ECONOMIC FACTORS AFFECTING HUMAN FERTILITY IN THE DEVELOPING AREAS OF SOUTH AFRICA

by

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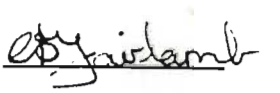
I hereby certify that the work reported in this thesis, unless specifically indicated to the contrary in the text, is my own original and unaided work.



C.D. FAIRLAMB

ABSTRACT

The World Bank has expressed concern over the high population growth rates in sub-saharan Africa. South Africa's annual population growth rate in the traditional sector is 2,9 percent. This study identifies the economic factors affecting family size choice to provide policy makers with a strategy for reducing fertility.

A neoclassical utility framework was used to analyse linkages between family size decisions and socio-economic variables. Household utility for "child services" and "standard of living" was maximised subject to the resource constraints of time, labour and income. A stratified sampling technique was used to collect household data from Ulundi and Ubombo in KwaZulu. One hundred and seventy five women in three occupational strata were interviewed. A static demand function for children was estimated by multiple regression. The demand function was re-estimated within a simultaneous model of family decision making which was estimated by two-stage least squares regression analysis. Dummy dependent variables were estimated by probit analysis. Principal components analysis was used to confirm the underlying theoretical linkages and discriminant analysis was used to distinguish users from non-users of modern contraception.

Results show that child education, woman's opportunity cost of time and formal labour market participation were negatively related to fertility reflecting a substitution from numbers of children (time intensive goods) to fewer, more educated children (less time intensive) as opportunity costs rise. Principal components confirmed that this substitution effect dominated the pure income effect as lifetime family earnings increased even though children are normal goods.

Child labour and children's contribution to income were positively related to fertility. These benefits accrued mainly to rural people because in urban areas parents depend less on subsistence farming and essential services (water and electricity supply) are provided.

Discriminant analysis showed that 47,7 percent of the respondents used contraception (including abstinence and sterility). The most important reasons for use were for child spacing and the desire for no more children. The latter reason was given by women who had completed fertility and young women who wanted to avoid untimely pregnancy. The actions of the young women emphasise the importance of opportunity cost which was further supported by positive relationships between woman's current income, child education and contraceptive use.

Therefore strategies to reduce population growth rates should include improvements in education and employment opportunities which would raise time costs for women. Provision of time saving devices and essential services, and better pension and social security schemes would reduce the benefits from children thereby reducing family size. For better community acceptance of contraception, the benefits for child spacing and survival should be promoted.

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INTRODUCTION

High population growth rates have been a major factor inhibiting economic development in third world countries. Africa has been the focus of world attention in recent years because its growth rate has increased from 2,1 percent per annum in 1950 to 2,9 percent in 1980 and is estimated to grow approximately 3 percent annually until the end of the century (United Nations, 1981). Rates have exceeded four percent per annum in Kenya, Mozambique, and the Ivory Coast, with others like Zimbabwe expected to join them by the turn of the century (World Bank, 1984).

South Africa's growth rate during 1970 - 2000 is estimated as being 2,5 percent per annum (University of South Africa, 1989). The population of 37 532 000 is made up of 13,5 percent Whites, 8,6 percent Coloureds, 2,6 percent Asians and 75,3 percent Africans. The estimated population growth rates for the different racial groups show that the highest growth rate of 2,9 percent per annum (1970 - 2000) is for Africans, Coloureds, Asians and Whites having growth rates of 1,9, 1,8 and 1,1 percent per annum respectively (University of South Africa, 1989). Within the African sector the Development Bank of Southern Africa (1987) estimates that 46 percent of the population is younger than fifteen years. This skewness causes a momentum effect which keeps birth rates high in spite of decreasing growth rates; the World Bank (1984) estimates that it can take 50 - 75 years for the momentum to adjust to growth rate declines.

These statistics have serious implications for development in South Africa. Provision of education, housing, employment, health care and food production are a few of the areas that need attention. For this reason in March 1984 Cabinet launched the Population Development Programme (PDP), whose aim was to establish an equilibrium between population size and available resources (van der Kooy, 1990). Future availability of natural resources, the country's economic and social potentials and possible governmental programmes were to be considered. The PDP, having acted on two investigations commissioned by the President's Council, found that South Africa can only accommodate 80 million people (van der Kooy, 1990). An economic growth rate of 4,5 percent per annum for 1980 -2000

would only create 12 million jobs, 6 million short by the year 2000 for no unemployment to exist. At an economic growth rate of 3,1 percent per annum, no more than 10 million jobs would be available while a rate closer to 2,5 percent appears achievable. It is therefore imperative that economic conditions of traditional[1] households associated with smaller family sizes should be studied in order to facilitate fertility declines and the raising of living standard potentials.

Family planning strategies have met with certain success in Taiwan, Korea, Singapore and China but in Africa they appear to be less effective. Dow and Werner (1981) in Kenya found that although 64,2 percent of women knew about modern contraception, those who were using it did so to complement and maintain rather than change and reduce their fertility aspirations. This exposes possibly the most fundamental problem of family planning strategies, the fact that they concentrate on the symptoms rather than the cause of high fertility. In Taiwan, focus was placed on motivating couples to reduce fertility by a comprehensive marketing strategy which explained the problems of rapid growth and the benefits of small family sizes. Taiwan coupled this campaign with inexpensive and readily available contraception and has achieved the most rapid declines in population growth rates in the world (Development and Communication Consultants, 1990).

In South Africa it is important to provide a comprehensive population programme that motivates people to reduce their family size preferences. This study was undertaken to consider how a long term approach to decreasing desired family size might be achieved. Emphasis is placed on the underlying economic factors affecting family size preferences which will allow policy makers to define an incentive structure encouraging couples to regulate their fertility. It is important, though, to consider the social and cultural aspects as well and to provide shorter term strategies.

Historically reduced population growth has taken place as development proceeds suggesting that socio-economic conditions play an important role in family expectations and decisions. Thus, much of the

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[1] Traditional throughout this thesis refers to the African sector of the population including the National States and TVBC countries. It must be distinguished from traditional people within the African sector.

economic literature on the subject has focused on a neoclassical framework of utility maximisation in an effort to derive a "demand curve" for children (Willis, 1971, 1973; De Tray, 1973, 1978; Michael, 1973; Ben-Porath, 1973, 1977; Gronau, 1973, 1977; Mincer, 1963, 1972; Becker 1960, 1965; Becker and Lewis, 1973; Rosenzweig and Evenson, 1977). Later models though, have a broader framework along behavioural lines where all aspects of the fertility decision including the demand for and supply of children, the decision for fertility regulation and the effect of social norms on fertility are incorporated (Bulatao and Lee, 1983; Freedman, 1963; Cadwell, 1967, 1977; Leibenstein, 1957, 1974, 1975; Dusenberry, 1960; and Easterlin, 1961, 1969).

Chapter one deals with the different approaches to the theory of family size decision-making, critically describing the differences between neoclassical, Behavioural and Chicago School approaches. Chapter two formulates the empirical model within the Chicago School paradigm. The demand curve for children is derived within a simultaneous model of family decision-making together with demand curves for child quality and woman's work participation. An estimate of permanent income and woman's opportunity cost are included.

Chapter three describes data collection and estimation techniques. Household data were collected from the Ubombo and Mahlabathini magisterial districts in KwaZulu. The former area was considered typically rural and Ulundi, in Mahlabathini was selected as an urban area. The sample was stratified by woman's occupation to ensure variability in woman's education and opportunity cost of time variables. One hundred and seventy eight women were interviewed in the following three strata, professional women (stratum 1), industrial workers (stratum 2), and women not formally employed (stratum 3).

Chapter four reports the descriptive statistics of the database, after which results are presented. Single equation demand functions for children will be estimated with ordinary least squares regression. The demand function will then be re-estimated in a simultaneous system using two-stage least squares regression with probit analysis to estimate dummy dependent variables. Principal components analysis

will be used to form indices where necessary and to confirm the theoretical linkages. Since family planning is considered to be an important short term strategy for fertility reduction a discriminant analysis will be used to distinguish users from non-users of modern contraception. Finally results will be discussed with a view to promoting a more balanced strategy for policy makers in their attempt at reducing population growth rates.

CHAPTER 1

REVIEW OF ECONOMIC APPROACHES TO FERTILITY ANALYSIS

1.1 INTRODUCTION

Malthus, as early as 1798 postulated that socioeconomic variables affected family size choice. He was primarily concerned that as incomes increased, population would outstrip food production because children were considered normal goods, thereby creating critical food shortages. Historically though, the reverse is true, that is as nations become more affluent with higher *per capita* incomes, population growth rates have declined inferring that children are inferior goods. This prompted analysis in the area of human fertility amongst economists in the early sixties, who intuitively felt that other economic or social factors caused the apparent negative relationship between income and fertility. They suggested that fertility behaviour was linked to consumption and was a result of choice rather than chance implying that decisions about having children reflect the behaviour of a rational utility maximising decision maker. These postulates allowed the use of microeconomic theory to explain fertility behaviour (Bagozzi and Van Loo, 1978; Schultz, 1973). Schultz (1974, p.4) proposed that the "analytical core of fertility studies rests on the economic postulate that the reproductive behaviour of parents is in large part a response to the underlying preferences of parents for children. Parents respond to economic considerations in the children they bear and rear equating the marginal sacrifices and satisfactions from children in arriving at a value of children to them. Thus the analytical key in determining the value of children to their parents is in the interactions between the supply and demand factors that influence these family decisions." This afforded theoretical models which were used to explain the apparent paradox that children were inferior goods. The models originated mostly from the works of Leibenstein (1957), Becker (1960, 1965), and Lancaster (1966a, 1966b) and have become the basis of the following different approaches to fertility analysis.

a. The Pure Neoclassical Approach

b. The Chicago School

c. Socioeconomic and Behavioural Models

1.2 THE PURE NEOCLASSICAL APPROACH

Neoclassical consumer theory lends itself to the study of fertility because it is based on the assumption of a rational utility maximiser. Decision makers, or parents in this case, are supposed to behave as if they maximise their utility function subject to certain, given, nonstochastic constraints. Constraints include prices of goods and services and income, where income is specified as equal to a given budget (with savings and wealth excluded). From this maximisation demand curves for the individual goods can be derived and the sensitivity of the solution checked by comparative statics. However a major limitation of this approach is that it is not a dynamic process, as shown by Becker's model in 1960. He assumed that a husband and wife make a single joint decision at the outset of marriage, about the quantity of children, expenditures per child (or quality) and the standard of living of the household. The couple maximises their utility between children and other goods and services which allows a demand function for number of children to be derived as a function of the prices of other goods and services, and the level of money income. The price of children is expressed in the terms of prices of other goods both complements to and substitutes for children and is therefore, not included in the demand function but rather an outcome of it (Bagozzi and Van Loo, 1978, p.200).

Becker postulated the negative relationship between money income and number of children was due to differential knowledge of contraception. Better educated couples with higher incomes have more knowledge about reducing the number of unintended births, thereby converting a positive income effect on desired fertility to a negative income relationship with actual fertility (Becker, 1960, p.220).

Becker's model however, besides being static, did not satisfactorily explain the negative relationship between income and fertility. Therefore other writers extended his basic model to improve on these areas. Mincer (1963) and Freedman (1963) were two major contributors in this sense.

1.2.1 The Mincer Model

Generally Mincer (1963, p.67) was concerned with specification bias in economic models because of "easily overlooked or misunderstood price variables". Prices in cross-sectional studies, were usually assumed to be constant, but Mincer suggested that there were specific costs which varied amongst individuals and should not be left out. Consumer's time and labour, being complementary resources are examples of such costs. Mincer suggested the most important of these was opportunity cost of time, which at the margin is linked to the wage rate, and consequently positively related to income. Thus he defined price as:

$$P = p + c$$

where: p is the market selling price

c is the opportunity cost of time

The relative size of these two components differs by commodities and individuals. Usually c is assumed to be negligible; at the other extreme (the case of leisure) p = 0 so P = c. The general demand function becomes:

$$Y_i = a + bX_i + \alpha_1(p_1 + c_{i1}) + \alpha_2(p_2 + c_{i2}) + \ldots + u_i$$

where: Y_i is the consumption of the commodity by consumer i

X_i is the income of consumer i

p_j is the market price of good j

c_{ij} is the opportunity cost to consumer i of good j

u_i is the error term for consumer i

Even if the p_js are fixed in cross-sectional studies, the c_{ij}s are not. If the c_{ij}s are a function of the wage rate their omission will bias the estimate of b. He illustrated the effect of opportunity cost on fertility

by including a cost of children variable in his demand analysis. In his fertility model he stressed that the decision to bear children is based on potential income flows or the long run anticipation of wealth. Thus permanent income rather than current income is relevant for the choice problem. Therefore the cost of bearing and rearing children is not current prices of market goods and services but rather the opportunity cost of mother's time measured as her forgone wage earnings in the labour market. His fertility demand function was

$$X_0 = b_1X_1 + b_2X_2 + b_3X_3 + u$$

where: X_0 is the fertility variable

X_1 is husband's income

X_2 is wife's full time earnings

X_3 is the level of contraceptive knowledge

This can be rewritten as

$$X_0 = b_1X_f + \alpha X_2 + b_3X_3 + u$$

where: $X_f = X_1 + X_2$ or potential family income

$\alpha = b_2 - b_1 \Rightarrow b_2 = \alpha + b_1$

Economic theory would predict a positive income effect $(b_1 > 0)$, and a negative opportunity cost effect $(\alpha < 0)$ but it does not predict the sign of b_2, the uncompensated price effect. The sign of b_2 depends therefore on whether the positive income effect or negative substitution effect dominates. In the case with rising permanent income, wife's time becomes more valuable, increasing her opportunity cost causing the substitution effect to outweigh the income effect which results in a negative relationship between income and family size.

Mincer's (1963) model improved on Becker's (1960) by including expectations on wife's full time earnings thereby making it more dynamic and providing a more convincing reason for the negative relationship between income and family size.

1.2.2 Freedman's Hypothesis on Relative Income

Deborah Freedman's (1963) model provided an alternative to Mincer's (1963) price of time variable by suggesting that within a socioeconomic reference group, the cost of rearing children is related to standard of living and norms of that group. Therefore, within each reference group the number of children is positively related to family income; between social groups however, the number of children is negatively related to income. If an increase in income moves a family from one social group to a higher status one the cost of children, in terms of standard of living, becomes greater which means fewer children are demanded. The social reference groups are determined by occupation, religion, place of residence, income and other socioeconomic variables.

1.2.3 The Theory of Economics of Time

Although Mincer (1963) made important theoretical contributions to fertility analysis by including time costs indirectly, his model failed to cope with the allocative role of the decision unit (family). The family must not only maximise utility in consumption but must allocate household members' time and goods through household production decisions. Becker (1965) addressed this problem by arguing that each consumer good or service has a money price and involves indirect costs of:

i. acquiring goods and processing them in household production activities

ii. consuming final goods obtained from household activities.

Therefore if children are economic goods, the costs of an additional child include the direct costs of bearing and rearing the child, and the indirect costs associated with the time and labour intensities of

the direct costs. The latter includes costs related to forgone job opportunities, reduced geographical and social mobility of the parents, etc. and therefore reflect the "price" of children in terms of goods and services that are complements to or substitutes for children.

The idea that household production activities lead to final consumption is the core of the "New Approach" (Ron, 1980). The household uses market goods and time to produce basic commodities (or fundamental goods) which are the true source of utility. Therefore the demand for market goods is a derived demand and the utility maximised is for the fundamental goods which in the case of children, is "child services" incorporating the Lancasterian characteristics of health, education, prestige and number of children. Family size is now explained by the prices of these basic commodity components and income.

The development of the household, general equilibrium model of fertility used extensively in the literature (Willis, 1971, 1973; De Tray, 1973, 1978; Schultz, 1969, 1974 and Ben-Porath, 1973, 1977) evolved from the integration of the "Economic Theory of Family Formation" (Leibenstein, 1957; Becker, 1960; Easterlin, 1961, 1969 and Mincer, 1963) with the "New Approach to Consumer Behaviour" (Becker, 1965; Lancaster, 1966a, 1966b). Simultaneous determination of choices an family income, woman's labour force participation and the quantity/quality trade off for children can be accommodated. The extended framework presented the idea that utility is obtained indirectly from market goods via the consumption of basic commodities. The latter are produced by the household using time and market goods and services as inputs. Thus when applied to family size decision making, it recognises that children in fact generate both consumer satisfaction and investment-like qualities, thereby incorporating both production and consumption relationships within the framework of household utility maximisation (Ron, 1980).

1.3 THE CHICAGO SCHOOL

The Chicago school adapts the "New Approach" to provide a framework to a choice problem where

there is an individual decision maker. The following assumptions are made:

i. A household production technology exists which converts market goods and time into home-consumed fundamental goods.

ii. Families choose quantity of children based on their utility function.

iii. Their choice is constrained by the availability of time and wealth and the derived demand for children is explained by income, relative prices (costs) and the parents' "tastes" for children.

The cost of children is defined by expenditures per child or child quality. Ron (1980) proposes that quality can serve as a proxy for the value of time for child care which is positively related to labour income. Therefore this framework implicitly incorporates the reasons proposed by Becker (1965), Mincer (1963) and Freedman (1963) for a negative relationship between income and family size. Becker and Lewis (1973) posited that child quality and child quantity are substitutes varying directly with expenditures of time and money. They further proposed that the income elasticity with respect to child quality is greater than that with respect to numbers of children suggesting that higher income earners will have fewer but higher quality children. Consequently, the cost of a child is associated with the rise in the price of human time which historically has been increasing with rising wage rates. Therefore as opportunity costs of child care have risen quality (which is less time intensive) has been substituted for numbers of children, resulting in higher average utility per child expressed by higher expenditures per child.

The Chicago School, following the neoclassical approach regards parents' tastes as a *ceteris paribus* condition because economic theory fails to provide a way of modelling taste formation. As Michael and Becker (1973) put it "for economists to rest a large part of their theory of choice on differences in tastes is disturbing since they admittedly have no useful theory of tastes from any other discipline in the social sciences since none exists" (quoted by Ron, 1980, p.15). Therefore followers of the Chicago school expect tastes to be "stable over time and similar amongst people" (Stigler and Becker, 1977, p.76) and thus are best incorporated as a disturbance term to explain residual error within the model (Robinson,

1979). However writers of the behavioural models reject the assumption that people are homogeneous in preferences and propose that proxies like background characteristics, social pressure or psychological needs should be used to explain fertility as well (Easterlin, 1969; Leibenstein, 1974; Turchi, 1975; Bulatao and Lee, 1983).

1.4 THE SOCIOECONOMIC AND BEHAVIOURAL MODELS

Later ideas summarised by Bulatao and Lee (1983) on the methods to approach fertility analysis provide a much boarder framework than that proposed by either the neoclassical or Chicago approaches. This framework incorporates all aspects affecting fertility and can be seen as an integrated approach. The decision unit here is the couple or household and all factors, including social influences, must affect this unit in some way. Because fertility involves both biology, influenced by cultural practices and social taboos, and individual choice which is strongly influenced by economic and social conditions, the basic constituents of study are broken down into three major components following Easterlin (1975, 1978) and are

i. the supply of children
ii. the demand for children
iii. fertility regulation

1.4.1 The Supply of Children

The supply of children is defined by Bulatao and Lee (1983) as the number of surviving children a couple would have if they made no deliberate attempt at limitation, or as Bulatao and Lee (1983, p.3) suggest the "biocultural potential for surviving children". This is similar to the demographic definition of "natural fertility" which Henry (1953) described as the "fertility of a human population that makes no deliberate effort to limit births". Although theoretically correct it is extremely difficult to measure, and supply is approximated by a family of age schedules of fertility.

Because natural fertility depends partly on cultural practices relating to such behaviours as intercourse, abstinence, and breast feeding, it varies widely amongst populations, and is measured by the average interval between births and the length of the reproductive span. Five major factors affecting these can be identified.

i. Postpartum infecundability: conception and birth interrupt a women's normal pattern of ovulation. How long after birth this interruption lasts depends largely on breast feeding practices, which are often dependent on cultural norms.

ii. The waiting time to conception: is the period from first postpartum ovulation to conception.

iii. Intrauterine mortality: a substantial number of pregnancies end prematurely and therefore effectively lengthen the interval between births.

iv. Permanent sterility

v. Entry into the reproductive span: this starts at the age of menarche and puberty for females and males respectively. However these ages are usually less important than the ages at marriage.

The first three of these factors influence the interval between births and the last two define the reproductive span. Combined with survival chances these five factors determine the potential number of children a couple can have.

1.4.2 The Demand for Children

Demand represents the number of children a couple desires as opposed to the potential number they can have. By definition, these desires do not consider supply or the possibility of fertility regulation. Other factors which may affect demand include gender preferences, birth spacing desires, the optimal level of education children should receive etc. Thus demand is seen as an interplay between tastes for children and constraints on the couple. The constraints which are emphasized by neoclassical writers are mostly objective economic ones, but tastes are subjective and are "partly captured in the couples'

perceptions of the values and disvalues of children"; these perceptions, though more difficult to measure, "are more immediately relevant to demand" (Bulatao and Lee, 1983, p.6). These issues will be discussed more fully in a later section.

1.4.3 Fertility Regulation

For demand to be effective, there must be some way to make a couple's choice effective; fertility regulation covers all their methods of doing so. Yet regulation always involves some costs, either direct economic costs or psychological ones, which a couple must weigh up before decisions are made. Fertility regulation includes contraception, induced abortion, infanticide, and to a lesser extent abstinence or prolonged breast feeding. The costs involved comprise monetary costs, inconvenience, embarrassment, guilt, the effort in getting the required information and using it, and lastly psychic or social costs such as fear of being seen at family planning.

For a couple to use contraception of any form they must weigh up the relative levels of supply and demand, and if supply exceeds demand, the costs involved in regulation. Hence only if a couple's supply is greater than demand, and the motivation to regulate outweighs the cost of doing so, will a couple even consider regulation. Therefore in this rather broad framework, supply influences demand in an indirect way through the fertility control component which means that these functions can not be considered to represent true economic demand and supply curves. Although this all-encompassing framework allows more specific model formulations to be included, the behavioural models generally are not as rigorous as neoclassical ones because of their emphasis on tastes. It is however important to consider the attempts to incorporate tastes specifically on the demand side as this component has the greatest potential for policy makers.

1.4.4 The Treatment of Tastes in Behavioural Models

Ron (1980, p.16) wrote that behavioural models try to explain fertility by "linking the process of individual utility maximisation to social-behavioural variables such as norms, externalities among various social groups and background characteristics." The result is that the demand function for children emphasizes the relationship between fertility and relative income (as did Freedman, 1953), and/or distribution rather than income *per se*. Therefore the core of these models is the assumption that preferences (or tastes) are not static but shift in time and across social groups. Hence tastes are explicitly considered by allowing socio-psychological factors, used as proxies for tastes, to enter the model. These factors, such as peer group pressure, social status and other background variables which explain taste formation, replace the rationale that the quantity-quality trade off interprets the negative relationship between income and family size. Ron (1980) classified these models according to the following behavioural dimensions:

i. the effects of social influence groups (SIGs) and the role of background characteristics
ii. income and its distribution
iii. the influence of normative determinants on fertility
iv. the integration of social-psychological factors

1.4.4.1 Social Influence Groups (SIGs) and Background Characteristics

Couples' tastes are expected to be influenced by socio-economic status groups. Leibenstein (1957, 1974, 1975) used a utility maximising framework to analyse the marginal decision to have an additional child at a parity[2] of three. He proposed that each family belonged to some peer group or status which was determined by historical, socio-cultural and economic factors. These factors affect tastes for living standards, consumption patterns and family size independently of income.

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[2] Parity is the number of children previously born.

Leibenstein (1974) argued that both personal expectations and a social composition effect influenced household utility; consequently the marginal utility may increase if the rise in income keeps a family within a certain status group (SIG), or may decrease if a family moves to a higher SIG. Moving to a higher SIG involves acquiring "status goods" which are more costly (ie. increased cost on clothing, education or recreation for children), but in utility terms, the benefits are greater than the child's utility benefits to the household. He concluded that changes in socio-economic status approximates changes in taste, while fertility changes within a status group is merely an adjustment to desired family size. Figure 1.1 explains the concept well. I_1, I_2 and I_3 are budget constraints with their slopes reflecting the substitutability between market goods and children among social groups. I_1 reflects the budget in the lowest SIG, I_2 and I_3 reflect budgets in the same SIG the latter having the highest absolute income. U_1 to U_3 are indifference curves associated with the budget constraints. Notice that the target consumption level of goods in proportion to income is lower for the lower SIG illustrating the assumption that those households have a utility function reflecting a higher marginal utility from children than market goods. As couples move to higher SIGs, taste patterns change and less children are demanded ($n_1 > n_2$ or n_3) because the status effect results in a relative increase in the marginal utility of expenditures on child related status goods. Within the same SIG however, the status effect is constant so that higher incomes result in an increase in demand for children ($n_3 > n_2$). To fully explain fertility though, background characteristics (Goldstein, 1973), religious affiliation, area of residence, education levels and age (Easterlin, 1969, 1975) need to be included. Although it is difficult to separate these two effects Robinson (1979) proposed that background characteristics form expectations about a "modal income" and child versus goods preferences. Therefore the households' decision making process is determined by tastes and potential income flows through time. The former are heterogeneous which allows the child versus other goods trade off to vary over time and amongst individuals.

