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# An Empirical Investigation of the Determinants of Fertility

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by

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**Abstract**

As sociologists and economists evaluate the demographic trends of the past century, they note that total fertility rates have fallen worldwide. Using various theories to explain demographic change, scholars attribute the fall in fertility rates to a variety of social and economic factors. This study evaluates the effect of determinants of fertility from three major theories of fertility decline. Using World Bank and United Nations data, this study considers the impact of female illiteracy, female labor force participation, per capita GNP, urbanization and female secondary education on total fertility rates. Linear regression analyses for the years 1970, 1980 and 1990 show female illiteracy to have the strongest, most consistent effect on fertility. Urbanization, per capita GNP, female labor force participation and female secondary education each demonstrate statistical significance for one or two of the years tested.

## Introduction

The world's natural resources are contained within the confines of a relatively small planet. While nature constantly recreates itself in order to maintain a balance of life, human activity has seriously compromised the earth's health. First extracting plant and animal resources for food and wood for fuel and shelter, humans now use almost every resource in some way to meet their consumption demands. In addition to expanding the types of resources used, the growing human population has vastly increased both the quantity of resources needed to support human life and the amount of waste discarded after production and consumption of goods. The environmental strain resulting from the growing human population concerns many people. It is often predicted that global population growth cannot be sustained far into the future if consumption patterns remain at current levels. Therefore, it is imperative that both population growth and consumption patterns be studied carefully.

In the 1991 *State of the World Report*, Lester Brown explores the two divergent views regarding population growth: the economic approach and the ecological approach (1991:16). Those people who espouse the economic approach view population growth as positive. As long as the economic growth rate exceeds the population growth rate, growth can be sustained long into the future and serves to improve the standards of living. Those who take the ecological stance view population growth negatively. They fear that as the population grows and the earth's resources shrink, humans will soon reach the earth's carrying capacity.

An integral part of the debate is the quality of life which the population wishes to maintain and the ability of the population to utilize available resources to meet its needs. Depending on resources available, one part of the world might be able to sustain a much greater concentration of people than another. Many of the fundamental arguments decrying population growth have not changed over the centuries. However, many

population experts see the need for increased urgency in addressing the population dilemma as the population doubling time gets shorter and shorter.

Often considered to be the father of population study, Thomas Malthus laid the foundation for the ecological approach to population growth in his1798 "An Essay on the Principle of Population." Malthus acknowledges that both food and sexual relations are necessary to ensure the continuation of human existence. He theorizes that population increases geometrically (or exponentially), while the means for subsistence increases only arithmetically. He writes "The perpetual tendency in the race of man to increase beyond the means of subsistence is one of the general laws of animated nature which we can have no reason to expect will change" (Malthus in Menard 1987:103). Therefore, the population must be checked in some way so as not to outgrow available resources. Malthus saw both voluntary and involuntary checks to population growth. The voluntary checks, also known as preventive checks, involve changes in behavior, either marrying late or practicing celibacy. The involuntary checks, also called positive checks, include war, famine, disease, and natural disasters brought upon by overuse or scarcity of natural resources. While the preventive checks lower the birth rate, the positive checks raise the death rate, each limiting population growth (Wrong 1964:101).

The major criticism of Malthus' theory is that he did not foresee the dramatic increase in output brought upon by the industrial revolution or the opening of new lands through colonization. Because he wrote in the late 1700s, he had no way of predicting the new sources of energy or improvements in production. His theory does not allow for human ability to expand the earth's carrying capacity (Wrong 1964:104). Secondly, Malthus did not advocate the use of birth control. The only behavior modifications he advocated were marrying later in life and practicing celibacy until able to financially support children. His belief that humans could reduce fertility rates merely through celibacy and delaying marriage seems both unrealistic and impractical.

Paul and Anne Ehrlich have established themselves as the modern leaders of the

ecological approach to population growth. In their book *Population, Resources, Environment*, they document the rapid decrease in many countries' doubling times and question whether most countries are prepared to double their resources and social services over the next few decades (Ehrlich and Ehrlich 1970:2). They acknowledge that in agricultural societies, children are sources of labor, whereas in industrial societies, children are merely consumers. While there is economic pressure, therefore, to decrease family size as industrialization occurs, such decreases in fertility might not occur rapidly enough. The concern with overpopulation is not merely density in relation to land, but density in relation to resources, an important indicator of living standards (Ehrlich and Ehrlich 1970:200). They write:

> "Although human beings are capable of adapting themselves to a wide variety of environments, it is plain that we do much better in some sets of circumstances than others. *Whether we measure adaptive success by how many individuals can survive in a given area or by how many can live healthy, productive, reasonably happy, and comfortable lives is a vitally important point.*"
> (Ehrlich and Ehrlich 1970:207)

Thus, they acknowledge that while the earth might be able to sustain high levels of population growth, the quality of human life would be seriously compromised.

Julian Simon, renowned economist, takes a much more optimistic approach to population growth. Because population growth results from advances in technology or health, growth is an indicator of increased living standards. He states that "...population growth represents economic success and human triumph" (Simon in Menard 1987: 124). Simon argues that population growth often leads to economic growth. A larger labor force provides a wider pool of skills for employers, promotes the economies of scale, and increases the demand for goods. While he does acknowledge that certain problems arise from rapid population growth, the benefits far outweigh the negative consequences. He states,

> "Adding more people causes problems, but people are also the means to solve these problems...The ultimate resource is people--skilled, spirited, and hopeful people--who will exert their wills and imaginations for their own benefit, and so,

invariably, for the benefit of us all" (Simon in Menard 1987:128).

Thus, limiting population growth would deprive society of many talents and contributions. Simon's optimism seems a bit naive, however. He is often criticized for placing too much hope in technological advancements which might or might not take place.

Economists and ecologists will probably continue the debate on population and economic growth long into the future, each using different studies to support their position. Studies on population growth inevitably focus on fertility rates. While a large population has more momentum for growth than a smaller one, the fertility rates ultimately determine the amount of growth that will occur. Garrett Hardin uses the concept of the "tragedy of the commons" to illustrate the concern over fertility rates.[1] Using this analogy, if everyone exercises their "right" to bear large numbers of children, eventually the population will no longer be able to maintain a high standard of living. Hardin writes:

> "If each human family were dependent only on its own resources; if the children of improvident parents starved to death; if, thus, overbreeding brought its own 'punishment' to the germ line--then there would be no public interest in controlling the breeding of families. But our society is deeply committed to the welfare state, and hence is confronted with another aspect of the tragedy of the commons" (Hardin in Menard 1987:109).

Already, the "commons" of food gathering and waste disposal have been replaced with legal regulation to protect our resources (Hardin in Menard 1987:111). It is not such a leap to imagine a time when fertility will also be regulated to control growth, as is currently being done in China.

This paper presents a systematic study of population growth and fertility. It first examines the history of world population growth and then reviews several major theories

[1]In William Forster Lloyd's famous illustration, all herdsmen of a village are allowed to keep their cattle in the common area. Each will try to keep as many cattle as possible because, while overgrazing compromises the commons as a whole, the individual incurs only a fraction of the cost of overgrazing. As everyone acts in their own self interest, the common resources are destroyed and the whole community suffers (Hardin in Menard 1987:108).

on fertility, highlighting the socioeconomic factors to which the decline is attributed. Several of these factors will then be used to develop an empirical model for the determinants of fertility.

## Literature Review

### History of Population Growth

The historical study of population growth is not exact. Estimates of population size prior to the 1600s are based largely on the projection of census figures for agricultural societies and the examination of archeological remains (Ehrlich and Ehrlich1970: 6). Demographers often emphasize three major technological revolutions in human history: the food producing revolution, the urban revolution, and the industrial revolution (Wrong 1964: 10). Each technological revolution is marked by an increase in the slope of the population curve. For thousands of years, humans existed in nomadic bands, engaging in hunting and gathering as means of survival. Most likely, early humans had moderate to high birth and death rates, slow population growth, and low population density (Menard 1987: 10). With little protection from weather or disease, birth rates had to be high to compensate for high death rates (Sax 1960:29).

As humans gained a greater understanding of the environment, they began practicing a primitive form of agriculture, perhaps watering dry plants and replanting the tops of yams and other tubers. Around 10,000 to 8000 BCE, more sophisticated forms of agriculture and animal domestication evolved (Wrong 1964: 10). The more constant food supply resulted in a marked increase in population growth.

The urban revolution is estimated to have occurred around 4000 BCE. Archeological remains dating back to this time indicate that humans settled in cities in the Nile Valley and Mesopotamia. The next few thousand years were marked by massive demographic upheaval (Menard 1987: 13). As civilizations grew, they expanded outward. This exploration and colonization of new lands brought peoples into contact with each other, frequently resulting in war and the spread of disease. Prior to the

Industrial Revolution, the human population grew in times of economic prosperity and political stability and declined as a result of war, disease and famine (Menard 1987: 13).

