

**IMPACT OF SOCIO-ECONOMIC AND DEMOGRAPHIC
VARIABLES ON HUMAN FERTILITY BEHAVIOUR-
A MULTIVARIATE STATISTICAL ANALYSIS**



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By

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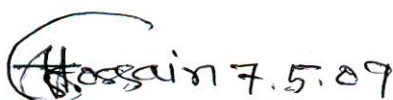


*Dedicated
To
My Family*

DECLARATION

This dissertation entitled, “Impact of Socio-Economic and Demographic Variables on Human Fertility Behaviour-A Multivariate Statistical Analysis.” Submitted by me in the department of Statistics, University of Rajshahi, Bangladesh for the award of the degree of Doctor of Philosophy is based on my research work carried out under the supervision of Dr. Md. Golam Gossain, Professor, Department of Statistics, University of Rajshahi.

To the best of my knowledge, this work neither in part nor in full has been submitted to any other university or institution for the award of any degree.



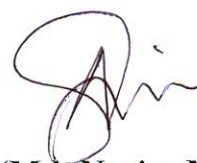
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ABSTRACT

The purpose of this study is to explore the possibility of further fertility decline in Bangladesh, with special attention to the role that might be played by improvements in socio-economic and demographic variables. In particular, researcher has attempted to estimate that after how long, and under what conditions, fertility rate should be taken for Bangladesh to reach replacement-level fertility (2.1 children per woman). The medium-variant scenario of the United Nations projection indicates that Bangladesh will achieve replacement-level fertility around 2025-2030 (United Nations, 1999, 2001). Researcher assess whether the analysis yields a similar conclusion.

The rapid decline of fertility, from over 6.5 births per woman to 3.3 births, in the last two decades in Bangladesh is, indeed, a historic record in demographic transition. The country is poor and has remained traditional and conservative. Although the extent and rapidity of the decrease in fertility have been very impressive by international standards, continued fertility decline is desirable, as population crowding, environmental deterioration, massive migration from rural areas to unplanned urban settings, and rapid depletion of resources are becoming acute. However, recent statistics suggest that, despite a continuing increase in contraceptive use, the fertility decline in Bangladesh has been stalled.

The present study covers a period of about 30 years, from 1975 to 2004. The study is based on the analysis of secondary data sources mainly obtained from 1993-1994, 1996-1997, 1999-2000 and 2004 Bangladesh

Demographic and Health Surveys (BDHSs) and 1975 and 1989 Bangladesh Fertility Surveys (BFSs). The time series data has been taken from the Bangladesh Bureau of Statistics (BBS) from 1985 to 2005, although the number of time series data is small, the annual data of Bangladesh for population studies are limited. In addition, data from the 1981, 1986 and 1991 Bangladesh Contraceptive Prevalence Surveys (CPSs) are also utilized. The samples of these surveys are nationally representative in scope and contain socio-economic and demographic information of individuals. Analyzing these data researcher has tried to focus on the past, present and future fertility situation of Bangladesh in connection with socio-economic and demographic variables based on several multivariate statistical analyses namely, logistic regression model, path model, Bongaarts' proximate determinants of fertility model and time series.

It is found from the logistic regression model that the age at marriage, educational level, region, mass media, contraceptive method and child mortality are most influential variables on human fertility behaviour. It suggests that socio-economic development policies as educational level, region, mass media and demographic indicators as age at first marriage, contraceptive method and child mortality giving special emphasis may produce significant desired effects with regard to fertility control in the national level of Bangladesh.

The path analysis reveals that there are regional variations in fertility among the six administration divisions of Bangladesh due to some particular socio-economic and demographic variables. It demonstrates while one of the strategies to reduce fertility should be bringing down the desired family size, other

strategies to narrow the gap of the regional variations should include efforts to increase education for female to reduce the preference for male children and to lower infant and child mortality, as well as to promote the effective use of contraceptives. Without a rapid improvement of these factors, it would be difficult to achieve replacement level fertility in near future.

Bongaarts' model is applied to estimate the fertility inhibiting effect of four important proximate determinants: marriage, contraception, abortion and lactational infecundability. The model clearly indicates that there is a downward trend in all the proximate indices. Data on induced abortion are not available. So, its effect on the model is about to be unmeasurable. Abortion is a sensitive issue in Bangladesh, and many women who have an abortion do not disclose this to others, particularly to outsiders. This makes the situation extremely difficult to get a clear picture of abortion from survey data in this country. Bongaarts' model indicates marriage variable made significant contributions to the overall fertility reduction. Contraceptive use has the highest impact on the total reduction of fertility which may be attributed to the increasing use of contraception from 7% in 1975 to 48.5% in 2004. The average estimated effect of lactational infecundability plays an important role in reducing fertility in Bangladesh. The analysis also shows that a downward effect on fertility at young ages caused by rising age at marriage has been balanced by an upwards effect at older ages caused by decreasing widowhood and divorced. Researcher suggests from the Bongaarts' model that the governmental policies can concentrate on effectively and

efficiently increasing contraceptive utilization and effectiveness, on encouraging breastfeeding and on rising the age of marriage.

One of the most interesting parts of this study that the researcher has developed a time series model to estimate after how long and under what conditions Bangladesh will achieve the replacement level of fertility (2.1 children per woman). Research has compared the time frame to reach the replacement level of fertility with the medium-variant scenario of the United Nations projection that Bangladesh will achieve replacement level of fertility around 2025-30 (UN, 1999, 2001). The research has found the similar result to reach the fertility rate of Bangladesh at the replacement level as the United Nations target year. Researcher has suggested that the total fertility rate (TFR) of Bangladesh will reach at the replacement level within the desired time period around 2025-2030 and to do so the government shall have to take necessary action- to increase mean age at marriage of female to be 20.3 years; to increase labor force participation of female to be 43.5%; and to decrease infant mortality rate per 1000 live births at 35.6.

Lastly, it is shown from the study that the fertility rate has remained almost same in the national level of Bangladesh for a long time. But it is also found from the study that fertility rate has reached near to the replacement level in the few divisions of Bangladesh. It is really a matter of hope for us. Being greatly encouraged. Researcher would like to suggest that the regional key measures, responsible for achieving the replacement level of fertility rate must be found out, analyzed and researched and finally applied in other divisions of the country. By doing these, we can reach to our goal to the replacement level of fertility.

CHAPTER 1

INTRODUCTION

RAPID POPULATION GROWTH IS A PROBLEM

Today no problem is made urgently important to the well being of mankind than the limitation of population growth. It is a problem, the effects of which are world-wide demanding the attention of all nations – east and west large and small, developed and developing. Too rapid population growth hinders a nation's ability to progress and to satisfy the growing demands of its people for a better life.

Population growth around the world effect all people through its impact on national economies, the environment, safety and health and the habitability of the world children will inherit. Two points on the interaction of population dynamics and human well being stand out. Population growth may have different impacts depending on when, where and how it occur through decreases/increases, death rate birth rate or immigration. The impact depend not just on the rate of growth but on the size and age structure of the existing population, the resources as water and crop land and the adaptability of the societies in which population growth is occurring. The second point is that population growth influences many areas of human affairs. The issue is not merely food security or health or environmental quality or economic growth, but all this and more because high population growth rate cause of poverty, low standard of living, malnutrition, ill health, environmental degradation and a wide other social problems. If we discuss about the population cycle too rapid, a population growth rate yields negative economic consequences and psychological problems associated with the conditions of under

employment. Population growth retards the prospects of a better life because problem of population is not simply of numbers. It also evolves the quality of life and material well being. The population size also intensifies the problem of under development.

In our lifetimes humanity has become a force on the planet. The reasons for this are complex and linked to changes not only in human population but in technologies consumption patterns, unequal distribution, choices made by people business and governments. The consequences of rapid population growth can be vivid in light of the carrying capacity of the earth but also and more importantly in relation to human capacities to improve welfare and reduce poverty. Rapid population growth raises concern at three levels of human experience: global resource sufficiency, national and local institutional capacity and individual family welfare.

The growth of world population and production combined with unsustainable consumption patterns places increasingly severe strain on the life supporting capabilities on our earth. These interactive processes affect the use of land, water, air, energy and other resources. Rapid growth and the high dependency ratio lead to another phenomenon called the “Hidden Momentum of Population Growth” means the population has the tendency to grow rapidly even after achieving the low fertility rates. The basic reason for this hidden momentum is that high birth rates cannot be brought down overnight.

The social, economic and institutional forces that have influenced the fertility rates over the course of centuries increase in population, within the last two centuries. The rural as well as the urban poor have been hardest hit. The available resources do not suffice for number of people we have. If the population growth is not effectively and immediately checked, the population bomb may prove to be more dangerous than the atom bomb.

WORLD POPULATION FEATURES

According to the 2006 revision (UNESA, 2007), the world population will likely increase by 2.5 billion over the next 43 years, passing from 6.7 billion in 2007 to 9.2 billion in 2050. This increase is equivalent to the size that the world population had in 1950 and it will be absorbed mostly by the less developed regions, whose population is projected to rise from 5.4 billion in 2007 to 7.9 billion in 2050. In contrast, the population of the more developed regions is expected to remain largely unchanged at 1.2 billion and would have declined were it not for the projected net migration from developing to developed countries, which is expected to average 2.3 million persons a year after 2010. As a result of declining fertility and increasing longevity, the populations of a growing number of countries are ageing rapidly. Between 2005 and 2050, half of the increase in the world population will be accounted for by a rise in the population aged 60 years or over, whereas the number of children (persons under age 15) will decline slightly. Furthermore, in the more developed regions, the population aged 60 or over is expected nearly to double (from 245 million in 2005 to 406 million in 2050) whereas that of persons under age 60 will likely decline (from 971 million in 2005 to 839 million in 2050). The 2006 revision (UNESA, 2007) confirms the diversity of demographic dynamics among the different world regions. While the population at the global level is on track to surpass 9 billion by 2050 and hence continues to increase, that of the more developed regions is hardly changing and will age markedly. As already noted, virtually all population growth is occurring in the less developed regions and especially in the group of the 50 least developed countries, many of which still have relatively youthful populations that are expected to age only moderately over the foreseeable future. Among

the rest of the developing countries, rapid population ageing is expected. Underlying these varied patterns of growth and changes in the age structure are distinct trends in fertility and mortality. Below-replacement fertility prevails in the more developed regions and is expected to continue to 2050. Fertility is still high in most of the least developed countries and, although it is expected to decline, it will remain higher than in the rest of the world. In the rest of the developing countries, fertility has declined markedly since the late 1960s and is expected to reach below-replacement levels by 2050 in the majority of them. Mortality in the established market economies of the developed world is low and continues to decline, but it has been stagnant or has even increased in a number of countries with economies in transition, largely as a result of deteriorating social and economic conditions and, in some cases, because of the spread of HIV. Mortality is also decreasing in the majority of developing countries, but in those highly affected by the HIV/AIDS epidemic, mortality has been increasing. Realization of the medium variant projections contained in the 2006 revision (UNESA, 2007) is also contingent on ensuring that fertility continues to decline in developing countries. According to the 2006 revision (UNESA, 2007), fertility in the less developed countries as a whole is expected to drop from 2.75 children per woman in 2005-2010 to 2.05 in 2045-2050. The reduction expected in the group of 50 least developed countries is even sharper: from 4.63 children per woman to 2.50 children per woman. To achieve such reductions, it is essential that access to family planning expands in the poorest countries of the world. The urgency of realizing the reductions of fertility projected is brought into focus by considering that, if fertility were to remain constant at the levels estimated for 2000-2005, the population of the less developed regions would increase to 10.6 billion instead of the 7.9 billion

projected by assuming that fertility declines. That is, without further reductions of fertility, the world population could increase by twice as many people as those who were alive in 1950. In July 2007, the world population will reach 6.7 billion, 547 million more than in 2000 or a gain of 78 million persons annually. Assuming that fertility levels continue to decline, the world population is expected to reach 9.2 billion in 2050 and to be increasing by about 30 million persons annually at that time, according to the medium variant. Future population growth is highly dependent on the path that future fertility takes. In the medium variant, the total fertility of the world declines from 2.55 children per woman today to slightly over 2 children per woman in 2050. If fertility were to remain about half a child above the levels projected in the medium variant, world population would reach 10.8 billion by 2050. A fertility path half a child below the medium variant would lead to a population of 7.8 billion by mid-century. That is, at the world level, continued population growth until 2050 is inevitable even if the decline in fertility accelerates (PN, 2007).

POPULATION POLICY IN ASIA

Many countries in Asia have formulated effective population policies and successfully implemented family planning, maternal and child health programmes in order to achieve their demographic goals like lowering fertility rates, raising the expectation of life at birth, reducing infant mortality rates and thereby slowing population growth rates. The Population growth rate among Asian countries divide the regions into two groups: one group of countries with high population growth rates exceeding 2.0% per year and the other with moderate or low growth rates of 1.4% or lower. Population policy

and programmes are different in these two groups. Where fertility is high the main demographic goals is to reduce responsible demographic factors as birth rate, death rate, infant mortality rate, growth rate, in addition to creating employment opportunities for the rapidly expanding working group population and also concentrating more on improving the quality of life of their population (UNESCAP, 2006).

South Asia, for the purposes of this chronicle, is composed of eight countries, namely Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and Sri Lanka. In 2007 the population in this region totaled nearly 1.6 billion inhabitants (UN, 2007), representing nearly 24% of the world's total population spread over less than 4% of the world's surface. From a demographic point of view, South Asia is dominated by India, which alone has a population of 1.17 billion, but there are two other densely populated countries in this region: Pakistan and Bangladesh, with populations of 164 and 159 million respectively in 2007. South Asia also includes countries with small populations such as Bhutan, with only 658,000 inhabitants and the Maldives with just 306,000. There are sharp contrasts between these countries, be it in terms of demographic growth, population density, mortality and fertility rates, urbanization or literacy. And the situation within India, the largest country in the region, is itself one of major internal contrasts. Its 28 states each have distinct demographic traits – population size, stage of demographic transition, density etc. – as well as different economic, social and religious characteristics. The demographic challenges confronting South Asia are those of developing countries faced with a major population increase. They are the challenges of educating, housing, caring for and employing a growing – sometimes rapidly growing – population. These countries have to fight against poverty while ensuring that the

economic growth they so badly need to improve the lives of their people does not result in serious environmental damage. The populations of South Asia are very vulnerable both economically (especially the children who start working at an early age) and environmentally. For instance, a portion of the Bangladeshi population lives at sea level with considerable exposure to flood risk, and several countries in the region were affected by the tsunami in the winter of 2004. In certain fragile or exposed areas, demographic growth and the consequent increase in population density exacerbate the vulnerability of the poorest populations (Véron, 2008).

Remarkable success has been achieved in the reduction of fertility in Asia. The total fertility rate (TFR) in the region has dropped to 2.3 births per woman by 2005. This regional average, however, masks considerable difference in the TFR observed among sub-regions. The TFR has plummeted to below replacement level in East and North-East Asia, and North and Central Asia (1.7 births per woman). In sharp contrast, South and South-West Asia exhibit a total fertility rate of 3.0 births per woman, while in South-East Asia the total fertility rate is 2.3 births per woman. Several countries in Asia now belong to the extremely low fertility category, with the fertility level of Hong Kong, China; Japan; Republic of Korea; Macao, China; and Singapore falling at critically low level of below 1.5 children per woman. It is also to be noted that almost all countries in the region have begun fertility transition. Country experiences reveal that various factors have contributed to the decline in fertility. In some countries, socio-economic development has played a major role in fertility decline; while in others strong family planning programmes – in the absence of development – have been successful in fostering fertility decline. It has, however, been highlighted that sustainable fertility decline occurred in

countries with higher human development index. By contrast, fertility decline had slowed down or even stalled in countries where fertility transition began at lower level of human development index (UNESCAP, 2006).

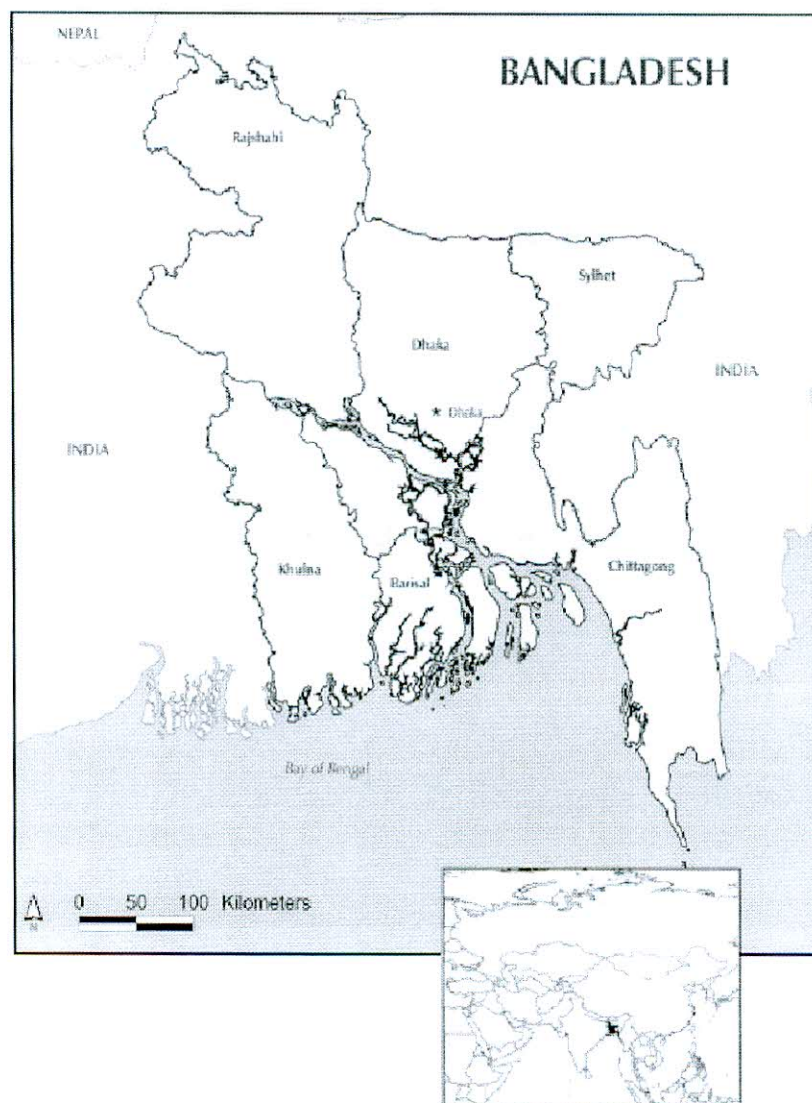
GEOGRAPHY, ECONOMY AND POPULATION IN BANGLADESH

Bangladesh is located in the northeastern part of South Asia and covers an area of 147,570 square kilometers. It is almost entirely surrounded by India, except for a short southeastern frontier with Myanmar and a southern coastline on the Bay of Bengal. It lies between latitudes 20° 34' and 26° 38' north and longitudes 88° 01' and 92° 41' east, and has a tropical climate.

The Moguls ruled the country from the 13th century till the 18th century, when the British took over and administered the subcontinent until 1947. During British rule, Bangladesh was a part of India. In 1947, the independent states of Pakistan and India were created with the present Bangladesh territory as apart of Pakistan. Bangladesh emerged on the world map as a sovereign state on March 26, 1971 after fighting a 9-month war of liberation.

Most of Bangladesh consists of low, flat and alluvial soil. The most significant feature of the landscape is the extensive network of large and small rivers that are of primary importance to the socioeconomic life of the nation. Chief among these, lying like a fan on the face of the land, are the Ganges-Padma, Brahmaputra-Jamuna, and Megna rivers. The climate of Bangladesh is dominated by seasonal monsoons. The country experiences a hot summer season with high humidity from March to June; a somewhat cooler but still hot and humid monsoon season from July through early October; and a

cool, dry winter from November to the end of February. The fertile delta is frequented by natural calamities such as floods, cyclones, tidal bores, and drought.



Source: BDHS, 2004.

For administrative purposes, the country is divided into 6 divisions, 64 districts, and 496 *upazilas* (subdistricts) (BBS, 2001:19). Muslims constitute almost 90 percent of the population of Bangladesh, Hindus constitute about 9 percent, and others constitute

about 1 percent. The national language of Bangladesh is Bangla, which is spoken and understood by all. Agriculture is the overwhelmingly dominant sector of the economy, occupying 80 percent of the total population and contributing 25 percent of gross domestic product (GDP). The average per capita income is as low as \$444 and more than one-third of the population lives below the absolute poverty line (UNDP, 2003). Rice, wheat, jute, sugarcane, tobacco, oilseeds, and potatoes are the principal crops. The country produces about 51 million kilograms of tea per year, a sizeable quantity of which is exported to foreign markets after meeting the internal demand. Bangladesh produces about 1,057,000 metric tons of superior quality jute annually and 16 percent of export earnings come from raw-jute manufactures (BBS, 2001). Industry, although small, is increasing in importance as a result of foreign investments. Unemployment/underemployment is a serious problem, and pressure on the land in rural areas has led to movement of people from rural to urban areas.

Bangladesh ranks 138th in the human development index (HDI) as presented in the human development report of 2004 with a HDI value of 0.519. With this HDI value, the country belongs to the category of medium human development countries. However, Bangladesh ranks among the three last countries in this category, followed by Sudan and Cameroon. Within the region, the position of Bangladesh is better only than Pakistan, which ranks 144 in the HDI.

Bangladesh is still struggling to emerge from the realm of poverty. Bangladesh ranks 72nd among 94 developing countries in terms of the human poverty index (HPI). The HPI is a multidimensional measure of poverty for developing countries; it takes into

account social exclusion, lack of economic opportunities, and deprivations in survival, livelihood and knowledge.

Bangladesh is the most densely populated country in the world, excluding city-states such as Hong Kong and Singapore. The country has a population of about 140 million, with a corresponding population density of more than 900 per square kilometer. During the first half of the last century the population increased by only 45 percent. This slow increase was due to a combination of high birth rates and high death rates. In the second half of the century, population growth was rapid, tripling during the period. The relatively young age structure of the population indicates continued rapid population growth in the future. According to the 2001 census, 39 percent of the population is under 15 years of age, 57 percent are between 15 and 64 years, and 4 percent are age 65 or over (BBS, 2003:51). This young age structure constitutes built-in “population momentum,” which will continue to generate population increases well into the future, even in the face of rapid fertility decline. The population projections indicate that the population will increase rapidly even after attaining replacement-level fertility because of the echo effect of the high fertility experienced in the past.

The Bangladesh Population Policy indicates that the population should stabilize at 210 million by 2060, if replacement-level fertility is reached by 2010. This estimate of future population size is reasonably consistent with the World Bank projections from 1994 (Bos et al., 1994), and the United Nations projections 1996 revision (UN, 1996), both of which estimated a mid-21st century population of 218 million. However, there is wide disparity between the estimates of the Bangladesh Government and others on the time when the population would stabilize. The World Bank boldly forecast a final

stationary population of 263 million by mid-22nd century (2150), whereas others have not projected beyond the mid-21st century. Recently however, the United Nations has revised their estimate for 2050 by 25 million (or 11 percent) to 243 million, apparently on the basis of the decade long fertility plateau (UN, 2004b).

This recent and very substantial upward revision of the mid-century population by the United Nations seems unduly pessimistic because a five-year delay in attaining replacement-level fertility adds only 3 percent to the population at any point in time. Nevertheless, Bangladesh still faces many decades of continued population growth, and efforts to slow that growth need to continue, through the family planning program, and increasingly, through social and health interventions that will facilitate further fertility decline, so that progress towards economic development is not hindered.

REPRODUCTIVE BEHAVIOUR IN BANGLADESH

Bangali peasant culture is suffused with a pro-fertility ethos which evolved over 3000 years of adoption and symbolic relationship between man and the land. The culture has become highly successful in its ecological setting. The various great religions are superimposed but rural beliefs about fertility and the human body are more fundamental and cut across them.

Human fertility and land fertility are analogous. A woman is the field and seed is nourished by her juices before birth and by her milk after birth. Muslims commonly say that every mouth brings its own food, and each person's food is pre-allocated before his birth. Therefore, some conclude that land can indefinitely support those souls to be born. Such pro-fertility beliefs were at one time functional, but because life expectancy is now

59 years they have become dysfunctional. It is thought by Muslims to be a moral duty to have and raise children and to increase one's kinship and lineage groups. The bodily substances shared by the breeding group are said to be transmitted by the male semen and the female semen, which mix at conception. Muslims consistently have higher fertility than Hindus and give negative advice about population control twice as much as Hindus (Maloney et. al., 1981). But these differences can disappear through motivation. The most fertile group is the rural middle class, who are mostly Muslim cultivators. Their higher fertility is not just because of religious affiliation, but because they are enmeshed in the matrix of peasant life that evolved with a pro-fertility bias.

It is believed that one's fate is written on one's forehead at conception, or that at births, fate is determined by Allah before the soul is sent to the fetus. God controls the four main aspects of living: life, death, wealth and sustenance. There are two kinds of fate- unchangeable and changeable fate on night of Shab-i-Barat. The concept of *Karma* is actively assented to by Muslims and Hindus: One's deeds, especially bad deeds, will affect the doer.

The number of one's children, thus, is pre determined by God, and food is allocated accordingly. It is a cultural expectation that people should affirm this. Stated dependence on God for number of children is statistically correlated with higher fertility, early marriage, stricter *purdah*, more fasting, more prayers, less abortion, negative opinion of religious leaders on family planning and less use of modern contraceptives.

Having children is a compulsory duty in Islamic tradition and children must be raised in the religion; this is also advocated in Hindu tradition. Muslims say if there are several sons one can be given for religious education. Many children will have more

voices to praise God and in the day of judgment the prophet will be pleased to see long lines of worshipers. Children have a duty to care for the parents' funerals. An infant who dies in innocence will plead in heaven for childlessness, like a barren field without nutrients. Children are needed for old age support and this need may increase with more landlessness. Children who do not support aged parents are said to be beasts and accursed. Sons are more desirable and more of them bring diversity of income and make the kinship group large and strong, but daughters require dowry to be married.

Among the reasons for people wanting more children, the first is sex preference. Sex preference operates as a relatively stronger reason for wanting more children among females than males. Most people want several children for undefined personal fulfillment, which is couched in terms of moral duty, family prosperity or future support. When there are many sons each one will take up a different occupation according to this taste and capacity. Then there will be an increase in the level of happiness and convenience. If one does not have children, his possession of property is meaningless.

A male child is favored. If the male in a family are few than the size of the lineage segment (*bangsa*) becomes small. Males are future earners, but females are economically unproductive. Parents have to spend a lot on arranging marriages of daughters. So for economic reasons a male child is preferred. Now a days a girl is viewed as a problem in the family. If parents could control the sex of children born then every couple would decided to have a male child first. A son is essential for continuity of the lineage and old age security.

SOCIO-ECONOMIC AND DEMOGRAPHIC CHANGE IN RECENT YEARS

Human fertility is known to be influenced by a host of socio-economic, socio-cultural, biological and demographic factors. Socio-economic and socio-cultural variables can not directly influence fertility but must act on fertility through their effect on one or more of the proximate determinants. Socio-economic conditions of a population and differences in them affect the level of fertility in a population and create differences among the sub-groups or sub-regions. Socio-economic variables in the form of normative social structure and social stratification and economic constraints influences fertility through their impact on social psychological processes (Bagozzi and Vanloo, 1978).

The lead and lag sub-regions reflect differences between such areas in terms of their socio-economic and structural characteristics, and the adoption of reproductive behavioral regulation, associated with innovation diffusion (Rogers, 1995). Certain factors act as catalytic agents in the process of diffusion and adoption of fertility regulation innovations. These include the personal attributes of the potential adopters, the availability of supportive infrastructure, socio-economic facilities and socio-cultural systems. Personal attributes encompass such factors as level of education, types of occupation, socio-cultural value systems (Kokole, 1994; Poo and Tey, 1994) and the stage in the life cycle of the potential adopter. Infrastructure includes transport and communication networks. Socio-economic services are health and educational institutions, and the mass media. Socio-economic opportunities include levels of participation by potential adopters in the economic, educational and sociopolitical activities. Socio-cultural value systems and norms include aspects such as secularization.

These are influenced by each individual's stage in the life cycle, which is closely associated with age.

Although Bangladesh is considered one of the poorest nations of the world, some positive changes have been taking place in various fields over the past few decades (UNICEF, 2001). The fundamental factors behind the changes are rapid population growth, development efforts of the government and increased influence of Western values and culture. Rapid population growth caused high population density, decline in the land-man ratio, increased rural-urban migration and growth of urban slums, increased unemployment and high incidence of poverty. On the other hand, due to development programmes, agricultural productivity has increased substantially, non-traditional employment opportunities have emerged, urbanization, industrialization and literacy have increased, mobility and women's role in the economy and society have changed, and traditional values and beliefs have been disintegrating. Alongside these changes, huge out-migration of labour and inflow of foreign aid and capital have increased the level of interaction between Bangladesh and the outside world raising the exposure of the people of Bangladesh to modern ideas and modes of living. As a result of rapid socioeconomic transformation in recent decades the role of family is changing and the traditional family is in decline. A wave of Western 'civilization' is gradually encroaching upon Bangladeshi society, replacing the traditional notions of strongly bonded family life with the concept of the nuclear family. The role and empowerment of women is increasing, but the vast majority of women still cannot play an effective role in making decisions within the family. In the past, Bangladeshi women experienced high fertility and did not consider controlling their fertility because fewer children survived to

adulthood. Studies conducted up until the 1970s documented that the familial, social, economic and religious conditions of Bangladesh were favourable to many rather than few children (Cain, 1977; Khuda, 1977), but subsequent KAP (knowledge, attitude and practice) surveys reported lower family size desire than actual fertility (BFS, 1978). This probably happened due to the decline in mortality after World War II, which led couples to adjust their desired family size to levels similar to the surviving children of their parent's generation. Over the last two decades, the country has undergone a remarkable demographic transition. The total fertility rate declined from 6.3 in the mid-1970s to 3.3 in the mid-1990s (BDHS, 2004). The crude death rate also fell dramatically from 19 (per 1000 population) in 1975 to 8 in the mid-1990s. The infant mortality rate was 150 (per 1000 live births) in 1975 and fell to about 80 in the mid-1990s. Maternal mortality declined from 6.2 (per 1000 births) in 1982 to 4.4 in 1995. Life expectancy at birth was 53.4 years for males and 49.3 years for females in 1974 and increased to 63.3 and 65.2 respectively in 1995. Mean desired family size was 4.5 in the mid-1970s and declined to 3.0 in 1990 and 2.5 in the mid-1990s. The literacy rate in Bangladesh was very low until the end of British rule (mid-1900s). In the latter half of the 20th century the then Pakistan government (East Pakistan) tried to improve the level of educational attainment of children but success was not satisfactory. The second five-year plan (1980–85) in Bangladesh introduced a universal primary education scheme (1–5 grades); no tuition and free books for all. To educate primary school drop-outs, the Bangladesh rural advancement committee (a national NGO) has undertaken a programme through an informal primary education scheme since the early 1990s. The scheme provides free books and stationery and preferential enrolment is given to girls and to children from

poor families. Since the mid-1990s, the government of Bangladesh has also initiated incentive schemes in selected villages to increase enrolment in primary education. In recent years, secondary education (6–10 grades) has been free for girls but fees are required for boys. Although many secondary institutions are private enterprises, they receive substantial government subsidies. Books have to be bought by the student and admissions and examination fees are imposed on both girls and boys. Since the mid-1990s, the government of Bangladesh has initiated a scholarship scheme for all girls in secondary school. Entitlement to a scholarship requires 65% school attendance and maintenance of a certain grade but there are no criteria for economic exclusion. Each school receives a subsidy for each girl enrolled under this programme and the girl receives a monthly stipend. Parents of scholarship recipients are required to sign a bond guaranteeing that the girls will not be married before reaching 18 years of age. In addition to falling fertility, these public investments in education would be expected to improve school retention rates, particularly for girls.

Bangladesh has experienced a large growth of population in the past, but due to the success of family planning programmes, the level of total fertility rate has declined rapidly. However, the increased level of contraceptive prevalence does not have the expected outcome during the recent past rather the level of fertility has remained unchanged. Hence, attainment of replacement level fertility remains as a formidable challenge to the policymakers. Human capital accumulation factors have been emerging as very important determinants in shaping up both the future growth of population and development. Moreover, once the process of population momentum is initiated, the population will keep on increasing very rapidly during the next 40-50 years until it is

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eventually stabilized. The overall economic growth will be severely affected due to the population momentum, and without integrated policy measures, it would be difficult to face the emerging challenges. The dynamics of population deals with the determinants and consequences of changes in the structure, growth and distribution of population over time. The structure of population is the distribution of a given population by age and sex. The growth of population indicates change in the population size relative to a base population size. The growth of a population is measured by three components: births, deaths, and migration. The distribution of population refers to the spatial distribution of a given population, such as population distribution by rural and urban locations in a country. This is also measured by population density for different regions (Sirageldin, 1995).

Only certain characteristics of population have an effect on the economy. The basic characteristics are total size, growth rate, density, age, distribution, sex ratio, and regional distribution of population. These are subject to any change through fertility, mortality and migration and the process of such change is termed as population dynamics. In other words, any change in the measures of structure and distribution occur as a consequence of prior changes in the components of population growth. However, even after reaching replacement level, it may take quite a long time to attain a growth rate of zero due to the young age structure of a population. Due to the young age structure, the population continues to increase even after reaching replacement level, because a relatively larger proportion of girls continue to enter into the childbearing age groups until the age structure stabilizes. This is known as population momentum. To explain the population momentum, age and sex are the two basic characteristics that need to be

considered. These are integral parts of the larger social, economic and environmental system. In addition, however, two other basic components need to be considered, education and labour force participation. Although these variables are not demographic in strict sense, but these population characteristics have shown increasingly important role in explaining fertility, mortality and migration (Islam et al., 2002).

For decades, economists and social thinkers have debated on the issue of the nature of influence of population change on economic growth (Boserup, 1981; Simon, 1981; Ehrlich and Ehrlich, 1990; Kelly and Schmidt, 1994; Coale, 1986; Barlow, 1994). According to them, population growth restricts, promotes, or is independent of economic growth. Proponents of each explanation can find evidence to support their cases. All of these explanations, however, focus on population size and growth. In recent years, however, the debate has under-emphasised a critical issue, the age structure of the population (that is, the way in which the population is distributed across different age groups), which can change dramatically as the population grows (Bloom and Williamson, 1998).

The economic behaviour of people varies at different ages of life, ranging from schooling at a young age, entering into labour force at an adult age (or even child labour in a country like Bangladesh), retirement at old age, additional expenses for health care at old age, etc. Similarly, male and female populations have different kind of economic characteristics at different ages that can be reflected in son preference, sex differential in infant and child mortality rates, differential pattern in schooling of boys and girls, discrimination towards women of all ages, childbearing of women during reproductive ages, healthcare facilities during pregnancy, etc. As the economic behaviour varies at

different stages of life, changes in a country's age-sex structure can have significant effects on its economic performance. A country with a high proportion of children is expected to devote a high proportion of resources to their care, which tends to depress the pace of economic growth. On the other hand, an increased population in the working ages, the added productivity of this group can be utilized to accelerate the economic growth, assuming that policies to take advantage of this are in place. In fact, the combined effect of this large working-age population and health, family, labour, financial, and human capital policies can create virtuous cycles of wealth creation. And if a large proportion of a nation's population consists of the elderly, the effects can be similar to those of a very young population. A country like Bangladesh, just being ready to initiate the process of population momentum, experiencing an overwhelming increase in the population size, initially at very young ages, then at working age groups, and finally elderly age groups, has the opportunity to capitalize on the bright side of the demographic transition. This demographic benefit is not, however, automatic. Given the right kind of policy environment, this demographic benefit can help to produce a sustained period of economic growth, as it did in several East Asian economies. The critical policy areas include: (i) public health, (ii) family planning, (iii) education, (iv) economic policies that promote labour-market flexibility, openness to trade, and savings. With this backdrop, it is noteworthy that, policymakers have the opportunity to consider the means to maximize and capture this benefit by accelerating the demographic transition, and allowing extra labour to be absorbed productively in the market. Finally, policymakers must plan for the healthcare and quality education of the children as an

investment and future health care and pension income needs of this baby boom generation when it ages as a security.

In the South Asian countries, both the levels of fertility and mortality were very high for a long period, and then fertility started to decline first in Sri Lanka since the early 1960s followed by India and Bangladesh in mid-70s. In Pakistan and Nepal, the decline in fertility was evident since the mid-80s. Among the South Asian countries, Sri Lanka has already achieved the replacement level fertility in 1993, but India and Bangladesh, expected to achieve the replacement level by the years 2001 and 2005, respectively, are lagging behind. The targets for India and Bangladesh are now set for a later period.

In South Asia, on the other hand, the emphasis was on national family planning programmes that led to the decline in the level of TFR to a certain extent, but except Sri Lanka, other countries are still lagging behind in achieving the replacement level fertility. The delay in the completion of the transitional phase of achieving replacement level fertility will result in a much higher size of the population after stabilization. In Sri Lanka, like in East Asian countries, basic education was emphasized, but other South Asian countries are still far from ensuring adequate quality of basic education for all. In examining the relationship between growth of population and the growth of economic development, we need to consider the use of resources, savings and investment, education, urbanization, renewable resource degradation, health, ageing, offsetting effect of economic growth attributable to growth of population, etc. The onset of fertility decline was evident since the mid-seventies in Bangladesh. The decline occurred at a

rapid pace during the period 1975 to 1993-94. The total fertility rate was 6.3 in 1975 and decreased to 3.4 in 1993-94. However, since 1993-94, the level of total fertility appears to be unchanged at a level of 3.3, as observed from the BDHS 1996-97 and 1999-2000 results. However, during the period from 1993-94 to 1999-2000, the contraceptive prevalence rate has increased substantially from 44.6 percent to 53.8 percent. The unchanged level of fertility despite a rapid increase in the level of contraceptive prevalence during the past 6 years, while the level of fertility still remains well above the level of replacement fertility, raised questions about the policy measures in order to complete the demographic transition. The steep decline in fertility since 1975 has corresponded with the rise in CPR up to 1993-94 in Bangladesh. Using the relationship between TFR and CPR during this period to predict future fertility, researchers argued that a replacement level of fertility could be attained in Bangladesh by raising the CPR at a level of 70 percent. However, results of the last two BDHS in 1996-97 and 1999-2000 demonstrated that despite an increase in CPR over the period 1994-2000, the TFR has remained at the same level of 1993-94 (Mitra et al., 2001). Even in Matlab experimental area (a research station of ICDDR,B), which boasts of its intensive FP service delivery system resulting in a sharp increase in the level of the CPR to 70 percent, the TFR had remained at the vicinity of 3 births for the last several years (Bairagi, 2001). This raises concern among researchers, policy makers and programme managers about the prospect of attaining the replacement level of fertility in Bangladesh in the near future.

1.1 AIMS OF THE STUDY

Bangladesh has been passing through a critical phase of fertility transition. The level of fertility started to decline since mid-seventies. The decline occurred at a rapid pace during the period 1975 to 1993-94. The total fertility rate was 6.3 in 1975 and decreased to 3.4 in 1993-94. However, since 1993-94, the level of total fertility appears to be unchanged at a level of 3.3, as observed from the BDHS 1996-97 and 1999-2000 results. The 2004 BDHS data indicated that after almost a decade-long stagnation, the TFR declined slightly from 3.3 to 3.0 between 1997-1999 and 2001-2004. However, during the period 1993-94 to 2004, the contraceptive prevalence rate has increased substantially from 44.6 per cent to 58.1 per cent. The unchanged level of fertility despite a rapid increase in the level of contraceptive prevalence during the past 10 years, while the level of fertility still remains well above the level of replacement fertility, raised several questions. Now it is necessary to find that: How at present socio-economic and demographic variables related with fertility? How socio-economic and demographic factors affect regional variations of fertility? Is there any role of proximate determinants of fertility? When will Bangladesh reach to the replacement level of fertility?

It is mentionable that in Bangladesh although several studies have been done in the relationship of socioeconomic, demographic variables and human fertility behaviour, but in order to highlight the factors affecting to depress the fertility level in different regions of Bangladesh and to estimate how long and under what conditions Bangladesh will reach the replacement-level of fertility is very limited in those studies. Secondly,

these variables are rapidly undergoing changes with the advancement of science and socioeconomic development of the country. The researcher found that nothing has been done in recent years to study these relationships in Bangladesh. Considering the recent qualitative and quantitative changes those took place in the life of the Bangladeshi people it is assumed that the people have also changed their attitude towards fertility behaviour. To fill-up the knowledge gap of changes that have taken place in recent years, this thesis is designed.

An attempt is taken to address the above issues of major concern to the policy makers and researchers. The main objectives of this study include the following:

- i) To estimate the impact of some important traditional qualitative, socio-economic and demographic variables of human fertility behaviour in Bangladesh.
- ii) To examine the regional variations and to identify the factors associated with regional variations among the six administrative divisions of Bangladesh.
- iii) To analyze fertility trends and to explore the role of biological and behavioural determinants of fertility in bringing change in fertility levels of Bangladesh.
- iv) To predict the time required for Bangladesh to reach the replacement-level of fertility under different conditions.

1.2 ORGANIZATION OF THE STUDY

There are six chapters in this thesis as follows:

Chapter 1 is *Introduction*. This chapter contains general introduction with aim of the study and organization of the study.

Chapter 2 is *Review of the Literature*, which contains information on the socio-economic and demographic changes in the reproductive behaviour of Bangladeshi studies and other population studies.

Chapter 3 is *Materials and Methods*, which contains source of data, and methods of finding the fertility situation in Bangladesh.

Chapter 4 is *Results and Discussions*. This chapter contains results with necessary discussions on the socio-economic and demographic factors of human fertility behaviour in Bangladesh.

Chapter 5 is *Summary and Conclusions*. This chapter contains summary on the results, and conclusion for the findings of this study.

Chapter 6 is *Policy Recommendations and Future Research*. This chapter concludes with some comments on the overview of the findings regarding policy implications and prospects for future research.

CHAPTER 2

REVIEW OF LITERATURE

The specific nature of the determinants of fertility is intricate and complex. While fertility behaviour influences population growth, which has consequences towards pressure on resources, employment situations, health and other social facilities and savings and investment, in turn, such consequences have great bearing on the socio-economic variables that affect fertility behaviour. Simultaneous changes in a number of factors associated with the process of socio-economic development tend to offset attempts to analyze the relative influences of each factor, and may result in contradictory evidence about how these various factors affect fertility. The conceptualization of the determinants of fertility involves a multitude of factors that vary greatly in the intensity and direction of force they exert on fertility. The study of the relationship of fertility levels to specific economic, social and cultural variables in the low as well as high fertility countries has “led to the hypothesis that for most part the same factors which are thought to account for the decline of fertility in the low fertility countries are, in a reverse sense, also responsible for the continued high levels of fertility in the high fertility group” (UN, 1973).

Socio-economic factors affect are in turn affected by the demographic factors. In the developed countries, growth of population was considered desirable for bringing about economic development and this growth of population made possible the division of labor, extension of personal contacts, the coordination of individual activities, the stimulation of initiative and technical innovations. The increases in population also

enabled these societies to bring about greater social development and progress. Further, the interactions of socio-economic and demographic factors do not take place in a vacuum but are shaped by the economic history, mode of production, production relations, growth and distribution of economic produce. These factors directly and indirectly affect the interaction processes. Socio-economic variables can not directly influence fertility but must act on fertility through their effect on one or more of the intervening variables.

Many researchers have tried to study the relationship of socioeconomic, demographic variables and human fertility behaviour. Some of these studies are described in below.

2.1 OTHER POPULATIONS STUDIES

Bongaarts (1978) presented a framework for analyzing the relationship between intermediate fertility variables and fertility levels. He defined an intermediate fertility variable as any behavioral or biological factor through which socioeconomic, cultural, or environmental variables affect fertility. He proposed a complete set of eight intermediate fertility variables, but it was shown that only four were important determinants of fertility differentials among populations: proportions married, contraception, induced abortion, and lactational infecundability. He allowed quantitative estimation of the fertility effects of each of these four variables was outlined, and its application was illustrated.

Atoh (1981) identified social determinants of marital fertility in Japan. He used the data from the 7th Japanese National Fertility Survey of 1977. He applied multiple classification analysis (MCA) for the number of children ever born (NCEB) of currently

married women to identify social determinants of marital fertility in Japan. He found among all of the explanatory variables included in the MCA model, spouses' age at marriage had the largest explanatory power. He observed the proportion of the total variance of NCEB explained by social variables was relatively small. Although wife's work before marriage did not have any significant relation to NCEB, wife's work during the early reproductive years had the largest negative effect on NCEB among social variables. He also found variables such as wife's education, nature of place of residence, and husband's occupation had a small but systematic effect on NCEB.

Kanyiri (1984) analyzed to examine the relationships between socioeconomic and demographic variables and current contraceptive usage among Kenyan women aged 15-50. He utilized both path analysis and multiple regression to determine the direct and indirect effects of selected predetermined variables on contraceptive behavior of currently married, fecund, and non-pregnant women. He demonstrated that the number of living children, ethnicity, women's occupation, and husband's occupation had significant direct effects on contraceptive use, while accessibility was shown to have the strongest direct effect on contraception. Education was shown to influence contraceptive behavior through other intervening variables such as woman's occupation, living children, and accessibility. He was also indicated that age, ethnicity, and place of residence were strong determinants of education, while education was in turn positively related to woman's occupation. He argued that the relationship between fertility preference and contraceptive use was significant particularly in the study of unwanted fertility and unmet needs for contraception.

Bailey and Weller (1985) analyzed to estimate the direct and indirect effects of background socioeconomic and demographic variables on the number of children ever born from the data of currently married women aged 15-49 living in rural Sierra Leone in 1979. They applied path analysis to investigate the study. Three background variables: tribe, religion, and wife's childhood place of residence: two socioeconomic variables: educational level of the woman and that of her husband, and three demographic variables: age, age at marriage, and desired family size: were studied to determine the effect they had on the dependent variable: number of children ever born. They used path analysis because there was a causal ordering between the variables in the model, and because these relationships were linear and additive. They revealed that five variables had a statistically significant effect on the dependent variable: age, tribal affiliation, childhood place of residence, age at marriage, and family size. They suggested fertility might be reduced by improving female education and therapy introducing several variables to the model, such as better knowledge of health care, awareness of quality of life, sense of family planning, and a higher age at marriage, and modernization through education, adequate medical care, mass media, and family planning could encourage couples to limit their fertility.

Salvini (1985) analyzed to assess models for describing the relationship between fertility and female employment based on the data from the 1979 Fertility Survey of Italy. He employed methods such as multiple regression and path analysis to the study. He selected sociodemographic factors such as duration of marriage, residence, and education was controlled, the data showed clear differentials in fertility by women's occupational status. He indicated by path analysis that the causal links between all endogenous and

exogenous variables; the best model appeared to be a nonrecursive one providing for interrelationships between fertility and work status. He found at constant marriage age and marriage duration, the influence of work on fertility exceeded the negative influence of family size on economic participation. He suggested that the existence of a child less than 10 years of age, especially at marriage durations under 10 years, had a clear negative influence on female employment.

Alvarez (1987) used Bongaarts' method for quantitating the effects of [proximate] determinants on fertility in Cuba. He separated the effect of each determinant and found out what factors was responsible for the rapid change in fertility in Cuba from 1972 on. The determinant of highest impact on the fertility level attained in each province was assessed. He observed that the most important results point [to] the use of contraceptives as the cause for the rapid decline in the fertility level and the married state as the variable conditioning provincial differences.

Osheba and Cochrane (1988) developed and tested a causal model of the determinants of desired family size of Egyptian husbands and wives, using data from the 1980 Egyptian Fertility Survey. They hypothesized that the family size preferences of husbands and wives were determined by their socioeconomic circumstances, their age at marriage, their educational aspirations for their daughters, their expectations for old age support from their children, and especially their attitudes towards the legitimacy of contraception as a means of regulating fertility. They used path analysis to analyze the determinants of desired family size because it moves beyond the estimation of direct effects, the basic output of regression. They showed that the total models for husbands and wives had very strong regional effects. The husbands and wives, the urban and rural

regional models differed dramatically. In urban areas, husbands and wives showed fairly similar endogenous factors affecting desired family size: desired education for daughters had a negative effect for both, as did intention to use contraception and age at 1st marriage. They found for both husbands and wives, desired education for girls was directly related to the spouses' own education and was negatively related to residing in urban Upper Egypt. For wives, however, educational aspirations were also negatively related to landownership, probably because the latter reflected rural origins. Finally they indicated the husband's education had indirect effects on his desired family size in all regions.

Rao and Balakrishna (1988) analyzed on factors correlated with fertility, at the community, Indian state, and international level by correlation matrix, path coefficient analysis. They argued on the community level, lower family size was correlated with better nutrition, reduced mortality, literacy, high socioeconomic status. Indian states (15 analyzed) which were characterized by wide regional variations, were compared by correlation matrices in the study. They found the indicators of fertility, mortality, nutrition, health, resource utilization and literacy were well correlated. Again fertility was correlated with mortality, and inversely correlated with socioeconomic development, resource utilization, health and nutrition. Fertility was also positively correlated with per capita income and nutritional status. The percentage of the population above the poverty line was correlated with high fertility. They showed that socioeconomic and nutritional statuses were inversely related with fertility and mortality. They indicated for a given level of mortality, economic and nutritional statuses were positively correlated with fertility.

Bailey and Serow (1991) examined the demographic and socioeconomic determinants of fertility in rural Sierra Leone among a sample of 2000 women

aged 15-49 years and 680 husbands in 1979. They applied multiple regression analysis with an ordinary least squares model to analyze the study. Size of place of current residence was their particular interest. They used eleven variables in the analysis: children ever born as the dependent variable; husband's tribal affiliation, his religion, and size of place of current residence as background variables; educational levels of the respondent and her husband, reported annual household income, and wife's occupation; and age at marriage, infant and child mortality, and desired family size. They observed among eleven variables, only size of place of residence was statistically significant ($p = .10$) and positively affecting fertility. They found only opportunity cost to the wife (women working in nonagricultural jobs and educational attainment) was negatively influences fertility as expected. Income effects were insignificant and in the wrong direction. Demographic influences were in the expected direction. Opportunity cost (nonagricultural employment) was strong and significantly negative only in large places. Household's infant and child mortality was significant and positive in all places. Desired family size was similar (positive and significant), but a stronger relationship occurs in larger places. Age at marriage was important only in large places, and child mortality less important.

Li (1992) used the Chinese In-Depth Fertility Survey data of 6654 ever married women aged 49 years and younger, from the Old Age Security Survey of 220 married couples, and records of the county family planning commission for Guangdong province were analyzed by path method. Analysis was for Guangdong province only. Findings indicated that fertility which violated current family size norms and family planning regulation in China was related to ideal family size, son preference, socioeconomic

development, type of employment, area of residence, failed pregnancy, and fertility discussions between spouses. He found that rural residence influenced fertility through socioeconomic (SES) characteristics and ideal large family size. He also found negative influences on fertility were also affected by socioeconomic (SES) characteristics and ideal large family size.

Hakim (1994) identified to determine whether there were any differentials in fertility levels by age at marriage, educational level, work status, region of residence (province), and place of residence (urban or rural) in Pakistan. He took Contraceptive Prevalence Survey (CPS) data of Pakistan from 1984 to 1985. He applied both bivariate and multivariate analyses to examine the effects of these factors on fertility. He used the technique of multiple classification analysis (MCA) to determine the net effect of each factor. He suggested among the predictors, age at marriage was the most significant variable, followed by the husband's education, woman's education, husband's occupation, woman's work status, region, and place of residence. He found among the demographic variables, age and age at marriage were the most important determinants of fertility. He also found among the socioeconomic variables, the educational level of both husband and wife were important determinants of cumulative fertility. Education had a negative effect on fertility. The mean number of children ever born to women with no education was 4.5; to women with primary education, 3.6; to women with secondary education, 3.2; and to women with tertiary education, 2.3. Age at marriage was inversely related to fertility. The mean number of children ever born was 5.1 for those who married below age 16 vs. 4.1 for age at marriage 16-19, and 3.6 for 20-24. He demonstrated in the multivariate analysis the effect of age at marriage was the strongest as a predictor. He

showed women working as salaried employees had higher fertility (5.0) compared to women working in family business or at home (4.2). On the other hand women whose husbands worked as salaried employees had comparatively lower fertility than those whose husbands were working in their own business or in agriculture.

