsilon^f) \prod_{k=1}^{C} L_k^c(\chi(t_k^c), \varepsilon^c) dF(\varepsilon^f, \varepsilon^c \mid \Omega) \qquad \textbf{5.20}$$

where F and C represent the number of waiting times respectively for occurrence of union formation and conception, $F(\varepsilon^f, \varepsilon^c \mid \Omega)$ is the joint distribution function of heterogeneity components, and Ω is the heterogeneity covariance matrix. Parameters are estimated by maximum likelihood (FIML) (Lillard 1993).

5.5.2 Identification

Both the classical literature (Griffiths and al 1993; Maddala 1988) and the newly developed joint models (Brien et al. 1999; Lillard 1993; Upchurch et al. 2001) stress the importance of a thorough analysis for the identification of the variables that should be inserted in the model. The absence of variables that are correlated across the outcomes in the model makes the use of joint modelling unnecessary. Without those variables single estimation would give the same results a joint model.

In the classical simultaneous model there is the need for at least one variable that characterises one outcome only to validate the model. However it has been stressed

that in recursive models[2] there is no need for this kind of variable (Brien et al. 1999; Lillard and Brien 1994). These type of models are based on the assumption that, conditional on the factors represented in the unmeasured components, which are assumed to represent all sources of correlation among the processes, the outcomes are independent except for the causal effect of the status of the other process (e.g. currently pregnant) or the cumulative outcomes of a related process (number of children) on the hazard of another process.

It is important to account for the endogeneity of the events. This includes variables that account for the events that happened before the current event (i.e. previous marriages, previous births) that are logically correlated to the current one. In our case the hazard of entering in a new union is affected by the number of children from previous unions, it is affected as well by the number of previous unions. At the same time the hazard of exiting a union is affected by the number of previous unions, as well as by the number of children in the current union. Failure to account for these effects may lead to biased estimates.
It is important to set the data in the correct way accounting for multiple episodes simultaneously.
The DHS calendar data gives limited information. As stressed in the previous chapter it is not possible to link each child to the corresponding union if the conception did not happen during the calendar period. At the same time it is not possible to identify the exact order of the unions. However it is possible to track whether the woman was in a union when she conceived, whether she was pregnant at the time she entered the union, the number of children at the time of either the union ended or started. Furthermore it is possible to track the timing of the events (i.e. it is possible to know for how long the woman has been in the current union before conceiving). All this information is included in the model accounting for endogenous effects.

The estimation is conducted with the help of the software AML (Applied Maximum Likelihood). This package, created by Panis and Lillard, allows to estimate multilevel multiprocess modelling using FIML.
Setting the data as described in section 4.3.3 PG 75 it is possible to subdivide each event in sub episode to account for the simultaneity of the events.

[3] Models that consider the correlation of the heterogeneity components only and that do not include the full simultaneity of the outcomes. For more details see Maddala (1988)

5.6 Summary

Two points are particularly important in the modelling of events: firstly it is important to account for unobserved heterogeneity. The observed covariates do not account for all relevant factors. Secondly, it is important to account the correlation between the outcomes considering the simultaneity of the events.

Multilevel analysis at longitudinal level could have been considered[3], however there were not enough spells to make sure that the estimations of the variation between spells were significant. An analysis of the variation at spell and woman level has been conducted but no significant result has been obtained. A multilevel analysis at community level could have been conducted, however this goes beyond the purposes of this study.

[3] For more details see Snijders, T., and Bosker, R. (2000). *Multilevel analysis*, Sage Publications, London.

Chapter 6

Event history analysis: the models

This chapter is dedicated to the description of the models, analysing the steps that have been followed to arrive at the final models. Firstly an analysis in discrete time conducted with SPSS will be presented. This analysis includes models of the hazard of union status change and of conception. As this is only an initial analysis, fixed effects only will be shown.
Secondly a continuous time analysis conducted with the help of aML will be described, distinguishing the fixed effect models from the random effect ones and from the multiprocess ones. In these more advanced models the hazard of union formation is separated from the hazard of union dissolution.

In the previous chapter the difficulty of carrying out an analysis with aML in discrete time has been described. However it is important to highlight the main differences between continuous-time and discrete-time models and the advantages of using either one or the other.

6.1 Model building strategy

Sample selection

In order to consider only those women who are at risk of conception in the conception model file there has been a further selection in the sample: women that were sterilised before the start of the calendar were removed. Those who got sterilised during the calendar period are observed only up to the date of sterilisation. For the same reason women who said they had never had sex have been excluded from the analysis as well. Due to the number of missing cases that there are in the

variable 'age at first sex', the assumption that the women were at risk of conception during the whole calendar period even if they had their first sexual experience after the beginning of the period of observation has been made. Anyhow the minimum age reported, as described in Chapter 4, is 12 to allow the woman to be at risk of conception.

The months in which the woman was pregnant have been excluded from the conception models, as pregnant women are not at risk of conception. Furthermore, in the discrete time model the birth interval and the union status duration variables have been truncated: the former at 120 months and the latter at 240 months. In this way problems due to the lack of data at long durations are avoided. The exposed-to-risk at these durations often refers to older women who stopped childbearing.

Variables

The data come from the 1996 Brazilian DHS calendar on the union histories and reproductive lives of women aged 15-49 years. A detailed description of the data, together with most of the data recoding, is given in Chapter 4.

Before starting to describe the variables included in the models, it should be pointed out that current status (the information refers to the time of the survey) as well as time varying variables have been used. Because the values of current status variables may have changed since the event of interest took place, careful consideration should be given to the interpretation of these variables. However current status variables still provide valuable information, in particular for datasets like the DHS where the number of time-varying variables is limited.

The variables that have been used in most of the models will be described. Then for each model, a list of the variables included with the rationale for including them in the model will be reported.

As described in Chapter 4, aML allows the specification of time dependent variables in the model. The variables are structured in three levels: level 1 includes the woman-level variables (i.e. education, socio-economic status); at level 2 are the variables that follow the 'clock' of the event that is analysed (i.e. duration, parity); and at level 3 are the variables that refer to the timing of another event parallel to the one that is analysed within the spell of the outcome variable. In the case of the conception

model the level 3 variables consider the timing of either union formation or union dissolution within the conception spell. In the case of the union formation or dissolution models the level 3 variables consider the timing of the conception and the timing of the pregnancy within each spell within or outside a union (Lillard and Panis 2000).

The variables that have been included in the models are socio-economic and demographic variables that have been recognised as significant in the analysis of fertility and union dynamics (Chen et al. 1974; Ebanks et al. 1974; Greene 1994; Heaton 1990; Henriques 1989; Koo et al. 1984; Lazo 1994; Onaka and Yaukey 1973; Ribeiro 1993; Turner 1990; Weistein et al. 1990).
The demographic variables included are: parity, number of unions, region, place of residence, ethnicity, age, age at first birth, age at first marriage, union order, whether the first birth was out of wedlock and if it was another variable has been created to see whether it was legitimised with a union within six months after the conception. For the union formation and dissolution models another time varying variable has been created: the age of the youngest child. This has been deduced from the birth histories reported in the current status data section. It has been demonstrated that the age of the youngest child is positively associated with the hazard of union disruption (Heaton 1990; Koo et al. 1984).

Among the socio-economic variables, the level of education of both respondent and partner has been considered. These variables give information at the time of the survey and are measured in completed years, rather than in terms of educational institutions attended. This choice is the result of previous discussions with Brazilian demographers that reported it as better suited to the kind of educational system Brazil has. The variable has been used in the same way in previous works as well (Lazo 1994).

Another socio-economic variable that has been included, and that is usually negatively correlated with the level of fertility, is whether the respondent watches television every week. This variable is an indicator of the woman's exposure to the mass media. Such exposure has been found to influence the decline of the level of fertility and the enhancement the autonomy of the woman (Carvalho and Wong 1996; Martine 1996). Woman's and partner's occupation, religion, source of electricity and water, and whether she owns a television or a car are some of the other proxies used as socio-economic indicators have been included. These variables have been

chosen to describe the socio-economic status of the woman as the descriptive analysis has revealed them to highlight significant differences in the social status.

In order to choose the 'best' model a 'screening' method has been used: including all the variables in the models, selecting only the significant one and re-running the model. The final, parsimonious models will describe the variables that were significant.

The splines' knots

As reported in Chapter 5 the choice of the natural cubic splines and their knots should reflect the type of variable being considered, keeping in mind that a high number of knots would make the analysis computationally difficult. The choice of the knots might differ according to the type of spline we are using. For the natural cubic splines two knots that are always included are the extremes of the interval.

For the birth interval variable 1, 12, 60 and 120 months have been chosen based on the plots of the raw hazards. The value 120 is the censoring point that in the discrete time models to minimise the problem of lack of data for higher durations. The same criteria have been followed for the union status duration spline. This time knots 1, 24, 60 and 240 have been chosen. The duration interval for age has been divided into three sections obtaining the knots at 12, 30 and 49 years. In all three cases the number of knots has been minimised in order to make the computation more straightforward. Different combinations of knots were tried and the best graphical fit has been obtained with the set of knots above mentioned. The fit of the splines has been tested in the model with the Wald statistic.

In the case of the piecewise linear splines there is no need to include the extremes of the interval. aML requires the specification of the origin only. This value is particularly important when specifying more than one 'clock' in the model, for then overlapping splines may be obtained. If we want to specify a spline for birth duration and one for age it is therefore useful to specify a starting variable that reports the value of the age at the beginning of the period of observation.

Piecewise splines are less flexible and less smooth than cubic splines and therefore more sensitive to the choice of the knots. For this reason, starting from the knots used for the discrete time model, they have been adjusted according to the significance

of the duration variables and following other examples in the literature as well (Brien et al. 1999; Lillard 1993; Lillard and Waite 1993). For the union dissolution models the knots 1, 7 and 14 years have been chosen as a tendency for the hazard of dissolution to people at 7 years has been identified (in correspondence of the 7 years 'itch') (Upchurch et al. 2001). The knots have been left the same for both formation and dissolution models to ease the interpretation. Furthermore the choice of more conventional knots (i.e. 1, 5 and 10 years) for the union formation case did not show particular differences. For the birth interval spline knots at 18 months 5 and 10 years have been chosen.

There have been more problems of convergence with the age spline compared with the discrete time model and the knots have been adjusted at 19, 25 and 35 years old.

6.2 Single equation models in discrete-time

In this section the results from a discrete-time model estimated using SPSS would be shown reporting the fixed effects only.

First of all the event change of union status regardless of whether considering entering in a union or exiting will be shown. The event is marked by the presence of the time dependent covariate *union status*. Furthermore the approach to the endogeneity of the events is given by the use of the interactions. For example to mark the change in union status at the time of conception an interaction between change of union status and union status at the time of the change is used. Therefore, different categories such as leaving first union or staying in second union are obtained.

Table 6.1 Discrete time models: union status change and conception model

Covariates	Model 1 **Union status change** [exp (b)][4]	Model 2 **Conception** [exp(b)]
Age spline	Figure 6.1	Figure 6.4
*Union status duration*union status spline*	Figure 6.2	Figure 6.6
Duration since preceding birth spline	Figure 6.3	Figure 6.5
Calendar month	1.020***[5]	1.000***
Union status		
Not in union	Reference	Reference
In first union	0.364***	13.000***
In 2nd higher order union	1.794***	9.415***
Age youngest child		
No child	Reference	NA[6]
Age 0	0.533***	NA
Age 1-4	0.659***	NA
Age 5+	0.399***	NA
*Age youngest child*Union status*		
No child not in union	Reference	NA
Age 0 in first union	3.421***	NA
Age 0 in 2nd+ union	1.176	NA
Age 1-4 in first union	3.198***	NA
Age 1-4 in 2+ order union	1.762*	NA
Age 5+ in first union	3.789***	NA
Age 5+ in 2+ order union	0.381	NA
First birth out of wedlock (ow)		
No birth	Reference	Reference
Not out of wedlock	1.764***	0.107***
Out of wedlock	0.529***	1.378***
*First birth out of wedlock (ow) *union status*		
No birth* not in union	Reference	NS
Not ow* in first union	0.365***	NS
Not ow* in 2nd+ union	0.107*	NS
Ow in first union	0.940	NS
Ow* in 2nd+ union	1.131	NS

[4] Defines the exponential of the coefficient (baseline odds ratio).

[5] The asterisks that follow each value represent the statistical significance of the variable given by the Wald statistics.***p<0.01 **0.01<p<0.05 * p>0.05

[6] The covariates reported with 'NA' were not included in that model, whereas 'NS' denotes covariates that were not significant in the final models

Pregnancy status		
Not pregnant	Reference	NA
Pregnant	3.875***	NA
*Pregnancy status * Union order*		
Not pregnant and not in union	Reference	NA
Pregnant in first union	0.338***	NA
Pregnant in 2+ union	0.179***	NA
Religion		
None	NS	Reference
Spiritrual/candomble'	NS	0.545***
Evangelist/Protestant	NS	0.849**
Catholic	NS	0.665**
Other	NS	0.933***
Parity		
0	Reference	Reference
1	1.647***	0.991
2	1.434**	1.100
3	1.247	1.612***
4	1.426*	2.181***
5	1.771**	2.960***
6+	1.352	4.540***
Education	NS	0.933***
Region		
Southeast	NS	Reference
Northeast	NS	1.441***
Other	NS	1.298***
Ethnicity		
White	NS	Reference
Mixed	NS	1.200***
Other	NS	1.171*
Union status change		
No change	NA	Reference
Change of union status	NA	4.794***
*Union status change * Union order*		
Not in union	NA	Reference
Leaving first union	NA	0.306***
Leaving 2nd + order union	NA	0.219**
Age at first sex		
Before 18	Reference	NS
After 18	0.539***	NS
*Age at first sex*union status*		
Before 17 not in union	Reference	NS
After 17 in first union	1.695***	NS
After 17 in 2nd+ union	1.520**	NS
χ^2	2880.79 DF=41	2310.92 DF=42

Table 6.1 and Figures 6.1-6.6 show the results for the two discrete time models. The results report the relative risks of either union status change (model 1) or conception (model 2) to allow an easier comparison. These relative risks are obtained by exponentiating the parameter estimates. For the duration variables, the results are in

Figures 6.1-6.6, showing the form of the hazard itself. Our main interest here is in the trend in the hazard with duration. To evaluate this necessitates holding the values of the other covariates constant. The absolute values of the hazard will depend on the constant values of the other covariates used.

Figure 6.1 Baseline probability of union status change by age (years)

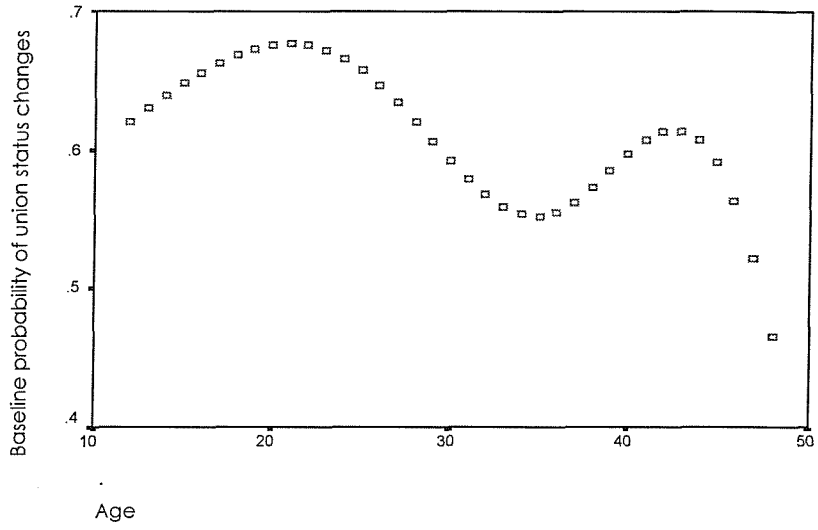


Figure 6.2 Baseline probability of union status change by union status (months)

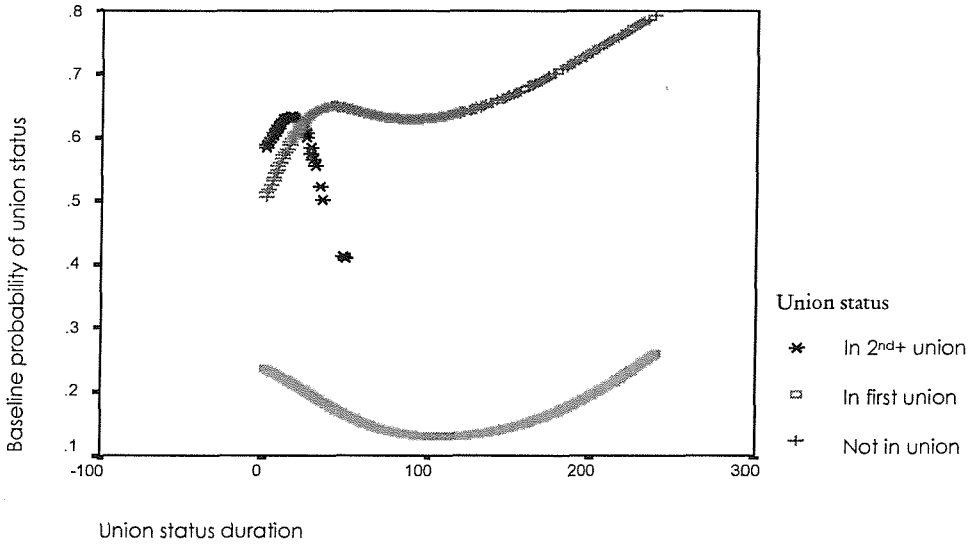
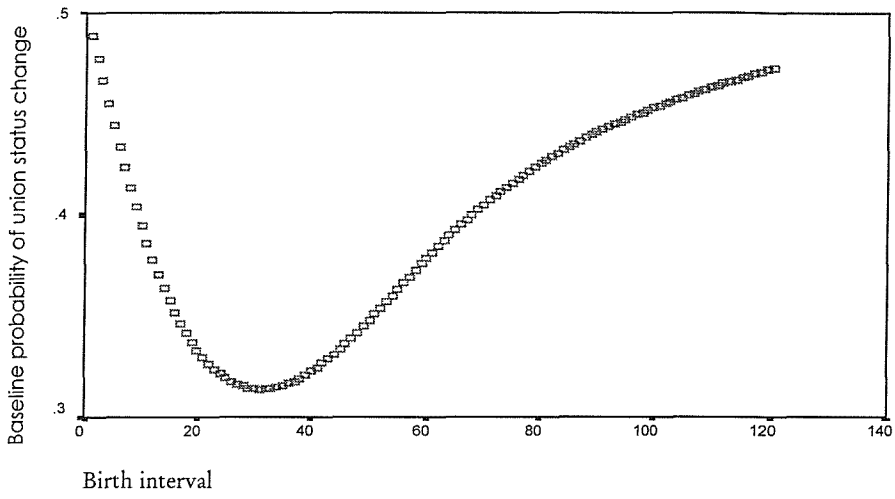


Figure 6.3 Baseline hazard of union status change by duration since previous birth (months)



The union status change model. Firstly the results for the duration variables are considered. There is a negative relationship between the risk of union status change and age (Figure 6.1). The second rise after age 35 is due to the risk of union dissolution rather than to union formation. Figure 6.2 explores the trends of the hazard of union status change according to union status. The hazard of dissolution is higher for women in second or higher order unions than for women in their first union. There is evidence that it decreases with duration for women in their second unions, but no duration greater than five years is available for such women (because of the nature of the calendar data). For women in first unions the hazards of dissolution are relatively low at all durations. The hazard of entering a union rises with duration for women who are not in a union. Figure 6.3 shows the relationship between the hazard of union status change and the duration since preceding birth. The hazard is high when the child is very young, it goes down at young ages of the child and then it increases when the child grows up apart from the last age group where the odds go down again.

Table 6.2 Odds ratios of union status change, interaction age youngest child by union status

	Union status		
Age youngest child	Not in union	In first union	Second higher order union
No child	1	0.364	1.794
0	0.533	0.664	1.124
1-4	0.659	0.767	2.083
5+	0.399	0.550	0.272

Table 6.3 Odds ratios of union status change, interaction first birth out of wedlock by union status

	Union status		
First birth out of wedlock	Not in union	In first union	Second higher order union
No child	1	0.364	1.794
Not out of wedlock	1.764	0.234	0.102
Out of wedlock	0.529	0.181	1.073

The relative risk of union status change is higher when the woman does not have any children. In particular it is more likely that the woman will enter in a union when she does not have any children. For the dissolution the risk increases with the age of the youngest child (Table 6.2) confirming the results of main literature that the hazard of dissolution are lower when the last child is very young (Koo et al. 1984; Lillard and Waite 1993). However the value decreases when the child is 5 or older. An interesting result comes out from the 'first birth out of wedlock' variable (Table 6.3): in general the risk is higher for women with no child. For women in their second or higher order union the relative risk of dissolution is higher for women who had their first birth out of wedlock. The result is different for women in their first union. As for the risk of union formation, interestingly women with their first birth out of wedlock have a lower risk of union formation. Women that are pregnant have a higher relative risk of changing their union status (Table 6.4), in particular the risk of entering in a union. No particular trend is highlighted in the variable parity. The relative risk of union status change is lower for women that had their first sexual intercourse after the age of 17 and in particular these women have a lower risk of dissolution (Table 6.5).

Table 6.4 Odds ratios of union status change,

	Union status		
Pregnancy status	Not in union	In first union	Second higher order union
Not pregnant	1	0.364	1.794
Pregnant	3.873	0.477	1.245

Table 6.5 Odds ratios of union status change, interaction age at first sex by union status

	Union status		
Age at first sex	Not in union	In first union	Second higher order union
Before 18	1	0.364	1.794
After 18	0.539	0.332	1.470

To summarise, the results of this model show that women in second or higher order unions are at a higher risk of dissolution than those in their first union. The risk of entering a union after a conception is high, confirming the tendency to 'formalise' a union before the birth of the child. Furthermore, very young children are still a strong binding force for the couple.

