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Interim Report **IR-00-052**

Assessing the Impact of Modernization on Fertilty: The Case of Mozambique

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August 18, 2000

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Abstract

Mozambique is one of the poorest countries in the world. It also has one of the world's highest birth rates. Until recently there has been virtually no way to study Mozambique's high fertility because of the civil war. This paper uses a very recent survey of Mozambican women from 1997. The objective of this paper is to assess the impact of modernization on fertility in Mozambique, using as a background the "supply-demand theory" presented by Easterlin and Crimmins (1985). The first part of this paper describes the indicators of modernization for Mozambique by using maps, and indicates eventual correlations. The second part deals with the estimation of equations for demand for children, the supply of children and the use of contraception. The third part shows how the modernization variables visualized in the first part of the paper influence all these equations. The results show that the country has one of the highest demands for children in the world, but also one of the largest supply of children, followed by high infant and child mortality. In many provinces, the regulation costs are still high. Those who deliberately use contraceptives already have many children. Among the modernization variables, education is the factor that most affects supply, demand and also regulation costs in Mozambique.

Acknowledgments

The author would like to express her thanks to Dr. Annababette Wils and Professor Warren Sanderson, for their advice during the author's three-month stay at IIASA during the Young Scientist's Summer Program (YSSP), which resulted in the final version of this paper. I am grateful to Isolde Prommer and other members of the Population Project for their help during my stay at IIASA.

The author is also grateful to the Swedish Council for Planning and Co-ordination of Research (FRN), which made her participation in the YSSP possible through their financial contribution.

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Assessing the Impact of Modernization on Fertility: The Case of Mozambique

Vania A. Ceccato

1 Introduction

Population issues have become an important subject in Mozambique. During the last few years they have been considered part of the country's development policies. After independence, the government of Mozambique recognized progressively the need to take demographic issues into the planning process at the national level. The recent policy focused not only on measures regarding population growth but also other aspects linked to modernization of the country as a whole, such as equality, quality of life, and women's rights (Gaspar *et al*. 1998:9). As part of these policies, health programs have been implemented directed to, among other things, infant and maternal health, infectious diseases, nutrition, vaccination and elderly care.

In this paper, we explore one aspect of population, namely fertility. The fertility experience of Mozambique is diverse, although in general it is high. The average fertility rate, according to the 1997 Demographic and Health Survey (DHS) (Gaspar *et al*. 1998) was 5.61, but was estimated to be 6.25 by the UN (2000). According to various sources (see Gaspar, unpublished) the total fertility rate has been declining slowly but steadily from a level of 7.1 in 1950. In both the present level of fertility and the trend, Mozambique is similar to many sub-Saharan African countries, such as Malawi, Zambia, and Rwanda, which all have fertility rates around 6 children per woman or higher. Surrounding countries, which have lower fertility rates, 3-5 children per woman, are Botswana, Kenya, Zimbabwe, South Africa, and Namibia.[1]

By province, fertility ranged from 3.96 in Maputo City to 7.58 in Manica, shown in Figure 1 (see also Appendix A). At a smaller geographical scale, the differences are even larger, with some districts in Maputo City having a lower fertility rate than the city overall, and some rural districts having a higher fertility than in Manica province (Gaspar *et al*. 1998). There are also fertility differentials by educational level and religion. As found elsewhere in the world, more highly educated women have a lower fertility (3.69 with secondary education or more; 5.66 primary; 5.81 no schooling). The Muslims have the lowest fertility rate (4.71), while those with "other" religions (mostly Zione, a local religion) have the highest (6.33). In order to inform the national population policy, and to better our understanding of sub-Saharan African fertility behavior, we would like to know what causes such differentials.

[1] According to the UN (2000) in alphabetical order for the period 1995-2000: Botswana 4.35; Kenya 4.45; Malawi 6.75; Mozambique 6.25; Namibia 4.90; Rwanda 6.20; South Africa 3.23; Zambia 5.55; Zimbabwe 3.80.

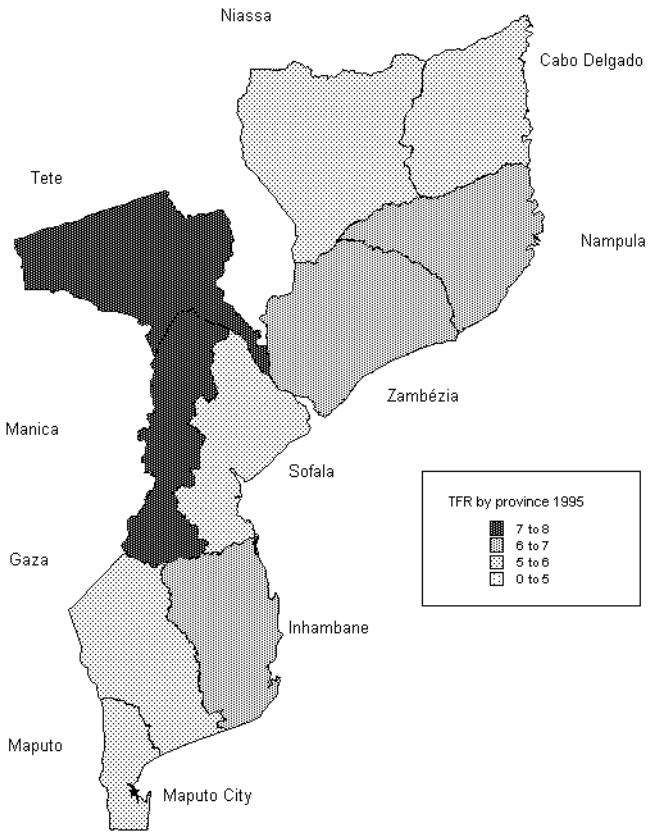

Figure 1. Total fertility rate in Mozambique by province. Source: Gaspar *et al*. (1998).

The actual level of fertility is still lower than the desired family size, which is 6.64. Many women desire much higher family sizes (Figure 2). It is worth noting that information about desired number of children may be biased since it reflects the respondent's statement after, not before, decisions regarding fertility control.

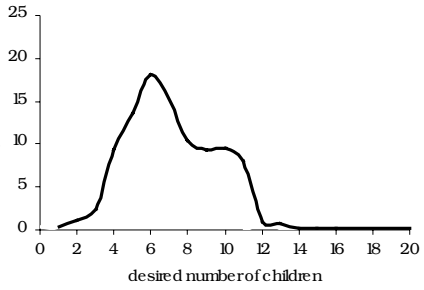

Figure 2. Desired family size according to Gaspar *et al*. (1998).

The DHS and the 1997 population census[2] provide us with the first national surveys of demographic behavior in almost two decades. Although a detailed description of the DHS has been published (Gaspar *et al*. 1998), there has not been a statistical analysis of the survey. This paper presents the results of an analysis using Easterlin and Crimmins' (1985) supply-demand theory. The first half of the paper is devoted to a discussion of the geographical distribution in Mozambique of the factors

[2] http://www.ine.gov.mz/censo2/Recens.htm

which have been linked to fertility behavior in earlier studies of Africa and less developed countries. The second half presents the analysis and the results.

The DHS was performed in Mozambique in 1997 from a sample of 9,000 females between 15 and 49 years old, and implemented by the National Institute of Statistics of Mozambique (INE)[3] and Macro International Inc.[4] The database includes, among other things, data on fertility, contraception, infant mortality, health of the mother and the child, and AIDS.

2 Theoretical Background

In their studies of fertility decline in Africa, Caldwell *et al*. (1992) and Caldwell and Caldwell (1993) pointed to a number of factors that can be linked to fertility behavior in Africa. Higher education, a lower infant mortality rate, and a concerted national family planning effort are all factors that lower fertility. On the other hand, "development" indicators such as urbanization, wealth, formal employment, but also education have an ambiguous impact. In Africa, these development indicators inhibit some of the traditional mechanisms that lower fertility, such as long breastfeeding, high still-birth rates, long periods of abstinence (Mondot-Bernard 1977; Cleland and Hobcraft 1985; May *et al*. 1990), and polygamy (Cleland *et al*. 1984; IFPP 1984), as well as leading to conscious fertility-reducing behavior.