The Industrial Revolution, occurring in Europe after1750 CE, led to unprecedented population growth. Improved living standards, including sanitation and medical technology, caused a dramatic fall in the death rate. As the birth rates stayed constant, the European population mushroomed (Menard 1987:13). Since the 1700s, technology has continued to advance and industrial progress has spread to most parts of the world. With life expectancy increasing and death rates falling globally, the world population has grown at a remarkable rate.

As shown in the graph in Appendix 1, the world population did not reach the first billion until around 1800 CE. By 1950, the world population had grown to above two billion. In the next fifty years, the population more than doubled, reaching six billion in 2000. This accelerated growth has led to a great deal of interest and concern among sociologists, economists and other scholars, who have attempted to explain the rapid population growth of the past hundred years and recent decline in fertility rates using various economic and social theories. While many theories exist, a few have been particularly influential in the field of demography. Each theory points to certain key factors in fertility decline, which will be used in this paper to create an empirical model of the determinants of fertility.

Theories on Population Growth and Fertility

Demographic Transition Theory: The demographic transition theory attempts to explain the extreme population growth of the past few hundred years by mapping the birth and death rates and the trend towards replacement level fertility. The theory is based on the experiences of 19th century Europe and the observation that mortality rates tend to respond more rapidly than birth rates to improvements in living conditions (Teitelbaum in Menard 1987: 29). There are three basic stages to the theory. In Stage One, both birth

and death rates are high. Because both are high, there is very little growth and population size remains stable. Most of human existence was spent in Stage One. With industrialization and the accompanying improvements in living conditions, nutrition and health practices, the death rate begins to fall, marking Stage Two. The birth rate, however, remains high. Because more children live to their reproductive years, there is dramatic population growth. After some time, the birth rate also begins to fall, until it reaches almost the level of the death rate. At the end of Stage Three, the population once again reaches replacement level fertility and population growth slows (Wrong 1964: 15). (See the graph in Appendix 2 for an illustration of the demographic transition theory.)

The demographic transition theory can easily be applied to Western Europe and the United States. However, it is unclear if it can be as effectively applied to the rest of the world. In Western Europe, advances in agriculture in the 1700s increased production, decreasing the number of workers needed in the rural sector. The excess rural workers were able to move over to industry, allowing for the rapid development of the industrial sector. The resulting advances in communication and transportation facilitated travel. During the Industrial Revolution, many excess workers emigrated to the United States, Latin America, or Australia, relieving some of the population pressure in Europe. Additionally, the spread of population and subsequent colonization of new lands provided much-needed natural resources and markets for new products. As modern medicine decreased the death rate and increased life expectancy, modern birth control also began to reduce the birth rate, until the population stabilized (Sax 1960:43).

The birth and death rates in Western Europe seemed to naturally reach equilibrium after completing the demographic transition. It is not so certain that today's developing countries will arrive at equilibrium naturally before growing to sizes which are beyond the means of their resources. There are several important differences between the experiences of Western Europe and today's developing countries. First, the death rate in Europe declined gradually because technology, particularly medical technology, was in

the early stages of development. With the phenomenal medical advances of the past hundred years, the death rates in developing countries have fallen much more rapidly, resulting in higher growth rates than in Europe. The fertility levels in developing countries today are higher than in Western Europe in the 1700s and 1800s, so the birth rates have farther to fall to approach the lower death rates. While Western Europe was able to relieve population pressure through emigration, there are no "new lands" left for the developing countries to colonize. Even more frustrating, once today's developing countries do achieve replacement level fertility, there will still be great momentum for further growth because of the very young age structure (Teitelbaum in Menard 1987: 32).

Certain factors, however, favor a smooth transition for developing countries. Modern birth control is much safer and more effective than that available to 19th century Europe. It is no longer so culturally unacceptable to have small families, so the social pressure to have many children has lessened. Similarly, national leaders are very concerned with the implications of population growth so are taking a more active role in population planning. Many developing countries also have much more advanced social and physical infrastructure than those of 19th century Western Europe (Teitelbaum in Menard 1987: 33). The fact remains, however, that today's developing countries are growing at a faster rate than Western Europe during its demographic transition.

The demographic transition theory points to several key determinants of fertility, the most important being industrialization. While it is difficult to find a single measure of industrialization, there are many measures which serve as good indicators. The first is the country's level of urbanization. A highly industrialized country is likely to have a large percentage of its population living in urban areas. Also, industrialized countries derive large percentages of their gross national product (GNP) from the secondary and tertiary sectors of the economy. GNP is often broken down to indicate the percentages that come from agriculture, manufacturing and services. In addition to economic indicators, standard of living is also measured by health and education. The Human

Development Index value, a composite of economic, health and education variables, attempts to encompass most aspects of life. Statistics looking at specific aspects of health or education, such as availability of immunization or gender ratios in higher education, are also useful. Unfortunately, statistics relating to education and health are not always gathered as regularly or reported as widely as economic statistics.

Wealth Flow Theory: John Caldwell attributes the transition towards a lower fertility rate to the changing economic value of children. In summarizing the wealth flow theory, he contends that the economic value of children is "progressively undermined by urbanization, compulsory schooling, legislation restricting the exploitation of minors, and the kind of employment available in an advanced industrial system" (Caldwell 1999:479). In advanced industrial societies, the intergenerational flow of wealth runs from parents to children, whereas in rural communities in less developed countries, wealth flows from children to their parents. Children in pre-industrial societies are often a valuable source of labor and can be considered an economic investment. In less developed countries, agriculture is very labor-intensive. While it would be expensive to hire workers to perform the necessary farm tasks, it is relatively less expensive to use the labor of one's children. Children's contributions to family income may be quite significant. Additionally, children may care for their parents in their old age and serve as a form of social security. Therefore, large families are economically rational (Caldwell in Bulatao et al 1983:469).

As industrialization and development occur and living standards improve, the cost of raising children increases. Because children in industrial countries are often required to attend school for a set period of time, they are no longer able to work and contribute to the family income. Additionally, higher levels of consumption of other goods and services make each child more expensive to raise than in pre-industrial societies. Another important consideration is the opportunity cost of women caring for children instead of participating in the labor force (Easterlin 1996:110). Child-rearing, while

perhaps emotionally satisfying, offers no economic compensation for the potential hours of work lost (Hess 1988:14). Because children simultaneously become more expensive to raise and contribute less to the family income, the demand for children decreases. As countries industrialize, Caldwell predicts that the demand for children, and therefore overall fertility, will naturally decrease.

The most important variables in the wealth flow theory involve the value of children, family structure and level of consumption. It is difficult to assign a value to family type. Simply stating the number of people in a particular family does not indicate whether the family unit includes only the nuclear unit or also the extended family. Measuring the economic value of children is slightly easier. Although it would be virtually impossible to measure the number of children employed in the informal sector, data is available that documents the number of children in the formal workforce. School enrollment statistics are also useful, although such statistics are not always accurate because children enrolled in school might not attend regularly. Measuring levels of consumption is more problematic since most countries have very bipolar societies. Per capita GNP, while demonstrating potential spread of wealth, does not account for the extreme inequality in resource distribution.

Relative Income Theory: Richard Easterlin theorized that there are two important economic factors in the decision to marry and have children: the couple's potential earning power and their desired standard of living (Easterlin 1980:39). The potential earning power is determined by the job market and the couple's job skills. The desired standard of living, sometimes called "material aspirations," is a combination of family upbringing, available consumer goods, and personal values. Because the minimum consumption level for which a young couple strives is usually that of their parents at the time the couple left home, the material aspirations tend to increase with each passing generation (Kohl 1984:29).

Easterlin postulates that income is relative. What might be considered a high

income for one person might be low for another, depending on the type of lifestyle one wishes to lead. Relative income is calculated by dividing the earning power by material aspirations (Easterlin 1980:42). As relative incomes rise, reflecting a greater increase in earning power than material aspirations, couples will be able to maintain a high standard of living for a greater number of children and will likely increase family size. As relative incomes fall, reflecting difficulty in maintaining a desired standard of living, fertility will likely fall (Easterlin 1980:43). Although absolute incomes have risen over the years, increased consumerism in much of the world has limited the rise in relative income, thus leading to the decrease in fertility.

The relative income theory attributes changes in fertility to the job market and level of consumption. Employment statistics for men and women are readily available, although they do not always indicate the type of employment opportunities or prospective wages likely to be earned. As stated earlier, consumption levels are difficult to measure, although per capita GNP is often used to show a country's potential affluence.

## Proposed Empirical Determinants of Fertility

When measuring changes in population size, one must consider the crude birth rate, crude death rate and net migration. The crude birth rate (CBR) refers to the number of live births per thousand members of the population in a given year. The crude death rate (CDR) gives the number of deaths per thousand members of the population in a year. Net migration is calculated by subtracting the number of people leaving the country from the number of people entering over the span of a year. These statistics are recalculated annually.