Figure 6.4 Baseline probability of conception by age (years)

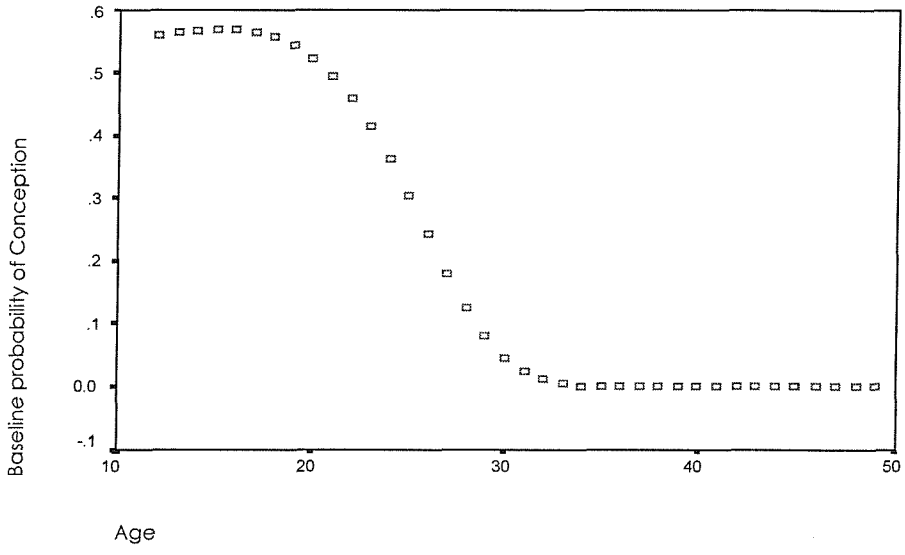


Figure 6.5 Baseline probability of conception by union status duration (months)

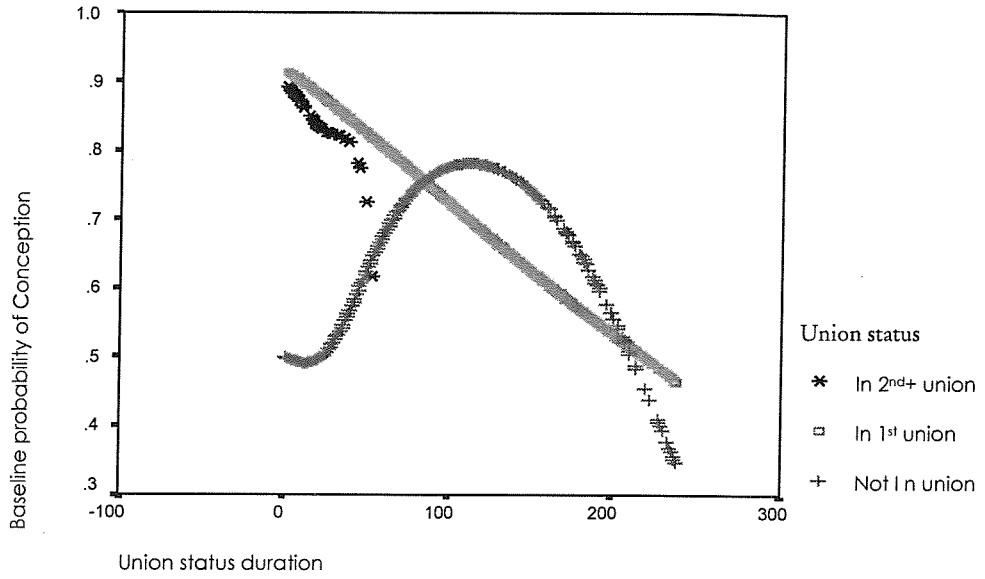
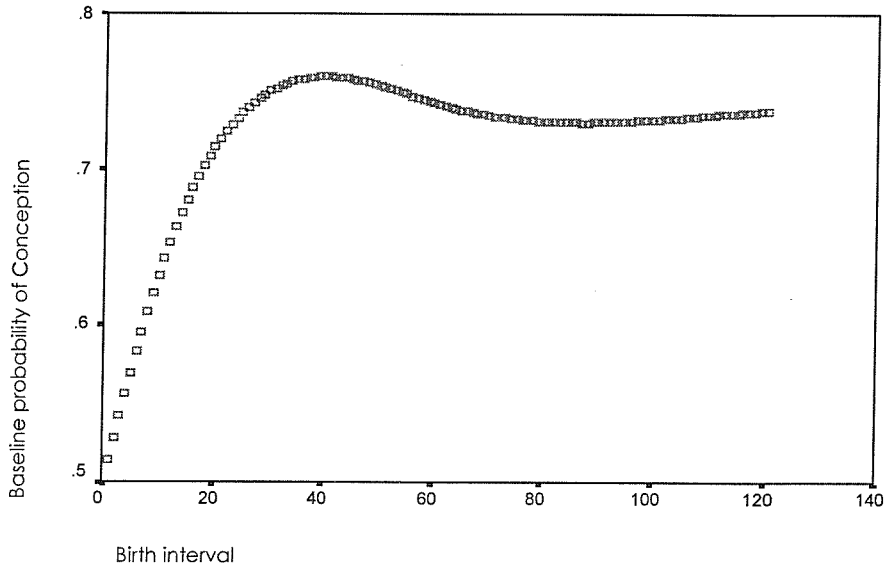


Figure 6.6 Baseline probability of conception by duration (months) since previous birth



The conception model. Figures 6.4-6.6 show the results for the duration variables in the conception model The effect of the woman's age (figure 6.4) demonstrates the high hazard of conception at young ages, confirming a high rate of teenage conceptions in Brazil in the last years (Gupta and Leite 1999). The hazard is practically zero after the age of 35, an age at which 50% of the women are sterilised. With the hazard of conception according to the union status duration (Figure 6.5) it is possible to see that the hazard decreases with duration if the woman is in a union, and the hazards are similar for both first and higher-order unions. The hazard of conception increases at the beginning of the birth interval (Figure 6.6) and then remains constant.

Table 6.6 Odds ratios of conception, interaction union order by union status change

	Union order		
Union status change	Not in union	First union	Second higher order
No change	1	13.045	11.268
Change	4.792	19.171	11.850

The variable 'first birth out of wedlock' confirms what expected: women that have their first birth out of wedlock are less in control of their fertility than other women, and are therefore at higher risk of conception. Women with no religion have a higher risk of conception than women from any other form of religion. This is probably because 'religion' is acting as a proxy for social status. Women with 'no religion' tend to be drawn from the better-off, more educated social groups, and in Brazil such women are not controlling their level of fertility to the same extent as other women. For the variable parity, higher risks are reported for higher parities. It is likely that this is a selection effect, as women who achieve successively higher parities are drawn from a smaller and smaller subset of increasingly fertile women. As expected, education has a negative impact on the risk of conception. The risk is highest in the Northeast, the region that has always reported the highest level of fertility. It is also higher for mixed women, who are known to have higher fertility than white groups.

The covariate 'union status change' (Table 6.6) is an indicator variable taking the value 1 if there was a change in union status during the current month and 0 otherwise. Women who experienced a change in union status were nearly five times as likely to conceive as those who did not. However, the interaction between union status change and union order was also significant. When taken together with the main effect for union status change, the positive effect of union status change on the

hazard of conception is much greater for entry into unions than it is for exits from unions (indeed, for exits from second and higher order unions, it is virtually zero).

The results of this model therefore confirm the general socio-demographic characteristics of the women with a higher risk of conception (ethnicity, education, region). But the analysis does not report a higher hazard of conception for women in second or higher order unions when controlling for union status duration, interval since previous birth and age. Transitions into unions (and out of first unions) are associated with increased risks of conception. However, it is hard to ascertain the direction of causality in this last effect (the multiprocess model does help to solve this problem). In the union status change model, pregnancy was a very strong predictor of union status change.

The results and their difficulty in interpreting them, then demonstrate the limits of this type of model to analyse the simultaneity of life events. However, these models have helped in building the variables for the main effects that were used in the simultaneous models that will be described in the next sections.

6.3 Continuous-time models: variables and hypotheses

Starting with the results obtained from the discrete time model the variables for the twelve continuous time models have been built up. The structure of the file and of the variables has been described in depth in Chapter 4.

What distinguishes these models from the previous lies in the approach to the joint determination of the union status changes and conceptions as described in Chapter 5. In these models the simultaneity of the life trajectories is taken into account using time varying variables to mark the transitions of one event within the spell of another event. Accounting for unobserved heterogeneity then will consider the differences in estimates when considering the influence of unobserved factors. The simultaneity is measured as well through the correlation term that is obtained taking into account the endogeneity of the events.

In these models the variables described in Section 6.1 have been included. However in the next section the variables that were significant in the three models will be described more fully with the hypotheses made to justify their inclusion.

6.3.1 Model of union formation

This model analyses the hazard of union formation, regardless of whether it is a consensual union or formal union. As specified in Chapter 4 the calendar does not distinguish between the two types of unions. Furthermore no distinction is made between women entering in the first union and women that are remarrying apart from the inclusion of a covariate that marks the number of unions the woman has ever experienced.

Time varying covariates

1. Union status duration spline. This indicates the length of the interval since the 12th birthday for those who have never been in a union and the end of the previous union for the others. The hazard of union formation would be expected to increase with duration up to a stage when the effect of age decreases the hazards.

2. Age spline. The hazards should follow a reversed U-shape. The peak of the hazards would correspond to the age group 12-25 years old (the mean age at first marriage is around 22 years old).

3. Birth interval duration spline. It measures the duration since the previous birth. For the first birth it is calculated since the age 12. Most of the women in this sample do not have a child yet. The trend of this spline should be strongly linked to the union duration spline as they both start from the 12th birthday for women never been in union and with no child.

4. Fertility status (pregnant, no child, with children). This variable is fundamental to analyse the mechanisms that link union formation to fertility. In this case the hazard of union formation regardless of whether it is the first or second union is considered. The hazard of entering in a union could be expected to be higher when the woman has no children. It decreases with the number of children, as a woman with offspring may be considered 'less attractive' (Koo et al. 1984). The impact of a

pregnancy on the hazard of union formation is, perhaps, less obvious. It is not uncommon to legitimise an out of wedlock birth with a union. It has been reported as well that women, in particular women in the lower social classes, use pregnancy as a mean to secure their relationship (Ribeiro 1993; Upchurch et al. 2001). This practice has been reported particularly common in Latin America and in particular in Brazil, where it is possible to find men who do not want to face their responsibilities and leave the woman when pregnant.

Current status variables, measured at the time of the survey

1. Years of education. More educated women should have a lower hazard of entering in a union, as they are more likely to delay the timing of marriage.

2. Residence (urban, rural). Brazil does not exhibit strong cultural differences between rural and urban areas. However rural women could report a higher hazard of union formation due to the fact that they are more likely to value traditional marriage. At the same time these women are less educated and more likely to rely on marriage as a source of economic security.

3. Number of unions (0, 1, more than 1). The hazard of union formation should be higher for those women who have never been in a union.

4. Whether the first birth was out of wedlock. This variable has been found to be highly significant in affecting the decisions to enter in a union (Upchurch et al. 2001). However the effect of this covariate on the outcome variable could be confounding and complex to interpret. On one hand it could be a sign of a disinterest towards the value of marriage as it is happening in several European countries. On the other hand in Brazil, having the first birth out of wedlock could identify a particular group of women who are less in control of their reproductive life, usually belonging to a lower social class. These women, as seen in Chapter 3, are usually more likely than other women to have more than one union; therefore they might have a higher hazard of remarrying.

5. Whether the respondent watches television at least once a week. This variable is commonly used to measure the level of exposure of the woman to the media. It is particularly relevant in Brazil as the television has a strong influence (in particular

through soap operas) on people's views about relationships and life in a partnership (Martine and Carvalho 1992; Merrick 1983; Rios-Neto et al. 2001). Television often portrays the ideal of a single independent woman. The influence of television could, therefore, delay the timing of marriage.

6. Religion (no religion, spiritual, Catholic, Protestant). Despite the common idea that the Brazilian culture is strongly influenced by the Catholic Church, as stressed in Chapter 2, Brazilian women are not so strongly linked to the Catholic culture (Martine 1996). However it would still be expected from Catholic women to place a higher value on marriage than women without any religious belief. Women that follow spiritual religions of the slavery tradition are usually more attracted to consensual unions. These unions involve less commitment and could lead these women to have a higher probability of entering unions.

7. Region (Southeast, North, Centre). The impact of mass media on Brazilian life has homogenised cultural differences at a regional level. However national trends show that women in the South tend to delay union formation, so for this reason the hazard of union formation should be lower in the South.

Some of the variables that were included in the model show clearly the simultaneity of the decisions about childbearing and union formation. For example, a woman that has a child when she is young is more likely to have an out of wedlock birth, this woman decides at the same time whether to enter in a union. If she does she will enter at a young age and this decision will influence the hazard of union dissolution. The decisions about whether to have a child and whether to enter into a union may be made simultaneously.

6.3.2 Model of union dissolution

The union dissolution model analyses the probability of a woman of leaving a union. From the way it is reported in the DHS calendar, the data reports when the woman does not believe she is in a union anymore. It is not know whether the woman is thereby separated or divorced. However for the purposes of this study it is enough to measure the timing of breaking up.

Time-varying covariates

1. Union status duration spline. This indicates the length of the interval since the beginning of the union. The hazard of union duration is expected to be low at the beginning of the union, increases towards the 7th year and then decreases as the duration increases.

2. Age spline. Young women are usually reported to have more unstable unions. For this reason the hazard of union dissolution should be high at young ages and low at older ages.

3. Birth interval duration spline. It measures the duration since the previous birth. For the first birth it is calculated since the 12th birthday.

4. Fertility status (pregnant, no child, 1-3 children, more than 3 children). It has been described fully in Chapter 3 how fertility can strongly influence the risk of union disruption. Women with no children are more likely to end their union, whereas the higher the number of the children the lower the probability of union disruption. The outcome for pregnant women might not be as clear as for women with children. Brazilian men sometimes try to avoid commitment leaving their partner when she is pregnant (Greene 1994).

5. Union status (in the first union, in the second or higher order union). Women in second or higher order unions are likely to be more at risk of disruption due to their general tendency of changing partners more often.

Current status variables, measured at the time of the survey

1. Years of education. As it has been shown in previous research (Becker et al. 1977; Lillard et al. 1994; Ribeiro 1993) education has potentially opposing effects on union disruption. Becker et al (1977) stress out that commonly women with a higher level of education have lower risk of union disruption. This is due to the fact that women with a higher level of education choose their partners more thoroughly and decide to enter in a union only after being sure of their partner. On the other hand there could be a positive relationship between union disruption and education. The hypothesis is that educated women are more exposed to the outside world and therefore more likely to be tempted to change partners (Becker et al. 1977).

2. Residence (Urban, Rural). As reported above, there is not a strong difference between rural and urban areas. However rural women could be more attached to the values of marriage then urban women.

3. Whether the first birth was out of wedlock. Women that had their first birth out of wedlock in Brazil more usually have consensual unions that are considered less stable (Greene 1994). At the same time, unions that started mainly because of a conception lead to a higher risk of dissolution as the relationship is based on the existence of the child rather then solely on mutual attraction between the partners.

4. Age at first sex (before or after age 18). This variable is strongly related to the age at first union. Women that have their first intercourse at young ages are more likely to enter in a union earlier. These women are usually more at risk of union dissolution. It has been constructed as a binary variable to ease the interpretation. Age 18 divides the sample into two roughly equal parts (i.e. is close to the median age at first sex).

5. Whether the respondent watches television at least once a week. This variable tests the influence that the media have on couple's life. Brazilian soap operas often show dramas of disrupted couples that enter into Brazilians homes as new models to follow.

6. Respondent owns a car. This variable is an indicator of economic status. Wealthier women might be less likely than poorer women to split up due to the fact that they usually enter in a union later and are usually in a formal union rather then consensual. At the same time poorer women might be more linked to the traditional values of marriage.

7. Respondent owns a television set. This variable is another indicator of economic status and is used for the same purposes of the variable 'owns a car'.

6.3.3 Models of conception

The conception models analyse the risk of conception when it leads to a live birth. As explained in Chapter 4 the conceptions that were terminated either through induced abortion or through miscarriage were not considered.

The variables are the same for the conception model created for the joint model with formation and that one created for the joint model with union dissolution. The only differences are in the samples and in the union status variables.

Time varying covariates

1. Birth interval duration. This measures the duration since the previous birth. For the first birth it is calculated since the woman's 12th birthday.

2. Age. Biologically the trend of fertility according to age follows the shape of a reversed U. In Chapter 2 it was reported that the level of adolescent fertility has been growing in Brazil and the level of fertility of all other age groups has been declining mainly due to the effect of sterilisation. Considering the characteristics of the Brazilian women it would be expected that the hazard is high at young ages and low at older ages, with a steeper decline after the age 30 due to the great influence of sterilisation.

3. Parity. The hazard of conception is commonly high at lower parity until it reaches a peak and then declines.

4. Union status (in first union, in second or higher order union): this variable is fundamental for the purposes of our analysis. At macro level women in second and higher order union have a higher level of fertility at each age group. This variable is not included in the conception model created for the multiprocess with union formation.

5. Change in union status. This variable is considered as a level three variable within the conception spell and accounts for lagged events. It is possible with this variable to test the hazard of conception if the woman has entered in a union (model created for the joint analysis with union formation) or left one (model created for the joint analysis with union dissolution) during the last conception spell.

Current status variables, measured at the time of the survey

1. Years of education. There is commonly a negative relationship between years of education and fertility.

2. Residence (urban, rural). It is expected, because of the characteristic of the rural women in Brazil, to obtain a higher hazard of conception in the rural areas.

3. Whether the first birth was out of wedlock. Women that have their first birth out of wedlock might be women that are less in control of their reproductive life therefore more at risk of conceiving.

4. Whether the respondent watches television at least once a week. As for the previous two models women could be influenced in their reproductive behaviour by the mass media. Women that are more exposed to the medias have usually reported a lower level of fertility.

5. Religion (Catholic, no religion, other religions). Catholics are reported to be the group with the highest fertility (BEMFAM 1997).

6. Region (Southeast, North, Centre): The North and in particular the Northeast of Brazil have the highest level of fertility (BEMFAM 1997).

7. Ethnicity (white, mixed, other). Mixed groups report a higher level of fertility. These ethnicities belong to lower social classes in particular in the North of the country.

8. Whether or not the woman owns a TV. As in the previous model this variable is used as an indicator of economic status. Women of a higher social class are more likely to have a lower level of fertility.

9. Whether the respondent owns a car. This variable is also used as proxy of the economic condition.

6.4 The results

6.4.1 The correlation terms

In order to arrive to the final joint model the analysis started from the single equation models that included the fixed effects only. In a second stage the unobserved heterogeneity has been introduced in the model. The single models estimates have then been used to set up the starting values of the joint models. Respectively the union formation with the conception model of women that are not in a union and the joint model of union dissolution and the conception model for women who are in

a union. The file has been split up in the case of conception to allow to model jointly the conception spells and union status spells belonging to the same type of woman. The analysis of the results starts from looking at the residual components to analyse whether the multiprocess models were significant. In Table 6.7 are reported the heterogeneity components for each model according to whether they were calculated individually or jointly.

All the random effects are statistically significant at the 0.01 level. This demonstrates that there is a strong behavioural component that is not represented by the variables that have been included in the model. Each model shows a higher variation of unobserved heterogeneity when considered in its multiprocess form.

Table 6.7 Heterogeneity components of all the models and correlation terms of the joint models

Heterogeneity terms	$\sigma^2_{\varepsilon f}$	$\sigma^2_{\varepsilon d}$	$\sigma^2_{\varepsilon cf}$	$\sigma^2_{\varepsilon cd}$
	Union formation	*Union dissolution*	*Conception-formation*	*Conception-dissolution*
Single	0.9355	1.2281	0.8091	0.9255
Standard Error	(0.0530)	(0.1447)	(0.1623)	(0.0396)
Joint	0.9760	1.4404	1.1734	1.0650
Standard Error	(0.0502)	(0.1252)	(0.1955)	(0.0497)
Correlation terms joint models				
Union Formation-Conception				
Standard Error				
$\rho_{\varepsilon f \varepsilon c}$			0.7028	
			(0.0846)	
Union Dissolution-Conception				
Standard Error				
$\rho_{\varepsilon d \varepsilon c}$			0.6592	
			(0.0754)	

The correlation terms of both the joint models are significant at the 0.01 level. Both models show a significant positive correlation. The correlation is particularly high for the union formation model. The positive correlation means that union formation leads

to an increase of the hazard of conceptions and vice versa. More importantly the ρ=0.6592 in the joint model of union dissolution and conception demonstrates that union dissolution also has a positive effect on conception as we hypothesised in Chapter 1. These results demonstrate the outcomes to be highly related. It therefore shows the need to account for endogeneity in the models.

6.4.2 The Union Formation model

The results are reported for each outcome comparing the model with the fixed effects only, the model that accounts for unobserved heterogeneity and the model that accounts for endogeneity.

Table 6.8 Hazard model: Union Formation

	No Heterogeneity (1a)	No endogeneity (1b)	Joint with conception (1c)	N[7]
Duration spline				
0-12 months	-0.0061	0.0284	0.0247	
	(0.0154)	(0.0173)	(0.0175)	
1-7 years	0.0188 ***[8]	0.0294 ***	0.0281 ***	
	(0.0023)	(0.0029)	(0.0029)	
8-14 years	0.0247 ***	0.0376 ***	0.0373 ***	
	(0.0020)	(0.0026)	(0.0027)	
15 years +	0.0312 ***	0.0470 ***	0.0465 ***	
	(0.0022)	(0.0027)	(0.0026)	
Age spline				
12-19 years	0.0273 ***	0.0359 ***	0.0371 ***	
	(0.0021)	(0.0026)	(0.0026)	
20-25 years	-0.0073 ***	-0.0016	0.0000	
	(0.0018)	(0.0023)	(0.0024)	
26-35 years	-0.0149 ***	-0.0160 ***	-0.0166 ***	
	(0.0016)	(0.0017)	(0.0018)	
35 years +	-0.0230 ***	-0.0295 ***	-0.0295 ***	

[7] N reports the number of woman-episodes in each category.

[8] The asterisks that follow each value represent the statistical significance of the variable given by the Wald statistics. ***p<0.01 **0.01<p<0.05 * p>0.05

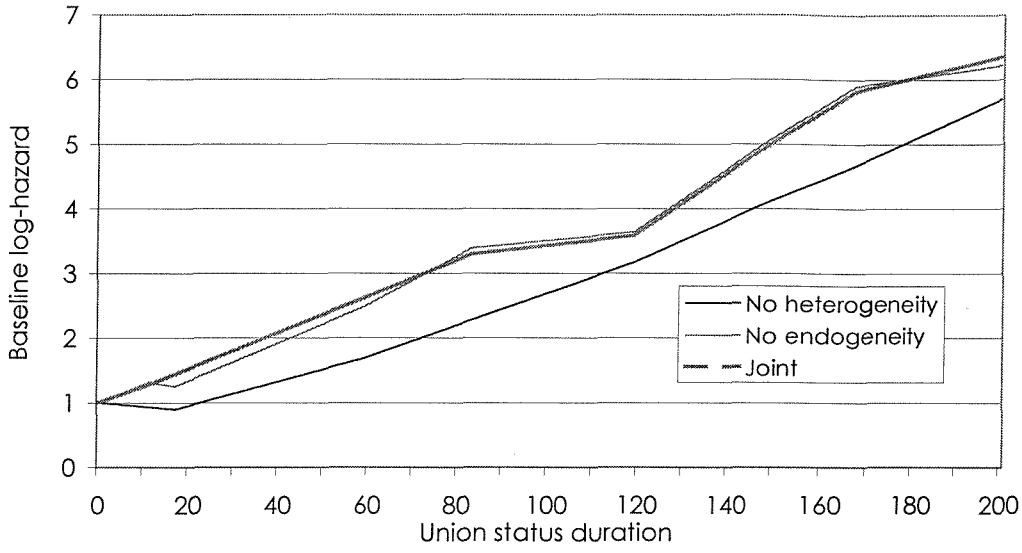
	(0.0029)	(0.0031)	(0.0031)	
Birth interval spline				
0-18 months	-0.0338	-0.0239	-0.0322	
	(0.0240)	(0.0266)	(0.0267)	
18-60 months	-0.0049	-0.0015	-0.0017	
	(0.0045)	(0.0054)	(0.0055)	
5-10 years	-0.0188 ***	-0.0255 ***	-0.0217 ***	
	(0.0019)	(0.0025)	(0.0026)	
10+ years	-0.0100 ***	-0.0174 ***	-0.0169 ***	
	(0.0005)	(0.0009)	(0.0009)	
	-0.0338	-0.0239	-0.0322	
Education	-0.0096	-0.0220 **	-0.0326 ***	
	(0.0071)	(0.0104)	(0.0113)	
Residence				
Urban	-0.0714	-0.0853	-0.0873	2089
	(0.0641)	(0.0893)	(0.0935)	
Fertility status				
Pregnant	-1.7257 *	-1.8900 *	-1.6567	314
	(1.0069)	(1.0561)	(1.1069)	
With children	2.3849 **	2.7794 ***	2.4741 **	461
	(1.0045)	(1.0537)	(1.1055)	
Number of unions				
At least one	-0.1615 **	0.1596	0.1808 *	444
	(0.0801)	(0.1083)	(0.1084)	
First birth out of wedlock				
Yes	-1.4715 ***	-1.8233 ***	-1.7473 ***	695
	(0.0726)	(0.0962)	(0.0976)	
Watches TV once a week				
Yes	0.0541	0.1177	0.1287	2197
	(0.0750)	(0.1026)	(0.1077)	
Religion				
No religion	0.2479 **	0.3404 **	0.3955 **	157
	(0.1107)	(0.1538)	(0.1563)	
Other	-0.0526	-0.0764	-0.0944	387
	(0.0678)	(0.0944)	(0.0966)	
Region				
North	-0.0551	-0.1015	-0.0967	1262

	(0.0568)	(0.0810)	(0.0855)	
Centre	0.0116	0.0243	0.0385	531
	(0.0684)	(0.0984)	(0.1025)	
Constant	-8.7021 ***	-11.2578 ***	-11.4396 ***	
	(0.5430)	(0.6703)	(0.6661)	
ln-Likelihood	-10936.36	-10827.54	-14018.79	2554

The models (Table 6.8) consider the hazard of entering a union regardless of the order of the union. The data did not offer enough cases to allow one analysis for entering the first union and one for second or higher order unions. Only 17% of the women considered in this model have been in a union already.
The graphs will report the baseline log-hazard of the spline in each case but the age spline to ease the readability of the graph.