To a large extent, these African studies corroborate global findings, or findings from other continents (Friedlander and Silver 1967; Fergany 1975; Siddiqui 1996; Freedman 1987; Cleland and Hobcraft 1985; Mauldin and Ross 1994; Jain 1985; Mauldin *et al*.1978).

The section below discusses these factors. In order, the sections discuss education, infant mortality, urbanization and standard of living, culture and ethnicity, family planning programs.

2.1 Education

One of the most important factors influencing fertility control behavior has been found to be formal female education. As Yousif *et al*. (1996) point out, education gives every woman the chance, the knowledge, the ability, and the potential to manipulate and control her environment, basically marriage, work, fertility and so on. Education, according to the authors, provides an alternative to the vicious circle experienced by many generations of teenage girls, school dropouts, household chores, early marriage, and early and frequent pregnancy.

Education directly affects the demand for children, but also the supply and the regulatory cost of fertility (Easterlin and Crimmins 1985; Cleland and Hobcraft 1985). From the demand side, education tends to reduce the demand for children by shifting tastes in a manner unfavorable to children. Among other things, education may imply changes in lifestyle and may change the standard for having and rearing a child. It may focus on the quality side of having children in detriment of the quantitative one. It has been found that both male and female education negatively impact the number

[3] http://www.ine.gov.mz
[4] http://www.macroint.com/dhs/data/data.html

of children, but female education more strongly. This is reflected in differences in desired family size for men and women (Table 1).

Table 1. Desired family size by level of education, men and women, age 15-49. Source: Gaspar *et al*. (1998:113).

Level of education	**All women**	**All men**
No schooling	6.6	8.1
Primary only	5.5	7.8
Secondary and higher	3.4	4.6

Formal education increases the supply of children by improvements in health conditions, by diffusing knowledge, for instance, about personal hygiene, food care and vaccination, and by reductions in the length of breastfeeding and post-partum abstinence.

Education makes information in general more accessible, and in turn it tends to lower the costs of fertility regulation. Easterlin and Crimmins (1985:22) argue that "it may provide information not formally available on various means of fertility control, reducing expense in time and money previously required" and may also alter cultural norms which lower the subjective costs of using contraceptives. Already in the 1960s, Friedlander and Silver (1967) pointed out some negative partial correlations between birth rate and a society's level of education. They argued that education could among other things be interpreted as a proxy for differential knowledge, including contraceptive knowledge.

In Mozambique 47% of the female population aged 6-65 and older have no formal education. There is a significant difference between male and female education: only 20% of the men in the same age group have no formal education. The population's low level of education comprises almost the whole country, except Maputo City which concentrates the largest amount of people formally educated, mostly males. About 43% of the female population aged 15-49 never went to school, against 20% of males of the same age group (Gaspar *et al*. 1998:26-27). Figures from DHS show that the highest levels of female illiteracy are found in the north-central parts of the country, mostly in Nampula, Niassa, Cabo Delgado, Tete and Sofala (Figure 3).

A factor, which is related to education, is employment of women, particularly employment in the modern sector. In studies of the World Fertility Survey results, one of the questions was whether formal employment is causally correlated with lower fertility. In several studies in the literature, among them Cleland and Hobcraft (1985), it was found that education is a major factor in determining formal employment, and that formal employment as a factor, by itself, was less significant than appears from the simple raw data on formal employment and fertility.

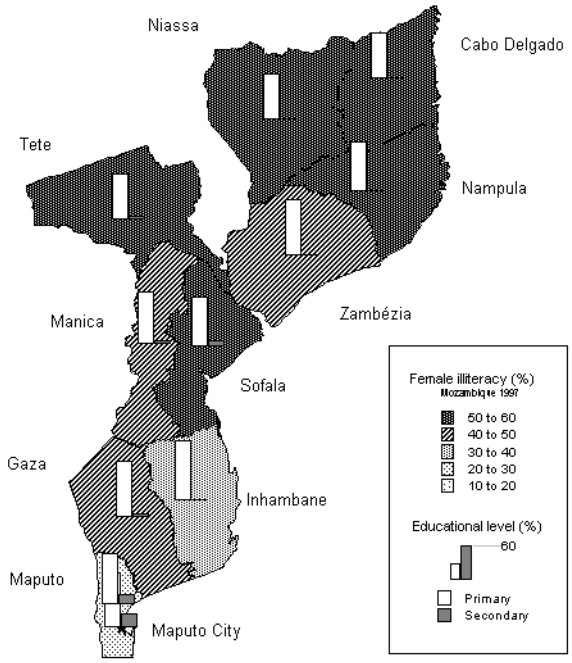

Figure 3. Female illiteracy and percentage with primary and secondary school by province. Source: Gaspar *et al*. (1998:26).

2.2 Infant mortality rate

Table 2 shows the 1997 infant mortality rate in Mozambique by province according to the DHS. The highest IMR is found in Nampula, followed by Sofala, and Tete. These are also the provinces with high fertility rates. On the other hand, provinces with lower than average fertility, Cabo Delgado, Zambézia, Maputo, and Maputo City have lower than average infant mortality rates. A notable exception is Manica, which has high fertility and low infant mortality.

Table 2. Infant mortality rate in Mozambique by province. Source: Gaspar *et al*. (1998).

Province	**Infant Mortality Rate**
Niassa	134
Cabo Delgado	123
Nampula	216
Zambézia	129
Tete	160
Manica	91
Sofala	173
Inhambane	151
Gaza	135
Maputo	92
Maputo City	49

Infant mortality is affected by the public health structure; in particular, there is a strong correlation between hospital births and lower infant mortality in Mozambique, as shown in Figure 4. Nampula, Cabo Delgado and Sofala have the lowest rates of live births in hospitals and the highest infant mortality rate, whereas Maputo City and

Maputo province have the lowest infant mortality rates and some of the highest rates of live births in hospitals in Mozambique. The number of institutionalized births is still lower (44%) than those performed at homes (55%) according to DHS survey. The differences among provinces and cities and rural areas are large. In Zambézia, for instance, only 24% of births were institutionalized against 87% in Maputo City, which is clearly related to differences in accessibility to the health services in the provinces, but also to the regional variations in the mothers' educational level.

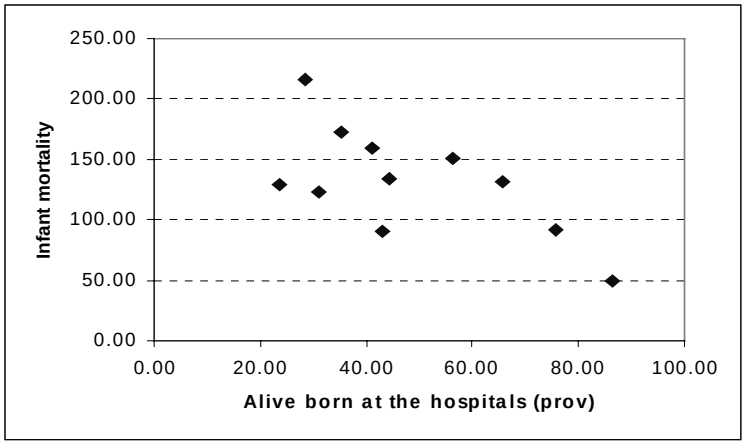

Figure 4. Infant mortality by the percentage of births in hospitals, provincial data. Source: INE (1998b).

Figure 5 shows large regional variations of public health infrastructure in Mozambique. Maputo City and Sofala are the provinces, which make most investments in medicine and public health in general, while the highest coverage rates regarding medical appointments are found in Niassa and Manica. The medical investments do not appear to be correlated to infant mortality levels at the provincial level, which indicates (if the data are correct) that it is not the level of expenditure, but other aspects of health care (accessibility, level of primary care) which affect mortality.

Accessibility can be measured by the number of appointments in a year, or the percentage of people having a medical appointment in a year, or for example the percentage of women who have births in a modern clinic or hospital. It is estimated by DHS 1997 that 71% of women had at least one prenatal appointment during pregnancy. The prenatal coverage rate varies from 60% among illiterate females to 99% among women who have completed secondary school or higher.