Rabago (1994) considered only eight Latin American countries, Colombia, Costa Rica, and Venezuela had much more significant contraceptive use than any other country except Panama. The influence of lactation was most significant in Peru and least significant in Costa Rica. A comparison of contraceptive usage in various subgroups of the Mexican population showed that the use of contraception increased significantly in all subgroups between 1976 and 1979 but remained much lower in rural and less educated groups than in more privileged groups or the population as a whole. The influence of lactation on fertility was less for the more privileged groups. The influence of abortion in general seemed small but increased with educational level. Between 1976 and 1981, the influence of prolonged lactation in reducing the fertility of the Mexican population appeared to have been supplanted to some degree by use of contraception. While the total marital fertility rate declined by 19%, the total natural marital fertility rate remained almost constant at slightly over twelve children/woman. The influence of nuptiality and abortion remained about the same.

Hassan (1996) analyzed by Bongaarts' fertility model on Egypt from 1980 to 1993 to identify the speed of change in fertility level varied substantially by regions of residence {Urban Governorates of Egypt (UG); Urban Lower Egypt (UL); Urban Upper Egypt (UU); Rural Lower Egypt (RL); Rural Upper Egypt (RU)}. He found the highest reduction in fertility level was in RL, where TFR fell from 6.0 live births in 1980 to about

3.31 in 1993. The percentage of reduction was about 44.8%. He reported the least reduction was in RU, where TFR reduced from 6.32 live births in 1980 to about 5.33 in 1993. The reduction was about 15.7% only during the period 1980-1993. He also reported in 1993, the lowest TFR observed in the UG. It reached about 2.12 live births. It was approximately equal to the replacement level of TFR. He showed all the values of marriage index (C_m) and contraception index (C_c) achieved an observed reduction during the study period. That reduction reflected the negative impact of the changes which occurred in marriage pattern and contraceptive prevalence rate on fertility level. He observed that the fertility inhibiting effect of contraception had the largest contribution to the decline in TFR in all regions of Egypt except urban upper Egypt, where the changes in the marriage pattern was the largest contribution to the decline in TFR during the whole period of study.

Qureshi and Adamchak (1996) assessed the relative impact of the indirect and direct determinants of fertility of Pakistani women using the 1990-91 Pakistan Demographic and Health Survey (PDHS). A total of 7926 households were selected and 5713 women of reproductive age (15-49 years old) who had at least one birth were interviewed. Several social, economic, and demographic variables were employed to assess the number of children ever born. Ordinary least squares regression was used to estimate four multivariate models of children ever born. The direct and indirect determinants and the control variable of current age were simultaneously entered for each of four models that differed by age: 15-49, 15-24, 25-34, and 35-49 years. There was a 0.5 child difference between children ever born (4.64) and living children (4.11) for the 15-49 age group. They indicated infant and child mortality: 26% of the women

experienced at least one child death before the age of two years. They found the oldest group had the lowest percentage ever attending school: 19% vs. 25% and 26% (15-24 and 25-34 age groups, respectively). They also found education was nonsignificant for the youngest and middle-aged cohorts, but it was negative and significant for the older cohorts. They indicated for employment, only the 25-34 age group was negative and significant. Age at marriage and breast feeding were strong and negative for all models. They analyzed the current use of family planning was positive and significant for the oldest age group and the total. They observed the younger cohorts did not have a negative and significant relationship between education and fertility; and the 15-24 age group living in a major city had significantly higher fertility than their town and village counterparts. They also observed the variables that showed differential impact were education, employment, residence, and contraceptive use. They revealed education did not significantly lower fertility for the younger groups, but it did for the older group. They also revealed employment significantly lowered fertility for the 25-34 age group. Contraceptive prevalence steadily increased from 7% in the 15-19 age group to nearly 21% in the 35-39 age group.

Saxena and Jurdi (1997) used 1997 Yemen Demographic and Maternal and Child Health Survey data to manipulate the proximate determinants of fertility in order to have further and faster fertility drop in Yemen, particularly among those living in rural and Mountainous areas and among illiterate women. They showed while much could not be done to increase the contribution of induced abortion to fertility decline because of religious and cultural prescriptions that forbidden this practice; then governmental policies

could concentrate on effectively and efficiently increasing contraceptive utilization and effectiveness, on encouraging breastfeeding and on rising the age of marriage.

Khraif (2001) attempted to understand fertility behavior of Saudi women, a regression analysis was utilized. He found that age at marriage and woman's education were apparently the most important determinants of fertility behavior. He also found that some variables, specifically "children death", "son preference", and the geographic region, were significant determinants of fertility. Opposite to the expectation, he showed from the analysis that living within an extended family setting was associated with low fertility levels. Also surprisingly, woman's participation in the labor force and husband's educational attainment were not among the significant fertility determinants in Saudi Arabia.

Wasao (2001) compared the effect on fertility of the socioeconomic characteristics of the two countries Cameroon and Central African Republic. He obtained data for the study from the Demographic and Health Survey (DHS) of the two countries of the year of 1998 and 1994-95. The dependent variable of the study was children ever born (CEB). He used logistic regression model for the study. The independent variables were: residence, education, region, religion, marriage type and current use of contraception. He found that some of the socioeconomic factors attributed to change in fertility were educational attainment, which depressed fertility through various mechanisms such as adoption by educated women of small family norms, better knowledge and use of modern contraception and later ages at first and first birth.

Kannan (2002) explored the process of age structural transition in the countries of South and Southeast Asia and its relation with economic growth. He found that the age

structural transition was not uniform among the countries of South and Southeast Asia. The differences in age structural transition were due to differences in the nature of fertility and mortality decline among these countries. He also hypothesized that each country would undergo a period of “window of opportunity” or “demographic bonus” during the age structural transition. However, he showed the timing and duration of that opportunity was determined by the timing and speed of the product of fertility and mortality decline. He observed the demographic bonus was available for Southeast Asian countries and Sri Lanka since 1970s whereas for the other two South Asian countries, it started only in the 1980s. He found the period of window of opportunity was likely to end around the year 2015 in Singapore, Thailand and Sri Lanka; 2020 in Malaysia; 2025 in Indonesia and India; and would continue till the year 2030 in the Philippines and Bangladesh.

David and Packard foundation (2003) analyzed by Bongaarts’ model from the 2000 Ethiopia Demographic Health Survey (EDHS) data to estimate the relative contribution of the different proximate determinants in bringing fertility below its biological maximum in the Oromia Region of Ethiopia. The survey collected detailed information on background characteristics and fertility related behaviours, including age at marriage and current marital status, number and timing of births, use of contraception, length of postpartum abstinence, and breastfeeding practices, from women age 15-49. They found non-marriage (due either to delayed marriage or the exit from marriage) and prolonged breastfeeding were the two most important factors that kept fertility below its biological maximum in the Oromiya region, especially in rural areas. They also found in urban areas, delayed marriage played an even more important role in keeping fertility

down, and contraceptive use approaches breastfeeding in terms of the magnitude of its inhibiting effects on fertility.

Leone *et al.* (2003) estimated the level of contraceptive use and the total fertility rate in the absence of sex preference. They used 1996 Nepal Demographic and Health Survey data on ever-married women aged 15-49. They applied logistic regression to analyze the association between socioeconomic and demographic variables and stopping childbearing after the birth of a son. They found sex preference decreased contraceptive use by 24% and increased the total fertility rate by more than 6%. They observed women's contraceptive use, exposure to the media, parity, last birth interval, educational level and religion were linked to stopping childbearing after the birth of a boy, as was the ethnic makeup of the local area. They deduced sex preference was an important barrier to the increase of contraceptive use and decline of fertility in the country; its impact would be greater as desired family size declines.

Alene and Worku (2008) examined by a comparative cross-sectional study in the Amhara region of Northwest Ethiopia which included 2424 women aged 25 years and above was undertaken. They applied both of bivariate and multivariate logistic regression analysis to their study. The study subjects were grouped into high fertile and low fertile categories. There were 1011 and 1413 women in the high and low fertile groups, respectively. A multi-stage cluster sampling stratified by place of residence was employed to select the required study subjects. They found among the twenty five variables in their study, only nine of them were significantly and independently associated with the level of fertility. They showed women with at least secondary education were at a lower risk of high fertility with odds ratio (OR) = 0.37 (95% CI: 0.21

to 0.64) compared to those with no formal education. Women with primary education did not show any significant difference when compared with the same baseline group. Age at first marriage was inversely associated with the number of children ever born alive. Place of residence, household expenditure, number of children who have died, attitude towards using contraceptives, women's knowledge on the safe period, and current marital status were the other variables that revealed significant associations with the level of fertility. Finally they concluded female education beyond the primary level, reduced infant and child mortality, delayed marriage and correct knowledge on the safe period during the menstrual cycle were amongst the main factors that had a bearing on high fertility.

2.2 BANGLADESHI STUDIES

Ahmed (1981) analyzed to seek the variables that significantly affected the cumulative fertility of both urban and rural women and to construct causal models to clarify the complex set of relationships from the 1975-1976 Bangladesh Fertility Survey (BFS) data. He used path analysis on eight variables: fertility index (number of children ever born to ever married women aged 9-49, age of wife (respondent), age at marriage, religion, childhood background of wife and husband, and educational attainment of both wife and husband. He obtained data from a sample of 4875 rural and 1403 urban women. He began according to causal ordering of the variables with the four exogenous variables: age, religion, and childhood backgrounds of the wife and husband. Education of husband and wife were placed next in sequence, followed by age at marriage and the fertility index. He estimated path coefficients by applying ordinary least squares regression to the equations. He regressed "children ever born" on all other variables for urban and rural

areas. The two sets of coefficients were not equivalent and he analyzed urban and rural data separately. He found thirteen paths were significant in the urban model and eleven in the rural model. He found five variables were statistically significant effect on fertility in the urban model: age, religion, education for both husband and wife, and age at marriage. He suggested the indirect effect of religion operating through a network of compound paths that Muslim affiliation tends to depress wife's and husband's education and age at marriage. He also suggested holding other variables constant, Muslim women tend to have more children than non-Muslim women. The effect of wife's age at marriage on fertility was negative. Wife's education had a negative effect on cumulative fertility and husband's education had a positive effect.

Kabir and Howlader (1982) discussed the advantages of use of path analysis in determining the effect of socioeconomic factors on fertility. The approach allowed the correlation between two variables to be decomposed into direct, indirect, and joint effects. They presented in the form of the study of fertility in nineteen districts in Bangladesh in which it was postulated that fertility was influenced by an area's level of socioeconomic development, its demographic status in terms of age at marriage and infant mortality, and level of contraceptive use. They treated age-specific fertility as the product of proportion married and age-specific marital fertility, and age at marriage and contraceptive use rate were treated as endogenous variables. They found the total effect of women's participation in the labor force was 0.694, reflecting the correlation of labor force participation with education as well as the effect of age at marriage. They also found the total effect of age at marriage might be expressed by the correlation between age at marriage and female labor force participation, for a direct effect of 0.615. They

showed the sum of the two components, the direct effect of age at marriage and the indirect effect of age at marriage acted through women's education; produce a direct effect of 0.694. They indicated the total effect of women's education was 0.237 and the education had a negative effect on fertility.

Islam *et al.* (1993) examined the effects of selected socioeconomic and demographic factors on fertility in a rural area of Bangladesh by path analysis. It was revealed that age at first marriage had direct significant effect while ever use of contraception and duration of breast-feeding had direct positive significant effects on fertility. They found that the total effects of wife's education and age at first marriage on fertility were negative while those of religion and household income on fertility were positive.

Ullah and Chakraborty (1993) analyzed to identify important determinants of contraceptive use among women of reproductive age based on 1989 Bangladesh Fertility Survey data. They used multivariate logistic regression analysis and showed twelve variables, among the fifteen selected socio-economic and demographic variables, were statistically significant factors influencing the current contraceptive prevalence rate. They found women's education emerged as the most influential factor, followed by women's participation in making decisions about family planning practice. They also found number of living children, religion, and education of husbands did not seem to have significant effects on current use of contraception.

Chowdhury *et al.* (1994) investigated the fertility among Bangladeshi females. They applied logistic regression analysis in their study, the dependent variable was contraceptive (temporary, permanent, male, female). They used a code of one if a couple

was currently using a contraceptive and zero if they were not. The study controlled for various socioeconomic and demographic background variables that might affect the results. These independent variables were: the number of living children, years of schooling, age, ownership of assets, and husband's occupation. They found that the income-generating projects had an independent effect on the demand for fertility regulation and contraceptive. That effect was stronger than the results from population education activities. In the projects Bangladesh appeared to be on its way towards achieving an economically, as well as socially, sustainable fertility rate. They also found the positive effects of income generating projects and their education component dealing with contraceptive use was more significant than the effect of other socioeconomic variables such as the women's education, husband's education, or possession of modern consumer items.

Khan and Raeside (1994) determined the influence of socioeconomic and demographic variables on fertility. They obtained the data from the 1989 Bangladesh Fertility Survey (BFS) on 11,905 ever married women: 8466 rural women and 3439 urban women. They applied path analysis to explore the study. They examined the number of children ever born (CEB) in terms of the influences of age, religion, childhood place of residence, and educational background. In the urban model CEB was significantly influenced by women's age, education, and childhood background. They found religion indirectly influenced CEB through women's age at marriage and education. Women's age did not indirectly significantly influence CEB. In the rural model CEB was directly and significantly influenced by women education, marriage age, religion, and age. They showed education had a smaller influence in the rural setting and

indirectly influenced marriage age but to a lesser extent than in an urban setting. In the rural setting women's age did have an indirect affect on fertility through educational status. They also found childhood background influenced the education of women in rural areas. In the rural setting age and religion had stronger impacted than in urban areas. In urban areas the indirect influence of age on women's education was stronger. They demonstrated that urbanization was an appropriate explanation for fertility decline in that it reduced fertility and increased educational levels.

Ullah and Chakraborty (1994) employed to study the differentials in the contraception use pattern by some selected demographic and socio-economic characteristics from the 1989 Bangladesh Fertility Survey (BFS) data. They applied multivariate logistic regression analysis to identify independent contributions of each selected covariate. They observed that duration of effective marriage emerged as a strong determinant of modern versus traditional methods use but it influenced modern methods use negatively. They also observed administrative division was an important variable. They found residents of Rajshahi division were significantly more (relative odds of 2.5) likely to be using modern methods than residents of Chittagong division.

Islam and Khan (1995) found that female age at marriage had a significant direct negative influence on fertility by path analysis. They suggested raising the age at marriage by implementing a minimum-age marriage law was likely to lower fertility on a national scale. They showed duration of breast-feeding was a significant direct negative effect on fertility. They also showed women to breast-feed their children for a relatively longer duration might also contribute to a reduction in fertility. Fetal loss appeared to have a significant direct positive effect on fertility in Bangladesh, which means that

mothers who had experienced fetal loss were found to have higher fertility. They found the total effect of female education on fertility was negative. They explained education might provide better employment opportunities outside the home and age at marriage can be raised by providing education to females, especially at the secondary and higher levels.

Khuda and Hossain (1996) examined the nature of fertility transition in Bangladesh, looked at the trends in contraceptive use and fertility, and identified the major factors accounting for the fertility decline, despite poor socio-economic conditions. They analyzed with 1993-94 Bangladesh Demographic and Health Survey (BDHS) on 4,194 women. They used logistic regression in their study. They found strong and highly significant effects of female education, female employment and access to media on contraceptive use and fertility.

Hoque and Murdock (1997) examined the effects of socioeconomic development, the status of women, and family planning on fertility and the extent to which these effects vary among the nineteen districts of Bangladesh. They applied the 1983 and 1991 Bangladesh Contraceptive Prevalence Survey (CPS) data to evaluate the effects of these factors on differences in contraceptive use among currently married women aged 15-49. They composed an analytical model of socioeconomic development, status of women, and family planning variables and tested using logistic regression. The analysis demonstrated clearly that socioeconomic development and women's status significantly impacted the use of contraceptive methods in Bangladesh. They suggested that better-educated, employed women were more likely to use contraception than those who had little or no formal education and who were not employed.

Islam *et al.* (1998) noted that in recent years contraception had emerged as the highest fertility-reducing factor in Bangladesh. Until recently, lactational infecundability was considered to be the most important and strongest fertility-reducing factor, but by 1994 contraception had become the most important determinant of fertility and its fertility-inhibiting effect was steadily increasing. The increasing effect of contraception was evident from the declining trend in the value of the index contraception from 0.937 in 1975 to 0.610 in 1994. On the other hand, the fertility-reducing effect of lactational infecundability was gradually decreasing. They mentioned that, although there was an increasing trend in the impact of the marriage component, reflecting the effect of an increased proportion non-married and/or an increased age at marriage, the rate of change was very slow. They found that the joint effect of marriage and lactational infecundability did not change much over the period 1975 to 1994 as the declining effect of lactational infecundability was offset by the increasing effect of marriage.

Khuda *et al.* (2000) used multiple regression analysis to disentangle the effects of changes in women's status and economic conditions from the independent effects of the family planning program. They found that six factors primarily accounted for the reproductive change in Bangladesh: communication between husbands and wives about family planning, desire for children, women's education, women's employment status, access to mass media, and the effects of the family planning program, including availability of contraceptives. Additionally, they observed, it was likely that program efforts had influenced several of the other factors, including communication about family planning between husbands and wives.

Islam (2002) said the process of population momentum had already begun in Bangladesh due to declining trend in the level of fertility. He estimated that the fertility component would be a dominant factor up to 2005 and often that population momentum would cause the population to grow rapidly. He was also estimated that about 70% of the total population growth would be attributed to the momentum factor during 2000-2025. He suggested three approaches to reduce the impact of population momentum– delayed age at marriage, delayed first birth after marriage and wider spacing of successive births. The paper recognized the importance of the issue of child survival in declining the fertility level. He observed that the role of son preference did not have any “visible impact” in the recent past on fertility. Therefore, the stagnant fertility was not due to son preference but to “lack of socio-economic development required to achieve the target of replacement level”.

Mahmud *et al.* (2002) examined the direct and indirect effects of some selected socio-economic and demographic factors on fertility by using Bangladesh Demographic and Health Survey (BDHS) data of 1996-97. They used a well known multivariate technique named path analysis for understanding of the causal links among the socio-economic and demographic variables on the one hand to the other were identified. They found from the study that age at marriage, marital status and index of contraceptive use had significant direct negative effects while the index of mortality had significant direct positive effect on fertility. Effect of female education on fertility was found to be negative.

Marten (2002) showed in the Bangladesh Demographic and Health Survey (BDHS) analysis, the effect of social interaction was more powerful than that of other factors that were generally credited with influencing fertility behaviour- education,

wealth and urban residence. These findings were further supported by the qualitative study which found that women actively discussed issues of family planning with neighbours, relatives, husbands and health workers, before making decisions regarding their own fertility behaviour.

Caldwell and Caldwell (2003) revealed the attainment of replacement fertility might depend upon continuing socio-economic change in Bangladesh on the basis of the time of the United Nations projections to reach the replacement level of fertility which was 2025-2003 (UN 1999, 2001). They found that the continuing urbanization was likely to erode further the supports for a high ideal number of children, in particular, the strong emphasized on the need for sons. They showed in the long run, competition for employment was likely to place increased emphasis on improved skills, particularly those associated with education; that would increase the cost of children. They also showed that urbanization might reduce the emphasis on boys with a decline in the importance of patrilineally-inherited property, especially farmland. They observed increasing opportunities for girls was also potentially important as represented by the explosive growth in recent years of jobs for women in the garment industry. They found continuing improvements in survival rates would be important in allowing couples to have the number of children they desired.

Mahmud *et al.* (2003) tried to increase understanding about the fertility situation and trends in Bangladesh. They used Bangladesh Demographic and Health Survey (BDHS) data of 1999-2000 to their study. They applied Bongaarts' proximate determinants of fertility model to estimate the fertility inhibiting effect of three important proximate determinants: marriage, contraception and lactational infecundability. They

showed that though the fertility level was declining, although it was still very high. They found data on induced abortion were not available and its effect remained essentially unmeasurable. They also found marriage variable made significant contributions to the overall fertility reduction and that the contraceptive use had the highest impact on reducing fertility of total reduction which might be attributed to the increase use of contraception from 7.7% in 1975 to 53.8% in 1999-2000. They observed the average estimated effect of lactational infecundability played prominent role in reducing fertility in Bangladesh.

Islam *et al.* (2004) focused to examine the role of the major proximate determinants of fertility in Bangladesh. The data for the study came from a series of nationally representative surveys of Bangladesh over the period of 1975 to 1999-2000. They applied Bongaarts' proximate determinants of fertility model to analyze the study. They revealed that although the fertility reducing effect of the marriage pattern was increasing, its effect was offset by the declining trend in the lactational infecundability period. A review of these two variables they suggested that their effect cannot be raised much for prevailing socioeconomic and cultural reasons, and any future reduction in fertility in Bangladesh might be largely dependent on increased use of effective birth control methods.

Kabir *et al.* (2006) analyzed to investigate the impact of four intermediate fertility variables namely marriage, contraception, lactational infecundability, and induced abortion on fertility in Bangladesh. They applied the 1989 Bangladesh Fertility Survey (BFS) and the 1999-2000 Bangladesh Demographic and Health Survey (BDHS) data to analyze the study. They used Bongaarts' proximate determinants of fertility model to

investigate the study. They observed the contribution of each proximate variable through the decomposition of the total fertility rate (TFR) into proximate components. They found contraception was seen to be the most prominent determinant in lowering the total fertility rate (from 5.1 to 3.3 or about 38.5%) between 1989 and 2000.

2.3 SUMMARY

Most researchers tried to examine the significant determinants of socioeconomic and demographic variables of contraceptive use among women of reproductive age of Bangladesh. Some times they applied multiple regression and multiple classification analyses revealing the results. So, it is needed to investigate the significant determinants of socioeconomic and demographic variables of human fertility behaviour in Bangladesh. Bailey and Serow (1991) examined the socioeconomic and demographic determinants of fertility in rural Sierra Leone. They used multiple regression analysis with an ordinary least squares model to their study. Researcher wants to measure qualitative dependent and independent variables to find the significant effects on fertility. In this case logistic regression model is used to analyze the study.

Path analyses have been found in several studies to assess the direct and indirect effects that background, socioeconomic, and demographic variables on contraception and fertility. In previous studies to identify the regional variations of fertility in Bangladesh by path models have been mostly used on the basis of the residence of rural and urban areas of selected socioeconomic and demographic variables. It may be noted that only Kabir and Howlader (1982) studied to demonstrate direct, indirect, and joint effects of socioeconomic and demographic factors on fertility in nineteen districts of Bangladesh.

Researcher did not find individually path analysis of six administrative divisions to show the regional variations of fertility including socioeconomic and demographic variations. The interest of path analysis of the study seeks to the regional variations and to identify the quantitative socioeconomic and demographic variables that significantly affect fertility of women of six divisions. Direct, indirect, joint, and net effects are presented by path analysis in the study.

It is observed from the above review of literatures that there are many works on the Bongaarts' model to estimate the role of biological and behaviour determinants of fertility. Bongaarts' model is exhibited in this research to explore the fertility situation of Bangladesh over the period of 1975 to 2004 that is near about of 30 years study. It is mentionable that Islam *et al.* (2004) have focused to their recent study on Bongaarts' model, the role of the major proximate determinants of fertility in Bangladesh from 1975 to 2000.

One of the keen interests of this research is after how long and under what conditions Bangladesh will reach the replacement level of fertility. Among the above review of literatures it is clear that few researchers have done about the replacement level of fertility in Bangladesh. They depended upon the medium-variant United Nations projection to fix a time frame to reach the replacement level of fertility of Bangladesh that was 2025-2030 (UN 1999, 2001). They discussed the general constrains but did not find out the particular conditions to reach the target level. In this study researcher has tried to check the United Nations projection to reach the replacement level of fertility of Bangladesh with particular conditions.

CHAPTER 3

MATERIALS AND METHODS

3.1 MATERIALS

The data for the present study have been extracted mainly from the following four nationally representative sources: Bangladesh Contraceptive Prevalence Surveys (CPSs), Bangladesh Fertility Surveys (BFSs), Bangladesh Demographic Health Surveys (BDHSs) and Bangladesh Bureau of Statistics (BBS).

Bangladesh Fertility Survey (BFS) of 1975 was conducted by the Bangladesh Ministry of Health and Population Control, Population Control and Family Planning Division as part of the World Fertility Survey (WFS). The survey was based on a multi-stage probability sample. The total number of sample was 6,500 of which 5,022 respondents were from rural areas and 1,488 were from urban areas. The respondents were ever-married women from age 15 to 49. The Survey was on five specific objectives: 1) to provide basic measures of the level of fertility trends; 2) to collect and analyze data on the prevalence of knowledge and use of contraception; 3) to study fertility differentials to identify the factors likely to affect fertility; 4) to make fertility data available to the national and international scientific community; 5) to attempt to institutionalize scientifically sound procedures of fertility data collection, processing and analysis.

Bangladesh Contraceptive Prevalence Survey (CPS) of 1979 was conducted by the National Institute for Population Research and Training (NIPORT) and Westinghouse Health Systems on 15,481 ever-married women under 50 years of age. A joint effort of the Government of Bangladesh and the United States Agency for International Development, Bangladesh Contraceptive Prevalence Survey (CPS) had as its main

objectives to develop and institutionalize a contraceptive prevalence survey as an ongoing data collection procedure for evaluating the efficacy of the family planning program, to collect data so that the knowledge and use of contraceptives and the availability of supplies may be ascertained, to obtain information on the relationship between selected population characteristics and contraceptive practices. The survey was discussed, including education, age, religion, work and marital status, and husband's education. Respondent's knowledge of family planning methods on several levels, Fertility rates and future fertility desires were also discussed.

Bangladesh Contraceptive Prevalence Survey (CPS) of 1981 had conducted Bangladesh Ministry of Health and Population Control, Population Control Division, Management Information System Unit. A total of 8510 ever-married women from age 15 to 49 were interviewed. The major objective of the 1981 Bangladesh Contraceptive Prevalence Survey (CPS) was to ascertain the current level of contraceptive use among the target population and determine differential use by selected factors such as age, number of living children, education, employment status, and urban-rural residence.

Bangladesh Contraceptive Prevalence Survey (CPS) of 1983 was conducted by Mitra and Associates, Dhaka on the 9,127 ever-married women aged 10-49. Mainly the survey was designed to obtain information on the fertility characteristics, fertility regulation information, source of contraceptive supplies/services, reason for non-use and future intention to use contraception and contraceptive availability.

Bangladesh Fertility survey (BFS) of 1989 was conducted by the National Institute of Population Research and Training (NIPORT), Dhaka. The survey used a two-stage probability sample design. At the first stage a sample of areas of clusters was drawn. Each selected area was then mapped and all households were listed. At the second stage, a sample of households was selected within each area. Thus a total of 11,729

households were selected, of which 11,236 households were successfully interviewed. Finally, in the 11,236 successfully enumerated households, a total of 12,096 ever-married women age under 50 years were identified as eligible for the individual interviewed. The survey was conducted to determine levels, trends, and causes of fertility during the past decade and to determine differences in fertility and child mortality by demographic and socioeconomic factors.

Bangladesh Contraceptive Prevalence Survey (CPS) of 1991 was conducted by the Mitra and Associates, Dhaka. Since 1979, CPS had periodically assessed family planning program performance in Bangladesh. The 1991 CPS, funded by the United States Agency for International Development, was the 6th national survey of households. It used a probability sample of 200 sampling spots (120 in rural and 80 in urban areas) that produced interviews with a total of 12,050 ever married women under age 50; 8973 in rural areas and 3077 in urban areas. The CPS asked women about their social and economic status, their fertility behavior and intentions, their knowledge and current and past practice of contraception, and their use of selected primary health care interventions. Nationally, 39.9% of currently married Bangladesh women under age 50 reported that they or their husbands currently used contraception. Contraceptive use was 48.0% in urban areas and 38.5% in rural areas.

The Bangladesh Demographic and Health Surveys (BDHSs) of 1993-1994, 1996-1997, 1999-2000 and 2004 were conducted under the authority of the National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare. These surveys were implemented by Mitra and Associates, a Bangladeshi research firm located in Dhaka. ORC Macro of Calverton, Maryland, provided technical assistance to the project as part of its international Demographic and

Health Surveys program, and financial assistance was provided by the U.S. Agency for International Development (USAID)/Bangladesh.

Bangladesh Demographic and Health Survey (BDHS) of 1993-94 used a two-stage sampling design. Bangladesh was divided into five administrative divisions, 64 districts (*zillas*), and 489 *thanas*. In rural areas, *thanas* were divided into unions and then *mauzas*, an administrative land unit. Urban areas were divided into wards and then *mahallas*. A total of 9,681 households were selected for the sample, of which 9,174 were successfully interviewed. Finally, in the 9,255 successfully enumerated households, a total of 9,640 ever-married women age under 50 years were identified as eligible for the individual interviewed. The survey was conducted to determine on the respondent's background characteristics (age, education, religion, etc.); reproductive history; knowledge and use of family planning methods; antenatal and delivery care; breastfeeding and weaning practices; vaccinations and health of children under age three; marriage; fertility preferences; husband's background; and respondent's work.

Bangladesh Demographic and Health Survey (BDHS) of 1996-97 used a two-stage sampling design. Bangladesh was divided into five administrative divisions, 64 districts (*zillas*), and 490 *thanas*. In rural areas, *thanas* were divided into unions and then *mauzas*, an administrative land unit. Urban areas were divided into wards and then *mahallas*. A total of 9,099 households were selected for the sample, of which 8,682 were successfully interviewed. Finally, in the 8,762 successfully enumerated households, a total of 9,127 ever-married women age under 50 years were identified as eligible for the individual interviewed. The survey was conducted to determine on the respondent's background characteristics (age, education, religion, etc.); reproductive history; knowledge and use of family planning methods; antenatal and delivery care; breastfeeding and weaning practices; vaccinations and health of children under age five;

marriage; fertility preferences; husband's background and respondent's work, knowledge of AIDS, height and weight of children under age five and their mothers.

Bangladesh Demographic and Health Survey (BDHS) of 1999-2000 used a two-stage sampling design. Bangladesh was divided into six administrative divisions, 64 districts (*zillas*), and 490 *thanas*. In rural areas, *thanas* were divided into unions and then *mauzas*, an administrative land unit. Urban areas were divided into wards and then *mahallas*. A total of 10,268 households were selected for the sample, of which 9,854 were successfully interviewed. Finally, in the 9,922 successfully enumerated households, a total of 10,544 ever-married women age under 50 years were identified as eligible for the individual interviewed. The survey was conducted to determine on the respondent's background characteristics (age, education, religion, etc.), reproductive history, knowledge and use of family planning methods, antenatal and delivery care, breastfeeding and weaning practices, vaccinations and health of children under age five, marriage, fertility preferences, husband's background and respondent's work, height and weight of children under age five and of their mother and HIV and AIDS.

The sample for the Bangladesh Demographic and Health Survey (BDHS) 2004 covered the entire population residing in private dwellings units in the country. Administratively, Bangladesh was divided into six divisions. In turn, each division was divided into *zilas*, and in turn each *zila* into *upazilas*. Each urban area in the *upazila* was divided into wards, and into *mahallas* within the ward; each rural area in the *upazila* was divided into *union parishads* (UP) and into *mouzas* within the UPs. The urban areas were stratified into three groups, i) Standard metropolitan areas, ii) Municipality areas, and iii) Other urban areas. These divisions allowed the country as a whole to be easily separated into rural and urban areas. The 2004 BDHS sample was a stratified, a multistage cluster sample consisting of 361 primary sampling units (PSUs), 122 in the urban area and 239

in the rural area. A total of 10,811 households were selected for the sample, of which 10,500 were successfully interviewed. Finally, in the 10,523 successfully enumerated households, a total of 11,440 ever-married women age under 50 years were identified as eligible for the individual interviewed. The survey was conducted to determine on the respondent's background characteristics (age, education, religion, etc.); reproductive history; knowledge and use of family planning methods; antenatal and delivery care; breastfeeding and weaning practices; vaccinations and health of children under age five; marriage; fertility preferences; husband's background and respondent's work; awareness of aids and other sexually transmitted diseases; and causes of deaths of children under five years of age.

The yearly time series data from 1985 to 2005 were collected from Bangladesh Bureau of Statistics (BBS) and DX-data base (available in the computer Lab of the School of Business, James Cook University, Australia). Although the number of time series data is small, the annual data of Bangladesh for population studies are limited.

3.2 METHODOLOGY

Multiple logistic regression model has been undertaken to estimate the impact of different qualitative socio-economic and demographic variables; current marital status, age at first marriage, respondent's education, partner's education, respondent's occupation, partner's occupation, region, residence, religion, index of wealth, index of mass media, ever used any method or choice of contraceptive method, currently breastfeeding and index of child mortality on human fertility behaviour among the Bangladeshi women. In this analysis to create a dependent variable as well as fertility measurement variable, have calculated the median of the variable named "total

number of children ever born” per women aged 10-49 and is found to be 3 (three). Then this variable has been coded as 0 (zero) for above median and 1 (one) for less or equal to median. To literally meaningful the new variable is treated as index of fertility and its two levels are accordingly disfavoured fertility behaviour instead of above median and favourable fertility behaviour instead of less or equal to median. The dependent variable “index of fertility” is shown to be binary or dichotomous one. The fertility behaviour or fertility rate of Bangladeshi women is to be estimated by the created fertility index in the logistic model analysis. When it takes the value 1 the probability will be P (say) if the respondent contains “favourable fertility behaviour” and 0 with probability $(1-P)$ if he/she contains “disfavourable fertility behaviour”. The independent variables for the model belong to fourteen selected socioeconomic and demographic variables. Brief explanations of these variables are shown in Table 1. All the independent variables of the analysis are categorical as well as indicator variables as to handle in multiple logistic regression analysis the individual category of a variable is converted into the present and absence of a characteristic, usually denoted by 1 and 0, often called dummy variables.

Path analysis with diagrams has been applied to analyze the regional variations of fertility differentials by selected quantitative variables; respondent’s current age, husband’s age, respondent’s education, husband’s education, number of household members, husband’s age at first marriage, respondent’s age at first marriage, respondent’s wealth index, wealth index of a family, number of living boys, number of living children at first contraceptive use, body mass index of respondent and number of children who have died using 2004 BDHS data, for the ever-married women aged 10-49 of the six

administrative divisions on Barisal (1360), Chittagong (2069), Dhaka (2589), Khulna (1708), Rajshahi (2564) and Sylhet (1150) out of 11,440 of Bangladesh, by separating their complex causal relationships, on the basis of their direct, indirect, joint, total and net effects. The quantitative variables and their descriptive statistics which have been used in the path analysis are presented in Tables 2, 3, 4, 5, 6 and 7 according to the six divisions.

To explore the role of biological and behavioural determinants, four variables namely proportion married among females, contraceptive use effectiveness, induced abortion and duration of lactational infecundability, and investigates their impact in bringing change in fertility level for the period 1975 to 2004 in Bangladesh, Bongaarts' proximate determinants of fertility model has been used.

The United Nations projection of a target level of the total fertility rate (TFR) of Bangladesh 2.1 by 2030 (UN, 1999, 2001), researcher develops a forecasting model for total fertility rate (TFR) up to the year 2030 depending on the observed time series data from 1985 to 2005 using combined methods of regression and time series forecasting. Exponential smoothing technique has been utilized to forecast the data. Theoretically some of the socio-economic and demographic variables can affect fertility. Therefore, considering a number of important variables: total fertility rate per 1000 women; female mean age at marriage; infant mortality rate per 1000 live births; percentage (%) of literacy: 7 years and above; labor force: female (% of total); unemployment rate; and GDP growth rate, this research has adopted Hendry's general-to-specific modeling approach (Hendry, 1993). Hendry's approach selects a simpler form of the forecast

model. In order to forecast beyond the sample period 2005 a number of regressors has been forecasted in the first stage and in the second stage these time series forecasts are used to forecast the total fertility rate (TFR). Based on the in-sample and out-of-sample comparison this model has the ability to forecast almost accurately.

Table 1: Description of Variables Appearing in the Logistic Regression Analysis, BDHS 2004.

Variables		Value Labels	N
Dependent Variable			
Index of Fertility = Y		Above Median = 0 ⇒ Y= 0 (Disfavourable Fertility Behaviour)	11440
		Median is Less or Equal = 1 ⇒ Y = 1 (Favourable Fertility Behaviour)	
Independent (Explanatory) Variables			
1.	Current Marital Status= X_1	Currently Married = 0 ⇒ $X_{11} = x_{11}$ Others (Separated, Deserted, Divorced & Widowed)= 1 ⇒ $X_{12}^{(r)} = 0$	11440
2.	Age at First Marriage= X_2	<15 = 1 ⇒ $X_{21} = x_{21}$ 15-19 = 2 ⇒ $X_{22} = x_{22}$ 20-24 = 3 ⇒ $X_{23} = x_{23}$ 25+ = 4 ⇒ $X_{24}^{(r)} = 0$	11440
3.	Respondent's Education= X_3	No Education = 0 ⇒ $X_{31} = x_{31}$ Primary = 1 ⇒ $X_{32} = x_{32}$ Secondary = 2 ⇒ $X_{33} = x_{33}$ Higher = 3 ⇒ $X_{34}^{(r)} = 0$	11440
4.	Partner's Education= X_4	No Education = 0 ⇒ $X_{41} = x_{41}$ Primary = 1 ⇒ $X_{42} = x_{42}$ Secondary = 2 ⇒ $X_{43} = x_{43}$ Higher = 3 ⇒ $X_{44}^{(r)} = 0$	11440
5.	Respondent's Occupation= X_5	Not Working = 0 ⇒ $X_{51} = x_{51}$ Home Based = 1 ⇒ $X_{52} = x_{52}$ Others = 2 ⇒ $X_{53}^{(r)} = 0$	11440
6.	Partner's Occupation= X_6	Manual (Not working, Agriculturer & Labourer) = 0 ⇒ $X_{61} = x_{61}$ Non-Manual (Professional worker & Business man) = 1 ⇒ $X_{62}^{(r)} = 0$	11440
7.	Region= X_7	Barisal = 1 ⇒ $X_{71} = x_{71}$ Chittagong = 2 ⇒ $X_{72} = x_{72}$ Dhaka = 3 ⇒ $X_{73} = x_{73}$ Khulna = 4 ⇒ $X_{74} = x_{74}$ Rajshahi = 5 ⇒ $X_{75} = x_{75}$ Sylhet = 6 ⇒ $X_{76}^{(r)} = 0$	11440

Table 1 (Continued)

8.	Residence= X_8	Rural = 0 Urban = 1	$\Rightarrow X_{81} = x_{81}$ $\Rightarrow X_{82}^{(r)} = 0$	11440
9.	Religion= X_9	Muslim = 0 Non-Muslim = 1	$\Rightarrow X_{91} = x_{91}$ $\Rightarrow X_{92}^{(r)} = 0$	11440
10.	Index of Wealth= X_{10}	Poor = 1 Middle = 2 Rich = 3	$\Rightarrow X_{10,1} = x_{10,1}$ $\Rightarrow X_{10,2} = x_{10,2}$ $\Rightarrow X_{10,3}^{(r)} = 0$	11440
11.	Index of Mass Media= X_{11} (Reading Newspaper, Listening to Radio & Watching T.V.)	Not at All = 0 Yes = 1	$\Rightarrow X_{11,1} = x_{11,1}$ $\Rightarrow X_{11,2}^{(r)} = 0$	11440
12.	Ever Used any Method= X_{12} or Choice of Contraceptive Method	Never Used = 0 Folkloric and Trad. Method = 1 Modern Method = 2	$\Rightarrow X_{12,1} = x_{12,1}$ $\Rightarrow X_{12,2} = x_{12,2}$ $\Rightarrow X_{12,3}^{(r)} = 0$	11440
13.	Currently Breastfeeding= X_{13}	No = 0 Yes = 1	$\Rightarrow X_{13,1} = x_{13,1}$ $\Rightarrow X_{13,2}^{(r)} = 0$	11440
14.	Index of Child Mortality= X_{14} (Sons who have died & Daughters who have died)	Not Died = 0 Died = 1	$\Rightarrow X_{14,1} = x_{14,1}$ $\Rightarrow X_{14,2}^{(r)} = 0$	11440

Table 2: Selected Quantitative Variables and their Descriptive Statistics of Barisal Division, BDHS 2004.

S.N	Quantitative Variables	N	Max	Min	Mean	SD
1	X_1 =Respondent's Current Age	1360	13.00	49.00	30.48	9.67
2	X_2 =Husband's Age	1265	16.00	85.00	39.86	11.61
3	X_3 =Respondent's Education in Single Years	1360	0.00	16.00	4.58	3.79
4	X_4 =Husband's Education in Single Years	1355	0.00	17.00	5.54	4.67
5	X_5 =No. of Household Members	1360	1.00	19.00	6.30	2.80
6	X_6 =Husband's Age at First Marriage	1354	13.00	58.00	25.08	5.84
7	X_7 =Respondent's Age at First Marriage	1360	10.00	35.00	15.03	2.66
8	X_8 =Respondent's Wealth Index	1360	100.00	1643.00	127.32	90.34
9	X_9 =Wealth Index of a Family	1360	-1.21	3.02	-0.08	0.79
10	X_{10} =No. of Living Boys	1360	0.00	6.00	1.31	1.23
11	X_{11} =No. of living children at first contraceptive use	1127	0.00	11.00	1.65	1.86
12	X_{12} =Body Mass Index of Respondent	1345	10.93	60.37	20.19	3.61
13	X_{13} =No. of Children who have Died	1360	0.00	6.00	0.43	0.87
14	X_{14} =Total Children Ever Born	1360	0.00	13.00	3.08	2.38

Table 3: Selected Quantitative Variables and their Descriptive Statistics of Chittagong Division, BDHS 2004.

S.N	Quantitative Variables	N	Max	Min	Mean	SD
1	X ₁ =Respondent's Current Age	2069	13.00	49.00	29.74	9.35
2	X ₂ =Husband's Age	1896	16.00	82.00	39.09	10.78
3	X ₃ =Respondent's Education in Single Years	2069	0.00	16.00	3.77	3.90
4	X ₄ =Husband's Education in Single Years	2064	0.00	16.00	4.92	4.60
5	X ₅ =No. of Household Members	2069	1.00	21.00	6.80	3.14
6	X ₆ =Husband's Age at First Marriage	2069	13.00	73.00	25.67	5.58
7	X ₇ =Respondent's Age at First Marriage	2069	10.00	39.00	15.49	3.00
8	X ₈ =Respondent's Wealth Index	2069	100.00	3465.00	129.45	119.22
9	X ₉ =Wealth Index of a Family	2069	-1.21	3.47	0.09	0.98
10	X ₁₀ =No. of Living Boys	2069	0.00	8.00	1.42	1.28
11	X ₁₁ =No. of living children at first contraceptive use	1513	0.00	10.00	1.93	1.78
12	X ₁₂ =Body Mass Index of Respondent	2038	11.22	36.82	20.52	3.43
13	X ₁₃ =No. of Children who have Died	2069	0.00	6.00	0.43	0.81
14	X ₁₄ =Total Children Ever Born	2069	0.00	12.00	3.22	2.39

Table 4: Selected Quantitative Variables and their Descriptive Statistics of Dhaka Division, BDHS 2004.

S.N	Quantitative Variables	N	Max	Min	Mean	SD
1	X ₁ =Respondent's Current Age	2589	13.00	49.00	30.02	9.22
2	X ₂ =Husband's Age	2396	16.00	95.00	39.09	10.71
3	X ₃ =Respondent's Education in Single Years	2589	0.00	17.00	3.61	4.06
4	X ₄ =Husband's Education in Single Years	2579	0.00	17.00	4.61	4.79
5	X ₅ =No. of Household Members	2589	1.00	19.00	5.68	2.56
6	X ₆ =Husband's Age at First Marriage	2583	12.00	70.00	24.64	5.12
7	X ₇ =Respondent's Age at First Marriage	2589	10.00	38.00	15.02	2.89
8	X ₈ =Respondent's Wealth Index	2589	100.00	1739.00	129.88	120.68
9	X ₉ =Wealth Index of a Family	2589	-1.21	3.83	0.24	1.21
10	X ₁₀ =No. of Living Boys	2589	0.00	8.00	1.23	1.12
11	X ₁₁ =No. of living children at first contraceptive use	2179	0.00	11.00	1.54	1.63
12	X ₁₂ =Body Mass Index of Respondent	2561	12.06	45.27	20.68	3.74
13	X ₁₃ =No. of Children who have Died	2589	0.00	12.00	0.42	0.87
14	X ₁₄ =Total Children Ever Born	2589	0.00	15.00	2.87	2.12

Table 5: Selected Quantitative Variables and their Descriptive Statistics of Khulna Division, BDHS 2004.

S.N	Quantitative Variables	N	Max	Min	Mean	SD
1	X ₁ =Respondent's Current Age	1708	13.00	49.00	29.82	9.50
2	X ₂ =Husband's Age	1586	16.00	84.00	38.83	11.08
3	X ₃ =Respondent's Education in Single Years	1708	0.00	17.00	4.03	3.83
4	X ₄ =Husband's Education in Single Years	1700	0.00	17.00	4.77	4.70
5	X ₅ =No. of Household Members	1708	1.00	17.00	5.60	2.49
6	X ₆ =Husband's Age at First Marriage	1707	13.00	60.00	24.27	5.30
7	X ₇ =Respondent's Age at First Marriage	1708	10.00	37.00	14.65	2.60
8	X ₈ =Respondent's Wealth Index	1708	100.00	3465.00	137.54	159.71
9	X ₉ =Wealth Index of a Family	1708	-1.21	3.42	0.18	0.98
10	X ₁₀ =No. of Living Boys	1708	0.00	6.00	1.15	1.09
11	X ₁₁ =No. of living children at first contraceptive use	1476	0.00	10.00	1.38	1.48
12	X ₁₂ =Body Mass Index of Respondent	1698	12.83	36.51	20.71	3.52
13	X ₁₃ =No. of Children who have Died	1708	0.00	7.00	0.31	0.71
14	X ₁₄ =Total Children Ever Born	1708	0.00	11.00	2.57	1.93

Table 6: Selected Quantitative Variables and their Descriptive Statistics of Rajshahi Division, BDHS 2004.

S.N	Quantitative Variables	N	Max	Min	Mean	SD
1	X ₁ =Respondent's Current Age	2564	13.00	49.00	29.87	9.73
2	X ₂ =Husband's Age	2372	15.00	80.00	38.73	11.43
3	X ₃ =Respondent's Education in Single Years	2564	0.00	16.00	3.21	3.70
4	X ₄ =Husband's Education in Single Years	2564	0.00	16.00	4.04	4.49
5	X ₅ =No. of Household Members	2564	1.00	22.00	5.48	2.67
6	X ₆ =Husband's Age at First Marriage	2560	14.00	95.00	24.02	5.68
7	X ₇ =Respondent's Age at First Marriage	2564	10.00	38.00	14.49	2.43
8	X ₈ =Respondent's Wealth Index	2564	100.00	1739.00	132.32	114.17
9	X ₉ =Wealth Index of a Family	2564	-1.21	3.02	-0.21	0.80
10	X ₁₀ =No. of Living Boys	2564	0.00	8.00	1.22	1.15
11	X ₁₁ =No. of living children at first contraceptive use	2205	0.00	10.00	1.50	1.48
12	X ₁₂ =Body Mass Index of Respondent	2546	11.87	66.04	20.07	3.17
13	X ₁₃ =No. of Children who have Died	2564	0.00	7.00	0.37	0.78
14	X ₁₄ =Total Children Ever Born	2564	0.00	12.00	2.74	2.10

Table 7: Selected Quantitative Variables and their Descriptive Statistics of Sylhet Division, BDHS 2004.

S.N	Quantitative Variables	N	Max	Min	Mean	SD
1	X ₁ =Respondent's Current Age	1150	13.00	49.00	30.41	9.33
2	X ₂ =Husband's Age	1021	17.00	90.00	40.25	11.32
3	X ₃ =Respondent's Education in Single Years	1150	0.00	19.00	2.78	3.51
4	X ₄ =Husband's Education in Single Years	1147	0.00	17.00	3.91	4.22
5	X ₅ =No. of Household Members	1150	1.00	33.00	7.91	4.75
6	X ₆ =Husband's Age at First Marriage	1150	12.00	62.00	26.56	6.41
7	X ₇ =Respondent's Age at First Marriage	1150	10.00	33.00	15.75	3.04
8	X ₈ =Respondent's Wealth Index	1150	100.00	3465.00	123.69	116.06
9	X ₉ =Wealth Index of a Family	1150	-1.21	3.47	0.21	1.13
10	X ₁₀ =No. of Living Boys	1150	0.00	8.00	1.41	1.32
11	X ₁₁ =No. of living children at first contraceptive use	607	0.00	13.00	2.28	1.90
12	X ₁₂ =Body Mass Index of Respondent	1124	12.19	39.21	19.79	3.62
13	X ₁₃ =No. of Children who have Died	1150	0.00	10.00	0.57	1.02
14	X ₁₄ =Total Children Ever Born	1150	0.00	15.00	3.39	2.57

3.3 LOGISTIC REGRESSION ANALYSIS

Logistic regression analysis extends the techniques of multiple regression analysis to research situations in which the outcome variable is categorical. In practice, situations involving categorical outcomes are quite common. In the setting of evaluating an educational program, for example, predictions may be made for the dichotomous outcome of success/failure or improved/not-improved. Similarly, in a medical setting, an outcome might be presence/absence of disease. The focus of this document is on

situations in which the outcome variable is dichotomous, although extension of the techniques of logistic regression analysis to outcomes with three or more categories (e.g., improved, same, or worse) is possible (see, for example, Hosmer and Lemeshow, 1989, Chapter 8). In this section, we have reviewed the multiple regression model and, then, present the model for logistic regression analysis. The fundamental model underlying multiple regression analysis posits that a continuous outcome variable is, in theory, a linear combination of a set of predictors and error. Thus, for an outcome variable, Y , and a set of p predictor variables, $X_1, \dots, X_p$, the multiple regression model is of the form:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p + \varepsilon = \alpha + \sum_{j=1}^p \beta_j X_j + \varepsilon \quad (1)$$

where α is the Y -intercept (i.e., the expected value of Y when all X 's are set to 0), β_j is a multiple (partial) regression coefficient (i.e., the expected change in Y per unit change in X_j assuming all other X 's are held constant) and ε is the error of prediction. If error is omitted, the resulting model represents the expected, or predicted, value of Y :

$$E(Y | X_1, \dots, X_p) = Y' = \alpha + \sum_{j=1}^p \beta_j X_j \quad (2)$$

Note that $Y = Y' + \varepsilon$. Thus, we can interpret the multiple regression model as follows: each observed score, Y , is made up of an expected, or predictable, component, Y' , that is a function of the predictor variables $X_1, \dots, X_p$, and an error, or unpredictable component, ε , that represents error of measurement (i.e., unreliability) and/or error in the selection of the model (i.e., mis-specification).