When evaluating demographic trends, it is often more useful to work with fertility rates than the crude birth rate. Because the crude birth rate measures the number of births per thousand members of the population as a whole, it does not give a clear indication of increases or decreases in average family size or the number of children a woman is likely

to bear over the course of her life, important considerations when studying changes in population growth.

The total fertility rate (TFR) is one of the most useful tools for evaluating demographic trends. The TFR measures the average number of children a hypothetical woman in a population is likely to bear over the course of her reproductive years. For statistical purposes, the reproductive years last from age fifteen to forty-nine. It should be noted that this number is always significantly lower than the level of fecundity, the maximum number of children a woman would bear if she engaged in regular sexual intercourse throughout her reproductive years without using any form of birth control.

The lower level of fertility than fecundity is due to a variety of biological, ecological, social, political and economic factors. People have a significant degree of control over their fertility and will choose to bear the number of children which is most beneficial to them. The decision regarding family size, then, is a combination of microlevel and macrolevel factors.

In the mid-1950s, Kingsley Davis and Judith Blake outlined a framework of direct and indirect determinants of fertility which are classified as intercourse variables, contraception variables, and gestation or parturition variables (Davis and Blake 1956:211). Intercourse variables include the age of first sexual unions, the proportion of women remaining celibate, the reproductive period between sexual unions, voluntary and involuntary abstinence within unions, and the frequency of intercourse. Contraception variables include voluntary and involuntary fecundity or infecundity and the use or nonuse of contraception. Gestation variables refer to involuntary or induced fetal mortality. Each variable is assigned a value according to its affect on fertility.

Davis and Blake write that "In general, the pre-industrial societies have high fertility-values for those variables farthest removed from the actual moment of parturition and which, therefore, imply an overall outlook favorable to fertility" (Davis and Blake 1956:234). Because many pre-industrial societies practice early, universal marriage and

use little contraception, the probability that women will become pregnant many times during their reproductive years is high. Industrial societies have successfully lowered their fertility rates not by targeting all variables, but by focusing on a few important ones. Specifically, industrial societies are generally marked by delayed marriage and widespread contraception use (Davis and Blake 1956:235).

John Bongaarts later took this framework and used it to create an equation for the fertility-inhibiting effects of key direct determinants, evaluating the TFR as a function of marriage, lactational infecundity, abortion, pathological sterility, contraception prevalence, and total fecundity (Stover 1998:255). This formula has been used extensively to evaluate changes in fertility.

Instead of focusing on the physical and biological determinants of fertility, this paper explores at the macrolevel the way certain social and economic factors affect fertility. This study investigates the effect of female literacy, female participation in secondary education, female workforce participation, the country's level of urbanization and per capita gross national product on fertility rates. As deduced from earlier discussions of the wealth flow theory, relative income theory and demographic transition theory, these variables are believed to have an impact on fertility.

Female literacy is measured using the female illiteracy rate. The female illiteracy rate is the percentage of females age fifteen and older that cannot read or write a simple sentence about their everyday life. Female labor force participation is measured by the percentage of the labor force that is female. The labor force includes all people between the ages of fifteen and sixty-five who meet the International Labor Organization's definition of the economically active population. The "economically active population" refers to all people who supply labor for the production of goods and services, generally including the armed forces, the formal sector and those who are unemployed. Homemakers, unpaid caregivers and people employed in the informal sector are not included. While data on the percentage of females employed would have been more

useful, complete sets of such data were hard to find. Urbanization is measured by the percentage of the country's population that lives in an urban area, as reported to the United Nations. Per capita GNP is calculated by dividing GNP by the midyear population. In order to adjust for inflation, per capita GNP is given in constant 1995 $US, making comparisons through time possible. Female participation in secondary education, specifically general education, programs is calculated by determining the percentage of students enrolled in these programs who are female.

## Methodology

The data used in this study come from the World Bank's *World Development Indicators* CD-ROM and the United Nations' *Wistat* CD (Women's Indicators and Statistics Database). These CDs are a compilation of the data sets included in each organization's yearly publications. The *World Development Indicators* CD contains more than five hundred economic and social timeseries indicators from 1960 to 1997. The *Wistat* CD contains over fifteen hundred statistical series on most aspects of life for both men and women in over two hundred countries or areas of the world. The data run from 1970 to 1993, with some series projected into the future. The per capita GNP, female illiteracy, urbanization, and female labor force participation statistics were taken from the *World Development Indicators* CD. Statistics for female enrollment in secondary education were found in the *Wistat* CD. Data for each variable were compiled for the years 1970, 1980 and 1990. These years were chosen because, being census years, more countries had complete data sets available.

Complete data for all census years were available for fifty-seven countries. The sample includes mostly developing countries and some more developed countries. According to the Population Reference Bureau's classifications, twenty-six of the countries are African, fourteen are Asian, twelve are Latin American or Caribbean, four are European and one is Oceanian. While it is useful to look at regional statistics, there is great variation within each regional bloc. Both Northern and Sub-Saharan Africa are

classified as "African," yet are vastly different. If the two African regions are considered separately, Northern Africa's per capita GNP is twice as high as that of Sub-Saharan Africa, its population is significantly more urban, more women use modern contraception, life expectancy is fifteen years longer, and the Infant Mortality Rate (IMR) is almost fifty percent lower (1999 *World Population Data Sheet*). Similar disparities exist in Latin America and Asia, although these regions generally have much more favorable life expectancies, IMRs, and contraception prevalence than Africa as a whole. Asia is still, however, very rural. Europe and Oceania, being more industrialized, have much longer life expectancies, higher per capita GNPs, larger percentages of their populations living in urban areas, and better health conditions than most of the developing world. Nevertheless, these fifty-seven countries show wide variation in fertility rates and the other identified variables. It is thus necessary to do a systematic analysis of the impact of these variables on fertility.

The following regression model shows the proposed relationship between female illiteracy, female secondary education, female participation in the labor force, urbanization, per capita GNP and fertility:

$$TFR = a + b_1 \text{per capita GNP} + b_2 \text{Illit} + b_3 \text{Labor} + b_4 \text{Urban} + b_5 \text{SecEd}$$

According to this model, the total fertility rate (TFR) is a function of five variables and a theoretical constant. The b-value indicates how much the TFR would change due to a one-unit change of that particular variable, all other variables held constant. For example, $b_1$ indicates how much the TFR would change if per capita GNP increased by one dollar, holding the levels of the other variables constant. The other b-values indicate the amount by which TFR would change if each respective variable were increased by one percentage point, assuming the levels of the other variables did not change.

## Results

### Descriptive Analysis

The data were first organized according to geographic region for descriptive

analysis. The mean, standard deviation and range were taken for each variable to show regional and global trends over the twenty year period. Results are shown in Appendix 3.1 to 3.5. Overall, the total fertility rate fell by 1.56, from 5.86 in 1970 to 4.3 in 1990. The European and African TFRs fell slightly, while the Asian and Latin American TFRs fell dramatically. The 1990 African TFR (5.63) is still almost twice as high as that of the other regions of the world, with the Asian and Latin American TFRs (3.31 and 3.62 respectively) halfway between those of Africa and Europe (1.46).

The overall average per capita GNP grew by only two hundred dollars over the twenty year period. Africa's mean per capita GNP ($774.9 in 1990) grew by fifty percent, but is still abysmally low when compared with every other region of the world. Europe was the only region that experienced significant economic growth, with its per capita GNP now above eleven thousand dollars.

The female illiteracy rate fell twenty percentage points in Africa (80% to 60%) and Asia (55% to 34%). Initially much lower than in other parts of the world, Europe's and Latin America's female illiteracy rates fell by only seven to eleven percentage points. The female illiteracy rate in Africa is still much higher than the global average (41% in 1990), with well over half the female population unable to read and write.

Female labor force participation remained fairly constant between 1970 and 1990 (over 30%). Europe and Latin America experienced the greatest growth, adding slightly under ten percentage points to the percentage of labor force that is female. Africa is still the region with the highest percentage of the labor force comprised of females (40%).

Each region experienced an increase of approximately ten percentage points in urbanization. Europe has the highest level of urbanization (66%) and Africa has the lowest (32%). The overall mean is around forty-five percent, with just under half the global population living in urban areas.

The percentage of students enrolled in secondary education who are female grew globally by roughly seven percentage points between 1970 and 1990 (from 37% to 44%).

Africa and Asia experienced the most significant growth. Europe and Latin America initially had a more equal ratio so their percentages grew only slightly.

Regression Analysis

For each year, the regression model was fitted to the data set. Results of the regression analyses are given in Table 1.