Vaccination is also a good indicator of whether health public services are accessible to the entire population or not, and an important indicator for health. Garenne *et al*. (1996) found that between 1974 and 1994, most of the infant mortality decline in Maringue, a district in central Mozambique, was due to vaccination for measles and to vitamin A supplementation. As Table 3 illustrates, still only half of the female population (aged 15-44) has ever been vaccinated in Mozambique. The vaccination coverage is much higher among children aged 12-23 months. The vaccination levels are particularly low in Cabo Delgado, Zambézia, and Nampula.

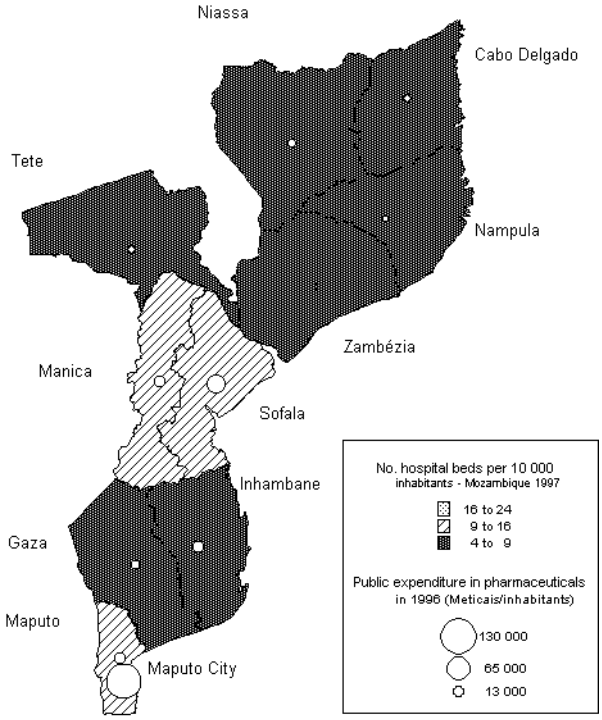

Figure 5. Number of hospital beds per 10,000 and expenditure on pharmaceuticals. Source: INE (1998b).

Table 3. Percentage of women aged 15-44 and percentage of children aged 12-23 months who ever had a vaccination by province. Source: Gaspar *et al*. (1998).

	Women age 15-44	**Children age 12-23 months**
Niassa	40.6	82.1
Cabo Delgado	22.6	70.2
Nampula	25	81.8
Zambézia	39.7	49.4
Tete	60.9	93.5
Manica	47.9	84.3
Sofala	49.5	72.7
Inhambane	56	93.5
Gaza	63.6	96.7
Maputo	96.2	94.7
Maputo City	100	98.8
Total	46.2	80.3

2.3 Urbanisation and living standard

According to the surveys mentioned above, urbanization is correlated with lower fertility. City life reduces the demand for children by reducing tastes and lowers the price of goods relative to children. It also increases the price of having a child, due for example to schooling. On the other hand, in regard to potential supply, urbanization has a positive influence on living conditions. Modern health services are generally more accessible in urban areas, which can reduce the demand for live births by lowering infant and child mortality, and can reduce the costs of fertility regulation.

Mozambique still has a predominantly rural population. More than 70% live in rural areas, mostly in the northern parts of the county. The level of urbanization is highest in the southern provinces of Maputo, Gaza, Inhambane, and in the north in Zambézia. Average household expenditure, a good indicator of the household earnings, is significantly lower in rural areas than in the cities, and is consequently lower in the northern parts of Mozambique than in the south. We also see a north-south gradient in the percentage of households with a flush toilet, electricity, and telephone (Figure 6).

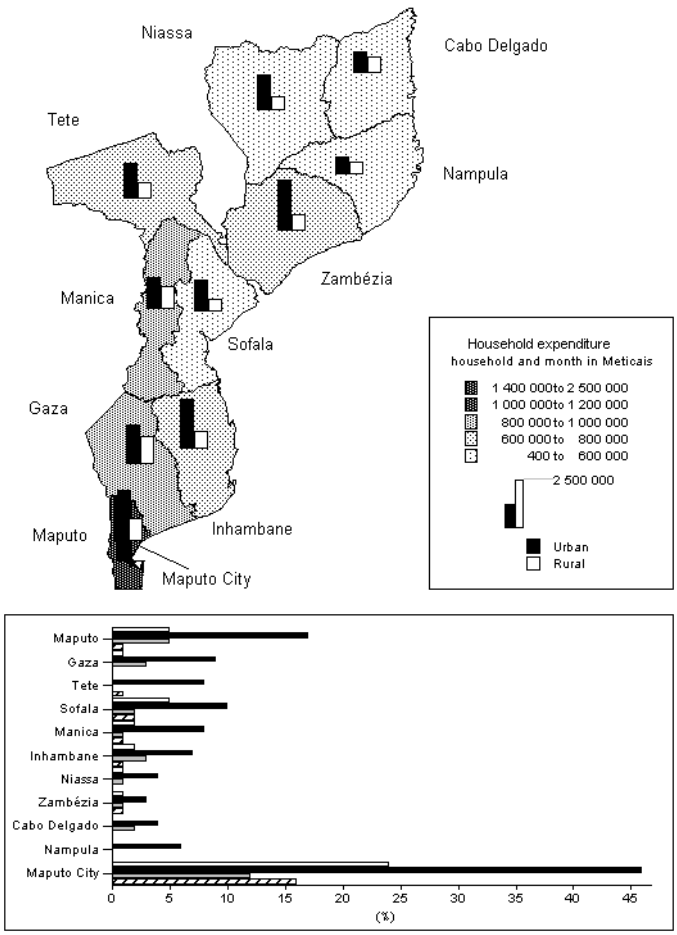

Figure 6. Proportion of population urban and rural, average household expenditure by province, and proportions of population with flush toilet (white bar), electricity (black bar), car (gray bar) and telephone (dashed bar). Source: Gaspar *et al.* (1998).

2.4 Culture and ethnicity

Polygamy is one of the factors of traditional lifestyle that typically inhibits the number of children born per woman (IFPP 1984; Cleland *et al.* 1984). It could be regarded as an indicator of lack of modernization. In Mozambique, for instance, polygamy varies inversely with educational level, for both genders. It is estimated that 27% of the DHS sample in Mozambique lived in polygamy, from which 14% had one co-partner and 13% more than one co-partner. This figure varies with age; the older, the greater the number of co-partners. There are also significant differences between rural (30%) and urban areas (17%) and also between the country's provinces. The provinces of

Manica, Sofala and Gaza had the highest proportion of women in polygamy (Figure 7).

Differences in religion also have an impact on fertility. As a religious group, the Muslims have the lowest fertility (4.71) and those with "other" religions (mostly Zione, a local religion) have the highest (6.33). Religion might be related to abstinence taboos or even create resistance to contraceptive use. Regarding religion in Mozambique, there are regional differences. Muslims are predominate in the northern parts of the country (provinces of Niassa, Cabo Delgado and Nampula) while Christians and those with other religions are mostly represented in the central south (Figure 7).

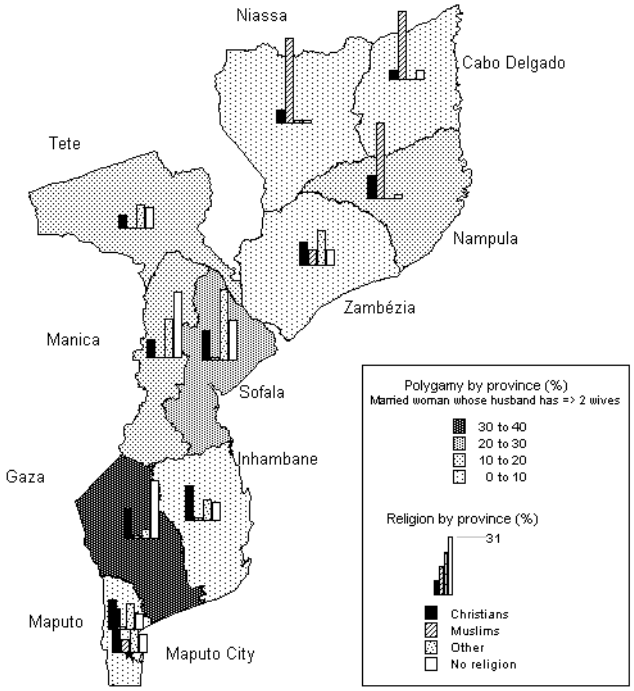

Figure 7. Religion and polygamy as indicators of differences in culture in Mozambique. Source: Gaspar *et al.* (1998).