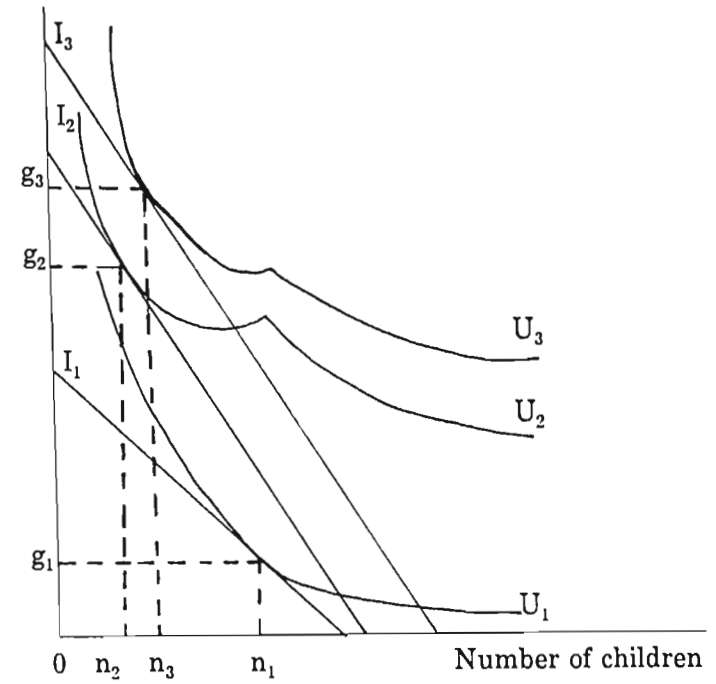

Figure 1.1 Social influence groups and the demand for children (Ron, 1980, p.19)

1.4.4.2 Income and Its Distribution

Empirically the relationship between fertility and income can be described by a U-shape or backward J-shape implying that increases in living standards at low income levels result in more rapid fertility declines than those at higher income levels (Ron, 1980). Economic status becomes the relevant determinant for understanding the impact of income on family size, i.e. who gets the income is important. This is consistent with Freedman (1963), Easterlin (1969, 1975) and the SIG concept where a status group has an expected modal income with which the couple compares their actual income throughout their life cycle, adjusting fertility desires up or down accordingly. Easterlin (1969) suggested that the comparison was between childhood expectations and current living standards so that amongst generations both relative and absolute income will result in increased consumption of all goods, including children, if above the peer groups' perceived mean. The increase in demand for material goods though, must be viewed as a change in tastes that will ultimately lead to fertility decline. These hypotheses have statistical evidence, Ron (1980) cites Repetto (1979) who found that

communities with unequal income distributions had higher aggregate birth rates. Although more egalitarian policies were suggested, the results must be treated with caution because modernisation rather than distribution itself may be important. Repetto (1979) emphasized that the effect also depends on the initial income position of recipients, which at certain levels may cause increases in fertility rather than declines. Simon (1974) concluded from his results that there was little evidence of income distribution effects on fertility in developing countries.

Easterlin (1975) tried a stock adjustment model whereby actual and desired fertility were brought into line. His model is similar to the framework suggested by Bulatao and Lee (1983) where the relationship between income and fertility contains a supply dimension, and after a certain critical fertility level, regulation is introduced to maintain desired family size levels. Consider Figure 1.2: F_p is potential fertility which rises with income and then levels off because income growth induces declining infant mortality and improved fecundity associated with modernisation. F_d is desired family size which falls sharply over some range and then slows or even increases if the income effect becomes positive. As long as income is less than Y_0, $F_p < F_d$ and actual fertility reflects potential fertility. After Y_0 though, $F_p > F_d$ yielding a motivation to limit births so actual fertility now depends upon regulation. The effectiveness of control improves with rising income so the distance between actual and desired fertility narrows as incomes rise.

1.4.4.3 Social Norms

Ron (1980) cited Turchi's (1975) attempt to systematically combine norms and other non economic determinants of fertility into the New Approach model. Channels through which norms on marriage, family size and contraceptive practice influence fertility in a recursive way were described. He assumed as Freedman (1963) and Leibenstein (1974) had done that as a family moves to higher potential income cohorts fewer children would be demanded, whilst higher incomes within the same cohort would be associated with more children. He further suggested group norms not only affect expectations on family size but also family perceptions about the cost of children, or resources devoted to child services,

through the perceived standard of behaviour required to meet those norms. Therefore norms associated with status dictate the prices of children and other goods and the opportunity cost of having children.

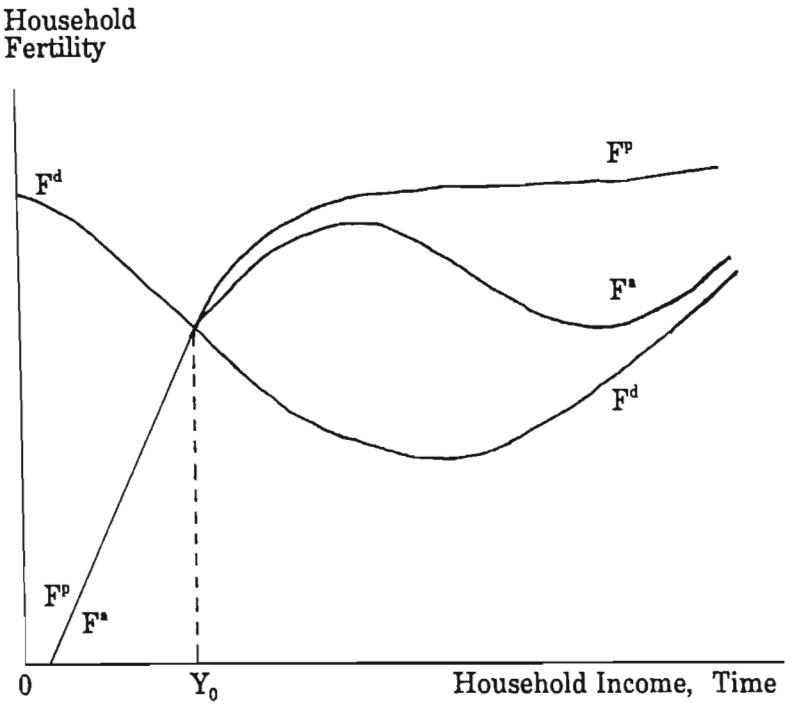

Figure 1.2 Hypothetical trends in household fertility (Easterlin, 1975, p.60)

Turchi's (1975) empirical model used proxies to represent norms such as place of residence, farm background, religion and age of wife etc . Expected family size was analysed through a recursive model on norms and economic variables and indirectly through expectations on the perceived price of children. Generally his results supported his model.

1.4.4.4 Social-psychological Approaches

There are two types of these behavioural theories:

i. sociological models emphasizing group pressure

ii. psychological models that aim to understand the processes of social exchange, regulating mechanisms and joint decision making within the family.

Comparing the two, the latter is more family orientated; the former being dependent on group pressure, norms and status as has previously been discussed. Decisions in psychological models are explained using concepts like motivation, needs, and values, eg. viewing children as a source of ego gratification or self-esteem. These models though, lack empirical testing because of difficulties in specification and measurement.

1.5 A SUMMARY AND CRITICAL OVERVIEW OF THE MICROECONOMIC ANALYSIS OF FERTILITY

Comparing the Chicago and behavioural approaches leads to the conclusion that the former provides a narrow framework which concentrates on identifying the price of children, neglects tastes as a variable and is static in the sense that fertility planning is collapsed into a single decision at the outset of marriage (Nerlove, 1974). The behavioural models emphasize tastes by including socio-psychological factors, underlying norms and SIGs, but lack empirical testing because of the absence of theory on taste formation. Consequently, the major issue dividing the two schools is their treatment of tastes. This can be illustrated using the "New Approach" framework.

$Z(x,t;e)$ is a household production function

where: Z is an output vector of the basic commodity

x is a vector of market goods

t is a time input vector associated with x

e is a vector of environmental variables.

Interpretation of {e} hinges on the philosophical differences of the two schools of thought (Ron, 1980). The Chicago school contends that {e} portrays a set of shift parameters (eg. education or occupation) which should be considered as residual proxies for tastes. The Behavioural school argues that {e} bears a technical progress connotation embedded in norms and education and should be seen to be capable of changing household preferences (or the utility function), and/or making the production of

Z more efficient. Consequently these models allow for a "mapping" of a new household production function on to its set of preferences such that a new function V(x,t;e) would result (Ron, 1980).

Because the behavioural models lack empirical testing and the object of the study was to identify variables which policy makers could use to affect fertility in a useful way, the Chicago approach was followed. However as Willis (1973) has stated, this framework has several limitations because some theoretical concepts are difficult to observe and measure. The following seven are those he listed.

1. Bearing and rearing children involves non-market activities whose costs are not observable.
2. Children and competing household activities require both expenditure in terms of money and in terms of parents' time.
3. Parental obligations are spread over time.
4. Children are not homogeneous products in terms of parents' time intensity, and therefore the cost concept of children becomes ambiguous unless discretionary expenditures on child quality are explicitly included in the analysis.
5. Motives for having children include direct satisfaction they provide parents and the indirect benefits they render by working in the household or family business, or by sending remittance incomes. Therefore fertility is motivated by consumption, savings and investment considerations.
6. Parents, even with perfect knowledge of contraception can not control their family size because of infant and child mortality, gender preference and multiple births; these add further dimensions to the analysis.
7. There are problems with defining an appropriate unit of analysis, i.e. who is the decision maker?

Ron (1980) adds that having children involves risk in the sense that parents can not reverse their decision if their *ex post* valuation is lower than the *ex ante* expectations. Finally Michael (1973)

suggests that children could be viewed as a joint product with sexual gratification and thus birth may be a result of contraceptive failure and not the decision of a rational individual.

There are a further two major criticisms of this model; the first, its static nature, and the second is the assumption concerning family behaviour and the concept of a derived demand function for children.

The model assumes that family size decisions are made once at the outset of marriage while in fact they are sequential involving readjustments as the family ages and their goals change. Schultz (1973, p.3) argued that "the static theory at hand still lumps together first all expectations on children and then all satisfactions from children that occur over the life cycle. It does not disentangle the early and latter parts of this cycle in determining the relative importance of the two parts...What is needed are the *ex ante* expectations of the time path of the family streams over the life cycle with the appropriate weights of these expectations at different stages in the life cycle with due regard for risk and discounting. Static models are unable to account for revisions of these expectations and for the adjustments parents make to unexpected income changes along the life cycle path."

A partial solution to this problem is to collapse lifetime decisions into a single period by using life cycle variables; the most important being expectations of economic variables such as wages, income, costs and benefits of unborn children. This neither accounts for the stochastic biological process over which there is little control, nor the sequential nature of decisions under uncertainty, nor the fact that Griliches (1974) observed that children can affect the decision making process. These problems made Ryder (1973, p.66) conclude that the Chicago model "solved the problems of family economics by dissolving the family". All these facts defy the implied assumption of homogeneous preferences, yet many cross-sectional studies have shown robust statistical estimates implying that this assumption is not highly restrictive to the analysis (Ron, 1980).

The second criticism hinges not on the existence of a derived demand for children, rather on the underlying assumption of a rational decision maker who maximises utility subject to the constraining

set of household production functions. Firstly it excludes other aspects of choice, like satisfaction with a certain number of family members, and secondly the demand function intrinsically assumes that each member's welfare is integrated into a unified family welfare function where each member's utility is independent of the utility of all the others (Willis, 1973). This forecloses interaction between members of the family and of other families as behavioural models suggest.

The basis of the problem is who makes the decisions. Within most fertility studies the choice is arbitrary, where it is formulated according to knowledge of the data. The Bergson-Samuelson welfare function was chosen because it allows the theoretical analysis to be brought into practice. One problem though, is that this function has the assumptions of constant returns to scale for household technology and the impossibility of joint production. Unfortunately these assumptions are critical because they allow the prices of basic commodities to be a function of market good prices and technology while at the same time being independent of tastes as revealed by consumption patterns. Pollak and Wachter (1979, p.271) argue that they "object to the implied but crucial assumption that time spent cooking and time spent cleaning are neutral from the standpoint of the household and that the only outputs of these production processes enter the household's utility function". They suggested that time spent in these activities is a direct source of utility or disutility. "Consequently, household decisions about the allocation of time reflect not only production considerations but also household preferences as to the use of time". Although this criticism is legitimate the neoclassical framework can still be used to explain fertility.

CHAPTER 2

FORMULATION OF THE MODEL

2.1 INTRODUCTION

Before presenting a detailed description of the model, it is necessary to outline the general choice problem adapted from neoclassical theory which allows for a better specification of the structural relationships and hence reduced form of the theoretical model. Larsson's (1976) model cited by Ron (1980) is followed.

$$\text{Max } U(Z)$$

$$\text{subject to} \quad Z = Z(x,t;\ e)$$

$$p'x = Y$$

$$t'i = T$$

$$t \geq Ax$$

where: Y = the budget constraint

T = total time available

i = a unit vector

Ax = time consumption constraint

p = price vector of market goods (x)

A = a diagonal matrix representing the technological or institutional determined minimum amount of time required to consume one unit of x; {a} ϵ A is an element of A

To derive the demand functions x, t, a_i and p are partitioned such that:

$$x = \begin{bmatrix} x_n \\ x_s \end{bmatrix} \qquad t = \begin{bmatrix} t_n \\ t_s \end{bmatrix} \qquad a_i = \begin{bmatrix} a_{in} \\ a_{is} \end{bmatrix} \qquad p = \begin{bmatrix} p_n \\ p_s \end{bmatrix}$$

where n and s represent the number of children and all other goods (aggregated), respectively. Thus the derived set of demand functions is:

$$x_j = f(P_j, a_{ij}, Y, t_j) \quad j = n,s$$

where: x_n = planned number of children

t_n = time used in rearing children

a_{in} = socially defined minimum amount of time required per child

p_n = price per child

x_s = planned consumption of the aggregate goods,otherwise known as standard of living

t_s = time used in the consumption of s

a_{is} = socially defined minimum amount of time per unit of consumption good

p_s = price per unit of consumption goods

This general outline of the choice problem allows for a more detailed specification of fertility, the possibility of overcoming the static nature of the Chicago model and the problem of tastes. Consequently the modified version of the neoclassical model provides an adequate framework for postulating the "cost" and "benefit" affects on family size choice. Decisions on marriage, family size and woman's labour market participation are simultaneously determined, each affecting and influencing each other. Therefore construction of the structural relationships and reduced forms derived from theory must ensure that simultaneous bias is minimised and control variables are identified.

The family is considered to be both a production and consumption unit which seeks to gain utility from competing sources of satisfaction among them children. Therefore microeconomic theory proposes that resource allocation would be derived according to income, relative prices of alternatives and production technologies. This chapter will review and specify the forces influencing income, relative prices and technology and proceed to specify a general formulation of the full theoretical model. The model will then be adapted to account for the specific situation in South Africa.

2.2 SPECIFICATION OF THE MAJOR RELATIONSHIPS

2.2.1 Income and Price Effects

Usually family income is defined as the sum of the husband's and wife's discounted lifetime earnings, non labour wealth and the opportunity costs of home production if the wife and children are not in the labour market (Ron, 1980). Of these, wife's opportunity costs are most difficult to measure in terms of the theoretical model. The two major difficulties are:

1. Measurement of price effects requires estimates of child costs and benefits, and then expressing these costs as complements to or substitutes for children. Often, however it is difficult to discern which goods are complements to or substitutes for children as the relationship depends upon the child's age and society's norms.
2. The measure of unbiased income effects necessitates that the price of time and market goods be held constant.

These problems are caused by two underlying assumptions. The first is that the wife alone faces the choice between home production and market work. This implies that the husband's earnings only affect family income and not the price of time inputs into child care (in which he is assumed not to be involved). Thus his income is an estimate of the "pure" income effect. However the assumption is unrealistic as shown by Mincer (1963) and Leibowitz (1974) who found that there was a correlation between wife's earning capacity and husband's income, and that wife's time is substituted for husband's time within the household. Consequently a rise in opportunity costs of husband's time will increase the value of wife's time, which implies the opportunity cost of child care will tend to increase with any growth in human capital.

The second assumption is that home skills or "home wage" is correlated with the market wage. This allows an approximation of wife's opportunity cost of time in planning lifetime labour allocation

between home and market production by her market wage to be made. Limitations arise in less developed countries though, where labour markets do not always exist, or where people choose not to work. In this case the market wage can no longer be treated as exogenous, and may not necessarily be correlated with the home wage, or it may bias estimates of opportunity costs (Heckman, 1974; Killingsworth, 1983).

The conclusions about income's effect on fertility are that husband's and wife's incomes are expected to pull in opposite directions, the former representing a pure income effect; the latter a negative substitution effect, which outweighs the wife's contribution to the pure income effect. Also, as Mincer (1963) has shown, there is an occupation factor operating which links the preferences for low fertility and higher work participation. The greater the number of women with these preferences, the more negative will be the relationship between family size and labour force participation.

2.2.2 Measurement of Income

Becker's (1960) use of current income was modified by Mincer (1963) following Friedman (1957, p.23) who suggested that a variable representing long run expectations of wealth accumulation was a better measure. They both used the notion of permanent income but, as the latter notes it is a behavioural concept since the "distinction between permanent and transitory is intended to interpret actual behaviour, and consumers are treated as if they regard their income as the sum of these two components". Therefore a measure of permanent income is the median income per age group, or the discounted value of wealth.

However with cross-sectional studies additional problems are encountered because data are collected at one point in time but are supposed to be estimating expected family income over a lifetime. So in cross-sectional studies Ron (1980) argues that researchers need to solve two problems.

1. Remove life cycle influences.

2. Account for the fact that certain explanatory variables may be partially a function of previous fertility behaviour.

Although the former precludes use of current income because it contains transitory components, there are still two options open. The first is to use expected values where income is measured by the present value of a projected lifetime stream. This is less useful than the second method because of the difficulties of choosing an appropriate discount rate, and the fact that it ignores the possibility that individuals' earning capacities are positively related with their characteristics (Ron, 1980). The second, usually preferred method is to use permanent income which is derived by the following equation:

$$Y_p^i = f(AGE^i, ED^i, D^i, N)$$

where: AGE^i = age of family member i

ED^i = education (formal schooling) of member i

D^i = vector of additional variables that may influence future income streams eg. occupation

N = number of children

Y_p^i = calculated value of the adjusted permanent income of member i

Note that a technical requirement of no intercept is imposed, because if all explanatory variables are zero, so to will be Y_p^i, by definition (Ron, 1980). The empirical model in this study has tried both options. The first uses wife's education as a proxy for expected lifetime income because it need not be discounted and accounts for background characteristics, but this is limited to the single equation model. The simultaneous model follows the second preferred method.

2.2.3 Education (Technology)

Parents education is highly correlated with income therefore its effects are difficult to predict. Consequently problems arise when trying to separate other possible effects of education such as the

"technology" aspect. Mothers' education, especially, is regarded as such because it affects her ability to do household chores and rear children by improving her productivity and efficiency. Ron (1980) has measured "technology" by knowledge and access to birth control. Her ability to control births affects her earnings in the labour force which improves the family's ability to raise funds and credit for increased child quality. Measurement problems precluded use of contraceptive knowledge in this study.

Husband's education can be used as a proxy for the family's social status, thus reflecting tastes. It is expected that better educated fathers would desire better educated children.

2.2.4 Tastes and Demographic Variables

It is possible to list a large variety of taste and demographic factors which represent the preference set of the decision unit. However little insight is provided into understanding why family size varies with these factors. Bagozzi and Van Loo (1978, p.217) suggest "the causal or functional mechanisms influencing fertility variables are proxies or surrogates for the real causes of fertility".

In practice, tastes are represented by dummy variables because they may capture systematic differences in preferences. Examples are shown below.

a. Religion, ethnicity, education, socioeconomic status, rural versus urban background, norms, contraceptive practices etc.

b. Direct living costs: farm children are relatively cheaper because they provide productive utility to parents.

c. Population density: in developing countries low densities may be associated with low levels of school and health care institutions.

d. Location of job opportunities: parents with tastes for market goods as opposed to home goods (children) may be located in areas where the price of children in terms of wage loss are higher.

Inclusion of these dummies in the model implies that they are control variables to capture unexplained variation by strict economic factors. This means they are viewed as utility shifters, or as parameters accounting for technological change in household production.

2.3 A MICROECONOMIC MODEL OF FERTILITY

A deterministic model of the lifetime "marital" family production and consumption relationships is developed following the Chicago school, and the general formulation is a composite approach of De Tray (1973), Willis (1973), Ben-Porath (1973) Becker and Lewis (1973) and Schultz (1973, 1974) as suggested by Ron (1980).

2.3.1 General Formulation

Families are assumed to allocate their resources in such a way as to maximise utility of the form

$$U_r = U_r (Z), \quad Z = \{ z_j \} \qquad 1$$

where: Z = vector of non-marketable home produced commodities

$z_j \in Z$ is a Lancaster - Becker basic commodity resulting from the combination of time and market goods and services by the consumer in his simultaneous role as producer, given his preferences, or tastes. (These are expressed as a shift factor).

j = 1...m basic commodities and r = 1...R time periods

$$z_j = z_j (T_j, X_j; \tau) \qquad 2$$

where: T_j and X_j are greater than or equal to zero and represent inputs of time and purchased market goods respectively.

τ represents technology or efficiency under which household production is conducted.

The underlying assumptions of the utility function are as follows:

a. $U_r = U \forall r$ that is lifetime decisions can be collapsed and expressed in a single period model.

b. U is a Bergson-Samuelson family welfare function in which the following are assumed to exist:

   i. $U^i = U^i(Z^i_j)$ for each member i. This means each family member's utility is independent of the level of utility of any other member.

   ii. $Z_j = \sum_i z^i_j$ This implies no jointness in consumption among family members, so an additional unit of z_j allocated to member i must be subtracted from the consumption of all the other members.

c. The household utility function for the decision period is twice differentiable and quasi-concave.

Children are viewed as home produced durable assets from which parents consume a flow of services. The flow varies with number and resource intensity (or quality) with which children are raised. Therefore the household utility function can be specified as:

$$U = U(C,S) \qquad 3$$

where the basic commodities are C, the discounted flow of child services and S, the parents' "standard of living", is an aggregate of all other goods, including leisure, used in the household. C is composed of the total number of children born (N) and the quality per child (Q) which is the investment of human capital per child (eg formal education). The model assumes that:

1. Q is equal for all children within a family which implies the flow of utility generating child services each period r, C^r, is proportional to the stock of children N such that $C^r = \mu^r N$ where μ^r is a quality index (Willis, 1973; Becker and Lewis, 1973; Ron, 1980) or is the r^{th} period rate of "psychic" services coming from each child (Rosenzweig, 1977).

2. The household production functions are separable and linearly homogeneous in T_i and X_i, (i.e. they exhibit constant returns to scale) and there is no joint production. These functions are specified as follows:

$$C = C\left(N, C_i\right) = C\left(T_c^h, T_c^w, X_c; \tau^h, \tau^w\right) \qquad 4.1$$

$$Q = \frac{1}{N}C \quad or \quad Q = Q\left(\frac{1}{N}T_c^h, \frac{1}{N}T_c^w, \frac{1}{N}X_c; \tau^h, \tau^w\right) \qquad 4.2$$

$$N = N\left(T_n^h, T_n^w, X_n; \tau^h, \tau^w\right) \qquad 4.3$$

$$S = S\left(T_s^h, T_s^w, X_s; \tau^h, \tau^w\right) \qquad 4.4$$

where: T_j^i = total time input of the i^{th} household member into the production of the j^{th} basic commodity.

X_j = index of purchased market goods inputs into the production of commodity j.

τ^i = efficiency index of household member i in household production

i = h (husband), w (wife); j = C, N, Q, S

Production capacity is limited by the wealth ($\bar{W}$) and time ($\bar{T}$) constraints.

$$\bar{W} = Y^h + Y^w + V = W^h T_L^h + W^w T_L^w + V \geq p_c X_c + p_s X_s \qquad 5$$

=> total potential income (consumption) always exceeds (or equals) total purchases made.

$$\bar{T} = T^h + T^w = \sum_i \sum_j T_j^i + \sum_i T_L^i \qquad (j = C, S;\ i = h, w) \qquad 6$$

where: Y^i = present value of member i's lifetime income at time period r

W^i = market wage per unit of time of member i

T_L^i = total labour supply since marriage of the i^{th} member

V = non labour related wealth

P_j = money price index of purchased market goods which are inputs to the production of commodity j

T^i = total lifespan after marriage of the i^{th} household member, allocated between market and non-market activities

The model assumes that husband's wage, W^h is exogenously determined and that his income does not respond to changes in his family size. Although this is realistic and especially true in Africa (Ainsworth, 1989) it is unlikely that the mother is also a price taker. Her earnings are likely to reflect variation in labour force participation as a result of bearing and rearing children, and other household activities. Thus T_L^w can vary from zero to full time participation depending on the wife's opportunity costs of remaining at home. Ron (1980) emphasised a point which Mincer (1972) made that females' wages are also determined with some form of initial human capital, either formal education, or "learning by doing". Consequently the wage structures or earning capacities can be represented as

$$W^h = W^h(\tau^h) \qquad \frac{\delta W^h}{\delta \tau^h} > 0 \qquad 7.1$$

$$W^w = W^w(T_L^w ; \tau^w) \qquad \frac{\delta W^w}{\delta \tau^w} > 0 \qquad 7.2$$

Note: $\tau^i = \tau^i(T_L^i)$ reflects the initial stock of human capital of member i, and can be interpreted as his/her efficiency in the production of j.

The assumption of non-joint production allows the inputs T and X to be formulated in additive terms.

$$X = X_c + X_s \qquad 8.1$$

$$T^i = T_c^i + T_s^i \qquad (i = h,w) \qquad 8.2$$

Since it is assumed that mothers alone are productive at home it follows that $T_c = T_c(T_c^w)$ and $T_s = T_s(T_s^w)$ hence 8.1 and 8.2 imply that:

$$T^w = \alpha_c X_c + \alpha_s X_s \qquad 9$$

where: $\alpha_j = T_j^w/X_j$ represents the wife's time intensity in household production of the j^{th} commodity.

The linear homogeneity assumption of the production functions allows expression of the marginal productivities of these two factors solely as a function of the input ratios (time intensities), which means that 4.1 and 4.4 may be rewritten as

$$C = X_c\, g^c(\alpha_c) \qquad 10.1$$

$$S = X_s\, g^s(\alpha_s) \qquad 10.2$$

where: $g'>0$ and $g''<0$ and it is assumed that $\alpha_c > \alpha_s$.

The simultaneity of variables belonging to production constraints, and wealth and time constraints allows the production possibility set of the household to be formulated as an implicit function, Φ, such that

$$\phi\left(C,S;\ T_L^h, T^w, \tau^w\right) = 0 \qquad 11$$

which implies that for given levels of the exogenous T_L^h, T^w and τ^w, the primal function can be expressed as

Max U (C, S)

subject to

$$\phi\left(C,S;\ T_L^h,\ T^w,\ \tau^w\right) = 0 \qquad (C \geq 0;\ S > 0) \qquad 12$$

The solution determines an optimal set of time and market goods vectors (T_c^*, T_s^*) corresponding to an optimal commodity vector (C^*, S^*) that maximises equation 3. During this process, the optimal physical resource allocation of commodities and factors is accompanied by a corresponding set of shadow prices (π's). These represent the marginal costs of commodities and factors in production and consumption, and are derived by combining the time and wealth constraints into a "full wealth" constraint or expenditure function (I). The time and income constraints are:

$$T^i = T_c^i + T_s^i + T_L^i \qquad (i = h, j) \tag{13.1}$$

$$V + T_L^h W^h + T_L^w W^w \geq p_c X_c + p_s X_s \tag{13.2}$$

Assuming the shadow price of wife's time is W^w, these two equations can be combined such that:

$$\left(t_c^h W^h + t_c^w W^w + p_c X_c\right) C + \left(t_s^h W^h + t_s^w W^w + p_s X_s\right) S = W^h T^h + W^w T^w + V$$

$$\therefore \quad \pi_c C + \pi_s S = I \tag{14}$$

where: t_j = marginal time coefficient into the production of one unit of j.