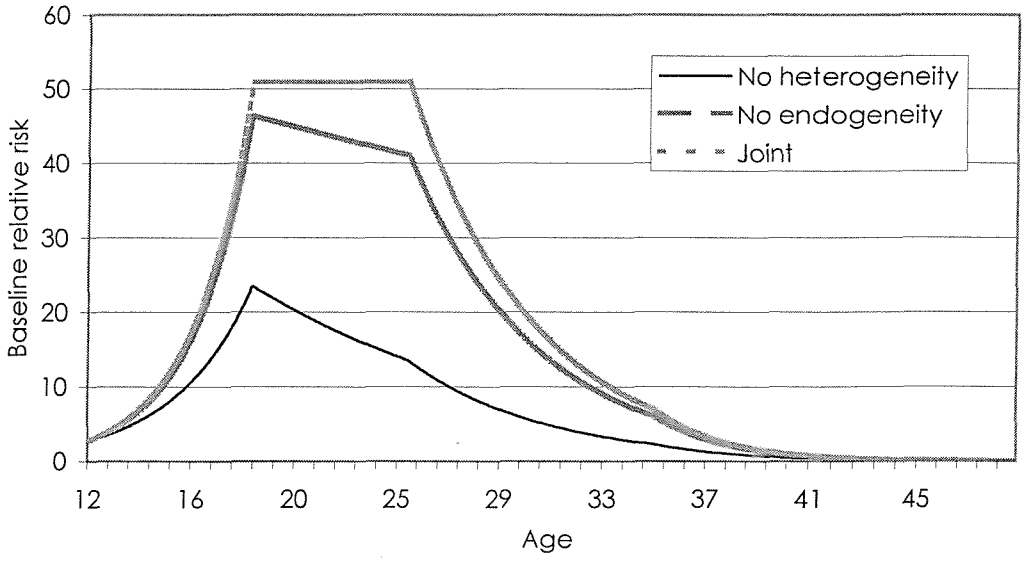
The risk of entering in a union increases with duration. After a slight decline in the first 12 months the risk increases (Figure 6.7). It is interesting that the decline in the first period is reported for the fixed effects model only. When controlling for unobserved factors the trend becomes more linear. It should be considered as well that the initial 12 months spline interval is not significant, as there are not many cases for the low durations. Most likely the fixed factors highlights the tendency of women who have been in one union already to avoid entering a new union immediately after the past one. When controlling for unobserved heterogeneity the result is most likely to be influenced by the age of the woman. Most of the women in the sample here considered are young. With the increase of the duration there is an increase of the chances of getting married as most of the Brazilian women experience at least one union in their life. These probabilities are higher if accounting for unobserved heterogeneity and even higher if accounting for endogeneity.

Figure 6.7 Baseline log-hazard of union formation by union status duration



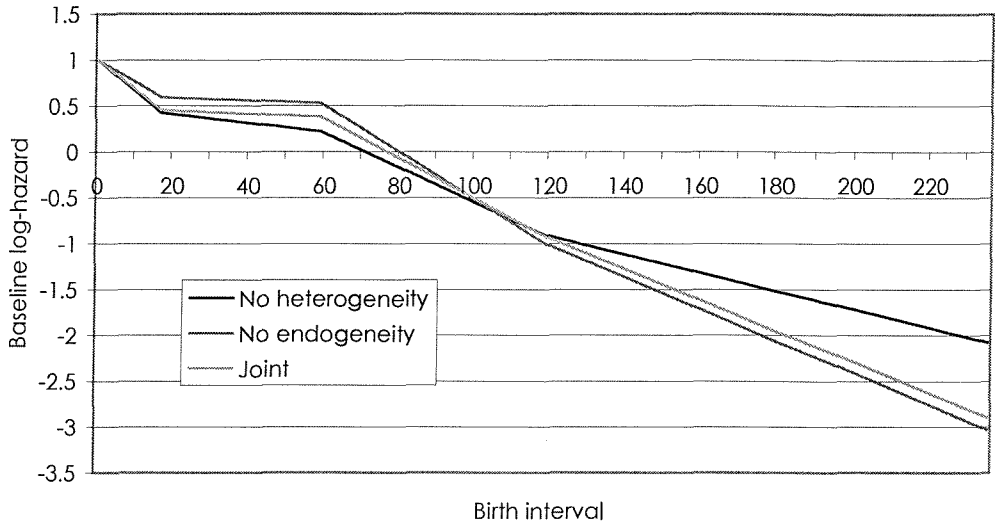
The baseline relative risk of the age spline (Figure 6.8) follows a U shape reversed that shows clearer results when accounting for endogeneity. The hazards go up until the age of 25 and then decrease steeply. The mean age at marriage in Brazil is 22 and the mean age at first consensual union is 19, so this result reflects the cross sectional data information. The hazard is higher for the joint model as the positive correlation with the hazard of conception has a positive impact on the hazard of union formation.

Figure 6.8 Baseline probability of union formation by age



The birth interval spline (Figure 6.9) does not show significant results at short durations. Whereas at long duration it is clear that there is a negative relationship between birth intervals and the hazard of union formation. Most likely this result is influenced by women that had a child already and are less likely to get married the older the child is.

Figure 6.9 Baseline log-hazard of union formation by birth interval



Those women that have experienced one union already show a lower risk of entering a subsequent union than those who have never been in one. It would be in fact expected that women who have already experienced one union might be more reluctant to experience another one regardless of their age due to the fear of going through another separation. However when accounting for endogeneity the result is reversed. The positive correlation with the hazard of conception has a positive impact on the hazard of union formation for women that have already experienced one union. It is in fact more likely that women in second or higher order unions conceive when they enter in a subsequent union or similarly it is possible that these women are more likely to enter in another union at the time of conception.

A surprising result comes from the fertility variable. There is only a small significant difference for women who are pregnant that disappears when accounting for unobserved heterogeneity or endogeneity. This result could be determined by a lack of male commitment in the relationship. This behaviour is not significant if other unobserved factors are considered. Women with children show a higher risk of

entering in a union than women with no children. This result somehow contradicts most of the previous researches on the topic (Koo et al. 1984; Lillard and Brien 1994; Upchurch et al. 2001). Women that do have children are less attractive for the type of commitment a formed family involves. For this reason their probability of marrying is usually lower. However with the DHS calendar it is not possible to identify whether the children belong to the partner in the union being formed or to a previous one. This result could explain why the variable legitimisation (entering in a union within 6 months after conceiving the child) was not significant in the model. Brazilian couples do not seem to hurry into a relationship during the pregnancy but do want to give a family to the children already born.

For the same reason those who had their first birth out of wedlock are less likely to enter in a union. Those who have a birth out of wedlock could be less attached to the value of marriage. Alternatively, and probably more likely, these women are those who are deserted by their partner when they become pregnant. The significance of this variable may, therefore, be a demonstration that Brazilian men do not want to take responsibility for unwanted pregnancies as already found in the result for the variable fertility status.

Education has a negative effect on the probability of entering a union. As explained earlier, educated women are more likely to aim towards a career rather than a family. This might induce them to delay union formation. At the same time their economic dependence on men is lower and therefore they rely less on a union as a source of economic security.

Women that watch television at least once a week have a higher chance to enter in a union. However this variable is not reported to be significant. The way this question has been formulated does not allow inferring causality. Women that watch television are more exposed to the media and in particular to the soap operas' message of an independent and free women. It would therefore be expected for these women to have a lower risk of entering in a union. On the other hand it is possible to suppose that women who are more exposed to the media might be of a higher social class and more linked to the social custom of marriage than the poorer ones.

Women with no religious belief show a higher hazard of union formation than Catholic women. It is likely that Catholic women do not commit themselves early to a union.

The results for the 'region' variable are not statistically significant. In general the North has a lower risk of union formation. The North and in particular the northeast are characterised by a high incidence of casual relationships that are hardly formalised (Greene 1994). Whereas, the centre, that shows a higher risk of union formation, is characterised by women linked with traditional values and where the union is valued more than in the South.

In general the results show that accounting for unobserved heterogeneity and endogeneity increases the hazard of union formation. In particular the positive correlation of the joint models has a positive impact on the hazard of union formation. However no fundamental differences are reported between the three models. The endogeneity improves the overall fitting of the model of the model with an increase of the likelihood value (Table 6.8).

6.4.3 The union dissolution model

The union dissolution model is certainly more relevant for this analysis than the union formation one as the major aim is to concentrate the attention on the influence of union instability on fertility. Furthermore, the size of the sample is bigger than it is the model of union formation and therefore assures more robust results even if the union formation model showed small standard errors.

Table 6.9 Hazard model: Union dissolution

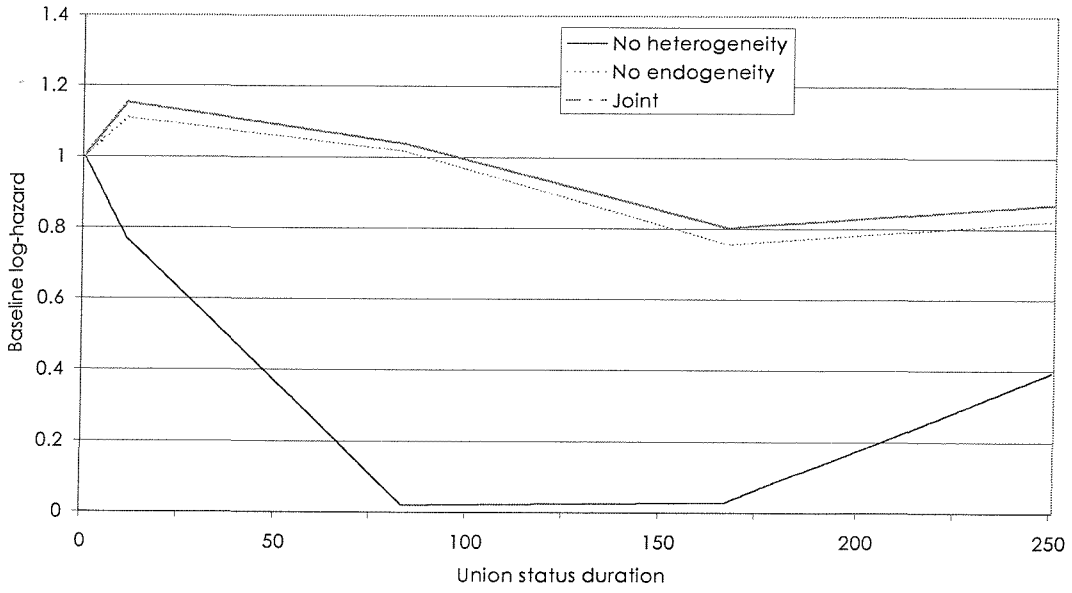
	No Heterogeneity (2a)	No endogeneity (2b)	Joint with conception (2c)	N
Union duration spline				
0-12 months	-0.0201	0.0099	0.0138	
	(0.0139)	(0.0166)	(0.0178)	
1-7 years	-0.0104 ***	-0.0013	-0.0016	
	(0.0025)	(0.0028)	(0.0030)	
8-14 years	0.0001	-0.0031	-0.0028	
	(0.0022)	(0.0026)	(0.0026)	
15 years +	0.0044 ***	0.0008	0.0008	
	(0.0016)	(0.0022)	(0.0021)	

Age spline				
12-19 years	0.0083 ***	-0.0115 **	-0.0056	
	(0.0015)	(0.0053)	(0.0048)	
20-25 years	0.0080 **	-0.0066 **	-0.0046 *	
	(0.0035)	(0.0026)	(0.0027)	
26-35 years	0.0038 *	0.0028 *	0.0027	
	(0.0023)	(0.0016)	(0.0017)	
35 years +	0.0014	0.0088 ***	0.0093 ***	
	(0.0011)	(0.0018)	(0.0016)	
Birth interval spline				
0-18 months	-0.0124 ***	0.0060	0.0024	
	(0.0041)	(0.0287)	(0.0301)	
18-60 months	-0.0081 ***	-0.0014	0.0022	
	(0.0023)	(0.0053)	(0.0054)	
5-10 years	0.0020	-0.0129 ***	-0.0126 ***	
	(0.0013)	(0.0029)	(0.0029)	
10+ years	0.0059 ***	0.0048 ***	0.0050 ***	
	(0.0015)	(0.0010)	(0.0010)	
Number of unions				
Two of unions	2.0773 ***	2.6072 ***	2.7122 ***	568
	(0.1113)	(0.1573)	(0.1779)	
Fertility status				
Pregnant	1.0089 ***	1.3771 ***	0.9618 ***	3066
	(0.1173)	(0.1307)	(0.1416)	
With children	0.9145 ***	1.3942 ***	1.0690 ***	2725
	(0.0922)	(0.1214)	(0.1123)	
Education	0.0675 ***	0.0930 ***	0.1021 ***	
	(0.0111)	(0.0142)	(0.0149)	
Residence				
Urban	0.7176 ***	0.8441 ***	0.8450 ***	5974
	(0.1227)	(0.1494)	(0.1489)	
Age at first sex				
Before 18 years old	0.1919 **	0.3472 ***	0.3492 ***	4181
	(0.0895)	(0.1112)	(0.1197)	
First birth out of wedlock				
Yes	0.0779	0.1162	0.1601	1774
	(0.0882)	(0.1131)	(0.1162)	

Owns TV				
Yes	-0.2218 **	-0.2458 **	-0.3317 ***	4929
	(0.0873)	(0.1105)	(0.1151)	
Owns a car				
Yes	-1.2159 ***	-1.4239 ***	-1.4565 ***	2161
	(0.1183)	(0.1410)	(0.1518)	
Watches TV at least once a week				
Yes	0.1537	0.2457	0.2248	6498
	(0.1262)	(0.1542)	(0.1372)	
Constant	-5.1451 ***	-6.8515 ***	-8.5094 ***	
	(0.8719)	(1.2850)	(1.1853)	
ln-L	-5706.30	-5717.23	-28451.22	7548

The hazard of union dissolution according to the duration (Table 6.9) does not show satisfactory results being almost every category not significant. Different type of knots have been tried to allow the duration to settle on particular significant values. However no significant result has been obtained. In general the results show a decreasing hazard for duration of 1-14 years and a little change after that (Figure 6.10). It is likely to expect that if a union is unstable the dissolution would occur at short durations. Furthermore the dissolution becomes more likely as the duration increases because of the growing up of the children as well.

Figure 6.10 Baseline log-hazard of union dissolution by union status duration



The inclusion of heterogeneity and endogeneity in the model has a negative effect on the significance of the age spline. In other words, the effect of the interrelation of the fertility behaviour with the union dynamics makes the age effect not significant. If not taking account of the unobserved heterogeneity the risk of union disruption is lower at younger ages and increases after the age 25 (figure 6.11). Furthermore controlling for endogeneity the hazard are higher relative to controlling for heterogeneity only due to the effect of the positive correlation with the hazard of conception.

Figure 6.11 Baseline relative risk of union dissolution by age

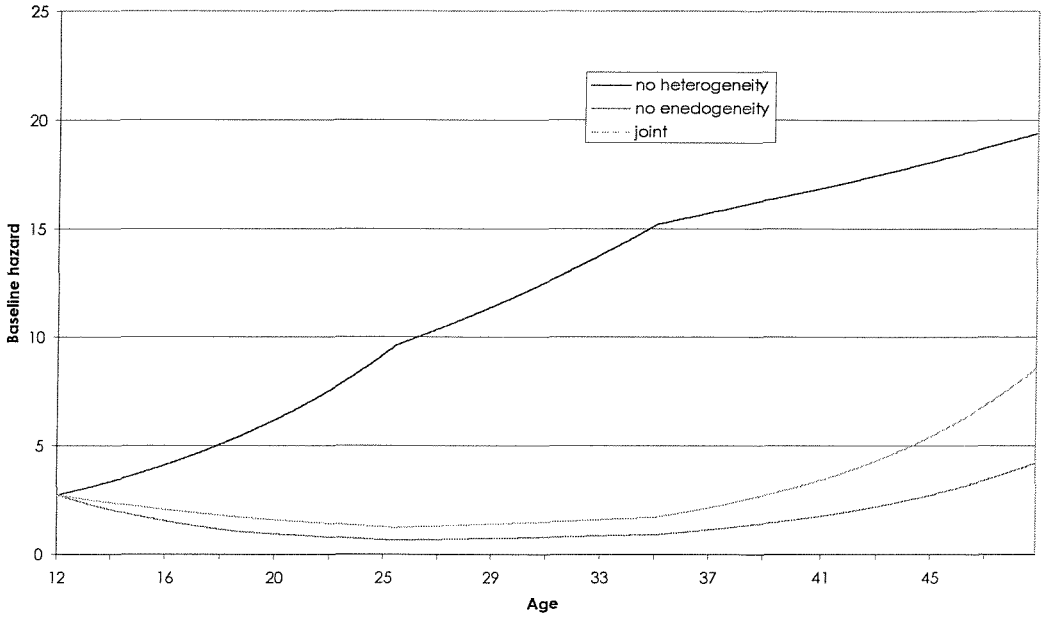
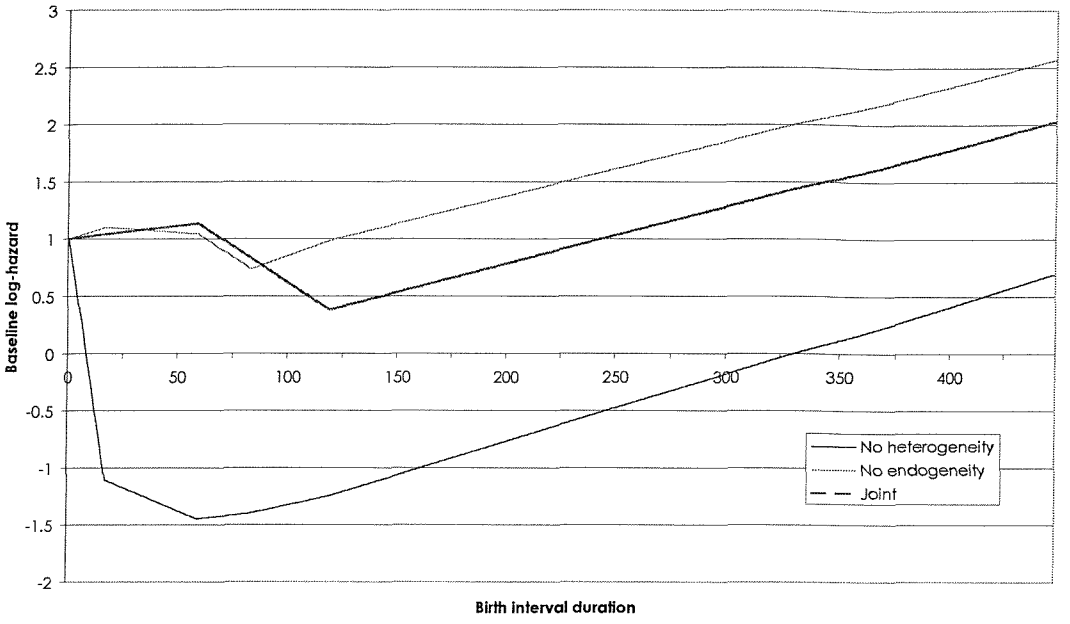


Figure 6.12 Baseline log-hazard of dissolution by birth interval



The significance of the birth spline varies according to whether controlling for unobserved heterogeneity or endogeneity (Figure 6.12). The trend goes down in the first period when modelling the fixed effects only. It goes further down between 5 and 10 years and then it rises after 10 years.

As expected women who are in their second or higher order union have a higher probability to split up. As hypothesised women that have already experienced a separation are more likely to experience it again. This is related to the fact that psychologically women that experience more than one union are more likely to experience another one. It is a behavioural factor that is emphasised when controlling for heterogeneity and endogeneity.

In the discrete time model (Table 6.1) it was found that there is a higher risk of changing union status when the woman is pregnant. In that model it was hypothesised that this was mainly due to the higher risk if union formation. However both the discrete time model and the continuous models demonstrated that during the pregnancy there is a higher risk of union dissolution. It could be interpreted as a tendency for a couple to split up when under the stress of a prospective new child coming to life. There is no distinction between pregnancies that lead to a stillbirth or miscarriage and those that lead to a life birth due to the poor quality of the data on

this matter. However it would have been interesting to see the effect of the dissolution on the decision to go on with the pregnancy.

Despite the literature on the topic, both discrete-time and piecewise linear models show a higher risk of dissolution for couples that have children. The interesting fact is that this variable measures the conceptions during the union interval and not only the number of children at the time of the separation.

Women that had their first sexual intercourse before the age of 18 show a higher risk of union dissolution. These women are more likely to be those that conceive a child earlier and enter in a union earlier. Their risk to enter in an unstable union is higher. However the result for the variable 'out of wedlock' is not significant.

Socio-economic variables such as 'owns a television' or 'owns a car' show that wealthier women have a lower risk of union dissolution. However the variable watches television at least once a week does not show any significant results.

6.4.4 The conception models

6.4.4.1 The conception model for women that are not in a union

The conception model considers the hazard of conception that will end in a life birth for women that are not in a union. Table 6.10 reports the fixed effect model (3a), the model that accounts for unobserved heterogeneity (3b) along with the model that accounts for endogeneity simultaneously with the union formation model (Table 6.8).