2.5 Contraception and family planning programs

Family planning programs can affect fertility in two ways. The first way is by making information and services more accessible to the population, for example, by offering services and methods below market prices. The second way is by reducing the "subjective drawbacks associated with adoption of family size limitation techniques" (Easterlin and Crimmins 1985:24-25) by providing social legitimization via publicity and demonstration for practices that might otherwise be viewed as strange to traditional culture.

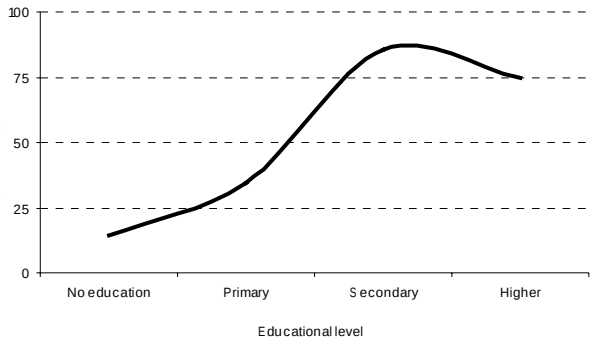

Figure 8. Proportion of women (aged 15-49) who have ever used contraception, by education. Source: DHS database.

The level of contraceptive use in Mozambique is low compared to the rest of the world, and average compared to sub-Saharan Africa: 14% of women aged 15-49 used contraception – 13% of those in unions and 30% of those sexually active and not in unions. The percentage of men using contraception was 25% (Gaspar *et al*. 1998:56). The percentage of women using contraception is significantly higher among the better-educated (Figure 8). It is also higher among women who have had more children (Figure 9). Studies of other countries (e.g., Akhter and Ahmed 1991, on Bangladesh; Hermalin 1983, on Taiwan) show the same positive correlation between contraception and number of children born. The higher the contraceptive level and the lower the number of children at which contraception is high, the lower the fertility. At the levels and parities of Mozambique, contraception has little effect on fertility, as we shall see below in the statistical analysis.

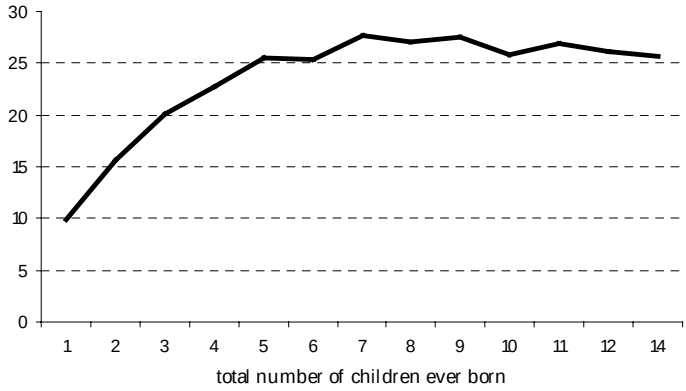

Figure 9. Proportion of women (aged 15-49) who have ever used contraception, by number of children ever born. Source: DHS database.

Among the women aged 15-44 with three or more children, the contraceptive use is, as would be expected, higher in urban areas, but mostly in large cities, often in the capitals of the provinces. Among this group, the users live mostly in Maputo City, Maputo Province, Tete and Niassa.

According to the DHS survey, only 63% of the women declared to know or have ever heard about family planning programs in Mozambique. Modern methods of contraception were much better known than the traditional and folkloric methods such

as the rhythm method and coitus interruptus. Generally men have somewhat more knowledge of contraception than women. The provinces of Nampula, Sofala and Cabo Delgado present the lowest level of knowledge about modern contraceptives when compared with other provinces, and Tete, Maputo Province, Gaza, and Maputo City have the highest levels of contraceptive knowledge. The high AIDS prevalence in Tete could partially explain why the knowledge of contraceptives is greater among the province's population.

The attitude related to family planning programs is essential for understanding the adoption and use of contraceptive methods in a certain group of the population. In Mozambique, for instance, only 29% of those interviewed declared that both partners approve of family planning, 14% do not agree, and 31% do not know the opinion of the partner. Cabo Delgado, Nampula and Gaza are the provinces where the wives declare that their partners do not approve of family planning programs (Figure 10). The level of approval among both partners is higher in areas of high education level, often urban centers.

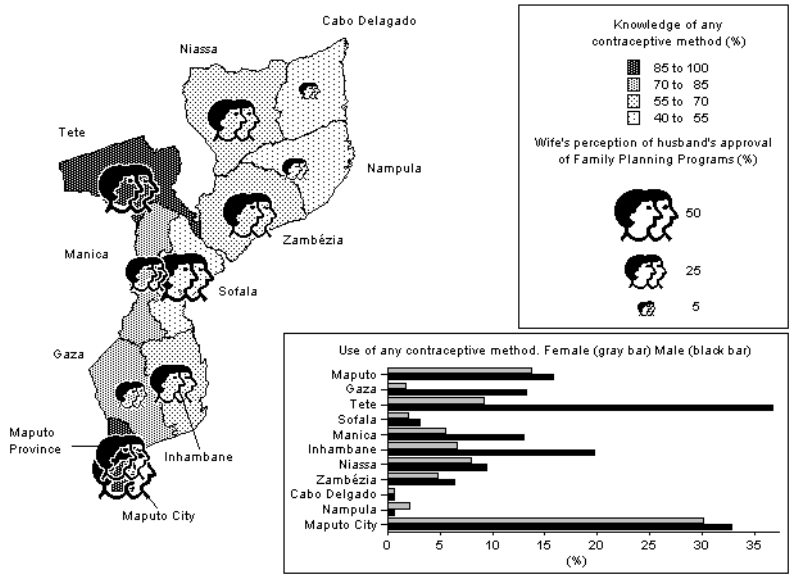

Figure 10. Knowledge about contraceptive and perception of use. Source: Gaspar *et al*. (1998).

3 The Supply-Demand Model and Results

Thus far, we have reviewed empirical facts and literature relating to factors which determine fertility. In this section, we turn to an economic theory of fertility, presented by Easterlin (1975) and Easterlin and Crimmins (1985). It incorporates concepts of supply and demand of children, and costs of fertility regulation for analyzing fertility behavior. In particular, the theory examines how modern development affects fertility.

According to the authors, the *supply of children* is the number of surviving children a woman would have if she made no deliberate attempt to limit family size. "This reflects both a couple's natural fertility and the chances of child survival" (Easterlin and Crimmins 1985:14). In the original Easterlin and Crimmins model, variables which affect supply are based on the proximate determinants of fertility from the

Bongaarts (1978, 1982) model. This model states that fertility is a function of sexual exposure, deliberate fertility control, and fecundability (the possibility to become pregnant).

The *demand for children* is basically "the number of surviving children parents would want if fertility regulation were costless, which depends on household tastes, income and child cost considerations. It is roughly approximated by survey responses on desired family size" (Easterlin and Crimmins 1985:14), and is affected by the factors of modern development and traditional lifestyle such as those discussed in the empirical studies above, such as education, urbanization, family planning, infant mortality, polygamy and other cultural factors.

An important concept in Easterlin and Crimmins' framework is the concept of *costs of fertility regulation.* These costs are determined by subjective disadvantages of regulation such as distaste for family planning, the objective drawbacks of specific techniques like abortion, as well as the economic costs for control, such as the time and money required to have access to family planning services. For a detailed description of factors classified as costs of fertility regulation, see Hermalin (1983).

Easterlin and Crimmins' theoretical framework is basically composed of a three-equation system. The first equation determines the supply of children as a function of the proximate determinants of fertility, including contraception, plus infant and child mortality. The second equation takes contraceptive use as its dependent variable, and expresses it as a function of the demand for children, supply of children and regulation costs. The third equation (or set of equations) looks at how factors of development and tradition affect the proximate determinants (excluding age, which is not a development factor), infant mortality, child demand, and the contraceptive regulation costs.