X_j = marginal market good coefficient into production of one unit of j. (NB: Marginal = average since the production functions of C and S exhibit constant returns to scale).

Because husbands are assumed to be unproductive at home, t_c^h and t_s^h equal zero, so that 14 can be rewritten as:

$$\left(t_c^w W^w + p_c X_c\right) C + \left(t_s^w + p_s X_s\right) S = \pi_c C + \pi_s S$$

$$= W^h T_L^h + W^w T^w + V = I \tag{14.1}$$

It is important to realise that the π_j are expressed in terms of market prices of time of member i, purchased market goods and endowments of time and market goods in activity j. The endowments are also determined by market prices and household income so the π_j may be specified as:

$$\pi_j = \pi_j\left(W_j^w, p_j, \bar{W}\right) \tag{15}$$

Hence the linkage between supply and demand sides of family behaviour is given by I and π_j (Willis, 1973; Ron, 1980). Willis (1973) argued that the duality between optimal production and consumption of C and S and the shadow prices π_c and π_s can be illustrated by understanding that the one stage process in 12 is equivalent to a two stage process involving the maximising of utility function 3 subject to home production constraints, and then maximising 3 subject to the minimum full wealth constraint (I). The shadow prices π_j are obtained via the Pareto conditions for optimal allocation, and these are used in the second stage to derive demand functions of C, N, and S. The process is achieved as follows:

a. first stage:

$$\textit{Max } U(C,S)$$

subject to

$$C = C\left(T_c^h\ ,\ T_c^w\ ,X_c\right)$$

$$S = S\left(T_s^h\ ,\ T_s^w\ ,\ X_s\right)$$

$$\bar{W} = \sum_j p_j X_j = \sum_i W^i T_L^i + V$$

$$\bar{T} = \sum_j \sum_i T_j^i + \sum_i T_L^i \qquad 16$$

where: $C \geq 0,\ S > 0; \quad i = h,w \quad j = C,S$

The Legragian function and first order conditions for the maximisation are:

$$\Lambda = U\left(C,S\right) + \lambda\left(\bar{W} - \sum_j p_j X_j\right) + \lambda^h\left(T^h - T_j^h - T_L^h\right) + \lambda^w\left(T^w - T_j^w - T_L^w\right) \qquad 17.1$$

$$\frac{\delta\Lambda}{\delta C} = \frac{\delta\Lambda}{\delta S} = 0 \qquad 17.2$$

The solution implies that

$$\frac{\delta\Lambda}{\delta Z} = \lambda\pi_z \frac{\delta X_z}{\delta Z} + \lambda^h \frac{\delta T_z^h}{\delta Z} + \lambda^w \frac{\delta T_z^w}{\delta Z} \qquad Z = C,\ S \qquad 18$$

where: λ = marginal utility of wealth

π_z = shadow price or marginal cost of activity Z

λ^i = value of marginal product of time (= marginal utility of time) for household member i in the production of Z.

When optimal conditions are satisfied the ratios of the marginal products of all inputs in each activity will be equal to their shadow prices or marginal costs i.e.

$$\frac{\delta Z/\delta T_z^i}{\delta Z/\delta X_z} = \frac{\lambda^i/\lambda}{\pi_z} \equiv \frac{W^i}{\pi_z} \qquad (Z = C,S); \quad (i = h,w) \tag{19}$$

Also the marginal rate of commodity substitution (MRCS) along 3 will equal the marginal rate of product transformation (MRPT) along 11 i.e.

$$MRCS_{c,s} \equiv \frac{MU_c}{MU_s} = \frac{\pi_c}{\pi_s} = \frac{-dS}{dC} = \frac{\delta\phi/\delta C}{\delta\phi/\delta S} = MRPT_{c,s} \tag{20}$$

b. second stage: the utility function is maximised subject to the minimum full wealth constraint

$$Max\ U = U(C,S)$$

subject to

$$I = \pi_c C + \pi_s S \tag{21}$$

Solving the first order conditions simultaneously and using comparative statics gives the demand functions below. (See Willis, 1973, for a full derivation).

$$\begin{aligned} C &= f_c\,(I,\ \pi_c,\ \pi_s;\ \tau) \\ S &= f_s\,(I,\ \pi_c,\ \pi_s;\ \tau) \qquad \because C = NQ \\ N &= f_n\,(I,\ \pi_n,\ \pi_s;\ \tau) \\ Q &= f_Q\,(I,\ \pi_Q,\ \pi_s;\ \tau) \end{aligned} \tag{22}$$

π_n = $\pi_c Q$ is the marginal cost of an additional child of given quality

π_q = $\pi_c N$ is the marginal cost of raising the quality per child for a given number of children

π_s marginal cost of the parents' standard of living

The properties of the demand functions are found by total differentiation of the following first order conditions

$$MU_n + \lambda \pi_c Q = 0$$

$$MU_Q + \lambda \pi_c N = 0$$

$$MU_s + \lambda \pi_s = 0$$

$$\pi_c NQ + \pi_s S - I = 0$$

Using comparative statics, the bordered Hessian and Youngs' theorem of symetricity, the relationship between p and q can be expressed in elasticity terms i.e.

$$\frac{\delta N}{\delta \pi_n} \cdot \frac{\pi_n}{N} \equiv \eta^*_{n,\pi_n} \qquad 23.1$$

$$\frac{\delta Q}{\delta \pi_Q} \cdot \frac{\pi_Q}{Q} \equiv \eta^*_{Q,\pi_Q} \qquad 23.2$$

$$\frac{\delta N}{\delta \pi_Q} \cdot \frac{\pi_Q}{\delta N} \equiv \eta^*_{n,\pi_Q} = \eta^*_{Q,\pi_n} \quad > 0 \text{ or } < 0 \qquad 23.3$$

(where η^* denotes the compensated substitution effect)

Note: Equation 23.3, the equivalent of a cross price elasticity, is positive if N and Q are substitutes and negative if they are complements.

Usually it is assumed that children are normal goods and that the number of children (N) is a substitute for Q, quality per child. (i.e. $\delta N/\delta I > 0$; $\delta N/\delta \pi_Q > 0$ respectively). Becker and Lewis (1973) have cautioned that observed relationships between number of children and income (holding wages and prices constant) could be negative even if the "true" (holding marginal costs constant) relationship is positive because the theoretical relations are in compensated terms which are not

observed. It is also assumed that quality is a complement to standard of living, S, *(i.e.* $\delta Q/\delta \pi_s < 0$*)* which implies that $\delta N/\delta \pi_s > 0$; number of children is a substitute for standard of living.

The existence of an equilibrium and the fact that both parents are thought to export their time to the labour market and import market goods permits a translation of the "terms of trade", which is determined by the exogenous prices for labour and goods and the earning capacities of husbands and wives. Thus the final set of demand functions can be represented in the following reduced form:

$$N = N\left(W^h,\ W^w,\ p_n,\ p_s,\ V;\ \tau\right) \qquad 24.1$$

$$S = S\left(W^h,\ W^w,\ p_s,\ p_n,\ V;\ \tau\right) \qquad 24.2$$

In summary then, the major theoretical arguments will be stated.

1. Using the full income equation 14 let $\eta^{*}_{z,\pi_z} \equiv \frac{\delta Z}{\delta \pi_z}.\frac{\pi_z}{Z}$ be the full price (Hicksian compensated) elasticity for the basic commodity Z, and let $\eta_{z,I} \equiv \frac{\delta Z}{\delta I}.\frac{I}{Z}$ be the full income elasticity for Z. Further let $\delta^h_z \equiv \frac{T^h_z\, W^h}{Z\pi_z}$; $\delta^w_z \equiv \frac{T^w_z\, W^w}{Z\pi_z}$ be husband's and wife's time input shares in the total costs of Z respectively, and $\theta^i \equiv \frac{T^i_L\, W^i}{I}$ $(i = h,w)$ be their respective shares in the income earned in the market.

Argument 1. Quantity and quality of children are substitutes in consumption i.e.

$$\eta^{*}_{Q,\pi_s} > 0 \Rightarrow \eta^{*}_{s,\pi_s} > 0$$

Argument 2. Increases in the family's resources will primarily result in an increase in their standard of living i.e. $\eta_{s,I} > \eta_{n,I}$

Argument 3. $T_L^h W^h > T_L^w W^w$ as both male wage rates and their labour force participation usually exceed those of females. This suggests that the positive income effect associated with a change in male wages will be greater than that associated with a change in female wages.

2. Traditional microeconomic theory allows the elasticity of demand for children with respect to a change in either of the parent's wage to be expressed in terms of the above defined shares, such that the compensated (holding full income constant) price and income elasticities of demand for children will be $\eta^*_{n,w^i} \equiv \frac{\delta N}{\delta W_i} \cdot \frac{W^i}{N} = \eta^*_{n,\pi_n} \left(\delta^i_n - \delta^i_s\right) + \eta_{n,I}\, \theta^i$

Argument 4. Assuming $\left(\delta^w_n - \delta^w_s\right) > \left(\delta^h_n - \delta^h_s\right)$ equation 25 suggests that $\eta^*_{n,w^h} > \eta^*_{n,w^w}$ if N is time intensive for women, then $\delta N/\delta W^w$ will be less than zero and $\delta N/\delta W^h$. Thus increases in the value of wife's time raises the relative price of N more than increases in the husband's time value.

Argument 5. Initial human capital endowments are assumed to affect the market wage (equations 7.1 and 7.2). Consequently they will also affect the number of children via their effect on full prices and full income. Using the previous argument, it follows that woman's education will be negatively related to the number of children she will have, provided $\eta_{n,I}$, the full income elasticity with respect to the number of children is small enough (Ben-Porath, 1973).

Argument 6. The net effect of an unexpected permanent change in income (holding prices constant) could be weakened or reversed depending on the source of the that change, especially if the source causes an offsetting change in the opportunity cost of time (price of a child). Therefore the relevant wage effects on demand would be reduced because it is likely that the income elasticity with respect to the demand for children is absolutely smaller than the corresponding price elasticity.

2.3.2 An Adaption to a Developing Country's Situation

In a rural environment parents view children both as a durable consumption good yielding psychic returns (expressed by a utility function), and productive assets yielding pecuniary returns to the family through the family labour supply. Consequently an additional dimension is added to the general formulation namely the child's contribution to agricultural production. Empirical studies confirm the importance of children as a productive labour unit showing a positive relationship between child productivity and labour force participation with birth rates. (Gardner, 1972, 1973; Rosenzweig, 1977; Rosenzweig and Evenson, 1977) These studies illustrate the importance of price and income effects associated with farm children's labour contribution by portraying that

i. changes in the market for farm labour determine the rural urban migration patterns and therefore influence fertility decisions of rural families
ii. variables which are positively related to pecuniary returns to child labour generally appear to be positively related to family size.

Thus it is hypothesised that pecuniary returns from farm children are a major factor affecting birth rates in these areas. Consequently it was proposed that historical decline in demand for farm man power and hence farm birth rates, was primarily the result of a relative price increase of farm labour units associated with capital-based technical progress (Hayami and Ruttan, 1970).

Other aspects which affect the farm fertility model specifically include a decline in the demand for survivors as infant and child mortality dropped along with their associated uncertainty, and decreases in the number of family enterprises resulting from increased off farm opportunities and the lower productive value of farm labour.

With the new dimension to the model come additional assumptions namely:

1. Child's and wife's labour can by viewed as close substitutes in farm production.
2. Child's schooling and labour are substitutes.
3. Productive capacities of each child is equal and constant.
4. Human capital endowments are equal on average for children and are represented by formal schooling levels.

The first two assumptions affect the value of time of a non- working mother. The former implies that her "wage" is negatively related to her children's earnings and the second suggests that improved school enrolments would increase her value of time and hence depress fertility rates. The final two assumptions imply homogeneity of farm children which although restrictive is necessary for the farm model.

2.3.2.1 An Appropriate Fertility Model

Since both urban and rural areas are included in the study and women have access to formal employment, profitable informal sector labour and subsistence farming, child labour contributions can not be restricted to farm households. The model has been adapted to accommodate the different options.

$$U = U\,(\,N,S,Q) \qquad 26$$

$$N = f_n\left(X_n, T_n^w\right) \qquad 27.1$$

$$S = f_s\left(X_s, T_s^w\right) \qquad 27.2$$

$$Q = f_Q\left(X_Q, T_Q^{ch}\right) \qquad 27.3$$

where: U is a utility function of Z home produced basic commodities

N is number of children

S is the stream of services provided by all other aggregated commodities (including leisure)

Q is child quality defined by schooling per child

f_n, f_s, f_Q are the associated linearly homogenous production functions

X_z are market goods and services used in the production of the Z goods *(Z = N,S,Q)*

T_j^w are the mother's time inputs into production of good j *(j = N,S)*

T_Q^{cj} is the child time input into quality production

Since the marginal and average input coefficients are equal, the inputs can be expressed as:

$$X_z = x_z Z \qquad 28.1$$

$$T_z^i = t_z^i Z \qquad 28.2$$

where x_z and t_z^i are the marginal input coefficients of X and T per unit of Z respectively. The labour services from children N, are assumed to be an additional input into the "farm" or household production function g(.) together with parents' labour time T_f^i, hired labour H, and services of land and capital K. This function is assumed to be twice differentiable, exhibit decreasing returns to scale (Rosenzweig, 1977; Ron, 1980) and is a component of the household profit function (π).

$$\pi = P\left[\, g\left(N,H,K,T_f^i\right)\right] - \pi_H H - \pi_K K \qquad 29$$

where: P = exogenous price per unit of household output

π_H = price per unit of hired labour services

π_K = rental price of K, the aggregate of capital services

Because a market for labour exists, mother's time can be distributed between the following activities;

$$T^w = T_n^w + T_s^w + T_f^w + T_L^w \qquad 30.1$$

where n, s, f, and L represents children, other goods, "farm" labour and market labour respectively. Following Rosenzweig (1977) the household value of mother's time equals the wage she earns in the labour market so long as she remains in the labour market. That is her marginal value product in household activities (subsistence and informal sector labour) Pg_{T_f} equals her market wage (W^w); mother's price of time will be invariant with respect to the commodity set chosen and the allocation of household production inputs. If, however the mother does not partake in the labour force, her value of time in household production ($\hat{W}$) is still equal to her marginal value product in household production but becomes an endogenous variable in the model.

Husbands are assumed not to take part in household chores and are therefore excluded. Although this is a common assumption it is particularly relevant to South Africa where women commonly have children out of wedlock and for many married women husbands are migrant workers spending most of their time in cities far from the household.

Child's time (T^{ch}) can be distributed between time inputs into child quality (T_Q^{ch}) and household production (T_f^{ch}) as follows:

$$T^{ch} = T_Q^{ch} + T_f^{ch} \qquad 30.2$$

The household resource constraint is given by:

$$V + T_L^w W + \pi - p_n x_n N - p_s x_s S - NQ\, p_Q x_Q = 0 \qquad 31$$

These constraints can be combined into the full wealth constraint (I).

$$I = t_L^w W^w + V + Pg\left(N,H,K,T_f^i\right) - N\left(p_n x_n + t_n^w W^w\right) - S\left(p_s x_s + t_s^w W^w\right)$$
$$- \hat{W} T_f^w - W^{ch} T_f^{ch} - N\,Q\left(p_Q x_Q + t_Q^{ch} W^{ch}\right) - \pi_H H - \pi_K K = 0 \qquad 32.1$$

or,

$$I = T_L^w W^w + V + Pg\left(N,H,K,T_f^i\right) - \hat{W} T_f^w - W^{ch} T_f^{ch}$$
$$- N\pi_n - S\pi_s - NQ\pi_Q - H\pi_H - K\pi_K = 0 \qquad 32.2$$

where: V = non labour wealth including remittance income from husbands and children not at home

$\pi_n = p_n x_n + t_n^w W^w$ is the consumption price of children

$\pi_s = p_s x_s + t_s^w W^w$ is the consumption price of other services

$\pi_Q = p_Q x_Q + t_Q^{ch} W^{ch}$ is the consumption price of child quality

The optimal set of N, S, Q, H, K, T_f^i is obtained by maximising 26 subject to 32. This yields the following legragian function and first order conditions:

$$L = U(N,Q,S) + \lambda\left(T_L^w W^w + Pg(\cdot) + V - \pi_n N - \pi_s S - \pi_Q NQ - \pi_H H - \pi_K K - \hat{W} T_f^w - W^{ch} T_f^{ch}\right) \qquad 33$$

$$L_n = U_n + \lambda(Pg_n - \pi_n - \pi_Q Q) = 0 \qquad 34.1$$

$$L_s = U_s + \lambda(-\pi_s) = 0 \qquad 34.2$$

$$L_Q = U_Q + \lambda(-N\pi_Q) = 0 \qquad 34.3$$

$$L_H = \lambda(Pg_H - \pi_H) = 0 \qquad 34.4$$

$$L_K = \lambda(Pg_K - \pi_K) = 0 \qquad 34.5$$

$$L_{T_f^w} = \lambda\left(Pg_{T_f^w} - \hat{W}\right) = 0 \qquad 34.6$$

$$L_{T_f^{ch}} = \lambda\left(Pg_{T_f^{ch}} - W^{ch}\right) = 0 \qquad 34.7$$

Equations 34.4 - 34.7 represent the first order conditions of a profit maximisation which shows that the value of the marginal products should equal their input prices. Thus labour is hired as long as its marginal product is at least as high as the hiring wage. If the mother works in the formal labour market, the value of $\hat{W}$ will equal not only the value of her marginal product in household production but also her labour wage. If she does not work in the formal labour market $\hat{W}$, her forgone time in household production (opportunity cost) will become an endogenous component related to her productivity in the household (Ron, 1980). This is also true of the child's wage rate W_f^{ch} which will equal his marginal value product in household production. Therefore the predetermined marginal cost of children π_n, defined in budget constraint 32 is only relevant if child services are solely consumption commodities. When children provide pecuniary contributions, the monetary equivalent of their marginal utility of services in the household must be subtracted from π_n. The true shadow price of child services will be:

$$\bar{\pi}_n = \frac{1}{\lambda}U_n = \pi_n - Pg_n + \pi_Q Q \qquad 35$$

where Pg_n is the value of the marginal utility and $\pi_Q Q$ is the total cost of child quality. Therefore as Rosenzweig and Evenson (1977) report, the shadow price of children is a positive function of the price of goods used to produce children, the wage of the mother and the level of child quality chosen, but is negatively related to total earnings per child[3]. Equation 35 indicates that the dual role of children makes the full shadow price of children endogenous and dependent on the number of children demanded. This happens because as N increases, Pg_n and $1/\lambda U_n$ will decrease *ceteris paribus*. The response of the stock of children demanded is dependent upon the market conditions affecting the price

[3] For exposition the quality component will be ignored until a later section where it will be discussed more fully.

of child's time. Using the model, the impact of these conditions can be demonstrated by directly analysing the relationships between the components of the model and family size.

2.3.2.2 Parametric Changes and Demand Analysis

The household's demand function for children can be obtained by a total differentiation of the first order conditions 34.1 - 34.7 which imply that the response of child demand to its price, $\bar{\pi}_n$, can be decomposed into compensated (*) substitution and full income effects.

$$\frac{\delta N}{\delta \bar{\pi}_n} = \left(\frac{\delta N}{\delta \bar{\pi}_n}\right)^* + \frac{N \delta N}{\delta I} \qquad 36$$

Since $\bar{\pi}_n = \bar{\pi}_n(P, \pi_j)$, the demand function may also be written as a function of I, P, and π_j, ie.

$$N = \xi(I, P, \pi_j) \qquad j = H, K \qquad 37$$

Although $\bar{\pi}_n$ is not observable, some of its components are an explicit part of the model so their predicted effects can be analysed.

i. Price of time and income effects where mother's wage equals W^w.

Under the assumption that the price of time of the mother is equal to her wage W^w in the labour market the uncompensated substitution elasticity of children with respect to her wage (η_{n,W^w}) is given by:

$$\eta_{n,W^w} = \eta^*_{n,\bar{\pi}_n}(\alpha_n - \alpha_s) + \gamma_{n,w} + \left(T_f^w + T_L^w\right) W^w \frac{\varepsilon_I}{I} \qquad 38$$

where: $\eta^*_{N,\bar{\pi}_n}$ is the own compensated price elasticity of children

ε_I is the (full) income elasticity of child services

$\alpha_z = \frac{t_z W^w}{\pi_z}$ the value of woman's time intensity in commodity Z, evaluated at its shadow price π_z.

$\gamma_{n,w}$ is the elasticity of substitution between mother and children in household production

As in the "consumption" household fertility models (Ben-Porath, 1973; Willis, 1973 etc.) a compensated increase in the mother's price of time will reduce the demand for children if N is the time intensive commodity since $\eta^{*}_{N,\bar{\pi}_n} < 0$ by second order conditions. This restriction, however, may not be sufficient because the compensated wage effect also depends on the magnitude and sign of the substitution elasticity in household production between the mother and her children. Moreover, as Rosenzweig (1977) states "if $\gamma_{n,w}$ is insignificant and even if the consumption price time intensities are equal an increase in W^w may result in a diminution on the desired stock of children since α_n would exceed α_z as $\pi_n > \bar{\pi}_n$ ". It appears therefore that, even when market prices and household production characteristics are identical in households where children are consumption goods alone to where they are also productive assets, the compensated female wage effect on fertility will differ between the two as a consequence of children's pecuniary contribution to the latter.

The sign of the mother's uncompensated wage effect also depends on the full income elasticity of children weighted by the share of the wife's earnings in full family income. The existence of the child productivity component in the full shadow price of children in consumption, however, leads to a discrepancy between the true and observed (price constant) income elasticities of children such that the observed income elasticity of "productive" children is likely to be less in absolute value than that of children who are merely consumption commodities, *ceteris paribus*.

An exogenous increase in non earnings income V, (woman's time value constant) will not directly affect the productivity of children; but if the optimal quantity of children increases as a result of the increased income ($\varepsilon_I > 0$), the marginal productivity component in $\bar{\pi}$ diminishes and the shadow price of children rises. Thus if the true income elasticity of "productive" children is greater than zero, under these conditions, the observed income elasticity understates the true elasticity because the full price of "productive" children relative to the price of S is dependent on the amount of N relative to the collection of production inputs, not the ratio of N to S.

ii Price of time effect when mother's wage is $\hat{W}$

Under the assumption that women do not partake in the formal labour market their price of time equals their marginal value product and $\hat{W}$ is their "home wage". The elasticity of family size with respect to their price of time is

$$\eta_{n,\hat{W}} = \eta^{*}_{n,\pi_n}(\alpha_n - \alpha_s) = \eta^{*}_{n,\pi_n}(\alpha_n - \alpha_s)\frac{Pg_n}{\pi_n} + \gamma_{n,\hat{W}} + \hat{W}(T_f^w)\frac{\varepsilon_I}{I}$$

$$= \eta^{*}_{n,\bar{\pi}_n}(\bar{\alpha}_n - \bar{\alpha}_s) + \gamma_{n,\hat{W}} + \hat{W}(T_f^w)\frac{\varepsilon_I}{I} \qquad 39$$

where: $\eta_{n,\hat{W}}$ is the elasticity of substitution between child quantity and their opportunity cost

$\alpha_z \left(=\frac{t_z \hat{W}}{\pi_z}\right)$

$\bar{\alpha}_z \left(=\frac{t_z \hat{W}}{\bar{\pi}_z}\right)$ is the value of woman's time intensity in Z, evaluated at its shadow price.

$\gamma_{n,w}$ is the elasticity of substitution in farm production between mother's and child's labour

ε_I is the pure (price constant) full income elasticity of child services

As 39 shows the elasticity of children with respect to the price of mother's time is a function of the time value intensity of children verses their substitutes. If children are indeed mother's time intensive a compensated increase in $\hat{W}$ will reduce the demand for children since $\eta^*_{n,\bar{x}}$ is negative.

iii. Product price and farm value effects

Although of less importance in the traditional areas of South Africa it is appropriate to mention the effects that product prices and farm values would have on fertility. Ron (1980) suggests that these may have important income effects in the short run as large proportions of people in developing countries are rural and agriculture constitutes a large proportion of income. This is not true in South Africa for various reasons. Table 2.1 reports the percentages of income from different sources for KwaZulu. It shows quite clearly that less than ten percent of income, even in rural areas comes from agricultural activity. Lyne (1989) stated that small land sizes limit the potential benefits from farming or subsistence. Households in traditional areas have limited access to land under a communal tenure system; as population expands land sizes decrease. Nieuwoudt and Vink (1989) and Lyne (1989) suggest introducing a rental market which would increase access to land and which is currently restricted under communal tenure. Consequently Lyne (1989, p.139) concludes that "long run food supply (agricultural output) is estimated to be inelastic with respect to changes in product and input prices. ... It is anticipated that higher food prices will harm the vast majority of rural households and that lower input prices will do little to improve household welfare".

Table 2.1 Mean total household income by source for KwaZulu (1988).

(Percentages)

Source	Urban	Rural	Total
Rent	0,78	0,14	0,47
Pensions	3,92	11,77	7,71
Interest	0,68	0,70	0,69
Insurance	0,80	0,29	0,55
Disability grants	0,45	0,91	0,67
Money gifts	0,79	0,46	1,04
Maintenance grants	1,23	0,43	0,63
Wages	89,20	76,80	83,22
Agricultural cash income	0,14	2,69	1,37
Subsistence income	0,36	2,04	2,09
Informal income	1,65	1,47	1,56
n	1190	1109	2299

Source: Perkins and May (1988, p.69)

Institutional changes to allow a rental market, however, may transform the incentive structure which would increase the importance of these effects on fertility.

A more important source of income which would induce income effects on fertility is remittance earnings from children who are employed in off form wage employment. Parkins and May (1988) have shown that on average, for a rural area in KwaZulu, 63,5 percent of wage earnings comes from remittance income. Cadwell (1976) in his research in Nigeria found this to be one of the most important motivations for large families.