Table 1.Regression coefficients for the different determinants of fertility, 1970, 1980 and 1990 for n=57 countries.

| Variable | 1970 Coefficients | 1980Coefficients | 1990 Coefficients |
|---|---|---|---|
| Per capita GNP (GNP) | 0.00003304 p<.114 ns | 0.00003408 p<.204 ns | -0.00007607 p<.060 * |
| Female illiteracy (ILLIT) | 0.02951 p<.001 *** | 0.05502 p<.000 *** | 0.04292 p<.000 *** |
| Female labor force participation (LABOR) | -0.02791 p<.061 * | -0.02193 p<.147 ns | 0.01844 p<.297 ns |
| Urbanization (URBAN) | -0.02917 p<.001 *** | -0.03352 p<.000 *** | -0.005583 p<.576 ns |
| Female secondary education (SECED) | -0.005585 p<.797 ns | 0.04787 p<.056 * | 0.01925 p<.476 ns |

ns not significant
* significant at 10% level
*** significant at 1% level

Female illiteracy, female labor force participation and urbanization were found to have a significant impact on fertility in 1970. Female illiteracy and urbanization were statistically significant at the 1% level. In 1980, female illiteracy and urbanization were once again highly significant. Instead of labor force participation, however, female secondary education was shown to impact fertility. In 1990, only female illiteracy and per capita GNP were statistically significant.

Scatter diagrams showing the relationship between fertility and the variables that

have a significant effect on fertility are located in Appendix 4.1 to 4.8. The diagrams show a strong positive relationship between fertility and female illiteracy and negative relationships between fertility and per capita GNP, female labor force participation and urbanization. Surprisingly, for the year in which female secondary education was shown to be statistically significant, it exhibited a positive relationship with total fertility rate.

**Discussion and Conclusion**

Female educational opportunities are both direct and indirect determinants of fertility. In societies where a large percentage of the female population attends school beyond the primary years, education serves to delay marriage and postpone childbearing (Hess 1988:19). Education also increases knowledge of health, hygiene, nutrition, and childcare. If parents are better able to care for their children's physical needs, more children will survive to adulthood. Thus, parents will need to have fewer children to ensure their optimal family size. Finally, education increases women's job skills. While education does not guarantee access to jobs in all societies, it generally increases women's earning power, making family care less attractive (Easterlin and Crimmins 1985:22). As an indirect determinant, education makes women more aware of opportunities for community involvement outside the home, decreasing the amount of time women are willing to spend caring for homes and families.

Data gathered in the mid-1970s for the World Fertility Survey (WFS) show an overall negative relationship between education and fertility (Kasarda, Billy and West 1986:89). For the most part, the expected number of children in developed countries declined in an L-shaped curve as education increased, although a few countries' curves appeared slightly U-shaped. Similarly, WFS data from developing countries also indicated an inverse relationship between education and fertility. However, this relationship is strongest when education increases to include secondary education or higher. As a direct determinant of fertility, a few years of primary education will reduce the length of breastfeeding, and thus the period of lactational amenorrhea, without

substantially changing other determinants of fertility related to education (Kasarda, Billy, and West 1986:92).

It is surprising, then, that this study found female secondary education to have only a small, positive impact on fertility. Literacy, however, proved to be the strongest determinant, showing significant effect at the highest level each year tested. It is possible that secondary education is better classified as an indirect determinant of fertility and that the effect of education on fertility is mediated by literacy. Literacy logically increases job skills and broadens the range of jobs able to be completed. Literacy determines a woman's ability to read and absorb written information regarding health, nutrition and sanitation.

Basic literacy can be achieved through primary education, however. To test education as a direct determinant of fertility, it might be better to use tertiary education instead of secondary. Certainly, secondary education impacts a variety of social, economic and demographic variables which directly affect fertility, such as employment, age at marriage and knowledge of contraception (Kasarda, Billy and West 1986:94). However, tertiary education necessitates a longer delay in marriage and childbearing so might have a more significant direct impact. Either way, education of women is one of the most important institutional variables for reducing fertility because it can easily be affected by public policy.

Female participation in the labor force is generally believed to lower fertility. WFS data show that in developed countries, there is a strong negative relationship between employment and childbearing. Findings for less developed countries, however, are inconsistent. Some studies conclude that there is a definite inverse relationship. Others are inconclusive or even suggest a slight positive one (Kasarda, Billy and West 1986:112). The inconsistencies in the findings are due, in part, to the way in which employment is defined. If employment includes agricultural work or cottage industry, much of the female population in developing countries would be considered to be

employed. If employment were limited to work done outside of the home, fewer women would be considered to be active in the work force. Because fertility rates tend to be higher in rural societies, studies which include agricultural work as a form of employment would obviously not show a negative relationship between labor force participation and fertility (Kasarda, Billy and West 1986:113). It could, therefore, be argued that the negative relationship between employment and fertility does not appear until industrialization occurs.

Given the inconsistencies regarding the effect of labor force participation on fertility, it is not surprising that the effect of female labor force participation was significant in only one of the three years tested, and then at only the ten percent level. The coefficient was negative, however, indicating a negative relationship between labor force participation and fertility. While the ILO does try to maintain some level of consistency in who is included in employment statistics, many countries have skewed data because they might count seasonal or migrant workers or part-time workers differently. Additionally, some countries include cottage industry and other activities in employment statistics. Clearly, inconsistencies in measurements weaken any generalizations about labor force involvement.

According to the demographic transition theory, industrialization, generally marked by an increase in both urbanization and per capita GNP, is accompanied by a decline in fertility. This study found urbanization to be a highly significant negative determinant in both 1970 and 1980. The significant impact of per capita GNP was evident only in 1990.

Industrialization is often accompanied by fertility decline. Since urbanization is one feature of industrialization, it is logical to assume that urbanization would directly impact fertility. In order for industrialization to occur, there must usually be a large rural to urban migration. Because food and shelter are often more expensive in urban areas, children "cost" more yet usually contribute less to family income (Easterlin and

Crimmins 1985:23). Additionally, it is generally more difficult for women to care for children while maintaining urban employment than to care for children while engaged in farmwork (Hess 1988:21). Urbanization, with increased pressures of cost and space, does not accommodate large families easily so demand for children should naturally decrease as societies urbanize.

Rising GNP is the other main indicator of industrialization. It should be noted that per capita GNP was significant only in the year in which urbanization was not significant. It is possible that economic growth is the real direct determinant of fertility and that its impact was captured by urbanization in 1970 and 1980 and by GNP in 1990.

This study found female illiteracy, female labor force participation and urbanization to have significant impact on fertility. If policy-makers were to use this model when implementing policies to reduce fertility, they would emphasize these areas. However, it is not realistic to expect a policy favoring urbanization to be a long-run solution to high fertility, particularly since it was not a significant determinant in 1990. Unless dramatic changes in agriculture and production take place, a certain portion of the population must always be employed in the agricultural sector. Societies will therefore have a limit on the level of urbanization that they can sustain. Instead, governments should focus on economic growth as a deterrent to high fertility.

Illiteracy should be significantly easier to address through public policy. Illiteracy can be greatly reduced through improved education. Many countries have compulsory schooling laws. Additionally, the government can legislate that boys and girls be given equal educational opportunities. Similarly, adult literacy programs sponsored by government ministries or departments can target both men and women. While such programs do require a significant investment in the educational system, once implemented, they should be relatively easy to maintain. If leaders are truly serious about reducing fertility, they must channel resources to the education and literacy of women. As shown in this study, female literacy has the strongest and most consistence

impact on fertility.

Education and the level of female literacy influence the level and type of female labor force participation. If males and females are taught the same curriculum and allowed to participate in the same academic activities, they will cultivate comparable skills, making them competitive for the same jobs. However, labor force participation is not determined solely by skills. If religious or cultural values discourage women from working outside the home, even qualified women will not be as likely to seek outside employment. While government can legislate anti-discrimination laws in job training and hiring, it cannot necessarily change underlying societal values. Thus, policy efforts to increase labor force participation might have mixed results.

A variety of factors other than those included in this study affect fertility. Religious and cultural values influence desired family size and attitudes regarding fertility control. Ability to limit family size to a desired number is largely dependent on the availability of contraception. Health and sanitation impact the number of children women can bear to term. In addition to studying these determinants, future studies could investigate the effect of female political participation or tertiary education on fertility. If more specific statistics were found, studies could compare the effects of participation in the primary, secondary and tertiary economic sectors on fertility. While this study focused on macrolevel determinants, microlevel factors should not be ignored. Also, it is important to evaluate the existing programs which target fertility to determine which have been effective and can be replicated in other areas.

At the personal level, fertility is ultimately determined by choice. If a wide range of social and economic options are available to women, they will choose the number of children which best fits their lifestyle. If limits are placed on women's ability to make

economic and social decisions, however, women will have little input in decisions regarding family size and society at large will be compromised. Most people acknowledge that population growth is a serious concern. If it is to be treated as such, women must be actively involved in the discussion and implementation of potential solutions.