Thus, the first two equations indicate links between fertility and fertility control, demand, supply and regulation costs; the third equation focuses on the impact of modernization and other factors concerning fertility and fertility control, demand, supply and regulation costs.

As with any theory a number of simplifications are made. For example, the authors themselves recognize that demand for children would include a couple's desired spacing as well as number of children, which would be difficult to implement empirically. Easterlin and Crimmins' theoretical framework has also been a target of criticism among other things by its character statistic. It is known that a couple's desire for children changes over time, thus, it could be expected that the model would be able to incorporate the continuous changes of the couple's decision-making. However, we use the model because it is a robust tool with a strong theoretical basis from economics that has been applied empirically in many other less developed countries such as Colombia, India, Sri Lanka and Taiwan with interesting results.

In the next section, the Easterlin and Crimmins model is applied to Mozambique, using the recent DHS database.

3.1 First equations: Children ever born, B, and natural fertility, N

3.1.1 Children ever born, B

Children ever born (B) is measured based on the equation presented by Easterlin and Crimmins (1985:38). From their original model with seven variables, we have slightly altered three to conform to the Mozambican situation. Duration of marriage was, for instance, replaced by years of sexual activity. The equation we use is:

$$B = \alpha_0 + \sum_{i=1}^{i=5} \alpha_i X_i + \alpha_7 U \qquad (1a)$$

where the variables are:

B = children ever born
X_1 = years of sexual activity
X_2= first birth interval
X_3 = second birth interval
X_4 = women whom have been sterilized
X_5 = proportion of infant and child mortality
U = ever used contraceptives.

Sexual exposure is measured by years of sexual activity and whether the partner lives at home or not. It is known that there are many regions in Mozambique where males migrate temporarily to other parts of the country or to neighboring countries in search of jobs. In the provinces of Inhambane, Manica and Sofala, between 15%-20% of the women had their partners living temporally elsewhere, according to 1997 DHS sample.

Deliberate fertility control is measured by the proportion of women sterilized and the proportion who ever used contraceptives. Information about women's sterilization, X_4, and use of contraceptives, *U*, is theoretically expected to be one of the strongest indicators of external hindrance of fertility. However, in Mozambique only 20% of the sample have ever used contraceptives and only around 2% have been sterilized.

Fecundability, or the possibility to become pregnant, is measured by the first and second birth intervals, age, and the proportion of infant mortality (early infant death reduces post-partum amenorrhea). In our data set, 35% of the women had birth intervals shorter than two years, 25% 2-3 years; and the rest 3 years or longer.

The choice of these variables was the outcome of an analysis with many variations in the equation. Other variables which were tested include polygamy, problems giving birth, months of breastfeeding, partner works at home, as well as the squares of most variables. The set in Eq. (1) gives the most significant results. The model was applied to the provinces as well as to the country as a whole, but because of the small data sets within each province, most results are not significant at the provincial level. The calculations were run with and without contraceptive use because of the unexpected results for U. However, this hardly affected the coefficients and significance level of the other independent variables.

The model was applied to women in unions aged 15-44, with three children and more. This group was chosen since it includes those women who are biologically capable to become fecund and might have motivations for using contraception. Age is

limited to 44 years because of the low life expectancy in Mozambique.[5] By including younger women, the number of births calculated with Eq. (1) will be biased downward by the women who have not finished childbearing.

It is hypothesized that the supply of children to women between 15 and 44 years of age with three or more live births would be greater

1. the longer her period and level of sexual exposure, as measured by years of sexual activity, and partner living at home;
2. the higher her total fecundability, measured by shorter duration of first and second birth intervals, higher infant mortality, and lower age;
3. the more the use of deliberate fertility control by the woman.

The coefficients of Eq. (1) were estimated by using ordinary least squares (OLS) regressing *B* against fertility determinants and contraceptive use in a statistical package.[6] The coefficients are presented in Tables 4 and 5. The coefficients for first and second birth interval as well as age are low, while those for years of sexual activity, contraceptive use, sterilization and infant and child mortality are higher. The variables are years of sexual activity, first and second birth interval, infant mortality, sterilization (coefficient has the right sign).

The most perplexing result is the positive relation between contraceptive use and B. This result was consistent for many perturbations of the analysis that we did. The only calculation that showed the expected negative correlation between contraceptive use and B was when we limited the group of women to those with secondary education and more.

Use of contraception is expected to be inversely correlated with total children ever born, thus, the coefficient for *U* should be negative. A misleading interpretation for such a result is that the more one uses contraception, the greater the number of children ever born. The most plausible explanation for this result is that in Mozambique many women who started using contraception have already had many children (Figure 9). Overall, 27% of those who had five children or more use contraceptives, while among those who have less than five the figure is 16%. It is only among women with secondary or higher education that the use of contraceptives is higher at lower parities.

Thus, although contraception is correlated with a higher number of births, the *reason* for the correlation is not as we usually think it might be. Usually, we think of contraception causing lower fertility. It seems that for Mozambique, on average, it is the other way around: a large number of children cause a couple to consider family planning.

3.1.2 Limited natural fertility, N_l

Natural fertility (N) is the number of children that would ever be born under conditions of natural fertility as understood by Bongaarts (1978), that is, the level of marital fertility without any use of contraceptives. *N* is obtained for the sample by substituting the observed values on X_1 through X_7 in Eq. (1a), adding the constant term, and summing up the results. It is given by Eq. (1a) minus contraceptives:

[5] 43.6 in 1994 according to the household survey on living conditions (INE 1998a:9).
[6] Statistical package SPSS for windows, release 8.01.

$$N = \alpha_0 + \sum_{i=1}^{i=7} \alpha_i X_I \qquad (1b)$$

Actual natural fertility, which is the maximum number of children a woman in an union can bear, cannot be found with the composition of our sample. Calculated natural fertility will be biased upward because only women with three or more children are included in the analysis (excluding those who stop childbearing at parity two or less), and downward because the average age is lower than that of women who have completed childbearing. We calculate limited natural fertility, N_l, which is the maximum number of children that could be born *given the age structure and minimum parity of the sample*.

We calculated two values for limited natural fertility, one using the coefficients found for Eq. (1a) with contraception, and the second without contraception, which were 4.94 and 5.05, respectively. The actual number of average births in the sample was 5.04, virtually the same as the second limited natural fertility. The problem becomes which set of coefficients to use as correct. The coefficients without contraception give an answer for limited natural fertility which is closer to the actual number of average births in the sample, and this predisposes us to use this set of coefficients in the calculations for the factors affecting fertility control below.

3.2 Second equation: Factors affecting fertility control, U

Although contraceptive use (U) has the wrong sign in Eq. (1a), the determinants of U are as expected. This further supports the notion that the correlation between contraceptive use and fertility found above is correct, and that in Mozambique we have a situation where the causation is from (high) fertility to contraception instead of the other way around. In the Easterlin and Crimmins model, the level of U is a function of motivation for control (the excess of supply over demand) and the costs of fertility control. The original Eq. (2) is

$$U = ß_0 + d(C_n - C_d) + \gamma RC + \mu, \qquad (2)$$

where

U = fertility control
C_n = potential supply of surviving children, Eq. (1b)
C_d = demand for children
RC = regulation costs.

3.2.1 Motivation for fertility control: Supply of children minus demand (Cn-Cd)

The *demand for children* (C_d) is indicated by the response to the question: "If you could choose exactly the number of children to have in your whole life, how many would that be?" (Gaspar *et al*. 1998:251). Around 10% of the interviewed population gave a non-numeric response to the question and was excluded from the analysis. Easterlin and Crimmins recognize that this type of measure shows the response on number of desired children reflecting the respondent's statement after, not before, decisions regarding fertility control. "Thus, actual family size may bias upward

responses to desired family size, because children unwanted before the fact are reported as desired after the fact" (Easterlin and Crimmins 1985:49).

The *supply of children (C_n)* is estimated as the product of natural fertility and the child survival rate

$$C_n = (1 - ICMR)N$$

where

ICMR = proportion of infant plus child mortality.

Easterlin and Crimmins use only infant mortality in their calculation of C_n, but given the high levels of child mortality (ages 0-4) in Mozambique, we have decided to include it in our calculation of C_n. According to the DHS, child mortality was 83 per 1000 in 1997.