The long run effects are not clear. They can be shown using the full differential of 34.1 - 34.7.

$$\eta_{n,p} = -\eta^{\bullet}_{n,\bar{\pi}} \frac{Pg_n}{\bar{\pi}_n} + Pg(\cdot)\frac{e_I}{I} + \sum_j \gamma_{n,\pi_j} \qquad (j = H,K) \qquad 40$$

Equation 40 illustrates the result of an exogenous change in market product prices in elasticity terms. The sign of $\eta_{n,p}$ is ambiguous because it depends upon the complementary - substitutionary relationships between children and other agricultural inputs. These, in turn, determine the compensated substitution effect $\gamma_{n,\pi j}$. Although ambiguous, equation 40 does propose that a rise in the price of farm product, *ceteris paribus*, would increase fertility where child labour productivity is high. This happens because improvements in land values from higher product prices induces positive substitution and income effects if children are normal goods and are seen as productive household labour units. The strength of the elasticity depends on the share of the child's marginal product in π_n and the share of the children's contribution to the family's full income.

Where land is owned, not common in traditional communal areas, an improvement in farm value by an increase in scale of operation may also raise fertility. Under intensive conditions more land raises the demand for children by lowering the child's full marginal cost $\bar{\pi}$ and other

input prices per unit of land, and by increasing total resources (income effect). Agricultural land in South Africa's developing areas is underutilised because of the poor underlying incentive structures (Lyne, 1989) but establishment of rental arrangements or private tenure may enhance the probability of these income effects on fertility.

iv. The quantity/quality trade off

Equations 27.1 - 27.3 are the household production functions for numbers of children, standard of living and child quality respectively. These yield the following optimisation where the full expenditure equation is

$$I = N\left(p_n x_n + t_n^w W^w\right) + NQ\left(p_Q x_Q + t_Q^{ch} W^{ch}\right) + S\left(p_s x_s + t_s^w W^w\right)$$
$$= N\pi_n + Q\pi_Q + S\pi_s = V + NW^{ch}T^{ch} + W^w T^w \qquad 41$$

where: T^i and W^i are the full time constraint and market wage per unit time respectively of member i (i = w, ch).

x_z and t_z^i are the marginal (equals average) input coefficients of goods and time respectively used in the production of the basic Z commodity (Z = N, Q, S)

Thus the shadow prices associated with the optimal set are

$$\pi_n = p_n x_n + t_n^w W^w = Q\left(p_Q x_Q + t_Q^{ch} W^{ch}\right)$$

$$\pi_Q = N\left(p_Q x_Q + t_Q^{ch} W^{ch}\right)$$

$$\pi_s = p_s x_s + t_s^w W^w \qquad 42$$

[Note: $\pi_s \equiv 1$ ie. considered the numeraire].

Because t^{ch}_Q represents the child's foregone time in the labour force (= $-T^{ch}_L$) such that the opportunity cost of school attendance is equal to the child's wage rate, the shadow prices and the derived demand function can be presented as

$$\pi_n = \pi_n(p_n, p_Q, W^w, W^{ch}, Q) \qquad 43.1$$

$$\pi_Q = \pi_Q(p_n, p_Q, W^{ch}, n) \qquad 43.2$$

$$z = (W^w, W^{ch}, p_z) \qquad 44$$

where it is assumed that

$$\frac{\delta \pi_n}{\delta p_n} > 0; \quad \frac{\delta \pi_n}{\delta W^w} > 0; \quad \frac{\delta \pi_n}{\delta W^{ch}} < 0; \quad \frac{\delta \pi_n}{\delta Q} > 0; \quad \frac{\delta \pi_Q}{\delta N} > 0; \quad \frac{\delta \pi_Q}{\delta W^{ch}} > 0$$

Total differentiation of first order conditions gives the elasticities of demand for the Z goods. Using traditional microeconomics, the sum of the compensated price elasticities ($dU^* = 0$) weighted by the goods share in total expenditures equals zero, and the uncompensated substitution elasticity ($dI = 0$) equals the sum of the compensated price and weighted income elasticities. i.e.

$$\eta^*_{z,W^w} + \alpha^w_z \eta^*_{z,\pi_Q} - \left(\alpha^w_n - \alpha^w_z\right) \eta^*_{z,\pi_n} = 0 \qquad (Z = N,S) \qquad 45.1$$

$$\eta^*_{Q,W^{ch}} - \alpha^{ch}_Q \eta^*_{Q,\pi_Q} - \left(-\alpha^{ch}_n\right) \eta^*_{Q,\pi_n} = 0 \qquad 45.2$$

$$\eta^*_{z,W^i} = \eta^*_{z,W^i} + \theta^i e_{p_z} \quad (i = w, ch) \qquad 46$$

where: $\alpha^i_z = \dfrac{t_z W^i}{\pi_z}$ is the value of time intensity of member i evaluated at the shadow price of commodity Z

$\theta^i = \dfrac{T^i_L W^i}{I}$ is the proportionate share of the i^{th} household member in earned family income

$\varepsilon_{I,z}$ is the pure income elasticity for commodity Z

The second order conditions imply that $\eta_{n,W^n} > 0$, which suggests that an increase in child wage would both reduce the relative price of child quantity π_n and increase income (if equality is precluded). However the signs of $\eta^{\bullet}_{z,W^n}$ *and* η_{z,W^n} cannot be determined unless assumptions are made about the complementary-substitution relationships between N, Q, and S, their relative value of time intensities and their relative shares of household expenditure. (De Tray, 1970, gives mathematical proof of this). Nevertheless a discussion of the elasticities is possible under the following assumptions and propositions.

a. Q and N are substitutes (i.e $\eta^{\bullet}_{Q,\pi_n} > 0$; $\eta^{\bullet}_{n,\pi_Q} > 0$) which implies that $\eta^{\bullet}_{n,W^n} > 0$ *and* $\eta^{\bullet}_{Q,W^n} < 0$. A compensated rise in the child wage rate (W^{ch}) or factors positively related to the marginal monetary contribution of children would increase the demand for numbers of children and decrease child's education.

b. Equation 46 states that a compensated substitution effect is more likely to dominate the income effect for children the higher the time value intensity differential between π_n and π_s, the greater α_s and the lower the wife's contribution to family income. As it was assumed that $\alpha_n > \alpha_s$ the expected outcome is that a compensated increase in W^w would lead to a substitution of n for s (i.e. $\eta_{nW^w} < 0$), and that $\eta_{Q,W^w} > 0$ because of reinforcing income and substitution effects.

c. The relationship between household production activities and farm production can be derived through their link to the child's shadow price ($\tilde{\pi}_n$). This is achieved from equation 37 which suggests that farm children's marginal contribution, W^{ch} ($=\tilde{\pi}_n$) is

influenced by its relationship to any set of other inputs, β, in the farm production function so that $W^{ch} = \zeta(\beta)$. Since $\zeta' > 0$, the sign of the compensated elasticity of education with respect to other farm inputs, $\eta^{*}_{e,\beta}$ implies a negative $\eta^{*}_{n,W^{ch}}$.

In summary then investment in child quality is negatively associated with family size. The size of land under cultivation is positively related to fertility. Farm income is likely to be positively related to fertility in the short run, especially in those households who depend on this contribution as their major source of family income.

CHAPTER 3

SAMPLING AND ESTIMATION TECHNIQUES

The aim of the survey was twofold. Firstly, quantitative, household data were collected in order to test the theoretical model. Secondly, opinion data on costs and benefits of children, reasons for non-contraceptive use, attitudes to education, job opportunities and other aspects which would aid interpretation of quantitative results were gathered.

Before discussing the survey, however, different sampling techniques will be discussed and the procedure followed will be outlined with reasons for its choice.

3.1 SAMPLING TECHNIQUES

Simple random sampling is a statistical technique whereby the target population's characteristics are measured by randomly selecting sample units from the study population. Theoretically the study and target populations should coincide but often practically this is impossible. In study populations, the probability of choice of a specific sample unit depends upon the number of those units, which suggests the sample should represent its target population. In practice, the sampling frame is not always representative, and sampling variance is large. Associated with non-representation is the possible problem of insufficient variation in the characteristics to be measured. This limits the sample's usefulness in further statistical analysis. Simple random sampling also requires lists from which the sample can be drawn, such lists are not always available. Multi-stage and stratified sampling procedures help to overcome these problems.

Stratified sampling allows the researcher to get a representative sample with a lower sampling variance than with simple random sampling as long as the within stratum variance is less than the between strata variance (Barnett, 1984). The target population is divided into various strata for ease of

sampling and other administrative reasons. Within each stratum a simple random sample of the sampling units are chosen and their characteristics measured. This method of stratification, however, is only more efficient if the characteristics measured within each stratum are expected to be fairly homogenous (Barnett, 1984).

Multi-stage sampling is also possible. In this case the sample would be stratified more than once under different criteria. Multistage sampling is extremely useful in developing areas because geographical and other information can be used in identifying an appropriate sampling frame.

In this research, the sampling unit was defined as KwaZulu women of child bearing age, (15 - 49 years, United Nations, 1985). KwaZulu was chosen to be representative of a developing area in South Africa. Women were chosen because they were assumed to be the ultimate decision makers regarding family size. Although this may be an unrealistic assumption, NDaba (undated), not all women were expected to be married, and the husbands of those that were, were likely to be migrant workers. Therefore it was anticipated that women would be solely responsible for their children's welfare, and fertility choice could be made effective without their husband's knowledge.

The sample was restricted following the United Nations (1985), to include only women of child bearing age. Women older than 49 were included however, as it was assumed that they would have completed child bearing. Limited resources (time and money) restricted the study population to two areas of KwaZulu. Ubombo magisterial district was chosen to represent a typical rural environment and Ulundi, in Mahlabathini magisterial district, an urban one. Although other areas may have been more appropriate, especially considering Ulundi as urban, an effort was made to avoid areas suffering political unrest to ensure respondents could give accurate answers without fear of intimidation.
The two areas were stratified according to women's occupation resulting in the following strata:

i. professional workers: including teachers, nurses, clerks, typists, secretaries, computer operators, managers and other related occupations.

ii semi-skilled industrial workers: including office cleaners, gardeners, tractor and other heavy vehicle drivers, cotton scouts, irrigation workers and kitchen staff, etc .

iii. respondents not formally employed: like pensioners, housekeepers, subsistence farmers and the self employed.

Before detailing how these stratifications were conducted, a description of the survey areas is appropriate.

3.2 THE SURVEY

3.2.1 Introduction

South Africa's economy is composed of two, reasonably distinct economic structures. The first, which runs along developed economy lines, is largely under the control of "White" commercial and farming areas. The second operates as a third world economy and falls under what are known as the National States and the TVBC countries. The National States are self governing territories and include QwaQwa, Gazankulu, KwaNdebele, Kangwane, Lebowa and KwaZulu. The TVBC countries are independent states and include Transkei, Bophuthatswana, Venda and the Ciskei. These areas are geographically distinct although economic activity transcends the boundaries as workers migrate to the cities in search of employment.

3.2.2 Description of the Survey Areas

3.2.2.1 Ubombo Magisterial District

KwaZulu, because of its proximity, was chosen to represent a developing area. It is a self governing territory situated in the Natal Provincial region of South Africa. Much of KwaZulu is in northern

Natal and stretches along the eastern seaboard with Mozambique as its for northern boundary. There are two Ubombo districts, one under the Natal administration which is not considered here; the other under the KwaZulu authority. It lies in Northern Natal between the latitudes of 27^0 and 28^0 south and is bounded by Ubombo, Natal in the South, the Pacific Ocean in the East, Ingwavuma and Ngotshe in the North and West respectively. The area forms part of the Makathini Flats which lie to the east of the Lebombo Mountains and are extremely flat. The closest industrial towns are Mtubatuba, Pongola, and Empangeni, although Mkusi is a mere 30 km away. Consequently the area is not well serviced with roads, most of which are dirt and have only been excavated since the opening of the Mjindi cotton scheme. Two villages Jozini and Ubombo, provide most of the community's required services including communication and employment, and rural stores supply basic necessities.

Construction of the Pongolapoort Dam in 1966, initiated the introduction of the Mjindi cotton scheme under the auspices of the Department of Development Aid. This scheme developed irrigated cotton farms for local Blacks on Stateland that was not under the control of the chiefs. As this scheme grew, however, cotton production spread and is now one of the major activities in the area. Mjindi, although unpopular with the locals (Wakelyn, 1988) is the major employer of women in the area, Bethesda Hospital being the other. The area, divided into ten chief's wards is typically rural and representative of a rural KwaZulu community.

3.2.2.2 Ulundi: An Urban Area

Ulundi is situated in the Mahlabathini magisterial district and is the administrative capital of KwaZulu housing the Government offices and Parliament buildings. Moore (1988) criticised Ulundi as a choice of an urban area because its function is administrative, yet the town is well serviced by road, rail and air, has shopping complexes, schools, a hospital and other small enterprise although there is little industrial production.

From the point of view of the study, Ulundi was accepted as "typical" for an urban area because services were more easily available than in rural areas, market work rather than subsistence agriculture was the major occupation and electricity, water and other essential facilities were available.

3.2.3 Methodology

In each area the stratification of women was achieved in a similar fashion. In Ubombo, a list of major employers was drawn up and included Mangusi and Bethesda Hospitals, and the Mjindi cotton scheme. As dual research was being conducted in the area, mutually exclusive chief's wards were surveyed, and Mangusi hospital was therefore excluded.

Bethesda hospital is situated in the village of Ubombo, and Mjindi on the outskirts of the Jozini village; therefore Chief Myeni's ward was chosen which lies between the two employment sources (see Figure 3.1). Lists from both Mjindi and Bethesda were constructed for all female workers and from these the first two strata were identified. Each employee was numbered in her stratum, and 30 women were randomly chosen from each.

Since a list of women (aged 15 - 49) was not available for Myeni Ward the third stratum was sampled by a multi-stage procedure. Myeni ward was divided up geographically with the aid of 1:50 000 survey maps (1980 issue) into eight identifiable blocks which represented the primary stage units (PSU). Within the PSU, households were enumerated as a measure of population density and hence size. Two households were randomly selected and were in blocks seven and eight respectively (Figure 3.1). Thus these blocks were selected by proportional probability sampling.

Secondary stage units, or women, were impossible to sample from lists or maps. Therefore it was decided that the best strategy would be to go systematically from household to household in blocks

seven and eight interviewing women who were not formally employed and who did not have a husband present at the time of the interview[4]. In this way 30 respondents were interviewed.

In Ulundi, the process of selection of strata one and two was similar to Ubombo. A list of all possible employment sources was obtained, and only those granting permission for their staff to be interviewed were used. The list included all Government Departments, Holiday Inn catering service, Supervision Services and Leitch Gardening Services. Full lists of women employees were obtained from each and women were classified according to strata definitions. Within each stratum a list was compiled from which women were randomly selected. Not all institutions were chosen because selection became proportional to the number of employees within the institution.

As with the case of Ubombo, the third stratum was more difficult. Here though, town plans were obtained and the lot numbers listed for each suburb. It was decided that one suburb would be representative and it was selected randomly proportional to size. Thus Unit A represented the PSU within which a list of the total number of house plots became the secondary sampling unit. A simple random sample of these were chosen without replacement (Lyne and Stewart, 1988). Households were visited and if a woman fulfilling the criteria was found she was interviewed. If not, the neighbouring houses were visited until 30 women had been interviewed.

A *post hoc* stratification was imposed on stratum three, reclassifying the group into entrepreneurs and the unemployed. Tables 4.1 and 4.2 show t-tests on the group means which were used to test the significant differences between the groups, most were non-significant therefore the stratum was not split for further statistical analysis. Chapter four will discuss the descriptive statistics and t-tests.

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[4] It was found in a pilot survey that attitudes were biased when husband's were present; wives answering as their husband's would expect rather than how they truly thought.

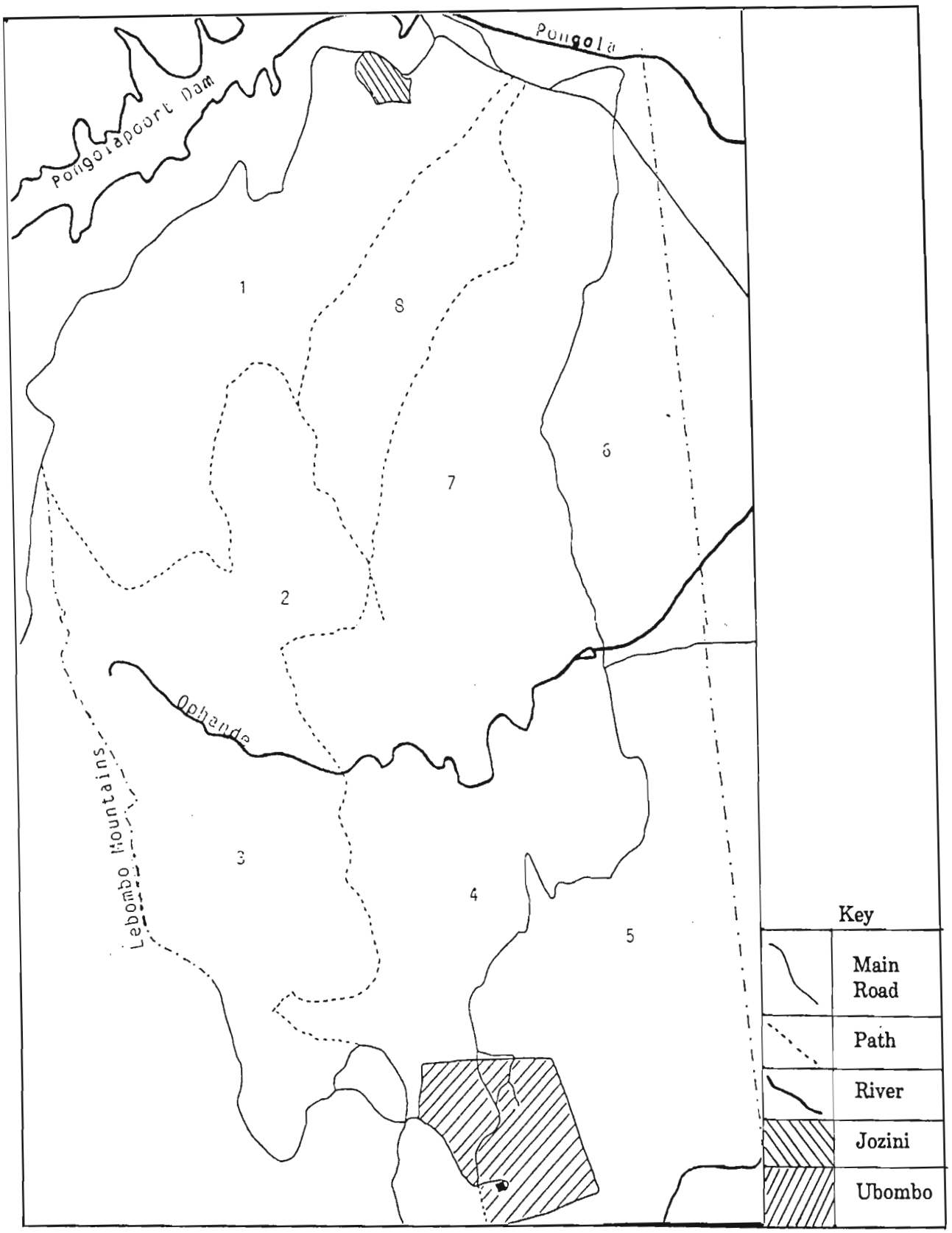

Figure 3.1 Map of Myeni ward showing the blocks from which "housewives" in Ubombo were chosen

3.2.4 Interview Technique

The survey was conducted over a two and a half month period during the months of July, August and September of 1988. The original goal was to interview 180 respondents, 30 from each stratum in each of the two areas. After completion, results were coded and some cases had to be reclassified because income sources revealed that respondents were in fact entering the job market and could not be classified as self- or unemployed. Respondents were personally interviewed by the writer with the aid of an interpreter, thus excluding possible bias caused from use of several interpreters, or misinterpretation of the questions.

3.2.4.1 Questionnaire

The questionnaire (Appendix A.1) was designed to gather both quantitative and opinion data. The former included information on family size and structure, education levels, employment, incomes, expenditures, family size preferences and other appropriate, general characteristics. Opinions on desired family size, contraceptive use, education, costs and benefits of children and other relevant aspects were also identified.

During the interview discussions on the problems women face were raised as were issues about how children could be better prepared for their future. Less educated women stressed financial burdens, especially schooling for children, which was considered extremely important by all. However better educated people, mostly in the Ubombo district, brought up issues relating to social interaction for their children, like dances, and sport which would help their children prepare more for a Western type lifestyle; the lack of library facilities for those who were interested in further education was also mentioned. Another aspect which became apparent was the need for information and advice on very basic issues. In Ulundi especially, women were volunteering to be interviewed because they had specific problems to discuss and treated the interview as a counselling session. Miss Mbatha, the nursing services manager for the department of health in KwaZulu pinpointed the problem by

suggesting the establishment of women's groups where they could get together to discuss common problems and gain from the experience of better educated women.

3.3 ESTIMATION TECHNIQUES

Multiple regression was used to express major relationships between family size and socioeconomic variables for the single equation model. Two-stage least squares (TSLS) was employed to estimate the simultaneous model of family decision making. Dummy dependent variables, within the simultaneous system were estimated by probit analysis.

Principal component analysis was used to confirm the underlying relationships because multicollinearity in regression caused some variables to be excluded. Principal components was also used to form indices where necessary. Discriminant analysis was undertaken to distinguish between users and non-users of contraception. Consequently these techniques will be discussed in the following sections.

3.3.1 Regression Analysis

3.3.1.1 Multiple Regression

Although multiple regression, estimated by ordinary least squares (OLS), allows a powerful interpretation of data, it is restricted to use where the underlying assumptions of both model and technique hold true.

Multiple regression assumptions are (Pindyck and Rubinfeld, 1981):

i. The dependent variable Y, is a linear (or intrinsically linear) function of the explanatory X variables.

ii. The X's are nonstochastic and there is no linear relationship between two or more of the independent variables.

iii. The error term (u) has zero expected value and constant variance for all observations.

iv. Errors corresponding to different observations are uncorrelated.

v. The error variable is normally distributed.

When these assumptions are violated parameters cannot be estimated or at best are biased, inefficient or inconsistent. The theoretical model of family decision making violates the first assumption of regression. Because it is a simultaneous process OLS provides inconsistent and biased parameter estimates (Gujarati, 1979). Therefore two-stage least squares regression was used to estimate the simultaneous model.

Multicollinearity was encountered during estimation of the single equation model because the explanatory variables were highly correlated, thus violating the second assumption. Multicollinearity caused insignificant t-values and incorrect and unstable signs for parameters. Consequently those which were highly collinear were excluded, but reinstated during principal component analysis.

3.3.1.2 Simultaneous Equation Models

Simultaneous equation models are appropriate where there is a two way influence among variables in the model (Gujarati, 1979). Thus two equations are necessary one for each interdependent or endogenous variable. The theoretical model requires four equations because quantity of children, woman's opportunity cost, child quality and woman's labour market participation are mutually dependent. Unlike single equation models, simultaneous models must account for all information (from each equation) when estimating parameters otherwise they will be biased and inconsistent (Gujarati, 1979). Mutually dependent variables are correlated with the disturbance terms and are not independently distributed of them (Gujarati, 1979), resulting in bias. Therefore OLS may not be used to estimate simultaneous models, indirect, two-stage and three-stage least squares must be employed.

In simultaneous systems the problem of identification means whether numerical estimates of parameters of the structural equations can be obtained from reduced form coefficients. If so, the equation is identified otherwise it is underidentified. An equation is exactly identified if unique numerical values of the structural parameters can be obtained, and over identified if more than one numerical value is possible for some parameters in the structural equation. Only when equations are exactly or over identified can parameters be estimated because there are enough independent equations to allow estimation of the unknown structural parameters. Identification can be simply tested using the order condition as follows (Gujarati, 1979):

$$\text{If } K - k = m - 1 \quad => \text{ the equation is exactly identified and if}$$

$$K - k > m - 1 \quad => \text{ the equation is over identified}$$

where: K is the number of predetermined variables in the model

k is the number of predetermined variables in the given equation

m is the number of endogenous variables in the given equation

Therefore in a simultaneous system each equation must be tested to see whether it is identified and whether there is exact or over identification. This classification is important to ensure the correct technique is used. The statistical model was found to be over identified in each equation, consequently two-stage least squares regression was appropriate.

3.3.1.3 Two-Stage Least Squares Regression Analysis

Two-stage least squares regression analysis proposes using proxy or instrumental variables, which are no longer correlated with the error term, in place of stochastic explanatory variables. The technique involves two successive applications of OLS in the following manner.

Consider the model:

$$Y_1 = \beta_{10} + \beta_{12} Y_2 + X_{11} + \ldots + X_{1n} + u_1$$

$$Y_2 = \beta_{20} + \beta_{21} Y_1 + X_{21} + \ldots + X_{2m} + u_2$$

Stage 1: To rid the second equation of possible correlations between the endogenous explanatory variable (Y_1) and the error term (u_2), the former is first regressed on all predetermined or truly exogenous variables (X's) in the whole system. This affords an estimate of the mean value of Y_1 conditional upon the X's. Thus Y_1 can be expressed as $Y_1 = \hat{Y}_1 + e_1$, which shows that $\hat{Y}_1$ consists of $\hat{Y}_1$, a linear combination of the nonstochastic X's, and a random component e_1. This no longer violates the assumption that the explanatory variable ($\hat{Y}_1$) and error term (e_1) are uncorrelated. The instrument, $\hat{Y}_1$, can be used as a true explanatory variable in the other equations.

Stage 2: Stage 2 involves replacing the endogenous explanatory variables with the instruments and re-estimating the equations by OLS. Equation Y_2 is re-estimated as

$$Y_2 = \beta_{20} + \beta_{21} \left(\hat{Y}_1 + e_1 \right) + u_2$$

$$\Rightarrow \quad Y_2 = \beta_{20} + \beta_{21} \hat{Y}_1 + (u_2 + \beta_{21} e_1)$$

Since $\hat{Y}_1$ is independently distributed of $(u_2 + \beta_{21}e_1)$, the parameters are no longer biased or inconsistent when OLS is applied. Thus two-stage least squares "purifies" the stochastic explanatory variables of the influence of the stochastic error terms (Gujarati, 1979).

Multicollinearity was a severe problem in two-stage least squares estimation of the statistical model. Instruments formed by regressing them on all predetermined variables in the system exaggerated the problem. Kelejian and Oates'(1981) suggested using an "adequate set" of predetermined variables to form instruments, as long as all predetermined variables from the structural equation were included.

This approach was followed and any loss of information by exclusion of variables was more than compensated for by the reduction in multicollinearity.