The multiple regression model summarized above is applicable when the outcome variable, Y , is continuous, but is not appropriate for situations in which Y is categorical. For example, if Y takes on the value 1 for “success” and 0 for “failure,” the multiple regression equation would not result in predicted values restricted to exactly 1 or 0. In fact, these predicted values would be spread out over an interval that contains uninterpretable values such as 0.5 or 0.33 and could even include negative values and/or values greater than 1. The model for logistic regression analysis, described below, is a more realistic representation of the situation when an outcome variable is categorical.

The model for logistic regression analysis assumes that the outcome variable, Y , is categorical (e.g., dichotomous), but logistic regression does not model this outcome variable directly. Rather, logistic regression analysis is based on probabilities associated with the values of Y . For simplicity, and because it is the case most commonly encountered in practice, we assume that Y is dichotomous, taking on values of 1 (i.e., the positive outcome, or success) and 0 (i.e., the negative outcome, or failure). In theory, the hypothetical, population proportion of cases for which $Y = 1$ is defined as $\pi = P(Y = 1)$. Then, the theoretical proportion of cases for which $Y = 0$ is $1 - \pi = P(Y = 0)$. In the absence of other information, we would estimate π by the sample proportion of cases for which $Y = 1$. However, in the regression context, it is assumed that there is a set of predictor variables, $X_1, \dots, X_p$, that are related to Y and, therefore, provide additional information for predicting Y . For theoretical, mathematical reasons, logistic regression analysis is based on a linear model for the natural logarithm of the odds (i.e., the log-odds) in favor of $Y = 1$:

$$\begin{aligned} \text{Log}_e \left[\frac{P(Y=1 | X_1, \dots, X_p)}{1 - P(Y=1 | X_1, \dots, X_p)} \right] &= \text{Log}_e \left[\frac{\pi}{1 - \pi} \right] \\ &= \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p + \varepsilon = \alpha + \sum_{j=1}^p \beta_j X_j \end{aligned} \quad (3)$$

Note that in the logistic regression model, π is a conditional probability of the form $P(Y=1 | X_1, \dots, X_p)$. That is, it is assumed that “success” is more or less likely depending on combinations of values of the predictor variables. The log-odds, as defined above is also known as the logit transformation of π and the analytical approach described here is sometimes known as logit analysis.

The logistic regression model above is identical to the multiple regression model except that the log-odds in favor of $Y=1$ replaces the expected value of Y . There are two basic reasons underlying the development of the model above. First, probabilities and odds obey multiplicative, rather than additive, rules. However, taking the logarithm of the odds allows for the simpler, additive model since logarithms convert multiplication into addition. And, second, there is a (relatively) simple exponential transformation for converting log-odds back to probability. In particular, the inverse transformation is the logistic function of the form:

$$P(Y=1 | X_1, \dots, X_p) = \frac{e^{\alpha + \sum_{j=1}^p \beta_j X_j}}{1 + e^{\alpha + \sum_{j=1}^p \beta_j X_j}} \quad (4)$$

Due to the mathematical relationship, $e^a/(1+e^a) = 1/(1+e^{-a})$, the logistic function for logistic regression analysis is sometimes presented in the form:

$$P(Y = 1 | X_1, \dots, X_p) = \frac{1}{1 + e^{-\alpha - \sum_{j=1}^p \beta_j X_j}} \quad (5)$$

Due to the mathematical relation, $1 - e^a/(1+e^a) = 1/(1+e^a)$, the probability for a 0 response is:

$$P(Y = 0 | X_1, \dots, X_p) = 1 - P(Y = 1 | X_1, \dots, X_p) = \frac{1}{1 + e^{\alpha + \sum_{j=1}^p \beta_j X_j}} \quad (6)$$

3.3.1 FITTING THE LOGISTIC REGRESSION MODEL TO DATA

As in multiple regression analysis, there are two important stages in the analysis of data. First, estimates for the parameters in the model must be obtained and, second, some determination must be made of how well the model actually fits the observed data. In multiple regression analysis, the parameter estimates are obtained using the least-squares principle and assessment of fit is based on significance tests for the regression coefficients as well as on interpreting the multiple correlation coefficient. The process is analogous for logistic regression analysis, although specific details of these stages of analysis are somewhat different as outlined here.

The parameters that must be estimated from the available data are the constant, α , and the logistic regression coefficients, β_j . Because of the nature of the model, estimation is based on the maximum likelihood principle rather than on the least-squares principle. In the context of logistic regression analysis, maximum likelihood estimation (MLE) involves the following. First, we define the likelihood, L , of the sample data as the product, across all sampled cases, of the probabilities for success or for failure:

$$L = \prod_{i=1}^n P(Y_i | X_{i1}, \dots, X_{ip}) = \prod_{i=1}^n \left[\left(\frac{e^{\alpha + \sum_{j=1}^p \beta_j X_{ij}}}{1 + e^{\alpha + \sum_{j=1}^p \beta_j X_{ij}}} \right)^{Y_i} \times \left(\frac{1}{1 + e^{\alpha + \sum_{j=1}^p \beta_j X_{ij}}} \right)^{1-Y_i} \right] \quad (7)$$

Note that Y is the 0/1 outcome for the i^{th} case and, $X_{i1}, \dots, X_{ip}$ are the values of the predictor variables for the i^{th} case based on a sample of n cases. The use of Y_i and $1-Y_i$ as exponents in the equation above includes in the likelihood the appropriate probability term dependent upon whether $Y_i=1$ or $Y_i=0$ (note that $F^0=1$ for any expression, F). Using the methods of calculus, a set of values for α and the β_j can be calculated that maximize L and these resulting values are known as maximum likelihood estimates (MLE's). This maximization process is somewhat more complicated than the corresponding minimization procedure in multiple regression analysis for finding least-square estimates. However, the general approach involves establishing initial guesses for the unknown parameters and then continuously adjusting these estimates until the maximum value of L is found. This iterative solution procedure is available in popular statistical procedures such as those found in SPSS (statistical software). To distinguish them from parameters, we denote the MLE's as a and b_j . Given that these estimates have been calculated for a real data set, tests of significance for individual logistic regression coefficients can be set up as in multiple regression analysis. That is, for the hypothesis, $H: \beta_j = 0$, a statistic of the form $z = b_j/S_j$ can be calculated based on the estimated standard error, S_j , for b_j (SPSS report $\chi^2 = z^2$ and label these values as Wald statistics).

Similarly, the usefulness of the model as a whole can be assessed by testing the hypothesis that, simultaneously, all of the partial logistic regression coefficients are 0; i.e., $H: \beta_j = 0$ for all j . In effect, we can compare the general model given above with the restricted model $\text{Log}_e\left(\frac{\pi}{1-\pi}\right) = \alpha$. This test, that is equivalent to testing the significance of the multiple R in multiple regression analysis, is based on a chi-squared statistic (Statistical Package SPSS labels this value as “Model Chi-Square”).

Finally, different logistic regression models fitted to the same set of data can be compared statistically in a simple manner if the models are hierarchical. The hierarchy principle requires that the model with the larger number of predictors include among its predictors all of the predictors from the simpler model (e.g., predictors X_1 and X_2 in the simpler model and predictors X_1 , X_2 , X_3 and X_4 in the more complex model). Given this condition, the difference in model chi-squared values is (approximately) distributed as chi-squared with degrees of freedom equal to the difference in degrees of freedom for the two models (e.g., for the above example, the degrees of freedom would be 2). In effect, this procedure tests a conditional null hypothesis that, for the example, would be: $H: \beta_3 = \beta_4 = 0 \mid \beta_1, \beta_2$. That is, the values of the logistic regression coefficients associated with X_1 and X_2 are unrestricted, but the logistic regression coefficients associated with X_3 and X_4 are assumed by hypothesis to be 0. If the models are specified in a series of “blocks” in SPSS, an “Improvement” chi-square value is computed for each successive model and this can be used to test whether or not the additional predictors result in significantly better fit of the model to the data.

3.3.2 INTERPRETING THE FITTED LOGISTIC REGRESSION MODEL

We may interpret the results from a logistic regression analysis at three different levels. First, each term in the equation represents contributions to estimated log-odds. Thus, for each one unit increase (decrease) in X_j , there is predicted to be an increase (decrease) of b_j units in the log-odds in favor of $Y = 1$. Also, if all predictors are set equal to 0, the predicted log-odds in favor of $Y = 1$ would be the constant term, a . Second, since most people do not find it natural to think in terms of log-odds, the logistic regression equation can be transformed to odds by exponentiation:

$$\frac{\pi}{1 - \pi} = e^{a + b_1 X_1 + \dots + b_p X_p} = e^a \times e^{b_1 X_1} \times \dots \times e^{b_p X_p} \quad (8)$$

$$P(Y = 1 | X_1, \dots, X_p) = \frac{e^{a + \sum_{j=1}^p b_j X_j}}{1 + e^{a + \sum_{j=1}^p b_j X_j}} \quad (9)$$

With respect to odds, the influence of each predictor is multiplicative. Thus, for each one unit increase in X_j , the predicted odds is increased by a factor of $\exp(b_j)$. If X is decreased by one unit, the multiplicative factor is $\exp(-b_j)$. Note that $\exp(c) = e^c$. Similarly, if all predictors are set equal to 0, the predicted odds are $\exp(a)$. Finally, the results can be expressed in terms of probabilities by use of the logistic function. With estimates substituted the equation above becomes:

$$P(Y = 1 | X_1, \dots, X_p) = \frac{e^{a + \sum_{j=1}^p b_j X_j}}{1 + e^{a + \sum_{j=1}^p b_j X_j}} \quad (10)$$

Although this form of the model may seem simplest because it results in predicted probabilities for $Y = 1$, there is no simple interpretation for the logistic regression coefficients in this form.

3.3.3 LOGISTIC REGRESSION MODEL FOR THE VARIABLES OF TABLE -1

The explanation of the model corresponding to selected socio-economic and demographic variable in Table 1 is as follows:

Expression of P_i is given by

$$P_i = E \left[Y_i = 1 \left| \begin{array}{l} X_{11} = x_{11}, X_{12} = 0, X_{21} = x_{21}, X_{22} = x_{22}, X_{23} = x_{23}, X_{24} = 0, X_{31} = x_{31}, X_{32} = x_{32}, \\ X_{33} = x_{33}, X_{34} = 0, X_{41} = x_{41}, X_{42} = x_{42}, X_{43} = x_{43}, X_{44} = 0, X_{51} = x_{51}, X_{52} = x_{52}, \\ X_{52} = 0, X_{61} = x_{61}, X_{62} = 0, X_{71} = x_{71}, X_{72} = x_{72}, X_{73} = x_{73}, X_{74} = x_{74}, X_{75} = x_{75}, \\ X_{76} = 0, X_{81} = x_{81}, X_{82} = 0, X_{91} = x_{91}, X_{92} = 0, X_{10,1} = x_{10,1}, X_{10,2} = x_{10,2}, X_{10,3} = 0, \\ X_{11,1} = x_{11,1}, X_{11,2} = 0, X_{12,1} = x_{12,1}, X_{12,2} = x_{12,2}, X_{12,3} = 0, X_{13,1} = x_{13,1}, X_{13,2} = 0, \\ X_{14,1} = x_{14,1}, X_{14,2} = 0 \end{array} \right. \right] \quad (11)$$

(Here the values of the variables corresponding to the reference category are considered as '0')

That is,

$$E(Y_i = 1 | X_i) = P_i = \frac{e^{\left(\beta_0 + \sum_{j=1}^k \beta_j X_j\right)}}{1 + e^{\left(\beta_0 + \sum_{j=1}^k \beta_j X_j\right)}} = \frac{1}{1 + e^{-\left(\beta_0 + \sum_{j=1}^k \beta_j X_j\right)}} \quad (12)$$

and

$$1 - P_i = \frac{e^{-\left(\beta_0 + \sum_{j=1}^k \beta_j X_j\right)}}{1 + e^{-\left(\beta_0 + \sum_{j=1}^k \beta_j X_j\right)}} \quad (13)$$

Therefore,

$$\frac{P_i}{1 - P_i} = e^{\left(\beta_0 + \sum_{j=1}^k \beta_j X_j \right)}. \quad (14)$$

Hence the multiple binary logistic regression model is given by

$$\begin{aligned} \log_e \frac{P_i}{1 - P_i} = & \beta_0 + \beta_1 X_{11} + \beta_2 X_{21} + \beta_3 X_{22} + \beta_4 X_{23} + \beta_5 X_{31} + \beta_6 X_{32} + \beta_7 X_{33} + \beta_8 X_{41} + \beta_9 X_{42} \\ & + \beta_{10} X_{43} + \beta_{11} X_{51} + \beta_{12} X_{52} + \beta_{13} X_{61} + \beta_{14} X_{71} + \beta_{15} X_{72} + \beta_{16} X_{73} + \beta_{17} X_{74} + \beta_{18} X_{75} \\ & + \beta_{19} X_{81} + \beta_{20} X_{91} + \beta_{21} X_{10,1} + \beta_{22} X_{10,2} + \beta_{23} X_{11,1} + \beta_{24} X_{12,1} + \beta_{25} X_{13,1} + \beta_{26} X_{14,1} \end{aligned} \quad (15)$$

3.4 PRINCIPLES OF PATH ANALYSIS

The technique of path analysis which was developed during 1920s by Sewall Wright as an aid to the quantitative development of genetics gained popularity in social science studies with the further expositions made by Duncan and Land. Its application in demography is gaining popularity only recently (Loebner and Driver, 1973; De Jong and Sell, 1977; Sivamurthy and Ahmad, 1979a; Sharma and Rutherford, 1990).

The method of path analysis builds on ordinary multiple regression analysis. It applies only to sets of relationships among the variables which are linear, additive and causal. In multiple regression each predictor variable has a direct effect on the response variable. However, variables may also affect the response variable through one or more intervening variables. Path analysis is a technique for analyzing such casual relationships.

Moreover, path analysis provides mechanism of decomposing the total effect of an independent variable into its component parts: direct and indirect effects. A total effect

is that part of the total association or zero order correlation between two variables in a causal model which is not due to common causes, i.e. due to correlation between their causes or unanalyzed correlation among the pre-determined variables (Alwin and Hauser, 1975:38-39). A total effect indicates how much change in dependent variable is brought about by a given change in the independent variable. The indirect effects indicate how much of the total effect of an independent variable on a dependent variable is mediated via a specific intervening variable, while the direct effect measures the total effect which is not transmitted via intervening variables in a casual sequence but which remains after the effect of intervening variables have been removed (Call and Otto, 1977:72-73).

3.4.1 ASSUMPTIONS IN THE PATH ANALYSIS

The underlying assumptions that are used in the path analysis:

- (i) it is assumed that the variables are arranged in a causal fashion;
- (ii) it is assumed that all the variables are linearly related;
- (iii) it is assumed that each equation in the model is additive; and
- (iv) it is assumed that the residual variables are uncorrelated with each other and also with prior exogenous variables in the model.

The methodology used in the application of path analysis in this case is that developed by Alwin and Hauser's (1975) method of effect decomposition.

3.4.2 ALWIN AND HAUSER'S (1975) METHOD OF EFFECT DECOMPOSITION

Alwin and Hauser (1975) have defined the total effect as a combination of direct and indirect effects. Easily one has to solve a number of regression equations to estimate the different effects by this method. The method requires the following steps:

“For each endogenous variable in the model, obtain the successive reduced form equation”. First regress the endogenous variables only on the exogenous variables. Next regress the endogenous variables on the exogenous variables and the intervening endogenous variable that comes in sequence from cause to effect. While the first reduced form of equation of a particular endogenous variable gives the total effects, the last equation, gives the direct effects. Successive deduction of path coefficients from first to second equation, from second to third equation etc., gives the indirect effects.

3.4.3 MODEL SPECIFICATION FOR THE PATH ANALYSIS

According to the causal ordering of variables, researcher may divide the selected set of variables for the assumed model into three groups, namely, exogenous variables, endogenous variables and the residual variables that are given below:

Groups	Selected Quantitative Variables
Exogenous Variables	X_1 = Respondent's Current Age
	X_2 = Husband's Age
	X_3 = Respondent's Education in Single Years
	X_4 = Husband's Education in Single Years
	X_5 = No. of Household Members
	X_6 = Husband's Age at First Marriage
Endogenous Variables	X_7 = Respondent's Age at First Marriage
	X_8 = Respondent's Wealth Index
	X_9 = Wealth Index of a Family
	X_{10} = No. of Living Boys
	X_{11} = No. of Living Children at First Contraceptive Use
	X_{12} = Body Mass Index of Respondent
	X_{13} = No. of Children who have Died
	X_{14} = Total Children Ever Born (Over all Dependent Variable)
Residual Variables	$R_q, R_r, R_s, R_t, R_u, R_v, R_w$ and R_x

The above exogenous variables (X_1 to X_6) are predetermined variables and may be intercorrelated. Endogenous variables (X_7 to X_{13}) on the other hand are dependent, at least in part, on the exogenous variables (X_1 to X_6), and on the residual variables (R_q to R_w). Thus, the role of residual variables is to account for the variance of the endogenous variables not accounted by the prior exogenous variables. As shown in the above X_{14} is an ultimate endogenous variable, i.e. dependent on both endogenous and exogenous variables prior to it and also on the residual variable R_x . It is assumed that R_x is uncorrelated with (X_1 to X_6) and (X_7 to X_{13}) that determine X_{14} and also with (R_q to R_w). Similarly (R_q to R_w) is assumed to be uncorrelated with (X_1 to X_6) that determines (X_7 to X_{13}). The path model is the fully recursive model as all the endogenous variables are assumed to be dependent on all causally prior variables. A set of regression equations arranged in an orderly manner can be said to constitute a path model. The equations of required path model can be written as:

$$X_7 = P_{71}X_1 + P_{72}X_2 + P_{73}X_3 + P_{74}X_4 + P_{75}X_5 + P_{76}X_6 + P_{7q}R_q \quad (16)$$

$$X_8 = P_{81}X_1 + P_{82}X_2 + P_{83}X_3 + P_{84}X_4 + P_{85}X_5 + P_{86}X_6 + P_{87}X_7 + P_{8r}R_r \quad (17)$$

$$X_9 = P_{91}X_1 + P_{92}X_2 + P_{93}X_3 + P_{94}X_4 + P_{95}X_5 + P_{96}X_6 + P_{97}X_7 + P_{98}X_8 + P_{9s}R_s \quad (18)$$

$$X_{10} = P_{10,1}X_1 + P_{10,2}X_2 + P_{10,3}X_3 + P_{10,4}X_4 + P_{10,5}X_5 + P_{10,6}X_6 + P_{10,7}X_7 + P_{10,8}X_8 \\ + P_{10,9}X_9 + P_{10,t}R_t \quad (19)$$

$$X_{11} = P_{11,1}X_1 + P_{11,2}X_2 + P_{11,3}X_3 + P_{11,4}X_4 + P_{11,5}X_5 + P_{11,6}X_6 + P_{11,7}X_7 + P_{11,8}X_8 \\ + P_{11,9}X_9 + P_{11,10}X_{10} + P_{11,u}R_u \quad (20)$$

$$X_{12} = P_{12,1}X_1 + P_{12,2}X_2 + P_{12,3}X_3 + P_{12,4}X_4 + P_{12,5}X_5 + P_{12,6}X_6 + P_{12,7}X_7 + P_{12,8}X_8 \\ + P_{12,9}X_9 + P_{12,10}X_{10} + P_{12,11}X_{11} + P_{12,v}R_v \quad (21)$$

$$X_{13} = P_{13,1}X_1 + P_{13,2}X_2 + P_{13,3}X_3 + P_{13,4}X_4 + P_{13,5}X_5 + P_{13,6}X_6 + P_{13,7}X_7 + P_{13,8}X_8 \\ + P_{13,9}X_9 + P_{13,10}X_{10} + P_{13,11}X_{11} + P_{13,12}X_{12} + P_{13,w}R_w \quad (22)$$

$$X_{14} = P_{14,1}X_1 + P_{14,2}X_2 + P_{14,3}X_3 + P_{14,4}X_4 + P_{14,5}X_5 + P_{14,6}X_6 + P_{14,7}X_7 + P_{14,8}X_8 \\ + P_{14,9}X_9 + P_{14,10}X_{10} + P_{14,11}X_{11} + P_{14,12}X_{12} + P_{14,13}X_{13} + P_{14,x}R_x \quad (23)$$

The above eight equations (16), (17), (18), (19), (20), (21), (22) and (23) taken together represent the general path model for the six divisions of Bangladesh in this analysis. In the path models $X_1, X_2, \dots, R_w, R_x$, etc, represent the variable values in their standardized form (i.e. after variables are standardized to zero mean and unit variance). The symbolic values $P_{71}, P_{72}, \dots$ are again the path coefficients, the so called parameters of the path model. Generally, path coefficients are represented here by P_{ij} , where i stands for the endogenous variable, j stands for the exogenous variables whose determining influence is under consideration. This system of equations are known as structural equations which gives the estimates of path coefficients and helps in understanding the important links between various variables considered in the causal model. The path coefficients are nothing but the ordinary least square partial regression coefficients in the standard form (or the beta's) in the regression analysis. Now all the variables are transformed into normal forms by subtracting the respective means and dividing by the respective standard deviations. Then multiple regression method is applied for each casual relationship. The regression coefficients thus obtained are the path coefficients. Path coefficients may

exceed +1 or -1 in absolute value. Path coefficients are generally written along with their positive or negative signs. The sign of the path coefficient tells that in which direction (expected or unexpected) the exogenous variable is effecting the endogenous variable. Each conventional path coefficient P_{ij} gives the amount of standard deviation change in the endogenous variable of a one standard deviation change in the exogenous variable (holding other exogenous variables constant). The residual path coefficients can also be estimated with case from the regression equation as square root of $(1-R^2)$, where R^2 (unadjusted) is the multiple correlation coefficients (square) of the regression equation.

3.4.4 COMPONENT ANALYSIS OF THE COEFFICIENT OF DETERMINATION, R^2

The coefficient of determination measures the proportion of variation in the dependent variable explained by all the independent variables involved in the regression equation. Thus, it shows the strength of the regression equation. It is of interest to know how a coefficient of determination is split into its components namely net effects and joint effects. Let us consider the coefficient of determination, $R^2_{14.123456789,10,11,12,13}$ of the structural equation X_{14} . After estimating the path coefficients, researcher can easily estimate the R square value using the relationship:

$$\begin{aligned}
R_{14.123456789,10,11,12,13}^2 = & P_{14,1}^2 + P_{14,2}^2 + P_{14,3}^2 + P_{14,4}^2 + P_{14,5}^2 + P_{14,6}^2 + P_{14,7}^2 + P_{14,8}^2 + P_{14,9}^2 \\
& + P_{14,10}^2 + P_{14,11}^2 + P_{14,12}^2 + P_{14,13}^2 + 2P_{14,1}P_{14,2}r_{12} + 2P_{14,1}P_{14,3}r_{13} + 2P_{14,1}P_{14,4}r_{14} \\
& + 2P_{14,1}P_{14,5}r_{15} + 2P_{14,1}P_{14,6}r_{16} + 2P_{14,1}P_{14,7}r_{17} + 2P_{14,1}P_{14,8}r_{18} + 2P_{14,1}P_{14,9}r_{19} \\
& + 2P_{14,1}P_{14,10}r_{1,10} + 2P_{14,1}P_{14,11}r_{1,11} + 2P_{14,1}P_{14,12}r_{1,12} + 2P_{14,1}P_{14,13}r_{1,13} \\
& + 2P_{14,2}P_{14,3}r_{23} + 2P_{14,2}P_{14,4}r_{24} + 2P_{14,2}P_{14,5}r_{25} + 2P_{14,2}P_{14,6}r_{26} + 2P_{14,2}P_{14,7}r_{27} \\
& + 2P_{14,2}P_{14,8}r_{28} + 2P_{14,2}P_{14,9}r_{29} + 2P_{14,2}P_{14,10}r_{2,10} + 2P_{14,2}P_{14,11}r_{2,11} \\
& + 2P_{14,2}P_{14,12}r_{2,12} + 2P_{14,2}P_{14,13}r_{2,13} + 2P_{14,3}P_{14,4}r_{34} + 2P_{14,3}P_{14,5}r_{35} + 2P_{14,3}P_{14,6}r_{36} \\
& + 2P_{14,3}P_{14,7}r_{37} + 2P_{14,3}P_{14,8}r_{38} + 2P_{14,3}P_{14,9}r_{39} + 2P_{14,3}P_{14,10}r_{3,10} + 2P_{14,3}P_{14,11}r_{3,11} \\
& + 2P_{14,3}P_{14,12}r_{3,12} + 2P_{14,3}P_{14,13}r_{3,13} + 2P_{14,4}P_{14,5}r_{45} + 2P_{14,4}P_{14,6}r_{46} + 2P_{14,4}P_{14,7}r_{47} \\
& + 2P_{14,4}P_{14,8}r_{48} + 2P_{14,4}P_{14,9}r_{49} + 2P_{14,4}P_{14,10}r_{4,10} + 2P_{14,4}P_{14,11}r_{4,11} + 2P_{14,4}P_{14,12}r_{4,12} \\
& + 2P_{14,4}P_{14,13}r_{4,13} + 2P_{14,5}P_{14,6}r_{56} + 2P_{14,5}P_{14,7}r_{57} + 2P_{14,5}P_{14,8}r_{58} + 2P_{14,5}P_{14,9}r_{59} \\
& + 2P_{14,5}P_{14,10}r_{5,10} + 2P_{14,5}P_{14,11}r_{5,11} + 2P_{14,5}P_{14,12}r_{5,12} + 2P_{14,5}P_{14,13}r_{5,13} \\
& + 2P_{14,6}P_{14,7}r_{67} + 2P_{14,6}P_{14,8}r_{68} + 2P_{14,6}P_{14,9}r_{69} + 2P_{14,6}P_{14,10}r_{6,10} + 2P_{14,6}P_{14,11}r_{6,11} \\
& + 2P_{14,6}P_{14,12}r_{6,12} + 2P_{14,6}P_{14,13}r_{6,13} + 2P_{14,7}P_{14,8}r_{78} + 2P_{14,7}P_{14,9}r_{79} + 2P_{14,7}P_{14,10}r_{7,10} \\
& + 2P_{14,7}P_{14,11}r_{7,11} + 2P_{14,7}P_{14,12}r_{7,12} + 2P_{14,7}P_{14,13}r_{7,13} + 2P_{14,8}P_{14,9}r_{89} + 2P_{14,8}P_{14,10}r_{8,10} \\
& + 2P_{14,8}P_{14,11}r_{8,11} + 2P_{14,8}P_{14,12}r_{8,12} + 2P_{14,8}P_{14,13}r_{8,13} + 2P_{14,9}P_{14,10}r_{9,10} + 2P_{14,9}P_{14,11}r_{9,11} \\
& + 2P_{14,9}P_{14,12}r_{9,12} + 2P_{14,9}P_{14,13}r_{9,13} + 2P_{14,10}P_{14,11}r_{10,11} + 2P_{14,10}P_{14,12}r_{10,12} \\
& + 2P_{14,10}P_{14,13}r_{10,13} + 2P_{14,11}P_{14,12}r_{11,12} + 2P_{14,11}P_{14,13}r_{11,13} + 2P_{14,12}P_{14,13}r_{12,13}
\end{aligned} \quad (24)$$

In the above equation the first thirteen terms on the right hand side are the path coefficient squared. Each one of them represents a net effect in the components of the coefficient of determination $R_{14.123456789,10,11,12,13}^2$. As there are thirteen independent variables namely $X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}$ and X_{13} in the structural equation there are thirteen net effect terms in the coefficient of determination. The meaning of the net effect is that the direct effect of variable $X_j, J=1, 2, \dots, 13$, on the dependent variable X_{14} is the amount of variation in X_{14} accounted for by the variation in the variable X_j while the influences of the other variables removed. Each of the remaining terms in the right hand side of equation (24) represents the joint effect in the components of the coefficient of determination. The joint effects are the joint influence of two variables on the dependent variable X_{14} through their mutual correlation. For instant the joint effect of variable X_1 and X_2 on the dependent variable X_{14} is $2P_{14,1}P_{14,2}r_{12}$. It is the amount of variation in the variable X_{14} accounted for by the variables X_1 and X_2 jointly via their

mutual correlation apart from their respective net effects. The results of the component analysis of the coefficient of determination, $R^2_{14.123456789,10,11,12,13}$ for the assumed path model of six divisions are presented in Tables (27- 38).

3.4.5 PATH DIAGRAM

The fundamental to the path analysis is the path diagram which is the out come of a set of linearly interrelated variables and the assumed casual relationship among them. In the path diagram, the causal links among the variables are assumed based on theory or a conceptual framework conceived in advance by the researcher. It is to be noted that data set has no role to play in deciding either the causal links between the variables or the variables to be included in the path analysis. Path diagram follows the following principles:

- (i) the variables are arrange from left to right in such a way that all the endogenous variables are to the right of their exogenous variables.
- (ii) the unidirectional straight arrows called henceforth as casual paths that go from left to right represents the endogenous variables.
- (iii) the two-headed arrows of the left side in the diagram represent the non-causal (correlational) relationship among the exogenous variables.
- (iv) on the other hand the green color arrows of the right side in the diagram reveals total effects; and
- (v) the un-measured, residual variables are also represented by unidirectional straight arrows coming from the residual variable to the endogenous variable.

The path diagram of six divisions have been presented in Figures 1, 2, 3, 4, 5 and 6, which are consists of six exogenous variables namely, X_1 , X_2 , X_3 , X_4 , X_5 , X_6 ; seven endogenous variables namely, X_7 , X_8 , X_9 , X_{10} , X_{11} , X_{12} , X_{13} and X_{14} corresponding to the equations (16), (17), (18), (19), (20), (21), (22) and (23). As there are seven endogenous variables, so also there are seven residual variables namely, R_q , R_r , R_s , R_t , R_{tt} , R_v , R_w and R_x . The variables in the path diagram are arranged in a presumed causal sequence guided by the conceptual framework. It is assumed that theoretically respondent's current age, husband's age, respondent's education, husband's education, number of household members and husband's age at first marriage affect total children ever born that is measurement of fertility directly and indirectly through respondent's age at first marriage, respondent's wealth index, wealth index of a family, number of living boys, number of living children at first contraceptive use, body mass index of respondent and number of children who have died. Further it is assumed that theoretically respondent's age at first marriage affects fertility directly and through respondent's wealth index, wealth index of a family, number of living boys, number of living children at first contraceptive use, body mass index of respondent and number of children who have died. Respondent's wealth index affects fertility directly and through wealth index of a family, number of living boys, number of living children at first contraceptive use, body mass index of respondent and number of children who have died. Wealth index of a family affects fertility directly and through number of living boys, number of living children at first contraceptive use, body mass index of respondent and number of children who have died. Number of living boys affects fertility directly and through number of living children at first contraceptive use, body mass index of respondent and number of children who have died. Number of living children at first contraceptive use affects fertility directly and through body mass

index of respondent and number of children who have died. Body mass index of respondent affects fertility directly and through number of children who have died. However, number of children who have died is assumed to affect fertility directly only.

3.5 BONGAARTS' MODEL OF THE PROXIMATE DETERMINANTS OF FERTILITY

The level of fertility in a society is directly influenced by a set of variables called intermediate variables or proximate determinants (Davis and Blake, 1956). In general, the biological and behavioral factors through which socio-economic, cultural, and environmental variables affect fertility are called intermediate fertility variables. The primary characteristic of an intermediate fertility variable is its direct influence on fertility. Davis and Blake (1956) produce the first systematic classification of the intermediate or proximate determinants of fertility through which economic, social and other factors must operate to influence fertility. Bongaarts (1978) revised the original classification and provide a simple analytical method accounting frame work which permits a quantitative assessment of the contribution of different proximate determinants to give fertility levels or change. Bongaarts (1982) demonstrated that most of the variation in fertility is due to four intermediate variables or proximate determinants. These are marriage, contraception, abortion and lactational infecundability. Since fertility is the resultant of multiplicity of factors, studies have attempted to identify these factors which have important bearing for policy interventions in altering the level of fertility (Heer, 1966; Cain and Weiniger, 1973; Bahr, 1975; Defranzo, 1976; Kohli, 1977).

There has been a growing interest in quantifying the changes in fertility in Bangladesh in the recent past. Application of Bongaarts' model for identification of changes in terms of proximate variables seems to be rewarding on many occasions. The model is necessarily multiplicative in nature and requires data, among others, on proportion married, extent of use effectiveness of contraception, prevalence of induced abortion and lactational infecundability. In this section, an attempt is made to assess the above parameters of fertility change and their contribution thereof, with recourse to Bongaarts' model for proximate determinants of fertility. The special interest of this section is to study the contribution of the indices on the decline of fertility. The model is discussed briefly below.

In this model Bongaarts' (1978) expressed TFR as the product of four indices measuring the fertility inhibiting effect of these four indices and the total fecundity (TF). The total fecundity rate is the average number of live births expected among women who during their entire reproductive period, remain married, do not use contraception, do not have any induced abortion and do not breastfeed their children (Bongaarts, 1982). According to Bongaarts' model, the total fertility rate (TFR) can be written as

$$TFR = C_m \times C_c \times C_a \times C_i \times TF \quad (25)$$

where,

C_m = the index of proportion married.

C_c = the index of contraception.

C_a = the index of induced abortion; and

C_i = the index of lactational infecundability.

Each index indicates the extension to which fertility reduced from maximal level (i.e. $TF = 15.3$)¹ by the specific proximate determinants. The indices can only take the values between 0 and 1. If there is no fertility inhibiting effect of a given intermediate fertility variables, the corresponding index equals 1 if the fertility inhibiting is complete, the index is 0. The estimation procedure of the indices of intermediate fertility variables are as follow.

3.5.1 INDEX OF PROPORTION MARRIED (C_m)

The index of proportion married is estimated by the equation

$$C_m = \frac{\sum m(a).g(a)}{\sum g(a)} \quad (26)$$

Where $m(a)$ is the age specific proportion of females currently married and $g(a)$ is the age specific marital fertility rate. Equation (26) can also be written as

$$C_m = \frac{TFR}{TM} ; \text{ So that } TFR = C_m \times TM \quad (27)$$

The index C_m gives the proportion by which TFR is smaller than TM , as the result of non-marriage, $C_m = 0$, if nobody is married and $C_m = 1$, if all women are married during the entire reproductive period. Here, $TM = \sum g(a)$ = total marital fertility rate, equal to the number of births a woman would have at the end of the reproductive years if she were to bear children at prevailing age specific marital fertility rates and to remain married during the entire reproductive period (based on the fertility of married women aged 15-

¹ TF varies from culture to culture. For high level of C_c Bongaarts (1978) considered TF as 15.4, Kabir and Rab (1990) as 15.3 and BFS (1989) as 15.3.

49). If $C_m = 1$ then $TFR = TM$ and hence the difference between TM and TFR are accounted for by the effects of the marriage.

3.5.2 INDEX OF CONTRACEPTION (C_c)

To estimate the effect of contraception on marital fertility, the following equation expresses marital fertility as the interaction of contraceptive practice and natural fertility.

$$TM = C_c \times TNM \quad (28)$$

Where TNM is the total natural marital fertility rate which is equal to TM in the absence of contraception and induced abortion. Equation (28) simply states that TM is smaller than TNM by a proportion C_c , with the value of C_c depending on the prevalence of contraception, that is the extent of use effectiveness of contraception (induced abortion is assumed absent for the moment). When no contraception is practiced, $C_c = 1$ and when all non-sterile women in the reproductive years are protected by 100 percent effective contraception, $C_c = 0$ and then $TM = 0$. If all couples who practice contraception are assumed non-sterile, the index C_c can be written as

$$C_c = 1 - S \times u \times e \quad (29)$$

Where u is the average proportion of married women currently using contraception (average of age specific use rate), e is the average contraceptive effectiveness and a value for $S = 1.08$ obtained by Henry (1961) is likely to provide a good approximation for many countries (Bongaarts, 1978). To relate the index of contraception to the total fertility rate, equation (28) is substituted in equation (27) and becomes

$$TFR = C_m \times C_c \times TNM \quad (30)$$

This equation gives the total fertility rate from the natural marital fertility rate by taking into account the fertility reducing impact of contraception and marriage measured by the index of C_c and C_m respectively.

3.5.3 INDEX OF INDUCED ABORTION (C_a)

Although reliable measurements of the prevalence of induced abortion is practiced in many societies, even in cases where good estimates are available, it has proven difficult to determine the reduction in fertility that is associated with the practice of induced abortion. Estimates of the number of births averted by induced abortion are largely based on numerical exercises using mathematical reproductive models. The most detailed studies of this topic have been made by Potter (1976), whose work has demonstrated the following:

In absence of contraception, an induced abortion averts about 0.4 births, while about 0.8 births are averted when moderately effective contraceptive is practiced. To generalize from these findings the births averted per induced abortion b , may be estimated with the following equation

$$b = 0.4(1 + u) \quad (31)$$

A convenient overall measure of the incidence of induced abortion is provided by the total abortion rate (TA), equal to the average number of induced abortions per woman at the end of the reproductive period, if induced abortion rates remain at prevailing levels through the reproductive period (excluding induced abortions to women who are not married). The reduction in fertility associated with a given level of total abortion rate is calculated as

$$A = b \times TA = 0.4(1 + u) \times TA$$

Where, A equals the average number of births averted per woman by the end of the reproductive years. The index of induced abortion is defined as the ratio of the observed total fertility rate (TFR), to the estimated total fertility rate without induced abortion, $TFR + A$.

$$\text{i.e. } C_a = \frac{TFR}{TFR + A} \quad (32)$$

The index C_a equals the proportion by which fertility is reduced as the consequence of the practice of induced abortion (Note that C_a declines with increasing incidence of induced abortion). Modifying equation (30) accordingly, the relationship between TFR and TNM becomes

$$TFR = C_m \times C_c \times C_a \times TNM \quad (33)$$

Estimating Abortion as a Residual:

The index of abortion can be estimated as a residual by rearranging Bongaarts' equation as

$$C_a = \frac{TFR}{TF \times C_m \times C_c \times C_i}$$

Like the indices representing the other proximate determinants, the index representing the fertility-reducing effects of abortion should have a value between 0 and 1, although with real data there is no guarantee that a residual estimate of the index will not exceed 1 (Johnston and Hill, 1996).

3.5.4 INDEX OF LACTATIONAL INFECUNDABILITY (C_i)

In modern western population lactation is generally short and many women do not lactate at all. In traditional societies in Africa, Latin America and Asia, lactation is usually long and lasts until the next pregnancy occurs. Lactation has an inhibiting effect on fertility and thus increases the birth interval and reduces natural fertility (Potter, 1965). A typical average birth interval with lactation can be estimated to be 18.5 months². The ratio of the average birth intervals without and with lactation is given by

$$C_i = \frac{20}{18.5 + i} \quad (34)$$

where i is the average duration (in months) of infecundability from birth to the first postpartum ovulation (menses).

An indirect estimate of i as developed by Bongaarts is given by

$$i = 1.753 \exp(0.1396B - 0.001872B^2)$$

where B is the duration of breastfeeding. The relationship between lactation and the total natural marital fertility rate becomes $TNM = C_i \times TF$.

Where TF is the total fecundity rate to the natural marital fertility rate in the absence of lactation. Then the model is represented including lactational infecundability as

$$TFR = C_m \times C_c \times C_a \times C_i \times TF$$

² Chen, Ahmed, Gesche and Mosely (1974) found for Matlab population an average duration of lactational infecundable period as 18.7 months and BFS (1989) as 18.5 months.

3.5.5 DECOMPOSITION OF THE CHANGES IN FERTILITY AND CONTRIBUTION OF PROXIMATE VARIABLES

Bongaarts' model given by the equation (25) can easily be turned to a decomposition equation that allows the quantification of the contribution made by each of the four intermediate fertility variables to an observed change in fertility between two time points 0 and t . The basic equation is as follows:

$$\frac{TFR(t)}{TFR(0)} = \frac{C_m(t)}{C_m(0)} \times \frac{C_c(t)}{C_c(0)} \times \frac{C_i(t)}{C_i(0)} \times \frac{TF(t)}{TF(0)}$$

Here, the two points of time are 1975 and 1989 and hence the above equation becomes

$$\frac{TFR(89)}{TFR(75)} = \frac{C_m(89)}{C_m(75)} \times \frac{C_a(89)}{C_a(75)} \times \frac{C_i(89)}{C_i(75)} \times \frac{TF(89)}{TF(75)} \quad (35)$$

Defining again,

$$P_f = \frac{TFR(89)}{TFR(75)} - 1 = \text{Proportional change in } TFR \text{ between 1975 and 1989.}$$

$$P_m = \frac{C_m(89)}{C_m(75)} - 1 = \text{Proportional change in } TFR \text{ due to a change in the index of marriage.}$$

$$P_c = \frac{C_c(89)}{C_c(75)} - 1 = \text{Proportional change in } TFR \text{ due to a change in the index of contraception.}$$

$$P_a = \frac{C_a(89)}{C_a(75)} - 1 = \text{Proportional change in } TFR \text{ due to a change in the index of induced abortion.}$$

$$P_i = \frac{C_i(89)}{C_i(75)} - 1 = \text{Proportional change in } TFR \text{ due to a change in the index of lactational infecundability.}$$

$$P_r = \frac{TF(89)}{TF(75)} - 1 = \text{Proportional change in } TFR \text{ due to a change in the remaining proximate determinants-natural fecundability, spontaneous intrauterine mortality and permanent sterility.}$$

Equation (35) can now be rearranged as

$$P_f = P_m + P_c + P_a + P_i + P_r + I \quad (36)$$

Here I represent an interaction factor. This equation simply states that a given proportional change in the TFR between 1975 and 1989 equal to the sum of the proportional fertility changes due to the different intermediate fertility variables plus an interaction term. It is simply estimated by subtracting the sum of P_m , P_c , P_a , P_i and P_r from P_f . Equation (36) can now easily be turned into a decomposition equation for the absolute decline in $TFR(89)$ viz. $TFR(89) - TFR(75)$ multiplying $TFR(75)$. The decomposition procedure for the TFR can easily be extended also to allow the decomposition of a change in the crude birth rate (CBR). The CBR is linked to its proximate determinants by the following equation.

$$CBR = S \times C_m \times C_c \times C_a \times C_i \times TF \quad (37)$$

where S is an age-sex composition term calculated by

$$S = \frac{CBR}{TFR} - 1$$

Defining again,

$$P_b = \frac{CBR(89)}{CBR(75)} - 1 = \text{Proportional change in the } CBR \text{ between 1975 and 1989.}$$

$$P_s = \frac{S(89)}{S(75)} - 1 = \text{Proportional change in the } CBR \text{ due to a change in the age-sex composition.}$$

Then it becomes

$$P_b = P_s + P_m + P_c + P_a + P_i + P_r + I \quad (38)$$

where P_m , P_c , P_a , P_i and P_r are the values obtained earlier.

3.6 HENDRY'S GENERAL-TO-SPECIFIC APPROACH FOR MODEL SELECTION

The Hendry's general-to-specific methodology is widely employed in modeling economic data, but less in demographic modeling due to computational complexity when many explanatory variables are involved. This research proposes a simple way of avoiding this problem and undertakes an out-of-sample forecast evaluation of the methodology applied to the modeling of total fertility rate (TFR) in Bangladesh up to 2030. Hendry's approach is popularly known as top-down or general-to-specific modeling approach in the sense that one starts with a model with several regressors and then whittles it down to a model containing only the "important" variables. Over the last three decades, this methodology (Hendry, 1993, 1993b) has emerged as a leading approach for pursuing econometric model building. One of its main tenets is the concept of general-to-specific modeling: starting from a general dynamic statistical model, which captures the essential characteristics of the underlying data set, standard testing procedures are used to reduce its complexity by eliminating statistically insignificant variables and to check the validity of the reductions in order to ensure the congruency of the model.

There are four basic stages, beginning with an economic analysis to delineate the most important factors. The next stage embeds those factors in a general model that also allows for other potential determinants and relevant special features. Then, the congruence of that model is tested. Finally, that model is simplified to a parsimonious undominated congruent final selection that encompasses the original model, thereby ensuring that all reductions are valid. Sometimes Hendry's methodology is also known as TTT methodology, that is, "test, test, and test."

General-to-specific modeling is particularly suited for explanatory econometric modeling since it provides a systematic framework for statistical tests of economic hypotheses, model development and model (re-)evaluation, and the methodology is relatively popular among large scale econometric model developers and proprietors. However, since the initial model formulation typically entails many explanatory variables this poses challenges already at the outset for computationally complex models. The parameters of interests can thus be consistently estimated with ordinary least squares (OLS) under related assumptions.

In this study researcher overcome the computational challenges traditionally associated with the application of the general-to-specific methodology. To forecast beyond 2005 based on the full sample (1985-2005) analysis two-stage procedure has been adopted. In the first stage simple exponential smoothing technique is used to forecast the explanatory variables of the selected model beyond 2005. In the second stage these forecast values are used to forecast the TFR beyond 2005 using the selected model. Both in-sample and out-of-sample forecasts are compared with the squared loss associated with the forecasts.

3.6.1 EMPIRICAL MODEL OF TOTAL FERTILITY RATE (TFR)

In this section, researcher has considered an initial model to specify a desired model of forecasting to predict the future TFR by using general-to-specific modeling approach. The following model is assumed to relate the TFR within the regression framework.

$$TFR = f(FMAM, IMR, LITR, LFF, UER, GDPGR) \quad (39)$$

TFR = Total fertility rate per 1000 women.

FMAM = Female mean age at marriage.

IMR = Infant mortality rate per 1000 live births.

LITR = Percentage (%) of Literacy: 7 years and above.

LFF = Labor force: female (% of total).

UER = Unemployment rate; and

GDPGR = GDP growth rate.

In econometrics practice general-to-specific modeling proceeds in cycles of three steps:

1) Formulate a general unrestricted model which is congruent, 2) simplify the model sequentially in an attempt to derive a parsimonious congruent model while at each step checking that the model remains congruent, and 3) test the resulting congruent model against the general unrestricted model. The test of the final model against the general unrestricted model serves as a parsimonious encompassing test, that is, a test of whether important information is lost or not in the simplification process. If the final model is not congruent, or if it does not parsimoniously encompass the general unrestricted model, then the cycle starts all over again by re-specifying the general unrestricted model. As such the general-to-specific methodology treats modeling as a process, where the aim is to derive a parsimonious congruent encompassing model while at the same time acknowledging that “the currently best available model” (Hendry and Richard, 1990) can always be improved.

3.6.2 GENERAL-TO-SPECIFIC MODELS

The following models according to equation (39) presents with both certain and uncertain information. Specifically they are:

Model 1:

$$TFR_t = \alpha_1 + \alpha_2 FMAM_t + \alpha_3 IMR_t + \alpha_4 LITR_t + \alpha_5 LFF_t + \alpha_6 UER_t + \alpha_7 GDPGR_t + \varepsilon_t, \quad (40)$$

$$t = 1, 2, \dots, T$$

Model 2:

$$TFR_t = \alpha_1 + \alpha_2 FMAM_t + \alpha_3 IMR_t + \alpha_5 LFF_t + \alpha_6 UER_t + \alpha_7 GDPGR_t + \varepsilon_t, \quad (41)$$

$$t = 1, 2, \dots, T$$

Model 3:

$$TFR_t = \alpha_1 + \alpha_2 FMAM_t + \alpha_3 IMR_t + \alpha_5 LFF_t + \alpha_6 UER_t + \varepsilon_t, \quad (42)$$

$$t = 1, 2, \dots, T$$

Model 4:

$$TFR_t = \alpha_1 + \alpha_2 FMAM_t + \alpha_3 IMR_t + \alpha_5 LFF_t + \varepsilon_t, \quad (43)$$

$$t = 1, 2, \dots, T$$

Where α 's are unknown parameters and $\{\varepsilon_t\}$ is a sequence of innovation errors each with conditional mean equal to 0. Where $t = (1 = 1985), (2 = 1986), \dots, (T = 21 = 2005)$.

The first specification model 1 is a general and unrestricted model with both known and unknown information, whereas the second model, third model and fourth model are retained sequentially using the general-to-specific modeling approach. It should be noted that we only perform a single specification search where, at each step, we remove the regressor with highest p -value (or lowest critical value). Significant test should be performed according to the theory sign of the coefficient. As research hypothesis states the direction of the relationship, one-sided test is used.

$$H_0 : \alpha_i = 0 \quad (44)$$

$$H_1 : \alpha_i < 0 \quad \text{and/or} \quad H_1 : \alpha_i > 0$$

Hoover and Perez (1999) have pointed out that performing only a single simplification search might result in “path dependence”, in the sense that a relevant variable being removed early on in the search whereas irrelevant variables that proxy its role are retained.

3.6.3 SIMPLE EXPONENTIAL SMOOTHING TECHNIQUE FOR FORECASTING

The exponential smoothing generates a forecast as a weighted average of current and past values, which is described below.

Let x_t be the actual value at time t ; F_t be the forecast (i.e. smoothed) value at time t ; F_{t+1} be the forecast for the period $(t+1)$; and $0 < \alpha < 1$ be the smoothing parameter. Then for all successive periods, the forecast (i.e. the smoothed) value F_{t+1} is determined by

$$F_{t+1} = \alpha x_t + (1 - \alpha)F_t \quad (45)$$

Alternatively, one can write this simple exponential smoothing model as:

$$\begin{aligned} F_{t+1} &= \alpha x_t + F_t - \alpha F_t \\ &= F_t + \alpha(x_t - F_t) \end{aligned} \quad (46)$$

The choice of α depends on the characteristics of the series. For example, if the series is quite volatile, use a small value of α in order to give large weight to the previous smoothed value and only a small weight to the current value of x . If the data are not too volatile, then the random component of the series is probably fairly small. In this case, x_t gets large weight when calculating forecast.

3.6.4 FORECASTING OF TOTAL FERTILITY RATE (TFR) BASED ON THE FINALLY SELECTED SPECIFIC MODEL

The estimated model 4 in equation (43) is used to evaluate the forecast performance of the model, which is given below.

$$TFR_t = \hat{\alpha}_1 + \hat{\alpha}_2 FMAM_t + \hat{\alpha}_3 IMR_t + \hat{\alpha}_4 LFF_t, \\ t = (1 = 1985), (2 = 1986), \dots, (T = 2005).$$

Where $\hat{\alpha}_i (i = 1, 2, 3, 4)$ are the estimated coefficients as in equation (43).

Our objective is to (i) compute the in-sample and out-of-sample forecasts to evaluate the forecast performance of the model; (ii) predict each of the explanatory variables, FMAM (female mean age at marriage), IMR (infant mortality rate per 1000 live births), and LFF (labor force: female (% of total)) of model 4 beyond 2005 up to and including 2030; and (iii) predict TFR using the predicted values of the variables FMAM, IMR, and LFF of (ii) beyond 2005 up to and including 2030.

3.6.5 FORECASTING ACCURACY MEASURE

Let Y_t denote the observation at time t and F_t denote the forecast of Y_t . Then define the forecast error, $e_t = Y_t - F_t$, $t = 1, 2, 3, \dots, n$. We may compute out-of-sample forecasts $F_{n+1}, \dots, F_{n+m}$ based on data. We simply look at ways of summarizing forecast accuracy assuming that we have m forecasts and that we observe the data at each forecast period. The statistics of fit evaluate how well a forecasting model performs by comparing the observed data to the predictions. For a given forecast model that has been

fitted to the time series data, the model should be checked or evaluated to see how well it fits or forecasts the data. Commonly used statistics of fit are mean square Error (MSE) and the root mean square error (RMSE) have been popular, largely in comparing forecast accuracy across many series because of their theoretical relevance in statistical modeling (Armstrong, 2001).