Table 4 shows the calculated supply of children, limited natural fertility, and motivation for control. It also shows the demand for children (desired family size), actual number of children ever born, surviving children, unwanted children in the sample. Variables that can be found directly from the data are shown for the provinces as well as national, whereas those, which can be obtained only from the model, are shown only for Mozambique as a whole. The model results and the actual sample values correspond closely.

Table 4. Values for limited natural fertility, children ever born, supply and demand for children, motivation for fertility control, and surviving children according to the coefficients obtained including and excluding contraceptive use.

Variable	**With U**	**Without U**
Limited natural fertility, N	5.10	5.21
Children ever born, B	5.04	5.04
Supply of children, Cn	4.05	4.13
Surviving children, C	3.99	3.99
Demand for children, Cd	6.64	6.64
Motivation for fertility control, Cn - Cd	-2.59	-2.51
Children averted, N-B	0.06	0.17
Unwanted children, C-Cd	-2.65	-2.65

In all eleven provinces, the demand is higher than the supply. It is only in Maputo City that the supply-demand *Cn-Cd* is close to zero; however, the resulting number is still negative. Across provinces, demand usually varies inversely with supply – the number of surviving children. The correlation coefficient for whole country is -0.59. The highest desired number of children is 7.66 in Niassa, where the supply is only 3.92; whereas in Maputo City demand is 4.64 and supply is 4.24. According to Easterlin and Crimmins (1985:154), this phenomena adds further support to the view that in pre-modern or early modern society couples have difficulty in achieving their desired family size even under the best circumstances.

3.2.2 Regulation costs

Regulation costs (*RC*) are indicated in the model by knowledge of at least one contraceptive method and the following dummy variables: Heard about family programs on radio last month, heard about family programs on poster last month, heard about family programs on brochures last month, discussed family programs with partner, discussed family programs with friends and/or neighbors. By hypothesis, the coefficient of regulation costs (*RC*) on contraceptive use should be negative.

Knowledge of contraceptive use was calculated based on total number of women knowing at least one type of contraceptive method – modern, traditional or folkloric – divided by total number of women by cluster. The average by cluster was used, in this case, as an indicator not only of the effectiveness of the health service infrastructure by area but also of the strength of the local social networks for spreading information on contraception.

3.2.3 Results: Factors affecting contraceptive use, U

Since the variable fertility control was a dummy variable (1/0), the regression was run using the PROBIT model in a special statistical package.[7] The regression model of y (U) on x (C_n, C_d, *R, L, RC*) was applied to those individual women with three children or more aged 15-44.

Table 5 shows that motivation for fertility control (Cn-Cd) is positively correlated to the use of fertility control. In other words, those individual women who had more children than desired, were more likely to use contraception. The variables for regulation costs, which are significant for fertility control, are whether the woman has any knowledge of contraceptive methods and whether she has discussed family planning with her partner.

Those who have ever used contraceptives live, as would be expected, in urban areas (Table 5, column 11), mostly in large cities, often in the capital of the provinces. Among this group, the users live mostly in Maputo City, larger cities of Maputo Province and in the provinces of Tete and Niassa.

[7] LIMDEP, version 7.0, is econometric software, which includes among other things, the PROBIT model. The model runs following the procedure PROBIT; Lhs = dependent variable (1/0); Rhs = constant + regressors $. For more details, see http://www.limdep.com/.

Table 5. State regression for the estimate of fertility control, U.

				Regulation Costs, RC									
	Cn-Cd	**Religion, R, Catholic**	**Language, L, Portuguese**	**Knowledge of contraceptives**	**Discussed FP with partner**	**Heard about FP on radio**	**Heard about FP on TV**	**Read about FP in newspaper**	**Read about FP on posters**	**Read about FP in brochures**	**Dummy urban**	**Constant**	**R2**
Maputo City (N=363)	0.045* (0.125)	0.075 (0.061)	-0.000 (0.077)	0.548* (0.198)	0.025 (0.058)	0.447 (0.618)	0.079 (0.067)	-0.098 (0. 074)	-0.018 (0. 068)	(0.153)* (0.077)	--	0.202 (0.217)	0.130
Maputo (N=268)	0.017 (0.015)	-0. 071 (0.104)	0.204 (0.138)	0.465* (0.168)	0.060 (0.074)	0.019 (0.081)	0.256* (0.141)	-0. 080 (0.136)	-0.088 (0. 097)	0.546 (0.124)	0.145* (0.800)	0.101 (0.132)	0.188
Gaza (N=347)	0.081 (0.078)	0.227* (0.073)	-0.124 (0.192)	0.116 (0.117)	0.080 (0.085)	0.076 (0.055)	0.249 (0.194)	0.461* (0.234)	0.097 (0.093)	0.186* (0.090)	0.203* (0.089)	0.065 (0.052)	0.214
Inhambane (N=276)	0.025 (0.102)	-0.049 (0.057)	--	0.408* (0.104)	0.126* (0.066)	0.068 (0.069)	-0.005 (0.259)	0.107 (0.185)	-0.046 (0.091)	0.037 (0.103)	0.285* (0.116)	0.017 (0.048)	0.206
Sofala (N=390)	0.010 (0.008)	0.103* (0.049)	--	0.412* (0.094)	0.274* (0.052)	-0.066 (0.062)	0.061 (0.133)	-0.156 (0.100)	0.088 (0.093)	-.0.188* (0.109)	0.060 (0.049)	-0.096 0.059	0.249
Manica (N=393)	0.022* (0.007)	0.121* (0.525)	0.364* (0.156)	0.315* (0.764)	0.225* (0.058)	0.124* (0.045)	-0.041 (0.124)	-0.068 (0.148)	0.063 (0.057)	0.022 (0.091)	-0.138* (0.539)	0.006 (0.047)	0.262
Tete (N=234)	0.024 (0.015)	0.075 (0.071)	--	0.603* (0.268)	0.214* (0.075)	0.058 (0.077)	0.009 (0.281)	-0.191 (0.216)	0.045 0.126)	0.062 (0.211)	0.191 (0.121)	-0.124 (0.204)	0.200
Zambézia (N=349)	0.018* (0.008)	0.054 (0.041)	--	0.441* (0.122)	0.046 (0.087)	0.092 (0.067)	-0.327 (0.267)	0.342* (0.134)	0.193* (0.057)	0.072 (0.098)	0.018 (0.105)	-0.005 (0.044)	0.279
Nampula (N=409)	0.008 (0.005)	0.042 (0.028)	0.126 (0.144)	0.213* (0.066)	0.196* (0.515)	0.068 (0.057)	--	0.184 (0.117)	0.035 (0.072)	-0.070 (0.060)	0.312* (0.569)	-0.038 0.369	0.340
Cabo Delgado (N=219)	0.001 (0.087)	0.021 (0.043)	--	0.135* (0.883)	0.276* (0.125)	0.210* (0.076)	--	-0.147 (0.114)	0.247* (0.077)	-0.102 (0.087)	0.227 (0.094)	-0.002 (0.036)	0.308
Niassa (N=342)	0.008 (0.008)	0.077* (0.046)	--	0.291* (0.095)	0.115 (0.105)	0.190 (0.139)	--	--	-0.297 (0.272)	0.439 (0.313)	0.136* (0.064)	0.237 (0.584)	0.104

- Not relevant
** Significant at .05 level or better*

Table 6. Third equation results: Regressions for desired family size, knowledge of contraceptives, determinants of child supply on modernization and cultural variables.