3.3.2 Probit Analysis

Child quality and woman's labour participation were measured by dummy variables which violate three of the OLS assumptions. For this reason probit analysis replaced OLS estimation of these variables in the simultaneous model. The violated assumptions include:

i. Non-normality of the disturbances (u_i)

Although OLS does not require disturbances to be normally distributed, it is assumed to allow statistical inference and hypothesis testing (Gujarati, 1979). Dummy dependent variables, otherwise known as linear probability models (LPM), have only two values for Y and likewise u_i, i.e.

$$u_i = Y_i - \alpha - \beta X_i$$

$$\text{when} \quad Y_i = 1 \quad u_i = 1 - \alpha - \beta X_i$$

$$Y_i = 0 \quad u_i = - \alpha - \beta X_i$$

Obviously u_i is not normally distributed, which is not critical because estimators are still unbiased and consistent.

ii. Heteroscedastic variances of the disturbances

Heteroscedasticity results from a violation of the third regression assumption; constant variance of the disturbance terms. Disturbances have the following probability distribution.

u_i	probability
$-\alpha - \beta X_i$	$1 - P_i$
$1 - \alpha - \beta X_i$	P_i

which is derived from Y_i's probability distribution.

Y_i	probability
0	$1 - P_i$
1	P_i

where $P_i = Pr(Y_i = 1/X_i) = \alpha + \beta X_i$

By definition

$$var(u_i) = E(u_i^2) = (-\alpha - \beta X_i)^2 (1 - P_i) + (1 - \alpha - \beta X_i)^2 (P_i)$$

$$= (-\alpha - \beta X_i)(1 - \alpha - \beta X_i) \text{ or,}$$

$$var(u_i) = E(Y_i/X_i)\,[1 - E(Y_i/X_i)]$$

$$= P_i(1 - P_i)$$

This shows that the error variance is heteroscedastic because it depends on the conditional expectation of Y which depends on X (Gujarati, 1979). Heteroscedasticity implies that estimated parameters are not efficient and that standard errors of the OLS parameter estimates are biased (Capps and Kramer, 1985). The Goldberger transformation can be used to correct the problem (Derbertin, Pagoulatis and Smith, 1980).

iii. Nonfulfillment of $[0 \leq E(Y_i/X) \leq 1]$

With probability models the conditional probability of the event occurring $E(Y_i/X)$ must necessarily lie between 0 and 1 (Gujarati, 1979). In LPMs $\hat{Y}_i$, the estimate of $E(Y_i/X)$ is not guaranteed to fall within this interval. Possible solutions to the problem are to set any

negative values of $\hat{Y}_1$ equal to 0, and those values greater than 1 equal to 1. This results however, in unrealistic kinks at the extremes of the LPM.

Other solutions include using techniques such as probit or logit analyses.

Probit and logit analyses circumvent problems of LPMs by the use of monotonic transformations to guarantee that the predictions lie in the unit range. The probit model is associated with the standard cumulative distribution function which implies that the probability that the i^{th} decision maker selects the first alternative is given by

$$P_i = F(z_i) = \int_{-\infty}^{z_i} (2\pi)^{-\frac{1}{2}} \exp^{(-s^2/2)} ds$$

$$-\infty < Z_i < \infty \qquad Z_i = x_i' \beta$$

The logit model transforms the data using

$$P_i = F(Z_i) = \frac{e^{Zi}}{(1 + e^{Zi})} \qquad -\infty < Z_i < \infty$$

$$Z_i = x_i \beta$$

Since the logit probability model is associated with the logistic cumulative density function which closely resembles the t distribution with 7 degrees of freedom (Hanushek and Jackson, 1977) the logit and probit formulations are quite similar (Capps and Kramer, 1985; Pindyck and Rubinfeld, 1981). The only difference is that the logistic density has slightly heavier tails (Capps and Kramer, 1985). Studies conducted on comparisons between logit and probit models have concluded that differences between their estimators are negligible (Capps and Kramer, 1985; Aldrich and Nelson, 1989; Finney, 1971; Armitage and Allen, 1950; Berkson, 1950; Biggers, 1952; Chambers and Cox, 1967; Hewlett

and Plackett, 1979) and choice between models becomes arbitrary. It is important to note, however, that probit rests on the assumption that disturbances are normally distributed as in OLS estimation, unlike the logit models where they follow the logistic distribution. Consequently probit was chosen.

Probit has several desirable characteristics when used to measure dichotomous dependent variables. It determines the decision variable Y by $Y = 0$ *if* $X < X^*$ and $Y = 1$ *if* $X \geq X^*$. It is clear that X^* is the critical cut off value and is explicitly incorporated in the model (Hill and Kau, 1973). In a multivariate case A^* is the threshold value where the aggregated variable A is assumed to be a linear combination of the explanatory variables (X's). Thus A^* "plays the role of disturbances forces" (Hill and Kau, 1973 p.21), and the disturbance term in probit is therefore homoscedastic (Goldberger, 1964).

The final equation derived from the probit model is

$$E(Y_i/A_i) = prob(Y_i = 1/A_i) = F(A_i) = F(\beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_m X_{mi})$$

Since F is the normal cumulative function, no matter what value A_i takes, F will necessarily be transformed into the interval of zero and unity (Hill and Kau, 1973). Moreover as Hill and Kau (1973) explain the derived functional form is sigmoid in shape which allows any linear or nonlinear relationship between X and Y through A can be accommodated.

An additional property of the multivariate probit model is that the effect of economic stimuli depends upon both the status and magnitude of the estimated coefficient $\hat{\beta}_j$. For example the decision to educate children or not when family income is increased, will depend on the initial income position and its increase, which is consistent with both economic theory and empirical observation (Hill and Kau, 1973).

Probit is estimated by maximum likelihood methods which means "picking parameter estimates that imply the highest probability or likelihood of having obtained the observed sample" (Aldrich and

Nelson, 1984, p.51). Properties of the likelihood estimates are that they are asymptotically unbiased, efficient and their errors are normally distributed. Although asymptotic, Aldrich and Nelson (p.53) state that "the large sample properties seem to hold reasonably well even in moderate-sized samples on the order of N-K = 100" [NB. N is the number of observations, and K the number of explanatory variables]. In the results, significance of the t-values are not stated as the sample size was considered too small to exhibit true asymptotic properties.

Finally goodness of fit was measured by the chi-square statistic and its associated probability. Chi-square tests whether residuals are distributed homogeneously about the regression line and if significant can indicate that a different response model or predictor transformation is required (SPSS-X User Manual, 1975, p.614). The associated probability should be as near to 0,5 as possible for a good fit. Mean deviance (= residual deviance / residual degrees of freedom) was also used, values close to one represent good fits (Ryan and Wallace, 1985).

3.3.3 Principal Components

Daultrey (1976) explains principal components as a data transformation technique whereby each variable measured for a series of people, objects etc., has a variance which is measured in an axis (or dimension) of variability, and is correlated with other variables (i.e. there is a covariance between pairs of variables). The total data variation is the sum of the individual variances. What happens in principal components is that data is transformed to describe the same amount of variance, with the same number of axes as variables, but in such a way that the first axis accounts for as much of the variation as possible. The second and following axes account for as much of the remaining variance as possible in descending order without being correlated to any of the previous ones. Thus the new axes are uncorrelated with each other and are weighted according to the amount of total variance they describe (Daultrey, 1976, See Figure 3.2). Each principal component is derived as

$$PC_i = a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{im}X_m$$

where: $X_1...X_m$ are independent variables

$i = 1...m$

$a_{i1}...a_{im}$ are the component loadings

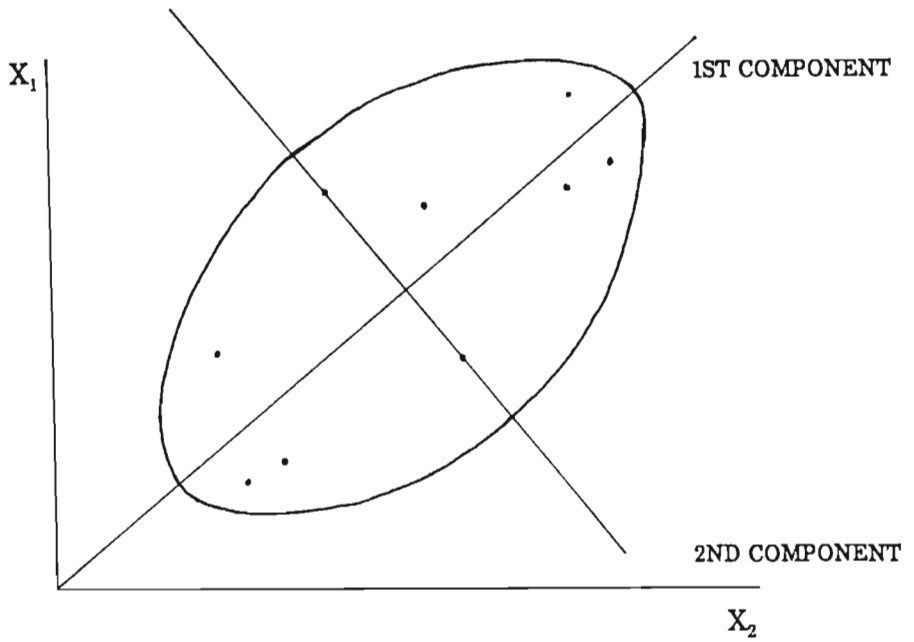

Figure 3.2 Hypothetical data with two principal components and equiprobability contour (Daultrey, 1976, p. 9)

The number of PC_i equals the number of variables but not all components need be used, choice depends on

i. subjectivity, percent of variance accounted for by the component

ii. the eigen value which is the variance corresponding to the principal component (or eigen vector)

iii. the ability of the components to be interpreted economically (in this case).

Therefore principal components can be used to economise on the number of variables used in regression and discriminant analyses, (Nieuwoudt, 1977) to counter multicollinearity by its orthogonality properties and to identify and interpret relationships in the data about which no *a priori* information or theory is available (Montgomery and Peck, 1982).

3.3.4 Discriminant Analysis

Discriminant analysis is a technique which statistically distinguishes between two or more groups of data. These groups are defined by the research situation (Klecka, 1975) and in this study are users versus non-users of contraception. Maximum separation of the groups is achieved by forming weighted linear combinations of the independent variables which measure the characteristics on which the groups are expected to differ (Klecka, 1975). Thus the functions take the form

$$D_i = d_{i1}Z_1 + d_{i2}Z_2 + \ldots + d_{ip}Z_p$$

where: D_i is the score on the discriminant function

d_{ip} are the weighting coefficients

Z_p are the standardized values of the discriminating variables

The potential number of functions is equal to the number of predictor variables or equal to one less than the number of groups whichever is smaller.

Discriminant analysis has two dimensions according to Tabachnick and Fidell (1983). The first being construction of a decision rule for classifying new cases. The second dimension is to emphasize the interpretation of the discriminant space in terms of those variables contributing most to the separation of the groups in space. Each group in the analysis, as measured by its centroid, is treated as a point and each discriminant function is a unique (orthogonal) dimension describing the location of that group relative to the others (Klecka, 1975). However there is a possibility that g points only define g - 1 dimensions, that is a situation where three points may fall on the same line etc . This happens in discriminant analysis where the first function describes most of the information, yet some residual information is left over for the second and third functions, but these are not statistically significant. Practically, what happens is that the last functions do not disappear mathematically due to sampling

and measurement errors, even though they do not actually exist as a separate dimension in the population.

There are three measures of importance of the functions; the first is the relative percentage of the function's eigen value. The sum of the eigen values is equal to the total variance existing in the discriminating variables so this is an easy measure of the function's relative importance. The second is the canonical correlation which is a measure of association between the single discriminant function and the set of (g - 1) variables that define the g group memberships. Thus it can be seen to represent the proportion of variance of the discriminant function explained by the groups (Klecka, 1975). The final criteria for selecting significant functions is an inverse measure of discriminating power, Wilks' Lambda. Hence, the smaller the value of Wilks' Lambda, the better the discriminating power of the variables.

Because of the large number of potentially relevant variables, a stepwise analysis was employed based on a minimum Wilks' Lambda criterion. Multicollinearity and singularity problems were avoided through the use of a tolerance test at each step, and over-fitting was not considered relevant because there were many more cases than explanatory variables. One final check was done to determine the adequacy of the model; this being to predict the function using 75 percent of the data and to reclassify all the cases, including the 25 percent omitted cases, via the function in order to determine the percentage correctly classified.

CHAPTER 4

THE EMPIRICAL MODEL AND RESULTS

4.1 DESCRIPTIVE STATISTICS

The empirical model is based on the theoretical model derived in previous chapters. Before discussing the empirical model in detail though, it is necessary to describe the way in which the variables were measured and how they are expected to affect the fertility model[5].

4.1.1 The Measure of Fertility

The research aim was to derive a demand function for the number of children a family would like to have. Practically though desired family size is difficult to measure and, in fact, seldom reflects reality. M^{c}Clelland (1983) quotes a study done by MacDonald, Simpson and Whitfield (1978) where a test and retest survey was undertaken. It was found that four months after the initial survey, 46 percent of respondents replied differently to desired family size questions, although 82 percent of them reported a family size within one of the previous interview.

M^{c}Clelland (1983) stated that the problem is defining the correct decision maker. Past studies found conflicting results between husbands' and wives' expectations (Coombs and Fernandez, 1978; Knodel and Prachaubmoh, 1973; Pebley, Delgado and Brineman, 1980; Vinokur-Kaplan, 1977 and Westoff, 1981). M^{c}Clelland (1983) regarded use of wife's desires as justifiable because she ultimately bears the children and is likely to incorporate her husband's expectations into her decision. Amongst those surveyed women carry the financial burden of children; professional (stratum one) and industrial (stratum two) workers contributed 68,7 percent and 53,4 percent respectively to total income. The

[5] A full list of variables collected on the survey is included in Appendix A.2.

entrepreneurs (group one) and the unemployed (group two) of stratum three contributed 28,7 percent and 4,7 percent to family income respectively.

Since the sample was not limited to women at a specific stage of their life cycle, there were problems in trying to measure desired family size at the beginning of the child bearing period. It is probable that older couples had changed their perceptions, and could better estimate the costs and benefits associated with children than could childless couples. M°Clelland (1983) suggested several questions which were designed to elicit true preferences, but most were plagued by theoretical and conceptual problems which diminish their usefulness. Measurement complications also arise where family size desires are evaluated without reference to gender preference; family size will increase if a son or daughter preference is not satisfied within the desired size.

In this study number of living children (NOC) was used to represent demand as the zero order correlation between number of children and stated desires was 0,28. This seemingly low correlation reflects uncertainty associated with fertility choices in the traditional sector. Only 30 percent of the sample were married at the time of the survey, the percentage increasing to 47 percent if common law unions and widows are included. A young woman's expectations about marriage, income and employment affects her family size desires; consequently only if her socioeconomic status coincides with her expectations will desires accurately reflect reality.

Table 4.1 reports the mean number of children for each stratum and the two groups in stratum three with their associated t-test. Family size increases from stratum one to stratum three, the former having an average of 1,22 children, stratum two have 3,36 children and stratum three 3,40 children. Although the self employed group have 4,13 children and the unemployed only 2,94 the t-test is not significant. The trend is that more educated women appear to have less children. Comparing NOC with desired family size (TST) confirms the trend, but there appears to be little difference between stratum two and three. Unlike NOC, the entrepreneurs (group one) desire less children than the unemployed. This would be consistent with theory as entrepreneurs have higher opportunity costs

TABLE 4.1 Means of quantity of children, income, costs and education of the different family members by strata in KwaZulu, 1988.

Variable description		Stratum 1: Professional	Stratum 2: Industrial	Stratum 3: Combined	Group 1 Self Employed	Group 2 Unemployed	t-Value * p < 0,05 ** p < 0,01
NOC	Number of children	1,22	3,36	3,40	4,13	2,94	1,85
TST	Tastes for children	3,19	4,21	4,15	3,82	4,35	-1,21
FAMI	Total family earnings	12 275	4 530	5408	7040	4198	1,64
TCOST (R)	Total child cost	2 985	1 875	2 381	2642	2187	0,85
WINC (R)	Wife's income	8 431	2 420	1 288	2758	198	4,14**
INC (R)	Husband's income	4 974	2 571	4 315	4282	4000	0,21
EDW (yrs)	Education of wife	11,89	4,73	5,55	5,30	5,61	-0,30
EDH (yrs)	Education of husband	3,16	2,20	4,58	5,05	4,17	0,56
OCCH1	Skilled husband	0,37	0,18	0,39	0,50	0,31	0,99
OCCH2	Semi-skilled husband	0,13	0,25	0,43	0,33	0,50	-0,86
CFAM[1]		0,00	0,04	0,15	0,06	0,21	-2,09*
TCPC[2]		1 516	459	662	627	689	-0,43
TYPC[3]		7 305	1 717	1 881	2 324	1432	1,09
PWT (R)	Price of mother's time	0,91	0,28	0,14	0,30	0,02	4,18**
PART	Woman's labour market participation	1,00	1,00	0,06	0,09	0,03	0,08
EMPW (yrs)	Woman's employment experience	5,44	3,34	0,07	0,17	0	1,16
	n	58	62	54	23	31	

Notes: 1. CFAM is a ratio of child to family earnings

2. TCPC is total child cost per child

3. TYPC is total family earnings per child

of time than housekeepers. Poor health may cause the unemployed not to attain their family size preferences.

4.1.2 Income Measures

Different measures of income were used to test the empirical model. Estimates of current earnings from the family were collected as were data on the value of farm produce and livestock. Total current income was the sum of the family earnings (FAMI) and net farm income (NFI), as follows:

$$TOTY = WINC + INC + (CPE + ANC + CPS + (ANSD - AB))$$

where: WINC is woman's current annual earnings inclusive of formal and informal sector income and transfer payments

INC is annual earnings income from all other sources including remittances from husbands and children and other transfers to the family

NFI = *CPE + ANC + CPS + (ANSD - AB)*

CPE is the value of crops consumed by the family annually

ANC is the value of livestock consumed by the family annually

CPS is the value of crops sold annually

(ANSD - AB) is the residual value of livestock sold over that purchased annually

Unfortunately it was impossible to exclude transfer payments from the estimates of current income as in some cases, especially in Ubombo, these transfers were the only source of income. The variable, INC, is a poor measure of husband's income as it includes only that portion of his wage that his wife receives as remittance income. It is further distorted by inclusions of remittance income from children, parents, brothers and sisters. For these reasons another estimate of family income was collected;

TCOST, the family's current consumption. Consumption was restricted to the respondent's children to exclude possible distortions by extended family members. Thus it was measured as

$$TCOST = GROC + EDCT + TRAN + CLOT + MEDC + SUNC$$

where: GROC = annual cost of the family's groceries (R)

EDCT = annual cost of children's education (R)

TRAN = annual cost of transport for children (R)

CLOT = annual cost of clothes for children (R)

MEDC = annual cost of medication for children (R)

SUNC = annual sundry cost for children (R) i.e. scout fees etc.

The zero order correlation between FAMI and TCOST is 0,53 which shows that the trend of the two variables is similar although discrepancies in absolute values are large (Table 4.1).

Since theoretical models require that expected lifetime income streams as perceived by the family should be measured, educational levels were used in the single equation model. This appears reasonable considering the high correlations between education and earnings as shown in Table 4.1. Lyne's (1988) study supports this. Table 4.1 shows that women in stratum one earn, on average, three times more, and their education levels are twice as high as those in strata two and three. Although woman's education in both groups in stratum three are similar to stratum two, the unemployed, as expected, have much smaller incomes. Comparing an estimate of husband's income and their eduction shows that more educated husbands tend to earn better incomes. His occupational levels and education are also correlated.

In the simultaneous model a different approach was employed. Permanent income, as suggested by Ron (1980) was tried. Although a good estimate of permanent income was achieved by regressing

TOTY on parent's ages, education, marital status and family size, multicollinearity precluded its use. Therefore a principal component was constructed to measure "pure" income effects in the model. The component accounted for 33,6 percent of variance and had an eigen value of 2,7. Table 4.2 reports the equation.

Family consumption (TCOST) and father's income were included. Ages of parents were captured by AGEH (husband) and AGEW (wife) respectively. The variables EDH and EDW reflect husband's and mother's formal education. Married women were separated from others by the dummy MSD1 and social status was measured by a principal component of the household's status assets (STAT). There is a fairly even weighting amongst the variables except for woman's education which has a lower weight. The positive coefficients show that higher family income is associated with older, more educated parents and those in higher social status groups. The positive marriage dummy shows that these couples have larger per capita total incomes than single women.

Parent's income is expected to influence fertility positively if the income effect outweighs the negative opportunity cost effect. Both woman's current income and education have a negative relationship with fertility (Table 4.1). Husband's current income and education are difficult to interpret as there is little variation in the data; his education does suggest a slight positive association with numbers of children (Table 4.1).

Estimation of the proportion of family earnings from children, using CFAM, reveals that less educated women depend more on children's earnings; stratum three mothers receiving up to 15 percent of total earnings from their children. Taking this further reveals that within stratum three, the unemployed group receive 21 percent of earnings from children whereas the entrepreneurs receive only 6 percent (Table 4.1). This suggests that women with low incomes do invest in children as a source of financial security. If child earnings (CFAM) is considered together with TCOST, TCPC (total consumption per child), and TYPC (FAMI per child), it is clear that most families spend similar total amounts on children; but the educated spend more per child, while the less educated have larger families.

Table 4.2 Permanent Income Estimated by Principal Component Analysis

Variable Description	Variable Name	Coefficient
Husband's education	**EDH**	0,8342
Married couples	**MSD1**	0,7669
Family consumption	**TCOST**	0,5664
Social status index	**STAT**	0,5578
Mother's age	**AGEW**	0,5153
Father's age	**AGEH**	0,5050
Father's income	**INC**	0,4809
Mother's education	**EDW**	0,1459
Percent variance accounted for 33,6		
Eigen value 2,7		

Notes: 1. MSD1 is a dummy distinguishing married women from single women.

2. TCOST and INC are measured on a per capita basis.

The opportunity cost of time theory is supported where high income earners replace quantity of children for "better" quality ones.

The behavioural school notion where relative income is important as a status effect could not be incorporated into the model for two reasons.

1. An estimate for mean village income would have been meaningless, given the three strata, and within each stratum there was a wide range of income levels eg. in Ubombo for stratum one the range for wife's current income was R1 974 - R23 004 per annum.

2. The status effect depends upon the model's ability to predict changes in taste. This implies that a simultaneous model needs to be formulated with tastes as an endogenous variable. An attempt was made to model taste formation but the fact that risk was involved meant measurement problems prevented an acceptable statistical formulation. Because the status effect is important, a proxy for different status groups was incorporated into the principal component analysis and simultaneous regression model which will be presented in a later section.

4.1.3 Opportunity Cost of Woman's Time

Opportunity cost of woman's time was measured by time spent in market and household labour, each weighted by the value of the marginal product of that activity as a fraction of total time available. The formula used to calculate it is:

$$PWT = \frac{W^w T_L^w + \hat{W}^w T_f^w}{T^w}$$

where: W^w = woman's market wage rate

$\hat{W}^w$ = marginal value product of household labour measured by the woman's time share of the household profit

T_L^w = woman's annual hours spent in market labour

T_f^w = woman's annual hours spent in household labour

T^w = woman's total time available

The reason why household labour could not be valued at the market wage rate is that not all women enter the market because their price of time is higher than the market wage offer as they are more productive in household work (Heckman, 1974; Killingsworth, 1983). It is also possible that unemployment limits job opportunities which would cause wage rates to fall to values less than the value of household labour. As anticipated professional women have higher opportunity costs than the other strata because they are more highly educated. Within stratum three the t-test between entrepreneurs and the unemployed is significantly different from zero (4,18) proving that informal sector participation is more time costly than housework. The variable PWT, was used to measure the substitution effect of an increase in income in the simultaneous model. Table 4.1 confirms the assumed negative relationship between opportunity costs and children.

Woman's labour market participation was measured by the dummy PART, which scored one if a respondent worked in formal labour markets and zero otherwise. This variable divided the sample into those women with a fairly high opportunity cost, their potential market wage exceeded the benefits derived from household production drawing them into the market place. Non-participants however, had low potential market earnings, either from insufficient education (stratum three had an average of 5,55 years of education) or labour market experience. Stratum three had an mean value of 0,07 years of employment experience (EMPW), as opposed to 5,44 years (stratum one) and 3,34 years (stratum two). Consequently their time was more productive in household or informal sector work. Although the variable PWT, accounts for earnings from the informal sector, PART distinguishes participants from non-participants on the basis of time for child rearing because informal sector labour is usually more compatible with child rearing.

4.1.4 Child Quality as an estimate of Child Costs

Child quality is regarded as a time cost in the Chicago model in the sense that as the cost of time increases (i.e. wages rise), quality becomes less costly than numbers of children and is therefore substituted for quantity. In the behavioural models, it is a cost in terms of goods and services which are expected to be spent on children in particular status levels. Therefore as couples move to higher status positions they gain utility from the extra cost associated with their higher quality children and status goods. Thus in both models the expected sign for the effect of child quality on family size is negative. Two measures of child quality were constructed.

First was the optimal level of schooling parents would like their children to receive given their financial constraints. The levels were converted into a continuous variable by using the number of years taken to achieve that standard (i.e. standard 8 is equivalent to 10 years of education including the pre-primary years of sub a and b). If tertiary education was desired, the following conversions were taken. Commercial, secretarial or other business courses added one year, nursing or teaching diplomas, degrees or other equivalents meant three years were added except in the case of four year degrees or post graduate courses where the appropriate number of years was used. It was assumed that each child was desired to receive the stated level of education in spite of the child's ability. Respondents however, in most cases overlooked their financial situation consequently it was not a reliable measure of the cost of children.

The second approach was to construct a dummy variable (EDCD), which differentiated between parents favouring education and those against. The dummy, EDCD scored a one if parents had educated children within the correct time period, had strong opinions on why education was important or had made some kind of financial provision for their children's education. It also scored a one if under very poor financial circumstances, a mother had managed to educate her children to a reasonable level (standard 8). Otherwise the variable scored a zero.

According to Table 4.3 DEDC, the optimal education variable, is similar throughout the strata suggesting that it was a better measure of desired education irrespective of financial circumstances. The dummy EDCD, better describes the situation. Ninety one percent of educated and wealthy parents (stratum one) favoured investments in child education. Mothers in the other two strata were less interested, although in both Ulundi's mean for EDCD was higher than Ubombo's. Within stratum three, however, the entrepreneurs and the unemployed have significantly different mean values for child education. Entrepreneurs favoured child education more than industrial women and the unemployed.

Comparing these with numbers of (NOC) and tastes for children (TST), illustrates that educated women both desired and had less children than their less educated counterparts. This is consistent with the Chicago model where high time costs cause a shift from quantity to quality of children. Professional women desired fewer children and made their choice effective by using contraception; the dummy CU, representing contraceptive use, shows that 67 percent of stratum one as opposed to between 20 and 30 percent of the other strata used contraception.