To analyze forecasting efficiency of the required model the observed time series data from 1985 to 2005 has been grouped into two parts as 1985 to 1999 of 15 observations, the in-sample period and from 2000 to 2005 of 6 observations, out-of-sample (hold-out) period. After dividing the available data on the target level into parts: the in-sample data set have roughly 71% of the data and the out-of-sample data set is the remaining 29% of the entire data set. The out-of-sample forecasts are obtained using the in-sample forecast values. The in-sample and out-of-sample mean square errors are denoted by MSE_1 and MSE_2 and defined as:

$$MSE_1 = \frac{1}{N_1} \sum_{t=1}^{N_1} (TFR_t - \hat{TFR}_t)^2; \quad t = (1 = 1985), \dots, (N_1 = 1999).$$

and

$$MSE_2 = \frac{1}{N_2} \sum_{t=1}^{N_2} (TFR_t - \hat{TFR}_t)^2; \quad t = (1 = 2000), \dots, (N_2 = 2005).$$

(47)

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 LOGISTIC REGRESSION ANALYSIS OF SELECTED SOCIO-ECONOMIC AND DEMOGRAPHIC DETERMINANTS

The results of logistic regression analysis of equation (15) are given in Table 8. It is shown from the Table 8 that currently married women are significantly ($P<0.01$) 1.3 times more likely than others women to have disfavoured fertility behaviour or are less likely than others women to have had favourable fertility behaviour. Clearly it means currently married women have the higher fertility than others (separated, deserted, divorced & widowed) as generally at that time separated, deserted, divorced & widowed women are abstained from sexual union.

Age at marriage has inverse relationship to favourable fertility behaviour, that is, higher the age at marriage lower the fertility. The odds ratios of the age at first marriage corresponding to age group less than 15 and 15-19 except 20-24 represents that are significantly $(1-0.222)\times 100 = 77.8\%$ ($P<0.01$) and $(1-0.332)\times 100 = 66.8\%$ ($P<0.01$) less likely favourable as compared to reference group (25+), that is fertility rate is decreasing with the increasing of the age at marriage. It is a well known fact that fertility rate is higher in countries where marriages take place at comparatively early ages, as compared with the people who marry at late stage.

Logistic regression coefficients of respondent's education under study to different levels are obtained and the coefficients are negative and statistically significant ($P<0.01$).

Table 8: Logistic Regression Estimates of the Odds Ratios of Selected Socio-economic and Demographic Characteristics of Human Fertility Behaviour of Bangladesh: BDHS, 2004.

Independent Variables	B	S.E.	Exp(B)	95.0 % C. I. for Exp(B)	
				Lower	Upper
Current Marital Status					
Currently Married	0.268	0.096	1.308*	1.084	1.578
Others ^(r)	-	-	1.000	-	-
Age at First Marriage					
<15	-1.507	0.373	0.222*	0.107	0.461
15-19	-1.104	0.374	0.332*	0.159	0.690
20-24	-0.073	0.403	0.929	0.422	2.048
25+ ^(r)	-	-	1.000	-	-
Respondent's Education					
No Education	-3.024	0.245	0.049*	0.030	0.079
Primary	-2.491	0.243	0.083*	0.051	0.133
Secondary	-1.432	0.237	0.239*	0.150	0.380
Higher ^(r)	-	-	1.000	-	-
Partner's Education					
No Education	0.646	0.116	1.907*	1.519	2.394
Primary	0.610	0.113	1.840*	1.474	2.296
Secondary	0.533	0.107	1.704*	1.382	2.101
Higher ^(r)	-	-	1.000	-	-
Respondent's Occupation					
Not Working	-0.148	0.084	0.862***	0.731	1.017
Home Based	-0.021	0.104	0.980	0.799	1.201
Others ^(r)	-	-	1.000	-	-
Partner's Occupation					
Manual	-0.137	0.059	0.872**	0.777	0.979
Non-Manual ^(r)	-	-	1.000	-	-
Region					
Barisal	0.241	0.107	1.272**	1.032	1.568
Chittagong	-0.036	0.096	0.965	0.800	1.164
Dhaka	0.623	0.096	1.864*	1.546	2.248
Khulna	0.793	0.104	2.211*	1.803	2.712
Rajshahi	0.836	0.098	2.306*	1.903	2.794
Sylhet ^(r)	-	-	1.000	-	-
Residence					
Rural	0.191	0.057	1.211*	1.083	1.353
Urban ^(r)	-	-	1.000	-	-

Table 8 (Continued)

Religion					
Muslim	0.130	0.082	1.138***	0.970	1.336
Non-Muslim ^{r}	-	-	1.000	-	-
Index of Wealth					
Poor	0.395	0.069	1.485*	1.298	1.699
Middle	0.244	0.072	1.277*	1.108	1.471
Rich ^{r}	-	-	1.000	-	-
Index of Mass Media					
Not at All	0.615	0.056	1.850*	1.658	2.064
Yes ^{r}	-	-	1.000	-	-
Ever Used any Method					
Never Used	0.929	0.070	2.532*	2.208	2.903
Folkloric and Trad. Method	0.081	0.106	1.084	0.881	1.335
Modern Method ^{r}	-	-	1.000	-	-
Currently Breastfeeding					
No	0.363	0.055	1.437*	1.289	1.603
Yes ^{r}	-	-	1.000	-	-
Index of Child Mortality					
Not Died	-2.176	0.054	0.113*	0.102	0.126
Died ^{r}	-	-	1.000	-	-
Constant	3.414	0.446	30.375*		
Chi-square	4210.88				
df	27				
-2 Log likelihood	10378.86				
Cox & Snell R Square	0.308				
Nagelkerke R Square	0.428				

r = Reference Category; B = Logistic Regression Coefficient; and Exp (B) = Odds Ratio

‘*’ = Significant at 1% level; ‘**’ = Significant at 5% level; and ‘***’ = Significant at 10% level

Higher level of education is considered as reference category from the levels of education. The logistic regression coefficients of no education, primary and secondary are -3.024, -2.491 and -1.432 respectively. It is observed that odds ratios are increasing with the logistic regression coefficients. The odds ratios are 0.049, 0.083 and 0.239 respectively. The analysis depicts favourable fertility are found to be $(1-0.049) \times 100 =$

95.1% less for no education, $(1-0.083) \times 100 = 91.7\%$ less for primary and $(1-0.239) \times 100 = 76.1\%$ less for secondary level of educated women in Bangladesh compared to higher level of education. Partner's education has also significant ($P < 0.01$) effect on fertility. The result indicates that disfavoured fertility behaviour is 1.9, 1.8 and 1.7 times more likely accordingly for no education, primary and secondary to be higher educated partners. It represents higher the educational level lower the fertility for both the cases of wife and husband.

Respondent occupation is negatively related to fertility. Women who have no work have a significant ($P < 0.10$) negative relationship with fertility and has $(1-0.862) \times 100 = 13.8\%$ higher than its counter parts. Partner's occupation has also significant ($P < 0.05$) negative effect on fertility. It is shown from the analysis that partner's who have been engaged in manual works have $(1-0.872) \times 100 = 12.8\%$ higher fertility than who are engaged in non-manual works. Women who are involved with a job are not dependent on men. Both socially and mentally these have their own rights and absence of dependence, men cannot use women forcibly to increase their fertility. It is usually seen that those who are engaged in mental work have less number of children, as compared with those who are occupied with physical labor. It is primarily because husband and wife always live together and have no other source of entertainment except that of sexual exposure.

In the logistic regression analysis six divisions of Bangladesh is taken as region. The six divisions are Barisal, Chittagong, Dhaka, Khulna, Rajshahi and Sylhet respectively. To the analysis Sylhet is assumed to be the reference category. All the logistic regression coefficients are found to be positive and statistically significant except Chittagong region. The odds ratios of Barisal, Dhaka, Khulna and Rajshahi are 1.272 ($P < 0.05$), 1.864 ($P < 0.01$), 2.211 ($P < 0.01$) and 2.306 ($P < 0.01$) respectively which means

favourable fertility behaviour is according to about 1.3, 1.9, 2.2 and 2.3 times more likely than the women of Sylhet division in Bangladesh. Also the odds ratio of Chittagong indicates that favourable fertility rate is $(1-0.965) \times 100 = 3.5\%$ more than Sylhet. It was evident in BDHS 2004 data that revealed, fertility varied widely by administrative divisions. It also observed that Sylhet and Chittagong divisions had the highest TFRs (4.2 and 3.7, respectively), while the lowest TFRs were in Rajshahi and Khulna (2.6 and 2.8, respectively) (BDHS, 2004, p.52). These regional variations in fertility may be the causes of socio-economic and demographic inequalities of that area.

The analysis demonstrates the effect of residence on fertility is positive and significant ($P < 0.01$). It reveals disfavoured fertility behaviour in rural women is 1.2 times more than urban women. That is urban fertility for women are lower than in rural areas. Caldwell (1978) observed fertility differential might be attributed to higher age at marriage, higher level of real income per person, better health services, educational facilities, employment of women in the modern sector and other social amenities in the urban areas, which had the effect of reducing fertility. He also found children might be considered as economic assets rather than burden in the rural areas which caused higher fertility in the rural areas where children were considered both as earners during childhood and as social security in old age. He suggested the relative economic cost of bearing children and the lower economic value of children in the urban area, opportunity cost for mothers' time might have played an important role in lowering the fertility of urban women through practice of the effective methods of birth control.

The logistic regression coefficients of the analysis under Muslims and Non-Muslims are computed. There is a positive significant pattern of association between

fertility and religion. Research shows women who are Muslims are significantly ($P < 0.1$) 1.12 times more likely as compared to the reference category, which are Non-Muslims. That is Muslims have shown the higher fertility behaviour than Non-Muslims women. The causes of higher fertility may be as follows: generally Muslims marry at early stage as compared with the Non-Muslims and on the whole literacy among the Muslims is less, compared with the Non-Muslims with the result that more Non-Muslims women go in far employment. Naturally employed women do not prefer to have large families. These wish to limit their family size, because there are many problems involved in their bringing up, schooling and their final settlement in life. On the other hand it is presumed that in Bangladesh the Muslims are more inclined towards family planning programme compared with Non-Muslims.

The analysis reveals index of wealth plays an important role in the women of Bangladesh to contain the disfavoured fertility behaviour. BDHS 2004 data has categorized the index of wealth into three levels as poor, middle and rich. The analysis shows that poor women are positively and significantly ($P < 0.01$) differ from middle class or rich in order to fertility measurement. The results indicate that poor women have 1.3 times higher fertility than middle and about 1.5 times compared to rich. This means economic condition of a Bangladeshi people affects her fertility behaviour as poor have more children than other classes. Becker (1981) said there was a large literature tracing out the theory and evidence relating to the ways in which material wealth or income of a population was connected to standards of education and health, and also to fertility. He also showed average standards of education and health were elements of human capital that were likely to determine a region's overall productivity level, and hence its *per capita* income. He observed, with decreasing returns to scale higher fertility and

population growth would result in lower labor productivity. On the other hand, a household's decisions about human capital investment and the number of children to produce might depend on its current income level, especially with imperfect capital markets.

Index of mass media has a significant ($P < 0.01$) positive effect to reduce fertility. It is found from the analysis that women who are not in touch of any kind of mass media have about 1.9 times higher disfavoured fertility than who are in touch. The finding indicates that newspaper, radio and television are playing an important role for declining fertility rate of Bangladesh. Kojima (1994) and Gerard (1984) found the role of mass media might not be limited to the diffusion of attitude and knowledge of family limitation, but it could include the change in the world view or the value system which indirectly affected fertility behaviour as a whole.

The logistic regression coefficient of ever used any contraceptive method is 0.929 which is positive in sign and significant ($P < 0.01$) and its odds ratio is 2.532. That means disfavoured fertility behaviour is 2.5 times higher among the women who are used modern methods than that of never used any method. That is higher uses of modern contraceptive devices may be one of the most influential factor to reduce fertility rate in Bangladesh. Ullah and Chakraborty (1994) found by using logistic regression model that visiting of family planning workers had very strong and positive influence on the current use of modern contraceptives as compared to traditional methods.

The variable current status of breastfeeding is to contribute positively and significantly ($P < 0.01$) to the fertility behaviour and is indicated that women who are continued breastfeeding their children have chances 1.4 times more likely favourable fertility behaviour than women who are stopped breastfeeding. That is longer the duration

of breastfeeding; the lower will be the fertility. Kabir and Islam (2003) found the relationship between the duration of breastfeeding and mean number of live births was direct and negative. The mean number of live births was lower in case of mothers who gave full breastfeeding compared to others.

Among various demographic factors index of child mortality emerged as one of the important determinant of the fertility measurement variable. The logistic regression coefficient of this variable is -2.176, which is significant ($P < 0.01$). The odds ratio of the coefficient is 0.113. A negative relationship between this child mortality index and fertility which indicate the favourable fertility behaviour is $(1 - 0.113) \times 100 = 88.7\%$ less among women while child mortality is occurring in a family than that of counter part. ESCAP (1985) revealed in their study whether someone had experienced the death of a child then there was the decision to have earlier another child.

4.2 APPLICATION OF PATH MODEL TO RECENT DATA

In this research path analysis has been utilized to find out the mechanism and to estimate the importance of some of the quantitative socio-economic and demographic factors on the fertility differentials among the six divisions in Bangladesh using BDHS 2004 data. The following six Tables 9, 10, 11, 12, 13 and 14 produces the results of zero order correlation coefficients of various socio-economic and demographic variables which are in Tables (2-7) according to the divisions. That helps us to get the non-causal (correlational) relationship among exogenous variables. The path coefficients of variables of the application of the Alwin and Hauser's procedure are presented in Tables (15-20). The direct, indirect and total effects are showed in Tables (21-26). Joint effects are in Tables (27-32). Net effects have been demonstrated in Tables (33-38).

Table 9: Correlation Matrix of Fourteen Selected Quantitative Socioeconomic and Demographic Variables for Barisal Division in Bangladesh, BDHS 2004.

Variables	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄
X ₁	1	.875(**)	-.247(**)	-.043	-.122(**)	.101(**)	-.022	-.426(**)	.074(**)	.501(**)	.552(**)	.085(**)	.437(**)	.698(**)
X ₂		1	-.264(**)	-.083(**)	-.079(**)	.468(**)	-.087(**)	-.379(**)	.031	.483(**)	.521(**)	.071(**)	.425(**)	.656(**)
X ₃			1	.628(**)	.051(*)	.075(**)	.427(**)	.116(**)	.607(**)	-.313(**)	-.468(**)	.333(**)	-.282(**)	-.437(**)
X ₄				1	.037	.087(**)	.315(**)	.042	.549(**)	-.155(**)	-.290(**)	.300(**)	-.188(**)	-.248(**)
X ₅					1	.003	.024	.093(**)	.057(*)	.090(**)	.059(*)	-.005	-.069(**)	.077(**)
X ₆						1	.301(**)	-.098(**)	.084(**)	.009	.008	.064(**)	.043	.004
X ₇							1	-.084(**)	.293(**)	-.216(**)	-.228(**)	.165(**)	-.131(**)	-.260(**)
X ₈								1	.021	-.267(**)	-.248(**)	-.060(*)	-.142(**)	-.330(**)
X ₉									1	-.125(**)	-.259(**)	.430(**)	-.144(**)	-.189(**)
X ₁₀										1	.551(**)	-.062(*)	.264(**)	.690(**)
X ₁₁											1	-.147(**)	.437(**)	.768(**)
X ₁₂												1	-.098(**)	-.098(**)
X ₁₃													1	.640(**)
X ₁₄														1

(**) Correlation is significant at the 0.01 level (1-tailed), (*) Correlation is significant at the 0.05 level (1-tailed).

Table 10: Correlation Matrix of Fourteen Selected Quantitative Socioeconomic and Demographic Variables for Chittagong Division in Bangladesh, BDHS 2004.

Variables	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄
X ₁	1	.855(**)	-.294(**)	-.059(**)	-.054(**)	.050(*)	-.003	-.337(**)	.020	.561(**)	.558(**)	.088(**)	.413(**)	.711(**)
X ₂		1	-.272(**)	-.044(*)	-.011	.378(**)	-.073(**)	-.274(**)	.012	.515(**)	.510(**)	.094(**)	.354(**)	.653(**)
X ₃			1	.497(**)	.132(**)	.154(**)	.385(**)	.100(**)	.491(**)	-.292(**)	-.398(**)	.239(**)	-.294(**)	-.405(**)
X ₄				1	.116(**)	.124(**)	.217(**)	.037(*)	.389(**)	-.124(**)	-.194(**)	.225(**)	-.150(**)	-.181(**)
X ₅					1	.039(*)	.040(*)	.054(**)	.242(**)	.078(**)	.105(**)	.066(**)	-.063(**)	.084(**)
X ₆						1	.364(**)	-.024	.105(**)	-.041(*)	-.060(**)	.103(**)	-.042(*)	-.066(**)
X ₇							1	-.097(**)	.212(**)	-.217(**)	-.249(**)	.146(**)	-.183(**)	-.294(**)
X ₈								1	.073(**)	-.211(**)	-.166(**)	-.036	-.116(**)	-.263(**)
X ₉									1	-.105(**)	-.167(**)	.434(**)	-.133(**)	-.157(**)
X ₁₀										1	.560(**)	-.060(**)	.263(**)	.722(**)
X ₁₁											1	-.056(*)	.336(**)	.733(**)
X ₁₂												1	-.112(**)	-.089(**)
X ₁₃													1	.613(**)
X ₁₄														1

(**) Correlation is significant at the 0.01 level (1-tailed), (*) Correlation is significant at the 0.05 level (1-tailed).

Table 11: Correlation Matrix of Fourteen Selected Quantitative Socioeconomic and Demographic Variables for Dhaka Division in Bangladesh, BDHS 2004.

Variables	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄
X ₁	1	.873(**)	-.220(**)	-.016	-.016	.023	-.034(*)	-.358(**)	.065(**)	.480(**)	.542(**)	.129(**)	.360(**)	.655(**)
X ₂		1	-.237(**)	-.033	.018	.342(**)	-.118(**)	-.306(**)	.043(*)	.450(**)	.522(**)	.131(**)	.318(**)	.598(**)
X ₃			1	.466(**)	.109(**)	.211(**)	.512(**)	.100(**)	.568(**)	-.264(**)	-.395(**)	.327(**)	-.240(**)	-.386(**)
X ₄				1	.033(*)	.138(**)	.281(**)	.012	.374(**)	-.093(**)	-.150(**)	.226(**)	-.130(**)	-.154(**)
X ₅					1	.043(*)	.062(**)	.064(**)	.121(**)	.116(**)	.113(**)	.055(**)	-.035(*)	.134(**)
X ₆						1	.370(**)	-.032	.169(**)	-.067(**)	-.067(**)	.137(**)	-.070(**)	-.115(**)
X ₇							1	-.079(**)	.355(**)	-.220(**)	-.276(**)	.217(**)	-.158(**)	-.302(**)
X ₈								1	.030	-.220(**)	-.179(**)	-.050(**)	-.108(**)	-.275(**)
X ₉									1	-.103(**)	-.226(**)	.495(**)	-.152(**)	-.190(**)
X ₁₀										1	.497(**)	-.019	.155(**)	.652(**)
X ₁₁											1	-.104(**)	.327(**)	.729(**)
X ₁₂												1	-.103(**)	-.096(**)
X ₁₃													1	.607(**)
X ₁₄														1

(**) Correlation is significant at the 0.01 level (1-tailed), (*) Correlation is significant at the 0.05 level (1-tailed).

Table 12: Correlation Matrix of Fourteen Selected Quantitative Socioeconomic and Demographic Variables for Khulna Division in Bangladesh, BDHS 2004.

Variables	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄
X ₁	1	.894(**)	-.309(**)	.000	-.051(*)	.046(*)	-.044(*)	-.333(**)	.066(**)	.506(**)	.594(**)	.162(**)	.349(**)	.677(**)
X ₂		1	-.313(**)	.003	.000	.366(**)	-.088(**)	-.295(**)	.041	.501(**)	.560(**)	.138(**)	.336(**)	.649(**)
X ₃			1	.400(**)	.084(**)	.131(**)	.444(**)	.107(**)	.555(**)	-.290(**)	-.411(**)	.227(**)	-.238(**)	-.377(**)
X ₄				1	.061(**)	.129(**)	.231(**)	.031	.396(**)	-.106(**)	-.159(**)	.163(**)	-.098(**)	-.140(**)
X ₅					1	.055(*)	.025	.035	.187(**)	.158(**)	.071(**)	-.032	-.041(*)	.136(**)
X ₆						1	.358(**)	-.043(*)	.104(**)	-.033	-.021	.071(**)	.002	-.048(*)
X ₇							1	-.080(**)	.275(**)	-.199(**)	-.233(**)	.142(**)	-.136(**)	-.241(**)
X ₈								1	.052(*)	-.204(**)	-.198(**)	-.056(*)	-.089(**)	-.252(**)
X ₉									1	-.074(**)	-.165(**)	.385(**)	-.132(**)	-.113(**)
X ₁₀										1	.527(**)	.011	.159(**)	.685(**)
X ₁₁											1	-.023	.282(**)	.722(**)
X ₁₂												1	-.070(**)	.001
X ₁₃													1	.572(**)
X ₁₄														1

(**) Correlation is significant at the 0.01 level (1-tailed), (*) Correlation is significant at the 0.05 level (1-tailed).

Table 13: Correlation Matrix of Fourteen Selected Quantitative Socioeconomic and Demographic Variables for Rajshahi Division in Bangladesh, BDHS 2004.

Variables	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄
X ₁	1	.870(**)	-.340(**)	-.032	-.033(*)	.052(**)	-.051(**)	-.400(**)	.050(**)	.521(**)	.571(**)	.081(**)	.379(**)	.700(**)
X ₂		1	-.355(**)	-.075(**)	-.010	.402(**)	-.099(**)	-.356(**)	.020	.477(**)	.510(**)	.064(**)	.338(**)	.635(**)
X ₃			1	.654(**)	.124(**)	.076(**)	.449(**)	.157(**)	.513(**)	-.287(**)	-.393(**)	.197(**)	-.245(**)	-.392(**)
X ₄				1	.113(**)	.105(**)	.364(**)	.032	.548(**)	-.114(**)	-.220(**)	.238(**)	-.137(**)	-.159(**)
X ₅					1	-.001	.064(**)	.074(*)	.237(**)	.109(**)	.081(**)	.019	-.029	.129(**)
X ₆						1	.289(**)	-.062(**)	.076(**)	-.042(*)	-.059(**)	.023	-.023	-.063(**)
X ₇							1	-.073(**)	.303(**)	-.203(**)	-.233(**)	.154(**)	-.160(**)	-.263(**)
X ₈								1	.033(*)	-.245(**)	-.226(**)	-.069(**)	-.117(**)	-.303(**)
X ₉									1	-.051(**)	-.179(**)	.336(**)	-.130(**)	-.095(**)
X ₁₀										1	.527(**)	.011	.202(**)	.684(**)
X ₁₁											1	-.065(**)	.305(**)	.717(**)
X ₁₂												1	-.065(**)	-.015
X ₁₃													1	.617(**)
X ₁₄														1

(**) Correlation is significant at the 0.01 level (1-tailed), (*) Correlation is significant at the 0.05 level (1-tailed).

Table 14: Correlation Matrix of Fourteen Selected Quantitative Socioeconomic and Demographic Variables for Sylhet Division in Bangladesh, BDHS 2004.

Variables	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄
X ₁	1	.839(**)	-.240(**)	.033	.041	.042	-.031	-.281(**)	.064(*)	.462(**)	.528(**)	.087(**)	.400(**)	.654(**)
X ₂		1	-.252(**)	.004	.075(**)	.424(**)	-.121(**)	-.224(**)	.034	.436(**)	.484(**)	.052	.360(**)	.607(**)
X ₃			1	.437(**)	.208(**)	.084(**)	.386(**)	.071(**)	.553(**)	-.213(**)	-.334(**)	.352(**)	-.276(**)	-.324(**)
X ₄				1	.134(**)	.040	.191(**)	-.003	.399(**)	-.032	-.213(**)	.261(**)	-.094(**)	-.052(*)
X ₅					1	.057(*)	.103(**)	.012	.398(**)	.123(**)	.083(*)	.169(**)	-.063(*)	.116(**)
X ₆						1	.297(**)	-.025	.072(**)	-.046	-.028	.048	-.106(**)	-.084(**)
X ₇							1	-.062(*)	.232(**)	-.225(**)	-.201(**)	.149(**)	-.216(**)	-.295(**)
X ₈								1	.060(*)	-.160(**)	-.225(**)	.022	-.100(**)	-.207(**)
X ₉									1	-.064(*)	-.137(**)	.521(**)	-.171(**)	-.090(**)
X ₁₀										1	.537(**)	.018	.197(**)	.721(**)
X ₁₁											1	.024	.328(**)	.730(**)
X ₁₂												1	-.111(**)	-.012
X ₁₃													1	.616(**)
X ₁₄														1

(**) Correlation is significant at the 0.01 level (1-tailed), (*) Correlation is significant at the 0.05 level (1-tailed).

Table 15: Coefficients of Variables in Standard Form, in Reduced Form and Structural Equations in a Model of Selected Quantitative Socioeconomic and Demographic Determinants of Fertility at Barisal Division in Bangladesh, BDHS 2004.

EV	Equation and Endogenous Variable													
	X ₇	X ₈	X ₈	X ₉	X ₉	X ₉	X ₁₀	X ₁₀	X ₁₀	X ₁₀	X ₁₀	X ₁₁	X ₁₁	X ₁₂
X ₁	1.45	-0.55	-0.38	0.23	0.23	0.25	0.25	0.46	0.43	0.45	0.33	0.47	0.48	0.50
X ₂	-1.71	0.18	-0.03	-0.04	-0.04	-0.03	0.29	0.04	0.03	0.03	0.20	0.04	0.04	0.02
X ₃	0.22	0.01	0.04	0.42	0.42	0.42	-0.13	-0.10	-0.09	-0.07	-0.25	-0.22	-0.22	-0.18
X ₄	0.05	0.04	0.05	0.33	0.33	0.33	-0.07	-0.06	-0.06	-0.04	-0.12	-0.12	-0.12	-0.09
X ₅	0.00	0.06	0.06	0.04	0.04	0.03	0.15	0.15	0.15	0.15	0.11	0.11	0.11	0.08
X ₆	0.91	-0.13	-0.01	0.01	0.01	0.01	-0.12	0.01	0.01	0.01	-0.07	0.03	0.03	0.02
X ₇			-0.12		0.00	0.01		-0.15	-0.16	-0.16		-0.10	-0.10	-0.10
X ₈						0.05			-0.09	-0.08			0.02	0.03
X ₉										-0.07			-0.10	-0.08
X ₁₀														0.25
X ₁₁														
X ₁₂														
X ₁₃														
X ₁₄														
Table 15 (Continued)														
EV	X ₁₂	X ₁₂	X ₁₂	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₄	X ₁₄	X ₁₄	X ₁₄
X ₁	-0.09	-0.08	-0.06	0.25	0.31	0.34	0.36	0.36	0.24	0.24	0.40	0.59	0.57	0.60
X ₂	0.18	0.18	0.22	0.20	0.12	0.12	0.12	0.12	0.16	0.17	0.34	0.11	0.11	0.10
X ₃	0.10	0.10	0.09	-0.09	-0.08	-0.08	-0.04	-0.04	0.01	0.01	-0.17	-0.14	-0.14	-0.10
X ₄	0.09	0.09	0.09	-0.11	-0.11	-0.11	-0.09	-0.09	-0.08	-0.08	-0.11	-0.10	-0.10	-0.07
X ₅	-0.02	-0.02	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.17	0.17	0.17	0.12
X ₆	-0.06	-0.06	-0.04	-0.06	-0.02	-0.02	-0.01	-0.01	-0.07	-0.06	-0.16	-0.04	-0.04	-0.04
X ₇	0.04	0.04	0.05		-0.05	-0.04	-0.04	-0.04	-0.01	-0.01		-0.14	-0.14	-0.14
X ₈	-0.06	-0.06	-0.06			0.06	0.06	0.06	0.07	0.07		-0.06	-0.06	-0.06
X ₉	0.33	0.33	0.30				-0.09	-0.09	-0.08	-0.09		-0.06	-0.06	-0.10
X ₁₀		-0.03	-0.02					-0.01	-0.06	-0.06				0.33
X ₁₁			-0.08						0.22	0.21				0.37
X ₁₂										0.01				-0.01
X ₁₃														0.36
X ₁₄														0.31

“Blue color” Significant at 1% level; “Pink color” Significant at 5% level; “Dark Red color” Significant at 10% level and “Red color” insignificant
EV = Exogenous Variable

Table 16: Coefficients of Variables in Standard Form, in Reduced Form and Structural Equations in a Model of Selected Quantitative Socioeconomic and Demographic Determinants of Fertility at Chittagong Division in Bangladesh, BDHS 2004.

EV	Equation and Endogenous Variable													
	X ₇	X ₈	X ₈	X ₉	X ₉	X ₉	X ₁₀	X ₁₀	X ₁₀	X ₁₀	X ₁₁	X ₁₁	X ₁₁	X ₁₂
X ₁	1.14	-0.44	-0.27	0.17	0.16	0.18	0.37	0.58	0.57	0.58	0.29	0.47	0.46	0.48
X ₂	-1.29	0.13	-0.06	0.00	0.01	0.01	0.21	-0.03	-0.03	-0.03	0.26	0.06	0.06	0.06
X ₃	0.21	0.00	0.04	0.45	0.45	0.45	-0.12	-0.08	-0.08	-0.04	-0.22	-0.18	-0.18	-0.15
X ₄	0.00	0.02	0.02	0.16	0.16	0.16	-0.03	-0.03	-0.03	-0.02	-0.07	-0.07	-0.05	-0.05
X ₅	-0.01	0.04	0.04	0.17	0.17	0.16	0.12	0.12	0.12	0.13	0.15	0.15	0.17	0.13
X ₆	0.80	-0.06	0.06	0.00	0.00	-0.01	-0.12	0.03	0.03	-0.14	-0.02	-0.02	-0.02	0.05
X ₇			-0.15		0.01	0.02		-0.18	-0.19	-0.19	-0.14	-0.14	-0.14	0.03
X ₈						0.08			-0.04	-0.04		-0.01	-0.01	-0.01
X ₉										-0.08		-0.09	-0.09	
X ₁₀											0.27			
X ₁₁														
X ₁₂														
X ₁₃														
X ₁₄														

Table 16 (Continued)														
EV	X ₁₂	X ₁₂	X ₁₂	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₄	X ₁₄	X ₁₄	X ₁₄
X ₁	0.08	0.12	0.14	0.27	0.45	0.46	0.47	0.49	0.55	0.56	0.45	0.74	0.72	0.74
X ₂	0.01	0.01	0.02	0.10	-0.11	-0.10	-0.10	-0.10	-0.21	-0.21	0.28	-0.05	-0.05	-0.04
X ₃	0.03	0.03	0.03	-0.16	-0.13	-0.13	-0.09	-0.09	-0.11	-0.11	-0.19	-0.13	-0.13	-0.07
X ₄	0.05	0.05	0.03	-0.04	-0.04	-0.04	-0.02	-0.02	-0.01	-0.01	-0.05	-0.05	-0.03	-0.03
X ₅	-0.04	-0.03	0.00	-0.01	-0.01	-0.02	0.00	0.00	-0.02	-0.01	0.15	0.14	0.15	0.12
X ₆	0.04	0.04	0.03	-0.07	0.06	0.06	0.06	0.06	0.11	0.12	-0.16	0.04	0.05	0.05
X ₇	0.02	0.00	-0.01		-0.16	-0.16	-0.16	-0.17	-0.16	-0.16		-0.25	-0.26	-0.26
X ₈	-0.04	-0.05	-0.04		0.01	0.01	0.02	0.01	0.02	0.01		-0.06	-0.05	-0.05
X ₉	0.40	0.39	0.40				-0.08	-0.08	-0.08	-0.06			-0.11	-0.09
X ₁₀		-0.08	-0.08					-0.03	-0.11	-0.11				0.34
X ₁₁			-0.02						0.12	0.11				0.21
X ₁₂									-0.07					0.30
X ₁₃														0.29
X ₁₄														0.29

“Blue color” Significant at 1% level; “Pink color” Significant at 5% level; “Dark Red color” Significant at 10% level and “Red color” insignificant
EV = Exogenous Variable

Table 17: Coefficients of Variables in Standard Form, in Reduced Form and Structural Equations in a Model of Selected Quantitative Socioeconomic and Demographic Determinants at Fertility of Dhaka Division in Bangladesh, BDHS 2004.

EV	Equation and Endogenous Variable													
	X ₇	X ₈	X ₈	X ₉	X ₉	X ₉	X ₁₀	X ₁₀	X ₁₀	X ₁₀	X ₁₁	X ₁₁	X ₁₁	X ₁₂
X ₁	1.35	-0.52	-0.31	0.27	0.18	0.19	0.25	0.47	0.45	0.46	0.25	0.54	0.53	0.55
X ₂	-1.52	0.19	-0.04	-0.08	0.02	0.02	0.23	-0.02	-0.02	-0.02	0.27	-0.06	-0.06	-0.06
X ₃	0.26	0.05	0.09	0.54	0.52	0.51	-0.16	-0.11	-0.11	-0.08	-0.29	-0.25	-0.25	-0.17
X ₄	0.01	0.00	0.00	0.13	0.13	0.13	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.04
X ₅	0.00	0.07	0.07	0.04	0.04	0.04	0.15	0.15	0.15	0.16	0.13	0.13	0.14	0.11
X ₆	0.83	-0.11	0.02	0.06	0.00	0.00	-0.12	0.02	0.02	0.02	-0.10	0.08	0.08	0.08
X ₇			-0.15		0.07	0.08		-0.16	-0.18	-0.17		-0.19	-0.19	-0.15
X ₈						0.05			-0.08	-0.08		-0.01	-0.01	0.01
X ₉										-0.05			-0.15	-0.14
X ₁₀													0.19	
X ₁₁														
X ₁₂														
X ₁₃														
X ₁₄														

Table 17 (Continued)														
EV	X ₁₂	X ₁₂	X ₁₂	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₄	X ₁₄	X ₁₄
X ₁	0.09	0.10	0.16	0.28	0.40	0.41	0.43	0.47	0.34	0.34	0.42	0.72	0.70	0.72
X ₂	0.04	0.04	0.02	0.06	-0.08	-0.08	-0.07	-0.07	-0.01	0.00	0.22	-0.12	-0.13	-0.12
X ₃	0.09	0.09	0.07	-0.12	-0.10	-0.10	-0.04	-0.04	-0.03	-0.03	-0.24	-0.18	-0.17	-0.10
X ₄	0.02	0.02	0.04	-0.06	-0.06	-0.06	-0.05	-0.05	-0.06	-0.06	-0.02	-0.02	-0.02	0.00
X ₅	0.01	0.01	0.03	-0.01	-0.01	-0.02	-0.01	0.00	-0.02	-0.02	0.17	0.17	0.18	0.18
X ₆	0.02	0.02	0.05	-0.04	0.03	0.03	0.03	0.03	-0.03	-0.03	-0.14	0.05	0.05	0.04
X ₇	0.00	-0.01	-0.02		-0.09	-0.09	-0.08	-0.09	-0.04	-0.04		-0.23	-0.24	-0.23
X ₈	-0.03	-0.03	-0.03			0.02	0.02	0.02	0.02	0.02			-0.08	-0.07
X ₉	0.44	0.44	0.42				-0.12	-0.13	-0.10	-0.08			-0.13	-0.11
X ₁₀		-0.02	0.00					-0.08	-0.11	-0.11				0.33
X ₁₁			-0.09						0.13	0.13				0.33
X ₁₂										-0.03				-0.04
X ₁₃														0.36
X ₁₄														

“Blue color” Significant at 1% level; “Pink color” Significant at 5% level; “Dark Red color” Significant at 10% level and “Red color” insignificant
 EV = Exogenous Variable

Table 18: Coefficients of Variables in Standard Form, in Reduced Form and Structural Equations in a Model of Selected Quantitative Socioeconomic and Demographic Determinants of Fertility at Khulna Division in Bangladesh, BDHS 2004.

EV	Equation and Endogenous Variable													
	X ₇	X ₈	X ₈	X ₉	X ₉	X ₉	X ₉	X ₁₀	X ₁₀	X ₁₀	X ₁₀	X ₁₁	X ₁₁	X ₁₂
X ₁	1.48	-0.49	-0.30	0.25	0.24	0.26	0.26	0.44	0.42	0.44	0.35	0.62	0.62	0.44
X ₂	-1.66	0.18	-0.04	0.00	0.00	0.00	0.28	0.08	0.08	0.08	0.21	-0.10	-0.10	-0.22
X ₃	0.24	0.00	0.04	0.54	0.54	0.54	-0.11	-0.09	-0.08	-0.05	-0.22	-0.19	-0.19	0.24
X ₄	0.00	0.05	0.05	0.19	0.19	0.18	-0.06	-0.06	-0.06	-0.04	-0.07	-0.07	-0.07	0.06
X ₅	-0.02	0.02	0.02	0.13	0.13	0.13	0.18	0.18	0.18	0.19	0.10	0.10	0.10	-0.06
X ₆	0.88	-0.10	0.02	-0.02	-0.02	-0.02	-0.13	-0.02	-0.02	-0.02	-0.07	0.09	0.09	0.08
X ₇			-0.13		0.00	0.01		-0.12	-0.13	-0.13		-0.16	-0.16	-0.03
X ₈						0.08			-0.05	-0.05		0.00	0.01	0.00
X ₉										-0.07			-0.10	
X ₁₀											0.20			
X ₁₁														
X ₁₂														
X ₁₃														
X ₁₄														

Table 18 (Continued)														
EV	X ₁₂	X ₁₂	X ₁₂	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₄	X ₁₄	X ₁₄	X ₁₄
X ₁	0.35	0.36	0.41	0.14	0.24	0.25	0.28	0.31	0.29	0.32	0.44	0.67	0.66	0.54
X ₂	-0.22	-0.22	-0.26	0.20	0.08	0.08	0.08	0.09	0.04	0.02	0.26	0.00	0.00	0.38
X ₃	0.07	0.06	0.05	-0.11	-0.09	-0.09	-0.03	-0.04	-0.04	-0.04	-0.15	-0.11	-0.11	0.00
X ₄	-0.01	-0.01	-0.01	-0.05	-0.05	-0.05	-0.03	-0.03	-0.02	-0.02	-0.08	-0.08	-0.08	-0.03
X ₅	-0.10	-0.10	-0.09	-0.01	-0.02	-0.02	0.00	0.01	0.00	0.00	0.17	0.17	0.17	0.11
X ₆	0.12	0.12	0.15	-0.05	0.01	0.01	0.01	0.00	0.04	0.05	-0.14	0.00	0.00	0.01
X ₇	-0.04	-0.04	-0.05		-0.07	-0.06	-0.06	-0.07	-0.08	-0.09		-0.16	-0.16	-0.12
X ₈	-0.03	-0.03	-0.03		0.03	0.03	0.03	0.03	0.03	0.02		-0.04	-0.04	-0.04
X ₉	0.35	0.35	0.36				-0.11	-0.12	-0.10	-0.08			-0.11	-0.09
X ₁₀		-0.02	-0.01					-0.08	-0.09	-0.09				0.35
X ₁₁			-0.04						0.08	0.08				0.26
X ₁₂										-0.07				0.30
X ₁₃														-0.02
X ₁₄														0.32

“Blue color” Significant at 1% level; “Pink color” Significant at 5% level; “Dark Red color” Significant at 10% level and “Red color” Insignificant
 EV= Exogenous Variable

Table 19: Coefficients of Variables in Standard Form, in Reduced Form and Structural Equations in a Model of Selected Quantitative Socioeconomic and Demographic Determinants of Fertility at Rajshahi Division in Bangladesh, BDHS 2004.

EV	Equation and Endogenous Variable													
	X ₇	X ₈	X ₈	X ₉	X ₉	X ₉	X ₁₀	X ₁₀	X ₁₀	X ₁₀	X ₁₁	X ₁₁	X ₁₁	X ₁₂
X ₁	1.40	-0.54	-0.35	0.23	0.17	0.19	0.40	0.65	0.62	0.63	0.41	0.62	0.61	0.64
X ₂	-1.58	0.17	-0.04	-0.05	0.02	0.02	0.13	-0.15	-0.15	-0.15	0.13	-0.10	-0.10	-0.10
X ₃	0.26	0.03	0.06	0.36	0.35	0.34	-0.11	-0.06	-0.06	-0.04	-0.16	-0.12	-0.12	-0.07
X ₄	0.03	0.02	0.02	0.30	0.30	0.30	-0.04	-0.04	-0.02	-0.02	-0.10	-0.10	-0.10	-0.06
X ₅	0.00	0.07	0.07	0.16	0.16	0.15	0.13	0.13	0.13	0.14	0.13	0.13	0.15	0.12
X ₆	0.90	-0.12	0.00	0.04	0.00	0.00	-0.10	0.06	0.06	0.06	-0.09	0.04	0.04	0.03
X ₇			-0.14		0.05	0.05		-0.18	-0.19	-0.19		-0.15	-0.15	-0.14
X ₈						0.05			-0.07	-0.06		-0.01	-0.01	0.01
X ₉										-0.05		-0.14	-0.13	
X ₁₀											0.23			
X ₁₁														
X ₁₂														
X ₁₃														
X ₁₄														

Table 19 (Continued)													
EV	X ₁₂	X ₁₂	X ₁₂	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₄	X ₁₄	X ₁₄
X ₁	0.04	0.03	0.04	0.26	0.41	0.42	0.45	0.47	0.43	0.43	0.50	0.78	0.76
X ₂	0.06	0.06	0.08	0.12	-0.05	-0.05	-0.05	-0.05	-0.07	-0.07	0.22	-0.10	-0.11
X ₃	0.05	0.05	0.04	-0.05	-0.02	-0.02	0.02	0.02	0.01	0.01	-0.13	-0.08	-0.08
X ₄	0.04	0.04	0.03	-0.09	-0.08	-0.08	-0.05	-0.05	-0.03	-0.03	-0.06	-0.05	-0.05
X ₅	-0.06	-0.06	-0.07	0.00	0.00	0.00	0.02	0.02	-0.01	-0.01	0.17	0.17	0.17
X ₆	-0.06	-0.06	-0.08	-0.08	0.02	0.02	0.02	0.02	0.03	0.03	-0.16	0.02	0.02
X ₇	0.06	0.06	0.05		-0.11	-0.11	-0.10	-0.11	-0.11	-0.11		-0.20	-0.21
X ₈	-0.05	-0.05	-0.05		0.03	0.03	0.04	0.04	0.05	0.04		-0.06	-0.06
X ₉	0.29	0.29	0.30				-0.12	-0.13	-0.11	-0.09		-0.10	-0.10
X ₁₀		0.00	0.01				-0.04	-0.08	-0.08	-0.09			
X ₁₁			-0.05						0.11	0.11			
X ₁₂										-0.05			
X ₁₃													
X ₁₄													

"Blue color" Significant at 1% level; "Pink color" Significant at 5% level; "Dark Red color" Significant at 10% level and "Red color" insignificant
EV= Exogenous Variable

Table 20: Coefficients of Variables in Standard Form, in Reduced Form and Structural Equations in a Model of Selected Quantitative Socioeconomic and Demographic Determinants of Fertility at Sylhet Division in Bangladesh, BDHS 2004.

EV	Equation and Endogenous Variable													
	X ₇	X ₈	X ₈	X ₉	X ₉	X ₉	X ₁₀	X ₁₀	X ₁₀	X ₁₀	X ₁₀	X ₁₁	X ₁₁	X ₁₂
X ₁	1.31	-0.41	-0.29	0.18	0.22	0.24	0.28	0.58	0.57	0.59	0.40	0.59	0.59	0.60
X ₂	-1.56	0.15	0.01	-0.02	-0.08	-0.08	0.23	-0.13	-0.13	-0.14	0.15	-0.08	-0.08	-0.05
X ₃	0.22	0.00	0.02	0.49	0.50	0.50	-0.12	-0.07	-0.07	-0.01	-0.18	-0.14	-0.15	-0.12
X ₄	-0.02	0.01	0.01	0.14	0.14	0.14	0.00	-0.01	-0.01	0.01	-0.12	-0.11	-0.11	-0.09
X ₅	0.02	0.03	0.03	0.26	0.26	0.26	0.12	0.13	0.13	0.16	0.12	0.12	0.12	0.14
X ₆	0.94	-0.08	0.00	0.03	0.06	0.06	-0.16	0.06	0.06	0.07	-0.08	0.07	0.07	0.04
X ₇			-0.09		-0.03	-0.03		-0.23	-0.23	-0.24		-0.14	-0.14	-0.08
X ₈						0.08			-0.05	-0.04		0.01	0.02	0.03
X ₉										-0.11			-0.06	-0.04
X ₁₀											0.30			
X ₁₁														
X ₁₂														
X ₁₃														
X ₁₄														

Table 20 (Continued)														
EV	X ₁₂	X ₁₂	X ₁₂	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₃	X ₁₄	X ₁₄	X ₁₄
X ₁	0.28	0.26	0.33	0.17	0.33	0.33	0.36	0.40	0.11	0.14	0.36	0.36	0.66	0.64
X ₂	-0.23	-0.22	-0.25	0.27	0.08	0.08	0.07	0.07	0.34	0.32	0.36	0.00	0.00	0.00
X ₃	0.08	0.08	0.02	-0.14	-0.11	-0.11	-0.05	-0.05	0.01	0.01	-0.17	-0.12	-0.12	-0.07
X ₄	0.03	0.03	0.08	-0.03	-0.03	-0.03	-0.02	-0.02	-0.05	-0.06	0.00	-0.01	-0.01	0.01
X ₅	-0.06	-0.07	-0.07	-0.05	-0.05	-0.05	-0.02	-0.01	0.03	0.03	0.13	0.13	0.13	0.16
X ₆	0.12	0.11	0.16	-0.20	-0.09	-0.09	-0.08	-0.07	-0.20	-0.19	-0.24	-0.02	-0.02	-0.02
X ₇	-0.07	-0.06	-0.10		-0.12	-0.12	-0.12	-0.14	-0.10	-0.10		-0.23	-0.23	-0.23
X ₈	0.01	0.01	-0.09		0.01	0.02	0.02	0.01	0.02	0.02		-0.04	-0.03	-0.04
X ₉	0.50	0.50	0.52				-0.12	-0.13	-0.14	-0.12			-0.10	-0.05
X ₁₀		0.04	0.02					-0.06	-0.05	-0.06				0.42
X ₁₁			0.01						0.09	0.09				0.28
X ₁₂										-0.05				0.33
X ₁₃														0.00
X ₁₄														0.33

“Blue color” Significant at 1% level; “Pink color” Significant at 5% level; “Dark Red color” Significant at 10% level and “Red color” insignificant
EV= Exogenous Variable

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Table 21 (Continued)

E.V	Ex.V	D.E	Indirect Effects Via							T.E	T.A
			X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃		
X ₁₂	X ₁	-0.059	0.070	0.016	0.081	-0.012	-0.021			0.074	0.085
	X ₂	0.222	-0.082	0.001	-0.010	-0.001	-0.042			0.088	0.071
	X ₃	0.090	0.011	-0.002	0.141	0.002	0.010			0.252	0.333
	X ₄	0.091	0.002	-0.002	0.109	0.001	0.000			0.202	0.300
	X ₅	-0.005	0.000	-0.002	0.010	-0.004	-0.013			-0.014	-0.005
	X ₆	-0.042	0.044	0.001	0.005	0.000	-0.014			-0.006	0.064
	X ₇	0.047		0.005	0.003	0.005	-0.011			0.049	0.165
	X ₈	-0.058			0.016	0.002	-0.002			-0.042	-0.060
	X ₉	0.299				0.002	0.033			0.334	0.430
	X ₁₀	-0.019					-0.009			-0.028	-0.062
	X ₁₁	-0.076								-0.076	-0.147
X ₁₃	X ₁	0.244	-0.067	-0.022	-0.021	-0.004	0.118	0.000		0.247	0.437
	X ₂	0.168	0.080	-0.002	0.003	0.000	-0.039	-0.006		0.203	0.425
	X ₃	0.011	-0.010	0.002	-0.037	0.001	-0.052	-0.004		-0.089	-0.282
	X ₄	-0.083	-0.002	0.003	-0.029	0.000	-0.006	0.003		-0.114	-0.188
	X ₅	-0.011	0.000	0.003	-0.003	-0.001	0.006	-0.001		-0.006	-0.069
	X ₆	-0.063	-0.042	-0.001	-0.001	0.000	0.050	-0.002		-0.059	0.043
	X ₇	-0.012		-0.007	-0.001	0.001	-0.033	0.004		-0.047	-0.131
	X ₈	0.071			-0.004	0.001	-0.011	0.001		0.057	-0.142
	X ₉	-0.085				0.001	-0.008	0.006		-0.087	-0.144
	X ₁₀	-0.060					0.051	0.000		-0.009	0.264
	X ₁₁	0.212						0.012		0.224	0.437
	X ₁₂	0.009								0.009	0.437
X ₁₄	X ₁	0.210	-0.199	0.023	-0.024	0.148	0.160	0.001	0.077	0.396	0.698
	X ₂	0.058	0.236	0.002	0.003	0.011	-0.014	-0.004	0.053	0.343	0.656
	X ₃	-0.031	-0.030	-0.002	-0.041	-0.022	-0.047	-0.004	0.003	-0.174	-0.437
	X ₄	-0.020	-0.007	-0.003	-0.032	-0.012	-0.012	0.000	-0.026	-0.111	-0.248
	X ₅	0.098	0.000	-0.003	-0.003	0.051	0.029	-0.001	-0.003	0.168	0.077
	X ₆	-0.052	-0.125	0.001	-0.001	0.004	0.028	0.002	-0.020	-0.163	0.004
	X ₇	-0.067		0.007	-0.001	-0.052	-0.023	0.002	-0.004	-0.137	-0.260
	X ₈	-0.064			-0.004	-0.027	0.012	0.000	0.022	-0.061	-0.330
	X ₉	-0.019				-0.022	-0.027	-0.003	-0.027	-0.098	-0.189
	X ₁₀	0.227					0.121	0.000	-0.019	0.329	0.690
	X ₁₁	0.298						0.003	0.067	0.367	0.768
	X ₁₂	-0.010							0.003	-0.008	-0.098
	X ₁₃	0.314								0.314	0.640

E.V=Endogenous Variable; Ex.V=Exogenous; D.E= Direct Effect; T.E= Total Effect and T.A= Total Association

Table 22 (Continued)

E.V	Ex.V	D.E	Indirect Effects Via							T.E	T.A
			X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃		
X ₁₂	X ₁	0.138	0.031	0.002	0.075	-0.048	-0.015			0.184	0.088
	X ₂	0.017	-0.035	0.001	0.003	0.002	-0.008			-0.020	0.094
	X ₃	0.032	0.006	0.000	0.177	0.003	-0.003			0.214	0.239
	X ₄	0.034	0.000	0.000	0.063	0.002	0.014			0.112	0.225
	X ₅	-0.004	0.000	0.000	0.066	-0.011	-0.025			0.025	0.066
	X ₆	0.028	0.022	0.000	-0.004	-0.002	0.009			0.053	0.103
	X ₇	-0.015		0.001	0.007	0.016	0.018			0.027	0.146
	X ₈	-0.044			0.033	0.003	-0.001			-0.009	-0.036
	X ₉	0.397				0.006	-0.004			0.399	0.434
	X ₁₀	-0.079					-0.004			-0.082	-0.060
	X ₁₁	-0.023								-0.023	-0.056
X ₁₃	X ₁	0.559	-0.185	-0.003	-0.015	-0.019	-0.055	-0.013		0.269	0.413
	X ₂	-0.215	0.210	-0.001	-0.001	0.001	0.109	0.001		0.104	0.354
	X ₃	-0.114	-0.035	0.000	-0.036	0.001	0.021	-0.001		-0.163	-0.294
	X ₄	-0.006	0.000	0.000	-0.013	0.001	-0.014	-0.004		-0.036	-0.150
	X ₅	-0.012	0.002	0.000	-0.013	-0.004	0.018	-0.003		-0.012	-0.063
	X ₆	0.117	-0.130	0.001	0.001	-0.001	-0.052	-0.004		-0.068	-0.042
	X ₇	-0.164		-0.001	-0.002	0.006	-0.002	0.001		-0.162	-0.183
	X ₈	0.014			-0.007	0.001	-0.003	0.003		0.009	-0.116
	X ₉	-0.055				0.002	-0.004	-0.024		-0.081	-0.153
	X ₁₀	-0.114					0.078	0.004		-0.033	0.263
	X ₁₁	0.108						0.008		0.116	0.336
	X ₁₂	-0.072								-0.072	-0.112
X ₁₄	X ₁	0.327	-0.286	0.015	-0.021	0.196	0.063	-0.006	0.162	0.451	0.711
	X ₂	-0.015	0.324	0.003	-0.001	-0.009	0.036	0.000	-0.062	0.276	0.653
	X ₃	-0.018	-0.053	-0.002	-0.050	-0.014	-0.015	-0.001	-0.033	-0.185	-0.405
	X ₄	-0.019	0.000	-0.001	-0.017	-0.007	-0.004	0.000	-0.002	-0.051	-0.181
	X ₅	0.094	0.004	-0.002	-0.018	0.044	0.030	-0.001	-0.004	0.147	0.084
	X ₆	0.021	-0.201	-0.003	0.001	0.009	-0.015	-0.002	0.034	-0.156	-0.066
	X ₇	-0.121		0.008	-0.002	-0.063	-0.025	0.000	-0.048	-0.251	-0.294
	X ₈	-0.034			-0.009	-0.013	-0.006	0.003	0.004	-0.055	-0.263
	X ₉	-0.041				-0.025	-0.009	-0.020	-0.016	-0.111	-0.157
	X ₁₀	0.244					0.129	-0.003	-0.033	0.337	0.722
	X ₁₁	0.263						0.008	0.031	0.302	0.733
	X ₁₂	-0.029							-0.021	-0.050	-0.089
	X ₁₃	0.290								0.290	0.613

E.V=Endogenous Variable; Ex.V=Exogenous; D.E= Direct Effect; T.E= Total Effect and T.A= Total Association

Table 23: Interpretations of Effects in a Model of Some Selected Quantitative Socioeconomic and Demographic Determinants of Fertility at Dhaka Division in Bangladesh, BDHS 2004.