			Determinants of Supply, Cn					
A. Variables	**Demand, Cd**	**Knowledge contraceptive method(s), RC**	**Infant and child mortality**	**Years of sexual activity**	**First birth interval**	**Second birth interval**	**Dummy sterilization**	**Dummy contraception**
1. Modernisation variables								
Wife / woman's education	-0.349 (0.091)*	0.060 (0.009)*	-0.000 (0.008)	-2.987 (0.232)*	-0.115 (0.724)	0.039 (0.809)	-0.004 (0.004)	0.081 (0.015)*
Husband / partner's education	-0.130 (0.089)	0.007 (0.008)	-0.025 (0.008)*	-0.951 (0.227)*	0.013 (0.709)	-0.581 (0.791)	-0.001 (0.004)	0.013 (0.015)
Living standard index	-0.116 (0.032)*	0.022 (0.003)*	-0.012 (0.003)*	0.127 (0.083)	-0.286 (0.259)	0.544 (0.289)*	0.006 (0.001)*	0.054 (0.005)*
Access to health care (last 12 months)	-0.091 (0.085)	0.069 (0.008)*	-0.008 (0.008)	-0.508 (0.217)*	0.722 (0.675)	-0.131 (0.755)	-0.000 (0.003)	0.054 (0.014)*
2. Cultural variables								
Religion[1]								
Catholic	0.127 (0.170)	-0.003 (0.016)	0.001 (0.016)	0.308 (0.435)	0.049 (1.356)	-0.432 (1.515)	0.004 (0.008)	0.064 (0.028)*
Protestant	0.201 (0.170)	-0.009 (0.016)	-0.004 (0.016)	0.185 (0.434)	0.537 (1.556)	-1.073 (1.511)	0.002 (0.008)	0.038 (0.028)
Islamic	0.593 (0.186)*	-0.007 (0.018)	-0.021 (0.017)	-0.005 (0.474)	0.664 (1.480)	2.104 (1.653)	0.007 (0.009)	0.003 (0.031)
No religion	0.595 (0.175)*	-0.057 (0.017)*	0.004 (0.016)	-0.139 (0.447)	1.909 (1.395)	-1.561 (1.558)	-0.008 (0.008)	-0.048 (0.029)*
Language-ethnic background[1]								
Xitsonga	-0.402 (0.195)*	0.065 (0.019)*	0.046 (0.018)*	1.388 (0.499)*	0.537 (1.555)	3.509 (1.737)*	0.019 (0.009)*	0.069 (0.032)*
Emakua	0.410 (0.184)*	-0.002 (0.018)	0.108 (0.017)*	0.360 (0.472)	-2.276 (1.471)	-1.639 (1.644)	-0.001 (0.009)	-0.059 (0.031)*
Cisena	0.439 (0.180)*	0.152 (0.017)*	0.065 (0.017)*	-0.300 (0.459)	-1.48 (1.431)	0.396 (1.599)	0.002 (0.008)	0.008 (0.030)
Elomue	0.215 (0.275)	-0.149 (0.026)*	0.037 (0.026)	1.408 (0.704)*	-1.846 (2.194)	2.610 (2.451)	0.004 (0.013)	-0.021 (0.046)
Xitswa	-0.693 (0.211)*	0.022 (0.020)	0.017 (0.020)	0.648 (0.541)	1.032 (1.686)	1.835 (1.884)	0.017 (0.009)*	0.032 (0.035)
Portuguese	-1.334 (0.321)*	0.125 (0.031)*	0.006 (0.030)	0.064 (0.820)	1.360 (2.557)	5.567 (2.856)*	0.073 (0.015)*	0.195 (0.053)*
Polygamy	0.194 (0.098)*	-0.042 (0.009)*	0.006 (0.009)	-0.300 (0.250)	0.128 (0.780)	0.018 (0.871)	-0.001 (0.004)	-0.063 (0.016)*
3. Place of residence								
Urban	-0.686 (0.111)*	0.319 (0.011)*	-0.021 (0.010)*	0.344 (0.284)	-0.277 (0.887)*	0.051 (0.990)	0.015 (0.005)*	0.245 (0.018)*
B. Summary statistics								
Constant	6.847 (0.217)	0.314 (0.021)	0.172 (0.020)	19.076 (0.553)	32.303 (1.724)	34.098 (1.926)	-0.005 (0.010)	0.057 (0.036)
No. of cases	3.150	3.150	3.150	3.150	3.150	3.150	3.150	3.150
R^2	0.138	0.463	0.052	0.082	0.007	0.011	0.0418	0.265

[1] *Excluding "others"*

** Significant at .10 level or better*

3.3 Third equation: The impact of modernization and cultural aspects

The third equation in Easterlin and Crimmins is the most important in terms of policy. Here, we calculate the impact of modernization and cultural aspects on determinants of fertility, demand for children, and regulation costs. In this equation, each of these independent variables becomes, in turn, a dependent variable, as a function of modernization, cultural and other aspects. Thus,

$$W_j = \kappa_j + \pi_j Y_k + \rho_j Z_m + \eta \qquad (3)$$

where

W_j stands for each of the independent variables, X_1 through X_7, C_d and *RC*
Y_k is a vector of modernization variables
Z_m is vector of cultural and regional variables
η is a stochastic disturbance.

The variables that have been chosen as indicators of modernization follow those discussed in the empirical section above. They are: female literacy, male literacy, and index of standard of living (composed of access to safe water, toilet, electricity, has radio, television, refrigerator, bicycle, motorcycle, car and telephone), access to modern health care services (visits during the last 12 months) and urban residence. The cultural and regional characteristics included are religion, spoken language, and polygamy.

3.3.1 Results of third equation

We expect that factors of modernization will be negatively correlated with child demand and regulation costs. They will be negatively correlated with infant mortality. The other effects are expected to be ambiguous. Table 6 presents results for *Cd*, *RC* and *Cn*, which in general are in the expected direction. The results show that they are sensitive to the indicators of modernization.

Education is one of the most important variables affecting demand, regulation costs and supply. Female and male education is negatively correlated to the demand for children. It is negatively correlated with infant mortality and years of sexual activity. The negative correlation of education and years of sexual activity (which is strongly related to age) is due to the fact that the younger cohorts in Mozambique are significantly better educated than the older ones (see Wils and Gaspar, unpublished).

These findings show that more educated women face lower regulation costs than illiterate women, but also that they have different lifestyles and a lower desired family size. These two factors mutually reinforce contraceptive use. As a result, the differences in contraceptive use by education are very high. Among those who have secondary or higher education, 98% had some knowledge about at least one contraceptive method, and 30% were using it at that time. Among the illiterate, only 3% were using contraceptives and around 50% had no knowledge about it.

The correlation between education and birth intervals is ambiguous, which is expected, given the conflicting effects of active birth spacing versus shorter breastfeeding and post-partum abstinence in more highly educated families.

The index of standard of living, modern health care, and urban residence are all correlated with child demand, regulation costs, and infant mortality as expected. The

cultural results are interesting. The coefficients for child demand ascend in order from Catholic, Protestant, Muslim, to other.

The coefficient for infant and child mortality is highest for the following ethnic groups: the Emakua (living mostly in Cabo Delgado and Nampula), the Cisena (living mostly in Manica, Sofala and Tete), and the Xitsonga (living mostly in Gaza and Maputo provinces).

3.3.2 Hypothetical effect of "complete" modernization

In order to verify to what extent the modernization variables affect the demand in Mozambique, Eq. (3) was run assuming the hypothetical situation that 100% of the population would be literate, live in urban areas, have access to modern health infrastructure and to all the commodities in the standard of living index. In this hypothetical situation, Mozambique would have passed through a development associated with the demographic transition. The question is whether fertility would be similar to that of developed countries, with the coefficients found in the regression above.

The result would be a child demand of 5.8, as opposed to the present 6.64. While 5.8 is certainly lower than the present level, it is much higher than the desired family size in developed regions. This result shows that while the modernization variables *by themselves* reduce fertility, they are not sufficient to reach replacement fertility or lower. There are a number of reasons for this. First of all, development is a composite process, in which the whole is more powerful than the parts. Therefore, it may be that the coefficients separately underestimate the effect of modernization. Second, various studies have shown that a strong family planning program is conducive to lowering fertility, not included here and not present in Mozambique in 1997. Third, there may be a process of cultural diffusion of small family size values once a certain threshold level is reached (discussed in Lutz 1994). None of these three effects is captured in our calculation, although it is likely that they are each important.

4 Final Considerations

Mozambique is characterized as having regional disparities regarding modernization performance. There are relatively prosperous areas, mostly in the southern urban parts of the country, where the general living standard is comparatively high and where information flows reach most groups of society. As pointed out earlier, the largest share of the population with formal education is found in these areas as well as the best supply of modern medical care services. Thus, these areas are supposedly characterized by low regulation costs regarding fertility control, as well as lower child demand. On the other hand, there is the countryside of the northern regions, which is relatively isolated from other parts of the country. These regions tend to be characterized by indicators of a typical pre-modern society. Access to modern health services is still difficult for a great majority of the population; many of them do not approve of the idea disseminated by family planning programs. How do these differentiated levels of modernization affect the fertility in Mozambique?