4.1.5 Child Benefits

Child help is an estimate of child benefits and is assumed to be more important in rural areas where subsistence agriculture is largely dependent upon family labour services. Theory expects the relationship between benefits and quantity of children to be positive. Child benefits were measured by an index of household chores in which children were involved (HLP), This index was constructed using principal components from a large number of dummy variables which scored a one if a child was involved in the activity and a zero otherwise. Chores included cooking, cleaning, agricultural work, shopping errands and informal sector labour. Each activity was split into two dummies by gender so that the index could be weighted appropriately by the most productive children. The component, calculated from the variance - covariance matrix, accounted for 34,8 percent of the variance and is presented in Table 4.4.

TABLE 4.3 Means of child education, child help and control variables by strata in KwaZulu, 1988

Variable description		Stratum 1: Professional	Stratum 2: Industrial	Stratum 3: Combined	Group 1 Self Employed	Group 2 Unemployed	t-Value * p < 0,05 ** p < 0,01
DEDC	Optimal school level	14,21	12,18	12,35	12,30	12,29	0,02
EDCD	Parents pro education	0,91	0,36	0,36	0,61	0,19	3,39**
HLP	Child help component	-0,89	1,63	-0,78	-0,30	-1,14	0,83
CLAB (hrs)	Child labour	205,03	685,42	623,96	717,35	554,68	0,52
REL	Number of adult relatives	1,12	1,40	1,44	1,52	1,39	0,34
STAT	Social status index	1,43	-0,90	-0,66	-0,61	-0,70	0,19
AGEW (yrs)	Age of wife	28,52	33,35	36,02	38,39	34,84	0,93
AGEH (yrs)	Age of husband	24,16	34,64	40,79	43,67	39,19	0,92
MSD1	Fraction of women married	0,24	0,27	0,40	0,65	0,48	1,23
MSD2	Fraction of women in CL	0,02	0,08	0,13	0,04	0,19	-1,78
	Fraction of women single	0,74	0,65	0,47	0,30	0,32	NA
CREC	Creche attendance	0,17	0,16	0,07	0,17	0	2,51*
CU	Contraceptive use	0,67	0,32	0,27	0,30	0,26	0,37
CON	Conception problems	0,02	0,07	0,06	0	0,10	-1,54
R14	Child spacing	0,52	0,16	0,20	0,17	0,23	-0,46
NC	No more children desired	0,14	0,11	0,07	0,13	0,03	1,25
	n	58	62	54	23	31	

Notes: 1. MSD1 and MSD2 are dummy variables distinguishing married and common law (CL) wives from single women respectively.

According to Table 4.4 daughters are more productive than sons; chores done by daughters are more highly weighted than those done by the latter. The urban-rural effect is evident as collecting water and firewood, agricultural labour and grinding grain are important. These activities are more prevalent in rural areas implying child labour is a strong motivation for larger family sizes.

It was considered important to derive some measure of child labour hours although data were not collected on the survey. Using information from the questionnaire about activities in which children participated, allowed average estimates of time taken to complete chores (from Levi and Havinden, 1982, and the Agricultural Compendium, 1989) to be distributed between different labour sources. This provided estimates of total annual child labour hours (CLAB). Table 4.3 reports that professional women depended very little on child labour, only 205 hours per annum on average. Strata two and three use similar amounts, 685 and 624 hours per annum respectively. Within stratum three the self employed rely more on child labour than do the unemployed although the difference is not statistically significant. It appears from Table 4.3 that industrial workers and the self employed require more child labour than the other strata. There are several possible reasons for this. Firstly professional women, especially in Ubombo, hired labour. This, together with the fact that they had less children could account for the stratum's low value of child labour use. Industrial workers and the entrepreneurs, however, would be less inclined to hire labour because it is relatively expensive but still need labour to do household tasks. These workers tended to work longer hours than professional women further enhancing the need for substitute labour. Therefore child labour is probably more beneficial to them than to the other strata.

Another possible substitute for woman's labour is that of other adult relatives in the household (REL). According to Table 4.3 however, there is little variation between the strata which means that the relative quantities of child labour used would remain unchanged even though the absolute values could be reduced.

Table 4.4 Index of child help variables constructed by principal component analysis

Variable Description	Gender Name	Variable	Coefficient
Collecting water:	sons	**CW2**	0,1537
Collecting water:	daughters	**CW3**	0,8089
Collecting firewood:	sons	**CF2**	0,1140
Collecting firewood:	daughters	**CF3**	0,8139
House cleaning:	daughters	**HC2**	0,8107
Cooking:	sons	**COOK1**	0,0250
Cooking:	daughters	**COOK2**	0,7975
Working the fields:	sons	**FIELD2**	0,3814
Working the fields:	daughters	**FIELD3**	0,6762
Caring for siblings:	daughters	**LAC2**	0,5192
Herding animals:	sons	**HERD1**	0,0339
Grinding grain:	daughters	**GRAIN2**	0,4135
Shopping errands:	sons	**SHOP1**	0,0450
Shopping errands:	daughters	**SHOP2**	0,5167
Percent variance accounted for 34,8			
Eigen value 4,9			

Notes: 1. All variables were standardized and the rotated factor matrix was used to compute HLP.

2. The means and standard deviations of these variables are given in Appendix A.3.1.

3. Base categories of the dummies represented children not performing the tasks.

4.1.6 Tastes for Children and the Status Effect

As discussed in chapter one the treatment of tastes was a major issue separating the Chicago and Behavioural approaches. Although the specification of tastes in the empirical model followed the neoclassical treatment by specifying tastes as exogenous, a status component was included to account for the change in tastes among the different social status groups. The variable used to represent tastes was the desired number of children (TST), couples would have had if they could have had their life over again. Consistency was checked by asking how many more children they wanted and why. Answers suggested that with more information on costs of children smaller families would prevail. According to Table 4.3 tastes for children increase across the strata, professional women wanting 3,2 children on average, with strata two and three desiring 4,2 and 4,1 children respectively.

Household social status was formed as an index of status assets using principal component analysis. The index function (Table 4.5) is constructed from variables associated with a high family status, consequently it distinguishes those with from those without status goods. The component reports that families owning one status commodity are likely to own them all because there is a very even weighting structure amongst the variables.

4.1.7 The Control Variables

The most important control variables were those directly affecting the woman, including her age (AGEW), age squared (AGEWSQ), and marital status (MSD1 and MSD2). It is important to account for these conditions so that like circumstances can be evaluated. Age allows women at similar stages of the life cycle to be compared. According to Table 4.3 woman's age and quantity of children follow the expected trend.

Table 4.5 Index of status variables constructed by principal component analysis

Variable Description	Variable Name	Coefficient
Ownership of:		
Television	**TV**	0,6565
Bank account	**BANK**	0,6440
Watch	**WATCH**	0,5235
Motor car	**CAR**	0,5210
Sewing machine	**SMAC**	0,4987
Radio	**RAD**	0,4320
Insurance	**INS**	0,5198
Percent variance accounted for 30,0		
Eigen value 2,1		

Notes: 1. All variables are dummies scoring a one if the family had ownership and zero otherwise.

2. The descriptive statistics are reported in Appendix A.3.2.

As age increases numbers of children increase but at a decreasing rate. In regression this should be captured by a negative AGEWSQ. Husband's age (AGEH) is a proxy for his desired family size and is therefore important. Comparisons between quantity of children and AGEH in Table 4.3 confirm the expected positive relationship.

Three marital status groups were identified, single, married and women in common law unions. Two dummy variables (MSD1 and MSD2) identify the groups with single women being used as a base category. The dummy MSD1, distinguishes married from single women by scoring one; similarly MSD2 differentiates common law wives from single women by scoring one. Both single and common law women are expected to exert more control on fertility than married women because they are less socially and economically secure.

Table 4.3 shows that most respondents were single women. As sole supporters of their children, the opportunity cost of child care would be relatively high, therefore they were expected to reduce their family sizes. Evidence is found in Table 4.3 where the highest percentage of single women and the lowest number of children was in stratum one. The dummy MSD1 is highest in stratum three as is quantity of children suggesting there is a positive relationship between the two. This is justified by the fact that their time is "less valuable" in terms of opportunity cost as husbands are also supporting the household. The common law case is more complicated. Table 4.3 shows that strata two and three have the largest proportions of women in these arrangements whose opportunity costs are relatively low; this may induce women to have more children (high values for TST and NOC) as an investment for future support when their situation may become less secure. It is noteworthy that Ubombo has, in all strata, more couples in common law unions than Ulundi reflecting an urban-rural effect where in rural areas women desire children as a productive labour source as well as an investment option.

The use of creche facilities, measured by the dummy CREC, was considered to be an estimate of tastes for child education because it was associated with good performance at school. Another interpretation which is also relevant is that it acts as a substitute for mother's time. Table 4.3 portrays that working

mothers, either formally or informally employed do use creches as a substitute for their time. Seventeen percent of stratum one and group one of stratum three, and sixteen percent of stratum two substitute creches for their time in child rearing.

4.1.8 Variables associated with Contraception

Contraceptive use was defined by a binary variable scoring one for women using modern techniques including abstinence and sterility and zero otherwise. The variable, CU, split the sample into 67 non-user and 61 user cases. Table 4.3 reports that 67 percent of users were found in stratum one, 32 percent in stratum two and 27 percent in stratum three. This agrees with theory as more educated women have greater knowledge and make better use of contraception.

Other variables associated with contraceptive use are dummies representing the reasons for use or restraint (Appendix A.3.3 reports the means and standard deviations associated with these reasons). The first of these is a variable CON, which controls for those women who battle to conceive. Less than two percent of professional women, 6,5 percent of industrial workers and 5,6 percent of stratum three women had any problems. The other two variables R14, and NC are both reasons stated for using contraception. The variable, R14, represents those who use contraception to space their children. Traditionally child spacing has been achieved by prolonged breastfeeding (Bulatao and Lee, 1983) but as time becomes more costly women are switching to "artificial" methods. Fifty two percent of professional women used contraception for child spacing, whereas only 16 percent and 20 percent of strata two and three respectively reported the same reason. The variable, NC, represents respondents who are using contraception to limit the number of children to the amount they already have. Again professional women had the greatest proportion, 13,8 percent although strata two and three were along much the same lines, 11,3 percent and 7,4 percent respectively.

4.2 RESULTS OF REGRESSION ANALYSIS

One of the major problems with data collection was confining the interview to women, because it meant that information on husbands such as their ages, incomes and education levels were difficult to extract especially from less educated and single mothers. Therefore in many cases this information was missing which reduced the overall sample size dramatically; 53 of the 175 cases were married couples and even within these cases information, on income especially, was scarce. Also men's attitudes to children and family planning were not discussed. As NDaba (undated) points out men are in fact the family's decision maker although women sometimes do take the initiative to reduce family size often secretly. NDaba (undated) lists reasons why African men desire large families, an important aspect is continuance of his lineage. He also suggests, as the data on income support, that fathers take little financial responsibility for their children, consequently they do not feel the same economic pressures to reduce numbers of children as do their wives.

In order to include some aspects of the husband's behaviour and to ensure that a true income effect could be measured, a calibration model was used to estimate husband's education for the 128 missing cases. Comparisons of the means between EH, the true education variable, and EDH, the composite one show that the latter is a good proxy for the former. In stratum one EH was 3,11 and EDH 3,16 years, in stratum two they were 2,20 and 2,20 respectively while in stratum three they were 4,45 and 4,58 years respectively.

The final data set included 175 women either married, single or in common law unions, all of whom were between the ages of 18 and 65 years.

4.2.1 The Effect of Intercept Changes on Regression

The first model presented is one which only accounts for intercept changes caused by the control variables. Results are shown in Tables 4.6 and 4.7. The adjusted coefficients of variation ($\bar{R}^2$) are both

57,4 percent, an improvement over other studies (Mincer's, 1963, and Willis, 1973, range from 35 percent to 47 percent). This improvement is due to the fact that data were stratified by occupation level thereby allowing maximum variation in woman's education and opportunity costs.

Three equations were derived from Table 4.7 showing changes in intercept brought about from MSD1 in equation two and MSD2 in equation 3 as opposed to single women. Both have significant positive effects on the intercept, common law status (MSD2), being the most positive.

Women living under common law arrangements appear to be behaving as Schultz (1973, 1981) proposed, that is investing in numbers of children in expectation of future social and financial risk as hypothesized in Section 4.1.5.

The variables AGEW and AGEWSQ confirm the expected theoretical signs, the former being positive, the latter negative, and both being significant at the one percent level. The positive sign shows older women have greater parities (number of children already born). There is a peak in the life cycle, however, beyond which fertility decreases; this is captured by the negative AGEWSQ term.

The most useful and informative variable from a policy view point is woman's education levels. The variable EDW, a proxy for her future income streams and hence a measure of her opportunity cost of time, illustrates a significant substitution effect between numbers of children and other commodities as her time price rises. In all three equations there is a negative relationship between number of children and EDW which is significant at the one percent level. This implies that all women in spite of their marital status respond to opportunity costs rationally substituting quantity of children (the time intensive commodity), with other less time intensive goods. The indication being that with increased expenditure on education population growth rates could be significantly reduced with increases in both the human capital resource base of the population and the basic quality of life as intrinsic results. Therefore it is both a politically attractive and economically feasible policy option.

Table 4.6 Demand for children (NOC), KwaZulu, 1988: on all proposed explanatory variables, restricting dummies to intercept changes alone

Dependent Variable: **NOC**

Variable Description	Variable Name	Coefficient	t-value	Expected Sign
Woman's age	**AGEW**	0,3270	4,12	+
Woman's age squared	**AGEWSQ**	$-3,1948 \times 10^{-3}$	-3,06	-
Married couples	**MSD1**	1,2164	2,64	+
Common law unions	**MSD2**	1,8470	3,13	+
Woman's education	**EDW**	-0,1446	-4,30	-
Husband's education	**EDH**	-0,0577	-1,30	+
Child help component	**HLP**	0,0428	1,30	+
Tastes for children	**TST**	0,0779	0,90	+
	CONSTANT	-3,8703	-2,57	

$\bar{R}^2$ = 57,4% F-value = 25,6** df = 146

Notes: 1. ** $p < 0,01$

Table 4.7 Demand for Family Size, KwaZulu, 1988: predictor variables' t-value > 1, and dummies are restricted to intercept changes alone

Dependent Variable: **NOC**

Variable Description	Variable Name	Coefficient	t-value	Expected Sign
Woman's age	**AGEW**	0,3241	4,08	+
Woman's age squared	**AGEWSQ**	$-3,1640 \times 10^{-3}$	-4,48	-
Married couples	**MSD1**	1,2874	2,84	+
Common law unions	**MSD2**	1,88634	3,21	+
Woman's education	**EDW**	-0,1490	-4,48	-
Husband's education	**EDH**	-0,0610	-1,38	+
Child help	**HLP**	0,0467	1,43	+
	CONSTANT	-3,5129	-2,42	

$\bar{R}^2$ = 57,4% F-value = 29,1** df = 146

Notes 1. ** $p < 0,01$

Equation 1: Single Women

NOC = - 3,5129 + 0,3241 AGEW - 0,0032 AGEWSQ - 0,1490 EDW - 0,0610 EDH + 0,0467 HLP

Equation 2: Married Women

NOC = - 2,2255 + 0,3241 AGEW - 0,0032 AGEWSQ - 0,1490 EDW - 0,0610 EDH + 0,0467 HLP

Equation 3: Common Law Wives

NOC = -1,6266 + 0,3241 AGEW - 0,0032 AGEWSQ - 0,1490 EDW - 0,0610 EDH + 0,0467 HLP

Husband's education is not significant and therefore is less important. The variable EDH, entered the model with an unexpected negative sign either suggesting that the husband's income effect is also outweighed by an opportunity cost effect, or that the variable is inconsistent. Models run with EDH as the only explanatory variable resulted in very small positive effects. The implication is that this variable is inconsistent and should be treated cautiously. It is clear, however, from an examination of MSD1 and MSD2 that "husbands" living with their wives have important positive effects on fertility which may be tentatively regarded as evidence for the income effect. As multicollinearity complicates the issue, principal components analysis was used to confirm the existence of this effect.

The child help index, HLP, although not significant does have the expected positive sign. The fact that it is not an important variable suggests that children are becoming less economically beneficial (as a labour source), as has been historically true with modernisation in the Western World (Espenshade, 1977). The variable HLP does however give some evidence of child benefits and the fact that parents do make rational decisions concerning their family size.

The final variable in the model (see Table 4.7) is the taste component captured by TST. Although not significant, it shows the positive effect tastes for children has on family size. It provides confidence in the model however, because it has the correct sign as predicted from theory, even though serious measurement problems exist.

4.2.2 Regressions with Full Interaction Terms

Interaction terms between control dummy variables (MSD1 and MSD2) were included to allow for slope changes between different groups. Interaction terms were formed by multiplying the dummy variable by the other predictor variables as in Table 4.8.

Table 4.8 Construction of interaction variables:
each row is multiplied by each column

	MSD1	MSD2
EDH	INT11	INT21
EDW	INT21	INT22
HLP	INT31	INT32
TST	INT41	INT42
AGEW	INT51	INT52

For example: EDH x MSD1 = INT11 which allows the model to distinguish between the effect of husband's education on single and married women. In the latter case MSD1 equal one so that INT11 will enter the model as (1 x EDH), the coefficient of which will be added to the normal EDH coefficient. With single women MSD1 equals zero thus effectively removing INT11.

Results of regression are presented in Table 4.9. Although Table 4.9, when compared with Tables 4.6 and 4.7 has improved the adjusted coefficient of variation ($\overline{R}^2$) little from 57,4 to 60,0 percent, the t-values for the individual variables now are all significant to at least the five percent level.

More flexibility in the model has allowed the effects of tastes, child benefits and mother's age to pertain specifically to the appropriate marital status. Consequently this has clarified the other relationships, and reduced the negative effect of the constant, which implies that more variation is being described by the explanatory variables. Comparing Tables 4.7 and 4.9 the AGEW coefficient is smaller in the latter, INT52 capturing the residual effect. The variable AGEWSQ has become less negative but EDW has become even more negative being - 0,1490 in Table 4.7 as compared to - 0,1717 in Table 4.9. The effects of the interaction variables are best illustrated by referring to the equations below Table 4.9 which describe the different marital status groups.

Equation 4 reveals the importance of opportunity cost to single women regarding their family size. The highly significant negative association between EDW and NOC, controlling for age, illustrates that Equation 1 without interaction terms was distorted with associations that could not be properly modelled i.e. child help and tastes. The variable EDW is a proxy for expected future incomes and as such is an appropriate measure for opportunity costs. Single women usually sole supporters of their children are more sensitive to opportunity costs than other marital status groups because often employment is their only source of income.

The fifth equation introduces a positive taste interaction variable (INT41). Married couples are more likely to make joint decisions on family size, therefore the wife's response probably reflects both her husband's desires as well as her own.

Table 4.9 Demand for family size, KwaZulu, 1988

(including interaction variables)

Dependent Variable: **NOC**

Variable description	Variable name	Coefficient	t-value
Woman's age	**AGEW**	0,2907	3,81
Woman's age squared	**AGEWSQ**	-0,0027	-2,71
Woman's education	**EDW**	-0,1717	-6,03
Taste interaction	**INT41**	0,2315	3,70
Age interaction	**INT52**	0,0628	3,58
Child help interaction	**INT32**	0,2454	2,29
	CONSTANT	-2,8142	-2,04

$\overline{R}^2$ = 60,0% F-value = 37,5** df = 146

Notes 1. ** $p < 0,01$

Equation 4. Single women: MSD1, MSD2 = 0

NOC = - 2,8142 + 0,2907 AGEW - 0,1717 EDW - 0,0027 AGEWSQ

Equation 5. Married women: MSD1 = 1, MSD2 = 0

NOC = - 2,8142 + 0,2907 AGEW - 0,1717 EDW - 0,0027 AGEWSQ + 0,2315 TST

Equation 6. Common Law wives: MSD1 = 0, MSD2 = 1

NOC = - 2,8142 + 0,3535 AGEW - 0,1717 EDW - 0,0027 AGEWSQ + 0,2454 HLP

Because the association is highly significant, it is evident that women's tastes change as circumstances change. Marriage offers a more secure environment both economically and socially so tastes become significant.

Table 4.9 reports that the interaction variable INT32 (= MSD2 x HLP), was positive and significant at the five percent level, indicating that common law status and child benefits are jointly related to family size. The sixth equation describing these circumstances shows that children are desired and used as economic agents. As mentioned previously Ubombo, the rural area, has higher proportions of couples in these unions therefore child help may be expected to be of greater importance here because subsistence agriculture and chores such as collecting water and firewood are more labour intensive than those in urban areas.

Interaction variable INT52 (= MSD2 x AGEW) was positive and significant at the one percent level implying that the positive effect of living together reflects itself through the wife's age variable. By differentiating NOC with respect to AGEW and setting the equation equal to zero it is possible to compare the peak ages between the three classes. These peak ages show the maximum age beyond which the woman's fertility decreases. Married and single women both peak at 53,8 years whereas common law wives peak at 65,5 years. Since the latter unions are more common in rural areas it shows that women are using children as productive assets and as investments as their social circumstances become more uncertain. By comparing equations four and six, single mothers with little security depend upon their ability to support the family so opportunity costs are extremely important; whilst women living with boyfriends are more secure in a sense but have no future guarantee of stability, so they invest in children as a safeguard against future economic and social risk.

From this analysis it is obvious that the income effect of women's earnings was outweighed by the substitution effect brought about by opportunity cost of time. Husband's educational levels (income) did not have a significant influence on family size; their influence was felt however, through the taste interaction variable. Women's education reports the extent to which the substitution effect outweighs

the income effect and suggests that investment in formal education would have significant negative effects on population growth rates in traditional areas. Another important issue is the evidence of children being used as productive assets and an investment source, particularly in the less educated strata, and with women in semi-permanent marriage arrangements. Policy makers should consider providing alternative investment options and time saving devices in rural areas, especially providing more support for pensioners. Another strategy would be to provide good quality education which may induce a change in tastes as time becomes costly with better job opportunities.

4.3 RESULTS FROM PRINCIPAL COMPONENTS ANALYSIS

Principal components analysis was conducted on all variables presented, with results in Table 4.10. A description of these variables is given in Appendix A.2. Three factors were extracted accounting for 53,8 percent of total variance.

4.3.1 The Substitution Effect

Component 1 confirms the substitution effect. Table 4.10 reports that variables associated with a high opportunity cost of time are strongly weighted in the first component. It follows that women with higher educational qualifications (EDW), professional status jobs (OCCW1), and with more years of employment experience (EMPW) would have high incomes (WINC), and opportunity costs. Therefore quality would be substituted for quantity shown by the positive weightings for current child costs (TCOST), child education proxies (EDCD and DEDC), a higher standard of living (STAT), and a high negative coefficient for number of children. The dummies, CU and R14, representing contraceptive use and the desire to space children respectively, indicate that parents are behaving rationally and consistently. Eigen values and percentage of variance accounted for reports that statistically this component is the most important rationalisation of family size.

There is some evidence supporting theory from behavioural models. The positive education, income,

occupation and status variables prove that better educated families have better jobs, better salaries which they spend on status goods and quality of children rather than increased numbers of children. Therefore as families move to higher status levels numbers of children are substituted for fewer higher quality children. The negative coefficients for HLP, CFAM and TST disclose the reasons for which more children would be desired because they have the same sign as NOC. In effect component one suggests that child benefits and desires are outweighed by the substitution effect of increasing time costs, or by taste changes due to a status effect depending on the theoretical approach followed.

4.3.2 The Income Effect

The second component orthogonal to the first exposes another aspect of theory, the income effect. This component is dominated by MSD1, EDH, AGEW, EMPW, WINC, NOC and STATUS which are all positively related. This implies that with married couples in particular, increases in parents' income or their potential earnings are associated with increased expenditure on normal goods including children and status commodities. The estimate for husband's current income INC, although positive is not highly weighted because it was computed as a residual of total earnings less woman's and child's earnings and as such is not a true reflection of his income. In many cases husband's were migrant workers, remitting a proportion of their income to their wives, and this, together with any welfare payments from extended family members are included in INC. The positive signs for these variables are also consistent with behavioural models where increases in income within a given status should be associated with more children, a normal income effect.

4.3.3 Investment in Children

Component 3 supports the child investment theory as variables associated with child benefits eg. HLP and CFAM are positively associated with quantity of children. The positive link between contraceptive use and these variables may reflect that women are using it to space children to reduce the perceived risk of infant death, and possibly because women tend to be older (AGEW).

TABLE 4.10

Results of principal component analysis

Variable Description	Variable Name	Substitution effect	Income effect	Investment in children
Education: wife	**EDW**	0,8353	-0,0448	-0,0229
Skilled wife[1]	**OCCW1**	0,8104	-0,0694	0,2117
Wife's income	**WINC**	0,7333	0,3788	0,1345
Status index[2]	**STAT**	0,7015	0,3634	-0,1206
Total child cost	**TCOST**	0,6763	0,0898	-0,1243
Child education[1]	**EDCD**	0,6426	0,0582	0,1934
Optimal child education	**DEDC**	0,5997	0,0305	0,0129
Number of children	**NOC**	-0,6121	0,4404	0,4319
Child help index[2]	**HLP**	-0,4751	0,1741	0,3341
Husband's income	**INC**	0,4288	0,1747	-0,3982
Married women[1]	**MSD1**	-0,0315	0,8102	-0,0687
Education: husband	**EDH**	0,3137	0,7047	-0,1883
Wife's age	**AGEW**	-0,3712	0,6993	0,2956
Employment: wife	**EMPW**	0,4616	0,5069	0,1979
Contraceptive use[1]	**CU**	0,4404	-0,3507	0,6104
Space children[1]	**R14**	0,4969	-0,2468	0,4990
Child:Family earnings	**CFAM**	-0,3591	0,2715	0,1370
Tastes	**TST**	-0,3397	0,2214	0,0389
Eigen value		5,5	2,8	1,4
% Variance		30,7	15,3	7,8
Cum. % Var		30,7	46,0	53,8

Notes: 1. All these are dummy variables scoring one if the description concerning them is true.
2. Index functions were formed by principal components.

The relationship is not a major cause of high fertility. Lack of education and the consequent lack of work opportunity means children are women's best investment for future welfare.

4.3.4 Summary of Principal Component Analysis

Principal component analysis helps to illustrate theory behind child bearing by distinguishing the different influences which make the fertility decision and analysis of that decision so complicated. It allows the researcher to evaluate the different strengths of the opposing factors and draws attention to areas that may be overlooked by a simple regression analysis. This analysis also has the advantage of having no a priori theories on causation, and overcomes multicollinearity.