Table 6.10 Hazard model: conception for women not in union

	No Heterogeneity (3a)	No endogeneity (3b)	Joint with formation (3c)	N
Birth interval duration				
0-18 months	0.0555 **	0.0872 ***	0.0946 ***	
	(0.0221)	(0.0244)	(0.0256)	
18-60 months	0.0060	0.0183 **	0.0221 ***	
	(0.0059)	(0.0072)	(0.0076)	
5-10 years	0.0009	0.0099 **	0.0125 **	
	(0.0041)	(0.0049)	(0.0053)	
10+ years	0.0128 ***	0.0235 ***	0.0246 ***	

	(0.0032)	(0.0044)	(0.0045)	
Age spline				
12-19 years	0.0265 ***	0.0317 ***	0.0390 ***	
	(0.0044)	(0.0050)	(0.0059)	
20-25 years	-0.0050	-0.0045	0.0000	
	(0.0034)	(0.0038)	(0.0042)	
26-35 years	-0.0172 ***	-0.0213 ***	-0.0217 ***	
	(0.0037)	(0.0041)	(0.0043)	
35 years +	-0.0288 ***	-0.0363 ***	-0.0361 ***	
	(0.0108)	(0.0114)	(0.0117)	
Union status duration				
0-12 months	0.0495 ***	-0.0956	-0.0766	
	(0.0093)	(0.0953)	(0.1012)	
1-7 years	0.0048 *	-0.0071	-0.0066	
	(0.0025)	(0.0049)	(0.0052)	
8-14 years	0.0018	-0.0027	-0.0036	
	(0.0019)	(0.0022)	(0.0025)	
15 years +	-0.0014	-0.0015	-0.0018	
	(0.0016)	(0.0012)	(0.0013)	
Union status during the conception spell				
Leaving first union	0.2658	-1.6099 *	-1.8343 *	287
	(0.7196)	(0.8321)	(0.9668)	
Leaving second or higher order union	-1.8204 ***	-2.3447 ***	-2.8430 ***	46
	(0.1955)	(0.2660)	(0.3037)	
Parity				
1-2 children	0.3181	0.5353 *	0.8279 ***	331
	(0.2202)	(0.2744)	(0.3071)	
3+ children	0.5231	0.8424 *	1.1130 **	134
	(0.3608)	(0.4387)	(0.5152)	
First birth out of wedlock				
Yes	0.5729 ***	0.6485 ***	0.5522 ***	512
	(0.1071)	(0.1409)	(0.1568)	
Residence				
Rural	0.0260	0.1888	0.1546	167
	(0.1258)	(0.1664)	(0.1937)	

Education	-0.0454 ***	-0.0828 ***	-0.1152 ***	
	(0.0150)	(0.0217)	(0.0255)	
Owns TV				
Yes	-0.2327 **	-0.3290 **	-0.4938 ***	555
	(0.1094)	(0.1427)	(0.1611)	
Watches TV at least once a week				
Yes	-0.0347	-0.0423	0.0771	867
	(0.1528)	(0.2033)	(0.2279)	
Religion				
No religion	0.2593	0.6556 **	0.7839 **	64
	(0.2117)	(0.2775)	(0.3104)	
Other	0.0865	0.3980 **	0.3918 *	129
	(0.1439)	(0.1928)	(0.2123)	
Ethnicity				
Mixed	0.0893	0.0740	0.1233	600
	(0.0988)	(0.1367)	(0.1510)	
Other	-0.0453	-0.0273	0.2116	55
	(0.2311)	(0.3398)	(0.3393)	
Region				
North	0.1014	-0.0638	-0.0015	510
	(0.1140)	(0.1530)	(0.1780)	
Centre	-0.1143	-0.1460	-0.0433	187
	(0.1335)	(0.1819)	(0.2017)	
Constant	-11.9480 ***	-11.6157 ***	-13.5098 ***	
	(0.8977)	(1.4272)	(1.7067)	
ln-L	-3145.55	-3215.49	-14018.79	981

The hazard of conception by duration shows an increasing risk of conceiving with the increase of duration. Most women are young and therefore the duration is strictly linked with age. With time the risk of conception is higher and this relationship does not change when accounting for heterogeneity and endogeneity (Figure 6.13).

Figure 6.13 Baseline log-hazard of conception by birth interval

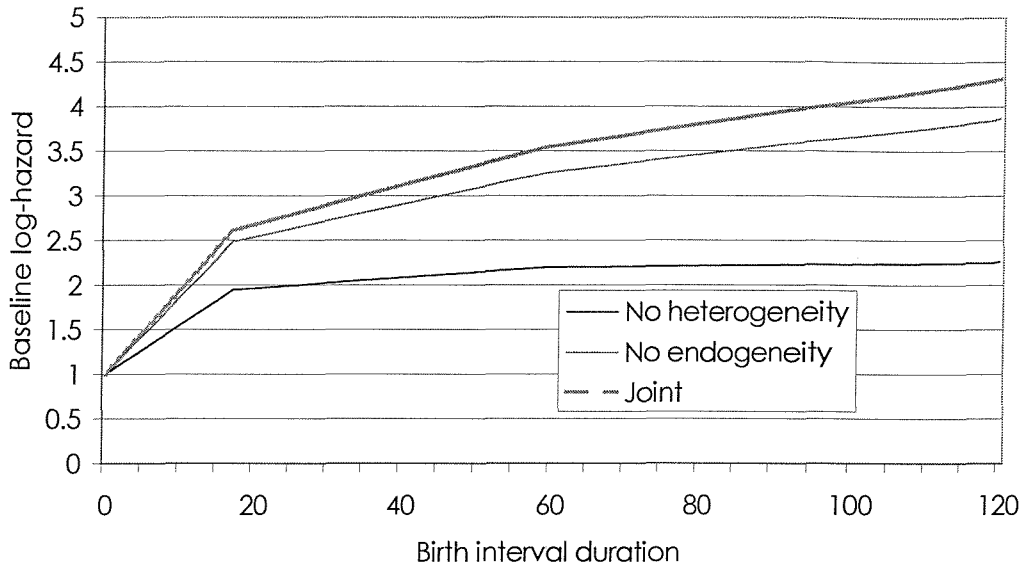
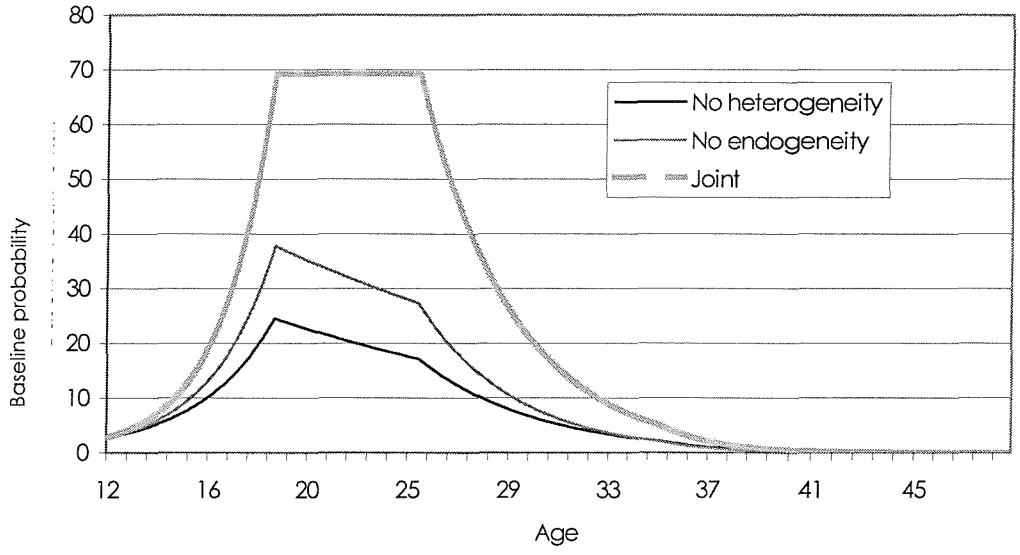
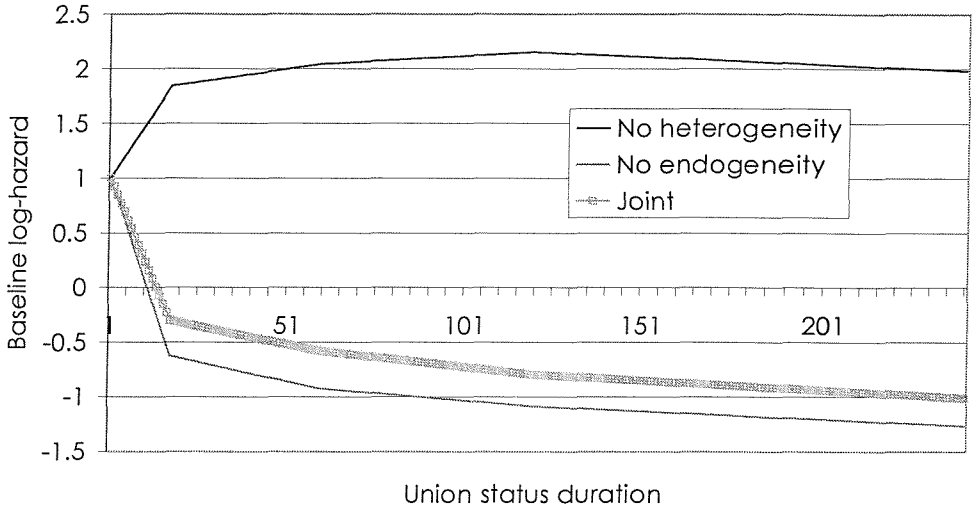


Figure 6.14 Baseline probability of conception by age (women not in union)



This result is confirmed by the age spline (Figure 6.14) that shows a an increasing hazard at younger ages up to the interval between 20 and 25 years (where the mean age at first birth lies) and the it decreases dramatically due to the high incidence of sterilisation. The effect is emphasised when accounting for endogeneity due to the positive correlation with the hazard of union formation, result that has been found in previous research as well (Lillard et al. 1994).

Figure 6.15 Baseline log-hazard of conception by union status duration (women not in union)



Due to the small number of observation included in this model it has been difficult to find significant values for the splines in particular for the union status duration spline (Figure 6.15). This variable was left in the model, as it is important to control for union status duration as well, however it is highly correlated with birth interval duration as this women are more likely to be in their first interval that starts on their 12th birthday.

The union status during the conception spell shows that in general women that have experienced at least one union have a lower risk of conception. This risk becomes more significant when accounting for endogeneity and heterogeneity. In particular women that have experienced more than one union show an even lower risk of conceiving demonstrating that women coming out of a separation are less likely to conceive.

Women that had their first birth out of wedlock show a higher risk of conceiving again. Women that have their first birth out of wedlock are usually less in control of their fertility, as it is more acceptable to have the first birth inside the union.

The variable residence does not show any significant difference between urban and rural areas. As reported in Chapter 2 there is not a substantive difference in Brazil between rural and urban areas

Education shows a negative relationship with the hazard of conceiving as demonstrated in previous research education has a negative impact on the level of fertility (Lam et al. 1994).

Owning a television set decreases the risk of conceiving. The results are instead not significant when considering whether the respondent watches television at least once a week. The results are not significant for the variables ethnicity and region as well mainly due to the lack of cases.

The variable religion shows that the risk is higher for a woman with no religious believes and for women that follow spiritual religions compared with Catholics ones. It is in fact more likely that catholic women would conceive inside the union.

6.4.4.2 Conception model for women that are in a union

The last model presented analyses the risk of conception for women that are in a union as it will ultimately be jointly modelled with the hazard of union dissolution (Table 6.9).

Table 6.11 Hazard model: conception for women that are in a union

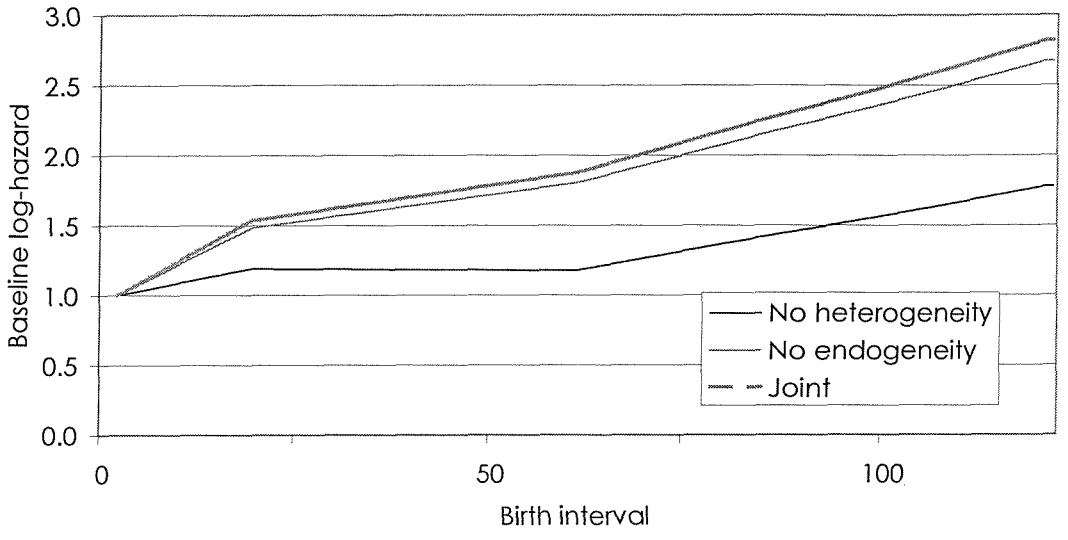
	No Heterogeneity (4a)	No endogeneity (4b)	Joint with formation (4c)	N
Birth interval duration spline				
0-18 months	0.0111 **	0.0282 ***	0.0312 ***	
	(0.0048)	(0.0051)	(0.0052)	
18-60 months	-0.0003	0.0077 ***	0.0082 ***	
	(0.0017)	(0.0019)	(0.0019)	

5-10 years	0.0100 ***	0.0145 ***	0.0157 ***	
	(0.0013)	(0.0014)	(0.0015)	
10+ years	-0.0013	-0.0019 *	-0.0024 **	
	(0.0009)	(0.0011)	(0.0011)	
Age spline				
12-19 years	0.0178 ***	0.0180 ***	0.0189 ***	
	(0.0018)	(0.0020)	(0.0020)	
20-25 years	-0.0051 ***	-0.0014	-0.0011	
	(0.0009)	(0.0011)	(0.0011)	
26-35 years	-0.0059 ***	-0.0062 ***	-0.0059 ***	
	(0.0006)	(0.0007)	(0.0007)	
35 years +	-0.0155 ***	-0.0182 ***	-0.0184 ***	
	(0.0014)	(0.0015)	(0.0015)	
Union duration spline				
0-12 months	0.0225	0.0273	0.0265	
	(0.0229)	(0.0239)	(0.0244)	
1-7 years	-0.0030 **	-0.0029 **	-0.0025 *	
	(0.0012)	(0.0014)	(0.0014)	
8-14 years	-0.0002	-0.0004	-0.0001	
	(0.0007)	(0.0009)	(0.0009)	
15 years +	0.0007 *	0.0010 **	0.0010 *	
	(0.0004)	(0.0005)	(0.0005)	
Union status during the conception spell				
Leaving second or higher order	1.0218	1.4463 *	0.9618 ***	120
	(0.7141)	(0.8023)	(0.1416)	
Leaving first union	-1.1706 ***	-1.3697 ***	0.9425	405
	(0.0566)	(0.0681)	(0.8633)	
Union status at the time of the conception				
In second union	0.4778 ***	0.5272 ***	0.5859 ***	465
	(0.0751)	(0.0990)	(0.1039)	
Parity				
1-2 children	0.0274	0.0773	0.1577 *	4026
	(0.0715)	(0.0911)	(0.0951)	
3+ children	0.0430	-0.0935	-0.0038	2046

	(0.0903)	(0.1185)	(0.1244)	
First birth out of wedlock				
Yes	0.0494	0.0991 *	0.1034 *	1833
	(0.0436)	(0.0589)	(0.0621)	
Residence				
Rural	0.0335	0.0441	0.0145	1898
	(0.0431)	(0.0608)	(0.0641)	
Education	-0.0161 ***	-0.0308 ***	-0.0301 ***	
	(0.0052)	(0.0072)	(0.0077)	
Owns TV				
Yes	-0.4971 ***	-0.6669 ***	-0.7177 ***	4420
	(0.0428)	(0.0594)	(0.0647)	
Watches TV at least once a week				
Yes	-0.2221 ***	-0.2336 ***	-0.2329 ***	6250
	(0.0504)	(0.0725)	(0.0766)	
Religion				
No religion	0.4104 ***	0.5273 ***	0.5156 ***	378
	(0.0845)	(0.1220)	(0.1254)	
Other	0.1248 **	0.1184 *	0.1252 *	1148
	(0.0492)	(0.0661)	(0.0691)	
Ethnicity				
Mixed	0.1495 ***	0.2290 ***	0.2483 ***	4210
	(0.0381)	(0.0523)	(0.0547)	
Other	0.0642	0.0761	0.0952	331
	(0.0888)	(0.1211)	(0.1265)	
Region				
North	0.4905 ***	0.6451 ***	0.6518 ***	3688
	(0.0453)	(0.0620)	(0.0647)	
Centre	0.3316 ***	0.4488 ***	0.4768 ***	1851
	(0.0507)	(0.0672)	(0.0717)	
Constant	-8.5531 ***	-9.4439 ***	-9.8377 ***	
	(0.4514)	(0.5030)	(0.5231)	
ln-L	-22896.56	-22767.31	-28451.22	7505

The hazard of conception increases steadily with duration up to 10 years (Figure 6.16). It then declines, as expected for high durations of the birth interval. No particular differences are reported according to whether accounting for heterogeneity or endogeneity. The only interval that shows different results according to which model referring to is the 18-60 months interval that is not result when considering the fixed effects only.

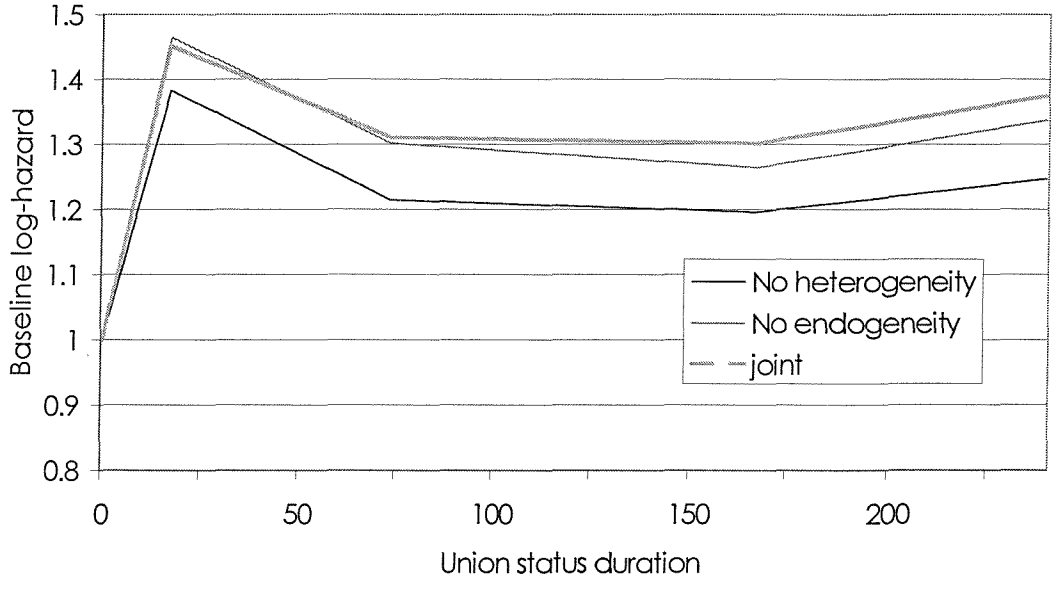
Figure 6.16 Baseline log-hazard of conception by birth interval



The age spline follows the same trend in all the models (Figure 6.17). The hazard increases at young ages and then decreases dramatically after the age 25 as in the discrete model due to the effect of sterilisation. However the decline in the continuous models is steeper. As in the conception model for women not in union the effect of endogeneity emphasises the hazard of conception. Due to a lower correlation in this case the difference between the models with and without endogeneity, is lower than in the previous model.

Figure 6.17 Baseline probability of conception by age

Figure 6.18 Baseline log-hazard of conception by union status duration



The union status duration spline (Figure 6.18) does not show particularly significant values. There is an increase of conceptions at the beginning of the union. After the first few years the hazard declines and increases again. However there are not enough cases for high durations to retain this value significant.

The union status variable has been divided into the status at the time of conception and the union status changes during the conception spell. The results show that if a woman is leaving her first union, the hazard of conception is much lower. The result is not significant when accounting for endogeneity. The value is reversed if the woman is leaving the second or higher order union. It is particularly significant if accounting for heterogeneity and endogeneity. It is an interesting result that could confirm the tendency of Brazilian women that have a history of unstable unions to bear a child to keep the relationship.

If a woman is in her second union the hazard of conception is higher. This risk is even higher when accounting for endogeneity with the union dissolution model. The interesting point, that confirms hypothesis previously made, is that women in second or higher order union have a higher risk of conception.

For the parity result the value is significant only when accounting for endogeneity for women with one or two children and in this case the risk of conception is higher. This result is more credible than the one of the discrete time model. There is a further decline of the level of fertility in Brazil and less and less women have a third or even more child. At the same time considering the type of sample women who do not have any children are more likely to remain childless at this stage that women with one child. This effect is emphasised when accounting for endogeneity. If the woman is about to split up with her partner not having had any children, she is less likely to conceive.

If the first birth is out of wedlock then the woman has a higher risk of conception leading to the possible conclusion that this type of women are less in control of their fertility.

Education shows to have a negative effect on the hazard of conception, as it would be expected.
At the same time the media have a negative impact on fertility as hypothesised. It has been highlighted several times that Brazilian TV often shows the image of a small family, often unstable and this has reflection on the woman's behaviour.

The result for the religion variable confirms once more the fact that Catholicism is not that strongly felt in the Brazilians' life. Women with no believe or that belong to spiritual groups show a higher risk of conception than Catholics. The catholic group was probably the first one to experience the fertility transition with the steepest

decline. At the same time it is possible that Catholic women delay their first conception with a negative effect on the hazard of conception.

Ethnicity confirms the higher level of fertility for mixed and others (mostly black) than for withes. Other ethnic groups do not have a particularly significant result probably due to the lack of cases.
The variable region confirms the lower levels of fertility in the South with higher risk of conception in the Centre and in particular in the North.
The type of residence is not significant.
Whether the respondent owns a TV has a negative impact on the hazard of conception.

Summarising women in second or higher order unions show a higher risk of conceiving in particular when modelling the outcome jointly with union dissolution. When the relationship is about to finish the risk is lower. There is a general increase of the hazard of conception when accounting for heterogeneity and for endogeneity. However no particular difference is reported in the results of the two joint models apart from the union status variable.

6.5 Modelling the calendar period only

In Appendix III the results of the models applied to the sub-sample of women that started their first union after the beginning of the calendar are reported, in order to obtain a more balanced sample of women with one or more than one union.
This analysis helped in understanding whether the exclusion of the women with left censored information or partial exclusion of women with left truncated information would lead to a serious bias. The aim is to analyse the main trends of the variables together with the extent of the estimates. The only models that report different variables are those of conception for women in union (Table 4 Appendix III). In this case for the sub-sample models the variables indicating the union transitions were excluded due to problems of convergence. It was preferred to run the model despite the absence of those variables. The samples where of 1933 cases for the union formation model, 1731 for the union dissolution model, 693 for the conception model for women not in union and 2304 for the conception model for women in a union.

It is evident that for all the 12 models the trends of the variables are very similar. For the splines the models of the initial sample show more statistically significant values. It is clear that the bigger the sample the higher the significance of the variables.
In general the initial sample models presented slightly higher estimates.
The only result to remark in terms of difference between the 'big' sample and the sub-sample is the one for the union formation model (Table 6.8, Table 1 Appendix III). The variable number of unions shows a negative effect on the hazard of union formation for those women that have been in a union already for the initial model, whereas when considering the sub-sample the relationship is reversed. It is evident that excluding the majority of women that started their first union before the beginning of the calendar it lifts the weight of the women with long durations that are more likely to have been in one union only (Code 1 Figure 4.4 PG 68).
Above all the results show very similar trends between the samples leading to the conclusion that the one given by the exclusion of left censored cases is not a serious bias. It could lead to a bias in the intensity of the estimates but not in the direction.