[illegible]

Table 23 (Continued)

E.V	Ex.V	D.E	Indirect Effects Via							T.E	T.A
			X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃		
X ₁₂	X ₁	0.159	0.042	0.003	0.082	-0.010	-0.062			0.214	0.129
	X ₂	0.024	-0.048	0.000	0.012	0.000	0.020			0.009	0.131
	X ₃	0.067	0.008	-0.001	0.226	0.002	0.020			0.323	0.327
	X ₄	0.036	0.000	0.000	0.056	0.000	-0.012			0.080	0.226
	X ₅	0.029	0.000	-0.001	0.017	-0.003	-0.015			0.028	0.055
	X ₆	0.047	0.026	0.000	0.001	0.000	-0.030			0.044	0.137
	X ₇	-0.018		0.001	0.034	0.004	0.010			0.032	0.217
	X ₈	-0.030			0.022	0.002	-0.002			-0.008	-0.050
	X ₉	0.420				0.001	0.020			0.442	0.495
	X ₁₀	0.002					-0.023			-0.021	-0.019
	X ₁₁	-0.085								-0.085	-0.104
X ₁₃	X ₁	0.339	-0.120	-0.006	-0.024	-0.037	0.133	-0.003		0.283	0.360
	X ₂	-0.004	0.135	-0.001	-0.003	0.002	-0.069	-0.002		0.058	0.318
	X ₃	-0.029	-0.023	0.002	-0.063	0.007	-0.013	-0.003		-0.123	-0.240
	X ₄	-0.061	-0.001	0.000	-0.016	-0.001	0.013	0.001		-0.065	-0.130
	X ₅	-0.020	0.000	0.001	-0.005	-0.012	0.018	0.003		-0.015	-0.035
	X ₆	-0.025	-0.074	0.000	0.000	-0.002	0.058	-0.001		-0.045	-0.070
	X ₇	-0.037		-0.003	-0.009	0.014	-0.055	0.002		-0.089	-0.158
	X ₈	0.017			-0.006	0.006	0.001	0.001		0.018	-0.108
	X ₉	-0.082				0.004	-0.030	-0.015		-0.123	-0.152
	X ₁₀	-0.112					0.030	0.002		-0.080	0.155
	X ₁₁	0.133						-0.001		0.133	0.327
	X ₁₂	-0.029								-0.029	-0.103
X ₁₄	X ₁	0.301	-0.306	0.025	-0.024	0.149	0.156	-0.005	0.123	0.419	0.655
	X ₂	-0.076	0.344	0.003	-0.003	-0.007	-0.036	-0.002	-0.001	-0.222	0.598
	X ₃	-0.040	-0.060	-0.007	-0.065	-0.027	-0.025	0.000	-0.010	-0.235	-0.386
	X ₄	0.008	-0.001	0.000	-0.016	0.005	0.010	0.000	-0.022	-0.018	-0.154
	X ₅	0.106	0.000	-0.005	-0.005	0.051	0.034	0.001	-0.007	0.173	0.134
	X ₆	0.019	-0.189	-0.002	0.000	0.006	0.033	-0.001	-0.009	-0.144	-0.115
	X ₇	-0.119		0.012	-0.010	-0.056	-0.040	-0.001	-0.014	-0.227	-0.302
	X ₈	-0.064			-0.006	-0.026	0.008	0.001	0.006	-0.081	-0.275
	X ₉	-0.023				-0.015	-0.042	-0.017	-0.030	-0.126	-0.190
	X ₁₀	0.255					0.109	0.003	-0.041	0.326	0.652
	X ₁₁	0.278						0.002	0.048	0.329	0.729
	X ₁₂	-0.027							-0.011	-0.038	-0.096
	X ₁₃	0.363								0.363	0.607

E.V=Endogenous Variable; Ex.V=Exogenous; D.E= Direct Effect; T.E= Total Effect and T.A= Total Association

[illegible]

Table 24 (Continued)

E.V	Ex.V	D.E	Indirect Effects Via							T.E	T.A
			X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃		
X ₁₂	X ₁	0.406	-0.047	0.001	0.089	-0.010	-0.045			0.395	0.162
	X ₂	-0.259	0.053	0.000	0.001	-0.002	0.038			-0.169	0.138
	X ₃	0.055	-0.008	0.000	0.182	0.001	0.010			0.240	0.227
	X ₄	-0.014	0.000	0.000	0.069	0.001	0.007			0.063	0.163
	X ₅	-0.090	0.001	0.000	0.043	-0.004	-0.005			-0.056	-0.032
	X ₆	0.149	-0.028	0.000	-0.008	0.001	-0.034			0.080	0.071
	X ₇	-0.054		0.001	0.005	0.003	0.014			-0.032	0.142
	X ₈	-0.034			0.026	0.001	0.003			-0.005	-0.056
	X ₉	0.357				0.002	-0.010			0.348	0.385
	X ₁₀	-0.006					-0.016			-0.022	0.011
	X ₁₁	-0.039								-0.039	-0.023
X ₁₃	X ₁	0.315	-0.101	-0.008	-0.030	-0.037	0.022	-0.024		0.138	0.349
	X ₂	0.019	0.113	-0.001	0.000	-0.007	0.056	0.016		0.195	0.336
	X ₃	-0.040	-0.016	0.001	-0.061	0.004	0.004	-0.001		-0.109	-0.238
	X ₄	-0.019	0.000	0.001	-0.021	0.004	-0.006	-0.004		-0.045	-0.098
	X ₅	0.000	0.001	0.001	-0.014	-0.016	0.009	0.005		-0.014	-0.041
	X ₆	0.049	-0.060	0.000	0.002	0.002	-0.033	-0.011		-0.050	0.002
	X ₇	-0.086		-0.003	-0.001	0.011	0.008	0.004		-0.068	-0.136
	X ₈	0.023			-0.009	0.004	0.005	0.003		0.026	-0.089
	X ₉	-0.076				0.006	-0.019	-0.025		-0.114	-0.132
	X ₁₀	-0.092					0.011	-0.002		-0.083	0.159
	X ₁₁	0.079						0.002		0.081	0.282
	X ₁₂	-0.067								-0.067	-0.070
X ₁₄	X ₁	0.287	-0.232	0.013	-0.029	0.154	0.153	-0.005	0.102	0.442	0.677
	X ₂	-0.012	0.260	0.002	0.000	0.027	-0.031	0.006	0.006	0.257	0.649
	X ₃	-0.012	-0.038	-0.002	-0.059	-0.016	-0.011	0.002	-0.013	-0.148	-0.377
	X ₄	-0.019	-0.001	-0.002	-0.020	-0.015	-0.014	-0.003	-0.006	-0.079	-0.140
	X ₅	0.085	0.003	-0.001	-0.014	0.065	0.028	0.003	0.000	0.168	0.136
	X ₆	-0.004	-0.138	-0.001	0.002	-0.008	-0.002	-0.005	0.016	-0.139	-0.048
	X ₇	-0.071		0.006	-0.001	-0.045	-0.018	0.000	-0.028	-0.157	-0.241
	X ₈	-0.043			-0.009	-0.016	0.015	0.001	0.008	-0.044	-0.252
	X ₉	-0.016				-0.024	-0.034	-0.011	-0.025	-0.110	-0.113
	X ₁₀	0.289					0.092	-0.002	-0.030	0.349	0.685
	X ₁₁	0.274						-0.001	0.025	0.298	0.722
	X ₁₂	-0.002							-0.022	-0.023	0.001
	X ₁₃	0.322								0.322	0.572

E.V=Endogenous Variable; Ex.V=Exogenous; D.E= Direct Effect; T.E= Total Effect and T.A= Total Association

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Table 25 (Continued)

E.V	Ex.V	D.E	Indirect Effects Via							T.E	T.A
			X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃		
X ₁₂	X ₁	0.039	0.110	0.013	0.054	0.001	-0.005			0.212	0.081
	X ₂	0.077	-0.124	0.002	0.006	0.000	-0.018			-0.057	0.064
	X ₃	0.043	0.020	-0.002	0.098	0.000	0.003			0.162	0.197
	X ₄	0.032	0.002	-0.001	0.084	0.000	0.012			0.130	0.238
	X ₅	-0.067	0.000	-0.003	0.044	0.000	0.008			-0.017	0.019
	X ₆	-0.076	0.071	0.000	0.000	0.000	0.015			0.010	0.023
	X ₇	0.051		0.005	0.015	0.000	0.007			0.079	0.154
	X ₈	-0.055			0.013	0.000	0.003			-0.039	-0.069
	X ₉	0.303				0.000	-0.017			0.286	0.336
	X ₁₀	0.014					-0.012			0.002	0.011
	X ₁₁	-0.046								-0.046	-0.065
X ₁₃	X ₁	0.433	-0.154	-0.012	-0.023	-0.026	0.047	-0.006		0.258	0.379
	X ₂	-0.066	0.175	-0.001	-0.003	0.006	0.015	-0.004		0.122	0.338
	X ₃	0.013	-0.028	0.002	-0.043	0.002	0.009	-0.002		-0.048	-0.245
	X ₄	-0.026	-0.003	0.001	-0.037	0.001	-0.019	-0.003		-0.087	-0.137
	X ₅	-0.013	0.000	0.002	-0.019	-0.006	0.035	0.002		0.002	-0.029
	X ₆	0.026	-0.099	0.000	0.000	-0.002	-0.006	0.002		-0.080	-0.023
	X ₇	-0.105		-0.005	-0.006	0.008	-0.001	0.000		-0.111	-0.160
	X ₈	0.042			-0.006	0.003	-0.008	0.003		0.035	-0.117
	X ₉	-0.094				0.002	-0.021	-0.012		-0.125	-0.130
	X ₁₀	-0.090					0.044	0.006		-0.041	0.202
	X ₁₁	0.106						0.004		0.110	0.305
X ₁₄	X ₁₂	-0.045								-0.045	-0.065
	X ₁	0.297	-0.282	0.020	-0.018	0.208	0.118	-0.004	0.157	0.496	0.700
	X ₂	-0.044	0.320	0.002	-0.002	-0.049	0.015	-0.001	-0.024	0.216	0.635
	X ₃	-0.045	-0.052	-0.004	-0.033	-0.012	0.008	-0.001	0.005	-0.134	-0.392
	X ₄	0.016	-0.006	-0.001	-0.028	-0.007	-0.020	0.000	-0.010	-0.057	-0.159
	X ₅	0.103	0.000	-0.004	-0.015	0.047	0.041	0.000	-0.005	0.168	0.129
	X ₆	0.008	-0.181	0.000	0.000	0.019	-0.012	-0.001	0.010	-0.158	-0.063
	X ₇	-0.095		0.008	-0.005	-0.061	-0.010	0.000	-0.038	-0.202	-0.263
	X ₈	-0.053			-0.004	-0.021	0.006	0.001	0.015	-0.056	-0.303
	X ₉	-0.005				-0.017	-0.037	-0.003	-0.034	-0.096	-0.095
	X ₁₀	0.253					0.107	0.003	-0.033	0.329	0.684
	X ₁₁	0.265						0.002	0.039	0.305	0.717
	X ₁₂	0.001							-0.016	-0.015	-0.015
	X ₁₃	0.364								0.364	0.617

E.V=Endogenous Variable; Ex.V=Exogenous; D.E= Direct Effect; T.E= Total Effect and T.A= Total Association

Table 26: Interpretations of Effects in a Model of Some Selected Quantitative Socioeconomic and Demographic Determinants of Fertility at Sylhet Division in Bangladesh, BDHS 2004.

[illegible]

Table 26 (Continued)

E.V	Ex.V	D.E	Indirect Effects Via							T.E	T.A
			X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃		
X ₁₂	X ₁	0.332	-0.106	-0.015	0.121	0.022	-0.073			0.281	0.087
	X ₂	-0.248	0.126	0.001	-0.040	-0.005	0.026			-0.141	0.052
	X ₃	0.022	-0.019	0.001	0.250	-0.001	0.061			0.315	0.352
	X ₄	0.075	0.002	0.000	0.066	0.000	-0.049			0.095	0.261
	X ₅	-0.069	-0.002	0.002	0.128	0.006	0.000			0.065	0.169
	X ₆	0.155	-0.076	0.000	0.032	0.002	-0.041			0.073	0.048
	X ₇	-0.095		-0.005	-0.012	-0.008	0.039			-0.082	0.149
	X ₈	-0.092			0.039	-0.001	0.107			0.052	0.022
	X ₉	0.525				-0.004	-0.023			0.498	0.521
	X ₁₀	0.021					0.016			0.037	0.018
	X ₁₁	0.008								0.008	0.024
X ₁₃	X ₁	0.136	-0.158	-0.002	-0.029	-0.038	0.289	-0.030		0.169	0.400
	X ₂	0.319	0.188	0.000	0.009	0.009	-0.273	0.020		0.272	0.360
	X ₃	0.012	-0.027	0.000	-0.060	0.001	-0.067	0.002		-0.138	-0.276
	X ₄	-0.056	0.002	0.000	-0.017	0.000	0.036	0.003		-0.032	-0.094
	X ₅	0.026	-0.002	0.000	-0.031	-0.010	-0.033	0.001		-0.048	-0.063
	X ₆	-0.192	-0.113	0.000	-0.008	-0.004	0.126	-0.009		-0.200	-0.106
	X ₇	-0.104		-0.001	0.003	0.015	-0.037	0.003		-0.120	-0.216
	X ₈	0.018			-0.009	0.003	-0.008	0.003		0.006	-0.100
	X ₉	-0.118				0.007	0.014	-0.023		-0.120	-0.171
	X ₁₀	-0.059					-0.010	0.006		-0.064	0.197
	X ₁₁	0.086						0.001		0.087	0.328
	X ₁₂	-0.048								-0.048	-0.111
X ₁₄	X ₁	0.166	-0.300	0.012	-0.024	0.250	0.212	-0.006	0.045	0.355	0.654
	X ₂	0.064	0.359	-0.001	0.008	-0.058	-0.125	0.006	0.105	0.358	0.607
	X ₃	-0.030	-0.051	-0.001	-0.049	-0.006	-0.040	0.002	0.004	-0.171	-0.324
	X ₄	-0.047	0.005	0.000	-0.014	0.003	0.064	0.004	-0.018	-0.004	-0.052
	X ₅	0.081	-0.004	-0.001	-0.025	0.066	0.008	-0.004	0.009	0.128	0.116
	X ₆	-0.026	-0.216	0.000	-0.006	0.028	0.048	-0.003	-0.063	-0.238	-0.084
	X ₇	-0.037		0.004	0.003	-0.100	-0.066	0.001	-0.034	-0.230	-0.295
	X ₈	-0.043			-0.008	-0.017	0.018	0.001	0.006	-0.043	-0.207
	X ₉	0.010				-0.047	-0.020	-0.002	-0.039	-0.098	-0.090
	X ₁₀	0.298					0.142	0.002	-0.019	0.422	0.721
	X ₁₁	0.300						0.002	0.028	0.330	0.730
	X ₁₂	0.013							-0.016	-0.003	-0.012
	X ₁₃	0.330								0.330	0.616

E.V=Endogenous Variable; Ex.V=Exogenous; D.E= Direct Effect; T.E= Total Effect and T.A= Total Association

Table 27: Component Analysis of Joint Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ in Barisal Division.

Joint Effect	Component	Amount $R^2_{14.123456789,10,11,12,13}$	(%)
Due to X_1X_2	$2P_{14,1} P_{14,2} r_{12}$	0.0212	2.12
Due to X_1X_3	$2P_{14,1} P_{14,3} r_{13}$	0.0033	0.33
Due to X_1X_4	$2P_{14,1} P_{14,4} r_{14}$	0.0004	0.04
Due to X_1X_5	$2P_{14,1} P_{14,5} r_{15}$	-0.0050	-0.50
Due to X_1X_6	$2P_{14,1} P_{14,6} r_{16}$	-0.0022	-0.22
Due to X_1X_7	$2P_{14,1} P_{14,7} r_{17}$	0.0006	0.06
Due to X_1X_8	$2P_{14,1} P_{14,8} r_{18}$	0.0114	1.14
Due to X_1X_9	$2P_{14,1} P_{14,9} r_{19}$	-0.0006	-0.06
Due to X_1X_{10}	$2P_{14,1} P_{14,10} r_{1,10}$	0.0477	4.77
Due to X_1X_{11}	$2P_{14,1} P_{14,11} r_{1,11}$	0.0690	6.90
Due to X_1X_{12}	$2P_{14,1} P_{14,12} r_{1,12}$	-0.0004	-0.04
Due to X_1X_{13}	$2P_{14,1} P_{14,13} r_{1,13}$	0.0577	5.77
Due to X_2X_3	$2P_{14,2} P_{14,3} r_{23}$	0.0010	0.10
Due to X_2X_4	$2P_{14,2} P_{14,4} r_{24}$	0.0002	0.02
Due to X_2X_5	$2P_{14,2} P_{14,5} r_{25}$	-0.0009	-0.09
Due to X_2X_6	$2P_{14,2} P_{14,6} r_{26}$	-0.0028	-0.28
Due to X_2X_7	$2P_{14,2} P_{14,7} r_{27}$	0.0007	0.07
Due to X_2X_8	$2P_{14,2} P_{14,8} r_{28}$	0.0028	0.28
Due to X_2X_9	$2P_{14,2} P_{14,9} r_{29}$	-0.0001	-0.01
Due to X_2X_{10}	$2P_{14,2} P_{14,10} r_{2,10}$	0.0127	1.27
Due to X_2X_{11}	$2P_{14,2} P_{14,11} r_{2,11}$	0.0180	1.80
Due to X_2X_{12}	$2P_{14,2} P_{14,12} r_{2,12}$	-0.0001	-0.01
Due to X_2X_{13}	$2P_{14,2} P_{14,13} r_{2,13}$	0.0155	1.55
Due to X_3X_4	$2P_{14,3} P_{14,4} r_{34}$	0.0008	0.08
Due to X_3X_5	$2P_{14,3} P_{14,5} r_{35}$	-0.0003	-0.03
Due to X_3X_6	$2P_{14,3} P_{14,6} r_{36}$	0.0002	0.02
Due to X_3X_7	$2P_{14,3} P_{14,7} r_{37}$	0.0018	0.18
Due to X_3X_8	$2P_{14,3} P_{14,8} r_{38}$	0.0005	0.05
Due to X_3X_9	$2P_{14,3} P_{14,9} r_{39}$	0.0007	0.07
Due to X_3X_{10}	$2P_{14,3} P_{14,10} r_{3,10}$	0.0044	0.44
Due to X_3X_{11}	$2P_{14,3} P_{14,11} r_{3,11}$	0.0086	0.86
Due to X_3X_{12}	$2P_{14,3} P_{14,12} r_{3,12}$	0.0002	0.02
Due to X_3X_{13}	$2P_{14,3} P_{14,13} r_{3,13}$	0.0055	0.55
Due to X_4X_5	$2P_{14,4} P_{14,5} r_{45}$	-0.0001	-0.01
Due to X_4X_6	$2P_{14,4} P_{14,6} r_{46}$	0.0002	0.02
Due to X_4X_7	$2P_{14,4} P_{14,7} r_{47}$	0.0008	0.08
Due to X_4X_8	$2P_{14,4} P_{14,8} r_{48}$	0.0001	0.01
Due to X_4X_9	$2P_{14,4} P_{14,9} r_{49}$	0.0004	0.04
Due to X_4X_{10}	$2P_{14,4} P_{14,10} r_{4,10}$	0.0014	0.14
Due to X_4X_{11}	$2P_{14,4} P_{14,11} r_{4,11}$	0.0035	0.35

Table 27 (Continued)

Due to X_4X_{12}	$2P_{14,4} P_{14,12} r_{4,12}$	0.0001	0.01
Due to X_4X_{13}	$2P_{14,4} P_{14,13} r_{4,13}$	0.0024	0.24
Due to X_5X_6	$2P_{14,5} P_{14,6} r_{56}$	0.0000	0.00
Due to X_5X_7	$2P_{14,5} P_{14,7} r_{57}$	-0.0003	-0.03
Due to X_5X_8	$2P_{14,5} P_{14,8} r_{58}$	-0.0012	-0.12
Due to X_5X_9	$2P_{14,5} P_{14,9} r_{59}$	-0.0002	-0.02
Due to X_5X_{10}	$2P_{14,5} P_{14,10} r_{5,10}$	0.0040	0.40
Due to X_5X_{11}	$2P_{14,5} P_{14,11} r_{5,11}$	0.0034	0.34
Due to X_5X_{12}	$2P_{14,5} P_{14,12} r_{5,12}$	0.0000	0.00
Due to X_5X_{13}	$2P_{14,5} P_{14,13} r_{5,13}$	-0.0042	-0.42
Due to X_6X_7	$2P_{14,6} P_{14,7} r_{67}$	0.0021	0.21
Due to X_6X_8	$2P_{14,6} P_{14,8} r_{68}$	-0.0007	-0.07
Due to X_6X_9	$2P_{14,6} P_{14,9} r_{69}$	0.0002	0.02
Due to X_6X_{10}	$2P_{14,6} P_{14,10} r_{6,10}$	-0.0002	-0.02
Due to X_6X_{11}	$2P_{14,6} P_{14,11} r_{6,11}$	-0.0002	-0.02
Due to X_6X_{12}	$2P_{14,6} P_{14,12} r_{6,12}$	0.0001	0.01
Due to X_6X_{13}	$2P_{14,6} P_{14,13} r_{6,13}$	-0.0014	-0.14
Due to X_7X_8	$2P_{14,7} P_{14,8} r_{78}$	-0.0007	-0.07
Due to X_7X_9	$2P_{14,7} P_{14,9} r_{79}$	0.0007	0.07
Due to X_7X_{10}	$2P_{14,7} P_{14,10} r_{7,10}$	0.0066	0.66
Due to X_7X_{11}	$2P_{14,7} P_{14,11} r_{7,11}$	0.0091	0.91
Due to X_7X_{12}	$2P_{14,7} P_{14,12} r_{7,12}$	0.0002	0.02
Due to X_7X_{13}	$2P_{14,7} P_{14,13} r_{7,13}$	0.0055	0.55
Due to X_8X_9	$2P_{14,8} P_{14,9} r_{89}$	0.0001	0.01
Due to X_8X_{10}	$2P_{14,8} P_{14,10} r_{8,10}$	0.0078	0.78
Due to X_8X_{11}	$2P_{14,8} P_{14,11} r_{8,11}$	0.0094	0.94
Due to X_8X_{12}	$2P_{14,8} P_{14,12} r_{8,12}$	-0.0001	-0.01
Due to X_8X_{13}	$2P_{14,8} P_{14,13} r_{8,13}$	0.0057	0.57
Due to X_9X_{10}	$2P_{14,9} P_{14,10} r_{9,10}$	0.0011	0.11
Due to X_9X_{11}	$2P_{14,9} P_{14,11} r_{9,11}$	0.0029	0.29
Due to X_9X_{12}	$2P_{14,9} P_{14,12} r_{9,12}$	0.0002	0.02
Due to X_9X_{13}	$2P_{14,9} P_{14,13} r_{9,13}$	0.0017	0.17
Due to $X_{10}X_{11}$	$2P_{14,10} P_{14,11} r_{10,11}$	0.0744	7.44
Due to $X_{10}X_{12}$	$2P_{14,10} P_{14,12} r_{10,12}$	0.0003	0.03
Due to $X_{10}X_{13}$	$2P_{14,10} P_{14,13} r_{10,13}$	0.0377	3.77
Due to $X_{11}X_{12}$	$2P_{14,11} P_{14,12} r_{11,12}$	0.0009	0.09
Due to $X_{11}X_{13}$	$2P_{14,11} P_{14,13} r_{11,13}$	0.0818	8.18
Due to $X_{12}X_{13}$	$2P_{14,12} P_{14,13} r_{12,13}$	0.0005	0.05
Total of Joint Effects		0.528	52.8
Total Multiple Determination	$R^2_{14.123456789,10,11,12,13}$	0.838	83.8

Table 28: Component Analysis of Joint Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ in Chittagong Division.

Joint Effect	Component	Amount $R^2_{14.123456789,10,11,12,13}$	(%)
Due to X_1X_2	$2P_{14,1} P_{14,2} r_{12}$	-0.0082	-0.82
Due to X_1X_3	$2P_{14,1} P_{14,3} r_{13}$	0.0034	0.34
Due to X_1X_4	$2P_{14,1} P_{14,4} r_{14}$	0.0007	0.07
Due to X_1X_5	$2P_{14,1} P_{14,5} r_{15}$	-0.0033	-0.33
Due to X_1X_6	$2P_{14,1} P_{14,6} r_{16}$	0.0007	0.07
Due to X_1X_7	$2P_{14,1} P_{14,7} r_{17}$	0.0002	0.02
Due to X_1X_8	$2P_{14,1} P_{14,8} r_{18}$	0.0075	0.75
Due to X_1X_9	$2P_{14,1} P_{14,9} r_{19}$	-0.0005	-0.05
Due to X_1X_{10}	$2P_{14,1} P_{14,10} r_{1,10}$	0.0897	8.97
Due to X_1X_{11}	$2P_{14,1} P_{14,11} r_{1,11}$	0.0960	9.60
Due to X_1X_{12}	$2P_{14,1} P_{14,12} r_{1,12}$	-0.0017	-0.17
Due to X_1X_{13}	$2P_{14,1} P_{14,13} r_{1,13}$	0.0784	7.84
Due to X_2X_3	$2P_{14,2} P_{14,3} r_{23}$	-0.0001	-0.01
Due to X_2X_4	$2P_{14,2} P_{14,4} r_{24}$	0.0000	0.00
Due to X_2X_5	$2P_{14,2} P_{14,5} r_{25}$	0.0000	0.00
Due to X_2X_6	$2P_{14,2} P_{14,6} r_{26}$	-0.0002	-0.02
Due to X_2X_7	$2P_{14,2} P_{14,7} r_{27}$	-0.0003	-0.03
Due to X_2X_8	$2P_{14,2} P_{14,8} r_{28}$	-0.0003	-0.03
Due to X_2X_9	$2P_{14,2} P_{14,9} r_{29}$	0.0000	0.00
Due to X_2X_{10}	$2P_{14,2} P_{14,10} r_{2,10}$	-0.0038	-0.38
Due to X_2X_{11}	$2P_{14,2} P_{14,11} r_{2,11}$	-0.0040	-0.40
Due to X_2X_{12}	$2P_{14,2} P_{14,12} r_{2,12}$	0.0001	0.01
Due to X_2X_{13}	$2P_{14,2} P_{14,13} r_{2,13}$	-0.0031	-0.31
Due to X_3X_4	$2P_{14,3} P_{14,4} r_{34}$	0.0003	0.03
Due to X_3X_5	$2P_{14,3} P_{14,5} r_{35}$	-0.0004	-0.04
Due to X_3X_6	$2P_{14,3} P_{14,6} r_{36}$	-0.0001	-0.01
Due to X_3X_7	$2P_{14,3} P_{14,7} r_{37}$	0.0017	0.17
Due to X_3X_8	$2P_{14,3} P_{14,8} r_{38}$	0.0001	0.01
Due to X_3X_9	$2P_{14,3} P_{14,9} r_{39}$	0.0007	0.07
Due to X_3X_{10}	$2P_{14,3} P_{14,10} r_{3,10}$	0.0026	0.26
Due to X_3X_{11}	$2P_{14,3} P_{14,11} r_{3,11}$	0.0038	0.38
Due to X_3X_{12}	$2P_{14,3} P_{14,12} r_{3,12}$	0.0002	0.02
Due to X_3X_{13}	$2P_{14,3} P_{14,13} r_{3,13}$	0.0031	0.31
Due to X_4X_5	$2P_{14,4} P_{14,5} r_{45}$	-0.0004	-0.04
Due to X_4X_6	$2P_{14,4} P_{14,6} r_{46}$	-0.0001	-0.01
Due to X_4X_7	$2P_{14,4} P_{14,7} r_{47}$	0.0010	0.10
Due to X_4X_8	$2P_{14,4} P_{14,8} r_{48}$	0.0000	0.00
Due to X_4X_9	$2P_{14,4} P_{14,9} r_{49}$	0.0006	0.06
Due to X_4X_{10}	$2P_{14,4} P_{14,10} r_{4,10}$	0.0012	0.12
Due to X_4X_{11}	$2P_{14,4} P_{14,11} r_{4,11}$	0.0019	0.19

Table 28 (Continued)

Due to X_4X_{12}	$2P_{14,4} P_{14,12} r_{4,12}$	0.0002	0.02
Due to X_4X_{13}	$2P_{14,4} P_{14,13} r_{4,13}$	0.0017	0.17
Due to X_5X_6	$2P_{14,5} P_{14,6} r_{56}$	0.0002	0.02
Due to X_5X_7	$2P_{14,5} P_{14,7} r_{57}$	-0.0009	-0.09
Due to X_5X_8	$2P_{14,5} P_{14,8} r_{58}$	-0.0003	-0.03
Due to X_5X_9	$2P_{14,5} P_{14,9} r_{59}$	-0.0018	-0.18
Due to X_5X_{10}	$2P_{14,5} P_{14,10} r_{5,10}$	0.0036	0.36
Due to X_5X_{11}	$2P_{14,5} P_{14,11} r_{5,11}$	0.0052	0.52
Due to X_5X_{12}	$2P_{14,5} P_{14,12} r_{5,12}$	-0.0004	-0.04
Due to X_5X_{13}	$2P_{14,5} P_{14,13} r_{5,13}$	-0.0034	-0.34
Due to X_6X_7	$2P_{14,6} P_{14,7} r_{67}$	-0.0018	-0.18
Due to X_6X_8	$2P_{14,6} P_{14,8} r_{68}$	0.0000	0.00
Due to X_6X_9	$2P_{14,6} P_{14,9} r_{69}$	-0.0002	-0.02
Due to X_6X_{10}	$2P_{14,6} P_{14,10} r_{6,10}$	-0.0004	-0.04
Due to X_6X_{11}	$2P_{14,6} P_{14,11} r_{6,11}$	-0.0007	-0.07
Due to X_6X_{12}	$2P_{14,6} P_{14,12} r_{6,12}$	-0.0001	-0.01
Due to X_6X_{13}	$2P_{14,6} P_{14,13} r_{6,13}$	-0.0005	-0.05
Due to X_7X_8	$2P_{14,7} P_{14,8} r_{78}$	-0.0008	-0.08
Due to X_7X_9	$2P_{14,7} P_{14,9} r_{79}$	0.0021	0.21
Due to X_7X_{10}	$2P_{14,7} P_{14,10} r_{7,10}$	0.0128	1.28
Due to X_7X_{11}	$2P_{14,7} P_{14,11} r_{7,11}$	0.0159	1.59
Due to X_7X_{12}	$2P_{14,7} P_{14,12} r_{7,12}$	0.0010	0.10
Due to X_7X_{13}	$2P_{14,7} P_{14,13} r_{7,13}$	0.0129	1.29
Due to X_8X_9	$2P_{14,8} P_{14,9} r_{89}$	0.0002	0.02
Due to X_8X_{10}	$2P_{14,8} P_{14,10} r_{8,10}$	0.0035	0.35
Due to X_8X_{11}	$2P_{14,8} P_{14,11} r_{8,11}$	0.0030	0.30
Due to X_8X_{12}	$2P_{14,8} P_{14,12} r_{8,12}$	-0.0001	-0.01
Due to X_8X_{13}	$2P_{14,8} P_{14,13} r_{8,13}$	0.0023	0.23
Due to X_9X_{10}	$2P_{14,9} P_{14,10} r_{9,10}$	0.0021	0.21
Due to X_9X_{11}	$2P_{14,9} P_{14,11} r_{9,11}$	0.0036	0.36
Due to X_9X_{12}	$2P_{14,9} P_{14,12} r_{9,12}$	0.0010	0.10
Due to X_9X_{13}	$2P_{14,9} P_{14,13} r_{9,13}$	-0.0217	-2.17
Due to $X_{10}X_{11}$	$2P_{14,10} P_{14,11} r_{10,11}$	0.0000	0.00
Due to $X_{10}X_{12}$	$2P_{14,10} P_{14,12} r_{10,12}$	0.0000	0.00
Due to $X_{10}X_{13}$	$2P_{14,10} P_{14,13} r_{10,13}$	0.0000	0.00
Due to $X_{11}X_{12}$	$2P_{14,11} P_{14,12} r_{11,12}$	0.0009	0.09
Due to $X_{11}X_{13}$	$2P_{14,11} P_{14,13} r_{11,13}$	0.0513	5.13
Due to $X_{12}X_{13}$	$2P_{14,12} P_{14,13} r_{12,13}$	0.0019	0.19
Total of Joint Effects		0.359	35.9
Total Multiple Determination	$R^2_{14.123456789,10,11,12,13}$	0.708	70.8

Table 29: Component Analysis of Joint Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ in Dhaka Division.

Joint Effect	Component	Amount $R^2_{14.123456789,10,11,12,13}$	(%)
Due to X_1X_2	$2P_{14,1} P_{14,2} r_{12}$	-0.0397	-3.97
Due to X_1X_3	$2P_{14,1} P_{14,3} r_{13}$	0.0054	0.54
Due to X_1X_4	$2P_{14,1} P_{14,4} r_{14}$	-0.0001	-0.01
Due to X_1X_5	$2P_{14,1} P_{14,5} r_{15}$	-0.0010	-0.10
Due to X_1X_6	$2P_{14,1} P_{14,6} r_{16}$	0.0003	0.03
Due to X_1X_7	$2P_{14,1} P_{14,7} r_{17}$	0.0024	0.24
Due to X_1X_8	$2P_{14,1} P_{14,8} r_{18}$	0.0137	1.37
Due to X_1X_9	$2P_{14,1} P_{14,9} r_{19}$	-0.0009	-0.09
Due to X_1X_{10}	$2P_{14,1} P_{14,10} r_{1,10}$	0.0736	7.36
Due to X_1X_{11}	$2P_{14,1} P_{14,11} r_{1,11}$	0.0908	9.08
Due to X_1X_{12}	$2P_{14,1} P_{14,12} r_{1,12}$	-0.0021	-0.21
Due to X_1X_{13}	$2P_{14,1} P_{14,13} r_{1,13}$	0.0787	7.87
Due to X_2X_3	$2P_{14,2} P_{14,3} r_{23}$	-0.0015	-0.15
Due to X_2X_4	$2P_{14,2} P_{14,4} r_{24}$	0.0000	0.00
Due to X_2X_5	$2P_{14,2} P_{14,5} r_{25}$	-0.0003	-0.03
Due to X_2X_6	$2P_{14,2} P_{14,6} r_{26}$	-0.0010	-0.10
Due to X_2X_7	$2P_{14,2} P_{14,7} r_{27}$	-0.0021	-0.21
Due to X_2X_8	$2P_{14,2} P_{14,8} r_{28}$	-0.0030	-0.30
Due to X_2X_9	$2P_{14,2} P_{14,9} r_{29}$	0.0002	0.02
Due to X_2X_{10}	$2P_{14,2} P_{14,10} r_{2,10}$	-0.0174	-1.74
Due to X_2X_{11}	$2P_{14,2} P_{14,11} r_{2,11}$	-0.0221	-2.21
Due to X_2X_{12}	$2P_{14,2} P_{14,12} r_{2,12}$	0.0005	0.05
Due to X_2X_{13}	$2P_{14,2} P_{14,13} r_{2,13}$	-0.0176	-1.76
Due to X_3X_4	$2P_{14,3} P_{14,4} r_{34}$	-0.0003	-0.03
Due to X_3X_5	$2P_{14,3} P_{14,5} r_{35}$	-0.0009	-0.09
Due to X_3X_6	$2P_{14,3} P_{14,6} r_{36}$	-0.0003	-0.03
Due to X_3X_7	$2P_{14,3} P_{14,7} r_{37}$	0.0049	0.49
Due to X_3X_8	$2P_{14,3} P_{14,8} r_{38}$	0.0005	0.05
Due to X_3X_9	$2P_{14,3} P_{14,9} r_{39}$	0.0011	0.11
Due to X_3X_{10}	$2P_{14,3} P_{14,10} r_{3,10}$	0.0054	0.54
Due to X_3X_{11}	$2P_{14,3} P_{14,11} r_{3,11}$	0.0088	0.88
Due to X_3X_{12}	$2P_{14,3} P_{14,12} r_{3,12}$	0.0007	0.07
Due to X_3X_{13}	$2P_{14,3} P_{14,13} r_{3,13}$	0.0070	0.70
Due to X_4X_5	$2P_{14,4} P_{14,5} r_{45}$	0.0001	0.01
Due to X_4X_6	$2P_{14,4} P_{14,6} r_{46}$	0.0000	0.00
Due to X_4X_7	$2P_{14,4} P_{14,7} r_{47}$	-0.0005	-0.05
Due to X_4X_8	$2P_{14,4} P_{14,8} r_{48}$	0.0000	0.00
Due to X_4X_9	$2P_{14,4} P_{14,9} r_{49}$	-0.0001	-0.01
Due to X_4X_{10}	$2P_{14,4} P_{14,10} r_{4,10}$	-0.0004	-0.04
Due to X_4X_{11}	$2P_{14,4} P_{14,11} r_{4,11}$	-0.0007	-0.07

Table 29 (Continued)

Due to X_4X_{12}	$2P_{14,4} P_{14,12} r_{4,12}$	-0.0001	-0.01
Due to X_4X_{13}	$2P_{14,4} P_{14,13} r_{4,13}$	-0.0008	-0.08
Due to X_5X_6	$2P_{14,5} P_{14,6} r_{5,6}$	0.0002	0.02
Due to X_5X_7	$2P_{14,5} P_{14,7} r_{5,7}$	-0.0016	-0.16
Due to X_5X_8	$2P_{14,5} P_{14,8} r_{5,8}$	-0.0009	-0.09
Due to X_5X_9	$2P_{14,5} P_{14,9} r_{5,9}$	-0.0006	-0.06
Due to X_5X_{10}	$2P_{14,5} P_{14,10} r_{5,10}$	0.0063	0.63
Due to X_5X_{11}	$2P_{14,5} P_{14,11} r_{5,11}$	0.0067	0.67
Due to X_5X_{12}	$2P_{14,5} P_{14,12} r_{5,12}$	-0.0003	-0.03
Due to X_5X_{13}	$2P_{14,5} P_{14,13} r_{5,13}$	-0.0027	-0.27
Due to X_6X_7	$2P_{14,6} P_{14,7} r_{6,7}$	-0.0017	-0.17
Due to X_6X_8	$2P_{14,6} P_{14,8} r_{6,8}$	0.0001	0.01
Due to X_6X_9	$2P_{14,6} P_{14,9} r_{6,9}$	-0.0001	-0.01
Due to X_6X_{10}	$2P_{14,6} P_{14,10} r_{6,10}$	-0.0006	-0.06
Due to X_6X_{11}	$2P_{14,6} P_{14,11} r_{6,11}$	-0.0007	-0.07
Due to X_6X_{12}	$2P_{14,6} P_{14,12} r_{6,12}$	-0.0001	-0.01
Due to X_6X_{13}	$2P_{14,6} P_{14,13} r_{6,13}$	-0.0010	-0.10
Due to X_7X_8	$2P_{14,7} P_{14,8} r_{7,8}$	-0.0012	-0.12
Due to X_7X_9	$2P_{14,7} P_{14,9} r_{7,9}$	0.0020	0.20
Due to X_7X_{10}	$2P_{14,7} P_{14,10} r_{7,10}$	0.0131	1.31
Due to X_7X_{11}	$2P_{14,7} P_{14,11} r_{7,11}$	0.0183	1.83
Due to X_7X_{12}	$2P_{14,7} P_{14,12} r_{7,12}$	0.0014	0.14
Due to X_7X_{13}	$2P_{14,7} P_{14,13} r_{7,13}$	0.0137	1.37
Due to X_8X_9	$2P_{14,8} P_{14,9} r_{8,9}$	0.0001	0.01
Due to X_8X_{10}	$2P_{14,8} P_{14,10} r_{8,10}$	0.0072	0.72
Due to X_8X_{11}	$2P_{14,8} P_{14,11} r_{8,11}$	0.0064	0.64
Due to X_8X_{12}	$2P_{14,8} P_{14,12} r_{8,12}$	-0.0002	-0.02
Due to X_8X_{13}	$2P_{14,8} P_{14,13} r_{8,13}$	0.0050	0.50
Due to X_9X_{10}	$2P_{14,9} P_{14,10} r_{9,10}$	0.0012	0.12
Due to X_9X_{11}	$2P_{14,9} P_{14,11} r_{9,11}$	0.0029	0.29
Due to X_9X_{12}	$2P_{14,9} P_{14,12} r_{9,12}$	0.0006	0.06
Due to X_9X_{13}	$2P_{14,9} P_{14,13} r_{9,13}$	-0.0282	-2.82
Due to $X_{10}X_{11}$	$2P_{14,10} P_{14,11} r_{10,11}$	0.0000	0.00
Due to $X_{10}X_{12}$	$2P_{14,10} P_{14,12} r_{10,12}$	0.0000	0.00
Due to $X_{10}X_{13}$	$2P_{14,10} P_{14,13} r_{10,13}$	0.0000	0.00
Due to $X_{11}X_{12}$	$2P_{14,11} P_{14,12} r_{11,12}$	0.0016	0.16
Due to $X_{11}X_{13}$	$2P_{14,11} P_{14,13} r_{11,13}$	0.0660	6.60
Due to $X_{12}X_{13}$	$2P_{14,12} P_{14,13} r_{12,13}$	0.0020	0.20
Total of Joint Effects		0.296	29.6
Total Multiple Determination	$R^2_{14.123456789,10,11,12,13}$	0.699	69.9

Table 30: Component Analysis of Joint Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ in Khulna Division.

Joint Effect	Component	Amount $R^2_{14.123456789,10,11,12,13}$	(%)
Due to X_1X_2	$2P_{14,1} P_{14,2} r_{12}$	-0.0064	-0.64
Due to X_1X_3	$2P_{14,1} P_{14,3} r_{13}$	0.0021	0.21
Due to X_1X_4	$2P_{14,1} P_{14,4} r_{14}$	0.0000	0.00
Due to X_1X_5	$2P_{14,1} P_{14,5} r_{15}$	-0.0025	-0.25
Due to X_1X_6	$2P_{14,1} P_{14,6} r_{16}$	-0.0001	-0.01
Due to X_1X_7	$2P_{14,1} P_{14,7} r_{17}$	0.0018	0.18
Due to X_1X_8	$2P_{14,1} P_{14,8} r_{18}$	0.0083	0.83
Due to X_1X_9	$2P_{14,1} P_{14,9} r_{19}$	-0.0006	-0.06
Due to X_1X_{10}	$2P_{14,1} P_{14,10} r_{1,10}$	0.0838	8.38
Due to X_1X_{11}	$2P_{14,1} P_{14,11} r_{1,11}$	0.0934	9.34
Due to X_1X_{12}	$2P_{14,1} P_{14,12} r_{1,12}$	-0.0001	-0.01
Due to X_1X_{13}	$2P_{14,1} P_{14,13} r_{1,13}$	0.0645	6.45
Due to X_2X_3	$2P_{14,2} P_{14,3} r_{23}$	-0.0006	-0.06
Due to X_2X_4	$2P_{14,2} P_{14,4} r_{24}$	0.0000	0.00
Due to X_2X_5	$2P_{14,2} P_{14,5} r_{25}$	0.0000	0.00
Due to X_2X_6	$2P_{14,2} P_{14,6} r_{26}$	0.0002	0.02
Due to X_2X_7	$2P_{14,2} P_{14,7} r_{27}$	-0.0010	-0.10
Due to X_2X_8	$2P_{14,2} P_{14,8} r_{28}$	-0.0019	-0.19
Due to X_2X_9	$2P_{14,2} P_{14,9} r_{29}$	0.0001	0.01
Due to X_2X_{10}	$2P_{14,2} P_{14,10} r_{2,10}$	-0.0220	-2.20
Due to X_2X_{11}	$2P_{14,2} P_{14,11} r_{2,11}$	-0.0233	-2.33
Due to X_2X_{12}	$2P_{14,2} P_{14,12} r_{2,12}$	0.0000	0.00
Due to X_2X_{13}	$2P_{14,2} P_{14,13} r_{2,13}$	-0.0165	-1.65
Due to X_3X_4	$2P_{14,3} P_{14,4} r_{34}$	0.0002	0.02
Due to X_3X_5	$2P_{14,3} P_{14,5} r_{35}$	-0.0002	-0.02
Due to X_3X_6	$2P_{14,3} P_{14,6} r_{36}$	0.0000	0.00
Due to X_3X_7	$2P_{14,3} P_{14,7} r_{37}$	0.0008	0.08
Due to X_3X_8	$2P_{14,3} P_{14,8} r_{38}$	0.0001	0.01
Due to X_3X_9	$2P_{14,3} P_{14,9} r_{39}$	0.0002	0.02
Due to X_3X_{10}	$2P_{14,3} P_{14,10} r_{3,10}$	0.0020	0.20
Due to X_3X_{11}	$2P_{14,3} P_{14,11} r_{3,11}$	0.0027	0.27
Due to X_3X_{12}	$2P_{14,3} P_{14,12} r_{3,12}$	0.0000	0.00
Due to X_3X_{13}	$2P_{14,3} P_{14,13} r_{3,13}$	0.0018	0.18
Due to X_4X_5	$2P_{14,4} P_{14,5} r_{45}$	-0.0002	-0.02
Due to X_4X_6	$2P_{14,4} P_{14,6} r_{46}$	0.0000	0.00
Due to X_4X_7	$2P_{14,4} P_{14,7} r_{47}$	0.0006	0.06
Due to X_4X_8	$2P_{14,4} P_{14,8} r_{48}$	0.0001	0.01
Due to X_4X_9	$2P_{14,4} P_{14,9} r_{49}$	0.0002	0.02
Due to X_4X_{10}	$2P_{14,4} P_{14,10} r_{4,10}$	0.0012	0.12
Due to X_4X_{11}	$2P_{14,4} P_{14,11} r_{4,11}$	0.0017	0.17

Table 30 (Continued)

Due to X_4X_{12}	$2P_{14,4} P_{14,12} r_{4,12}$	0.0000	0.00
Due to X_4X_{13}	$2P_{14,4} P_{14,13} r_{4,13}$	0.0012	0.12
Due to X_5X_6	$2P_{14,5} P_{14,6} r_{5,6}$	0.0000	0.00
Due to X_5X_7	$2P_{14,5} P_{14,7} r_{5,7}$	-0.0003	-0.03
Due to X_5X_8	$2P_{14,5} P_{14,8} r_{5,8}$	-0.0003	-0.03
Due to X_5X_9	$2P_{14,5} P_{14,9} r_{5,9}$	-0.0005	-0.05
Due to X_5X_{10}	$2P_{14,5} P_{14,10} r_{5,10}$	0.0078	0.78
Due to X_5X_{11}	$2P_{14,5} P_{14,11} r_{5,11}$	0.0033	0.33
Due to X_5X_{12}	$2P_{14,5} P_{14,12} r_{5,12}$	0.0000	0.00
Due to X_5X_{13}	$2P_{14,5} P_{14,13} r_{5,13}$	-0.0022	-0.22
Due to X_6X_7	$2P_{14,6} P_{14,7} r_{6,7}$	0.0002	0.02
Due to X_6X_8	$2P_{14,6} P_{14,8} r_{6,8}$	0.0000	0.00
Due to X_6X_9	$2P_{14,6} P_{14,9} r_{6,9}$	0.0000	0.00
Due to X_6X_{10}	$2P_{14,6} P_{14,10} r_{6,10}$	0.0001	0.01
Due to X_6X_{11}	$2P_{14,6} P_{14,11} r_{6,11}$	0.0000	0.00
Due to X_6X_{12}	$2P_{14,6} P_{14,12} r_{6,12}$	0.0000	0.00
Due to X_6X_{13}	$2P_{14,6} P_{14,13} r_{6,13}$	0.0000	0.00
Due to X_7X_8	$2P_{14,7} P_{14,8} r_{7,8}$	-0.0005	-0.05
Due to X_7X_9	$2P_{14,7} P_{14,9} r_{7,9}$	0.0006	0.06
Due to X_7X_{10}	$2P_{14,7} P_{14,10} r_{7,10}$	0.0082	0.82
Due to X_7X_{11}	$2P_{14,7} P_{14,11} r_{7,11}$	0.0091	0.91
Due to X_7X_{12}	$2P_{14,7} P_{14,12} r_{7,12}$	0.0000	0.00
Due to X_7X_{13}	$2P_{14,7} P_{14,13} r_{7,13}$	0.0062	0.62
Due to X_8X_9	$2P_{14,8} P_{14,9} r_{8,9}$	0.0001	0.01
Due to X_8X_{10}	$2P_{14,8} P_{14,10} r_{8,10}$	0.0051	0.51
Due to X_8X_{11}	$2P_{14,8} P_{14,11} r_{8,11}$	0.0047	0.47
Due to X_8X_{12}	$2P_{14,8} P_{14,12} r_{8,12}$	0.0000	0.00
Due to X_8X_{13}	$2P_{14,8} P_{14,13} r_{8,13}$	0.0025	0.25
Due to X_9X_{10}	$2P_{14,9} P_{14,10} r_{9,10}$	0.0007	0.07
Due to X_9X_{11}	$2P_{14,9} P_{14,11} r_{9,11}$	0.0014	0.14
Due to X_9X_{12}	$2P_{14,9} P_{14,12} r_{9,12}$	0.0000	0.00
Due to X_9X_{13}	$2P_{14,9} P_{14,13} r_{9,13}$	-0.0246	-2.46
Due to $X_{10}X_{11}$	$2P_{14,10} P_{14,11} r_{10,11}$	0.0000	0.00
Due to $X_{10}X_{12}$	$2P_{14,10} P_{14,12} r_{10,12}$	0.0000	0.00
Due to $X_{10}X_{13}$	$2P_{14,10} P_{14,13} r_{10,13}$	0.0000	0.00
Due to $X_{11}X_{12}$	$2P_{14,11} P_{14,12} r_{11,12}$	0.0000	0.00
Due to $X_{11}X_{13}$	$2P_{14,11} P_{14,13} r_{11,13}$	0.0498	4.98
Due to $X_{12}X_{13}$	$2P_{14,12} P_{14,13} r_{12,13}$	0.0001	0.01
Total of Joint Effects		0.263	26.3
Total Multiple Determination	$R^2_{14.123456789,10,11,12,13}$	0.623	63.2

Table 31: Component Analysis of Joint Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ in Rajshahi Division.