4.4 RESULTS OF THE SIMULTANEOUS MODEL

Although the single equation regression results and principal component analysis support the theoretical model, a simultaneous estimation of the model was undertaken to allow decisions on child quality, woman's market work participation and opportunity costs to influence fertility simultaneously as theory proposes. Structural equations will be defined and presented with their anticipated results. Results of the estimated instrumental variables will be presented and finally the second stage results.

4.4.1 Structural Equations of the Simultaneous Model

Theory postulates that the decision to have children is simultaneously determined with the decisions to educate children, achieve a desired standard of living and the woman's decision as to the extent of her market participation. These competing goals must be achieved within the family's limited resource. Demand curves for quantity and quality of children, standard of living, and woman's labour force participation are derived from the utility maximisation. The system is completed by a lifetime measure of income and the woman's opportunity cost of time equation which is solved from the first order conditions of the maximisation. The full empirical model is specified as:

$NOC = f(CLAB, PWT, EDCD, PART, INCOME; v^{i})$

$EDCD = e(NOC, PWT, PART, REL, INCOME; v^{ii})$

$PART = p(NOC, INCOME; v^{iii})$

$PWT = w(NOC, PART, EDW, EMPW, INCOME)$

Endogenous variables

NOC	number of living children
EDCD	child quality
PART	woman's labour market participation
PWT	woman's opportunity cost of time
INCOME	principal component estimate of permanent family income described in section 4.1.2

Exogenous variables

CLAB	child labour
REL	number of adult relatives
EDW	woman's education
EMPW	woman's labour market experience
v^{i}	control variables including ages of husband (AGEH), respondent (AGEW) and the latter squared (AGEWSQ)
v^{ii}	taste control including the household status component (STAT), and the use of creche facilities (CREC)
v^{iii}	controls for respondent's age (AGEW, AGEWSQ), education (EDW), and the marital status dummies (MSD1 = married and MSD2 = common law status)

Because the variables have been previously discussed a summary of the expected relationships is presented in Table 4.11

Table 4.11 *A Priori* Prediction of Coefficient Signs in the Econometric Model of Fertility

	Dependent variables				
Explanatory variables	NOC	EDCD	PART	PWT	INCOME
CLAB	+				
PWT	-	+			
EDCD	–				
PART	-	+		+	
INCOME	+	+	-	+	
AGEH	+				+
AGEW	+		+		+
AGEWSQ	-		-		
NOC		-	-	-	
REL		+			
STAT		+			+
CREC		+			
EDW			+	+	+
MSD1			-		+
MSD2			-		
EMPW				+	
EDH					+
TCOST					+
INC					+

4.4.2 Derivation of Instrumental Variables

Instead of regressing the endogenous variables on all predetermined variables in the system, Kelejian and Oates' (1981) suggestion (described previously) was used to form instrumental variables. Better specifications of the instruments were possible but multicollinearity reduced their usefulness in the second stage regressions. Both child quality and woman's labour market participation variables were estimated with probit analysis, whereas ordinary least squares was used to derive the fertility and price of woman's time variables. Results are reported below:

Quantity of Children Instrument

NOC = - 3,2115 + 0,0466 AGEH - 0,2154 STAT + 0,1973 AGEW - 2,0498x10^{-3} AGEWSQ +

(-2,8) (5,1) (-3,9) (2,9) (-2,4)

6,4732x10^{-4} CLAB

(4,6)

$\bar{R}^2$ = 63,7% F = 54,3** df = 152

Quality of Children Instrument (Probit equation)

EDCD = 0,0161 + 0,6222 CREC + 0,3200 STAT + 0,0573 REL

(0,1) (1,9) (5,0) (0,8)

Residual Deviance = 207,2 Residual df = 168

The Participation Proxy (Probit equation)

PART = - 3,2274 + 0,0814 EDW + 0,2045 AGEW - 2,540x10^{-3} AGEWSQ - 0,8572 MSD1 -

(2,6) (2,9) (3,1) (-3,1) (-3,0)

0,8239 MSD2

(-2,0)

Residual Deviance = 197,1 Residual df = 166

Price of Woman's Time Instrument

PWT = - 0,0317 + 0,0606 EMPW + 0,0451 EDW

(-0,9) (13,3) (9,8)

$\bar{R}^2$ = 73,1% F = 206,3** df = 151

Note: t-values are in parenthesis.

** $p < 0,01$

The fertility instrument has an $\bar{R}^2$ of 64 percent, all coefficients are significant to the one percent level and have the expected signs. The supply aspect of fertility accounted for much of the variation, ages of husband, wife and the latter squared are all important. Child labour is also important with a t-value of 4,5. The status component, although not in the structural equation was included to improve the goodness of fit. The negative sign confirms the postulate that children and status goods are substitutes. The instrument is a good proxy for observed fertility.

The child quality proxy, estimated by probit analysis, has a mean deviance of 1,2. The magnitudes of the t-values have been presented but the sample size is too small to expect true asymptotic properties. The function shows that the status index represents a close complement to quality. Creche attendance and the number of adult relatives are also complements, the first acts as a taste for quality and the second acts as a substitute for mother's or child's time in household chores, thereby allowing children to attend school without reducing household labour supply.

The participation instrument has a good fit; the mean deviance is 1,2. Only exogenous variables in its structural equation are included and all have the anticipated signs. Both marital status dummies reduce participation, whilst woman's education increases it. As women age their participation increases, positive AGEW, but at a decreasing rate, negative AGEWSQ.

Woman's opportunity cost of time proxy is predicted from her education and employment experience

variables. These account for her investments in human capital and show that both formal education and on-the-job training have important contributions to increasing her opportunity costs. The $\overline{R}^2$ is 73 percent confirming the function's goodness of fit, and the coefficients are highly significant. Heckman's (1974) suggestion of including an adjustment coefficient (λ) to correct for sample selection bias was tried. In wage offer models, Heckman (1974) showed that the offer wage was biased by restricting the sample to people who were working and for whom an estimate of wages was available. He included lambda, which is estimated by probit analysis from the participation function, to account for this bias. A significant lambda in ordinary least squares estimation of the wage offer, or in this case PWT, shows that sample selection bias is a problem but is corrected by inclusion of lambda. A non-significant coefficient for lambda suggests that sample selection has not biased the OLS estimators, and that lambda may be safely excluded. The equation below shows that there was very little bias caused by sample selection, probably as the opportunity cost measure was derived from both market and informal sector employment.

$$\mathbf{PWT = - 0{,}0321 + 0{,}0606\ EMPW + 0{,}0453\ EDW - 4{,}1403x10^{-3}\ \lambda}$$

(-0,6) (13,1) (8,5) (-0,1)

$\overline{R}^2$ = 73% F = 135,5** df = 149

Note: t-values are in parenthesis ** $p < 0{,}01$

4.4.3 Results of the Simultaneous Model of Family Size Decision-making

Results support the neoclassical approach to fertility. Table 4.12 shows that parents consider the economic costs and benefits of children when deciding on the number and quality of children to bear.

The first equation reports the demand function for quantity of children. The $\overline{R}^2$ is 69 percent with all t-values except EDCD, PART and INCOME significant to at least the five percent level. All variables, however, have the expected signs and were included for theoretical reasons. The improvement in $\overline{R}^2$ over similar studies (Ron's (1980) simultaneous equation reported an $\overline{R}^2$ of 32

percent) is attributed to the data stratification which allowed maximum variation in woman's education and price of time variables.

The most significant variable was the estimate of child labour (CLAB) which is positively related to fertility. Because the major portion of the children's work effort was water and firewood collection, provision of water and electricity facilities would help to reduce family size.

Husband's age controls for household's tastes for children, and is positively related to fertility. Woman's age variables have the expected theoretical signs, both significant at the one percent level.

Price of woman's time (PWT) is negatively related to quantity of children and significant at the five percent level. As expected increasing opportunity costs of time for women cause a substitution away from numbers of children because child rearing is time intensive. Labour market participation (PART) is also significantly, negatively related to fertility because it competes with child rearing. The negative coefficient for EDCD proves that as opportunity costs rise, numbers of children are replaced with better quality children. It is this trade off that suggests a policy for reducing long term fertility. Increasing opportunity costs by improving education and employment opportunities will cause quantity of children to be replaced by quality as woman's time becomes more costly. Although PART and EDCD are not significant, their t-values are greater than one. Multicollinearity between them and the instrument PWT reduce their significance.

The permanent income component has a weak positive effect on fertility proving that children are, in fact, normal goods. The fact that woman's opportunity cost and INCOME are negatively and positively related to fertility respectively supports Mincer's propositions. The coefficient for PWT is larger than that for INCOME showing that the substitution effect outweighs the income effect of increased earnings.

Table 4.12 Results of the Simultaneous Model of Family Size Decision-making (Data were collected in 1988).

1. Fertility Demand

$$NOC = -1.8958 + 9.8760\times10^{-4}\ CLAB - 0.9812\ PWT - 1.0936\ EDCD - 1.2198\ PART +$$
$$(1.1) \quad (5.9) \quad (-2.3) \quad (-1.3) \quad (-1.2)$$

$$0.0521\ INCOME + 0.0326\ AGEH + 0.2523\ AGEW - 2.7153\times10^{-3}\ AGEWSQ$$
$$(0.5) \quad (3.0) \quad (2.5) \quad (-2.1)$$

$\bar{R}^2 = 69.2\%$ F-value = 36.4** df = 127

2. Child Quality Demand (Probit)

$$EDCD = -1.3871 - 0.1705\ NOC + 0.4179\ PWT + 2.3029\ PART + 0.0992\ REL +$$
$$(2.2) \quad (-1.4) \quad (0.7) \quad (2.0) \quad (1.1)$$

$$0.1369\ STAT + 0.8149\ CREC + 0.1938\ INCOME$$
$$(1.1) \quad (1.8) \quad (1.7)$$

Residual Deviance = 168.2 Residual df = 119

3. Woman's Labour Market Participation (Probit)

$$PART = -4.4207 - 0.2740\ NOC + 0.2817\ AGEW - 0.0031\ AGEWSQ + 0.1118\ EDW$$
$$(1.0) \quad (-1.4) \quad (2.1) \quad (-2.0) \quad (2.3)$$

$$-0.8712\ MDS1 - 1.5529\ MSD2 - 0.0808\ INCOME$$
$$(-1.7) \quad (-2.6) \quad (-0.7)$$

Residual Deviance = 176.3 Residual df = 123

4. Woman's Opportunity Cost of Time

$$PWT = -0.1020 - 0.0347\ NOC + 0.3452\ PART + 0.0287\ EDW + 0.0646\ EMPW +$$
$$(-0.9) \quad (-1.8) \quad (1.9) \quad (3.0) \quad (11.9)$$

$$0.0296\ INCOME$$
$$(2.5)$$

$\bar{R}^2 = 77.8\%$ F-value = 89.1** df = 127

5. Component of Permanent Family Income (INCOME)

$$0.56636\ TCOST + 0.48091\ INC + 0.50498\ AGEH + 0.51525\ AGEW + 0.83415\ EDH +$$

$$0.14587\ EDW + 0.55777\ STAT + 0.76687\ MSD1$$

Percentage of variance accounted for: 33.6 Eigen value: 2.7

Notes: a. t-values are in parenthesis, ** $P < 0{,}01$.
b. In probit functions goodness of fit is measured by mean deviance (= residual deviance / residual degrees of freedom).
c. The permanent income equation was included for completion

Recall that Mincer's (1963) specification was

$$NOC = b_1 INCOME + \alpha PWT + ... + u$$

where b_1 measured the positive income effect and α the negative substitution effect. The uncompensated price effect b_2 is

$$b_2 = \alpha + b_1 = - 0,9812 + 0,0521$$
$$= -0,9291$$

The negative sign proves that the negative substitution effect dominates, therefore improvements in income earning potentials will reduce the demand for children and thus family size.

The second equation reports the demand function for child quality. The mean deviance equals 1,4 an improvement on the proxy equation. The magnitudes of the t-values are informative and all are greater than one.

Child quality is a substitute for numbers of children, being negatively related to NOC. This trade off between numbers and quality of children occurs as income (positive INCOME) and shadow price of time variables (positive PART and PWT) increase. Household social status is also positively related to quality. These show that as woman's opportunity costs increase, numbers of children are replaced by fewer better quality children and more status goods. Behaviourial models suggest that couples plan their family size on an expected social status level. If income increases enough to move them to a higher status group more utility is gained by acquiring status goods than children so fewer, "better" quality children are desired. If however, the increase keeps them within the same status group more children and status goods are desired since they are all normal goods (Ron, 1980).

The number of adult relatives in the household (REL) is a complement to quality because children can attend school without the household sacrificing labour or drawing mothers from more productive

employments. The dummy, CREC, scores one if parents sent or intend sending their children to creche or preschool. It was regarded as a taste for education which was confirmed by its positive relationship with EDCD. Creche attendance can also be considered as a substitute for mother's time which confirms the opportunity cost effect and the need for time saving technology in the traditional sector.

Equation 4, mother's labour force participation was also estimated by probit analysis and all t-values are greater than 1 except INCOME. The mean deviance of 1.4 shows a reasonable function. Woman's labour market participation depends primarily on her age, education and marital status because these exogenous variables describe her eligibility for participation. As a woman ages her participation increases confirmed by the positive AGEW term. The negative AGEWSQ term shows that participation peaks and then decreases as she approaches retirement. Higher education increases opportunity cost of remaining at home and is therefore positively related to participation. Both common law and married status are negatively related to participation as household demands increase. Given these however, participation varies with household income and family size. As family income increases there is less need for women to participate; thus INCOME has a negative coefficient. Larger numbers of children reduce the probability of participation as woman's household demands increase.

Finally equation four reports woman's opportunity cost of time. The $\bar{R}2$ is 78 percent and t-values are significant. The equation shows that any increase in the household's stock of human capital is associated with an increase in woman's opportunity costs. The positive coefficients for woman's education and work experience confirms this. Work experience is measured by market participation (PART) and years of experience in her current job (EMPW); the latter is the most important (t-value = 11,9). Permanent income is also positively related to opportunity costs because it adds to the family's stock of human capital (Mincer, 1963). More offspring decrease opportunity costs because time taken to bear and rear children competes directly with time spent in the market place.

Results support the underlying assumptions of the Chicago School. The simultaneous model indicates that mothers are responding to economic and social constraints by adjusting fertility to opportunity cost

and social benefits (of children). By manipulating these constraints policy makers can provide incentives to parents to reduce desired family size, thus facilitating population growth rate declines.

One strategy would be to provide the services which parents gain from their children. The model showed that child labour was the most important determinant of fertility demand. Provision of water and electricity, especially to rural people, would reduce demand for child labour and at the same time improve living standards.

In extended households adults' and child's time are substitutes in production. Reducing the supply of child labour by introducing legislation on and providing for compulsory schooling and/or subsidising education would cause a shift to child labour substitutes including mother's and other adult family members' time. This shift increases the time costs of the affected family members. The effect of raising opportunity costs of time for mothers is an important strategy open to policy makers. The model shows that there are a number of ways in which it can be achieved. The first, as suggested, is through compulsory schooling for children. Another approach may be to improve both the quantity and quality of education. Equations 4 and 5 report that education affects both measures of time costs; directly increasing the variables PART and PWT, which induce the substitution between quantity and quality of children. The fertility equation reports significant effects for both variables which shows that opportunity costs affect women who have high potential market earnings and those who have a low shadow price of time, and are not yet formally employed. Improving education will therefore cause women in all economic strata to substitute child quality for numbers of children as their opportunity costs rise. This change in tastes as opportunity costs rise can be facilitated by training women to develop marketable skills for employment in expanding trades and professions. Equation 4 shows that woman's current labour market experience is an important factor increasing opportunity costs; consequently provision of employment for those entering the labour market is critical for fertility reduction.

4.5 DISCRIMINANT ANALYSIS

As family planning plays an important role in population reduction policies discriminant analysis was used to statistically discriminate between users and non-users of contraception. This is important because policy measures may be used to promote more extensive use of modern contraception if the constraints and circumstances of the non-users can be changed to ones more conducive to fertility control. During the interview, questions concerning contraceptive use were asked with the reasons for use or disuse (Appendix A.3.3 provides a summary of their answers, with associated means and standard deviations). From these answers the sample was classified into two groups on the basis of their contraceptive use. The dummy CU, used to distinguish these groups was classified as a zero if the respondent had never used any form of contraception including abstinence and sterility, and a one if they had. This split the sample into two groups of approximately the same size, 67 cases in the non-user category and 61 in the other.

To allow a full range of potential discriminating variables several more were constructed. The first of these was CON, representing those respondents who had no need for contraception because they were infertile or had passed through menopause. The dummy NC, accounted for the desire for no more children was also constructed. These, together with all variables from the previous analyses were tested in discriminant analysis. A stepwise procedure was followed using minimum Wilks' Lambda criterion for selection. Other selection criteria included minimum tolerance levels, minimum F-to-enter and maximum F-to-remove. F-to-enter is a test for statistical significance of the amount of group centroid separation added by the variable, above and beyond the separation produced by previously entered variables (Klecka, 1975). F-to-remove tests whether the variable still adds a significant amount to the separation given other variables now in the equation (Klecka, 1975). The final discriminant function and the statistics showing "goodness of fit" are presented in Table 4.13. The canonical correlation (0,8) and Wilks' Lambda (0,34) report that the function was satisfactory and these are supported by the classification table which shows that 89,4 of the selected cases and 88,4 percent of unselected cases were correctly classified. The group means show the average values for the two

groups (users and non-users) with the associated F-tests that report their significant differences. The standardised coefficients indicate each variable's relative contribution to the discriminant function. This implies that R14 is the most important discriminating factor. It distinguishes between people who use contraception to space their children throughout their life cycle and those who do not. The latter group includes both users and non-users of fertility regulation. Hence the major reason for women using regulation is to space children to improve their chances of survival. This practice is common especially in Africa where infant mortality rates are still relatively high (World Bank). Cadwell found evidence of post-partum abstinence and extended breast feeding practices in Nigeria and suggested that modern contraceptives would be introduced there on a wider scale if their benefits for child spacing were emphasised. A report for KwaZulu's social development programme (1990) also found that promotion of contraception as a tool for improving primary health care and infant health a more acceptable way of extending its use.

The next most important variable was NC, women using contraception because they did not want children. Reasons for not wanting children could be classified into two groups; the first being women who had already achieved desired family size and the second being young women in training, especially nurses did not want to forfeit their study by unwanted pregnancy.

The first group shows an encouraging trend of women who are taking active steps to plan their families and control them. Better community acceptance of fertility regulation could encourage this attitude and help to reduce population growth rates. The second group lends further support to the opportunity cost effect revealed in the previous analyses. Nursing in traditional areas is a lucrative career, with salaries ranging from approximately R400 to R2 000 per month for professional nurses. Thus the opportunity cost for trainee nurses is high encouraging them to regulate their fertility.

This effect is further supported by a positive coefficient for WINC, wife's current income. It is unlikely that users need to be wealthy to afford regulation because in both areas clinics were providing free services. Both WINC and EDCD, the next most important factor, emphasise the trade off between

numbers of children and quality. Wife's current income is a current measure of her opportunity cost and as this rises time is invested in quality rather than quantity. Consequently the discriminant function is merely restating theory and providing further statistical evidence of this effect. Therefore an effort to promote education and income earning potential will have a major influence on family sizes in traditional sectors. The final significant factor CON, reflects people with fertility problems as such it is a control variable.

Some further aspects should be considered when designing a strategy for extending contraceptive use. The first which seems most important is educating men on the benefits of child spacing and the advantages of smaller families. NDaba (undated) found that men had negative attitudes to family planning because they had never been consulted about it. Therefore a possible solution is education. In Taiwan, where son preference is extremely important, impressive growth rate reductions have been achieved by this method (Development and Communication Consultants, 1990).

Communication on the advantages of family planning, not only to improve primary health care of mothers and children but also now to reduce the risk of Aids infection is vitally important. Aids awareness campaigns will play an increasingly important role in educating families an contraception and should be supported.

Another possible strategy, which is a longer term solution, is to uplift the status of women as has been promoted in Zimbabwe (Development and Communication Consultants, 1990). African women are still treated as minors by law, and are subject to their husband's wishes. NDaba (undated) comments that Zulu men view women as an object for sex because Zulu women generally have little else to offer. Changing this by improved education and employment potentials will allow women to become less economically and socially dependent on men and thus allow them to take more decisions concerning their own welfare and that of their families.

Table 4.13 The discriminant function showing variables which best distinguish between users and non-users of contraception (n = 170)

Variable	Standardized Discriminant Function		Group Means		
	Coefficient	F-test	User	Non-user	F-test
EDCD	0,1257	1,1	0,7050	0,3731	15,6**
R14	1,1587	158,8	0,6066	0,0149	90,6**
CON	-0,1242	1,2	0	0,0746	4,8**
NC	0,9435	73,5	0,2131	0,0149	14,1**
WINC (R)	0,1519	1,6	5006,0	3116,0	5,6*
Canonical correlation	0,8				
Wilks' lambda	0,3				
Eigen value	2,0				
df	5				
Percent of cases correctly classified		Cases selected (75% of sample) 89,39%		Cases not selected (25% of sample) 88,37%	
Actual group membership		Group 0	Group 1	Group 0	Group 1
Number of cases		68	64	24	19
Cases correctly classified		66 97,1%	52 81,3%	23 95,8%	15 81,3%
Cases incorrectly classified		2 2,9%	12 18,8%	1 4,4%	4 21,4%

Note: 75% of the sample was used to estimate the function, and 25% was used to evaluate the predictive accuracy of the function.

DISCUSSION AND CONCLUSION

Results support the underlying assumptions of the Chicago School. Mothers respond to economic and social constraints by adjusting fertility to opportunity cost, social benefits of children and social pressures. By manipulating these constraints policy makers can provide incentives to parents to reduce their desired family size, thus facilitating population growth rate declines.

The first option is to provide the services performed by children. The single equation regression model revealed that children play an important investment function for parents, especially those in semi-permanent marriage arrangements. Women in common law unions were older when fertility "peaked" confirming that they perceive children as a safeguard against risk in old age. The proportion of household income provided by children shows that although it is not a major income source for this sample of women, it is important for unemployed women and pensioners. Therefore promotion of improved knowledge of and access to pension and social security schemes may reduce parent's dependability on children. Descriptive statistics reported that these effects were more common in the rural area which suggests that increasing urbanisation will reduce the benefits derived from children and therefore shrink the demand for children.

The simultaneous regression model displayed the benefit of child labour to the household (especially in rural areas). Much of the children's work effort comprised water and firewood collection and this was an important determinant of fertility demand. Provision of these services would reduce the demand for child labour whilst also improving living standards. In extended households it was found that adults' and child's time were substitutes in household production. Reducing the supply of child labour by introducing legislation on and providing for compulsory schooling would cause a shift to child labour substitutes including mother's and other adult family members' time. It will also raise the direct costs of children through fees and equipment. Although the latter effect may be undesirable for the poor, subsidised education could reduce these effects.

The importance of compulsory schooling though, is its effect of shifting the burden of child labour to the other family members which will increase their time costs. The effect of increasing opportunity costs of mother's time is an important strategy open to policy makers, as shown by all the statistical results. The principal component analysis found it to be the most important contributor to fertility demand, out-weighing the positive income effect as Mincer (1963) proposed. The simultaneous model provides a quantitative estimate of the substitution effect (-0,929) which shows that it does, in fact, dominate the woman's contribution to the income effect. Although other adult family members, eg. grandmothers may reduce the mother's work burden, thereby decreasing her opportunity cost, it is important for women in all economic strata and becomes more important for higher income earners.

Although compulsory education will raise opportunity costs, a better strategy would be to improve both the quantity and quality of education in the developing sector. The simultaneous model shows that education effects both measures of time costs directly increasing woman's participation and price of time which induce the substitution between quantity and quality of children. The fertility equation reports significant effects for both variables which means that opportunity costs affect women who have high potential market earnings and those who have a low shadow price of time and are not yet formally employed. Improving education will therefore cause women in all economic strata to substitute child quality for numbers of children as their opportunity costs rise.

The change in household tastes as opportunity costs rise, or as behavioural models suggest as households move to higher social status groups as income increases, can be facilitated by training women to develop marketable skills for employment in expanding trades and professions. The simultaneous model shows that woman's current labour market experience is an important factor increasing opportunity costs; consequently provision of employment is critical for reducing fertility reduction.

Job creation is possible both in formal and informal markets. Policy makers should reduce the constraints to informal sector growth such as access to markets, credit and expertise. It became clear

from the interviews that information on jobs, qualifications, remuneration and financial support for study etc. was very limited (especially in rural areas). Provision of this information could help to reduce some of these constraints.

The discriminant analysis showed that more information is necessary on the advantages of modern contraception. Misconceptions about its affect on health and conception rates for women who have been using them for family planning purposes could change the attitudes of less educated women. Promotion of its benefit for child spacing could extend its use.

Many of these policy suggestions are long term strategies aimed at changing the household's incentive structures. What is also important though, is ensuring that there are short term programmes which will facilitate the long term solution. Family planning has an important role to play in this regard. As suggested by Development and Communication Consultants (1990) contraception and family planning needs to be "sold" on the benefits they have for infant and mother survival and primary health care. Discriminant analysis showed that some of the more educated women were already using contraception for its benefits for child spacing. Reasons quoted for not using contraception revealed that education on the advantages of the different techniques and how they should be used is necessary. Husbands should be included in this education process so that parents together can take active control over their fertility. In this regard Aids awareness campaigns can make important contributions to spread information in the outlying areas. NDaba (undated) and Development and Communication Consultants (1990) also remark on the importance of easy and relatively inexpensive access to contraception, Taiwan's strategy may be a good one to follow.

Therefore the policy options are clear. Increases in both quantity and quality of education is a prerequisite for reducing fertility demand and hence population growth rates. The strategy should be combined with investments in job creation, provision of services, improved pension schemes and information on the advantages of modern contraception. Family planning initiatives and Aids awareness campaigns should also receive attention.

SUMMARY

High population growth rates have hindered economic development in the third world. South Africa's population growth rate has been estimated at 2,5 percent per annum (1970 - 2000). The population of 37 500 000 comprises 13,5 percent Whites, 8,6 percent Coloureds, 2,6 percent Asians and 75,3 percent Africans, of which the Africans have the highest growth rate (2,9 percent per annum).

These statistics encouraged the Government in 1984 to launch a Population Development Programme whose aim was to establish an equilibrium between population size and natural resources. Their results show that no more than 80 million people can be accommodated in South Africa and that already population growth rates exceed economic growth rates causing declining per capita incomes. Consequently it was imperative to study the economic conditions of traditional households associated with smaller families in order to facilitate fertility decline and the raising of living standard potentials.