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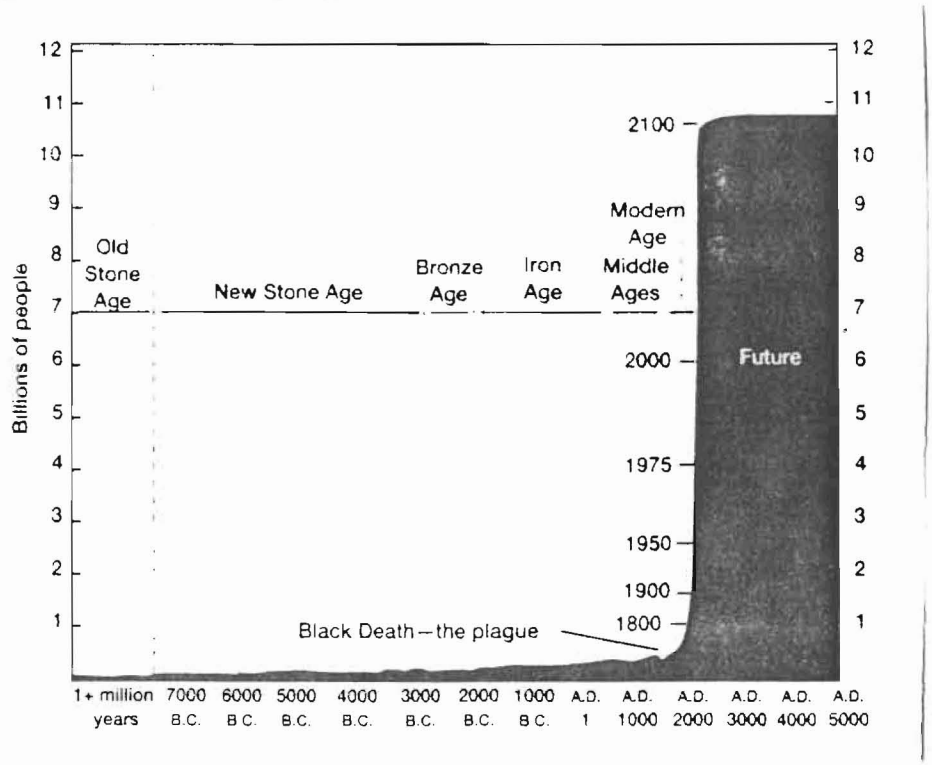
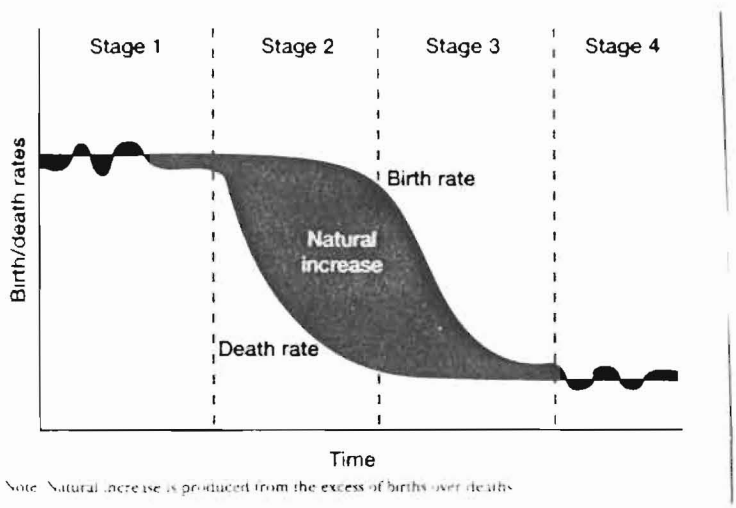
Appendix 1. World Population Growth Through History.




Source: *Population Bulletin* Vol. 53, No. 3. Population Reference Bureau. September 1998.

Appendix 2. The Demographic Transition.




Source: *Population Bulletin* Vol. 53, No. 3. Population Reference Bureau. September 1998.

Appendix 3.1 Descriptive statistics for entire sample.

| World (n=57) | 1970 mean | standard deviation | 1970 range | 1980 mean | standard deviation | 1980 range | 1990 mean | standard deviation | 1990 range |
|---|---|---|---|---|---|---|---|---|---|
| per capita GNP | 2786.27 | 7719.66 | 51,578.68-122.52 | 2993.19 | 6341.89 | 39,913.74-153.95 | 2991.52 | 5023.18 | 20,965.88-147.68 |
| Female Illiteracy | 58.56 | 29.85 | 98.7-2.3 | 49.8 | 29.68 | 97.3-1.5 | 40.88 | 28.41 | 94.9-1.1 |
| Labor Force Participation | 32.66 | 11.95 | 53.5-4.2 | 34.31 | 10.49 | 51-6.7 | 36.18 | 8.66 | 50.9-11.3 |
| Urbanization | 33.86 | 22.52 | 100-2.4 | 39.1 | 22.93 | 100-4.3 | 44.55 | 22.73 | 100-5.3 |
| Secondary Education | 36.97 | 11.35 | 66.92-11.21 | 41.65 | 10.44 | 65-21 | 44.25 | 8.75 | 66-28 |
| Total Fertility Rate | 5.86 | 1.5 | 8.17-1.97 | 5.2 | 1.81 | 8.26-1.64 | 4.3 | 1.72 | 7.4-1.26 |

All countries included in study: Algeria, Bangladesh, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Chile, Colombia, Congo, Costa Rica, Cote d'Ivoire, Ecuador, Egypt, El Salvador, Fiji, Gambia, Ghana, Greece, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Italy, Jamaica, Kenya, Republic of Korea, Kuwait, Lesotho, Malawi, Malaysia, Mauritania, Mauritius, Morocco, Nicaragua, Niger, Nigeria, Pakistan, Panama, Peru, Qatar, Rwanda, Senegal, Singapore, Spain, Sri Lanka, Sudan, Swaziland, Syria, Thailand, Tunisia, Turkey, Zambia

Appendix 3.2 Descriptive statistics for African countries.

| Africa (n=26) | 1970 mean | standard deviation | 1970 range | 1980 mean | standard deviation | 1980 range | 1990 mean | standard deviation | 1990 range |
|---|---|---|---|---|---|---|---|---|---|
| per capita GNP | 491.98 | 307.89 | 1255.65-122.52 | 648.38 | 493.74 | 1763.85-153.95 | 774.9 | 770.91 | 2924.30-147.68 |
| Female Illiteracy | 80.37 | 18.26 | 98.7-24.6 | 71.24 | 20.38 | 97.3-16.9 | 60.45 | 22.25 | 94.9-10.6 |
| Labor Force Participation | 39.57 | 10.03 | 53.5-19.9 | 39.82 | 8.89 | 51-21.4 | 39.93 | 8.29 | 50.9-21.1 |
| Urbanization | 20.6 | 13.34 | 44.53-2.4 | 26 | 13.74 | 51.5-4.3 | 32.43 | 14.65 | 57.9-5.3 |
| Secondary Education | 28.97 | 8.83 | 52.55-11.21 | 35.84 | 9.57 | 60-21 | 39.54 | 7.98 | 60-28 |
| Total Fertility Rate | 6.66 | 0.88 | 8.17-3.65 | 6.45 | 1.11 | 8.26-2.69 | 5.63 | 1.2 | 7.4-2.25 |

African countries included in study: Algeria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cote d'Ivoire, Congo, Egypt, Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Malawi, Mauritania, Mauritius, Morocco, Niger, Nigeria, Rwanda, Senegal, Sudan, Swaziland, Tunisia, Zambia

Appendix 3.3 Descriptive statistics for Asian countries.

| Asia (n=14) | 1970 mean | standard deviation | 1970 range | 1980 mean | standard deviation | 1980 range | 1990 mean | standard deviation | 1990 range |
|---|---|---|---|---|---|---|---|---|---|
| per capita GNP | 7092.3 | 14680.69 | 51,578.68-198.75 | 6742.07 | 11230.46 | 39,913.74-215.11 | 6029.61 | 7416.39 | 20,965.88-281.11 |
| Female Illiteracy | 55.02 | 23.28 | 91.9-20.2 | 43.97 | 24.74 | 86.1-11.3 | 33.74 | 24.84 | 79.9-6.7 |
| Labor Force Participation | 28.3 | 11.82 | 48.2-4.2 | 30.59 | 11.03 | 47.4-6.7 | 32.84 | 9.3 | 46.7-11.3 |
| Urbanization | 43.28 | 30.45 | 100-7.61 | 48.56 | 31.14 | 100-11.3 | 54.17 | 31.46 | 100-15.67 |
| Secondary Education | 35.95 | 9.6 | 50.83-19.68 | 41.36 | 9.51 | 51-24 | 43.86 | 8.08 | 52-29 |
| Total Fertility Rate | 5.57 | 1.45 | 7.73-3.09 | 4.46 | 1.74 | 7.42-1.74 | 3.31 | 1.34 | 5.84-1.27 |

Asian countries included in study: Bangladesh, Hong Kong, India, Indonesia, Korea Rep., Kuwait, Malaysia, Pakistan, Qatar, Singapore, Sri Lanka, Syria, Thailand, Turkey

Appendix 3.4 Descriptive statistics for European countries.