Joint Effect	Component	Amount $R^2_{14.123456789,10,11,12,13}$	(%)
Due to X_1X_2	$2P_{14,1} P_{14,2} r_{12}$	-0.0228	-2.28
Due to X_1X_3	$2P_{14,1} P_{14,3} r_{13}$	0.0090	0.90
Due to X_1X_4	$2P_{14,1} P_{14,4} r_{14}$	-0.0003	-0.03
Due to X_1X_5	$2P_{14,1} P_{14,5} r_{15}$	-0.0020	-0.20
Due to X_1X_6	$2P_{14,1} P_{14,6} r_{16}$	0.0002	0.02
Due to X_1X_7	$2P_{14,1} P_{14,7} r_{17}$	0.0029	0.29
Due to X_1X_8	$2P_{14,1} P_{14,8} r_{18}$	0.0125	1.25
Due to X_1X_9	$2P_{14,1} P_{14,9} r_{19}$	-0.0001	-0.01
Due to X_1X_{10}	$2P_{14,1} P_{14,10} r_{1,10}$	0.0782	7.82
Due to X_1X_{11}	$2P_{14,1} P_{14,11} r_{1,11}$	0.0898	8.98
Due to X_1X_{12}	$2P_{14,1} P_{14,12} r_{1,12}$	0.0001	0.01
Due to X_1X_{13}	$2P_{14,1} P_{14,13} r_{1,13}$	0.0819	8.19
Due to X_2X_3	$2P_{14,2} P_{14,3} r_{23}$	-0.0014	-0.14
Due to X_2X_4	$2P_{14,2} P_{14,4} r_{24}$	0.0001	0.01
Due to X_2X_5	$2P_{14,2} P_{14,5} r_{25}$	0.0001	0.01
Due to X_2X_6	$2P_{14,2} P_{14,6} r_{26}$	-0.0003	-0.03
Due to X_2X_7	$2P_{14,2} P_{14,7} r_{27}$	-0.0008	-0.08
Due to X_2X_8	$2P_{14,2} P_{14,8} r_{28}$	-0.0017	-0.17
Due to X_2X_9	$2P_{14,2} P_{14,9} r_{29}$	0.0000	0.00
Due to X_2X_{10}	$2P_{14,2} P_{14,10} r_{2,10}$	-0.0106	-1.06
Due to X_2X_{11}	$2P_{14,2} P_{14,11} r_{2,11}$	-0.0119	-1.19
Due to X_2X_{12}	$2P_{14,2} P_{14,12} r_{2,12}$	0.0000	0.00
Due to X_2X_{13}	$2P_{14,2} P_{14,13} r_{2,13}$	-0.0108	-1.08
Due to X_3X_4	$2P_{14,3} P_{14,4} r_{34}$	-0.0009	-0.09
Due to X_3X_5	$2P_{14,3} P_{14,5} r_{35}$	-0.0012	-0.12
Due to X_3X_6	$2P_{14,3} P_{14,6} r_{36}$	-0.0001	-0.01
Due to X_3X_7	$2P_{14,3} P_{14,7} r_{37}$	0.0039	0.39
Due to X_3X_8	$2P_{14,3} P_{14,8} r_{38}$	0.0007	0.07
Due to X_3X_9	$2P_{14,3} P_{14,9} r_{39}$	0.0002	0.02
Due to X_3X_{10}	$2P_{14,3} P_{14,10} r_{3,10}$	0.0065	0.65
Due to X_3X_{11}	$2P_{14,3} P_{14,11} r_{3,11}$	0.0094	0.94
Due to X_3X_{12}	$2P_{14,3} P_{14,12} r_{3,12}$	0.0000	0.00
Due to X_3X_{13}	$2P_{14,3} P_{14,13} r_{3,13}$	0.0080	0.80
Due to X_4X_5	$2P_{14,4} P_{14,5} r_{45}$	-0.0004	-0.04
Due to X_4X_6	$2P_{14,4} P_{14,6} r_{46}$	0.0000	0.00
Due to X_4X_7	$2P_{14,4} P_{14,7} r_{47}$	0.0011	0.11
Due to X_4X_8	$2P_{14,4} P_{14,8} r_{48}$	0.0001	0.01
Due to X_4X_9	$2P_{14,4} P_{14,9} r_{49}$	0.0001	0.01
Due to X_4X_{10}	$2P_{14,4} P_{14,10} r_{4,10}$	0.0009	0.09
Due to X_4X_{11}	$2P_{14,4} P_{14,11} r_{4,11}$	0.0019	0.19

Table 31 (Continued)

Due to X_4X_{12}	$2P_{14,4} P_{14,12} r_{4,12}$	0.0000	0.00
Due to X_4X_{13}	$2P_{14,4} P_{14,13} r_{4,13}$	0.0016	0.16
Due to X_5X_6	$2P_{14,5} P_{14,6} r_{5,6}$	0.0000	0.00
Due to X_5X_7	$2P_{14,5} P_{14,7} r_{5,7}$	-0.0013	-0.13
Due to X_5X_8	$2P_{14,5} P_{14,8} r_{5,8}$	-0.0008	-0.08
Due to X_5X_9	$2P_{14,5} P_{14,9} r_{5,9}$	-0.0002	-0.02
Due to X_5X_{10}	$2P_{14,5} P_{14,10} r_{5,10}$	0.0058	0.58
Due to X_5X_{11}	$2P_{14,5} P_{14,11} r_{5,11}$	0.0045	0.45
Due to X_5X_{12}	$2P_{14,5} P_{14,12} r_{5,12}$	0.0000	0.00
Due to X_5X_{13}	$2P_{14,5} P_{14,13} r_{5,13}$	-0.0022	-0.22
Due to X_6X_7	$2P_{14,6} P_{14,7} r_{6,7}$	-0.0004	-0.04
Due to X_6X_8	$2P_{14,6} P_{14,8} r_{6,8}$	0.0001	0.01
Due to X_6X_9	$2P_{14,6} P_{14,9} r_{6,9}$	0.0000	0.00
Due to X_6X_{10}	$2P_{14,6} P_{14,10} r_{6,10}$	-0.0002	-0.02
Due to X_6X_{11}	$2P_{14,6} P_{14,11} r_{6,11}$	-0.0002	-0.02
Due to X_6X_{12}	$2P_{14,6} P_{14,12} r_{6,12}$	0.0000	0.00
Due to X_6X_{13}	$2P_{14,6} P_{14,13} r_{6,13}$	-0.0001	-0.01
Due to X_7X_8	$2P_{14,7} P_{14,8} r_{7,8}$	-0.0007	-0.07
Due to X_7X_9	$2P_{14,7} P_{14,9} r_{7,9}$	0.0003	0.03
Due to X_7X_{10}	$2P_{14,7} P_{14,10} r_{7,10}$	0.0098	0.98
Due to X_7X_{11}	$2P_{14,7} P_{14,11} r_{7,11}$	0.0117	1.17
Due to X_7X_{12}	$2P_{14,7} P_{14,12} r_{7,12}$	0.0000	0.00
Due to X_7X_{13}	$2P_{14,7} P_{14,13} r_{7,13}$	0.0111	1.11
Due to X_8X_9	$2P_{14,8} P_{14,9} r_{8,9}$	0.0000	0.00
Due to X_8X_{10}	$2P_{14,8} P_{14,10} r_{8,10}$	0.0066	0.66
Due to X_8X_{11}	$2P_{14,8} P_{14,11} r_{8,11}$	0.0063	0.63
Due to X_8X_{12}	$2P_{14,8} P_{14,12} r_{8,12}$	0.0000	0.00
Due to X_8X_{13}	$2P_{14,8} P_{14,13} r_{8,13}$	0.0045	0.45
Due to X_9X_{10}	$2P_{14,9} P_{14,10} r_{9,10}$	0.0001	0.01
Due to X_9X_{11}	$2P_{14,9} P_{14,11} r_{9,11}$	0.0005	0.05
Due to X_9X_{12}	$2P_{14,9} P_{14,12} r_{9,12}$	0.0000	0.00
Due to X_9X_{13}	$2P_{14,9} P_{14,13} r_{9,13}$	0.0000	0.00
Due to $X_{10}X_{11}$	$2P_{14,10} P_{14,11} r_{10,11}$	-0.0239	-2.39
Due to $X_{10}X_{12}$	$2P_{14,10} P_{14,12} r_{10,12}$	0.0000	0.00
Due to $X_{10}X_{13}$	$2P_{14,10} P_{14,13} r_{10,13}$	0.0000	0.00
Due to $X_{11}X_{12}$	$2P_{14,11} P_{14,12} r_{11,12}$	0.0000	0.00
Due to $X_{11}X_{13}$	$2P_{14,11} P_{14,13} r_{11,13}$	0.0588	5.88
Due to $X_{12}X_{13}$	$2P_{14,12} P_{14,13} r_{12,13}$	0.0000	0.00
Total of Joint Effects		0.334	33.4
Total Multiple Determination	$R^2_{14.123456789,10,11,12,13}$	0.715	71.5

Table 32: Component Analysis of Joint Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ in Sylhet Division.

Joint Effect	Component	Amount $R^2_{14.123456789,10,11,12,13}$	(%)
Due to X_1X_2	$2P_{14,1} P_{14,2} r_{12}$	0.0177	1.77
Due to X_1X_3	$2P_{14,1} P_{14,3} r_{13}$	0.0024	0.24
Due to X_1X_4	$2P_{14,1} P_{14,4} r_{14}$	-0.0005	-0.05
Due to X_1X_5	$2P_{14,1} P_{14,5} r_{15}$	0.0011	0.11
Due to X_1X_6	$2P_{14,1} P_{14,6} r_{16}$	-0.0004	-0.04
Due to X_1X_7	$2P_{14,1} P_{14,7} r_{17}$	0.0004	0.04
Due to X_1X_8	$2P_{14,1} P_{14,8} r_{18}$	0.0040	0.40
Due to X_1X_9	$2P_{14,1} P_{14,9} r_{19}$	0.0002	0.02
Due to X_1X_{10}	$2P_{14,1} P_{14,10} r_{1,10}$	0.0456	4.56
Due to X_1X_{11}	$2P_{14,1} P_{14,11} r_{1,11}$	0.0526	5.26
Due to X_1X_{12}	$2P_{14,1} P_{14,12} r_{1,12}$	0.0004	0.04
Due to X_1X_{13}	$2P_{14,1} P_{14,13} r_{1,13}$	0.0439	4.39
Due to X_2X_3	$2P_{14,2} P_{14,3} r_{23}$	0.0010	0.10
Due to X_2X_4	$2P_{14,2} P_{14,4} r_{24}$	0.0000	0.00
Due to X_2X_5	$2P_{14,2} P_{14,5} r_{25}$	0.0008	0.08
Due to X_2X_6	$2P_{14,2} P_{14,6} r_{26}$	-0.0014	-0.14
Due to X_2X_7	$2P_{14,2} P_{14,7} r_{27}$	0.0006	0.06
Due to X_2X_8	$2P_{14,2} P_{14,8} r_{28}$	0.0012	0.12
Due to X_2X_9	$2P_{14,2} P_{14,9} r_{29}$	0.0000	0.00
Due to X_2X_{10}	$2P_{14,2} P_{14,10} r_{2,10}$	0.0166	1.66
Due to X_2X_{11}	$2P_{14,2} P_{14,11} r_{2,11}$	0.0186	1.86
Due to X_2X_{12}	$2P_{14,2} P_{14,12} r_{2,12}$	0.0001	0.01
Due to X_2X_{13}	$2P_{14,2} P_{14,13} r_{2,13}$	0.0152	1.52
Due to X_3X_4	$2P_{14,3} P_{14,4} r_{34}$	0.0012	0.12
Due to X_3X_5	$2P_{14,3} P_{14,5} r_{35}$	-0.0010	-0.10
Due to X_3X_6	$2P_{14,3} P_{14,6} r_{36}$	0.0001	0.01
Due to X_3X_7	$2P_{14,3} P_{14,7} r_{37}$	0.0009	0.09
Due to X_3X_8	$2P_{14,3} P_{14,8} r_{38}$	0.0002	0.02
Due to X_3X_9	$2P_{14,3} P_{14,9} r_{39}$	-0.0003	-0.03
Due to X_3X_{10}	$2P_{14,3} P_{14,10} r_{3,10}$	0.0038	0.38
Due to X_3X_{11}	$2P_{14,3} P_{14,11} r_{3,11}$	0.0060	0.60
Due to X_3X_{12}	$2P_{14,3} P_{14,12} r_{3,12}$	-0.0003	-0.03
Due to X_3X_{13}	$2P_{14,3} P_{14,13} r_{3,13}$	0.0055	0.55
Due to X_4X_5	$2P_{14,4} P_{14,5} r_{45}$	-0.0010	-0.10
Due to X_4X_6	$2P_{14,4} P_{14,6} r_{46}$	0.0001	0.01
Due to X_4X_7	$2P_{14,4} P_{14,7} r_{47}$	0.0007	0.07
Due to X_4X_8	$2P_{14,4} P_{14,8} r_{48}$	0.0000	0.00
Due to X_4X_9	$2P_{14,4} P_{14,9} r_{49}$	-0.0004	-0.04
Due to X_4X_{10}	$2P_{14,4} P_{14,10} r_{4,10}$	0.0009	0.09
Due to X_4X_{11}	$2P_{14,4} P_{14,11} r_{4,11}$	0.0060	0.60

Table 32 (Continued)

Due to X_4X_{12}	$2P_{14,4} P_{14,12} r_{4,12}$	-0.0003	-0.03
Due to X_4X_{13}	$2P_{14,4} P_{14,13} r_{4,13}$	0.0029	0.29
Due to X_5X_6	$2P_{14,5} P_{14,6} r_{5,6}$	-0.0002	-0.02
Due to X_5X_7	$2P_{14,5} P_{14,7} r_{5,7}$	-0.0006	-0.06
Due to X_5X_8	$2P_{14,5} P_{14,8} r_{5,8}$	-0.0001	-0.01
Due to X_5X_9	$2P_{14,5} P_{14,9} r_{5,9}$	0.0006	0.06
Due to X_5X_{10}	$2P_{14,5} P_{14,10} r_{5,10}$	0.0059	0.59
Due to X_5X_{11}	$2P_{14,5} P_{14,11} r_{5,11}$	0.0040	0.40
Due to X_5X_{12}	$2P_{14,5} P_{14,12} r_{5,12}$	0.0004	0.04
Due to X_5X_{13}	$2P_{14,5} P_{14,13} r_{5,13}$	-0.0034	-0.34
Due to X_6X_7	$2P_{14,6} P_{14,7} r_{6,7}$	0.0006	0.06
Due to X_6X_8	$2P_{14,6} P_{14,8} r_{6,8}$	-0.0001	-0.01
Due to X_6X_9	$2P_{14,6} P_{14,9} r_{6,9}$	0.0000	0.00
Due to X_6X_{10}	$2P_{14,6} P_{14,10} r_{6,10}$	0.0007	0.07
Due to X_6X_{11}	$2P_{14,6} P_{14,11} r_{6,11}$	0.0004	0.04
Due to X_6X_{12}	$2P_{14,6} P_{14,12} r_{6,12}$	0.0000	0.00
Due to X_6X_{13}	$2P_{14,6} P_{14,13} r_{6,13}$	0.0018	0.18
Due to X_7X_8	$2P_{14,7} P_{14,8} r_{7,8}$	-0.0002	-0.02
Due to X_7X_9	$2P_{14,7} P_{14,9} r_{7,9}$	-0.0002	-0.02
Due to X_7X_{10}	$2P_{14,7} P_{14,10} r_{7,10}$	0.0050	0.50
Due to X_7X_{11}	$2P_{14,7} P_{14,11} r_{7,11}$	0.0045	0.45
Due to X_7X_{12}	$2P_{14,7} P_{14,12} r_{7,12}$	-0.0001	-0.01
Due to X_7X_{13}	$2P_{14,7} P_{14,13} r_{7,13}$	0.0053	0.53
Due to X_8X_9	$2P_{14,8} P_{14,9} r_{8,9}$	0.0000	0.00
Due to X_8X_{10}	$2P_{14,8} P_{14,10} r_{8,10}$	0.0041	0.41
Due to X_8X_{11}	$2P_{14,8} P_{14,11} r_{8,11}$	0.0058	0.58
Due to X_8X_{12}	$2P_{14,8} P_{14,12} r_{8,12}$	0.0000	0.00
Due to X_8X_{13}	$2P_{14,8} P_{14,13} r_{8,13}$	0.0028	0.28
Due to X_9X_{10}	$2P_{14,9} P_{14,10} r_{9,10}$	-0.0004	-0.04
Due to X_9X_{11}	$2P_{14,9} P_{14,11} r_{9,11}$	-0.0008	-0.08
Due to X_9X_{12}	$2P_{14,9} P_{14,12} r_{9,12}$	0.0001	0.01
Due to X_9X_{13}	$2P_{14,9} P_{14,13} r_{9,13}$	-0.0337	-3.37
Due to $X_{10}X_{11}$	$2P_{14,10} P_{14,11} r_{10,11}$	0.0000	0.00
Due to $X_{10}X_{12}$	$2P_{14,10} P_{14,12} r_{10,12}$	0.0000	0.00
Due to $X_{10}X_{13}$	$2P_{14,10} P_{14,13} r_{10,13}$	0.0000	0.00
Due to $X_{11}X_{12}$	$2P_{14,11} P_{14,12} r_{11,12}$	0.0002	0.02
Due to $X_{11}X_{13}$	$2P_{14,11} P_{14,13} r_{11,13}$	0.0650	6.50
Due to $X_{12}X_{13}$	$2P_{14,12} P_{14,13} r_{12,13}$	-0.0010	-0.10
Total of Joint Effects		0.311	31.1
Total Multiple Determination	$R^2_{14.123456789,10,11,12,13}$	0.644	64.4

Table 33: Component Analysis of Net Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ for Barisal Division.

Net Effect	Component	Amount R^2	(%)
Due to X_1	$P^2_{14,1}$	0.044	4.42844
Due to X_2	$P^2_{14,2}$	0.003	0.33421
Due to X_3	$P^2_{14,3}$	0.001	0.09864
Due to X_4	$P^2_{14,4}$	0.000	0.0384
Due to X_5	$P^2_{14,5}$	0.010	0.96282
Due to X_6	$P^2_{14,6}$	0.003	0.26831
Due to X_7	$P^2_{14,7}$	0.005	0.45053
Due to X_8	$P^2_{14,8}$	0.004	0.40813
Due to X_9	$P^2_{14,9}$	0.000	0.03545
Due to X_{10}	$P^2_{14,10}$	0.051	5.14927
Due to X_{11}	$P^2_{14,11}$	0.089	8.85635
Due to X_{12}	$P^2_{14,12}$	0.000	0.01091
Due to X_{13}	$P^2_{14,13}$	0.099	9.87145
Total of Net Effects		0.309	30.9

Table 34: Component Analysis of Net Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ for Chittagong Division.

Net Effect	Component	Amount R^2	(%)
Due to X_1	$P^2_{14,1}$	0.1066	10.6611
Due to X_2	$P^2_{14,2}$	0.0002	0.02165
Due to X_3	$P^2_{14,3}$	0.0003	0.03083
Due to X_4	$P^2_{14,4}$	0.0004	0.03629
Due to X_5	$P^2_{14,5}$	0.0089	0.89239
Due to X_6	$P^2_{14,6}$	0.0004	0.04235
Due to X_7	$P^2_{14,7}$	0.0146	1.45801
Due to X_8	$P^2_{14,8}$	0.0012	0.11556
Due to X_9	$P^2_{14,9}$	0.0016	0.16446
Due to X_{10}	$P^2_{14,10}$	0.0597	5.97182
Due to X_{11}	$P^2_{14,11}$	0.0692	6.92006
Due to X_{12}	$P^2_{14,12}$	0.0008	0.08383
Due to X_{13}	$P^2_{14,13}$	0.0843	8.42916
Total of Net Effects		0.348	34.8

Table 35: Component Analysis of Net Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ for Dhaka Division.

Net Effect	Component	Amount R^2	(%)
Due to X_1	$P^2_{14,1}$	0.090	9.03611
Due to X_2	$P^2_{14,2}$	0.006	0.57172
Due to X_3	$P^2_{14,3}$	0.002	0.16391
Due to X_4	$P^2_{14,4}$	0.000	0.00646
Due to X_5	$P^2_{14,5}$	0.011	1.11451
Due to X_6	$P^2_{14,6}$	0.000	0.03435
Due to X_7	$P^2_{14,7}$	0.014	1.42533
Due to X_8	$P^2_{14,8}$	0.004	0.40509
Due to X_9	$P^2_{14,9}$	0.001	0.05372
Due to X_{10}	$P^2_{14,10}$	0.065	6.48422
Due to X_{11}	$P^2_{14,11}$	0.077	7.74151
Due to X_{12}	$P^2_{14,12}$	0.001	0.07232
Due to X_{13}	$P^2_{14,13}$	0.132	13.1948
Total of Net Effects		0.403	40.3

Table 36: Component Analysis of Net Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ for Khulna Division.

Net Effect	Component	Amount R^2	(%)
Due to X_1	$P^2_{14,1}$	0.082	8.23096
Due to X_2	$P^2_{14,2}$	0.000	0.01542
Due to X_3	$P^2_{14,3}$	0.000	0.01344
Due to X_4	$P^2_{14,4}$	0.000	0.03574
Due to X_5	$P^2_{14,5}$	0.007	0.71658
Due to X_6	$P^2_{14,6}$	0.000	0.00163
Due to X_7	$P^2_{14,7}$	0.005	0.50625
Due to X_8	$P^2_{14,8}$	0.002	0.18904
Due to X_9	$P^2_{14,9}$	0.000	0.02549
Due to X_{10}	$P^2_{14,10}$	0.083	8.32814
Due to X_{11}	$P^2_{14,11}$	0.075	7.49839
Due to X_{12}	$P^2_{14,12}$	0.000	0.00026
Due to X_{13}	$P^2_{14,13}$	0.104	10.3784
Total of Net Effects		0.359	35.9

Table 37: Component Analysis of Net Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ for Rajshahi Division.

Net Effect	Component	Amount R^2	(%)
Due to X_1	$P^2_{14,1}$	0.088	8.84595
Due to X_2	$P^2_{14,2}$	0.002	0.19409
Due to X_3	$P^2_{14,3}$	0.002	0.19979
Due to X_4	$P^2_{14,4}$	0.000	0.02554
Due to X_5	$P^2_{14,5}$	0.011	1.06997
Due to X_6	$P^2_{14,6}$	0.000	0.00588
Due to X_7	$P^2_{14,7}$	0.009	0.90815
Due to X_8	$P^2_{14,8}$	0.003	0.27766
Due to X_9	$P^2_{14,9}$	0.000	0.00208
Due to X_{10}	$P^2_{14,10}$	0.064	6.39095
Due to X_{11}	$P^2_{14,11}$	0.070	7.00773
Due to X_{12}	$P^2_{14,12}$	0.000	0.00017
Due to X_{13}	$P^2_{14,13}$	0.132	13.2216
Total of Net Effects		0.381	38.1

Table 38: Component Analysis of Net Effect of Coefficient of Determination, $R^2_{14.123456789,10,11,12,13}$ for Sylhet Division.

Net Effect	Component	Amount R^2	(%)
Due to X_1	$P^2_{14,1}$	0.028	2.75358
Due to X_2	$P^2_{14,2}$	0.004	0.40477
Due to X_3	$P^2_{14,3}$	0.001	0.08899
Due to X_4	$P^2_{14,4}$	0.002	0.21931
Due to X_5	$P^2_{14,5}$	0.006	0.64854
Due to X_6	$P^2_{14,6}$	0.001	0.06579
Due to X_7	$P^2_{14,7}$	0.001	0.14005
Due to X_8	$P^2_{14,8}$	0.002	0.18329
Due to X_9	$P^2_{14,9}$	0.000	0.00923
Due to X_{10}	$P^2_{14,10}$	0.089	8.85747
Due to X_{11}	$P^2_{14,11}$	0.090	8.98711
Due to X_{12}	$P^2_{14,12}$	0.000	0.01704
Due to X_{13}	$P^2_{14,13}$	0.109	10.9182
Total of Net Effects		0.333	33.3

4.2.1 ESTIMATED PATH EQUATIONS AND ITS COEFFICIENTS

Using the BDHS 2004 data, the path coefficients given in the equations (16), (17), (18), (19), (20), (21), (22) and (23) are estimated by the ordinary least square (OLS) regression procedure. Thus, the fitted form of the path model with their t values, significance level and R^2 (unadjusted) are given in equations from (48) to (95) according to the divisions is as follows:

Estimated equations of the path model for Barisal division:

$$\hat{X}_7 = 1.446(t = 24.75; sig = .000)X_1 - 1.714(t = -25.38; sig = .000)X_2 + 0.219(t = 7.08; sig = .000)X_3 + 0.048(t = 1.65; sig = .100)X_4 - 0.002(t = -0.09; sig = .928)X_5 + 0.910(t = 27.45; sig = .000)X_6 \quad R^2 = 0.513 \quad (48)$$

$$\hat{X}_8 = -0.375(t = -4.09; sig = .000)X_1 - 0.031(t = -0.29; sig = .770)X_2 + 0.036(t = 0.89; sig = .374)X_3 + 0.049(t = 1.28; sig = .200)X_4 + 0.056(t = 2.19; sig = .028)X_5 - 0.015(t = -0.27; sig = .787)X_6 - 0.122(t = -3.34; sig = .001)X_7 \quad R^2 = 0.193 \quad (49)$$

$$\hat{X}_9 = 0.246(t = 3.36; sig = .001)X_1 - 0.034(t = -0.40; sig = .688)X_2 + 0.422(t = 13.16; sig = .000)X_3 + 0.330(t = 10.99; sig = .000)X_4 + 0.033(t = 1.61; sig = .108)X_5 + 0.014(t = 0.33; sig = .741)X_6 + 0.006(t = 0.22; sig = .826)X_7 + 0.045(t = 2.03; sig = .042)X_8 \quad R^2 = 0.496 \quad (50)$$

$$\hat{X}_{10} = 0.499(t = 5.41; sig = .000)X_1 + 0.032(t = 0.34; sig = .736)X_2 - 0.065(t = -1.69; sig = .092)X_3 - 0.037(t = -1.03; sig = .302)X_4 + 0.154(t = 6.71; sig = .000)X_5 + 0.012(t = 0.24; sig = .808)X_6 - 0.159(t = -4.85; sig = .000)X_7 - 0.082(t = -3.23; sig = .001)X_8 - 0.068(t = -2.12; sig = .034)X_9 \quad R^2 = 0.355 \quad (51)$$

$$\hat{X}_{11} = 0.402(t = 5.33; sig = .000)X_1 + 0.025(t = 0.29; sig = .770)X_2 - 0.157(t = -4.27; sig = .000)X_3 - 0.078(t = -2.34; sig = .020)X_4 + 0.078(t = 3.52; sig = .000)X_5 + 0.022(t = 0.48; sig = .632)X_6 - 0.059(t = -1.88; sig = .061)X_7 + 0.050(t = 2.01; sig = .044)X_8 - 0.082(t = -2.70; sig = .007)X_9 + 0.246(t = 9.12; sig = .000)X_{10} \quad R^2 = 0.503 \quad (52)$$

$$\hat{X}_{12} = -.059(t = -0.62; sig = .535)X_1 + 0.222(t = 2.11; sig = .035)X_2 + 0.090(t = 1.94; sig = .053)X_3 + 0.091(t = 2.18; sig = .029)X_4 - 0.005(t = -0.18; sig = .857)X_5 - 0.042(t = -0.74; sig = .459)X_6 + 0.047(t = 1.19; sig = .236)X_7 - 0.058(t = -1.87; sig = .061)X_8 + 0.299(t = 7.87; sig = .000)X_9 - 0.019(t = -0.56; sig = .578)X_{10} - 0.076(t = -1.99; sig = .047)X_{11} \quad R^2 = 0.236 \quad (53)$$

$$\begin{aligned}\hat{X}_{13} = & 0.244(t = 2.63; sig = .009) X_1 + 0.168(t = 1.62; sig = .106) X_2 \\ & + 0.011(t = 0.24; sig = .813) X_3 - 0.083(t = -2.03; sig = .043) X_4 \\ & - 0.011(t = -0.41; sig = .684) X_5 - 0.063(t = -1.15; sig = .252) X_6 \\ & - 0.012(t = -0.31; sig = .760) X_7 + 0.071(t = 2.33; sig = .020) X_8 \\ & - 0.085(t = -2.22; sig = .027) X_9 - 0.060(t = -1.76; sig = .079) X_{10} \\ & + 0.212(t = 5.67; t = .000) X_{11} + 0.009(t = 0.30; sig = .764) X_{12} \quad R^2 = 0.267\end{aligned}\quad (54)$$

$$\begin{aligned}\hat{X}_{14} = & 0.210(t = 4.99; sig = .000) X_1 + 0.058(t = 1.23; sig = .219) X_2 \\ & - 0.031(t = -1.52; sig = .129) X_3 - 0.020(t = -1.05; sig = .292) X_4 \\ & + 0.098(t = 7.98; sig = .000) X_5 - 0.052(t = -2.07; sig = .039) X_6 \\ & - 0.067(t = -3.82; sig = .000) X_7 - 0.064(t = -4.63; sig = .000) X_8 \\ & - 0.019(t = -1.08; sig = .281) X_9 + .227(t = 14.63; sig = .000) X_{10} \\ & + 0.298(t = 17.29; sig = .000) X_{11} - 0.010(t = -0.76; sig = .446) X_{12} \\ & + 0.314(t = 22.48; sig = .000) X_{13} \quad R^2 = 0.849\end{aligned}\quad (55)$$

Estimated equations of the path model for Chittagong division:

$$\begin{aligned}\hat{X}_7 = & 1.139(t = 28.73; sig = .000) X_1 - 1.292(t = -29.225; sig = .000) X_2 \\ & + 0.213(t = 10.38; sig = .000) X_3 - .001(t = -0.74; sig = .941) X_4 \\ & - 0.015(t = -0.90; sig = .366) X_5 + 0.800(t = 34.22; sig = .000) X_6 \quad R^2 = 0.499\end{aligned}\quad (56)$$

$$\begin{aligned}\hat{X}_8 = & -0.273(t = -4.35; sig = .000) X_1 - 0.061(t = -0.87; sig = .387) X_2 \\ & + 0.035(t = 1.26; sig = .208) X_3 + 0.023(t = .928; sig = .354) X_4 \\ & + 0.035(t = 1.63; sig = .103) X_5 + 0.055(t = 1.41; sig = .159) X_6 \\ & - 0.146(t = -4.81; sig = .000) X_7 \quad R^2 = 0.127\end{aligned}\quad (57)$$

$$\begin{aligned}\hat{X}_9 = & 0.185(t = 3.37; sig = .001) X_1 + .011(t = 0.18; sig = .856) X_2 \\ & + 0.445(t = 18.34; sig = .000) X_3 + 0.156(t = 7.22; sig = .000) X_4 \\ & + 0.163(t = 8.62; sig = .000) X_5 - 0.008(t = -0.234; sig = .815) X_6 \\ & + 0.019(t = 0.73; sig = .467) X_7 + 0.084(t = 4.18; sig = .000) X_8 \quad R^2 = 0.340\end{aligned}\quad (58)$$

$$\begin{aligned}\hat{X}_{10} = & 0.582(t = 11.09; sig = .000) X_1 - 0.028(t = -0.48; sig = .631) X_2 \\ & - 0.043(t = -1.70; sig = .089) X_3 - 0.022(t = -1.04; sig = .297) X_4 \\ & + 0.131(t = 7.11; sig = .000) X_5 + 0.028(t = 0.85; sig = .395) X_6 \\ & - 0.188(t = -7.42; sig = .000) X_7 - 0.038(t = -1.99; sig = .046) X_8 \\ & - 0.075(t = -3.43; sig = .001) X_9 \quad R^2 = 0.400\end{aligned}\quad (59)$$

$$\begin{aligned}\hat{X}_{11} = & 0.333(t = 5.34; sig = .000) X_1 + 0.062(t = 0.90; sig = .367) X_2 \\ & - 0.130(t = -4.81; sig = .000) X_3 - 0.043(t = -1.90; sig = .057) X_4 \\ & + 0.133(t = 6.69; sig = .000) X_5 - 0.027(t = -0.715; sig = .475) X_6 \\ & - 0.093(t = -3.22; sig = .001) X_7 + 0.003(t = 0.15; sig = .883) X_8 \\ & - 0.067(t = -2.88; sig = .004) X_9 + 0.266(t = 10.95; sig = .000) X_{10} \quad R^2 = 0.481\end{aligned}\quad (60)$$

$$\begin{aligned}\hat{X}_{12} = & 0.138(t = 1.78; sig = .075) X_1 + 0.017(t = 0.19; sig = .844) X_2 \\ & + 0.032(t = 0.94; sig = .349) X_3 + 0.034(t = 1.19; sig = .234) X_4 \\ & - 0.004(t = -0.16; sig = .883) X_5 + 0.028(t = 0.59; sig = .555) X_6 \\ & - 0.015(t = -0.416; sig = .677) X_7 - 0.044(t = -1.75; sig = .081) X_8 \\ & + 0.397(t = 13.72; sig = .000) X_9 - 0.079(t = -2.50; sig = .012) X_{10} \\ & - 0.023(t = -0.70; sig = .484) X_{11} \quad R^2 = 0.215\end{aligned}\quad (61)$$

$$\begin{aligned}\hat{X}_{13} = & 0.559(t = 7.28; sig = .000) X_1 - 0.215(t = -2.56; sig = .011) X_2 \\ & - 0.114(t = -3.42; sig = .001) X_3 - 0.006(t = -0.22; sig = .825) X_4 \\ & - 0.012(t = -0.49; sig = .619) X_5 + 0.117(t = 2.50; sig = .012) X_6 \\ & - 0.164(t = -4.65; sig = .000) X_7 + 0.014(t = 0.58; sig = .562) X_8 \\ & - 0.055(t = -1.81; sig = .070) X_9 - 0.114(t = -3.67; sig = .000) X_{10} \\ & + 0.108(t = 3.31; sig = .001) X_{11} - 0.072(t = -2.73; sig = .006) X_{12} \quad R^2 = 0.233\end{aligned}\quad (62)$$

$$\begin{aligned}\hat{X}_{14} = & 0.327(t = 9.05; sig = .000) X_1 - 0.15(t = -0.38; sig = .704) X_2 \\ & - 0.018(t = -1.14; sig = .256) X_3 - 0.019(t = -1.48; sig = .139) X_4 \\ & + 0.094(t = 8.28; sig = .000) X_5 + 0.021(t = 0.95; sig = .341) X_6 \\ & - 0.121(t = -7.35; sig = .000) X_7 - 0.034(t = -2.96; sig = .003) X_8 \\ & - 0.041(t = -2.88; sig = .004) X_9 + 0.244(t = 16.93; sig = .000) X_{10} \\ & + 0.263(t = 17.41; sig = .000) X_{11} - 0.029(t = -2.367; sig = .018) X_{12} \\ & + 0.290(t = 23.53; sig = .000) X_{13} \quad R^2 = 0.837\end{aligned}\quad (63)$$

Estimated equations of the path model for Dhaka division:

$$\begin{aligned}\hat{X}_7 = & 1.341(t = 38.55; sig = .000) X_1 - 1.518(t = -39.59; sig = .000) X_2 \\ & + 0.221(t = 10.96; sig = .000) X_3 - 0.058(t = -3.02; sig = .003) X_4 \\ & - 0.002(t = -0.14; sig = .888) X_5 + 0.834(t = 43.37; sig = .000) X_6 \quad R^2 = 0.616\end{aligned}\quad (64)$$

$$\begin{aligned}\hat{X}_8 = & -0.309(t = -4.67; sig = .000) X_1 - 0.045(t = -0.62; sig = .538) X_2 \\ & + 0.078(t = 2.54; sig = .011) X_3 + 0.017(t = 0.59; sig = .549) X_4 \\ & + 0.064(t = 3.38; sig = .001) X_5 + 0.024(t = 0.62; sig = .534) X_6 \\ & - 0.158(t = -5.16; sig = .000) X_7 \quad R^2 = 0.149\end{aligned}\quad (65)$$

$$\begin{aligned}\hat{X}_9 = & 0.187(t = 3.47; sig = .001) X_1 - 0.007(t = -0.11; sig = .911) X_2 \\ & + 0.331(t = 13.24; sig = .000) X_3 + 0.343(t = 14.91; sig = .000) X_4 \\ & + 0.032(t = 2.08; sig = .037) X_5 + 0.004(t = 0.14; sig = .890) X_6 \\ & + 0.053(t = 2.12; sig = .034) X_7 + 0.048(t = 2.87; sig = .004) X_8 \quad R^2 = 0.441\end{aligned}\quad (66)$$

$$\begin{aligned}\hat{X}_{10} = & 0.460(t = 7.71; sig = .000) X_1 - 0.020(t = -0.31; sig = .760) X_2 \\ & - 0.074(t = -2.57; sig = .010) X_3 - 0.007(t = -0.27; sig = .786) X_4 \\ & + 0.155(t = 9.05; sig = .000) X_5 + 0.021(t = 0.59; sig = .551) X_6 \\ & - 0.172(t = -6.25; sig = .000) X_7 - 0.079(t = -4.28; sig = .000) X_8 \\ & - 0.041(t = -1.82; sig = .069) X_9 \quad R^2 = 0.316\end{aligned}\quad (67)$$

$$\begin{aligned}\hat{X}_{11} = & 0.482(t = 7.62; sig = .000) X_1 - 0.053(t = -0.76; sig = .445) X_2 \\ & - 0.107(t = -3.86; sig = .000) X_3 - 0.046(t = -1.78; sig = .075) X_4 \\ & + 0.111(t = 6.69; sig = .000) X_5 + 0.081(t = 2.23; sig = .026) X_6 \\ & - 0.149(t = -5.28; sig = .000) X_7 + 0.006(t = 0.342; sig = .732) X_8 \\ & - 0.120(t = -5.51; sig = .000) X_9 + 0.191(t = 9.82; sig = .000) X_{10} \quad R^2 = 0.463\end{aligned}\quad (68)$$

$$\begin{aligned}\hat{X}_{12} = & 0.159(t = 2.16; sig = .031) X_1 + 0.021(t = 0.27; sig = .791) X_2 \\ & + 0.053(t = 1.66; sig = .098) X_3 + 0.052(t = 1.75; sig = .080) X_4 \\ & + 0.029(t = 1.50; sig = .134) X_5 + 0.047(t = 1.13; sig = .258) X_6 \\ & - 0.019(t = -0.587; sig = .557) X_7 - 0.030(t = -1.48; sig = .138) X_8 \\ & + 0.413(t = 16.37; sig = .000) X_9 + 0.002(t = 0.07; sig = .946) X_{10} \\ & - 0.084(t = -3.31; sig = .001) X_{11} \quad R^2 = 0.293\end{aligned}\quad (69)$$

$$\begin{aligned}\hat{X}_{13} = & 0.342(t = 4.30; sig = .000) X_1 + 0.001(t = 0.02; sig = .987) X_2 \\ & + 0.002(t = 0.06; sig = .948) X_3 - 0.100(t = -3.13; sig = .002) X_4 \\ & - 0.019(t = -0.90; sig = .368) X_5 - 0.025(t = -0.55; sig = .582) X_6 \\ & - 0.035(t = -0.98; sig = .327) X_7 + 0.017(t = 0.78; sig = .436) X_8 \\ & - 0.068(t = -2.34; sig = .019) X_9 - 0.114(t = -4.59; sig = .000) X_{10} \\ & + 0.128(t = 4.65; sig = .000) X_{11} - 0.029(t = -1.21; sig = .227) X_{12} \quad R^2 = 0.179\end{aligned}\quad (70)$$

$$\begin{aligned}\hat{X}_{14} = & 0.303(t = 8.19; sig = .000) X_1 - 0.073(t = -1.82; sig = .068) X_2 \\ & - 0.025(t = -1.57; sig = .116) X_3 - 0.021(t = -1.43; sig = .152) X_4 \\ & + 0.106(t = 11.05; sig = .000) X_5 + 0.019(t = 0.91; sig = .362) X_6 \\ & - 0.119(t = -7.28; sig = .000) X_7 - 0.064(t = -6.36; sig = .000) X_8 \\ & - 0.017(t = -1.26; sig = .208) X_9 + 0.255(t = 22.08; sig = .000) X_{10} \\ & + 0.274(t = 21.37; sig = .000) X_{11} - 0.027(t = -2.43; sig = .015) X_{12} \\ & + 0.363(t = 35.36; sig = .000) X_{13} \quad R^2 = 0.824\end{aligned}\quad (71)$$

Estimated equations of the path model for Khulna division:

$$\begin{aligned}\hat{X}_7 = & 1.483(t = 27.37; sig = .000) X_1 - 1.658(t = -27.63; sig = .000) X_2 \\ & + 0.242(t = 11.29; sig = .000) X_3 + 0.003(t = 0.16; sig = .867) X_4 \\ & - 0.018(t = -1.05; sig = .294) X_5 + 0.878(t = 32.18; sig = .000) X_6 \quad R^2 = 0.522\end{aligned}\quad (72)$$

$$\begin{aligned}\hat{X}_8 = & 0.296(t = -3.32; sig = .001) X_1 - 0.037(t = -0.37; sig = .706) X_2 \\ & + 0.035(t = 1.16; sig = .243) X_3 + 0.048(t = 1.80; sig = .071) X_4 \\ & + 0.022(t = 0.94; sig = .348) X_5 + 0.017(t = 0.35; sig = .723) X_6 \\ & - 0.130(t = -3.81; sig = .000) X_7 \quad R^2 = 0.127\end{aligned}\quad (73)$$

$$\begin{aligned}\hat{X}_9 = & 0.265(t = 3.63; sig = .000) X_1 + 0.004(t = 0.04; sig = .961) X_2 \\ & + 0.538(t = 21.91; sig = .000) X_3 + 0.182(t = 8.46; sig = .000) X_4 \\ & + 0.125(t = 6.48; sig = .000) X_5 - 0.019(t = -0.49; sig = .620) X_6 \\ & + 0.012(t = 0.44; sig = .655) X_7 + 0.077(t = 3.76; sig = .000) X_8 \quad R^2 = 0.420\end{aligned}\quad (74)$$

$$\begin{aligned}\hat{X}_{10} = & 0.440(t = 5.75; sig = .000) X_1 + 0.079(t = 0.93; sig = .351) X_2 \\ & - 0.046(t = -1.58; sig = .114) X_3 - 0.043(t = -1.87; sig = .062) X_4 \\ & + 0.187(t = 9.12; sig = .000) X_5 - 0.023(t = -0.57; sig = .090) X_6 \\ & - 0.128(t = -4.37; sig = .000) X_7 - 0.046(t = -2.14; sig = .032) X_8 \\ & - 0.069(t = -2.60; sig = .009) X_9 \quad R^2 = 0.365\end{aligned}\quad (75)$$

$$\begin{aligned}\hat{X}_{11} = & 0.582(t = 7.06; sig = .000) X_1 - 0.134(t = -1.48; sig = .139) X_2 \\ & - 0.115(t = -4.07; sig = .000) X_3 - 0.045(t = -2.04; sig = .041) X_4 \\ & + 0.079(t = 3.95; sig = .000) X_5 + 0.095(t = 2.16; sig = .031) X_6 \\ & - 0.134(t = -4.39; sig = .000) X_7 + 0.020(t = 0.96; sig = .334) X_8 \\ & - 0.091(t = -3.59; sig = .000) X_9 + 0.201(t = 8.26; sig = .000) X_{10} \quad R^2 = 0.479\end{aligned}\quad (76)$$

$$\begin{aligned}\hat{X}_{12} = & 0.406(t = 3.89; sig = .000) X_1 - 0.259(t = -2.29; sig = .022) X_2 \\ & + 0.055(t = 1.53; sig = .126) X_3 - 0.014(t = -0.47; sig = .627) X_4 \\ & - 0.090(t = -3.59; sig = .000) X_5 + 0.149(t = 2.73; sig = .006) X_6 \\ & - 0.054(t = -1.41; sig = .158) X_7 - 0.034(t = -1.33; sig = .185) X_8 \\ & + 0.357(t = 11.12; sig = .000) X_9 - 0.006(t = -0.19; sig = .842) X_{10} \\ & - 0.039(t = -1.18; sig = .236) X_{11}\end{aligned}\quad R^2 = 0.194 \quad (77)$$

$$\begin{aligned}\hat{X}_{13} = & 0.315(t = 2.92; sig = .004) X_1 + 0.019(t = 0.16; sig = .871) X_2 \\ & - 0.040(t = -1.08; sig = .281) X_3 - 0.019(t = -0.65; sig = .516) X_4 \\ & - 0.000(t = -0.02; sig = .968) X_5 + 0.049(t = 0.86; sig = .387) X_6 \\ & - 0.86(t = -2.17; sig = .030) X_7 + 0.023(t = 0.87; sig = .383) X_8 \\ & - 0.076(t = -2.22; sig = .03) X_9 - 0.092(t = 2.88; sig = .004) X_{10} \\ & + 0.079(t = 2.31; sig = .021) X_{11} - 0.067(t = -2.44; sig = .015) X_{12}\end{aligned}\quad R^2 = 0.148 \quad (78)$$

$$\begin{aligned}\hat{X}_{14} = & 0.287(t = 5.76; sig = .000) X_1 - 0.012(t = -0.23; sig = .817) X_2 \\ & - 0.012(t = -0.68; sig = .492) X_3 - 0.019(t = -1.42; sig = .155) X_4 \\ & + 0.085(t = 7.11; sig = .000) X_5 - 0.004(t = -0.15; sig = .876) X_6 \\ & - 0.071(t = -3.92; sig = .000) X_7 - 0.043(t = -3.53; sig = .000) X_8 \\ & - 0.016(t = -1.01; sig = .313) X_9 + 0.289(t = 19.65; sig = .000) X_{10} \\ & + 0.274(t = 17.41; sig = .000) X_{11} - 0.002(t = -0.13; sig = .899) X_{12} \\ & + 0.322(t = 26.24; sig = .000) X_{13}\end{aligned}\quad R^2 = 0.820 \quad (79)$$

Estimated equations of the path model for Rajshahi division:

$$\begin{aligned}\hat{X}_7 = & 1.397(t = 33.08; sig = .000) X_1 - 1.582(t = -33.22; sig = .000) X_2 \\ & + 0.257(t = 11.99; sig = .000) X_3 + 0.031(t = 1.55; sig = .120) X_4 \\ & + 0.001(t = 0.09; sig = .930) X_5 + 0.898(t = 38.40; sig = .000) X_6\end{aligned}\quad R^2 = 0.529 \quad (80)$$

$$\begin{aligned}\hat{X}_8 = & -0.349(t = -5.17; sig = .000) X_1 - 0.043(t = -0.56; sig = .576) X_2 \\ & + 0.063(t = 2.16; sig = .031) X_3 + 0.019(t = 0.75; sig = .456) X_4 \\ & + 0.066(t = 3.51; sig = .000) X_5 + 0.003(t = 0.08; sig = .937) X_6 \\ & - 0.137(t = -5.05; sig = .000) X_7\end{aligned}\quad R^2 = 0.180 \quad (81)$$

$$\begin{aligned}\hat{X}_9 = & 0.186(t = 3.23; sig = .001) X_1 + 0.024(t = 0.37; sig = .714) X_2 \\ & + 0.343(t = 13.83; sig = .000) X_3 + 0.296(t = 13.40; sig = .000) X_4 \\ & + 0.152(t = 9.52; sig = .000) X_5 + 0.001(t = 0.03; sig = .978) X_6 \\ & + 0.052(t = 2.25; sig = .025) X_7 + 0.046(t = 2.63; sig = .009) X_8\end{aligned}\quad R^2 = 0.409 \quad (82)$$

$$\begin{aligned}\hat{X}_{10} = & 0.631(t = 10.49; sig = .000) X_1 - 0.150(t = -2.23; sig = .026) X_2 \\ & - 0.038(t = -1.41; sig = .159) X_3 - 0.022(t = -0.90; sig = .364) X_4 \\ & + 0.143(t = 8.39; sig = .000) X_5 + 0.059(t = 1.69; sig = .090) X_6 \\ & - 0.185(t = -7.66; sig = .000) X_7 - 0.065(t = -3.56; sig = .000) X_8 \\ & - 0.052(t = -2.41; sig = .016) X_9\end{aligned}\quad R^2 = 0.357 \quad (83)$$

$$\begin{aligned}\hat{X}_{11} = & 0.502(t = 7.38; sig = .000) X_1 - 0.070(t = -1.05; sig = .292) X_2 \\ & - 0.061(t = -2.27; sig = .023) X_3 - 0.055(t = -2.33; sig = .020) X_4 \\ & + 0.118(t = 7.05; sig = .000) X_5 + 0.028(t = 0.79; sig = .427) X_6 \\ & - 0.096(t = -3.94; sig = .000) X_7 + 0.010(t = 0.56; sig = .570) X_8 \\ & - 0.125(t = -5.96; sig = .000) X_9 + 0.232(t = 11.85; sig = .000) X_{10} \quad R^2 = 0.466\end{aligned}\quad (84)$$

$$\begin{aligned}\hat{X}_{12} = & 0.039(t = 0.50; sig = .614) X_1 + 0.077(t = 0.91; sig = .360) X_2 \\ & + 0.043(t = 1.25; sig = .209) X_3 - 0.032(t = 1.07; sig = .283) X_4 \\ & - 0.067(t = -3.10; sig = .002) X_5 - 0.076(t = -1.70; sig = .089) X_6 \\ & + 0.051(t = 1.65; sig = .098) X_7 - 0.055(t = -2.43; sig = .015) X_8 \\ & + 0.303(t = 11.26; sig = .000) X_9 + 0.014(t = 0.53; sig = .595) X_{10} \\ & - 0.046(t = -1.65; sig = .098) X_{11} \quad R^2 = 0.142\end{aligned}\quad (85)$$

$$\begin{aligned}\hat{X}_{13} = & 0.433(t = 5.74; sig = .000) X_1 - 0.066(t = -0.80; sig = .423) X_2 \\ & + 0.013(t = 0.38; sig = .704) X_3 - 0.026(t = -0.89; sig = .369) X_4 \\ & - 0.013(t = -0.61; sig = .536) X_5 + 0.026(t = 0.60; sig = .546) X_6 \\ & - 0.105(t = -3.46; sig = .001) X_7 + 0.042(t = 1.92; sig = .055) X_8 \\ & - 0.094(t = -3.47; sig = .001) X_9 - 0.090(t = -3.58; sig = .001) X_{10} \\ & + 0.106(t = 3.90; sig = .000) X_{11} - 0.045(t = -2.10; sig = .035) X_{12} \quad R^2 = 0.181\end{aligned}\quad (86)$$

$$\begin{aligned}\hat{X}_{14} = & 0.297(t = 8.65; sig = .000) X_1 - 0.044(t = -1.19; sig = .234) X_2 \\ & - 0.045(t = -2.97; sig = .003) X_3 + 0.016(t = 1.21; sig = .226) X_4 \\ & + 0.103(t = 10.87; sig = .000) X_5 + 0.008(t = 0.38; sig = .699) X_6 \\ & - 0.095(t = -5.27; sig = .000) X_7 - 0.053(t = -5.27; sig = .000) X_8 \\ & - 0.005(t = -0.37; sig = .711) X_9 + 0.253(t = 22.17; sig = .000) X_{10} \\ & + 0.265(t = 21.46; sig = .000) X_{11} + 0.001(t = 0.13; sig = .892) X_{12} \\ & + 0.364(t = 36.66; sig = .000) X_{13} \quad R^2 = 0.832\end{aligned}\quad (87)$$

Estimated equations of the path model for Sylhet division:

$$\begin{aligned}\hat{X}_7 = & 1.308(t = 23.65; sig = .000) X_1 - 1.564(t = -24.99; sig = .000) X_2 \\ & + 0.222(t = 8.50; sig = .000) X_3 - 0.020(t = -0.81; sig = .414) X_4 \\ & + 0.018(t = 0.79; sig = .428) X_5 + 0.942(t = 27.65; sig = .000) X_6 \quad R^2 = 0.537\end{aligned}\quad (88)$$

$$\begin{aligned}\hat{X}_8 = & -0.292(t = -3.01; sig = .003) X_1 + 0.013(t = 0.11; sig = .909) X_2 \\ & + 0.023(t = 0.61; sig = .541) X_3 + 0.008(t = 0.24; sig = .807) X_4 \\ & + 0.030(t = 0.96; sig = .335) X_5 + 0.003(t = 0.04; sig = .968) X_6 \\ & - 0.091(t = -2.05; sig = .040) X_7 \quad R^2 = 0.087\end{aligned}\quad (89)$$

$$\begin{aligned}\hat{X}_9 = & 0.244(t = 3.28; sig = .001) X_1 - 0.078(t = -0.91; sig = .363) X_2 \\ & + 0.500(t = 17.16; sig = .000) X_3 + 0.139(t = 5.35; sig = .000) X_4 \\ & + 0.258(t = 10.82; sig = .000) X_5 + 0.064(t = 1.32; sig = .187) X_6 \\ & - 0.028(t = -0.81; sig = .413) X_7 + 0.078(t = 3.23; sig = .001) X_8 \quad R^2 = 0.464\end{aligned}\quad (90)$$

$$\begin{aligned}\hat{X}_{10} = & 0.593(t = 7.05; sig = .000) X_1 - 0.138(t = -1.43; sig = .151) X_2 \\ & - 0.015(t = -0.39; sig = .692) X_3 + 0.008(t = 0.26; sig = .793) X_4 \\ & + 0.156(t = 5.54; sig = .000) X_5 + 0.066(t = 1.21; sig = .226) X_6 \\ & - 0.236(t = -6.21; sig = .000) X_7 - 0.040(t = -1.47; sig = .142) X_8 \\ & - 0.112(t = -3.17; sig = .002) X_9 \quad R^2 = 0.327\end{aligned}\quad (91)$$

$$\begin{aligned}\hat{X}_{11} = & 0.449(t = 4.44; sig = .000) X_1 - 0.047(t = -0.40; sig = .688) X_2 \\ & - 0.098(t = -1.95; sig = .051) X_3 - 0.085(t = -1.88; sig = .060) X_4 \\ & + 0.109(t = 3.24; sig = .001) X_5 + 0.038(t = 0.52; sig = .602) X_6 \\ & - 0.078(t = -1.62; sig = .105) X_7 + 0.028(t = 0.79; sig = .429) X_8 \\ & - 0.043(t = -0.95; sig = .340) X_9 + 0.298(t = 8.24; sig = .000) X_{10} \quad R^2 = 0.469\end{aligned}\quad (92)$$

$$\begin{aligned}\hat{X}_{12} = & 0.332(t = 2.90; sig = .004) X_1 - 0.248(t = -1.88; sig = .060) X_2 \\ & + 0.022(t = 0.40; sig = .688) X_3 - 0.075(t = 1.48; sig = .137) X_4 \\ & - 0.069(t = -1.82; sig = .068) X_5 + 0.155(t = 1.90; sig = .057) X_6 \\ & - 0.095(t = -1.76; sig = .078) X_7 - 0.092(t = -2.33; sig = .020) X_8 \\ & + 0.525(t = 10.46; sig = .000) X_9 - 0.021(t = 0.48; sig = .629) X_{10} \\ & + 0.008(t = 0.17; sig = .863) X_{11} \quad R^2 = 0.346\end{aligned}\quad (93)$$

$$\begin{aligned}\hat{X}_{13} = & 0.136(t = 1.10; sig = .269) X_1 + 0.319(t = 2.26; sig = .024) X_2 \\ & + 0.012(t = 0.20; sig = .834) X_3 - 0.056(t = -1.03; sig = .302) X_4 \\ & + 0.026(t = 0.64; sig = .521) X_5 - 0.192(t = -2.19; sig = .028) X_6 \\ & - 1.104(t = -1.80; sig = .071) X_7 + 0.018(t = 0.43; sig = .663) X_8 \\ & - 0.118(t = -2.01; sig = .045) X_9 - 0.059(t = -1.28; sig = .199) X_{10} \\ & + 0.086(t = 1.70; sig = .089) X_{11} - 0.048(t = -1.06; sig = .290) X_{12} \quad R^2 = 0.257\end{aligned}\quad (94)$$

$$\begin{aligned}\hat{X}_{14} = & 0.166(t = 2.82; sig = .005) X_1 + 0.064(t = 0.94; sig = .346) X_2 \\ & - 0.030(t = -1.04; sig = .295) X_3 - 0.047(t = -1.81; sig = .071) X_4 \\ & + 0.081(t = 4.17; sig = .000) X_5 - 0.026(t = -0.61; sig = .539) X_6 \\ & - 0.037(t = -1.35; sig = .175) X_7 - 0.043(t = -2.12; sig = .034) X_8 \\ & + 0.010(t = .343; sig = .731) X_9 + 0.298(t = 13.62; sig = .000) X_{10} \\ & + 0.300(t = 12.50; sig = .000) X_{11} + 0.013(t = 0.60; sig = .544) X_{12} \\ & + 0.332(t = 16.38; sig = .000) X_{13} \quad R^2 = 0.832\end{aligned}\quad (95)$$

4.2.2 DIAGRAMS OF THE ESTIMATED PATH MODELS

The path diagrams according to the equations (16), (17), (18), (19), (20), (21), (22) and (23) are represented in Figures 1, 2, 3, 4, 5 and 6. The path diagrams consists of six exogenous variables namely, X_1 , X_2 , X_3 , X_4 , X_5 and X_6 ; seven endogenous variables namely, X_7 , X_8 , X_9 , X_{10} , X_{11} , X_{12} and X_{13} . As there are seven endogenous variables, so also there are seven residual variables namely, R_q , R_r , R_s , R_t , R_u , R_v , R_w and R_x . Here X_{14} is the overall dependent as well as target variable that is index of fertility. The causal and non-causal relationships, total and residual effects are shown in the diagrams.