6.6 Summary and conclusions

6.6.1 Methodological issues

The choice between discrete time and continuous time piecewise linear technique has been mainly dictated by the availability of a software that can estimate the kind of model that was needed for the analysis. However the results and the type of information obtained in both results have shown the continuous time model to be a better technique for modelling joint processes.
Time is continuous but data are in grouped continuous time and for this reason it may be more sensible to use a discrete time approach rather than a continuous time approach. Furthermore it is easy to set up the data in Bernoulli format for a discrete time model. In particular it is easier to handle time varying variables. However continuous time models are less computationally tedious; the data files are much smaller and therefore the models are much faster to estimate. At the same time it is easier to handle piecewise linear splines than natural cubic spline as aML calculates them from knowledge of the upper limits of the duration variables and the knots of the distribution. In continuous time it has been easier to split the file into union formation and union dissolution. At the same time the simultaneity of the life course

events is full as the setting up of the variables as described in section 4.3.3 (PG75) allows us to record any transition within a spell.

Continuous time models resulted to be clearer to interpret and easier to handle for multiprocess model. It is clear that with the information given by the calendar data and with the tools that the software aML offers, continuous time is a better option over discrete time.

6.6.2 Substantive issues

The most important result is the demonstration that there is a significant positive relationship between union status change and fertility in Brazil. In particular the joint model has shown that there is positive correlation between union dissolution and the hazard of conceiving, showing that union instability does have a positive impact on fertility. The use of fertility and union dynamics variables in each equation has demonstrated a complex interaction decision-making that is influenced by both childbearing and union dynamics decisions. The results have confirmed the importance of modelling events jointly in order to highlight the interaction of the events.

However, the complexity of the issues that have been considered in the models limits having a clear plot of the interactions of union dynamics and fertility in Brazil. In particular the type of information that is given by the DHS calendar is not sufficient to draw strong conclusions.
It is not clear why women that are leaving their second or higher order union have a higher risk of conceiving that those who are leaving their first union. At the same time it is not clear why women that are pregnant are less likely to enter in a union as well as women that had an out of wedlock birth. All these results need further investigation with different type of surveys such as qualitative in depth interviews.

Chapter 7

Is increasing union instability going to make a difference to the level of fertility?

7.1 Introduction

Chapter 6 presented an in-depth analysis of the relationship between union dissolution and formation and fertility at micro-level. The analysis demonstrated that there is a positive relationship between union instability and fertility. Women that experienced more than one union during their reproductive life are more likely to conceive regardless of their age than women that experienced only one union. The mechanisms that interact in the union status and conception decision-making are far from being understood from a statistical analysis that is based on limited information. However the joint modelling of union dynamics and conception outcomes has highlighted a further need for analysis. The result showing that women splitting up whilst pregnant and the tendency of not entering in a union whilst pregnant should be analysed in more depth.

In the last decade very little emphasis has been put on the effect of union dynamics on fertility, both for the lack of complete data and for the fact that most of the attention of the Brazilian demographers is focused on the levels of female sterilisation. As pointed out in Chapter 2, Brazilian women rely on sterilisation as the main source of birth control. The mean age at sterilisation has been falling down dramatically in the last 10 years from 33 years old to 30. The literature on the topic is particularly rich. In particular because sterilisation has been one of the causes of the steep decline in fertility at least since the second half of 1970 (Potter 1999). It is hypothesised that the couple's relationship might be one of the key explanations for a better understanding of such a high rate of female sterilisations.

Findings in Chapter 3 indicated that one of the reasons for a higher level of fertility for women in unstable unions, than women in stable ones, could be a less effective use

of contraceptive methods or more in general could be the fact that women in unstable unions could use less effective or reversible contraceptive methods. An in-depth analysis of this relationship is not the aim of this study. However it is important to have at least a first idea of the possible implications that union instability could have on contraceptive use. In this Chapter a discrete time modelling of the timing of sterilisation according to union duration and union status is presented. Sterilisation has been chosen as it is the most common method of contraception and by far the main factor of the recent decline in the Brazilian fertility.

The second part is dedicated to a macro level analysis. The first part of the study focused on individual-level data that allowed an analysis of some of the interactions in couple's decision making. However as stated in Chapter 1, this analysis is informed by the fact that union instability did not have a negative impact on the level of fertility in Brazil, as the classic literature suggests (Bongaarts 1978), and despite the increase of union instability in the last decades the level of fertility has been decreasing steadily.

It is difficult to examine the impact of union instability on the level of fertility with the individual data only. For this reason, there is the need to link the micro level analysis to the macro level analysis that is described in the second half of this chapter. The analysis is limited to the decade 1986-1996 due to data constraints. Although the actual results will not be able to tell whether union instability had an impact on the fertility decline in the last 50 years, it could still give an impact of union instability in the last decade and possible indications for future trends in the Brazilian fertility.

Three components that are considered particularly prominent in the Brazilian scenario are highlighted. These are adolescent fertility, union instability and sterilisation. Demographic techniques are used to measure the specific contribution of each component to the level of fertility. Analysing the results of the effect that each of these components has on the level of fertility will help to understand whether union dynamics can slow down the fertility decline in Brazil.

This chapter serves as a conclusive remark on the role of union instability on the level of fertility in Brazil. Furthermore some of the issues that will be raised in the following sections could be starting results for future research on fertility issues in Brazil.

7.2 Micro level data- sterilisation

Chapter 3 showed that there is a lack of literature on the relationship between union dynamics and contraceptive dynamics, and in particular there is no such study on Brazil.

This analysis is limited to sterilisation as it is the main method of birth control in Brazil and it will help in understanding the possible link between the increase of the number of sterilised women and union dynamics.

It is hypothesised that sterilisation decision-making is strictly linked with the level of communication in the couple. The decision to be sterilised could depend on two factors: on one hand women who decide to get sterilised are those in stable relationships that have reached the desired family size and can see themselves continuing in the same relationship (Bailey et al. 2001). On the other hand, independent modern women who do not want to involve their partner in their reproductive life could use sterilisation. In particular when the relationship is about to end and the level of communication is low, women do prefer to avoid contraceptive methods that involve negotiation like condoms or withdrawal (Bumpass and Rindfuss 1982; Godecker et al. 2001).

Sterilisation in Brazil is highly dependent on the lack of communication between the partners. However women in unstable unions rely on childbearing to keep their relationship, particularly in situations of economic deprivation. Furthermore it is very important for most men to show their virility through childbearing, and it is likely that they would pressure on their partner to have another child. For these reasons they would not scatter their chances of keeping their partner by getting sterilised. At the same time women in unstable unions are less likely to have a long term plan for their reproductive life as the precariousness of the union might lead to a general feeling of instability on several aspects of everyday life.

7.2.1 Data and methodology

This analysis uses the calendar data recoded in a Bernoulli format described in Chapter 4. The outcome variable is the timing of the sterilisation. The women selected for the analysis are all women aged above 12 years old, who have had sex at least once and who are at risk of sterilisation during the calendar period. The pregnancy

months have been excluded as the woman is not at risk of getting sterilised. Age has been included as a duration variable. Of the sterilisation history the union history has been considered in the form of union status and union status duration. Birth interval is considered as a time varying covariate.

Event history analysis techniques described in Chapter 5 are used in this analysis. Sterilisation can be considered as a non-repeatable event and the woman is censored once she has experienced the event. As the interested is in analysing the effect of union instability on the timing and decision to get sterilised discrete time modelling is used.

The emphasis in this analysis is on the effect of union instability rather than any other characteristic. For this reason the analysis is limited to only few variables without going into in-depth analysis of sterilised women.
All the duration variables (union status duration, age and birth interval duration) have been transformed into polynomial splines. Cubic splines have been applied, although simpler quadratic splines were statistically more significant. Furthermore the time varying variable parity has been included. Among the cross sectional variables, residence in particular is relevant as it is one of the variables used for the survey design. Other variables that have been included in the model are region, religion, ethnicity, woman's occupation, women's education and whether the woman watches television at least once a week. Only the significant variables are described in the final model.

7.2.2 Results

The results show (Table 7.1) that women in second or higher order unions have a higher risk of sterilisation. However a closer look (table 7.2) reveals that this risk is higher only for nulliparous women or women with one child. The model firstly fitted without the interaction term revealed that women in second or higher order unions have a lower risk than women that have experienced one union only. This result should be interpreted in the light of the fact that women that have experienced more than one union have a higher level of fertility (Figure 3.6). Furthermore only 20% of the women in second unions have less than two children compared with 32% of women in their first union. It may be plausible to suggest that women in second unions are less likely to get sterilised. One of the possible explanations for this result

could be related to the characteristics of women in second unions and with one or no child. It may be possible that such women are more independent and do not rely on their partners economically. For this reason they are less likely to depend on childbearing to keep their relationship. It is also possible that these women are more in control of their reproductive life and choose a permanent method rather than a reversible one or generally a less effective one. However, women with a high level of fertility could be motivated by the idea that in each union there is need for a new child to stabilise it and strengthen it.

Table 7.1 Discrete time model of risk of sterilisation

	Coefficients	SE	Exp(B)	N (woman-month)
Union status duration				
Linear term	.00734***	.002	1.007	
Square term	-.00003***	.000	1.000	
Union status				
Not in union	Reference		1.000	163493
In first union	1.66802***	.173	5.302	264443
In second union	1.78605***	.230	6.259	33809
Age spline				
Linear term	.45446***	.049	1.578	
Square term	-.00782***	.001	.992	
Birth interval				
Linear term	.00547***	.001	1.006	
Square term	-.00018***	.000	1.000	
Parity	.51069***	.035	1.662	
Region				
South	Reference		1.000	148125
Centre	.42404***	.087	1.528	95598
North	.33066***	.078	1.392	218022
Education	.02202***	.009	1.025	
Watches television once a week				
No	Reference		1	60532
Yes	.18264**	.090	1.200	401213
Residence				
Urban	Reference		1	370574
Rural	-.18894***	.078	.828	91171
Parity by union status				
Parity by first union	-.23475***	.037	.790	
Parity by second or higher order union	-.29392***	.046	.745	
Constant	-14.80912***	.662		
χ^2	1606.89***	Df=16		

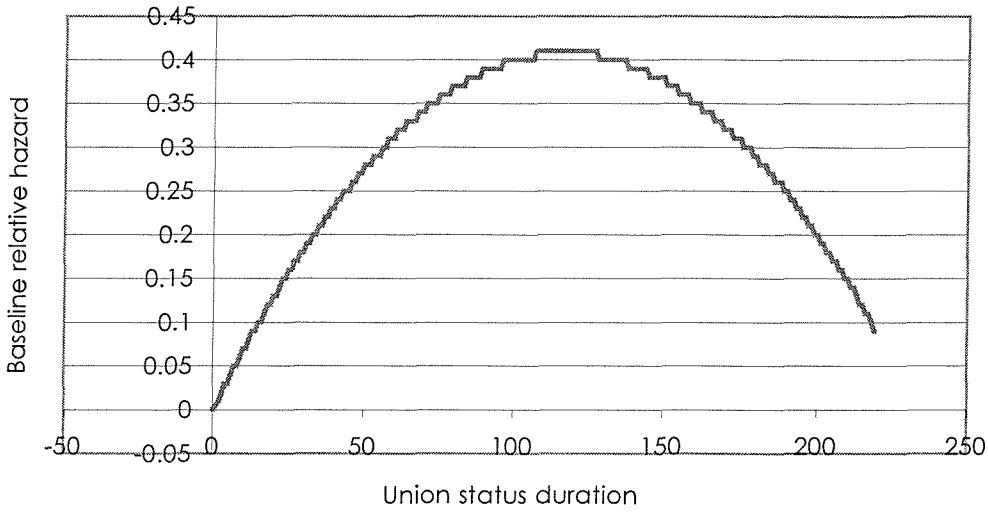
*** p<0.01 ** 0.01<p<0.05 * 0.05<p<0.10

Table 7.2 Baseline odds ratios of sterilisation by parity and union status (expressed in months)

	Not in union	In first union	In second or higher order union
No children	1.000	5.302	5.966
One child	1.665	6.983	7.404
Two children	2.773	9.198	9.189
Three children	4.618	12.116	11.404

Figures 7.1 to 7.3 show the trends of the relative risk of sterilisation according to union duration, age and birth interval duration respectively. If we consider the trend by union duration shows that the risk of sterilisation increases up to a duration of 10 years after which the risk declines. The trend shows an increasing risk for young couples in particular (Figure 7.1).

Figure 7.1 Baseline relative hazard of sterilisation by union status duration

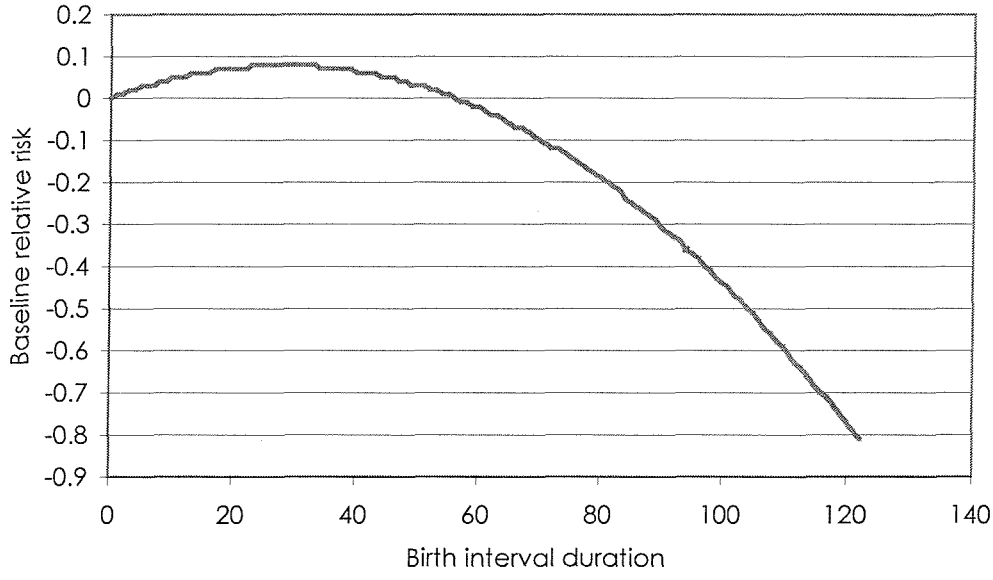


The relative hazard has a reversed U shape by age peaking at a mean age at sterilisation of 30 years old (Figure 7.2).

The risk by birth interval is high at short durations and it declines afterwards. This result could be influenced by the peculiarity of the Brazilian case as it is mentioned in the literature review (Caetano 2000; Perpetuo et al. 1997; Potter 1999), Brazilian women in most cases get sterilised at delivery, particularly after a caesarean delivery.

Figure 7.2 Baseline relative hazard of sterilisation by age

Figure 7.3 Baseline relative hazard of sterilisation by birth interval



Rural women have highlighted a lower risk of sterilisation than women in the urban areas. This result may be directly related to the result of exposure to the media and to the level of education. Women living in the rural areas in fact represent a stratum of the population that is less educated and less exposed to the media. The level of

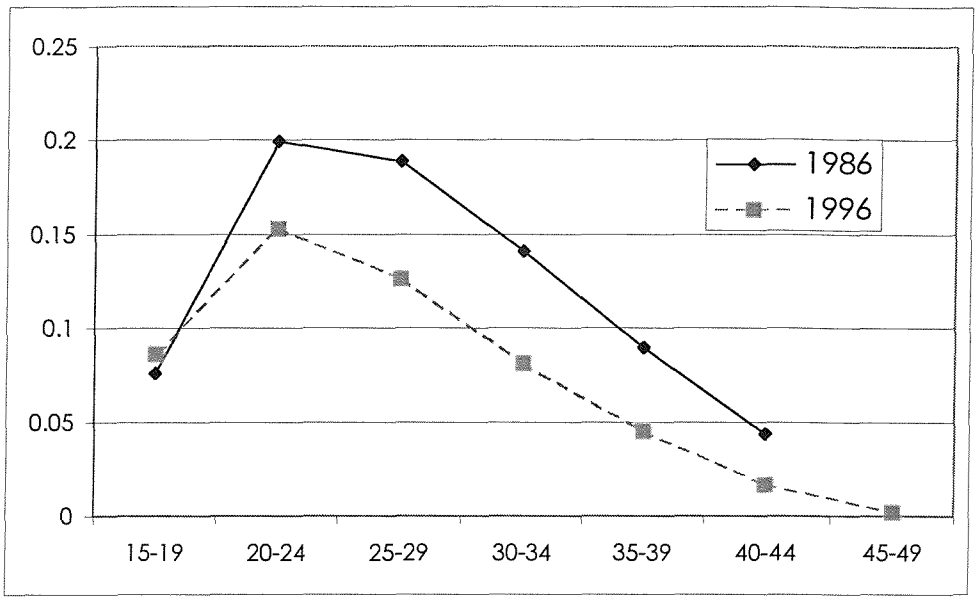
education is positively correlated to the risk of sterilisation and at the same time women who watch television at least once a week are more likely to get sterilised. Exposure to the media appears to have a strong impact on the people's reproductive life in Brazil (Rios-Neto 2001). The mass media has a considerable effect on every stratum of the population, considerably influencing the behaviour of low-income people. This result is further supported by the regional effect: women in the North, usually known to be poorer, have higher chances to be sterilised. There is evidence of an increase of poorer women requesting sterilisation to avoid the high cost of childbearing. Caétano (2000) observed that women in the northeast in particular, use political votes to pay for the costs of surgical sterilisation.

7.3 Macro-level analysis

As noted in Chapters 2 and 3, Brazilian fertility has experienced a substantial decline over the last 40 years. Scholars have analysed a range of causes including urbanisation, industrialisation, the rise in education, women's participation in the labour market, institutional determinants, and the diffusion of ideas and attitudes (Carvalho, 1996; Martine, 1996; Merrick, 1983; Potter, 1990; Sobrinho, 1993). However, other factors that have influenced fertility decline more recently are largely unexplored. Among these factors, may be adolescent childbearing, union dynamics and female sterilisation, issues that characterise the current Brazilian reproductive reality.

This analysis uses the 1986 and 1996 DHS data to study changes over time. A simulation of different scenarios of total fertility is considered to include lower levels of adolescent conception (births from women aged 15-19) and union instability, as well as, the absence of female sterilisation. Data from the 1986 and 1996 Brazilian DHSs indicate an increase of teenage fertility in the last two decades (BEMFAM, 1997). As shown in Figure 7.4, at any age group the level of fertility has declined apart from the age group 15-19.

Figure 7.4 ASFRs 1986-1996 Brazil DHS, five years period



Perhaps, this growth in teenage childbearing could have been one of the reasons for the increase of union instability, in Brazil, particularly if women enter into a union at earlier ages. The analysis in Chapter 6 demonstrated that at young ages the risk of dissolution is high (Figure 6.11). Earlier studies have indicated that unions starting at earlier ages tend to be relatively unstable (Lillard and Waite 1993). This is mainly due to the fact that a teenage pregnancy, if not aborted, is frequently followed by a marriage to legitimise the birth as explained in Chapter 3 (Chen et al. 1974; Greene 1991).

Another relationship worth studying is the one between the increase of adolescent fertility in both relative and absolute terms and the decline of the mean age at sterilisation in Brazil, which lowered from 33 years old in 1986 to 30 years in 1996 (BEMFAM 1997). It is likely that this decline may have been occasioned by a progressive shift of the childbearing peak to earlier ages, which would not affect the overall level of fertility, but only age-specific fertility rates. In this case, women might tend to get sterilised just immediately after they obtain their ideal number of children (Caetano 2000). On the other hand, there is evidence that women in unstable unions or women with a history of, or a tendency towards, union instability may delay, even if slightly, the age at sterilisation (the mean age at sterilisation in 1996 was 29 years for women in one union and 29.5 years for women in second or later unions). As mentioned earlier, women who experience more than one union are in general less likely to be sterilised. In fact, it appears that there are two contrasting forces that

affect the mean age at sterilisation and, consequently, the fertility level. Higher adolescent fertility may increase fertility directly or operate through inducing earlier unions and, therefore, union instability (union instability has a positive effect on fertility by itself as shown by the results in Chapter 6). Earlier initiation of reproductive life, on the other hand, may tend to decrease the mean age at sterilisation and thus depress fertility. On the other hand if sterilisation comes simply at the time the woman has reached the desired level of fertility, a decrease of the mean age at sterilisation will only mean a shift towards younger ages of reproductive life. It is likely though that an earlier sterilisation might somehow depress the chances of having another child in a second union with a depressing effect on the level of fertility.

7.4 Fertility Decline and the Brazilian Context

A review of the literature in Chapter 2 showed that the Brazilian fertility decline occurred despite the absence of a government-sponsored family planning.
Despite the significant economic growth and social transformations that have taken place in the last forty years, income inequality and poverty remain the major problems in Brazil. In addition, poverty continued unabated throughout the 1990s inspite of the improvement in the income levels among the poor following the control of inflation in 1994 (Potter 1990). In this context, the basic needs and rights of a large segment of the Brazilian population remain unfulfilled. Among the demands that continue unmet are adequate contraceptive services.

In the contraceptive domain, female sterilisation diffused throughout the country and across different socio-economic strata is becoming highly desired among low-income women. In a scenario where the influence of medicine and doctors expanded enormously and family planning policies not implemented and birth control alternatives inaccessible to most of the population, sterilisation became the dominant contraceptive option for low-income women, just as it had for upper income women who wished to terminate childbearing. At the same time, adolescent fertility increased and played a role in "slowing" the fertility decline. The ASFR of 15-19 year olds increased from 74.2 births per thousand women in 1986 to 86.3 in 1996. In addition, the mean age at first birth decreased from 20.9 in 1986 to 19.8 in 1996. Hence, adolescent fertility increased while in other age groups fertility declined.

7.4.1 Adolescent Childbearing

Adolescent childbearing occurs in every country, at different levels. In industrialised countries the age specific fertility rate of the 15-19 year old groups varies from 0.012 in the Netherlands (1992) to 0.070 in the US (1996). Nevertheless, in most developed countries, the adolescent birth rate has declined steadily over the past 25 years, with a general trend toward lower adolescent childbearing, suggesting that the causes such as increasing women's education and professional training, and decreased importance attached to motherhood are not limited to specific countries (Singh and Darroch 2000).

On the other hand, in Brazil, adolescent fertility rates have increased while fertility at other age groups has declined (Yinger 1992 cited by Gupta, 1999). As the pace of the fertility decline accelerated in the last two decades the proportionate impact of adolescent fertility on overall fertility has remained constant if not increased, especially in the Northeast. In Brazil, the proportion of all births among adolescents increased from 12% (74 per thousand) to nearly 19% (86 per thousand) between 1986 and 1996, whereas the rate among women aged 25-39 dropped from 53% to 48%.

Education is highly associated with teenage childbearing in Brazil. A teenager with fewer than eight years of study is twice as likely to have a child than an adolescent with at least secondary education (Gupta and Leite 1999). Indeed, young women living in the least developed regions of the country present the highest rates of fertility. Besides, data from the 1996 DHS indicates that half of the births among women aged 15-19 were unintended, despite near universal knowledge of contraceptive methods (Gupta and Leite 1999). Some authors associate the increase in teenage fertility to the lack of knowledge about the female fecund cycle (Camarano 1998).