| Europe (n=4) | 1970 mean | standard deviation | 1970 range | 1980 mean | standard deviation | 1980 range | 1990 mean | standard deviation | 1990 range |
|---|---|---|---|---|---|---|---|---|---|
| per capita GNP | 7020.99 | 3411.53 | 10,815.71-2649.71 | 9665.09 | 4327.94 | 14,654.25-4126.48 | 11603.7 | 5543.54 | 17,890.51-4645.86 |
| Female Illiteracy | 11.04 | 8.38 | 21.9-2.3 | 7.33 | 5.52 | 14.4-1.5 | 4.33 | 2.96 | 7.9-1.1 |
| Labor Force Participation | 29.6 | 7.01 | 39.8-24.4 | 33.1 | 7.17 | 43.3-27.9 | 37.68 | 4.3 | 44-34.6 |
| Urbanization | 57.84 | 8.64 | 66.04-48.52 | 63.51 | 7.61 | 72.97-56.86 | 65.73 | 7.19 | 75.35-58.8 |
| Secondary Education | 52.06 | 10.06 | 66.92-45.67 | 53.5 | 7.77 | 65-48 | 54.25 | 7.85 | 66-50 |
| Total Fertility Rate | 2.39 | 0.36 | 2.84-1.97 | 2 | 0.28 | 2.22-1.64 | 1.46 | 0.26 | 1.84-1.26 |

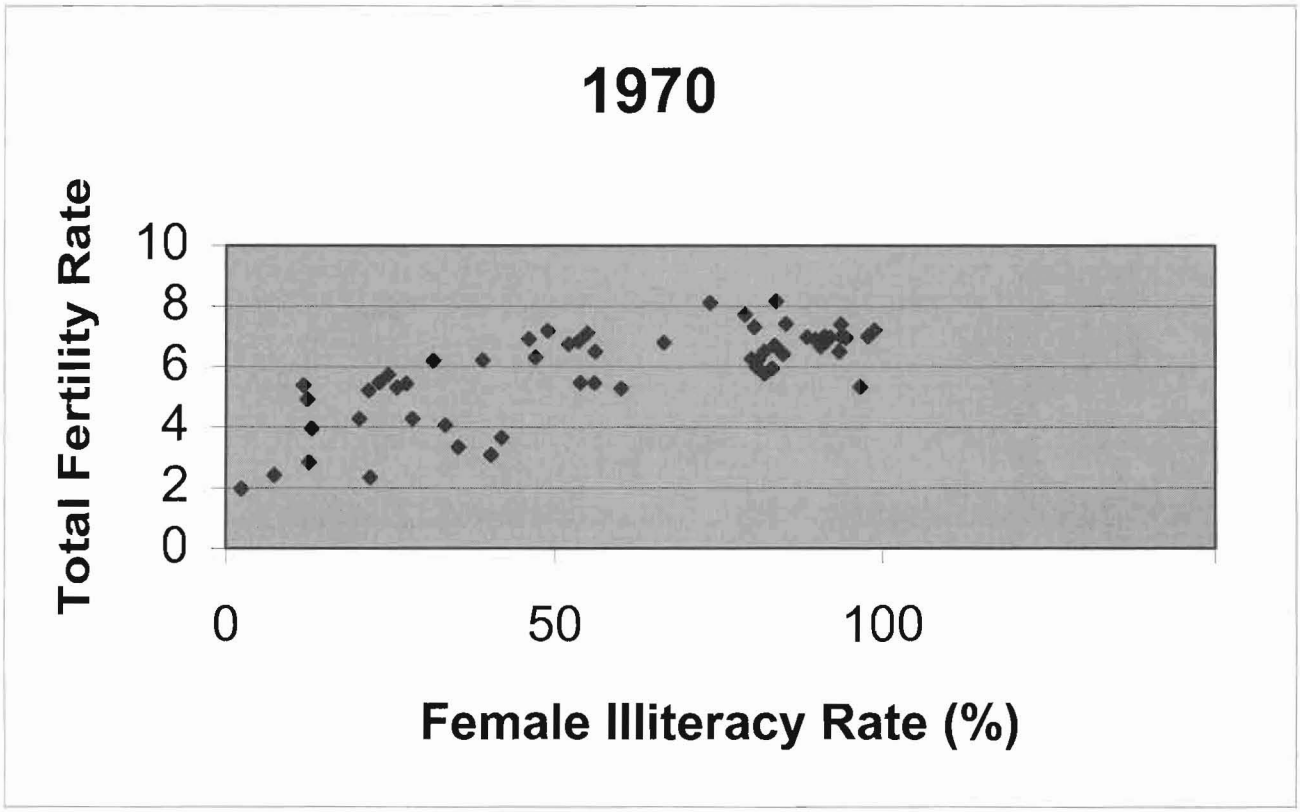
European countries included in study: Greece, Hungary, Italy, Spain

Appendix 3.5 Descriptive statistics for Latin American and Caribbean countries.

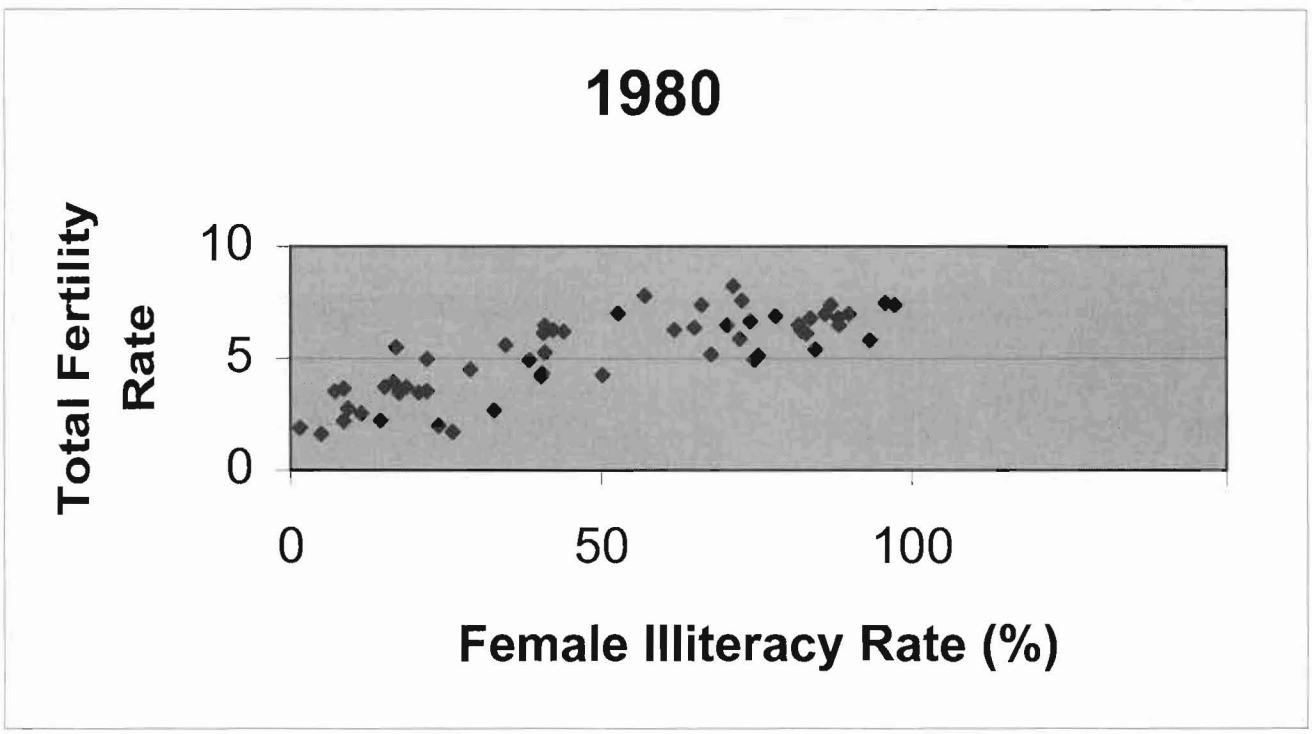
| Latin America, Caribbean (n=12) | 1970 mean | 1970 standard deviation | 1970 range | 1980 mean | 1980 standard deviation | 1980 range | 1990 mean | 1990 standard deviation | 1990 range |
|---|---|---|---|---|---|---|---|---|---|
| per capita GNP | 1416.45 | 748.28 | 2441.38-464.58 | 1536.47 | 777.25 | 2577.66-560.18 | 1434.87 | 839.5 | 2888.37-369.00 |
| Female Illiteracy | 33.39 | 20.2 | 80.7-11.7 | 26.64 | 19.12 | 72.4-7.1 | 21.21 | 17.59 | 63.5-3.7 |
| Labor Force Participation | 23.3 | 9.19 | 46.3-18.1 | 28.55 | 8.34 | 46.3-20.1 | 32.53 | 6.4 | 46.2-24.8 |
| Urbanization | 43.55 | 14.9 | 75.23-19.76 | 48.42 | 15.94 | 81.15-23.7 | 52.97 | 15.82 | 83.3-28.8 |
| Secondary Education | 47.44 | 4.63 | 56.6-42.1 | 49.92 | 3.42 | 55-43 | 51.17 | 2.89 | 58-47 |
| Total Fertility Rate | 5.76 | 0.9 | 7.20-3.95 | 4.54 | 0.83 | 6.48-2.78 | 3.62 | 0.92 | 5.16-2.58 |