4.2.3 INTERPRETATIONS OF RESULTS IN THE PATH MODELS

Path analysis reveals how the 13 selected quantitative socio-economic and demographic variables: respondent's current age (X_1), husband's age (X_2), respondent's education (X_3), husband's education (X_4), number of household members (X_5), husband's age at first marriage (X_6), respondent's age at first marriage (X_7), respondent's wealth index (X_8), wealth index of a family (X_9), number of living boys (X_{10}), number of living children at first contraceptive use (X_{11}), body mass index of respondent (X_{12}) and the number of children who have died (X_{13}) are associated with the regional variations of the total children ever born (X_{14}) as well as the index of fertility among the six administration divisions as Barisal, Chittagong, Dhaka, Khulna, Rajshahi and Sylhet in Bangladesh. The descriptive statistics of these variables are calculated in Tables 2, 3, 4, 5, 6 and 7.

Researcher has observed from the path diagram of Barisal division which is in Figure 1 that there are 36 paths out of 49 hypothesized paths are found to be statistically significant. Similarly, from the Figure 2 of the Chittagong division 39, from the Figure 3 of the Dhaka division 39, from the Figure 4 of the Khulna division 39, from the Figure 5 of the Rajshahi division 36 and from the Figure 6 of the Sylhet division 33 out of 49 hypothesized paths are found to be statistically significant. In this study researcher has mentioned about the significant path coefficients only. Using the individual *t*-test researcher has deduced whether the path coefficients are significant or not.

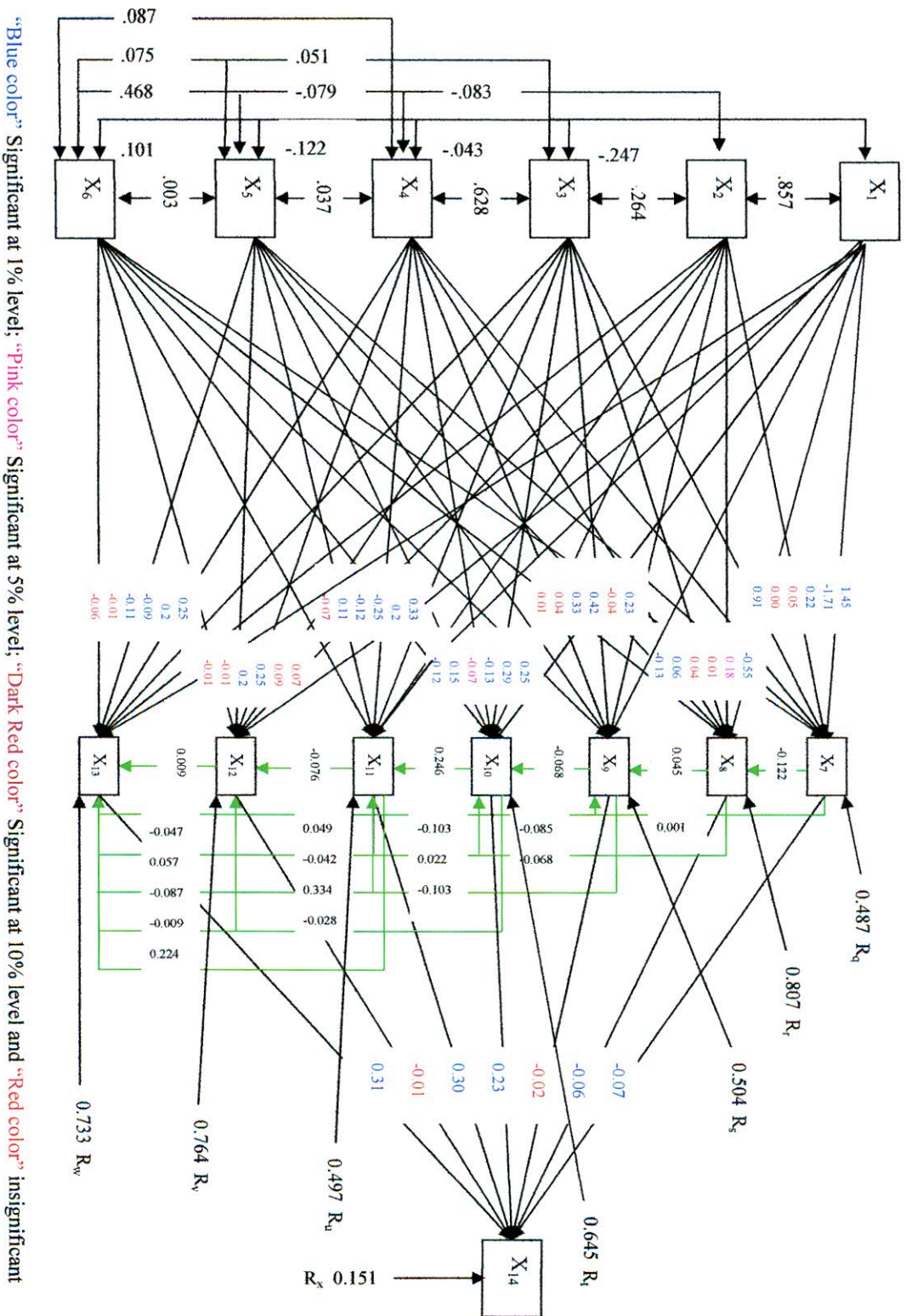
Figure 1: Path Diagram of Factors Affecting Fertility through Socio-economic and Demographic Variables in Barisal Division.

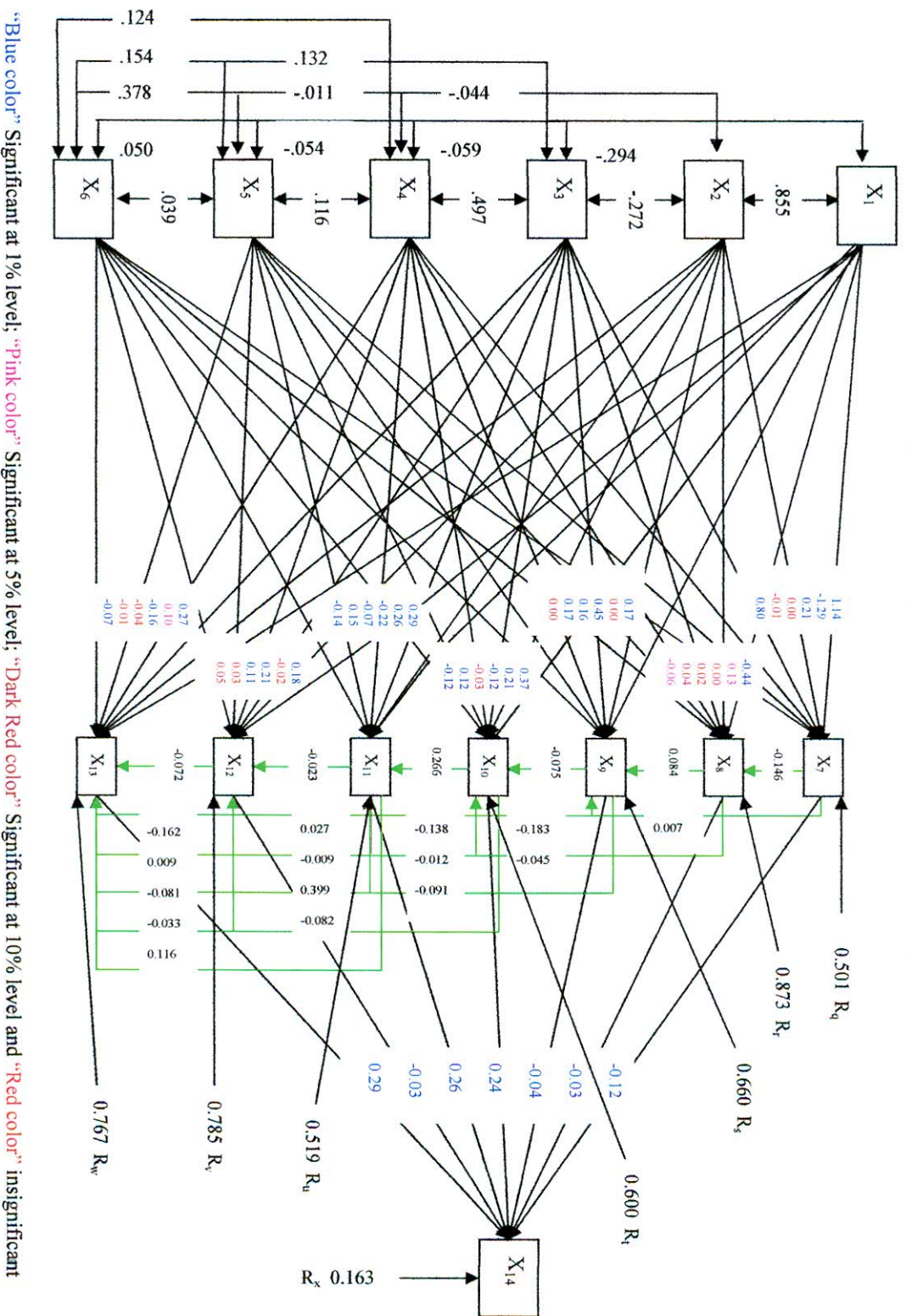
Figure 2: Path Diagram of Factors Affecting Fertility through Socio-economic and Demographic Variables in Chittagong Division.

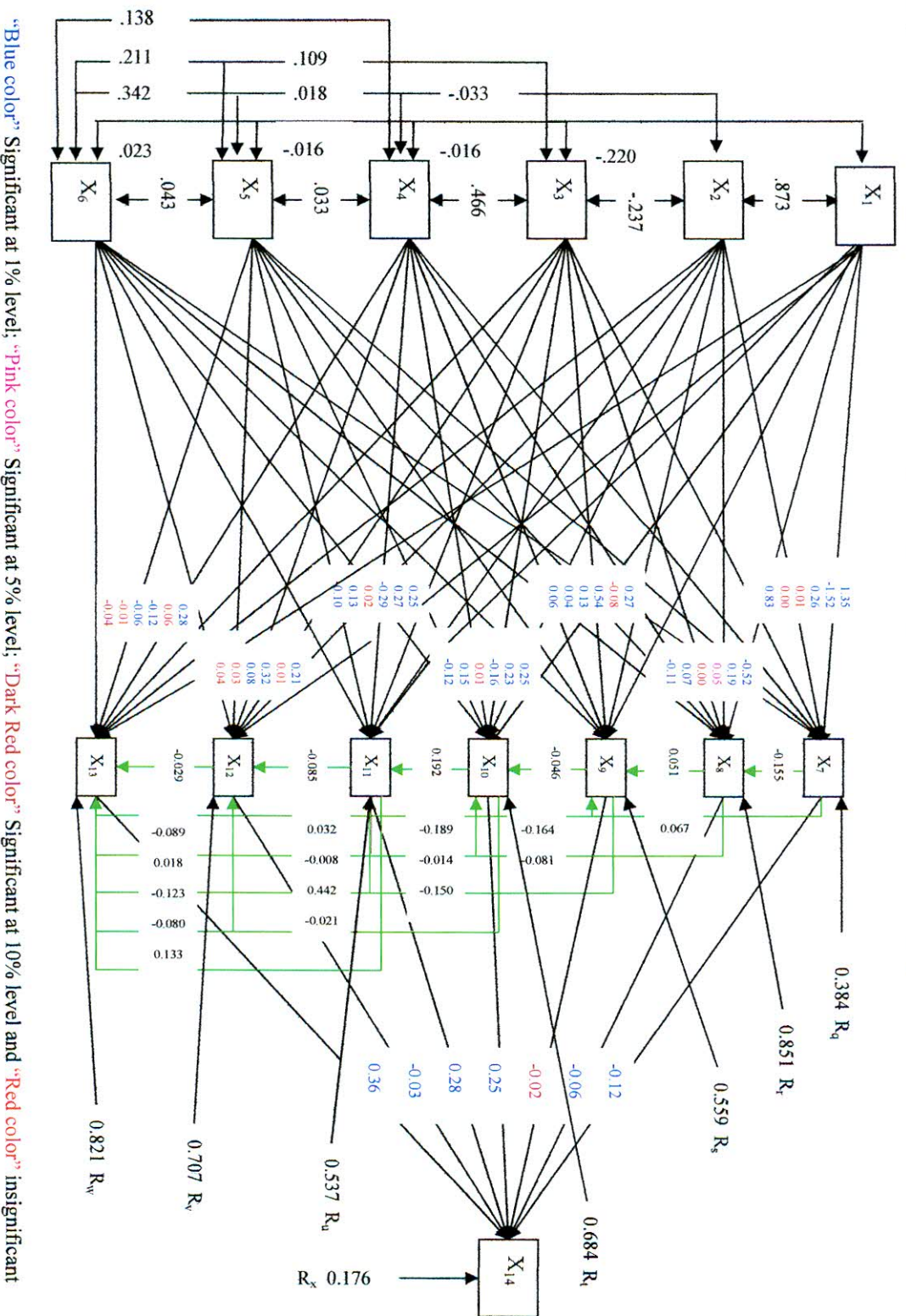
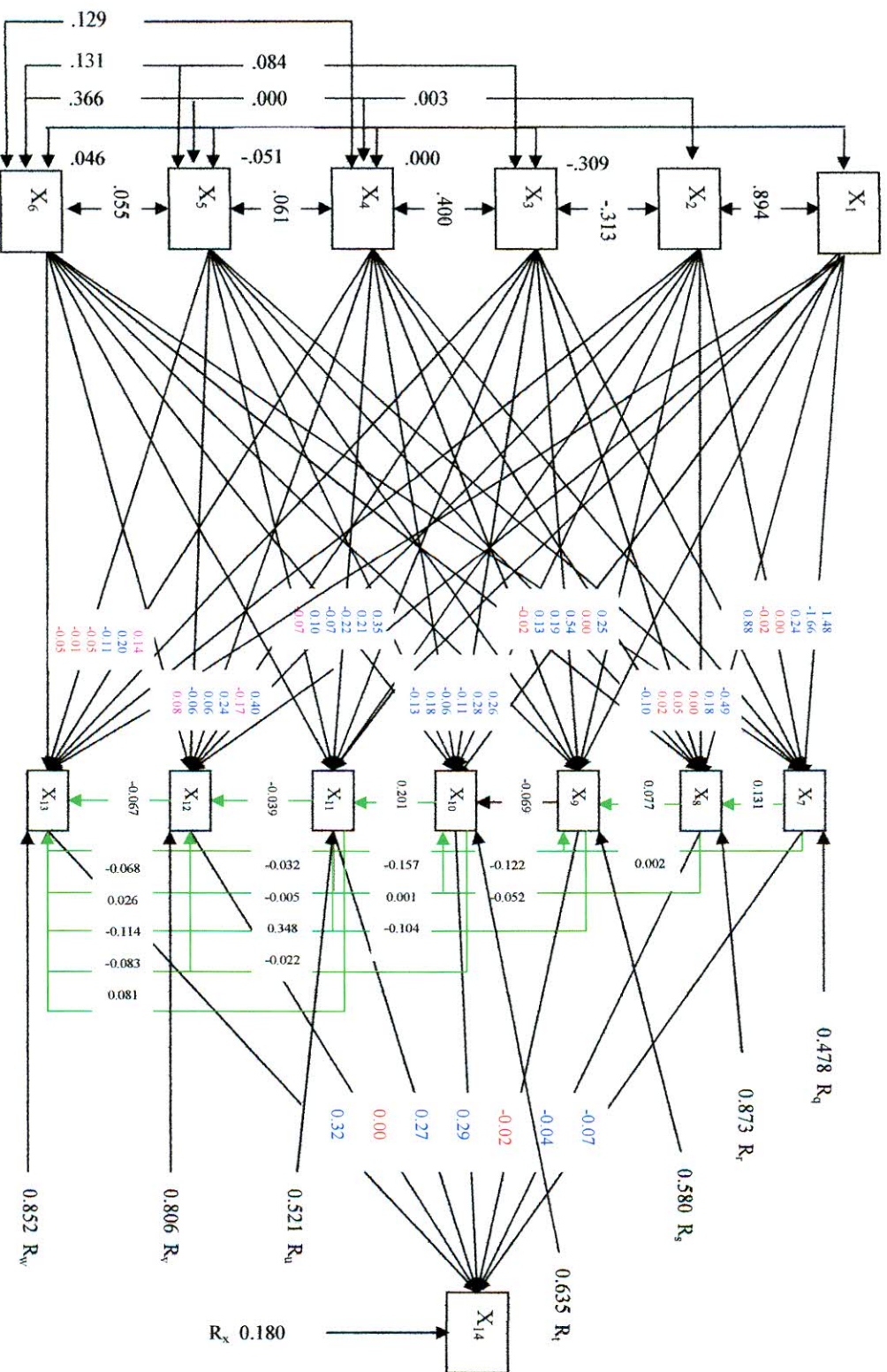
Figure 3: Path Diagram of Factors Affecting Fertility through Socio-economic and Demographic Variables in Dhaka Division.

Figure 4: Path Diagram of Factors Affecting Fertility through Socio-economic and Demographic Variables in Khulna Division.

“Blue color” Significant at 1% level; “Pink color” Significant at 5% level; “Dark Red color” Significant at 10% level and “Red color” insignificant

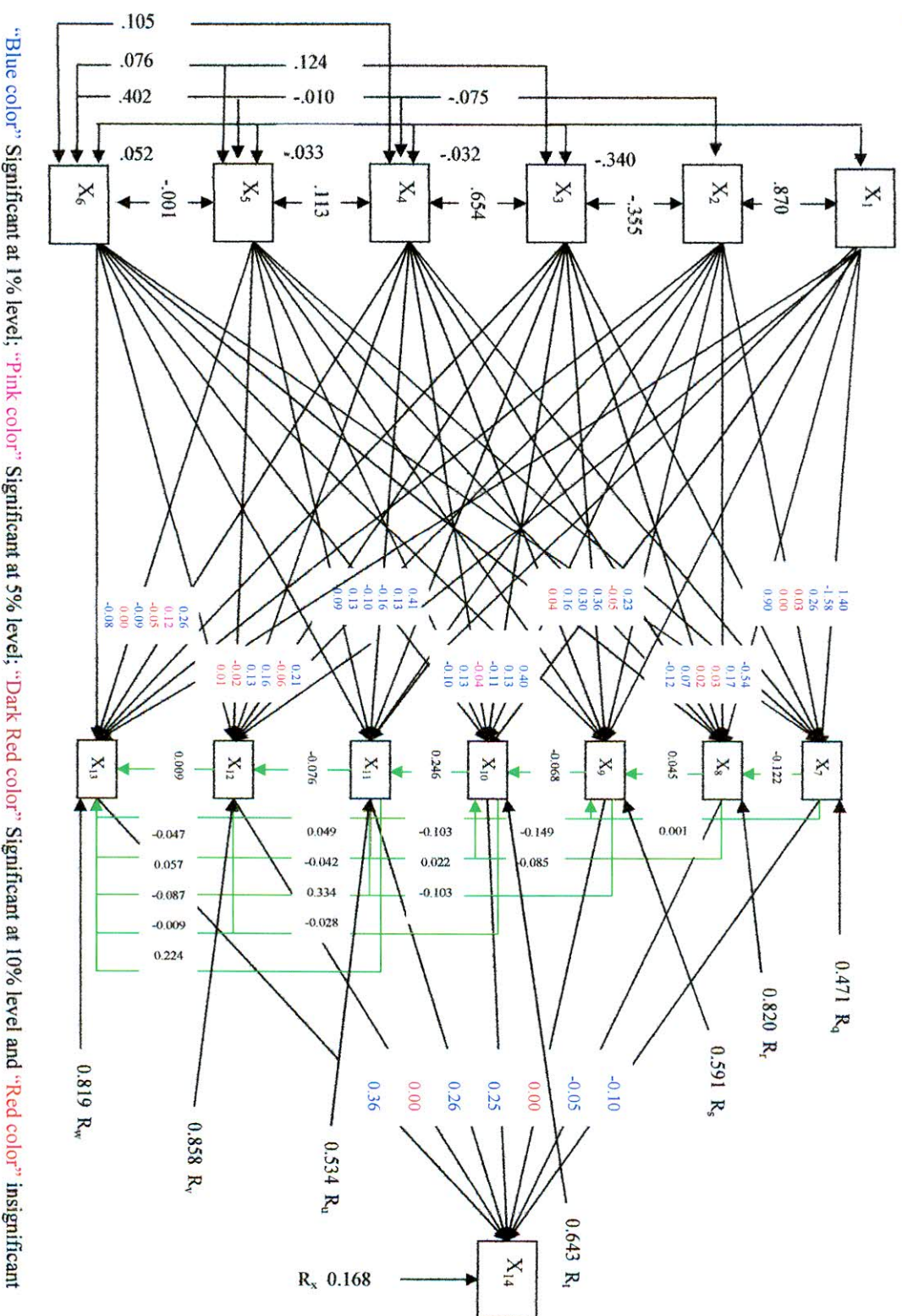
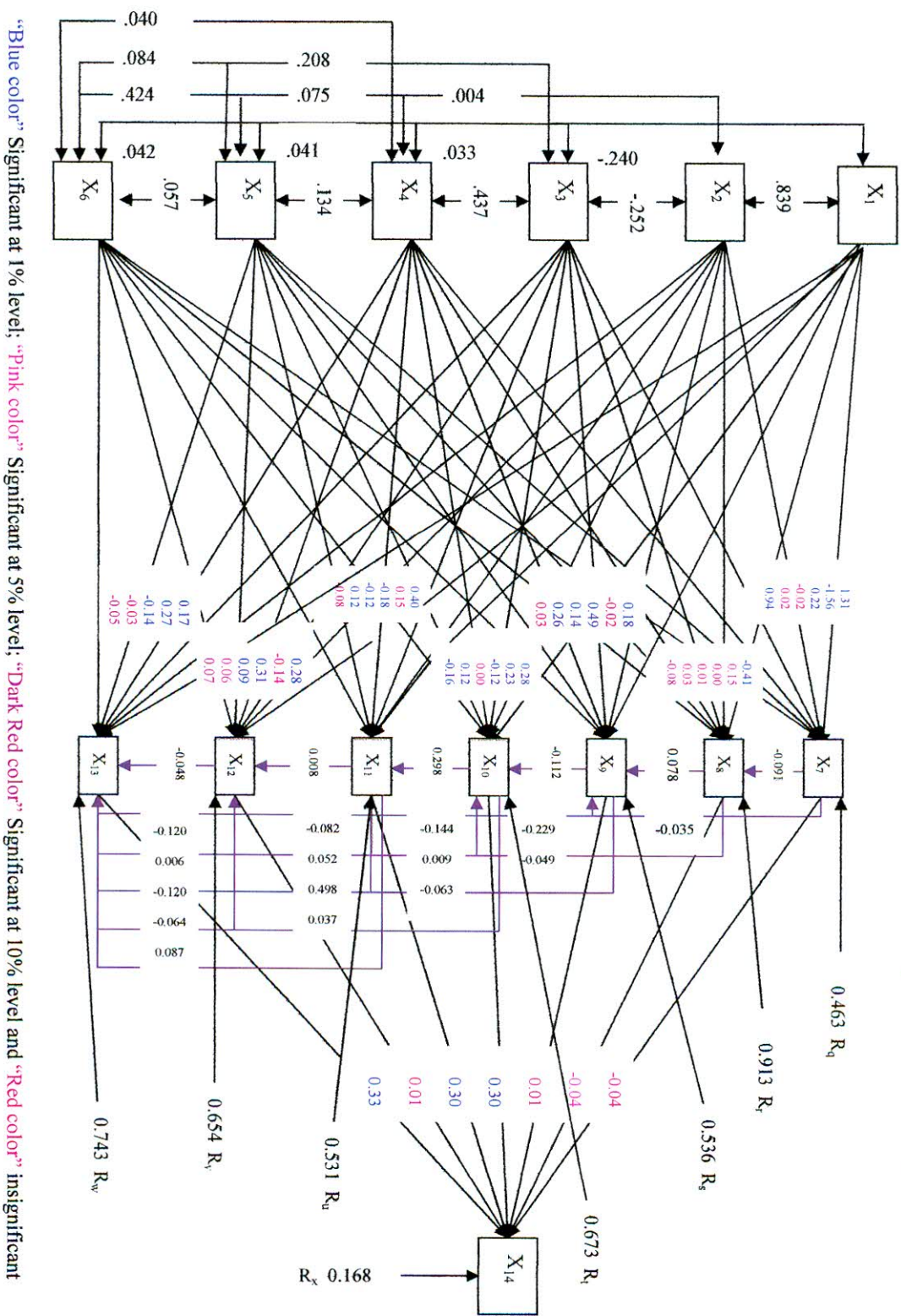
Figure 5: Path Diagram of Factors Affecting Fertility through Socio-economic and Demographic Variables in Rajshahi Division.

Figure 6: Path Diagram of Factors Affecting Fertility through Socio-economic and Demographic Variables in Sylhet Division.

According to the model of **Barisal** division out of 13 variables, 8 are found to have significant direct effect on the total children ever born as well as index of fertility (X_{14}). The direct significant positive effect of respondent's current age (X_1) is 0.210 about 53%, number of household members (X_5) is 0.098 about 58%, number of living boys as well as index of son preference (X_{10}) is 0.227 about 69%, number of living children at first contraceptive use as well as decision making of contraceptive use (X_{11}) is 0.298 about 81% and number of children who have died as well as index of child mortality (X_{13}) is 0.314 that is 100% on the index of fertility (X_{14}) while the total effects of these variables are 0.396, 0.168, 0.329, 0.367 and 0.314 respectively. The direct significant negative effect of husband's age at first marriage (X_6) is -0.052 about 32%, respondent's age at first marriage (X_7) is -0.067 about 49% and respondent's wealth index (X_8) is -0.064 about 100% on the index of fertility (X_{14}) while the total effects of these variables are -0.163, -0.137 and -0.061 respectively.

Out of 6 exogenous variables of the model respondent's current age (X_1) and number of household members (X_5) are found to be statistically significant.

The total effect of respondent's current age (X_1) on the fertility (X_{14}) is 0.396, of which about 37% is transmitted through the number of living boys (X_{10}), about 40% is transmitted through the decision making of contraceptive use (X_{11}) and about 19% is transmitted through the index of child mortality (X_{13}) in the positive direction then about 50% acts through the respondent's age at first marriage (X_7) in the opposite direction. Other indirect effects of respondent's current age (X_1) via respondent's wealth index (X_8), wealth index of a family (X_9) and body mass index of respondent (X_{12}) are negligible.

The total effect of number of household members (X_5) on the fertility (X_{14}) is 0.168, of which about 30% is transmitted through the number of living boys (X_{10}), about 17% is transmitted through the decision making of contraceptive use (X_{11}) in the positive direction. Other indirect effects of number of household members (X_5) via respondent's age at first marriage (X_7), respondent's wealth index (X_8), wealth index of a family (X_9) and body mass index of respondent (X_{12}) and number of children who have died (X_{13}) are negligible.

It is also represented from the path model of Barisal division that the amount of variations in the dependent variable i.e., index of fertility (X_{14}) accounted for by the variables respondent's current age (X_1) and the number of living boys (X_{10}) jointly about 5% via their mutual correlation apart from their respective net effects are about 4.5% and 5%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of living children at first contraceptive use (X_{11}) jointly about 7% via their respective net effects are about 4.5% and 9%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of children who have died (X_{13}) jointly about 6% via their respective net effects are about 4.5% and 10%. The amount of variations in the index of fertility (X_{14}) accounted for by the number of living boys (X_{10}) and the number of living children at first contraceptive use (X_{11}) jointly about 7.5% via their respective net effects are about 5% and 9%. The amount of variations in the index of fertility (X_{14}) accounted for by the number of living children at first contraceptive use (X_{11}) and the number of children who have died (X_{13}) jointly about 8% via their respective net effects are about 9% and 10%. Other joint effects of the remaining variables on the index of fertility (X_{14}) are not mentionable.

According to the model of **Chittagong** division out of 13 variables, 9 are found to have significant direct effect on the total children ever born as well as index of fertility (X_{14}). The direct significant positive effect of respondent's current age (X_1) is 0.327 about 72%, number of household members (X_5) is 0.094 about 64%, number of living boys as well as index of son preference (X_{10}) is 0.244 about 72%, number of living children at first contraceptive use as well as decision making of contraceptive use (X_{11}) is 0.263 about 87% and number of children who have died as well as index of child mortality (X_{13}) is 0.290 that is 100% on the index of fertility (X_{14}) while total effects of these variables are 0.451, 0.147, 0.337, 0.302 and 0.290 respectively. The direct significant negative effect of the respondent's age at first marriage (X_7) is -0.121 about 48%, respondent's wealth index (X_8) is -0.034 about 61%, wealth index of a family (X_9) is -0.041 about 36% and body mass index of respondent (X_{12}) is -0.029 about 58% on the index of fertility (X_{14}) while the total effects of these variables are -0.251, -0.055, -0.111 and -0.050 respectively.

Out of 6 exogenous variables of the model respondent's current age (X_1) and number of household members (X_5) are found to be statistically significant.

The total effect of respondent's current age (X_1) on the index of fertility (X_{14}) is 0.451, of which about 43% is transmitted through the number of living boys (X_{10}), about 14% is transmitted through the decision making of contraceptive use (X_{11}) and about 36% is transmitted through the index of child mortality (X_{13}) in the positive direction then about 63% acts through the respondent's age at first marriage (X_7) in the opposite direction. Other indirect effects of respondent's current age (X_1) via respondent's wealth index (X_8), wealth index of a family (X_9) and body mass index of respondent (X_{12}) are negligible.

The total effect of number of household members (X_5) on the index of fertility (X_{14}) is 0.147, of which about 30% is transmitted through the number of living boys (X_{10}), about 20% is transmitted through the decision making of contraceptive use (X_{11}) in the positive direction then about 12% acts through the wealth index of a family (X_9) in the opposite direction. Other indirect effects of number of household members (X_5) via respondent's age at first marriage (X_7), respondent's wealth index (X_8), body mass index of respondent (X_{12}) and number of children who have died (X_{13}) are negligible.

It is also represented from the path model of Chittagong division that the amount of variations in the dependent variable i.e., index of fertility (X_{14}) accounted for by the variables respondent's current age (X_1) and the number of living boys (X_{10}) jointly about 9% via their mutual correlation apart from their respective net effects are about 10.5% and 6%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of living children at first contraceptive use (X_{11}) jointly about 10% via their respective net effects are about 10.5% and 7%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of children who have died (X_{13}) jointly about 8% via their respective net effects are about 10.5% and 8.5%. The amount of variations in the index of fertility (X_{14}) accounted for by the number of living children at first contraceptive use (X_{11}) and the number of children who have died (X_{13}) jointly about 5% via their respective net effects are about 7% and 8.5%. Other joint effects of the remaining variables on the index of fertility (X_{14}) are not mentionable.

According to the model of **Dhaka** division out of 13 variables, 10 are found to have significant direct effect on the total children ever born as well as index of fertility

(X_{14}). The direct significant positive effect of respondent's current age (X_1) is 0.301 about 71%, number of household members (X_5) is 0.106 about 61%, number of living boys as well as index of son preference (X_{10}) is 0.255 about 78%, number of living children at first contraceptive use as well as decision making of contraceptive use (X_{11}) is 0.278 about 84% and number of children who have died as well as index of child mortality (X_{13}) is 0.363 that is 100% on the index of fertility (X_{14}) while the total effects of these variables are 0.419, 0.173, 0.326, 0.329 and 0.363 respectively. The direct significant negative effect of husband's age (X_2) is -0.076 about 34%, respondent's education (X_3) is -0.040 about 17%, respondent's age at first marriage (X_7) is -0.119 about 53%, respondent's wealth index (X_8) is -0.064 about 79%, wealth index of a family (X_9) is -0.023 about 18% and body mass index of respondent (X_{12}) is -0.027 about 71% on the index of fertility (X_{14}) while the total effects of these variables are -0.222, -0.235, -0.227, -0.081, -0.126 and -0.038 respectively.

Out of 6 exogenous variables of the model respondent's current age (X_1), respondent's education (X_3) and number of household members (X_5) are found to be statistically significant.

The total effect of respondent's current age (X_1) on the index of fertility (X_{14}) is 0.419, of which about 36% is transmitted through the number of living boys (X_{10}), about 37% is transmitted through the decision making of contraceptive use (X_{11}) and about 29% is transmitted through the index of child mortality (X_{13}) in the positive direction then about 73% acts through the respondent's age at first marriage (X_7) in the opposite direction. Other indirect effects of respondent's current age (X_1) via respondent's wealth index (X_8), wealth index of a family (X_9) and body mass index of respondent (X_{12}) are negligible.

The total effect of respondent's education (X_3) on the index of fertility (X_{14}) is -0.235, of which about 25% is transmitted through the respondent's age at first marriage (X_7), about 28% is transmitted through the wealth index of a family (X_9), about 11% is transmitted through the number of living boys (X_{10}) and about 10% is transmitted through the decision making of contraceptive use (X_{11}) in the positive direction. Other indirect effects of respondent's education (X_3) via respondent's wealth index (X_8), body mass index of respondent (X_{12}) and number of children who have died (X_{13}) are negligible.

The total effect of number of household members (X_5) on the index of fertility (X_{14}) is 0.173, of which about 30% is transmitted through the number of living boys (X_{10}) and about 20% is transmitted through the decision making of contraceptive use (X_{11}) in the positive direction. Other indirect effects of number of household members (X_5) via respondent's age at first marriage (X_7), respondent's wealth index (X_8), wealth index of a family (X_9), body mass index of respondent (X_{12}) and number of children who have died (X_{13}) are negligible.

It is also represented from the path model of Dhaka division that the amount of variations in the dependent variable i.e., index of fertility (X_{14}) accounted for by the variables respondent's current age (X_1) and the number of living boys (X_{10}) jointly about 7% via their mutual correlation apart from their respective net effects are about 9% and 6.5%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of living children at first contraceptive use (X_{11}) jointly about 9% via their respective net effects are about 9% and 8%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age

(X_1) and the number of children who have died (X_{13}) jointly about 8% via their respective net effects are about 9% and 13%. The amount of variations in the index of fertility (X_{14}) accounted for by the number of living children at first contraceptive use (X_{11}) and the number of children who have died (X_{13}) jointly about 7% via their respective net effects are about 8% and 13%. Other joint effects of the remaining variables on the index of fertility (X_{14}) are not mentionable.

According to the model of **Khulna** division out of 13 variables, 7 are found to have significant direct effect on the total children ever born as well as the index of fertility (X_{14}). The direct significant positive effect of respondent's current age (X_1) is 0.287 about 65%, number of household members (X_5) is 0.085 about 50%, number of living boys as well as index of son preference (X_{10}) is 0.289 about 82%, number of living children at first contraceptive use as well as decision making of contraceptive use (X_{11}) is 0.274 about 92% and number of children who have died as well as index of child mortality (X_{13}) is 0.322 that is 100% on the index of fertility (X_{14}) while the total effects of these variables are 0.442, 0.168, 0.349, 0.298 and 0.322 respectively. The direct significant negative effect of respondent's age at first marriage (X_7) is -0.071 about 45% and respondent's wealth index (X_8) is -0.043 about 98% on the index of fertility (X_{14}) while the total effects of these variables are -0.157 and -0.044 respectively.

Out of 6 exogenous variables of the model respondent's current age (X_1) and number of household members (X_5) are found to be statistically significant.

The total effect of respondent's current age (X_1) on the fertility (X_{14}) is 0.442, of which about 35% is transmitted through the number of living boys (X_{10}), about 34% is transmitted through the decision making of contraceptive use (X_{11}) and about 23% is

transmitted through the index of child mortality (X_{13}) in the positive direction then about 52% acts through the respondent's age at first marriage (X_7) and about 7% acts through the wealth index of a family (X_9) in the opposite direction. Other indirect effects of respondent's current age (X_1) via respondent's wealth index (X_8) and body mass index of respondent (X_{12}) are negligible.

The total effect of number of household members (X_5) on the index of fertility (X_{14}) is 0.168, of which about 39% is transmitted through the number of living boys (X_{10}), about 17% is transmitted through the decision making of contraceptive use (X_{11}) in the positive direction then about 8% acts through the wealth index of a family (X_9) in the opposite direction. Other indirect effects of number of household members (X_5) via respondent's age at first marriage (X_7), respondent's wealth index (X_8), body mass index of respondent (X_{12}) and number of children who have died (X_{13}) are negligible.

It is also represented from the path model of Khulna division that the amount of variations in the dependent variable i.e., index of fertility (X_{14}) accounted for by the variables respondent's current age (X_1) and the number of living boys (X_{10}) jointly about 8% via their mutual correlation apart from their respective net effects are about 8% and 8.5%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of living children at first contraceptive use (X_{11}) jointly about 9% via their respective net effects are about 8% and 7.5%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of children who have died (X_{13}) jointly about 6.5% via their respective net effects are about 8% and 10.5%. The amount of variations in the index of fertility (X_{14}) accounted for by the number of living children at first contraceptive use

(X_{11}) and the number of children who have died (X_{13}) jointly about 5% via their respective net effects are about 7.5% and 10.5%. Other joint effects of the remaining variables on the index of fertility (X_{14}) are not mentionable.

According to the model of **Rajshahi** division out of 13 variables, 8 are found to have significant direct effect on the total children ever born as well as index of fertility (X_{14}). The direct significant positive effect of respondent's current age (X_1) is 0.297 about 60%, number of household members (X_5) is 0.103 about 61%, number of living boys as well as index of son preference (X_{10}) is 0.253 about 76%, number of living children at first contraceptive use as well as decision making of contraceptive use (X_{11}) is 0.265 about 86% and number of children who have died as well as index of child mortality (X_{13}) is 0.364 that is 100% on the index of fertility (X_{14}) while the total effects of these variables are 0.496, 0.168, 0.329, 0.305 and 0.364 respectively. The direct significant negative effect of respondent's education (X_3) is -0.045 about 33%, respondent's age at first marriage (X_7) is -0.095 about 47%, respondent's wealth index (X_8) is -0.053 about 94% on the index of fertility (X_{14}) while the total effects of these variables are -0.134, -0.202, and -0.056 respectively.

Out of 6 exogenous variables of the model respondent's current age (X_1), respondent's education (X_3) and number of household members (X_5) are found to be statistically significant.

Total effect of respondent's current age (X_1) on the fertility (X_{14}) is 0.496, of which about 42% is transmitted through the number of living boys (X_{10}), about 24% is transmitted through the decision making of contraceptive use (X_{11}) and about 32% is transmitted through the index of child mortality (X_{13}) in the positive direction then about 57% acts through the respondent's age at first marriage (X_7) in the opposite direction.

Other indirect effects of respondent's current age (X_1) via respondent's wealth index (X_8), wealth index of a family (X_9) and body mass index of respondent (X_{12}) are negligible.

The total effect of respondent's education (X_3) on the index of fertility (X_{14}) is -0.134, of which about 39% is transmitted through the respondent's age at first marriage (X_7), about 25% is transmitted through the wealth index of a family (X_9), about 9% is transmitted through the number of living boys (X_{10}) in the positive direction then about 6% is transmitted through the decision making of contraceptive use (X_{11}) in the opposite direction. Other indirect effects of respondent's education (X_3) via respondent's wealth index (X_8), body mass index of respondent (X_{12}) and number of children who have died (X_{13}) are negligible.

The total effect of number of household members (X_5) on the index of fertility (X_{14}) is 0.168, of which about 28% is transmitted through the number of living boys (X_{10}), about 24% is transmitted through the index of contraception (X_{11}) in the positive direction then about 9% acts through the wealth index of a family (X_9) in the opposite direction. Other indirect effects of number of household members (X_5) via respondent's age at first marriage (X_7), respondent's wealth index (X_8), body mass index of respondent (X_{12}) and number of children who have died (X_{13}) are negligible.

It is also represented from the path model of Rajshahi division that the amount of variations in the dependent variable i.e., index of fertility (X_{14}) accounted for by the variables respondent's current age (X_1) and the number of living boys (X_{10}) jointly about 8% via their mutual correlation apart from their respective net effects are about 9% and

6.5%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of living children at first contraceptive use (X_{11}) jointly about 9% via their respective net effects are about 9% and 7%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of children who have died (X_{13}) jointly about 8% via their respective net effects are about 9% and 13%. The amount of variations in the index of fertility (X_{14}) accounted for by the number of living children at first contraceptive use (X_{11}) and the number of children who have died (X_{13}) jointly about 6% via their respective net effects are about 7% and 13%. Other joint effects of the remaining variables on the index of fertility (X_{14}) are not mentionable.

According to the model of **Sylhet** division out of 13 variables, 6 are found to have significant direct effect on the total children ever born as well as index of fertility (X_{14}). The direct significant positive effect of respondent's current age (X_1) is 0.166 about 47%, number of household members (X_5) is 0.081 about 63%, number of living boys as well as index of son preference (X_{10}) is 0.298 about 70%, number of living children at first contraceptive use as well as decision making of contraceptive use (X_{11}) is 0.300 about 90% and number of children who have died as well as index of child mortality (X_{13}) is 0.330 that is 100% on the index of fertility (X_{14}) while the total effects of these variables are 0.355, 0.128, 0.422, 0.330 and 0.330 respectively. The direct significant negative effect of respondent's wealth index (X_8) is -0.043 about 100% on the index of fertility (X_{14}) while the total effect of this variable is -0.043.

Out of 6 exogenous variables of the model respondent's current age (X_1) and number of household members (X_5) are found to be statistically significant.

The total effect of respondent's current age (X_1) on the fertility (X_{14}) is 0.355, of which about 70% is transmitted through the number of living boys (X_{10}), about 60% is transmitted through the decision making of contraceptive use (X_{11}) and about 13% is transmitted through the index of child mortality (X_{13}) in the positive direction then about 85% acts through the respondent's age at first marriage (X_7) and about 7% acts through the wealth index of a family (X_9) in the opposite direction. Other indirect effects of respondent's current age (X_1) via respondent's wealth index (X_8) and body mass index of respondent (X_{12}) are negligible.

The total effect of number of household members (X_5) on the index of fertility (X_{14}) is 0.128, of which about 52% is transmitted through the number of living boys (X_{10}), about 7% is transmitted through the decision making of contraceptive use (X_{11}) and about 7% number of children who have died (X_{13}) in the positive direction then about 20% acts through the wealth index of a family (X_9) in the opposite direction. Other indirect effects of number of household members (X_5) via respondent's age at first marriage (X_7), respondent's wealth index (X_8) and body mass index of respondent (X_{12}) are negligible.

It is also represented from the path model of Sylhet division that the amount of variations in the dependent variable i.e., index of fertility (X_{14}) accounted for by the variables respondent's current age (X_1) and the number of living boys (X_{10}) jointly about 5% via their mutual correlation apart from their respective net effects are about 3% and

9%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of living children at first contraceptive use (X_{11}) jointly about 5% via their respective net effects are about 3% and 9%. The amount of variations in the index of fertility (X_{14}) accounted for by the respondent's current age (X_1) and the number of children who have died (X_{13}) jointly about 4.5% via their respective net effects are about 3% and 11%. The amount of variations in the index of fertility (X_{14}) accounted for by the number of living children at first contraceptive use (X_{11}) and the number of children who have died (X_{13}) jointly about 6.5% via their respective net effects are about 9% and 11%. Other joint effects of the remaining variables on the index of fertility (X_{14}) are not mentionable.

Overall the path analysis reveals that respondent's current age (X_1), number of household members (X_5), number of living boys (X_{10}), number of living children at first contraceptive use (X_{11}) and numbers of children who have died (X_{13}) have significant direct positive effect, and the respondent's wealth index (X_8) has only significant direct negative effect on the index of fertility (X_{14}) for the six divisions. On the other hand respondent's age at first marriage (X_7) has found to be significant direct negative effect on the index of fertility (X_{14}) in the divisions except Sylhet. Respondent's education (X_3) has found to be significant direct negative on the index of fertility (X_{14}) for only Dhaka and Rajshahi divisions. Path analysis also demonstrates wealth index of a family (X_9) and body mass index of respondent (X_{12}) have significant direct negative effect on the index of fertility (X_{14}) in the two divisions, Chittagong and Dhaka.