The theory of fertility has followed two main approaches the first based on neoclassical theory proposes that parents are rational decision makers which allows their decisions to be examined within a utility maximisation framework. The parameters of the utility function, which are home produced and consumed fundamental goods, are maximised subject to the household production constraints, and family's resources of time, labour and income. Optimal levels of the fundamental goods are derived by first order conditions of the maximisation yielding their demand curves. In fertility analysis the fundamental goods are child services (both quantity and quality of children), standard of living and leisure.

The second approach, although possible, need not be specified within a utility maximising framework, concentrating not only on the demand side of family size decision making but on the supply side and fertility regulation aspects as well. Behavioural models stress that family size decisions are influenced by norms, social pressure and household expectations and can not, therefore, be limited to purely economic specifications. Unlike the neoclassical approach, socioeconomic variables, such as social

status, are included in the specification by incorporating an endogenous "taste" component which should reflect changes in these factors. Tastes in neoclassical models are treated exogenously. Although both paradigms have clear insight, the former was chosen because it is mathematically tenable and has much empirical support. Behavioural models are difficult to measure and specify because of their dependence on tastes.

A neoclassical utility function was defined in terms of child services and standard of living and maximised subject to the resources of time, labour and income. The theoretical model showed that mother's time in household production was important. Child quality and quantity were assumed to be substitutes, and the former a complement to standard of living. Thus theory proposes that increased income should cause fertility to decline if mother's time into child bearing and rearing is costly in terms of wage loss. Quantity of children would therefore replace quantity of children for higher wage earners. The general model was adapted to the specific situation in South Africa where the benefits of child labour, remittance income and support for old age were incorporated. The sample of women chosen was not restricted to either wage employment or subsistence agriculture, it included women employed in formal and informal markets and subsistence agriculture. Demand curves for quantity and quality of children and women's labour market participation were derived from the first order conditions, and parametric changes in demand were discussed.

Household data were collected to test the theoretical model. Because the analysis was restricted to the African sector of the population, a representative sample was drawn from KwaZulu. Ubombo magisterial district was chosen to represent rural areas and Ulundi in Mahlabathini was used as an urban area. A stratified sample of 175 women were interviewed. They were classified into three strata by occupation thereby allowing maximum variation in woman's education and opportunity cost of time variables. The strata were professional women (stratum one), industrial workers (stratum two) and those not formally employed (stratum three). Strata one and two in both areas were selected, by proportional probability sampling, from a list of all women employees from the major employers in the area. In stratum three, multi-stage sampling techniques were used.

Each stratum comprised 60 women, 30 from each area.

Descriptive statistics of the database were analysed providing general information about the data and exposing which trends would be expected in regression analysis. Demand functions for child quantity were then estimated by ordinary least squares regression. Because multicollinearity was a problem, a principal component analysis was conducted on all variables to ensure the underlying theoretical linkages. These analyses supported the theoretical model proving that opportunity cost of women's time is a major determinant of fertility, reducing family size as women's time costs increased. Child "help" variables were important to rural women and those in common law unions, who relied more on children in old age. Tastes were more important to married women than either single women or those in common law unions.

The demand function for children was then re-estimated in a simultaneous model of family decision making. Demand curves for child quality and women's work participation were also estimated. The model was completed by a function estimating opportunity cost of woman's time and a principal component measuring permanent family income. The simultaneous model was estimated by two-stage least squares regression analysis. Dummy dependent variables (child quality and woman's labour market participation) were estimated by probit analysis. Finally discriminant analysis was used to distinguish users from non users of modern contraception. Variables included those from the previous analyses and reasons for use or restraint which were elicited during the interviews. The variable, CU, representing contraceptive use split the sample into 61 users and 67 non users.

Women were found to be using contraception for three basic reasons. The first was to space children to reduce infant mortality and improve health for both mother and child. The second reason was that women had achieved desired family size and were therefore restricting the number of children to those they have already had. The final reason was to reduce the chance of an untimely pregnancy for women who were in training. The latter reason was taken to represent opportunity costs and was confirmed by its positive relationship with woman's income, and child education.

Results support the underlying assumptions of the neoclassical model. Mothers respond to economic and social constraints by adjusting fertility to opportunity cost, social benefits of children and social pressure. By manipulating the constraints and incentives, policy makers can encourage fertility decline.

Child education (quality), woman's opportunity cost of time and formal market participation were negatively related to fertility reflecting a substitution from number of children (time intensive commodities) to fewer more educated children (less time intensive) as opportunity costs rise. Child labour and remittance income were positively associated with fertility. Provision of these services, i.e. water and electricity, in rural areas, and better pension and social security investment options will reduce parents' dependence on children. Better education and employment opportunities are vitally important for fertility reduction because they increase the opportunity cost effect. These strategies must be accompanied with a shorter term policy of improving family planning services, and promoting the advantages of child spacing and improved primary health care.

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APPENDICES

APPENDIX A.1 QUESTIONNAIRE

Identification:

Magisterial District:

Strata Number:

Place:

Respondent Number:

1. PLEASE COMPLETE TABLE 1 FIRST.

Table 1.A

Name	Sex	Age	Occupation	Work place	Monthly income	Remitances	Pensions	School level	Years worked

Table 1.B

Water	Wood	Cook	Child care	House clean	Field work	Herd	Milk	Grind grain	Shop	Other

Note: Table 1.B is a continuation of Table 1.A, so the information in the table was collected for each member of the household.

If the respondent says she stays at home please ask the following questions. Otherwise move on to question 3.

2. Have you looked for wage employment in the past year?

Yes _____ Go to 2.1

No _____ Go to 2.5

2.1 How many times? _____

2.2 How many times did you get work? _____

2.3 What type of work did you look for? _____

2.4 What wage will you get in that job? _____

2.5 Why not? You do not want to _____

You cannot get work _____

You are too old _____

You are busy at home _____

Husband will not let you _____

3. How much land do you use for growing crops? _____ha

_____football

_____fields

4. What type of crops does your household grow? (If none move on to question 5.)

Type	Area	Yield	Value	Value sold

5. How many of the following do you own? Were any bought or sold last year?

	Number owned	Number sold last year	For how much money	Number bought last year	How much did you pay	Kill
cattle						
sheep						
goats						
chickens						
ducks						
pigs						

6. Labour

6.1 What time do your children start school? _____

6.2 What time do they get home after school? _____

6.3 What standard would you like your children to reach at school? _____

6.4 Did you hire anyone last year? Yes _____
No _____

6.5 If yes,

Type of work	How long did they work for	How much were they paid

7. Household Purchases

7.1 How many times do you buy the following?

Never	6
Once a year	5
Every 6 months	4
Once a month	3
Every 2 weeks	2
Every week	1
Every day	0

	Number of times	Approximate amount spent per purchase
Bread, flour		
Maize meal, rice, pasta		
Eggs, meat		
Milk, cheese, yoghurt, maas		
Oil, margarine, butter		
Vegetables, fruit		
Sugar and related products		
Tea, coffee, soft drinks		
Baby foods		
Toiletries		
Linen		
Fuel, firewood, gas, paraffin		
Furniture		
Household utensils		
Other (state)		

7.2 Please estimate the cost of education including fees, uniforms, books, and any other equipment for the following categories.

Annual cost per junior school scholar _____

Annual cost per high school scholar _____

Annual cost per university scholar _____

Annual cost for any other type of training _____

7.3 How much does it cost you to transport your children to school? _____

7.4 Approximately how much did you spend on clothing per child last year? _____

7.5 Approximately how much did you spend per child on medical expenses last year? _____

7.6 What other costs do your children incur?

_____

Type How much per child

_____

_____

_____

_____

8.1 Would you prefer more sons or more daughters? Sons _____

Daughters _____

Neither _____

Why? _____

_____

_____

8.2 Do you get the following benefits from your children?

Social status _____

Help in religious or social obligations _____

Financial assistance _____

Old age support _____

Lobola _____

Other (specify) _____

9.1 How much money would you expect from lobola for each daughter? _____

9.2 If financial assistance is expected, how much do you hope to receive per son _____

per daughter _____?

10. Do you own any of the following?

Television _____

Radio _____

Gas burner _____

Paraffin stove _____

Motor vehicle _____

Bicycle _____

Sewing machine _____

Knitting machine _____

Furniture _____

Tractor _____

Plough _____

Hoe, harrow _____

Watch _____

11. Do you own a bank or building society account? _____

12.1 At what age did you get married? _____years.

12.2 And your husband? _____years.

13.1 How many more children would you like if any? _____

Why? _____

13.2 If you could start life over again, knowing that things would be just the same for you and your husband, how many children would you want to have if you had just the number you wanted by the time you had finished? _____

13.3 If you could not have that number, would you prefer more or less? _____

13.4 How many pregnancies have you had? _____

13.5 How many miscarriages have you had if any? _____

13.6 Do you think your family is small or large in comparison to the normal family in your community?

Small _____

Large _____

14.1 Do you use contraceptives? Yes _____ Go to 14.1.1

No _____ Go to 14.2

14.1.1 What kind? _____

14.1.2 Are they easily available? _____

14.1.3 How much do they cost? _____

14.1.4 How long have you been using them? _____

14.1.5 Do you use them to help space your children? _____

14.2 If no, why not? _____

15.1 Have you always lived in this area? _____

15.2 If not, where were you before, and why did you move?

_____

_____

_____

_____

16. Do you think that school is a good thing for your children and why?

_____

_____

_____

_____

APPENDIX A.2 LIST OF VARIABLES

IND	Respondent number within each stratum
OW	Stratum identifier:
	Professional workers in Ubombo: OW = 1
	Industrial workers in Ubombo: OW = 2
	Unemployed women in Ubombo: OW = 3
	Professional workers in Ulundi: OW = 4
	Industrial workers in Ulundi: OW = 5
	Unemployed in Ulundi: OW = 6
CUM	Cumulative count for respondents
MSD1	Dummy variable scoring one for married women
MSD2	Dummy variable scoring one for common law wives
MSD3	Dummy variable scoring one for divorced women, these respondents were excluded from the analyses
MSD4	Dummy variable scoring one for widows, they were grouped with married women throughout the analysis
AGEH	Husband's age in years
AGEW	Respondent's age in years
AGEM	Respondent's age at first child's birth in years
DUR	Duration of marriage in years
OCCH1	Dummy variable scoring one if husbands are skilled workers
OCCH2	Dummy variable scoring one if husbands are semi-skilled workers

EH	Raw data values of husband's education in years of schooling
EDHT	Computed values of husband's education in years of schooling
EDH	Composite variable of husband's education, including both EH and EDHT for the missing value cases
EMPH	Years of employment of husband/boyfriend
EDW	Wife's education in years of schooling
PWT	Woman's opportunity cost calculated as: $PWT = \frac{W^w T_L^w + \hat{W}^w T_f^w}{T^w}$
PART	Woman's labour market participation
EMPW	Years of employment of wife
NOC	Number of living children
TST	Desired number of children
IM	Number of infant deaths, including miscarriages; infants less than one year old
CU	Dummy variable scoring one if the respondent used any form of contraception including abstinence and sterility
CCOST	Cost of contraception per annum (Rand)
R1 - R11	Reasons for not using contraception: all are dummy variables scoring one if the reason applies
R1	Abstinence
R2	Sterilisation
R3	Menopause

R4	Infertility
R5	Incompatibility
R6	Fertility problems
R7	No perceived need
R8	Facilities not available
R9	Spouse disapproval
R10	Discouraged by rumour
R11	Ignorant
R12	Want children
R13 - R15	Reasons for using contraception: all are dummy variables scoring one if the reason applies
R13	Desired family size completed
R14	To space children
R15	Prevent unwanted pregnancy during study
R16	Family support problem
SP1	Dummy variable scoring one if respondents have a daughter preference
SP2	Dummy variable scoring one if respondents have a son preference
LAND	Land area available to the household, in football fields
HIRE	A dummy, representing use of hired labour, scored one if labour was hired
HCOST	Labour hire cost: Rand per annum
FAMI	Annual family income from all sources except crops and livestock (Rand)
WINC	Respondent's annual income (Rand), including both formal and informal incomes
INC	FAMI - WINC

SEA1	Dummy variable scoring one if the respondent was actively searching for employment
SEA2	Dummy variable scoring one if the respondent was already employed
RATE	Number of jobs held per number of times respondent actively searched for one: RATE = 1 if SEA2 = 1
EWAGE	Expected wage for those actively searching, and wage rate for those already with jobs
OC	Opportunity cost: OC = RATE x EWAGE
CFAM	Ratio of child to family earnings
PFAM	Ratio of pensions to family earnings
CPS	Value of crops sold annually (Rand)
CPE	Value of crops consumed annually (Rand)
CAT	Number of cattle owned
GOAT	Number of goats owned
SHEEP	Number of sheep owned
DUCK	Number of ducks owned
PIG	Number of pigs owned
CHICK	Number of chickens owned
ANSD	Value of animals sold per annum (Rand)
ANC	Value of animals consumed per annum (Rand)
AB	Value of animals bought per annum (Rand)
NFI	Net farm income computed as: (CPE + ANC) + (CPS + (ANSD - AB))
HSIZE	Household size computed as: NOC + 1
TOTY	FAMI + NFI
TYPC	TOTY / (NOC + 1)

INCOME	Principal component estimate of permanent income
GROC	Annual cost of groceries for the family (Rand)
EDCT	Annual cost of children's education (Rand)
TRAN	Annual cost of transport for children (Rand)
CLOT	Annual cost of clothes for children (Rand)
MEDC	Annual medical cost for children (Rand)
SUNC	Annual sundry cost for children (Rand) i.e. scouts fees
TCOST	Total child cost computed as: TCOST = (GROC + EDCT + TRAN + CLOT + MEDC + SUNC)
TCPC	Total cost per child computed as: TCOST / (NOC + 1)
TIME	Time, in hours, children spend per day at school
DEDC	Desired level of child schooling, in years
EDCD	A dummy scoring one if parents are pro child education
CRECHE	Dummy variable scoring one if children were sent to creche
W1 - W10	Reasons for use or non-use of creche facilities: all are dummies and score one if the reasons applies
W1	None available
W2	Too expensive
W3	Cared for at home
W4	Ignorant
W5	Spouse decides
W6	Children too young
W7	Children spent time with other children at creche
W8	Allows respondent to work

W9	Gives children an advantage at school
W10	Will send
C1 - C5	Child benefits expected from respondents
C1	Financial assistance
C2	Old age support
C3	Lobola
C4	Social status
C5	Religious or social functions
FAS	Value of financial assistance expected per annum from sons (Rand)
FAD	Value of financial assistance expected per annum from daughters (Rand)
LOB	Value of lobola expected for each daughter (Rand)
STAT	Household's social status component
TV - INS	Dummy variables representing asset ownership: variable scores one if the family has ownership
TV	Television
RAD	Radio
GB	Gas burner
PS	Paraffin stove
CAR	Motor car
BIKE	Bicycle
SMAC	Sewing machine
FURN	Furniture i.e. beds, cupboards, lounge suites etc.
TRACT	Tractor
PLO	Plough

OXPL	Ox plough
HOE	Hoe or harrow
WATCH	Watch or clock
KMAC	Knitting machine
FRIDGE	Refrigerator (gas or electric)
STOVE	Oven as opposed to a hot plate, (gas or electric)
BANK	Bank, post office or building society account
INS	Insurance policy

SHH	Sex of household head
REL	Number of adult relatives in the household

CLAB	Child labour hours
HLP	Child "help" component

CW1-HAND2 Dummy variables relating to child help, which score one if applicable to the family

CW1	Household water supply
CW2	Sons collect water
CW3	Daughters collect water
CF1	Household electricity supply
CF2	Sons collect firewood
CF3	Daughters collect firewood
CF4	Buy firewood
COOK1	Sons cook
COOK2	Daughters cook
LAC1	Child care: sons
LAC2	Child care: daughters
HC1	House cleaning: sons
HC2	House cleaning: daughters

FIELD1	No access to land
FIELD2	Working in fields: sons
FIELD3	Working in fields: daughters
FIELD4	Hired workers
HERD1	Sons herd animals
HERD2	Daughter herd animals
HERD3	Hired workers
GRAIN1	Grain grinding: sons
GRAIN2	Grain grinding: daughters
GRAIN3	Taken to the miller
BEER1	Beer making: sons
BEER2	Beer making: daughters
SHOP1	Shopping and errands: sons
SHOP2	Shopping and errands: daughters
HAND1	Handicrafts: sons
HAND2	Handicrafts: daughters

APPENDIX A.3 DESCRIPTIVE STATISTICS

A.3.1 Means and standard deviations of the child help variables (KwaZulu, 1988)

Variable description	Stratum 1: Professionals			Stratum 2: Industrial workers			Stratum 3: Unemployed		
	Ubombo	Ulundi	Both	Ubombo	Ulundi	Both	Ubombo	Ulundi	Both
Sons collect water	**0,179** 0,390	**0,033** 0,183	**0,103** 0,307	**0,344** 0,483	**0,233** 0,430	**0,290** 0,458	**0,034** 0,186	**0,077** 0,272	**0,055** 0,229
Daughters collect water	**0,429** 0,504	**0,100** 0,305	**0,259** 0,442	**0,625** 0,492	**0,400** 0,498	**0,516** 0,504	**0,414** 0,501	**0,000** 0,000	**0,218** 0,417
Sons collect wood	**0,214** 0,418	**0,000** 0,000	**0,103** 0,307	**0,281** 0,457	**00267** 0,450	**0,274** 0,450	**0,034** 0,186	**0,038** 0,196	**0,036** 0,189
Daughters collect wood	**0,357** 0,488	**0,067** 0,254	**0,207** 0,409	**0,563** 0,504	**0,300** 0,466	**0,435** 0,500	**0,310** 0,471	**0,038** 0,196	**0,182** 0,389
Sons cook	**0,036** 0,189	**0,033** 0,183	**0,034** 0,184	**0,125** 0,336	**0,100** 0,305	**0,113** 0,319	**0,000** 0,000	**0,038** 0,196	**0,018** 0,135
Daughters cook	**0,393** 0,497	**0,100** 0,305	**0,241** 0,432	**0,406** 0,499	**0,367** 0,490	**0,387** 0,491	**0,310** 0,471	**0,192** 0,402	**0,255** 0,440
Child care: sons	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000	**0,063** 0,246	**0,000** 0,000	**0,032** 0,178	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000
Child care: daughters	**0,071** 0,262	**0,000** 0,000	**0,034** 0,184	**0,125** 0,336	**0,100** 0,305	**0,113** 0,319	**0,103** 0,310	**0,077** 0,272	**0,091** 0,290
Housework: sons	**0,107** 0,315	**0,067** 0,254	**0,086** 0,283	**0,219** 0,420	**0,100** 0,305	**0,161** 0,371	**0,000** 0,000	**0,077** 0,272	**0,036** 0,189
Housework: daughters	**0,393** 0,497	**0,067** 0,254	**0,224** 0,421	**0,500** 0,508	**0,300** 0,466	**0,403** 0,495	**0,172** 0,384	**0,154** 0,368	**0,164** 0,373
Field work: sons	**0,107** 0,315	**0,000** 0,000	**0,052** 0,223	**0,094** 0,296	**0,100** 0,305	**0,097** 0,298	**0,034** 0,186	**0,038** 0,196	**0,036** 0,189
Field work: daughters	**0,214** 0,418	**0,000** 0,000	**0,103** 0,307	**0,219** 0,420	**0,133** 0,346	**0,177** 0,385	**0,103** 0,310	**0,038** 0,196	**0,073** 0,262
Sons herd	**0,179** 0,390	**0,000** 0,000	**0,086** 0,283	**0,219** 0,420	**0,067** 0,254	**0,145** 0,355	**0,034** 0,186	**0,000** 0,000	**0,018** 0,135

A.3.1 continued:

Variable description	Stratum 1: Professionals			Stratum 2: Industrial workers			Stratum 3: Unemployed		
	Ubombo	Ulundi	Both	Ubombo	Ulundi	Both	Ubombo	Ulundi	Both
Daughters herd	**0,036** 0,189	**0,000** 0,000	**0,017** 0,131	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000	**0,034** 0,186	**0,000** 0,000	**0,018** 0,135
Milling: sons	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000	**0,000** 0,000
milling: daughters	**0,071** 0,262	**0,000** 0,000	**0,034** 0,184	**0,344** 0,483	**0,000** 0,000	**0,177** 0,385	**0,172** 0,384	**0,000** 0,000	**0,091** 0,290
Shopping: sons	**0,036** 0,189	**0,033** 0,183	**0,034** 0,184	**0,188** 0,397	**0,100** 0,305	**0,145** 0,355	**0,069** 0,258	**0,154** 0,368	**0,109** 0,315
Shopping: daughters	**0,071** 0,262	**0,067** 0,254	**0,069** 0,256	**0,438** 0,504	**0,233** 0,430	**0,339** 0,477	**0,310** 0,471	**0,154** 0,368	**0,236** 0,429
n	28	30	58	32	30	62	29	26	55

Notes: 1. Means are in bold type, standard deviations are in normal type below the means.

2. All variables are dummies scoring one if the activity is undertaken.

A.3.2 Means and standard deviations of the ownership of assets (KwaZulu, 1988)

Variable description	Stratum 1: Professionals			Stratum 2: Industrial workers			Stratum 3: Unemployed		
	Ubombo	Ulundi	Both	Ubombo	Ulundi	Both	Ubombo	Ulundi	Both
Television	**0,429**	**0,333**	**0,379**	**0,031**	**0,033**	**0,032**	**0,034**	**0,346**	**0,182**
TV	0,504	0,479	0,489	0,177	0,183	0,178	00186	0,485	0,389
Radio	**0,929**	**0,900**	**0,914**	**0,656**	**0,667**	**0,661**	**0,759**	**0,731**	**0,745**
RAD	0,262	0,305	0,283	0,483	0,479	0,477	0,435	0,452	0,440
Gas burner	**0,500**	**0,367**	**0,431**	**0,281**	**0,100**	**0,194**	**0,241**	**0,038**	**0,145**
GB	0,509	0,490	0,500	0,457	0,305	0,398	0,435	0,196	0,356
Paraffin	**0,143**	**0,500**	**0,328**	**0,375**	**0,800**	**0,581**	**0,448**	**0,192**	**0,327**
stove PS	0,356	0,509	0,473	0,492	0,407	0,497	0,506	0,402	0,474
Motor car	**0,143**	**0,100**	**0,121**	**0,094**	**0,067**	**0,081**	**0,034**	**0,192**	**0,109**
CAR	0,356	0,305	0,329	0,296	0,254	0,275	0,186	0,402	0,315
Sewing	**0,357**	**0,467**	**0,414**	**0,188**	**0,133**	**0,161**	**0,241**	**0,231**	**0,236**
machine	0,488	0,507	0,497	0,397	0,346	0,371	0,435	0,430	0,429
SMAC									
Furniture	**0,929**	**0,300**	**0,603**	**0,375**	**0,467**	**0,419**	**0,379**	**0,731**	**0,545**
FURN	0,262	0,466	0,439	0,492	0,507	0,497	0,494	0,452	0,503
Tractor	**0,071**	**0,000**	**0,034**	**0,000**	**0,000**	**0,000**	**0,000**	**0,077**	**0,036**
TRACT	0,262	0,000	0,184	0,000	0,000	0,000	0,000	0,272	0,189
Plough	**0,143**	**0,000**	**0,069**	**0,000**	**0,000**	**0,000**	**0,000**	**0,077**	**0,036**
PLO	0,356	0,000	0,256	0,000	0,000	0,000	0,000	0,272	0,189
Ox plough	**0,071**	**0,033**	**0,052**	**0,031**	**0,133**	**0,081**	**0,172**	**0,000**	**0,091**
OXPLO	0,262	0,183	0,223	0,177	0,346	0,275	0,384	0,000	0,290
Hoe	**0,857**	**0,867**	**0,862**	**0,906**	**0,967**	**0,935**	**0,621**	**0,538**	**0,582**
HOE	0,356	0,346	0,348	0,296	0,183	0,248	0,494	0,508	0,498
Watch	**0,929**	**0,867**	**0,897**	**0,469**	**0,700**	**0,581**	**0,586**	**0,462**	**0,527**
WATCH	0,262	0,346	0,307	0,507	0,466	0,497	0,501	0,508	0,504
Knitting	**0,036**	**0,033**	**0,034**	**0,000**	**0,033**	**0,016**	**0,000**	**0,038**	**0,018**
machine	0,189	0,183	0,184	0,000	0,183	0,127	0,000	0,196	0,135
KMAC									
Refrigerator	**0,179**	**0,100**	**0,138**	**0,031**	**0,000**	**0,016**	**0,034**	**0,308**	**0,164**
FRIDGE	0,390	0,305	0,348	0,177	0,000	0,127	0,186	0,471	0,373
Stove	**0,250**	**0,167**	**0,207**	**0,031**	**0,033**	**0,032**	**0,000**	**0,692**	**0,327**
STOVE	0,441	0,379	0,409	0,177	0,183	0,178	0,000	0,471	0,474

A.3.2 Continued:

Variable description	Stratum 1: Professionals			Stratum 2: Industrial workers			Stratum 3: Unemployed		
	Ubombo	Ulundi	Both	Ubombo	Ulundi	Both	Ubombo	Ulundi	Both
Bank	**0,821**	**0,967**	**0,897**	**0,250**	**0,467**	**0,355**	**0,276**	**0,346**	**0,309**
BANK	0,390	0,183	0,307	0,440	0,507	0,482	0,455	0,485	0,466
Insurance	**0,107**	**0,033**	**0,069**	**0,000**	**0,067**	**0,032**	**0,000**	**0,038**	**0,018**
INS	0,315	0,498	0,256	0,000	0,254	0,178	0,000	0,196	0,135

A.3.3 Summary of reasons given for use or non-use of contraception: means and associated standard deviations reported for 175 cases

Reasons	Variable	Mean	Standard deviation
a. for non-use:			
Abstinence	R1	0,029	0,167
Sterilisation	R2	0,046	0,209
Menopause	R3	0,017	0,130
Infertile	R4	0,011	0,107
Incompatibility with methods tried	R5	0,069	0,253
Fertility Problems	R6	0,017	0,130
No perceived need	R7	0,120	0,326
Facilities not available	R8	0,074	0,263
Spouse disapproval	R9	0,034	0,182
Discouraged by rumour	R10	0,131	0,339
Ignorance	R11	0,006	0,076
Want children	R12	0,074	0,263
b. for use:			
Desired family size completed	R13	0,086	0,281
Child spacing	R14	0,291	0,456
Prevention of unwanted pregnancy during study	R15	0,023	0,150
Family support problems	R16	0,011	0,107