Latin American and Caribbean countries included in study: Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guyana, Haiti, Honduras, Jamaica, Nicaragua, Panama, Peru

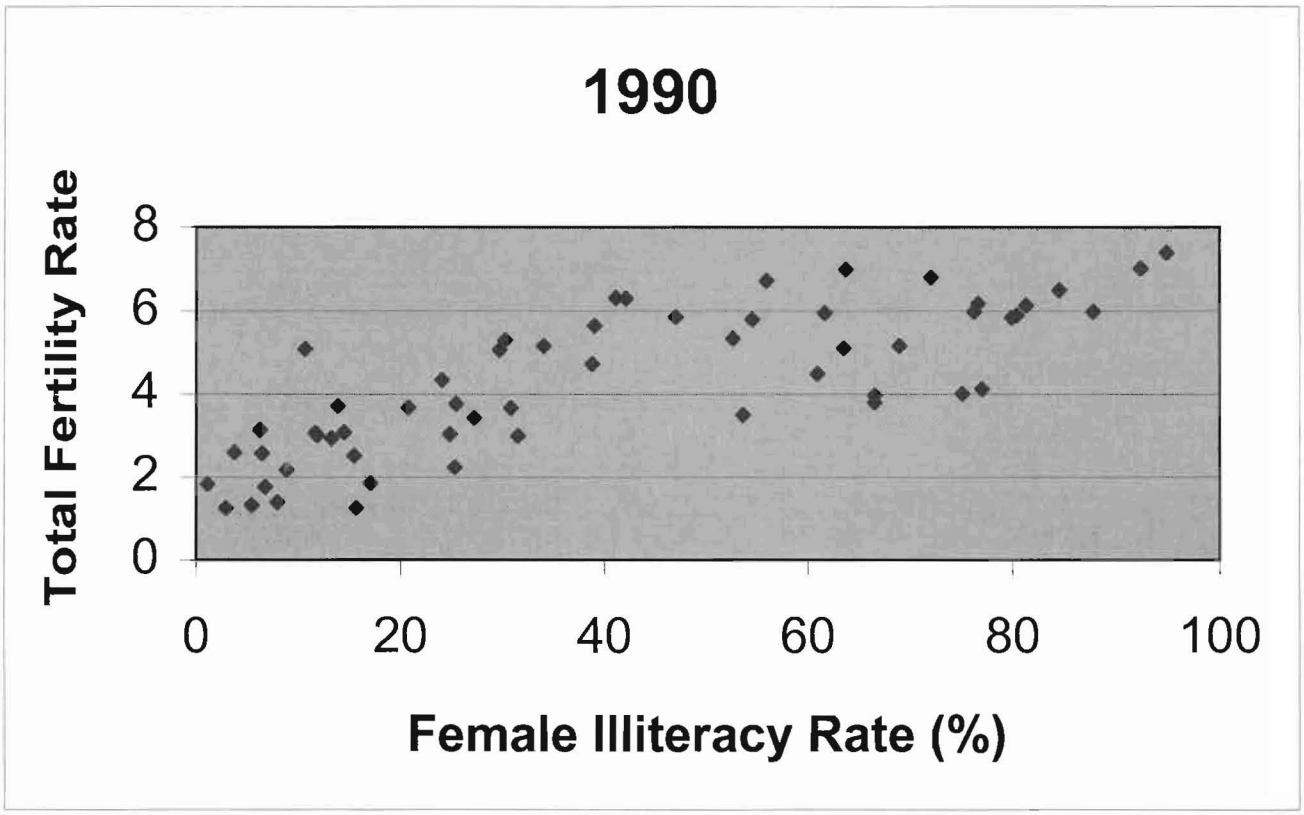
Appendix 4.1 Scatter diagram for 1970 female illiteracy and TFR data.



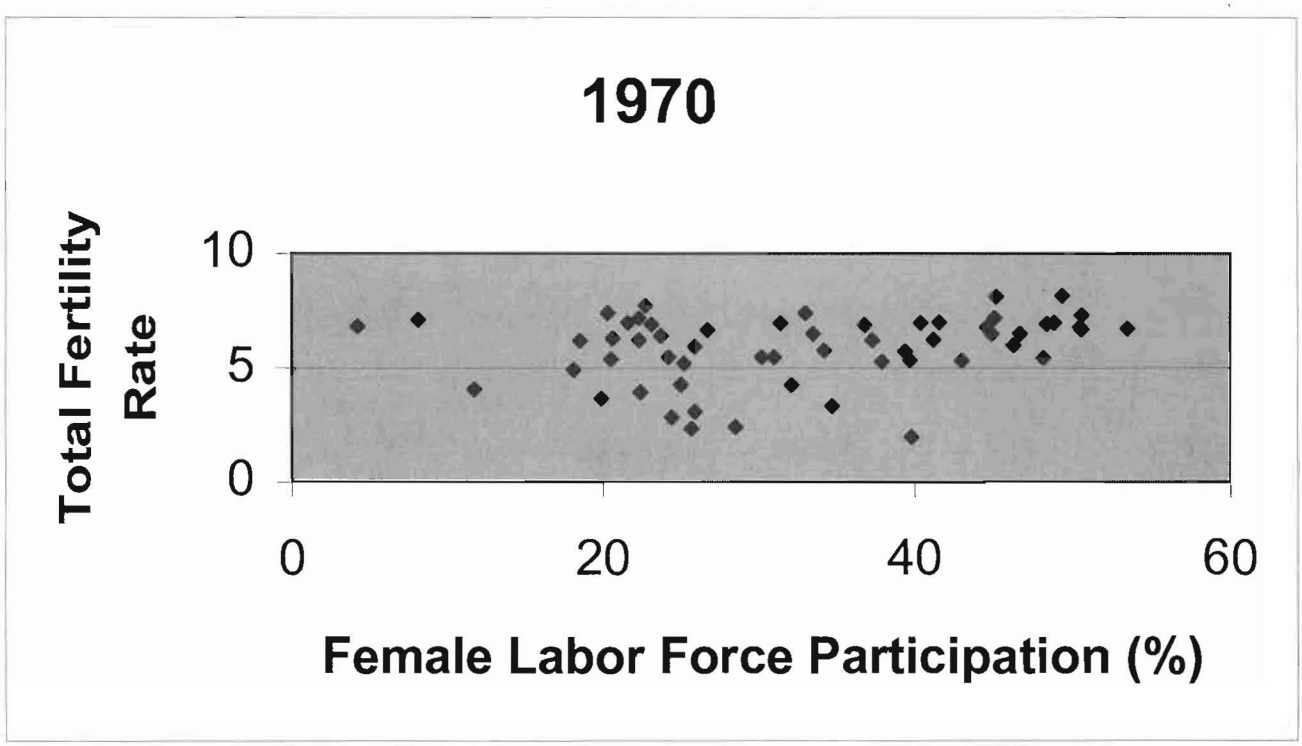

Appendix 4.2 Scatter diagram for 1980 female illiteracy and TFR data.