In all Mozambican provinces, demand is in average higher than supply. The country has one of the highest demands for children in the world but also one of the largest supply of children, followed by high infant and child mortality. In many

provinces, the regulation costs are still high. Those who deliberately use contraceptives already have many children.

The most perplexing result of our study is the positive correlation between births and contraception. A plausible explanation for this is the following. Usually, we think of contraception as the cause of lower fertility. In Mozambique, it appears to be exactly the opposite. A high number of births causes the use of contraception. It is only among well-educated women that a premeditated use of contraception appears and subsequently a negative correlation between contraception and number of births. The average Mozambican pattern of contraception (where use is caused by high fertility) might be an alternative or transitional phase from a situation of natural fertility to one of small, controlled family size. To establish this, one would have to do comparative studies of other countries which have a pattern of contraceptive use similar to that in Mozambique, namely overall low levels, and a very slow rise in the use of contraception to a plateau at parity five or above.

Among the modernization variables, education is the factor that most affects supply, demand and also regulation costs in Mozambique. However, education is not alone. Living standard and health infrastructure also play a role in determining fertility behavior.

We found that the coefficients for the effects of modernization on the determinants of fertility would not lead to replacement fertility if modernization were "total." To test this, we assumed a hypothetical situation in which literacy, modern health assistance, urban residence, and the standard of living index were all 100%. The demand for children in this calculation was around 20% lower than it is nowadays, or 5.8 children instead of 6.64.

It is hard to foresee if and when the demographic transition will take place in Mozambique. It depends on structural changes involving not only the standard of living but also changes in attitude and behavior. All these factors have a synergetic effect on fertility behavior that can be more dramatic than that from only the individual factors. However, it is likely that the demographic transition would be more visible in Mozambique, if a larger number of pupils would be going to school, more modern health services would be easily accessible to the population, and more often people would have the possibility to choose when and how many children they wish to have. Thus, any policy directed to reductions of population growth or public health, in general, should recognize the importance of the country's socio-political and economical development as an integrated system in which investments in the standard of living should be a priority.

To close, let us present three couples who could exemplify hypothetically the typical fertility behavior in Mozambique. The couples also represent three stages of fertility behavior: traditional, transitional, and modern. The stories of these families are set in terms of the interplay between supply-demand for children and regulation costs. In a national process of change from high fertility to low, the traditional couple would have to undergo substantial changes in their values and their living situation. They would also need to see a significant improvement in modern infrastructure such as health care and schooling. The transitional couple would have to undergo mostly changes in their values, while the modern couple would not change much at all, except to shift perhaps to a slightly smaller family size.

Let's start with the traditional couple. They belong to the Emakua ethnic group and live in the countryside of Nampula, one of the northern provinces. Living in an agricultural environment, the couple wishes to have as many children as possible, since for them, the greater the number of children, the greater the labor force for agriculture, and their long-term subsistence will be guaranteed. In fact, child mortality, as a result of poor living standards and extended breastfeeding[8] work against their short-term demand for children. They do not have access to safe water and nor to TV or radio. Two daughters have already died of cholera and they find that they always wish they had had more children. The total number of children depends on their uncontrolled fertility, symbolized by the statement "it is up to God" while the declared desirable number of children is eight. In this case, there is no motivation for contraception but even if, for any reason, they would wish fewer children, the costs for limiting the child supply would be high (both psychologically and economically), since the access to information regarding use of contraceptives would be limited and the access to health services would be selective. For instance, it takes more than three hours to go to the closest health care center. Strong religious taboos against the use of contraceptives would also play a role in defining the high regulation costs.

The transitional couple belongs to the Xitswa and Xitsonga ethnic groups and lives in the capital of the Inhambane province, after moving from the countryside a few years ago. Despite being healthy, the illiterate couple has an unstable living standard since family survival is dependent on the male's temporary jobs in other Mozambican provinces. The urban lifestyle has slightly lowered the couple's taste for children, since the costs of children are higher due to schooling. Moreover, the children are all vaccinated and their mortality is lower than that of their rural cousins. When the couple is expecting their fifth child, they discuss the unfamiliar and non-traditional notion of limiting their family size. However, they do not go to the clinic because they still see drawbacks associated to distaste for the use of various methods (e.g., abstinence or use of condoms) or actual costs in time and money involved in some techniques (e.g., abortion or sterilization). It is only when they are expecting their sixth child that they decide to limit their family size. They obtain a modern method of contraception in the local health clinic.

The modern couple, from the Xitsonga and Portuguese ethnic groups, has always lived in a town in Maputo City. One of the partners has secondary education and at least the male has a permanent full time job. Assuming urban lifestyles, since the beginning of the union, the couple has been motivated to control the family size, since having unwanted children would imply additional costs. This couple decided to have not more than three children, since the costs of having a fourth child could compromise the investments directed to the "quality of the education" for the first three. The prospect of unwanted children provided motivation for choosing contraception, which is relatively costless in Maputo City, where information and contraceptives are easily available compared to rural areas. Contraceptives, in their case, are used not only as a tool to reach the desired number of children, but also to define when the children should be born.

[8] It is worth noting that amnorrhea associated with prolonged breastfeeding is known as an important effect on family size, but the dominant motivation for breastfeeding is the concern of the couple for the health and well-being of their child, not family size per se.

5 References

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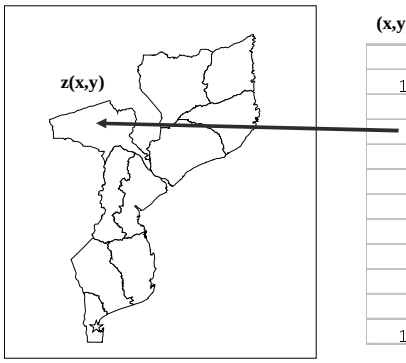
Appendix A: Mapping Indicators Using a Geo-Relational Database

Using a desktop mapping system called MapInfo 4.1 and aggregated statistics at the provincial level from the Demographic Health Survey and the household survey (INE 1998a), a geo-relational database has been built for Mozambique (Figure A1).



(x,y)	z_i	z_2	z_3
ID	PROVINC	POPULAT	HOSPITA
10.0	Maput	809.0	5.00
8.00	Gaza	1034.0	5.00
5.00	Tete	1149.0	4.00
7.00	Sofal	1380.0	5.00
6.00	Manic	975.0	1.00
9.00	Inhamba	1112.0	3.00
2.00	Niass	764.0	2.00
4.00	Zambézi	3202.0	4.00
1.00	Cabo	1284.0	4.00
3.00	Nampul	3065.0	6.00
11.0	Cidade	996.0	5.00

Figure A1. Structure of the geo-relational database for Mozambique.

The system that combines geo-referenced graphical features (lines, points or polygons) of a map with attributes (z) in table-format using as a link the feature co-ordinates (x,y) is usually called a “geo-relational database” (GD). GD is composed of two parts, one flexible, one fixed. The fixed part is basically composed of the co-ordinates or IDs to which each attribute will be addressed, and the geographical entity to which the attribute is linked. The flexible part constitutes the attributes, such as total population, average income. The most important advantage of a GD is that one can use a single cartographic basis to produce as many thematic maps as one wants, since the attribute (whatever it is) is associated with the “address” (ID or label) of that geo-referenced geographical feature, which is fixed.

In this particular case, the GD Mozambique provides a geographical basis for mapping indicators of modernization (Section 2) as well as of demography. The capability of including the spatial dimension to this analysis sheds light to the regional disparities at the province level in Mozambique as well as offers a more precise basis for discussions of the results. The eleven provinces are generally addressed based on larger regions, namely:

North: Cabo Delgado, Niassa and Nampula
Central: Tete, Manica, Sofala and Zambézia
South: Gaza, Inhambane, Maputo and Maputo City

The province level has been chosen as the level for analysis because of its inherent interest as a social unit, because of the data availability and because many social-health policies are primarily administrated at this level.