7.4.2 Union Instability

There has been an increase in the proportion of consensual unions in Brazil in the last few decades, from 15.3% in 1986 to 21.2% in 1996. The median age at first birth of legally married women was 21 years in 1996 as opposed to 19 years for women in consensual unions. The latter are considered unstable relative to legalized unions, which leads to an increased proportion of unions of shorter durations (Greene, 1991).

Among ever-married women aged 15-49 interviewed in 1996, 13.3% had experienced more than one union as opposed to 9.6% of those surveyed in 1986. Divorced women were 7.7% of the total female population aged 15-49 years, while 47.4% were in a union. These figures are similar to Sweden's (7.5% separated and 40% married, respectively). Nevertheless, the difference is significant when Brazil is compared to other Catholic countries. In Italy, the figures for divorced and married women in the age span 15-49 are 2% and 57%, respectively, in the Dominican Republic, 14.6% are divorced against 22% married (US Census Bureau, 2001).

As indicated in Chapter 6, union instability has a positive effect on the overall level of fertility. This effect is evident at both aggregate and individual level. As shown in Figure 3.6 (PG42) women in second or later unions have higher fertility levels than women in first unions, particularly for women aged 15-19 years and this pattern holds at each age group.

Union dynamics in Brazil depends, among other factors, on the woman's position in the family, which is heavily influenced by a culture of 'machismo,' placing women, especially the ones belonging to lower social strata, in a position of dependence on the male partner. Moreover, there are important regional and income effects on the status and timing of unions. Consensual unions are more likely in the North and Northeast regions as compared to the South and Southeast regions and at lower levels of income thus increasing the chances of women entering their first union at a young age (Berquó 1998).

Women in a new union may tend to bear a child in order to keep a relationship while men going through different unions are prone to leave children of previous relationships in the care of ex-partners and are more willing to have a child in each union (Greene, 1991; Heaton, 1990; Koo, Suchindran et al. 1984). Women in consensual unions are more likely to experience more than one union than women in formal unions, and those who experience more than one union tend to present a higher fertility. Indeed, the TFR of women with two unions was 4.9 in 1996 as compared to 4 for women with only one union.

The factors related to union dynamics that interact in fertility decision-making in Brazil are complex, depending also on cohort effects and on the woman's bargaining power, as described in Chapter 3. Brazilian women have made great efforts to gain independence and autonomy. This may be one of the reasons for the popularity of female sterilisation.

7.4.3 Sterilisation

Data from the 1996 DHS show that 27% of Brazilian women aged 15-49 years were sterilised and that one third of these women lived in the country's Northeast region. Whilst in the Northeast politicians and doctors arranged and paid for 77% of the tubal ligations from 1987 until 1996. In the other regions most sterilisations were paid for by the women themselves.

The importance of female sterilisation in Brazil has increased substantially since 1980. In 1996, 40% of married Brazilian women aged 15-49 years were sterilised as opposed to 29% in 1986. In the Northeast, these figures rose from 26% in 1986 to 44% in 1996. Female sterilisation is high in Brazil, but the country is not alone in the high use of tubal ligations. In the Dominican Republic in 1991, 38% of married women in the reproductive age span were sterilised. In El Salvador in 1993[9], this figure was 31%. In the United States, the proportion sterilised among married women aged 15-44 was 24% in 1995 (CDC and NCHS 1998).

What makes the situation in Brazil different, and the case of the Northeast unique, is that sterilisation was not regulated by law until 1997, and the government, which funds about 70% of the surgical procedures performed in the country (Carvalho 1997) did not provide reimbursement for tubal ligations. Nevertheless, sterilisation was in great demand. For low-income women with little contraceptive knowledge and difficult access to alternative options, sterilisation meant efficacy and low costs in terms of information and medical follow-up. This situation gave rise to a mutually beneficial relationship among politicians, doctors, and women, associating sterilisation with economic profit and political gains. As birth control rapidly diffused spatially and cut across socio-economic strata, the number of tubal ligations escalated, stimulating unnecessary caesarean births to circumvent hospitalisation costs, encouraging pregnancy as a means of being sterilised, and increasing child and maternal health risks.

[9] United Nations, "Levels and Trends of Contraceptive Use as Assessed in 1994." ST/ESA/SER.A/146, New York, 1996, [cited by Potter, J. (1999). "The persistence of outmoded contraceptive regimes." *Population and Development Review*, 25(4), 703-739.].

7.5 Decomposing the Effect of Teenage Fertility

7.5.1 Methodology

The effect of teenage fertility on overall fertility is analysed by examining its actual contribution to overall fertility in 1986 and 1996. Holding the ASFR for this age group constant from 1986 to 1996 how much the level of fertility would have changed if adolescent fertility had remained constant throughout this period is assessed.

Expressing the total fertility rate as $TFR = (f^{96}_{15-19} + f^{96}_{20-24} + ... + f^{96}_{40-44}) * 5$, it is rewritten as $TFR = (f^{86}_{15-19} + f^{96}_{20-24} + ... + f^{96}_{40-44}) * 5$.

7.5.2 Results

Looking at the age group 15-19 years in Table 7.3, it is observed that ASFR increased by 16% in the period 1986-1996. Keeping the level of fertility of the 15-19-year-olds constant throughout the period 1986-1996 gives a TFR 2.4% lower than the actual one in 1996. This is a not a substantial difference despite the fact that is the contribution of only one age group, holding all other groups constant. This result points to the fact that the Brazilian fertility would have declined by 27.1% rather then by 25.3% (comparing the actual and theoretical TFR) if there had not been an increase in teenage fertility.

Table 7.3 Contribution of adolescent fertility to the overall level of fertility in Brazil 1996

Age groups	1986		1996		1996 with 15-19 group like in 1986
	ASFRs	% Contribution of age group	ASFRs	% Contribution of age group	ASFRs
15-19	0.074	0.11	0.086	0.17	0.074
20-24	0.186	0.28	0.152	0.30	0.152
25-29	0.169	0.25	0.123	0.24	0.123
30-34	0.128	0.19	0.081	0.16	0.081
35-39	0.080	0.12	0.047	0.09	0.047
40-44	0.037	0.05	0.016	0.03	0.016
TFR	3.37		2.52		2.46

7.6 Decomposing the Effect of multiple unions

7.6.1 Methodology

To decompose the effect of multiple unions on the level of fertility, the TFR is decomposed considering the proportion of women by number of unions experienced.

Letting B_y be the number of births in year y, and as P_y the number of women at year y, the fertility rate is expressed as $f_y = \frac{B_y}{P_y}$

Thus $B_y = f_y * P_y$.

Decomposing considering the proportion of women by union histories, obtains $\frac{P_y^0 * f_y^0 + P_y^1 * f_y^1 + P_y^2 * f_y^2}{P_y} = \frac{B_y}{P_y}$, where P_y^0 is the proportion of women never in union, P_y^1 is the proportion of women that experienced, and P_y^2 is the proportion of women that experienced more than union. Assuming fertility of women that experienced more than one union is the same as that of women that have experienced one union:

$$\frac{P_y^0 * f_y^0 + P_y^1 * f_y^1 + P_y^2 * f_y^1}{P_y} = \frac{B_y^s}{P_y}$$

where B_y^s are the births in year y calculated under this assumption.

The advantage of this kind of decomposition lies in the fact that it is simple and straightforward. However the assumption that women in second or higher order women would have the same fertility of women in first union is the main limitation of this method: other factors such as union duration, frequency of coitus, exposure to the risk of conception that could be different according to the order of the union, should be taken into account. As the measurement of these complex factors is not in the aim of this decomposition, the decomposition relies only on the assumption that the fertility of women in first and second unions is the same.

7.6.2 Results

The aim of this analysis is to determine the macro-level impact of multiple unions on the level of fertility and compare it with the impact of sterilisation. Evidence in

Chapter Three (Figure 3.6) from the 1996 indicated that ASFRs were positively related to the number of unions. Since increased number of unions leads to a higher proportion of women with two or more unions, it would be expected that union instability would increase fertility.

The ASFRs in Table 7.4 indicate that the level of fertility has declined for women in unions whereas it has increased for women outside unions. At the same time, women with more than one union show higher level of fertility both in 1986 and 1996, than the others.

Table 7.4 Fertility trends by number of unions, Brazil DHS 1986-1996

Age groups	1986			1996		
	Never in union	One union	Two or more unions	Never in union	One union	Two or more unions
15-19	0.004	0.225	0.318	0.010	0.228	0.249
20-24	0.027	0.261	0.389	0.038	0.232	0.296
25-29	0.025	0.213	0.210	0.018	0.151	0.194
30-34	0.011	0.154	0.130	0.032	0.095	0.115
35-39	0.014	0.102	0.114	0.022	0.050	0.085
40-44	0.018	0.046	0.048	0.000	0.020	0.042
TFR	0.49	5.00	6.04	0.60	3.88	4.90

Table 7.5 shows the standardised TFR obtained by multiplying the proportion of women in second or later unions by the ASFRs of women in first unions. The results indicate that the level of fertility would be 3.2% lower if women in second unions were to have the same level of fertility of women in first unions. If the level of fertility in 1986 was a TFR of 3.4, the decline of fertility between 1986 and 1996 would have been of 28.5% in the absence of the excess of fertility of women with multiple unions instead of the actual 25.3%. In this case as well the difference is not substantially big.

Table 7.5 TFRs assuming fertility women two or more unions is same fertility of women with more than one union

Age groups	Actual values	Assuming fertility of women with 2 or more unions same as fertility of women with 1 union
15-19	0.086	0.052
20-24	0.152	0.149
25-29	0.123	0.125
30-34	0.081	0.089
35-39	0.047	0.047
40-44	0.016	0.019
TFR	2.52	2.41

7.7 Decomposing the Effect of Sterilisation

7.7.1 Methodology

Assuming that in a given year there are P_x women aged x years who have B_x births, and among the P_x women, P_x^s are sterilised and P_x^n are not, the reported ASFR, as calculated from the DHS data using all women, would be given by:

$f_x = B_x / P_x = B_x / (P_x^s + P_x^n)$.

If there were no sterilised women, then the revised ASFR would be given by

$$f_x^* = (B_x + B_x^s) / P_x = (B_x + B_x^s) / (P_x^s + P_x^n) \qquad \textbf{7.1}$$

where B_x^s are the additional births that the previously sterilised women would have had. In this case it is assumed that all women have fertility equal to the non-sterilised women. The ASFR for the non-sterilised women would then be equal to B_x/P_x^n, so $B_x^s = (B_x/P_x^n) P_x^s$.

Substituting in equation 7.1, gives $f_x^* = (B_x + (B_x/P_x^n) P_x^s) / (P_x^s + P_x^n)$,

which simplifies to $f_x^* = (B_x P_x^n + B_x P_x^s) / P_x^n(P_x^s + P_x^n) = B_x / P_x^n$.

This decomposition reports the same limits as the previous one: it is straightforward and it simplifies a more complex reality. However the simplification does not take into account of the fact that women that rely on sterilisation are in general more motivated to control their level of fertility than women that are not. It is therefore

more likely that they would choose a more effective contraceptive method than non- sterilised women.

7.7.2 Results

The impact of sterilisation is then calculated using a theoretical TFR, TFR*, that represents the level of fertility that would be attained in the absence of sterilisation, using the above assumption (that women who were sterilised would, if they had not been sterilised, have experienced the same fertility as the non-sterilised did). Table 7.6 compares the actual TFR with the sterilisation-free TFR*.

Table 7.6 Impact of sterilisation on the level of fertility

Year	TFR	TFR* (in the absence of sterilisation)	TFR/TFR*100
1986	3.37	4.26	79.28
1996	2.52	3.31	76.13

The results above measure the magnitude of the effect of sterilisation upon fertility in Brazil, especially during the 1990s. In the mid-1980s Brazilian fertility was 20% lower than it would have been otherwise. By the mid-1990s, the fertility-reducing effect of sterilisation had increased to 24%.

Considering the trend over the decade 1986-96, the hypothetical TFR* shows that in the absence of sterilisation declined by 22%, from 4.25 to 3.31, against the actual 27% decline. If sterilisation had remained at its 1986 level, then the 1996's TFR would have been 2.63, 6.7% higher than the actual 2.52. During this period, the median age at sterilisation declined by three years, from 30 to 27.

If the analyses showed in Table 7.6 is differentiated by number of unions it is possible to have an estimate of the impact of sterilisation on fertility according to whether the woman has experienced one or more than one union. Table 7.7 shows that the actual decline in fertility between 1886 and 1996 for women that have experienced one union only has been of 23%, whereas in absence of sterilisation it would have been 19%. The same calculations for women that have experienced more than one union show that the actual fertility decline has been of 19% and in absence of sterilisation it would have been of 2%. It is interesting to see that women that have experienced one union only have experienced the main fertility decline. However when looking at the influence of sterilisation it is possible to see that it had a small impact on the level of fertility. Whereas women that have experienced more than

one union show a lower fertility decline but it has been influenced mainly by sterilisation.

Table 7.7 Impact of sterilisation on the level of fertility by number of unions

	One union	One union	Two unions	Two unions
	TFR	TFR* in absence of sterilisation	TFR	TFR* in absence of sterilisation
1986	5.00	5.95	6.04	6.59
1996	3.88	4.82	4.90	6.45

7.8 Conclusions

The effect of union instability on reproductive life decisions has proved to be significant once more. Women experiencing a history of unstable unions, show to have a lower risk of sterilisation. This result should get further consideration in the analysis of the determinants of female sterilisation in Brazil. Couple's communication and bargaining could be one of the key elements to understand more in depth the high level of sterilisation in Brazil.

Increased teenage childbearing appears to have raised the Brazilian TFR by 2.4% between 1986 and 1996, keeping constant union dynamics and sterilisation. The growth of unstable unions also had a positive impact upon the fertility. Hypothesising that the fertility of "one-union" women would apply for every woman, showed that fertility would be 3.2% higher in 1996, keeping constant teenage fertility and sterilisation at the 1996 levels. Finally, if female sterilisation had kept the 1986 levels, fertility would be 6.7% higher given the patterns of adolescent pregnancy and union dynamics as in 1996. Despite the strong assumptions made for the calculations, these are not trivial figures. At a TFR of 2.5, a 16% decline would bring fertility down to 2.1, i.e., each 0.1 births per woman (4% of 2.5) represents one fourth of the way toward replacement level.

The overall balance is that the diffusion of female sterilisation exceeded the positive effects of teenage pregnancy and union instability upon the Brazilian fertility. On the other hand, teenage pregnancy and union instability played a role not to be underestimated in checking part of the negative effect of female sterilisation over fertility. It is possible that these effects have counterbalanced each other.

Chapter 8

Summary and conclusions

8.1 Background

Brazil has shown a dramatic fertility decline in the last century with the Total Fertility Rate decreasing from 6.5 in 1930 to 2.0 in 2001. This decline has been considered particularly striking by most Brazilian demographers in the light of the absence of a government sponsored family planning programme (Carvalho and Wong 1996; Goldani 2001; Martine 1996). The main reasons for the decline reside in the increased prevalence of contraceptive methods and the high number of abortions in particular during the 1960s and 1970s. Sterilisation has become increasingly important since the second half of the 1970s such that it has become the most used contraceptive method in Brazil (27% of all women aged 15-49 and 40% of all women ever married aged 15-49). The popularity of sterilisation is justified by the lack of alternative methods and by the easy access to it, in particular for low-income women. It is a method that is completely controlled by the woman and it avoids inconveniences such as side effects or ineffective use. The increase of education and the progressive rise of number of women in the labour market encouraged women to make more efforts to control their fertility. Furthermore, the role of mass media was undeniably important: soap operas brought new social behaviour and economic aspirations.

There has been a pronounced regional difference in fertility between the northern and the southern regions of Brazil: the former has higher fertility and in some recent periods has experienced an increase in the TFR; the latter are characterised by lower fertility and a continuous decline. However, all fertility differentials, whether economic, regional or residential, have attenuated with time as the fertility decline has led to a progressive homogenisation of the level of fertility. For example, women in the lower economic strata are now more willing to control of their fertility, having experienced the fertility transition after the wealthier women (Remez 1997).

Brazil's peculiarity lies in the union dynamics. They are characterised by a high prevalence of consensual unions: 13% of the women aged 15-49 years old are in a consensual union (Bemfam, 1997). Consensual unions in Brazil have unique features deriving from the tradition of slavery: most couples in a consensual union would define themselves as husband and wife. It is therefore difficult to measure the true number of consensual unions. There has been an increase in the proportion of consensual unions in the last few decades. Since these unions are usually considered less stable than more formal unions, this has led to an overall increase of union instability characterised by an increased proportion of unions of shorter durations (Greene 1991).

So far the influence of union instability on fertility has not been taken into consideration thoroughly as most demographers have always believed the influence of union instability to be negligible. Most of the analyses on the effect of union instability on the level of fertility simply stop at the analysis of the Bongaarts' model (Bongaarts 1978) of the proximate determinants of fertility. In this model it is hypothesised that union instability has a negative impact on the level of fertility as it is assumed that level of fertility of women not in union is zero. However this type of model is usually applicable to the fertility of married couples only and it does not consider fertility out of wedlock.

Brazil has a high incidence of consensual unions due to the slavery in heritage and to a culture that it is based on male 'machismo' that sees casual relationships as acceptable. However consensual unions in Brazil are relevant as the partners consider themselves as husband and wife. Nevertheless consensual unions are less stable than formal ones. The increase of consensual unions in Brazil in the last decades has corresponded to an increase in union instability. Considering the nature of the Brazilian unions it is likely that Bongaarts' model does not suit the Brazilian case. Furthermore this model hypotheses that union instability has a negative impact on the level of fertility when it has been demonstrated in several countries that union instability could have a positive impact on the level of fertility. The reasons could be several: usually couples tend to bear a child in each union, at the same time union instability leads to several unions of shorter duration. The fact that there is a negative relationship between the frequency of coitus and the duration of the union leads to the fact that women that experience several unions of shorter durations could be less exposed to the risk of conception in terms of time but could have an overall risk due to the greater frequency of coitus. Furthermore, as it happens in Brazil, women in unstable unions tend to conceive to keep their relationship. Finally women that

experience a history of unstable unions could have a less effective use of contraceptive methods. It could be, though, that those women are more prone to use less reliable methods rather than to use methods less effectively.

Brazil is thus an excellent setting for an analysis of union dynamics. Greene (1991, 1994) has conducted a very interesting study on the type of unions in Brazil and how they reflect the bargaining power of the woman inside the relationship. Women of lower income classes rely on the man economically. It is not uncommon to remain pregnant to keep the relationship, as it is not uncommon for the man to try to avoid commitments leaving the woman alone when she remains pregnant. All these factors should be included in the analysis of fertility matters in Brazil. However until now Greene (1991, 1994) has presented the only work that has tackled the analysis of fertility and union dynamics in Brazil despite the importance of the topic.

Union formation and union dissolution could affect and be affected by fertility at the same time and the study of these interactions could lead to even further studies that analyse the influence of union dynamics on contraceptive use. The lack of in depth studies on union dynamics, in particular in the last ten years, is mainly due to the lack of data reporting complete union and fertility histories. Furthermore it is the author's belief that the importance of union dynamics has been underestimated in efforts to get a better understanding of many changes in the reproductive matters.

There are important factors that need further investigation: women do not talk about family planning with their partners. Women like sterilisation also because they can be in full control of their reproductive life and stop whenever they want without relying on their partner. The analysis of the prevalence of sterilisation has so far focused on the relationship between doctors and patients and on the availability of other means of contraception. There has been no attempt so far to analyse the relationship between union dynamics and contraceptive use in particular sterilisation in Brazil. At international level as well there are very few attempts to analyse the relationship (Bumpass and Rindfuss 1982; Godecker et al. 2001).

8.2 Reaching the targets

This thesis had two main objectives. The first one was to analyse the relationship between union dynamics and fertility in Brazil with particular focus on the influence of union instability on fertility. The second target was to use the Demographic and Health Surveys calendar information to tackle the issue of analysing union dynamics and fertility.

The first objective was raised by the need to highlight one of the aspects of Brazilian demography that has been neglected in the last decade. It was felt that despite several studies that have analysed in depth the decline of the Brazilian fertility in the last fifty years, the effect of union instability has been underestimated.

The second aim comes from the lack of data on the topic and from the fact that the DHS calendar has not been fully exploited yet. To the best of the author's knowledge no other study has analysed the union histories section of the calendar to produce a detailed analysis of union dynamics.

8.3 Results of micro-level analysis

A micro-level and a macro-level approach have been used to analyse the relationship between union dynamics and fertility in Brazil.

The micro level analysis consisted in multiprocess event history analysis of union and birth histories. Parallel models of union formation, union dissolution and conception have been fitted. A first analysis included the single equations considering fixed effects only. Then a second step accounted for unobserved heterogeneity and finally the third step accounted for endogeneity as well using Lillard's (1993) estimation procedure. This last step consisted in two joint models that accounted for the endogeneity of the outcomes considering the correlation of the heterogeneities across the equations. The first joint model considered the correlation of the heterogeneities of the union formation and the conception models. The second joint model considered the correlation between the heterogeneities of the union dissolution and the conception model.

The first important result obtained from the analysis is that there is a positive correlation between the hazard of union formation and the hazard of conceiving; furthermore there is a positive correlation between the hazard of union dissolution and the hazard of conception. The first result is more straightforward as union formation and conception are strongly related. Conceiving inside the union is socially more acceptable and at the same time it is more natural for a couple that is newly formed to consolidate the union with the birth of a child.

Going deeper into the results of the individual models there are two interesting results that need further investigation. Women that are pregnant are less likely to enter in a union as well as women that had an out of wedlock birth. It would be expected for women that remain pregnant to be more likely to enter in a union to secure a family for the newborn.

The conception model that has been fitted for the sample of women that are not in a union shows on the other hand that women that are out of unions because they have just left one are less likely to conceive a child. Women that have had a first birth out of wedlock have a higher risk of conception possibly because of a lower control over fertility. Education and exposure to the mass media have a negative effect on the risk of conceiving. Furthermore women with a higher level of fertility are more likely (if not in a union) to conceive again.

The interesting result is the positive correlation between union dissolution and conception. In Chapter 3 possible reasons for such a relationship are discussed. It may be, for example, that women that are psychologically more prone to change partner have a higher risk to conceive due to their will to have a child in each relationship. It is possible also to think of another type of woman: the one that experiences unstable unions due to her low economic status and her dependence from the man. This type of women often enters in relationships with men that cannot face a strong commitment such as marriage. In those cases it is very likely that the woman would try to conceive a child to stabilise the relationship. However the result that shows a higher risk of union dissolution when the woman is pregnant could be a worrying factor for the Brazilian society and needs further investigation.

Women that are more likely to conceive are usually more educated and have a higher exposure to the media have a higher risk of union dissolution. However the

proxies that have been used to test the level of wealth show a lower risk of union dissolution for women of a higher social status.
The conception model for women that are in a union confirms that women that have experienced more than one union have a higher risk of conception. However if the woman is leaving the first union the risk is lower than when the woman is leaving the second union showing that there might be an attempt to keep the partner with a pregnancy more when in second unions then in first unions.

Following up the analysis of union dynamics and fertility a question was raised: is there any relationship between the timing of sterilisation and union dynamics? This question was raised by the lack of studies on the relationship between contraceptive use and union dynamics, in particular there is no evidence about different contraceptive use patterns among women with a history of unstable unions compared to those that experience one union only in their life. Women that experience a history of unstable unions could use less effective contraceptive methods or could use family planning less effectively. This factor could be one of the reasons for a higher level of fertility for women in unstable unions. In particular, since sterilisation is the main contraceptive method in Brazil, it is interesting to analyse the risk and the timing of being sterilised according to union status.