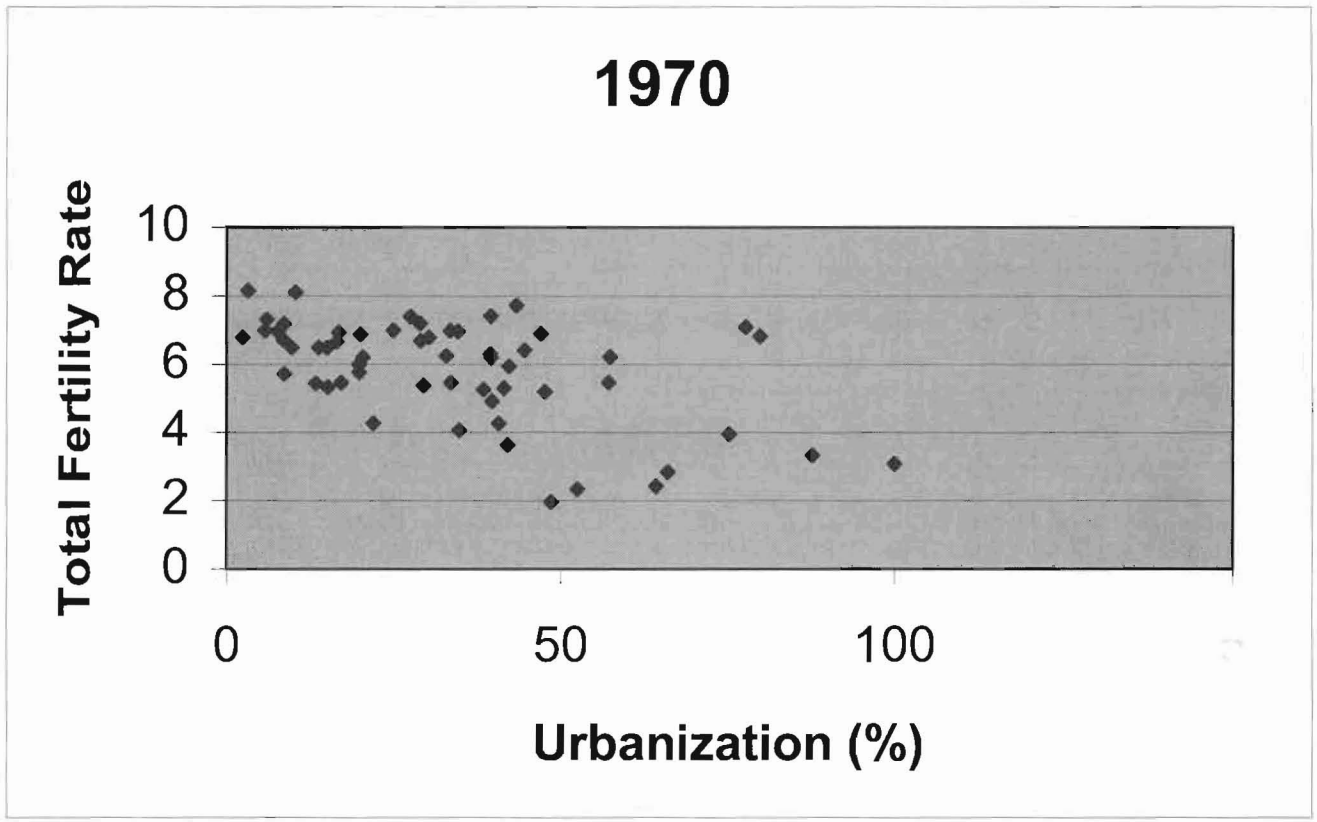
Appendix 4.3 Scatter diagram for 1990 female illiteracy and TFR data.



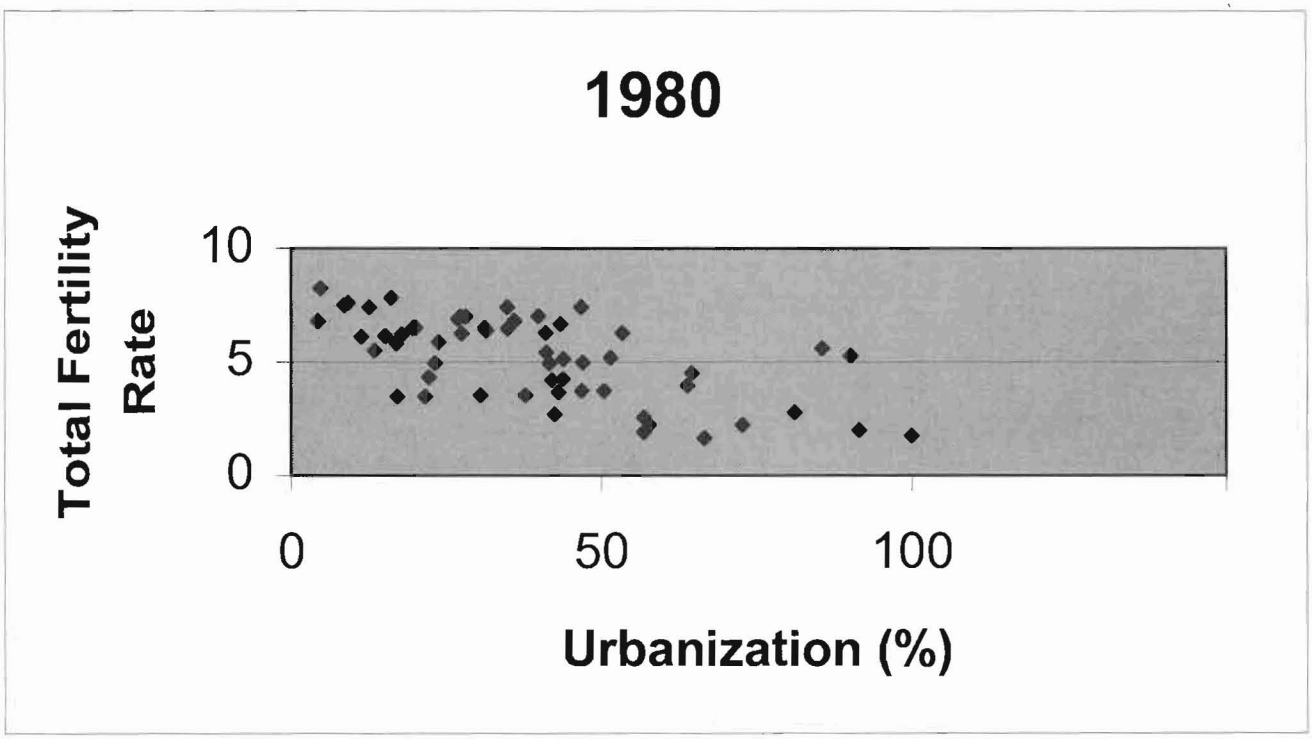

Appendix 4.4 Scatter diagram for 1970 female labor force participation and TFR data.



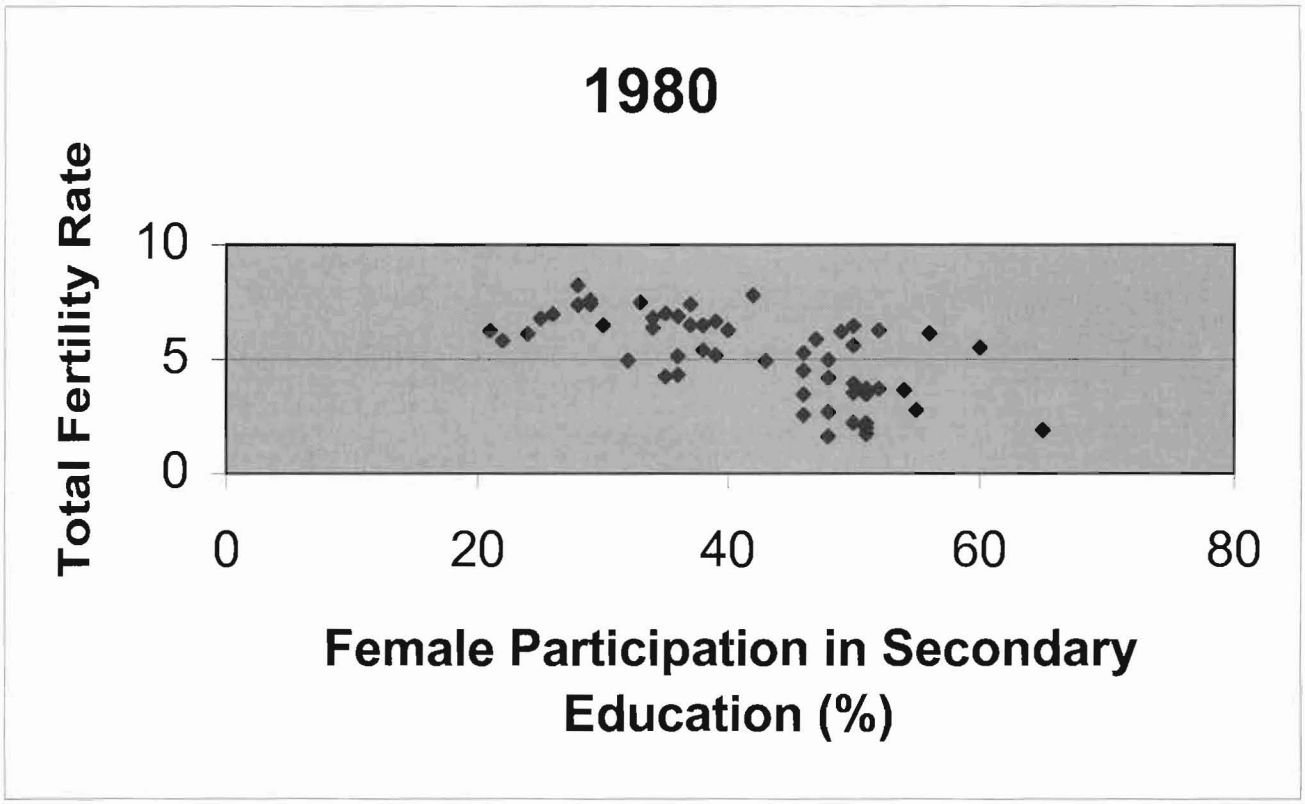
Appendix 4.5 Scatter diagram for 1970 urbanization and TFR data.




Appendix 4.6 Scatter diagram for 1980 urbanization and TFR data.



Appendix 4.7 Scatter diagram for 1980 female secondary education and TFR data.




Appendix 4.8 Scatter diagram for 1990 per capita GNP and TFR data.