Using discrete time techniques the timing of sterilisation has been modelled to understand whether there is a different behaviour according to whether the women has experienced one or more than one union and the relative union duration. The results show that women in second or higher order unions delay the timing of sterilisation in particular at higher parities. This result shows that women that experience a history of unstable unions are less likely to use non-reversible methods. The tendency of women that experience more than one union to have a child in each union could lead to a delay in sterilisation. This delay, in particular for low-income women, could be determined as well by the fear that men would not stay in a relationship if they know that the woman is sterile. At the same time, a child could be a powerful instrument to strengthen the relationship.

The full understanding of the relationship between union dynamics and fertility in Brazil is far from being fulfilled. This analysis relies on limited quantitative data only and does not go in depth with a qualitative analysis. An in depth survey would highlight the insights of the decision-making and explain in more detail the mechanism that link childbearing and union dynamics. However this research has achieved an important result: at both micro and macro level it now seems clear that women that

have experienced a history of unstable unions higher fertility than other women, and thus has a positive impact on Brazilian fertility overall.
On the methodological side continuous modelling resulted to be the best option for joint modelling. The continuous setting allowed an easier computation of the joint modelling. Furthermore it allowed an easier interpretation of the effects that each outcome had on the other models. The use of these models and in particular of the software aML, should be further developed in the future.

8.4 Macro-level analysis

The individual level analysis has highlighted two main results: union instability has a positive effect on the level of fertility and a negative effect on the risk of being sterilised. Thus raises the question of to what extent the increase in union instability could have slowed down the decline of the level of fertility. For this reason a macro-level analysis has been carried out to decompose the effects of three main components in the level of Brazilian fertility that have shown interesting trends in the last two decades: adolescent fertility, union instability and sterilisation.

Adolescent fertility has been added to the analysis as it represents the only age gap of the population where fertility has been increasing in the last 15 year. At the same time increasing adolescent fertility could be one of the causes of increasing union instability as women that have early childbearing are usually more at risk of union formation and dissolution. The decline of the mean age at first birth could have influenced the decline of the mean age at sterilisation by shifting the distribution of ages at childbearing towards younger ages.

Mainly due to low-income women's lack of access to other effective contraception methods, the fertility decline in Brazil is primarily due to female sterilisation. The fertility indicators by different groups of women have been broken down, in order to assess the effects of sterilisation as well as adolescent childbearing and unstable unions on total fertility. The analysis indicated that the impact of increased female sterilisation on fertility was more than sufficient to offset the positive effects of the increase of adolescent conceptions and union instability between 1986 and 1996. The recent stage of fertility decline in Brazil, chiefly driven by female sterilisation, would have

been steeper in the absence of the increase in teenage pregnancy and union instability.

Increased adolescent childbearing and widespread reliance on female sterilisation underscore the difficulties in the access to and the lack of contraceptive methods, concealing demand for reversible methods. Reducing unplanned teenage pregnancies may represent further contraction of fertility in a scenario in which alternatives to sterilisation are poorly offered. This, in turn, raises a broader political question of what continued replacement or below-replacement fertility represents to a developing country like Brazil.

8.5 Improvements to the Demographic and Health Surveys calendar

The Brazilian case in particular shows how important it is to stress the nature of a couple's relationship to understand most of the reproductive issues. It has been stressed several times that communication between the partners and the woman's bargaining power inside the household are key issues to consider when analysing the effect of union dynamics on childbearing. It is relevant as well to consider these issues when considering the impact of union dynamics on contraceptive dynamics.

The lack of studies that have analysed the relationships between union dynamics and fertility is mainly due to the lack of suitable data. The calendar section on union histories of the DHS could be a good source of information if improved. Too often union dynamics are underrated for the impact that they can have on fertility in general and contraceptive dynamics in particular.

The calendar data could be a valuable source of information for those countries like Brazil where there is no other information on union dynamics. The DHS that was planned for 2001 did not include the calendar section. Most researchers claim that it is too difficult to handle and its limitations do not justify complex analysis. However the survey has not been carried out yet as the Brazilian Ministry of Health, that is funding most of it, has delayed the data collection until further notice. As 2002 is an election year as well it is not possible to foresee when the data collection will take place. This would add further problems to the lack of data on demographic and health matters.

The attention of Brazilian demographers in the last two decades has been concentrated on Caesarean deliveries and on the prevalence of sterilisation. Little attention has been given contraceptive dynamics and to the lack of alternative contraceptive methods. The calendar data could definitely give a further input into the research on reproductive health in Brazil. However, to the best of the author's knowledge there is no in depth analysis of the 1996 DHS contraceptive calendar.

The main limitations of this analysis derive from the lack of full information in the DHS calendar. It is felt that in the future more information should be added to the calendar and to the cross-sectional section as well. The calendar information could be simply improved by reporting in the union section the order of the union, in this way instead of the symbol 'X' there would be the union order number. This would not add further stress to the interviewed but would add important information to the dataset. Furthermore, in the case of the variable that reports the number of unions it would be important to report the actual number of unions instead of reporting the category 'more than one union'. Finally, even probably impossible as it would add to much complexity to the interview, for each union a start and an end date with the number of births in each union should be ideally included. This information would allow reconstructing complete union histories along with reproductive histories.

8.6 Future research

It has been highlighted several times that the main limitation of this analysis is the lack of complete information on union history. It was felt at the end of this study that the amount of work carried out in recoding and structuring the data is probably not justified in the light of the gaps of knowledge that are still left after obtaining the results. However this analysis has highlighted important results that confirm the value of studying union dynamics and fertility in Brazil and in general in Latin American countries. Furthermore some of these results could be the starting point for further research. For example, in the micro-level analysis an attempt should be made to include conceptions leading to termination within the conception outcome.
Some of the points highlighted in the analysis should be further investigated through qualitative analyses. In-depth interviews would allow us to understand the

mechanisms that are behind childbearing and union formation and dissolution and explain in more depth some of the issues raised by the individual models.

The other issue that was raised in this study is the lack of research on the relationship between union dynamics and contraceptive use. The study highlighted the relationship between sterilisation and union dynamics. However, further study on contraceptive choice and discontinuation could be carried out. It should aim to analyse whether women that experience more than one union make particular contraceptive choices and whether they are likely to use contraception more ineffectively or to use less effective contraceptive methods. The DHS calendar could provide a very important source of information on this.

References

Allison, P. D. (1982). "Discrete-time methods for the analysis of event histories." Sociological methodology, S. Leinhardt, ed., Jossey-Bass, San Francisco, 61-98.

Allison, P. D. (1984). *Event History Analysis, regression for longitudinal event data*, Sage Publications.

Bailey, W., Wynter, H., Jackson, J., Lee, A., and Hamilton, P.(2001) "Male attitude to unplanned pregnancies in Jamaica." *PAA annual meeting*, Washington DC, USA.

Basu, A. M., and Amin, S. (2000). "Some preconditions for fertility decline in Bengal: history, language identity, and openness to innovations." Population Council.

Becker, G. (1960). "An economic analysis of fertility." Demographic and economic change in developed countries, Universities-National Bureau Commitee for Economic Research, ed., Princeton University Press.

Becker, G. (1973). "A theory of marriage: Part I." *Journal of Political Economy*, 81(4), 813-846.

Becker, G., Landes, E., and Michael, R. T. (1977). "An economic analysis of marital instability." *Journal of Political Economy*, 85, 1141-1187.

Becker, S., Costenbader, E., Stoebenau, K., and Suzuki, E.(2000) "Husbands' and wives' reports of contraceptive use." *Annual meeting Population association of America*, Los angeles.

BEMFAM. (1997). "Pesquisa nacional sobre demografia e saude 1996." BEMFAM and Macro International.

Berquó, E. (1998). "Como, Quando e Com Quem se Casam os Jovens Brasileiros." Jovens Acontecendo nas Trilhas das Políticas Públicas, Comissão Nacional de População e Desenvolvimento, Brasilia.

Blossfeld, H.-P., Hamerle, A., and Mayer, K. U. (1989). *Event History Analysis*, Lawrence Erlbaum Associates, Publishers, Hove and London.

Bongaarts, J. (1978). "A framework to analyse the proximate determinants of fertility." *Population and Development review*, 4(1), 105-132.

Brien, M. J., Lillard, L. A., and Waite, L. J. (1999). "Interrelated Family-building behaviours: cohabitation, marriage, and nonmarital conception." *Demography*, 36(4), 535-551.

Bumpass, L., and Rindfuss, R. R. (1982). "The effect of marital dissolution on contraceptive protection." Center for demography and ecology, University of Wisconsin-Madison.

Caetano, A. (2000). "Sterilization for votes in the Brazilian Northeast: the case of Pernambuco," PhD, University of Texas at Austin, Austin, USA.

Camarano, A. A. (1998). "Fecundidade e Anticoncepção da População Jovem." Jovens Acontecendo nas Trilhas das Políticas Públicas, Comissão Nacional de População e Desenvolvimento., Brasilia.

Carvalho, D. M. (1997). "Grandes Sistemas Nacionais de Informação em Saúde: Revisão e Discussão da Situação Atual." Informe Epidemiológico do SUS.

Carvalho, J. A. M. d., and Wong, L. R. (1996). "The fertility transition in Brazil: causes and consequences." The fertility transition in Latin America, J. M. Guzman, S. Sigh, G. Rodriguez, and E. A. Pantediles, eds.

CDC, and NCHS. (1998). "Surgical Sterilisation in the United States: Prevalence and Characteristics, 1965-95." *DHHS publication no. (PHS)98-1996*, Center for Disease Control and Prevention, National Center for Health Statistics, Hyattsville, Md.

Chen, K.-H., Wishik, S. M., and Scrimshaw, S. (1974). "Effects of unstable sexual unions on fertility in Guayaquil, Ecuador." *Social Biology*, 21, 353-359.

Curtis, S. L.(1997) "Using Calendar data to study contraceptive use dynamics." *IUSSP/EVALUATION Project seminar on methods for evaluating family planning program impact*, Costa Rica.

DHS. (1990). "Model 'A' questionnaire." Macro International, Maryland.

Diamond, I., McDonald, J., and Shah, I. H. (1986). "Proportional hazard models for current status data: application to the study of differentials in age at weaning in Pakistan." *Demography*, 23(4), 607-620.

Ebanks, E. G., Nobbe, P. M. G., and Nobbe, C. E. (1974). "Fertility and number of partnerships in Barbados." *Population studies*, 28(3), 449-465.

Everitt, B. S. (1984). *An introduction to latent variable models.*

Faria, V. E., and Potter, J. E.(1990) "Development, Government policy, and fertility regulation in Brazil." *Annual mMeeting of the Population Association of America, 1990*, Toronto, Ontario.

Flinn, C. J., and Heckman, J. J. (1982). "New methods for analyzing individual event histories." Sociological methodology, S. Leinhardt, ed., Jossy-Bass, San Francisco.

Frejka, T., and Atkin, L. C.(1990) "The role of induced abortion in the fertility transition of latin America." *IUSSP/CELADE/CENEP seminar on fertility transition in Latin America*, Buenos Aires, Argentina.

Glaser, K. (1999). "Consensual unions in two Costa Rican communities: an analysis using focus group methodology." *Journal of comparative family studies*, 30(1).

Godecker, A. L., Thomson, E., and Bumpass, L. L. (2001). "Union status, marital history and female contraceptive sterilization in the United States." *Family Planning Perspectives*, 33(1), 35-41.

Goldani, A. M.(2001) "Rethinking Brazilian fertility decline." *IUSSP XXIV General population conference*, Salvador Bahia, Brazil.

Goldman, N., Moreno, L., and Westoff, C. F. (1989). "Collection of survey data on contraception: an evaluation of an experiment in Peru." *Studies in Family Planning*, 20(3), 147-157.

Greene, M. (1991). "The importance of being married: Marriage choice and its consequences in Brazil.," Doctoral Thesis, University of Pennsylvania.

Greene, M. E.(1994) "Formal and informal marriage in Brazil: changes and consequences for family structure." *VIII Encontro ABEP 1994*, 165-206.

Greene, M. E., and Rao, V. (1995). "The marriage squeeze and the rise of informal marriage in Brazil." *Social Biology*, 42(1-2), 65-82.

Griffiths, W., and al, e. (1993). *Learning and practicing econometrics*, Wiley ed.

Grummer-Strawn, L. M. (1993). "Regression Analysis of current status data: an application to breast feeding." *Journal of the american Statistical association*, 88(423).

Gupta, N., and Leite, I. d. C. (1999). "Adolescent fertility behaviour: trends and determinants in northeastern Brazil." *Family Planning Perspectives*, 25(3), 125-130.

Heaton, T. B. (1990). "Marital stability throughout the child rearing years." *Demography*, 27(1), 55-63.

Heckman, J., Hotz, J., and Walker, J. R. (1985). "New evidence on the timing and spacing of births." *The American Economic Review*, 75(2), 179-184.

Heckman, J., and Singer, B. (1982). "Population heterogeneity in demographic models." Multidimensional mathematical demography, K. Land and A. Rogers, eds., Academic press.

Heckman, J., and Singer, B. (1984). "A method for minimizing the impact of distributional assumptions in econometric models for duration data." *Econometrica*, 52(2), 271-320.

Henriques, M. H. F. T.(1989) "Brazil: changes in nuptiality and their fertility implicatiopns." *International Population conference*, New Delhi, 163-174.

Hobcraft, J. N., Goldman, N., and Chidambaram, V. C. (1982). "Advances in the P/F ratio method for the analysis of birth histories." *Population Studies*, 36(2), 291-316.

Hopkins, K., and Potter, J.(1997) "Are Brazilian women really begging for caesarean?" *XI Encontro Nacional de Estudos Populacionais*.

Jameson, C. (2000). "The age difference between spouses: demographic and socio-economic aspects," Mphil upgrade to PhD, University of Southampton.

Kalbfleisch, J. D., and Prentice, R. L. (1980). *The statistical analysis of failure time data*, John Wiley and sons.

Kalton, G., and Kasprzyk, D. (1986). "The treatment of missing survey data." *Survey methodology*, 12(1), 1-16.

Koo, H. P., Suchindran, C. M., and Griffith, J. D. (1984). "The effects of children on divorce and re-marriage: a multivariate analysis of life table probabilities." *Population Studies*, 38, 451-471.

Lam, D., Sedlacek, G., and Duryea, S.(1994) "Increases in women's education and fertility decline in Brazil." *ABEP Meeting*, 89-118.

Lazo, A. C. G. V. (1992). "Marriage duration in Brazil: a proportional hazard analysis of separation and divorce for the state of Sao Paulo." Office of population research.

Lazo, A. V. (1994). "Marital fertility in Brazil: differential by type of union and its importance in the fertility transition, 1976-1991." Macro International, Calverton, Maryland, USA.

Leite, I. d. c. (1998). "Contraceptive dynamics in Northeast Brazil," University of Southampton, Southampton.

Lewis, S., and Raftery, A. (1995). "Comparing explanations of fertility decline using event history models with unobserved heterogeneity." University of Washington, Seattle US.

Lillard, L., and Panis, S. (2000). *AML User's guide and reference manual*, EconWare, Los Angeles.

Lillard, L., Panis, S., and Upchurch, D. (1994). "Interdependencies over the life course: women's fertility, marital, and educational experiences." RAND, Santa Monica, USA.

Lillard, L. A. (1993). "Simultaneous equations for hazards-Marriage duration and fertility timing." *Journal of Econometrics*, 56, 189-217.

Lillard, L. A., and Brien, M. J. (1994). "Simultaneity in the timing of marriage, cohabitation and non-marital fertility." RAND, Santa Monica, California.

Lillard, L. A., and Panis, S.(1998) "Multiprocess multilevel modelling." *Annual meeting Population Association of America*, Chicago, USA.

Lillard, L. A., and Waite, L. J. (1993). "A joint model of marital childbearing and marital disruption." *Demography*, 30(4), 653-680.

Maddala, G. S. (1988). *Introduction to econometrics*, McMillan Publishing Company, New York.

Magnani, R. J., Ruttemberg, N., and McCann, H. G. (1996). "Detecting induced abortions from reports of pregnancy terminations in DHS calendar data." *Studies in Family Planning*, 27(1), 36-43.

Martine, G. (1996). "Brazil's fertility decline, 1965-95: a fresh look at key factors." *Population and Development Review*, 22(1), 47-73.

Martine, G., and Carvalho, J. A. M.(1992) "Impacts of spatial patterns of development and population redistribution of the demographic transition." *Expert group meeting on po[pulation growth and demographic structure*, Paris, France.

McNeil, D. R., Trussel, T. J., and Turner, J. C. (1977). "Spline interpolation of demographic data." *Demography*, 14(2), 245-252.

Meekers, D. (1991). "The effect of imputation procedures on first birth intervals: evidence from the World Feritility Survey." *Demography*, 28(2), 249-260.

Merrick, T. W. (1983). "Fertility and family planning in Brazil." *Internatinal Family Planning Perspectives*, 9, 110-119.

Ministerio da saude. (1999). *Area de salude do adolescente e do joven*, Secretaris de politicas de saude.

Mundigo, A. I.(1990) "The role of family planning programmes in fertility transition in Latin America." *IUSSP seminar on the fertility transition in Latin America*, Buenos Aires, Argentina.

Onaka, A. T., and Yaukey, D. (1973). "Reproductive time lost due to sexual union dissolution in San Jose', Costa Rica." *Population Studies*, 27(3), 457-465.

Oppenheim Mason, K., and Taj, A. M. (1987). "Differences between women's and men's reproductive goals in developing countries." *Population and Development Review*, 13(4), 611-638.

Perpetuo, I. H. O., and Aguirre, M. A. C. C.(2000) "O papel da sterilizacao feminina nos diferenciais socio-economicos do declino da fecundidade in Brasil." *XI Encontro Nacional Estudos Populacionais da ABEP*, Brasil.

Perpetuo, I. H. O., Bessa, G. H. d., and Fonseca, M. d. C.(1997) "Parto cesareo: uma analise da perspectiva das mulheres de Belo Horizonte." *Encontro Nacional de Estudos Populacionais*.

Population Reference Bureau. (1999). "1999 World Population data sheet." www.prb.org/pubs/wpds99/wpds99_lac.htm.

Potter, J.(1990) "Social and economic consequences of rapid fertility decline in a period of economic crisis." *IUSSP Seminar on fertility transition in Latin America*, Buenos Aires, Argentina.

Potter, J. (1999). "The persistence of outmoded contraceptive regimes." *Population and Development Review*, 25(4), 703-739.

Potter, J., Perpetuo, I. H. O., Berquo', E., Hopkins, K., Leal, O. F., Formiga, M. C. d. C., and Souza, M. R.(2001) "Inequities and policy dilemmas in the course of an

unregulated, spontaneous fertility transition: the case of Brazil." *IUSSP XXIV General Poulation Conference*, Salvador Bahia, Brazil.

Rao, K. V., and Demaris, A. (1995). "Coital frequency among married and cohabiting couples in the United States." *Journal of Biosocial Science*, 2(2), 135-150.

Rao, V., and Greene, M. (1991). "Marital instability, inter-spouse bargaining and their implications for fertility in Brazil. A multi-disciplinary analysis." Population Research Center University of Chicago.

Remez, L. (1997). "More than half of all Brazilian contraceptive users rely on sterilization." *International Family Planning Perspectives*, 23(4).

Ribeiro, P. M. (1993). "Comecar de novo: um estudo comparativo do descasamento e recasamento," Master's, Universidade Federal do Minas Gerais, Belo Horizonte, Brazil.

Rios-Neto, E.(2001) "Television, value constructs, and reproductive behaviour in Brazilian "excluded" communities." *IUSSP XXIV General Population Conference*, Salvador Bahia, Brazil.

Rios-Neto, E., Potter, J., MacAnany, E., and Ribeiro, P. M. d.(2001) "Television and reproductive behaviour in Brazil: a reception study." *IUSSP General conference*, Salvador Bahia, Brazil.

Rodriguez, G., and Cleland, J. (1988). "Modelling marital fertility by age and duration: an empirical appraisal of the Page model." *Population Studies*, 42(2), 241-257.

Rutemberg, N., and Landry, E. (1993). "A comparison of sterilisation use and demand from the Demographic and Health Surveys." *International Family Planning Perspectives*, 19(4-13).

Rutemberg, N., Ochoa, L. H., and Arruda, J. M. (1987). "The proximate determinants of low fertility in Brazil." *International family Perspectives*, 13(3), 75-80.

Sande, I. G. (1982). "Imputation in surveys: coping with reality." *American Statistician*, 36(3), 145-152.

Sigh, S., and Wulf, D. (1991). "Estimating abortion levels in Brazil, Colombia and Peru, using hospital admissions and fertility survey data." *International Family Planning Perspectives*, 17, 8-13.

Singh, S. (1987). "Evaluation of data quality." The world fertility survey, J. Cleland and C. Scott, eds., Oxford University press.

Singh, S., and Darroch, J. E. (2000). "Levels and Trends in Developed Countries." *Family Planning Perspectives*, 32(1), 14-23.

Smith, P. L. (1979). "Splines: as a useful and convenient statistical tool." *The American statistician*, 33(2).

Snijders, T., and Bosker, R. (2000). *Multilevel analysis*, Sage Publications, London.

Sobrinho, D. d. F. (1993). *Estado e populacao: uma historia do planejamento familiar no Brasil*, UNFPA.

Steele, F., and Curtis, S. L.(2001) "Appropriate methods for analyzing the effect of method choice on contraceptive discontinuation." *PAA annual meeting*, Washington.

Strickler, j. A., Magnani, R. J., McCann, H. G., Brown, L. F., and Rice, J. C. (1997). "The reliability of reporting of contraceptive behaviour in DHS calendar data: evidence from Morocco." *Studies in family planning*, 28(1), 44-53.

Trussell, J., and Rodriguez, G. (1992). "Heterogeneity in demographic research." Convergent issues in genetics and demography, J. Adams, A. Hermalin, D. Lam, and P. Smouse, eds., Clarendon Press, New York, Oxford.

Turner, R. (1990). "Half of all women who remarry bear a child with their new spouse." *Family Planning Perspectives*, 22(5), 237-238.

United Nations. (1988). "World Population Trends and Policies: 1987 monitoring report." United Nations, New York.

Upchurch, D. M., Lillard, L. A., and Panis, S. W. (2001). "The impact of nonmarital childbearing on subsequent marital formation and dissolution." Out of Wedlock, L. L. Wu and B. Wolfe, eds., Russell-Sage.

US Bureau of the census. (2001). "http://WWW.Census.gov/cgi-bin/ipc/idbsprd."

Weistein, M., Wood, J. W., Stoto, M. A., and Greenfield, D. D. (1990). "Components of age-specific fecundability." *Population Sudies*, 44(3), 447-467.

Westoff, C. F., Goldman, N., and Moreno, L. (1990). "Dominican Repubblic experimental study." Institute for Resource development/Macro systems.

Yamaguchi, K. (1991). *Event history analysis*, SAGE publications.

Yinger, N. e. a. (1992). "Adolescent Sexual Activity and Childbearing in Latin America and the Caribbean: Risks and Consequences." Population Reference Bureau, Washington DC.

Appendix I
SPLINES' COEFFICENTS

Table AI.1 Conception Model 1 splines' coefficients

Splines*	Coefficients	Standard Error
Age spline		
Age	.017183	0.010
$(Age-12)^3$ - $(Age-25)^3$	-.000040	3.71e-005
$(Age-19)^3$ - $(Age-25)^3$	-.000125	0.000136
Birth interval spline		
Birth Interval	.0573	.004
$(BI-0)^3$ - $(BI-60)^3$	-.000034	3.70e-006
$(BI-12)^3$ - $(BI-60)^3$	.000043	4.85e-006
*Union Status Duration spline*union status*		
Union Status Duration	0.00506	.010
$(USD-0)^3$ - $(USD-60)^3$	.000008	1.69e-005
$(USD-24)^3$ - $(USD-60)^3$	-.000015	5.23e-006
USD* in first union	-.015709	0.011
USD*in second or higher order union	-.028397	0.019
[$(USD-0)^3$ - $(USD-60)^3$]* in first union	-.000006	3.45e-006
[$(USD-0)^3$ - $(USD-60)^3$]* in second or higher order union	.000007	1.69e-005
[$(USD-24)^3$ - $(USD-60)^3$]*in first unions	.000013	5.83e-006
[$(USD-24)^3$ - $(USD-60)^3$]*in second or higher order unions	-.000067	8.54e-005

*Equations 5.8, 5.9

Table AI.2 Conception Model 2 splines' coefficients

Splines*	Coefficients	Standard Error
Age spline		
Age	.012014	.0250
$(Age-12)^3$ -$(Age-25)^3$	-.000159	6.31e-005
$(Age-19)^3$ -$(Age-25)^3$	.000622	0.00023
Birth interval spline		
Birth Interval	-.044580	.008
$(BI-0)^3$-$(BI-60)^3$	.000034	6.41e-006
$(BI-12)^3$-$(BI-60)^3$	-.000043	8.26e-006
*Union Status Duration spline*union status*		
Union Status Duration	.025795	.007
$(USD-0)^3$-$(USD-60)^3$	-.000007	2.45e-006
$(USD-24)^3$-$(USD-60)^3$	.000013	4.19e-006
USD* in first union	-.034741	.012
USD*in second or higher order union	-.003473	.024
[$(USD-0)^3$-$(USD-60)^3$]* in first union	.000007	3.95e-006
[$(USD-0)^3$-$(USD-60)^3$]* in second or higher order union	-.000020	2.17e-005
[$(USD-24)^3$-$(USD-60)^3$]*in first unions	-.000011	6.73e-006
[$(USD-24)^3$-$(USD-60)^3$]*in second or higher order unions	.000083	9.75e-005

*Equations 5.8, 5.9

Appendix II
AML syntax files

Conversion file for rectangular data from ASCII format to AML readable file

```
/*conversion file*/
/*womanid, data structure and number of level three variables are in the first three
columns and are not specified*/
ascii data file=d:\recodes\amld.raw;

output data file="d:\recodes\amld.dat" (replace=yes);

option  irrelevance check=-99;

level 1 var=educated agebi marriage unum tv relig ethn ageste
occup cash sex ill legit agema owntv car roof region resid;

data structure=1; /*union formation structure*/

level 2 var=spellno event lo hi start agechild children unsta
agestar starage calage  contr times;

level 3 var (nb=11)= time status;

data structure=2;  /*conception structure*/

level 2 var=spellno event lo hi start agechild children unsta
agestar starage calage  contr times;

level 3 var (nb=11)= time status;

data structure=3;  /*union dissolution structure*/

level 2 var=spellno event lo hi start agechild children unsta
agestar starage calage  contr times;

level 3 var (nb=11)= time status;
```

Joint model union formation and conception

```
dsn=d:\recodes\amle.dat;
option iterations=200;
option numerical standard errors;
```

```
define spline dumar; nodes = 12 84 168;
define spline bint1; nodes = 18 60 120;
define spline calage; nodes = 228 300 420;

define regressor set union ;
var= 1 educated residence==1   status==99 status>=3
(status>0 and status<3)
 unum==2
 ill==1 tv==1  (relig!=6) (relig==0)
(region==6 | region==5) (region==7 | region==4)   ;

define spline bint2; nodes = 18 60 120;              /*birth interval spline*/
define spline calage2; nodes = 228 300 420;          /*age spline*/
define spline madur1; nodes = 12 84 168;             /*union status duration spline*/

define regressor set conception;
var= 1 resid==2 status>=2 status==1 educated  owntv==1
children>=3 (children>=1 and children<=2) ill==1 tv==1  relig==6 (relig==0)
ethn==2 ethn==3  (region==6 | region==5) (region==7 | region==4)
 ;

define normal distribution; dim=2;  number of integration points=4;
name=u2;
name=u3;

hazard model;
data structure=1;
censor=event;
duration= lo hi;
timemarks=time;
model= durspline(origin=0, ref=dumar) +durspline(origin=bint, ref=bint1)
+durspline(origin=starage, ref=calage) +
regset union+intres (draw=_id, ref=u2);

hazard model;
data structure=2;
keep if (unsta==0);
```

```
censor=event;
duration= lo hi;
timemarks=time;
model= durspline(origin=0, ref=bint2)+durspline(origin=starage, ref=calage2)
+durspline(origin=mar, ref=madur1)+regset conception+
intres (draw=_id, ref=u3);

starting values;
ad0-12          T   .02466804997
ad0-60          T   .02807704381
ad60-12         T   .03733258041
ad3             T   .04648298865
b1              T  -.03215597399
b2              T  -0.0016902688
b3              T  -.02172194874
b4              T  -.01692701243
age288          T   .03706860447
age432          T   .00003906189
age+            T  -0.0166492757
age35           T  -.02949767787
Const1          T  -11.439648123
ed              T  -.03263698333
resid2          T  -.08726832518
status3         T  -1.6567263854
child4          T   2.4740749102
child21         T   2.4851952597
unum2           T   0.180783459
ill2            T  -1.7472635363
tv1             T   0.1286988526
relig           T  -.09439290347
relig           T   .39547233134
region          T  -.09670967349
region          T   .03851761235
bd0-12          T   .09460270801
bd12-36         T   0.0220573195
bd60-36         T   .01251631976
bd120           T   0.0246046319
age1            T   .03895158305
```

age2	T	-.00001268677
age3	T	-.02166735414
age4	T	-.03613020721
m1	T	-.07663818187
m2	T	-.00662479124
m3	T	-.00356723379
m4	T	-.00183095225
constant	T	-13.509770288
resid	T	.15456032419
status	T	-2.8430032838
status	T	-1.8343178144
educated	T	-.11515202692
owntv	T	-.49378394043
child1	T	1.1129653041
child0	T	.82789972045
ill	T	.55221429694
tv	T	.07710252313
relig1	T	.39183352556
relig2	T	0.7839152323
eth1	T	0.1233414104
eth2	T	.21161992472
region2	T	-.00154972537
region3	T	-.04330151847
u3	T	.97599508825
u1	T	1.1734031015
rho	T	.70279590806;

Joint model union disruption and conception

```
dsn=d:\recodes\amle.dat;
option iterations=200;
option numerical standard errors;
define spline dumar; nodes = 12 84 174;
define spline bint1; nodes = 18 60 120;
define spline calage; nodes = 228 300 420;


define regressor set union ;
var= 1 educated resid==1  unsta==2 (status>0 and status<99) status==99
```

```
 sex<=18 owntv==1 car==1 /*(children>0 and children<3) children>=3*/
  ill==1  tv  ;

define spline bint; nodes = 18 60 120;
define spline madur1; nodes = 12 84 168;
define spline calage2; nodes = 228 300 420;


define regressor set conception;
var= 1 resid==2 status>=2 status==1  unsta==2 educated  owntv==1
children>=3 (children>=1 and children<=2) ill==1 tv==1  relig==6 (relig==0)
ethn==2 ethn==3  (region==6|region==5)  (region==7|region==4)
;
define normal distribution; dim=2;  number of integration points=4;
name=u1;
name=u3;


hazard model;
data structure=3;
censor=event;
duration= lo hi;
timemarks=time;
model= durspline(origin=0, ref=dumar) +durspline(origin=bint, ref=bint1)+
durspline(origin=starage, ref=calage)+
regset union+intres (draw=_id, ref=u1);

hazard model;
data structure=2;
keep if unsta>0;
censor=event;
duration= lo hi;
timemarks=time;
model= durspline(origin=0, ref=bint)+durspline(origin=mar, ref=madur1)+
durspline(origin=starage, ref=calage2)
+regset conception+intres (draw=_id, ref=u3)
;

starting values;
ad0-12          T   .01382179199
ad0-60          T  -0.0016123808
ad60-12         T  -.00278754745
ad120           T   .00080046977
b1              T   .00237079127
b2              T   .00223280129
b3              T  -.01256669037
b4              T   .00495275292
age288          T  -.00564465995
age432          T  -.00455697034
age+            T   .00273689114
age35           T   .00926927151
Const1          T  -8.5093592333
ed              T   .10207091878
resid2          T   .84501699264
unsta2          T   2.7121508375
status          T   .96179777947
```

```
status2          T   1.0689739058
sex              T   .34918595594
owntv2           T  -.33170537843
car2             T  -1.4564635403
ill2             T   .16006783253
tv2              T   0.2248269948
bd0-12           T   .03118996687
bd12-36          T   0.0082224547
bd60-36          T   .01570425827
bd120            T   .00238539164
m1               T   .02647245308
m2               T  -.00254481521
m3               T  -.00013278538
m4               T   .00099114281
age1             T   .01894200269
age2             T  -.00108280361
age3             T  -.00592411755
age4             T  -.01839102892
constant         T  -9.8376800087
resid            T   .01454705233
status           T   .94251782499
status           T  -1.4207262753
unsta            T   .58591958473
educated         T  -0.0300890624
owntv            T  -.71768182349
child1           T  -.00384926609
child0           T   .15767389163
ill              T   .10343854919
tv               T  -.23291853007
relig1           T   .12523151074
relig2           T   .51559716871
eth1             T   .24825752914
eth2             T   .09522251432
region2          T   .65182964717
region3          T   0.4768359422
u1               T   1.4404196966
u3               T   1.0650292653
rho1             T   .65918171542
;
```

Appendix III

Sample bias correction

Table AIII.1 Comparison model with and without censoring

Heterogeneity terms				
	Union formation	*Union dissolution*	*Conception-formation*	*Conception-dissolution*
Single	0.794	1.1-122	1.014	0.755
Standard Error	(0.107)	(2.74E+15)	(0.1632)	(.0915)
Joint	0.833	1.417	2.105	1.136
Standard Error	(0.0909)	(0.142)	(0.216)	(0.059)
Correlation terms joint models				
Union Formation-Conception			0.759	
Standard Error			(0.066)	
Union Dissolution-Conception			0.597	
Standard Error			(0.073)	

Table AIII.2 Union Formation-Conception

	No Heterogeneity	No endogeneity	Joint
Union status duration			
0-12 months	0.1432 ***	0.1473 ***	0.1360 ***
	(0.0304)	(0.0316)	(0.0316)
1-7 years	0.0474 ***	0.0626 ***	0.0586 ***
	(0.0037)	(0.0045)	(0.0044)
8-14 years	0.0365 ***	0.0452 ***	0.0452 ***
	(0.0035)	(0.0040)	(0.0045)
15 years +	-0.0030	0.0058	-0.0005
	(0.0066)	(0.0067)	(0.0078)

Birth interval spline			
0-18 months	-0.1020 ***	-0.0914 **	-0.0922 **
	(0.0349)	(0.0366)	(0.0365)
18-60 months	-0.0193 ***	-0.0239 ***	-0.0214 ***
	(0.0064)	(0.0070)	(0.0070)
5-10 years	-0.0408 ***	-0.0478 ***	-0.0423 ***
	(0.0023)	(0.0029)	(0.0028)
10+ years	-0.0171 ***	-0.0245 ***	-0.0236 ***
	(0.0006)	(0.0009)	(0.0009)
Age spline			
12-19 years	0.0235 ***	0.0279 ***	0.0301 ***
	(0.0032)	(0.0036)	(0.0036)
20-25 years	-0.0090 **	0.0002	0.0006
	(0.0037)	(0.0043)	(0.0047)
26-35 years	0.0186 ***	0.0234 ***	0.0293 ***
	(0.0056)	(0.0056)	(0.0069)
35 years +	0.0381 ***	0.0396 ***	0.0435 ***
	(0.0083)	(0.0084)	(0.0094)
Education	-0.0158 **	-0.0131	-0.0235 **
	(0.0074)	(0.0101)	(0.0106)
Residence			
Urban	-0.0232	-0.0663	-0.0614
	(0.0671)	(0.0871)	(0.0894)
Number of unions			
Two or more	0.4426 ***	0.4896 ***	0.4974 ***
	(0.0989)	(0.1342)	(0.1369)
First birth out of wedlock			
Yes	-2.0069 ***	-2.0591 ***	-1.9977 ***
	(0.0835)	(0.0949)	(0.0982)

Respondent watches television at least once a week			
Yes	-0.0422	-0.0783	-0.0758
	(0.0790)	(0.1029)	(0.1070)
Religion			
No religion	0.3117 ***	0.3502 **	0.4127 ***
	(0.1189)	(0.1549)	(0.1578)
Other	-0.1029	-0.1335	-0.1496
	(0.0727)	(0.0937)	(0.0965)
Region			
North	-0.0607	-0.1429 *	-0.1339
	(0.0587)	(0.0794)	(0.0819)
Centre	-0.1103	-0.1455	-0.1513
	(0.0729)	(0.0964)	(0.0995)
Constant	-7.5385 ***	-8.7044 ***	-9.1875 ***
	(0.7754)	(0.8764)	(0.8800)
-ln Likelihood	-9748.1993	-9664.5316	-12492.7900

Table AIII.3 Conception with union formation

	No Heterogeneity	No endogeneity	Joint
Birth interval spline			
0-18 months	0.0736 ***	0.0848 ***	0.1131 ***
	(0.0283)	(0.0292)	(0.0330)
18-60 months	0.0130 *	0.0291 ***	0.0454 ***
	(0.0069)	(0.0088)	(0.0105)
5-10 years	-0.0008	0.0101 *	0.0153 **

	(0.0046)	(0.0056)	(0.0066)
10+ years	0.0052	0.0128 *	0.0072
	(0.0048)	(0.0067)	(0.0066)
Age spline			
12-19 years	0.0281 ***	0.0296 ***	0.0540 ***
	(0.0049)	(0.0061)	(0.0089)
20-25 years	-0.0002	0.0044	0.0263 ***
	(0.0039)	(0.0051)	(0.0065)
26-35 years	-0.0031	-0.0020	0.0139
	(0.0064)	(0.0078)	(0.0087)
35 years +	0.0307	0.0241	0.0171
	(0.0401)	(0.0412)	(0.0440)
Union status duration spline			
0-12 months	-0.1654 *	-0.1435	-0.0574
	(0.0965)	(0.0995)	(0.1372)
1-7 years	-0.0040	-0.0055	-0.0079
	(0.0050)	(0.0059)	(0.0080)
8-14 years	-0.0028	-0.0040	-0.0047
	(0.0020)	(0.0025)	(0.0032)
15 years +	-0.0005	-0.0017	-0.0015
	(0.0009)	(0.0014)	(0.0016)
Residence			
Rural	0.2254 *	0.2633	0.2956
	(0.1323)	(0.1930)	(0.2980)
Union status during the conception spell			
Leaving first union	0.8253	1.0611	0.6652
	(0.7255)	(0.9310)	(1.1556)
Leaving second or higher order union	-1.6505 ***	-2.1057 ***	-3.2125 ***
	(0.2629)	(0.3228)	(0.4103)

Education	-0.0451 ***	-0.0762 ***	-0.1790 ***
	(0.0151)	(0.0230)	(0.0375)
Whether the respondent owns a Television set			
Yes	-0.3402 ***	-0.4124 **	-1.0064 ***
	(0.1172)	(0.1709)	(0.2567)
Parity			
1-2 children	0.2440	0.6898 **	1.0763 ***
	(0.2532)	(0.3104)	(0.3752)
3+ children	0.1963	0.5021	1.0336
	(0.5019)	(0.6410)	(0.8502)
First birth out of wedlock			
Yes	0.5165 ***	0.7317 ***	0.4670 **
	(0.1212)	(0.1799)	(0.2205)
Whether the respondent watches television at least once a week			
Yes	-0.0968	-0.0566	0.2515
	(0.1622)	(0.2388)	(0.3394)
Religion			
No religion	0.4881 **	0.7851 ***	1.3660 ***
	(0.2171)	(0.2999)	(0.4792)
Other	0.1984	0.3968 *	0.5205 *
	(0.1505)	(0.2296)	(0.2725)
Ethnicity			
Mixed	0.0436	0.0644	0.1765
	(0.1023)	(0.1616)	(0.2048)
Other	-0.0709	0.1153	0.1768
	(0.2503)	(0.5847)	(0.5450)
Region			
North	-0.0632	-0.2614	-0.3916
	(0.1207)	(0.1861)	(0.2741)
Centre	-0.0923	-0.2529	-0.5424

	(0.1405)	(0.2120)	(0.3298)
Constant	-9.6023 ***	-10.9778 ***	-17.7608 ***
	(1.2750)	(1.5641)	(2.4222)
-ln Likelihood	-2887.9003	-2880.0562	-12492.7900

Table AIII.4 Union dissolution-Conception

	No Heterogeneity	No endogeneity	Joint
Union duration spline			
0-12 months	0.0128	0.0166	0.0130
	(0.0189)	(0.0194)	(0.0177)
1-7 years	0.0055	0.0117 *	-0.0028
	(0.0069)	(0.0070)	(0.0030)
8-14 years	0.0001	0.0001	-0.0032
	(0.0000)	(0.0000)	(0.0026)
15 years +	0.0044	0.0044	0.0006
	(0.0000)	(0.0000)	(0.0021)
Age spline			
12-19 years	-0.0001	0.0192	0.0026
	(0.0022)	(0.0315)	(0.0302)
20-25 years	0.0284 ***	-0.0027	0.0016
	(0.0050)	(0.0062)	(0.0054)
26-35 years	-0.0378 ***	-0.0098 **	-0.0124 ***
	(0.0082)	(0.0042)	(0.0029)
35 years +	-0.0003	0.0034	0.0049 ***
	(0.0086)	(0.0022)	(0.0010)
Birth interval spline			
0-18 months	-0.0079	-0.0078	-0.0059
	(0.0048)	(0.0049)	(0.0048)
18-60 months	-0.0041	-0.0048	-0.0037

	(0.0036)	(0.0034)	(0.0028)
5-10 years	0.0068 *	0.0050	0.0034 **
	(0.0036)	(0.0035)	(0.0017)
10+ years	-0.0137	-0.0143	0.0094 ***
	(0.0186)	(0.0187)	(0.0016)
Education	0.0126	0.0089	0.0993 ***
	(0.0210)	(0.0214)	(0.0148)
Residence			
Urban	0.6231 ***	0.5718 ***	0.8400 ***
	(0.1808)	(0.1929)	(0.1492)
Number of unions			
Two or more	1.9088 ***	1.8690 ***	2.6369 ***
	(0.1442)	(0.1514)	(0.1802)
Fertility status			
Pregnant	-0.0767	-0.1896	1.0009 ***
	(0.1794)	(0.1790)	(0.1417)
With children	0.0471	-0.0850	1.0901 ***
	(0.1686)	(0.1630)	(0.1128)
Age at first sex			
Before 18	0.4570 **	0.5023 **	0.3563 ***
	(0.1993)	(0.1966)	(0.1191)
Respondent owns television set			
Yes	-0.1931	-0.1213	-0.3229 ***
	(0.1471)	(0.1538)	(0.1150)
Respondent owns a car			
Yes	-0.5060 **	-0.4866 **	-1.4560 ***
	(0.2039)	(0.2109)	(0.1513)
First birth out of wedlock			
Yes	-0.1211	-0.0889	0.1406
	(0.1498)	(0.1565)	(0.1156)

Respondent watches television at least once a week			
Yes	0.2382	0.2379	0.2306 *
	(0.2353)	(0.2421)	(0.1365)
Constant	-4.8765 ***	-4.7749 ***	-8.4101 **
	(1.0759)	(1.1885)	(1.1835)
-ln Likelihood	-1763.9522	-1789.6013	-28673.8403

Table AIII.5 Conception with union dissolution

	No Heterogeneity	No endogeneity	Joint
Birth interval duration			
0-18 months	0.0115	0.0249 ***	0.0310 ***
	(0.0087)	(0.0094)	(0.0052)
18-60 months	0.0057	0.0123 ***	0.0096 ***
	(0.0039)	(0.0044)	(0.0020)
5-10 years	-0.0029	-0.0007	0.0161 ***
	(0.0027)	(0.0029)	(0.0015)
10+ years	0.0034 *	0.0053 **	0.0058 ***
	(0.0020)	(0.0022)	(0.0011)
Union duration spline			
0-12 months	0.0295	0.0421	0.0211
	(0.0387)	(0.0412)	(0.0244)
1-7 years	-0.0074 ***	-0.0076 ***	-0.0027 *
	(0.0024)	(0.0027)	(0.0015)
8-14 years	0.0002	0.0004	-0.0003
	(0.0014)	(0.0015)	(0.0009)
15 years +	0.0013 **	0.0014 *	0.0008
	(0.0006)	(0.0008)	(0.0005)
Age spline			
12-19 years	0.0279 ***	0.0285 ***	0.0222 ***
	(0.0027)	(0.0031)	(0.0020)

20-25 years	-0.0018	0.0021	0.0018
	(0.0018)	(0.0021)	(0.0011)
26-35 years	-0.0044 *	-0.0033	-0.0057 ***
	(0.0023)	(0.0025)	(0.0008)
35 years +	-0.0245 ***	-0.0249 ***	-0.0194 ***
	(0.0073)	(0.0076)	(0.0015)
Residence			
Rural	-0.0526	-0.0643	0.0455
	(0.0778)	(0.1003)	(0.0666)
Union status			
In second or higher union	0.4065 ***	0.4625 ***	2.6369 ***
	(0.1337)	(0.1721)	(0.1802)
Education	-0.0592 ***	-0.0866 ***	-0.0361 ***
	(0.0096)	(0.0132)	(0.0080)
Respondent owns television set			
Yes	-0.3789 ***	-0.4976 ***	-0.7582 ***
	(0.0757)	(0.0991)	(0.0675)
Parity			
1-2 children	1.1020 ***	1.2063 ***	1.0502 ***
	(0.1559)	(0.1894)	(0.0913)
3+ children	1.9132 ***	1.7289 ***	0.8960 ***
	(0.2677)	(0.3198)	(0.1221)
First birth out of wedlock			
Yes	-0.6256 ***	-0.5490 ***	-0.0200
	(0.1044)	(0.1241)	(0.0643)
Respondent watches television at least once a week			
Yes	-0.1146	-0.0896	-0.1952 **
	(0.0898)	(0.1184)	(0.0794)
Religion			
None	0.3976 ***	0.4836 ***	0.5975 ***

	(0.1440)	(0.1877)	(0.1309)
Other	-0.0102	0.0252	0.0935
	(0.0887)	(0.1143)	(0.0719)
Ethnicity			
Mixed	0.0623	0.1122	0.2438 ***
	(0.0658)	(0.0846)	(0.0565)
Other	-0.2277	-0.2469	0.0553
	(0.1549)	(0.2006)	(0.1303)
Region			
North	0.2836 ***	0.3128 ***	0.6527 ***
	(0.0813)	(0.1022)	(0.0671)
Centre	0.1721 *	0.2092 *	0.4593 ***
	(0.0938)	(0.1191)	(0.0743)
Constant	-10.7064 ***	-11.4943 ***	-11.5857 ***
	(0.6759)	(0.7806)	(0.5269)
-ln Likelihood	-7109.7755	-7093.9733	-28673.8403