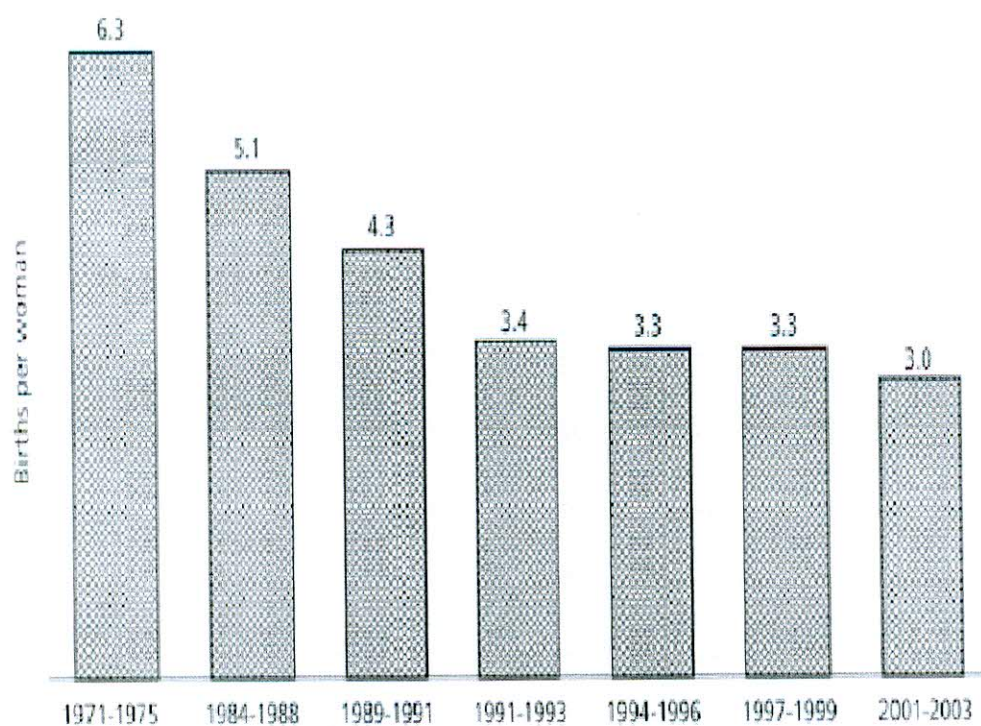
4.3 TRENDS IN FERTILITY, MARRIAGE AND CONTRACEPTION

Trends in fertility in Bangladesh since the early 1970s can be examined by observing a time series of estimates produced from demographic surveys fielded over the last two and half decades, beginning with the 1975 Bangladesh Fertility Survey (BFS). The estimates are shown in Table 39 describe the ongoing Bangladeshi fertility transition. The trend presents that fertility has declined sharply, from 6.3 in 1971-1975 to 3.0 in 2001-2003 (Figure 7). During this period, fertility declined rapidly in the late 1980s and early 1990s, and plateaued at around 3.3 for most of the 1990s. The 2004 BDHS data indicate that after almost a decade-long stagnation, the TFR declined slightly from 3.3 to 3.0 between 1997-1999 and 2001-2003. Table 39 also reveals that the level of fertility is still very high in Bangladesh although the age specific fertility rate has been decreasing over time in each age group. The peak age has shifted from 25-29 in 1975 to 20-24 in 2004. Looking at Figure 8, one can observe that the age pattern of fertility remains almost similar at different time points. Thus, it may be concluded that the level of fertility is still high and seems to change little overtime. It is observed that fertility increases up to age 25, and then declines sharply. This implies that women who postpone their marriage to later ages try to recover the reproductive period already lost by producing on the average more children. But beyond age 25, the fertility performance slows down, which might be due to the fact that women who postpone their marriage up to that age might be motivated to reduce their fertility by using some methods of modern contraception, and/or might have become less fecund as the level of fecundity decreases with increasing age or might have even become sterile.

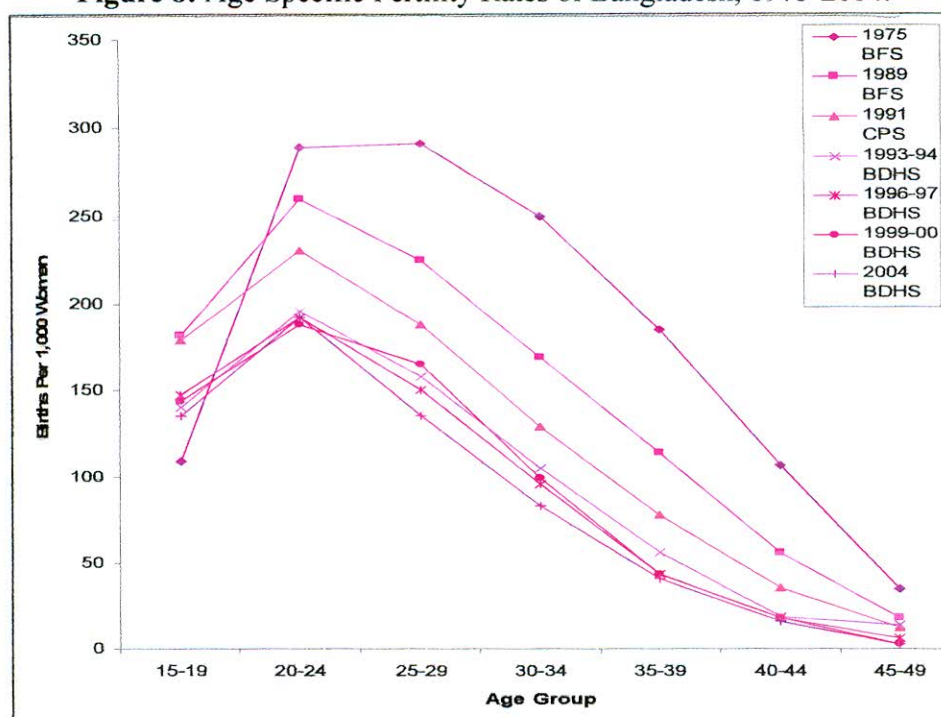
Table 39: Age-Specific Fertility Rates (per 1,000 women) and Total Fertility Rates (TFRs) among Women Age 15-49, Selected Sources, Bangladesh, 1975-2004.

Age Group	Year						
	1975	1989	1991	1993-94	1996-97	1999-00	2004
15-19	109	182	179	140	147	144	135
20-24	289	260	230	196	192	188	192
25-29	291	225	188	158	150	165	135
30-34	250	169	129	105	96	99	83
35-39	185	114	78	56	44	44	41
40-44	107	56	36	19	18	18	16
45-49	35	18	13	14	6	3	3
TFR	6.3	5.1	4.3	3.4	3.3	3.3	3.0

Source: BFS: 1975, 1989; CPS: 1991; BDHS: 1993-94, 1996-97, 1999-2000 and 2004.

Figure 7: Trends in Total Fertility Rates, Bangladesh 1971-2003.

Source: BDHS, 2004

Figure 8: Age Specific Fertility Rates of Bangladesh, 1975-2004.

Source: BDHS, 2004

A comparison of the mean number of children ever born reported in the 2004 BDHS and various other surveys is presented in Table 40 and Figure 9. The comparison does not highlight recent changes in fertility, but rather is an indication of the cumulative changes in fertility over the decades preceding the 2004 BDHS. Despite the fluctuations between surveys, the data generally show only modest declines until the late 1980s. Between 1985 and 1989, the decline in mean number of children ever born was substantial in all but the youngest and oldest age groups. Although this was followed by little change between 1989 and 1991, the mean number of children again declined considerably between 1991 and 1993-1994, especially among women age 25 and above, and showed further decline between 1993-1994 and 1999-2000 at all ages except 15-19. The most recent data showed a decline in the mean number of children between 1999-2000 and 2004 among women age 30 and above. Marriage in most Asian societies

defines the onset of the socially acceptable time for childbearing. Women who marry early will have, on average, a longer period of exposure to pregnancy, often leading to a higher number of children ever born.

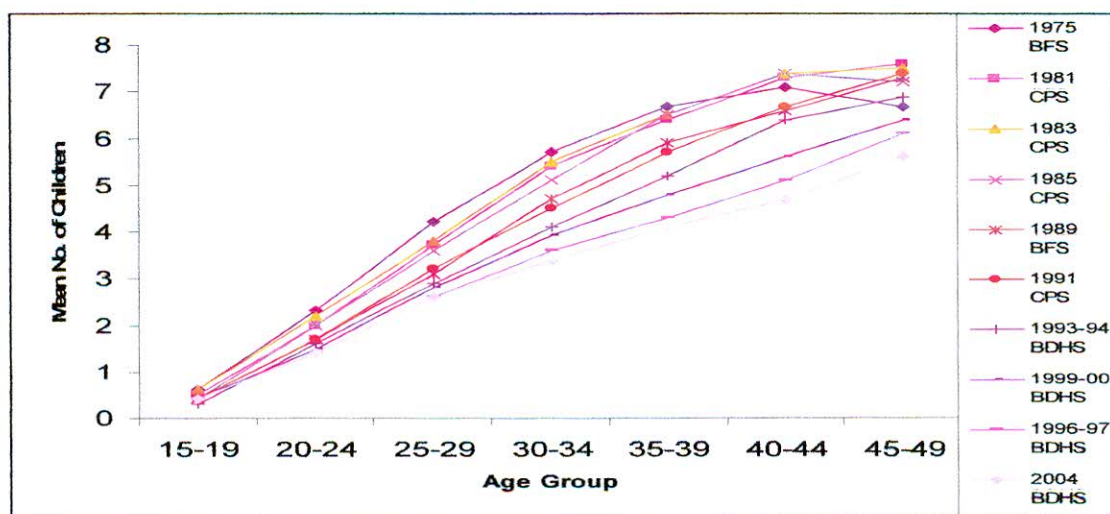
Table 41 shows the percentage of women who were first married by specific ages, and the median age at first marriage, according to current age. The data show that median age at first marriage has been increasing over time.

Table 40: Mean Number of Children Ever-Born Per Ever-Married Woman Aged 15-49, Selected Sources, Bangladesh, 1975-2004.

Age Group	Year									
	1975	1981	1983	1985	1989	1991	1993-1994	1996-1997	1999-2000	2004
15-19	0.6	0.5	0.6	0.4	0.4	0.4	0.3	0.4	0.4	0.4
20-24	2.3	2.0	2.2	2.0	1.7	1.7	1.6	1.5	1.4	1.4
25-29	4.2	3.7	3.8	3.6	3.1	3.2	2.9	2.8	2.6	2.6
30-34	5.7	5.4	5.5	5.1	4.7	4.5	4.1	3.9	3.6	3.4
35-39	6.7	6.4	6.5	6.5	5.9	5.7	5.2	4.8	4.3	4.1
40-44	7.1	7.3	7.4	7.4	6.6	6.7	6.4	5.6	5.1	4.7
45-49	6.7	7.6	7.5	7.2	7.3	7.4	6.9	6.4	6.1	5.6
Total	-	-	-	-	-	3.5	3.0	2.8	2.6	2.5

Source: BFS: 1975, 1989; CPS: 1981, 1983, 1985 and 1991; BDHS: 1993-94, 1996-97, 1999-2000 and 2004.

Figure 9: Mean Number of Children Ever-Born Per Ever-Married Woman: Bangladesh, 1975-2004.



The median age at first marriage rises from 13.9 years for women age 45-49 to 16.0 years for that age 20-24. The proportion of women marrying by age 15 has declined by almost half over time, from 71 percent among women in the oldest cohort to 37 percent among women age 20-24. Still, more than half of all women age 20-49 enter marriage before their 15th birthday. Comparison of data from the four BDHS surveys since 1993 indicates that although the median age at first marriage for women age 20-49 has increased over time, there was a decrease from a median of 15.0 years at the time of the 1999-2000 BDHS to 14.8 years in 2004.

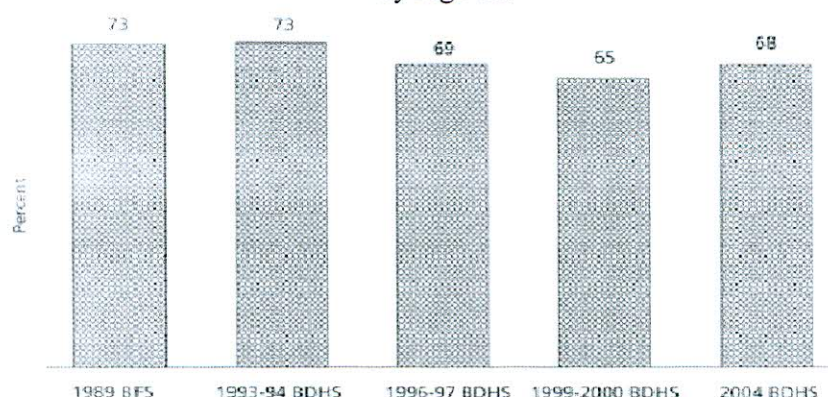
In Bangladesh the legal age of marriage is 18 years for women; however a large proportion of marriages still take place before the legal age. Figure 10 shows that in the 2004 BDHS, 68 percent of women age 20-24 were married before age 18. Data indicate that over the last two decades, the proportion of women marrying before the legal age had been gradually declining; but in recent years, it has increased again.

Table 41: Percentage of Women Age 15-49 Who Were First Married by Specific Exact Ages and Median Age at First Marriage, according to Current Age, Bangladesh 2004.

Current Age	Percentage First Married by Exact Age						% Never Married	Number of Women	Median Age at First Marriage
	12	15	18	20	22	25			
15-19	0.4	26.7	-	-	-	-	52.1	3,337	A
20-24	0.6	37.3	68.4	78.6	-	-	15.2	2,597	16.0
25-29	1.1	50.5	79.7	87.6	91.3	94.4	4.2	2,100	15.0
30-34	1.1	54.2	83.7	90.5	94.1	97.1	1.2	1,815	14.7
35-39	1.9	58.7	84.6	93.5	96.3	97.8	0.4	1,463	14.5
40-44	3.0	61.6	88.7	95.0	97.2	98.3	0.3	1,164	14.2
45-49	2.4	71.4	91.7	95.8	97.5	99.0	0.0	1,066	13.9
20-49	1.4	52.4	80.5	88.4	-	-	5.0	10,205	14.8
25-29	1.7	57.6	84.7	91.7	94.7	97.0	1.6	7,608	14.5

A= Omitted because less than 50 percent of the women married for the first time before reaching age 15.

Source: BDHS, 2004

Figure 10: Trends in Percentage of Women Age 20-24 Who Were First Married by Age 18.

Source: BDHS, 2004

Table 42 shows trends in the proportion of women reported as never married by age group from previous surveys in Bangladesh. Between 1975 and 2000, the proportion of never-married women in age groups 15-19 and 20-24 increased, but this upward trend did not continue beyond 2000. In 2004, the overall proportion of never-married women age 10-49 (23 percent) was lower than that reported in 1999-2000 (30 percent) and 1996-1997 (34 percent). The decline in the percentage of never-married women among those age 10-14 and 20-24 accounts for the decrease in the overall percentage of never-married women age 10-49.

Table 42: Percentage of Women Who have Never Married, by Age Group, as Reported in Various Surveys, Bangladesh 1975-2004.

Age Group	Year								
	1975	1983	1985	1989	1991	1993-1994	1996-1997	1999-2000	2004
10-14	91.2	98.0	98.7	96.2	98.5	95.2	95.2	92.7	88.6
15-19	29.8	34.2	47.5	49.0	46.7	50.5	49.8	51.9	52.1
20-24	4.6	4.0	7.1	12.0	12.3	12.4	17.2	18.5	15.2
25-29	1.0	0.7	1.0	2.3	2.8	2.2	3.4	4.2	4.2
30-34	0.2	0.4	0.1	0.3	0.5	0.3	0.5	0.1	1.2
35-39	0.4	-	-	0.1	0.1	0.3	0.0	0.2	0.4
40-44	0.1	0.1	-	0.2	0.3	0.7	0.0	0.0	0.3
45-49	0.0	0.1	-	0.1	-	0.2	0.0	0.0	0.0

Source: BFS: 1975, 1989; CPS: 1983, 1985 and 1991; BDHS: 1993-94, 1996-97, 1999-2000 and 2004.

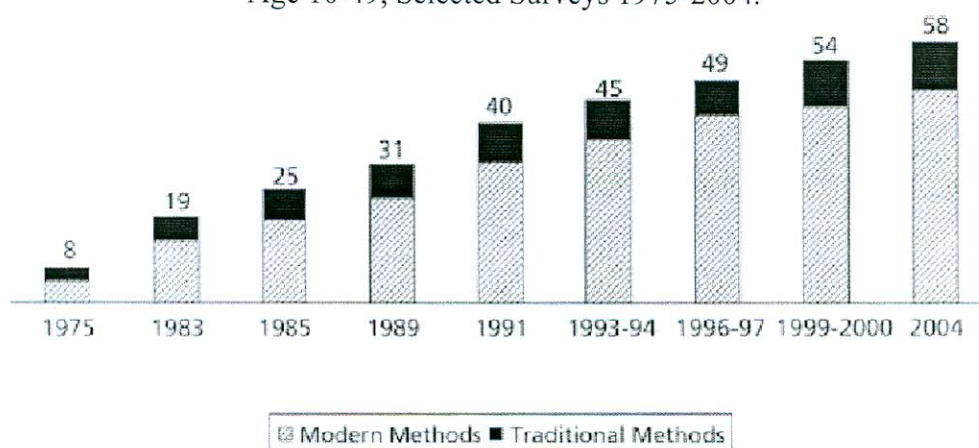
The contraceptive prevalence rate in Bangladesh has increased from 8 percent in 1975 to 58 percent of currently married women in 2004 (Table 43 and Figure 11). This translates to more than a sevenfold increase. The increase in the use of modern methods is even more dramatic – a more than ninefold increase (from 5 to 47 percent) in three decades. Between the 1999-2000 BDHS and the 2004 BDHS, overall contraceptive use increased by 4 percentage points, from 54 to 58 percent of currently married women. This increase has been almost entirely due to the higher use of modern methods, namely, the pill and injectables. Condom use has remained unchanged since the 1999-2000 BDHS, while the use of traditional methods shows a slight increase. A decade-long decline in the use of long-lasting contraceptive methods continues. In 2004, only 7 percent of currently married women were using sterilization, IUD, or Norplant, compared with 11 percent in 1993-94.

Table 43: Percentage of Currently Married Women Age 10-49 Who are Currently Using Specific Family Planning Methods, Selected Sources, Bangladesh 1975-2004.

Method	Year								
	1975	1983	1985	1989	1991	1993-1994	1996-1997	1999-2000	2004
Any Modern Method	5.0	13.8	18.4	23.2	31.2	36.2	41.5	43.4	47.3
Pill	2.7	3.3	5.1	9.6	13.9	17.4	20.8	23.0	26.2
IUD	0.5	1.0	1.4	1.4	1.8	2.2	1.8	1.2	0.6
Injectables	-	0.2	0.5	0.6	2.6	4.5	6.2	7.2	9.7
Norplant	-	-	-	-	-	-	0.1	0.5	0.8
Vaginal Methods	0.0	0.3	0.2	0.1	-	-	-	-	-
Condom	0.7	1.5	1.8	1.8	2.5	3.0	3.9	4.3	4.2
Female Sterilization	0.6	6.2	7.9	8.5	9.1	8.1	7.6	6.7	5.2
Any Traditional Method	2.7	5.4	6.9	7.6	8.7	8.4	7.7	10.3	10.8
Periodic Abstinence	0.9	2.4	3.8	4.0	4.7	4.8	5.0	5.4	6.5
Withdrawal	0.5	1.3	0.9	1.8	2.0	2.5	1.9	4.0	3.6
Other Traditional Methods	1.3	1.8	2.2	1.8	2.0	1.1	0.8	0.9	0.6
CPR	7.7	19.1	25.3	30.8	39.9	44.6	49.2	53.8	58.1

Source: BFS: 1975, 1989; CPS: 1983, 1985 and 1991; BDHS: 1993-94, 1996-97, 1999-2000 and 2004.

Figure 11: Trends in Contraceptive Use (%) among Currently Married Women Age 10-49, Selected Surveys 1975-2004.



Source: BDHS, 2004

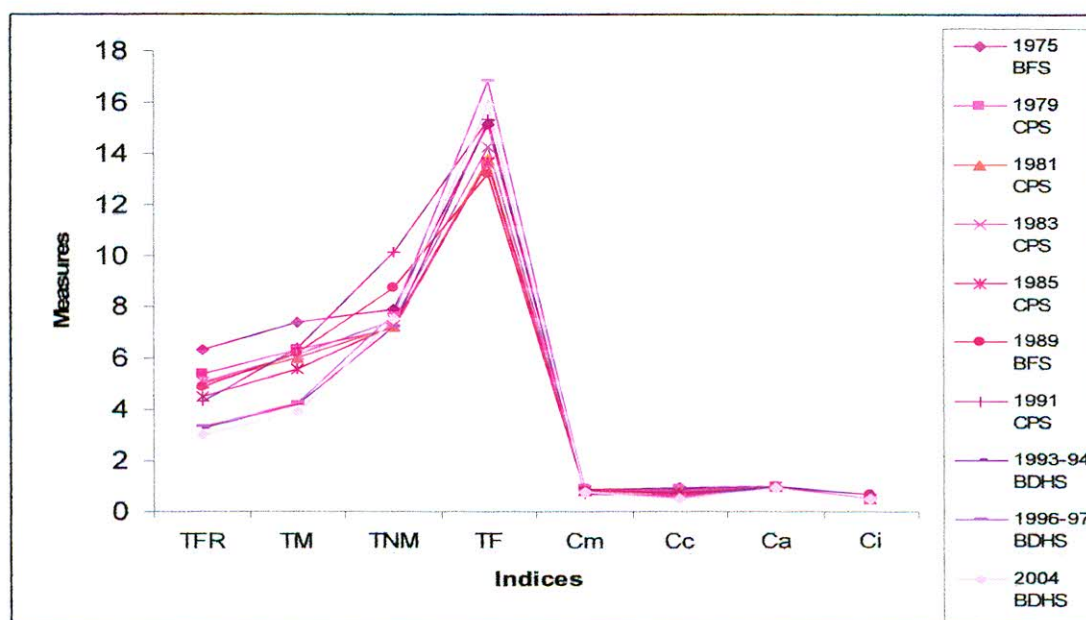
4.4 THE ESTIMATED FOUR PROXIMATE DETERMINANTS AND THEIR IMPLICATIONS ON THE FERTILITY DECLINE IN BANGLADESH

On the basis of Bongaarts' model given in equation (25), the estimated values of the measures and indices for different time points are presented in Table 44 and Figure 12. The complement of the indices represents the proportionate reduction in fertility attributed to the fertility determinant. The lower the estimated value of the indices the greater the fertility reducing effect. The analysis estimates the value of C_m in 1975 is 0.859, indicating that the proportion of women married reduces fertility by $(1-0.859) \times 100 = 14.1\%$, while the value of C_m in 1989 is 0.785 and in 2004 is 0.782, indicating that the proportion of women married reduces fertility by 21.5% and 21.8% respectively and the value of C_c in 1975 is 0.932 indicating that the index of contraception reduces fertility by 6.8%, while the value of C_c in 1989 is 0.718 and in 2004 is 0.515, indicating that the index of contraception reduces fertility by 28.2% and 48.5% respectively.

Table 44: Estimates of Different Reproductive Measures and Indices of Proximate Determinants of Fertility, Bangladesh, 1975-2004.

Measures/ Indices	1975	1979	1981	1983	1985	1989	1991	1996-97	1999-2000	2004
TFR	6.329	5.381	5.042	5.085	4.502	4.895	4.350	3.265	3.310	3.025
TM	7.368	6.331	6.017	6.134	5.558	6.236	6.400	4.181	4.265	3.870
TNM	7.906	7.121	7.206	7.462	7.284	8.685	10.090	7.196	7.726	7.515
TF	15.087	13.590	13.751	14.241	13.641	13.199	15.288	15.248	16.798	15.836
C_m	0.859	0.850	0.838	0.829	0.810	0.785	0.680	0.781	0.776	0.782
C_c	0.932	0.889	0.835	0.822	0.763	0.718	0.634	0.581	0.552	0.515
C_a	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.940	0.920	0.930
C_i	0.524	0.524	0.524	0.524	0.534	0.658	0.660	0.502	0.500	0.510

Source: BFS: 1975, 1989; CPS: 1979, 1981, 1983, 1985, 1991; BDHS: 1996-97, 1999-2000 and 2004.

Figure 12: Different Reproductive Measures and Indices of Fertility, Bangladesh, 1975-2004.

Again, the value of C_i in 1975 is 0.524 indicating that the index of lactational infecundability reduces fertility by 47.6%, while the value of C_i in 1989 is 0.658 and in

2004 is 0.510, indicating that the index of lactational infecundability reduces fertility by 34.2% and 49% respectively.

The decomposition of the changes of all indices in *TFR* between 1975 to 1989 and 1975 to 2004 are represented by Table 45. The results indicate that *TFR* has declined about 22.7% from 6.329 in 1975 to 4.895 in 1989 and 52.2% from 6.329 in 1975 to 3.025 in 2004. It also indicates that the decomposition of this decline in *TFR* between 1975 to 1989 has been nearly 8.6% decline due to decrease in the proportion of women married, about 23.0% decline due to an increase in contraceptive use and effectiveness but approximately 25.6% increase due to decrease of the duration of lactational infecundability.

Table 45: Decomposition of Changes in *TFR* by Different Measures and Indices between 1975 and 2004.

Changing Indices	Percentage of Change		Distribution of Percentage Change		Absolute Change of <i>TFR</i>	
	1975-89	1975-04	1975-89	1975-04	1975-89	1975-04
C_m	-8.615	-8.964	-38.021	-17.171	-0.543	-0.565
C_c	-22.961	-44.742	-101.341	-85.707	-1.447	-2.819
C_a	0.000	-7.000	0.000	-13.409	0.000	-0.441
C_i	25.573	-2.672	112.865	-5.118	1.611	-0.168
TF	-12.514	4.965	-55.231	9.510	-0.788	0.313
I	-4.140	6.209	-18.272	11.895	-0.261	0.391
TFR	-22.658	-52.204	100.000	100.000	-1.427	-3.289

Source: BFS: 1975 and 1989; BDHS: 2004.

Table 46: Decomposition of Changes in *CBR* by Different Measures and Indices between 1975 and 2004.

Changing Indices	Percentage of Change		Distribution of Percentage Change		Absolute Change of <i>CBR</i>	
	1975-89	1975-04	1975-89	1975-04	1975-89	1975-04
P_s	-10.640	32.082	-34.437	61.455	-4.327	9.216
C_m	-8.615	-8.964	-27.883	-17.171	-3.504	-2.575
C_c	-22.961	-44.742	-74.315	-85.707	-9.339	-12.853
C_a	0.000	-7.000	0.000	-13.409	0.000	-2.011
C_i	25.573	-2.672	82.769	-5.118	10.401	-0.768
TF	-12.514	4.965	-40.502	9.510	-5.090	1.426
I	-1.740	-25.873	-5.632	-49.560	-0.708	-7.432
P_b	-30.897	-52.204	100.000	100.000	-12.566	-14.997

Source: BFS: 1975 and 1989; BDHS: 2004.

The remaining proximate determinants together contribute about 12.5% decreases and by interaction factor decrease about 4.1% in *TFR*. Again the decomposition of this decline in *TFR* between 1975 to 2004 has been nearly 9.0% decline due to decrease in the proportion of women married, about 44.7% decline due to an increase in contraception use and effectiveness and about 2.7% decline due to increase of the duration of lactational infecundability. The remaining proximate determinants together contribute nearly 5.0% increases and by interaction factor increase about 6.2% in *TFR*. The decomposition results are standardized to add to 100%. Further, Table 45 indicates that during 1975 to 1989 it has declined by 1.427 births per woman of which 0.543 births declined by proportion married, 1.447 births declined due to contraception, 1.611 births increased due to lactational infecundability, 0.788 births declined by other proximate determinants and the interaction factor has declined 0.261 births. Again, during 1975 to 2004 it has declined by 3.289 births per woman of which 0.565 births has declined by

proportion married, 2.819 births declined due to contraception, 0.441 births declined due to induced abortion, 0.168 births declined due to lactational infecundability, 0.313 births increased by other proximate determinants and 0.391 births is increased by the interaction factor. It is clear from Table 46 that the change in CBR by different intermediate fertility variables and age-sex composition has also contributed to the change in CBR. It is indicated that in decreasing of CBR, by the proportion of women married has about 28% of total decrease during 1975 to 1989 and about 17% during 1975 to 2004, about 74% by use of contraception during the period 1975 to 1989 and about 86% during 1975 to 2004. Also it has decreased about 3.5 births by proportion of women married during 1975 to 1989 and about 2.6 births during 1975 to 2004, about 9 births by use of contraception out of 13 births during the period of 1975 to 1989 and about 13 births out of 15 births during 1975 to 2004.

4.4.1 THE INHIBITING EFFECT OF MARRIAGE ON FERTILITY

The approximate effect of marriage pattern on fertility can be measured by adopting Bongaarts' model (Bongaarts, 1982). The model assumes that women who are not currently married would experience the same fertility as their married counterparts, if they themselves were married as shown in Table 47 which includes the relevant data for 1975, 1981, 1989, 1991, 1996-97, 1999-2000 and 2004. Column 1 gives the all-women age specific fertility rates, averaged for the five year period prior to the survey.

By multiplying these rates by the reciprocal of the proportions ever-married at the time of the survey, an estimate is formed of hypothetical fertility in the absence of any postponement of marriage beyond age 15 which is shown in column 3. Column 4 shows the proportion who are currently married among those who ever-married. The reciprocal of these proportions multiplied by the rates in column 3 gives an estimate of hypothetical

fertility in the absence of any postponement of marriage beyond age 15 and in the absence of divorce and widowhood shown in column 5. In column 6, the reduction in fertility by marriage has shown.

Table 47: Estimation of the Effect of Marriage Pattern on Fertility.

Age	ASFR	Prop. ever married	ASEMFR	Prop. currently married among ever married	ASMFR	
	(1)	(2)	(3)=(1)/(2)	(4)	(5)=(3)/(4)	(6)=1.0-(1)/(5)
1975						
15-19	0.1090	0.7020	0.1553	0.9231	0.1682	0.3520
20-24	0.2886	0.9540	0.3025	0.9466	0.3196	0.0970
25-29	0.2911	0.9900	0.2940	0.9303	0.3160	0.0788
30-34	0.2502	0.9980	0.2507	0.9097	0.2756	0.0922
35-39	0.1848	0.9960	0.1855	0.8468	0.2191	0.1565
40-44	0.1074	0.9980	0.1076	0.7888	0.1364	0.2126
45-49	0.0347	1.0000	0.0347	0.7105	0.0488	0.2889
$\sum_{15}^{50}$	6.3290	-----	6.6515 0.3225	-----	7.4185 0.7670	0.1469
1981						
15-19	0.1330	0.6870	0.1936	0.9518	0.2034	0.3461
20-24	0.2755	0.9490	0.2903	0.9577	0.3031	0.0911
25-29	0.2384	0.9870	0.2415	0.9560	0.2526	0.0562
30-34	0.1667	0.9900	0.1684	0.9379	0.1796	0.0718
35-39	0.1296	0.9960	0.1301	0.9015	0.1443	0.1019
40-44	0.0465	0.9930	0.0468	0.8245	0.0568	0.1813
45-49	0.0185	0.9970	0.0186	0.7471	0.0249	0.2570
$\sum_{15}^{50}$	5.0410	-----	5.4465 0.4055	-----	5.8235 0.3770	0.1344
1989						
15-19	0.1422	0.5095	0.2791	0.9439	0.2957	0.5191
20-24	0.2599	0.8797	0.2954	0.9415	0.3138	0.1718
25-29	0.2254	0.9771	0.2307	0.9362	0.2464	0.0852
30-34	0.1642	0.9968	0.1647	0.9319	0.1767	0.0707
35-39	0.1141	0.9985	0.1143	0.9002	0.1270	0.1016
40-44	0.0555	0.9982	0.0556	0.8428	0.0660	0.1591
45-49	0.0176	0.9989	0.0176	0.8070	0.0218	0.1927
$\sum_{15}^{50}$	4.8945	-----	5.7870 0.8925	-----	6.2370 0.4500	0.2152

Table 47 (Continued)

Age	ASFR	Prop. ever married	ASEMFR	Prop. currently married among ever married	ASMFR	
	(1)	(2)	(3)=(1)/(2)	(4)	(5)=(3)/(4)	(6)=1.0-(1)/(5)
1991						
15-19	0.1910	0.5330	0.3583	0.9586	0.3738	0.4890
20-24	0.2350	0.8770	0.2680	0.9422	0.2844	0.1737
25-29	0.2030	0.9720	0.2088	0.9489	0.2200	0.0773
30-34	0.1500	0.9950	0.1508	0.9343	0.1614	0.0706
35-39	0.0890	0.9990	0.0891	0.0948	0.0985	0.0965
40-44	0.0500	0.9970	0.0502	0.8581	0.0585	0.1453
45-49	0.0100	1.0000	0.0100	0.7746	0.0129	0.2248
$\sum_{15}^{50}$	4.6400	-----	5.6760 1.0360	-----	6.0475 0.3720	0.2327
1996-97						
15-19	0.1470	0.5020	0.2930	0.9620	0.3050	0.5180
20-24	0.1920	0.8280	0.2320	0.9580	0.2420	0.2070
25-29	0.1500	0.9650	0.1550	0.9520	0.1630	0.0790
30-34	0.0960	0.9950	0.0960	0.9250	0.1040	0.0760
35-39	0.0440	0.9990	0.0440	0.9140	0.0480	0.0830
40-44	0.0180	1.0000	0.0180	0.8600	0.0210	0.1430
45-49	0.0060	1.0000	0.0060	0.7900	0.0080	0.2500
$\sum_{15}^{50}$	3.2650	-----	4.2200 0.9550	-----	4.4550 0.2350	0.2670
1999-2000						
15-19	0.1440	0.4810	0.2990	0.9690	0.3080	0.5320
20-24	0.1880	0.8150	0.2310	0.9550	0.2420	0.2230
25-29	0.1650	0.9580	0.1720	0.9510	0.1810	0.0880
30-34	0.0990	0.9990	0.0990	0.9390	0.1050	0.0570
35-39	0.0440	0.9980	0.0440	0.8790	0.0500	0.1200
40-44	0.0180	0.9990	0.0180	0.8430	0.0210	0.1430
45-49	0.0030	1.0000	0.0030	0.8230	0.0040	0.2500
$\sum_{15}^{50}$	3.310	-----	4.3300 1.0200	-----	4.5550 0.2250	0.2730
2004						
15-19	0.1350	0.4780	0.2820	0.9620	0.2930	0.5400
20-24	0.1920	0.8480	0.2260	0.9630	0.2350	0.1830
25-29	0.1350	0.9580	0.1410	0.9610	0.1470	0.0790
30-34	0.0830	0.9880	0.0840	0.9380	0.0900	0.0730
35-39	0.0410	0.9950	0.0410	0.8980	0.0460	0.1060
40-44	0.0160	0.9970	0.0160	0.8470	0.0190	0.1560
45-49	0.0030	0.9990	0.0030	0.8170	0.0040	0.1840
$\sum_{15}^{50}$	3.025	-----	3.9700 0.9450	-----	4.1650 0.1950	0.2740

Source: BFS: 1975, 1989; BCPS: 1981, 1991; BDHS: 1996-97; 1999-2000 and 2004.

In absolute terms, postponement of marriage in 1975, 1981, 1989, 1991, 1996-97, 1999-2000 and 2004 is estimated to reduce fertility by 0.323, 0.406, 0.893, 1.036, 0.955, 1.02 and 0.945 births respectively. Again, widowhood and divorced further reduce fertility by 0.767, 0.377, 0.450, 0.372, 0.235, 0.225 and 0.195 births respectively in these years. Table 47 also shows the effect of postponement of marriage on fertility by age. At the ages 15-19 the reduction of fertility by postponement of marriage is being 0.352 births in 1975, 0.346 births in 1981, 0.519 births in 1989, and 0.489 births in 1991, 0.518 in 1996-97, 0.532 in 1999-2000 and 0.540 in 2004. After the ages 15-19 the rate has been decreasing up to the ages 25-29 in 1975, up to the ages 25-29 in 1981, up to the ages 30-34 in 1989, up to the ages 30-34 in 1991, 1996-97, 1999-2000 and 2004. After that the rates are found to be gradually increased up to the marriageable ages. Further Table 47 shows the effect of marriage pattern respectively in the years of 1975, 1981, 1989, 1991, 1996-97, 1999-2000 and 2004 by 14.7%, 13.4%, 21.5%, 23.3%, 26.7%, 27.3% and 27.4% reduction in fertility. Thus, the fertility reducing effect of marriage pattern has increased over time for the years 1975, 1989, 1991, 1996-97, 1999-2000 and 2004 except 1981.

4.5 ESTIMATION OF GENERAL-TO-SPECIFIC MODELS

The estimated general to specific models of Hendry's modeling approach in equation (40), (41), (42) and (43) are reported below.

$$\begin{aligned}
 T\hat{F}R &= 27.739 - 0.133 FMAM_t + 0.012 IMR_t + 0.001 LITR_t - 0.551 LFF_t + 0.012 UER_t + 0.012 GDPGR_t, \quad (96) \\
 s.e &= (4.524) \quad (0.054) \quad (0.005) \quad (0.010) \quad (0.106) \quad (0.020) \quad (0.031) \\
 t &= (6.131) \quad (-2.470) \quad (2.407) \quad (0.098) \quad (-5.203) \quad (0.612) \quad (0.389) \\
 p &= (.000) \quad (.027) \quad (.030) \quad (.923) \quad (.000) \quad (.550) \quad (.703) \\
 R^2 &= 0.985, \quad DW = 1.648
 \end{aligned}$$

$$\begin{aligned}
\hat{TFR} &= 27.684 - 0.132 FMAM_t + 0.012 IMR_t - 0.549 LFF_t + 0.013 UER_t + 0.012 GDPGR_t, \\
s.e. &= (4.340) \quad (0.051) \quad (0.004) \quad (0.101) \quad (0.017) \quad (0.030) \\
t &= (6.379) \quad (-2.596) \quad (2.971) \quad (-5.427) \quad (0.737) \quad (0.400) \\
p &= (.000) \quad (.020) \quad (.010) \quad (.000) \quad (.473) \quad (.694) \\
R^2 &= 0.985, \quad DW = 1.655
\end{aligned} \tag{97}$$

$$\begin{aligned}
\hat{TFR} &= 27.686 - 0.134 FMAM_t + 0.011 IMR_t - 0.547 LFF_t + 0.013 UER_t, \\
s.e. &= (4.224) \quad (0.049) \quad (0.004) \quad (0.098) \quad (0.017) \\
t &= (6.554) \quad (-2.713) \quad (3.039) \quad (-5.561) \quad (0.780) \\
p &= (.000) \quad (.015) \quad (.008) \quad (.000) \quad (.447) \\
R^2 &= 0.985, \quad DW = 1.649
\end{aligned} \tag{98}$$

$$\begin{aligned}
\hat{TFR} &= 25.717 - 0.137 FMAM_t + 0.012 IMR_t - 0.489 LFF_t, \\
s.e. &= (3.349) \quad (0.049) \quad (0.004) \quad (0.064) \\
t &= (7.678) \quad (-2.826) \quad (3.369) \quad (-7.679) \\
p &= (.000) \quad (.012) \quad (.004) \quad (.000) \\
R^2 &= 0.984, \quad DW = 1.723
\end{aligned} \tag{99}$$

The sample size $n = 21$ from 1985 to 2005 is used in each of the above estimation. Equations (96), (97), (98) and (99) are the estimated models corresponding to models 1, 2, 3 and 4 in equations (40), (41), (42) and (43). According to general-to-specific methodology, equation (96) reduces to equation (97), equation (97) reduces to equation (98) and finally equation (98) reduces to equation (99) based on the value of t -statistics and significant test in equation (44) i.e. small t -value and if H_0 , do not reject it. The analysis reveals the value of variance inflation factors (VIF) (Gujarati, 1995, pp.328-339) of the explanatory variables (i.e., VIF of FMAM= 4.6, IMR=9.4 and LFF=5.1) in the final model of equation (99) are less than 10 (Hadi, 2006, p.236), so it can be said that the data have no evidence of collinearity problems. Variance inflation factor (VIF) is nothing only a multicollinearity measurement technique of a regression model. Again, the Durbin-Watson (DW) (Gujarati, 1995, pp. 420-423) test statistic of equation (99) is $DW = 1.723$, that evidents there is no significant autocorrelation at 0.05 level comparing with the DW bound values of $d_L = 1.026$ and $d_U = 1.669$. While in all other models DW are inconclusive.

4.5.1 THE SPECIFIC FORECASTING MODEL AND IT'S ACCURACY MEASURE

The estimated model in equation (99) is used to evaluate the forecast performance of the model, which is given below.

$$T\hat{F}R_t = 25.717 - 0.137 FMAM_t + 0.012 IMR_t - 0.489 LFF_t, \\ t = (1 = 1985), (2 = 1986), \dots, (T = 2005).$$

To check the adequacy of the forecast model the two mean square errors (MSEs) i.e. the in-sample mean square error and the out-of-sample mean square error are compared. The two mean squared errors are computed according to equation (47) as follows:

$$MSE_1 = \frac{1}{15} \sum_{t=1985}^{N_1=1999} (TFR_t - T\hat{F}R_t)^2 = 0.03373$$

and

$$MSE_2 = \frac{1}{6} \sum_{t=2000}^{N_2=2005} (TFR_t - T\hat{F}R_t)^2 = 0.02070$$

$$i.e., \quad MSE_2 < MSE_1$$

Note: suffix 1 and 2 indicate the in-sample and out-of-sample calculations of the MSE.

Based on MSE criteria researcher observes that the out-of-sample (hold-out period) mean square error (MSE_2) is smaller than the in-sample MSE_1 . This indicates that the above regression model for forecast can be adopted for policy decision purposes. Hence, researcher has suggested the estimated model in equation (99) can be adopted to predict TFR for future policy making purposes using the available data.

4.5.2 FUTURE PREDICTIONS (FORECASTS) OF TOTAL FERTILITY RATE

To achieve our aim of forecasting the TFR for the years 2006 through to 2030, researcher use the above regression forecast model of equation (99). The observed and predicted values of the selected indices are given in Table 48 and Table 49. Similarly are shown in Figure 13 and Figure 14. Table 50 represents the percentage of TFR and the selected indices from 1985-2030.

Table 48: Observed TFR and Selected Indices from 1985-2005.

Years	TFR	FMAM	IMR	LFF
1985	4.71	18.00	112.00	41.10
1986	4.70	17.50	116.00	41.10
1987	4.42	17.90	113.00	41.10
1988	4.39	17.60	116.00	41.10
1989	4.35	18.00	98.00	41.10
1990	4.33	18.00	94.00	41.10
1991	4.24	18.10	92.00	41.10
1992	4.18	18.20	88.00	41.20
1993	3.98	19.60	84.00	41.30
1994	3.58	19.90	77.00	41.40
1995	3.45	19.90	71.00	41.50
1996	3.41	20.10	67.00	41.80
1997	3.10	20.00	60.00	42.10
1998	2.98	20.20	57.00	42.40
1999	2.64	20.30	59.00	42.60
2000	2.59	20.40	58.00	42.90
2001	2.56	20.40	56.00	43.00
2002	2.56	20.60	53.00	43.10
2003	2.55	20.40	53.00	43.20
2004	2.54	19.00	52.00	43.30
2005	2.53	19.00	52.00	43.40

Source: BBS (1985-2005).

Table 49: Predicted TFR and Selected Predicted Indices from 2006-2030.

Years	TFR	FMAM	IMR	LFF
2006	2.5	19.1	51.3	43.4
2007	2.5	19.1	50.7	43.4
2008	2.5	19.2	50.0	43.4
2009	2.4	19.2	49.4	43.4
2010	2.4	19.3	48.7	43.4
2011	2.4	19.3	48.1	43.4
2012	2.4	19.4	47.4	43.4
2013	2.4	19.4	46.8	43.4
2014	2.4	19.5	46.1	43.5
2015	2.3	19.5	45.5	43.5
2016	2.3	19.6	44.8	43.5
2017	2.3	19.6	44.1	43.5
2018	2.3	19.7	43.5	43.5
2019	2.3	19.7	42.8	43.5
2020	2.2	19.8	42.2	43.5
2021	2.2	19.8	41.5	43.5
2022	2.2	19.9	40.9	43.5
2023	2.2	19.9	40.2	43.5
2024	2.2	20.0	39.6	43.5
2025	2.2	20.1	38.9	43.5
2026	2.1	20.1	38.3	43.5
2027	2.1	20.2	37.6	43.5
2028	2.1	20.2	37.0	43.5
2029	2.1	20.3	36.3	43.5
2030	2.1	20.3	35.6	43.5

Table 50: Percentage Change of TFR and Selected Indices from 1985-2030.

Indices	Year			% Change	
	1985	2005	2030	1985-05	2005-30
TFR	4.7	2.5	2.1		
	100	53.2	44.7	-46.8	-8.5
FMAM	18	19	20.3		
	100	105.6	112.8	+5.6	+7.2
IMF	112	52	35.6		
	100	46.4	31.8	-53.6	-14.6
LFF	41.1	43.4	43.5		
	100	105.6	105.8	+5.6	+0.2

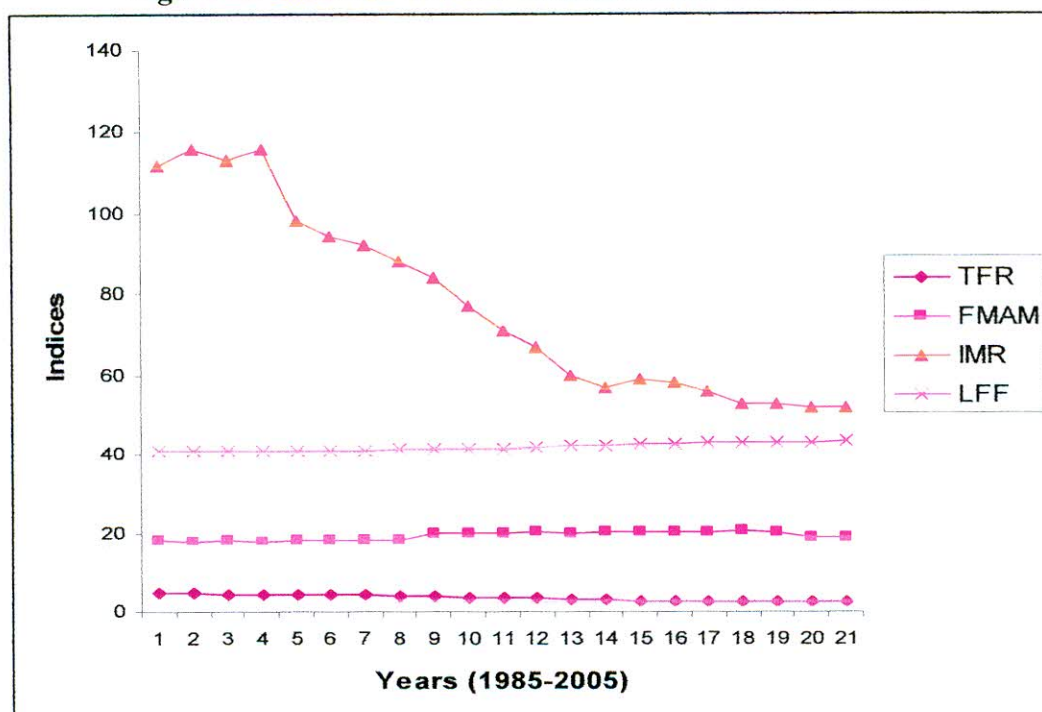
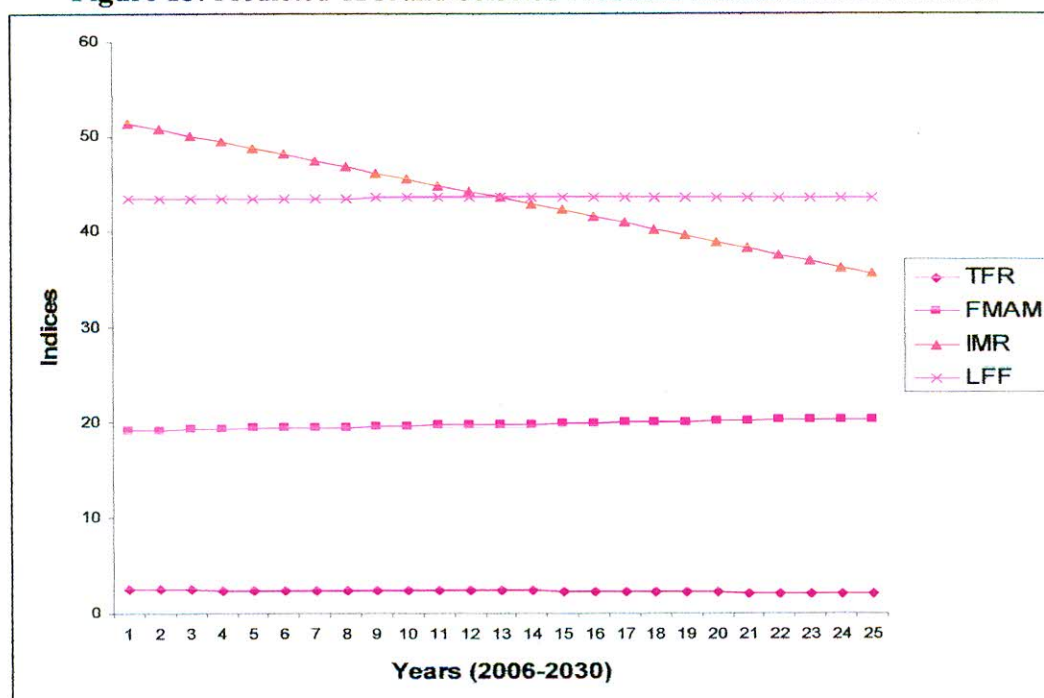
Figure 14: Observed TFR and Selected Indices from 1985-2005.**Figure 15:** Predicted TFR and Selected Predicted Indices from 2006-2030.

Table 50 depicts that the total fertility rate (TFR) and infant mortality rate per 1000 live births (IMR) has been decreased 46.8% and 53.6% during 1985-2005. On the other hand female mean age at marriage (FMAM) and labor force of female (LFF) have increased the same of 5.6% during the period from 1985 to 2005. Actually Table 49 reveals that Bangladesh will reach replacement-level of fertility as well as TFR 2.1 to 2026. To obtain a convergent result it has been continued up to 2030. The same scenarios are followed. The researcher wants to draw the conclusion on replacement-level fertility on the year of 2030 as the United Nations goal year to reach replacement-level of fertility of Bangladesh. Depending on the desired specific model it can be said that the fertility level as well as the measurement index of fertility TFR of Bangladesh will reach replacement-level 2.1 if the country may keep at the same time other selected indices FMAM, IMR and LFF as 20.3, 35.6 and 43.5. To reach this goal the country shall have to reduce the TFR at 8.5%, at the same time IMR to 14.6% when the FMAM and LFF will be increased to 7.2% and 0.2%.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Bangladesh has been experiencing a critical phase of fertility transition since the 1970s. The total fertility rate (TFR) has declined from a high level of 6.3 births per woman in 1975 to 3.4 births per woman in 1993–94 (Mitra *et al.*, 1994). The sharp decline in fertility in Bangladesh during the early 1990s has generated much interest among researchers and policymakers. The interest arises from the fact that the remarkable success in the reduction of fertility in Bangladesh has occurred without the substantial improvements in socioeconomic and health status that are thought to be needed to bring about a change in fertility level. Several researchers argued that the fertility decline in Bangladesh was achieved primarily due to a successful family planning programme (Cleland, 1994; Cleland *et al.*, 1994; Islam *et al.*, 1998; Caldwell *et al.*, 1999) that succeeded in raising the contraceptive prevalence rate (CPR) from a low level of 8% in 1975 to as high as 44% in 1993–94 (Mitra *et al.*, 1994). However, since 1993–94, the level of total fertility appears to be unchanged at a level of 3.3, as indicated by the last two consecutive Bangladesh Demographic and Health Surveys (BDHSs) conducted in Bangladesh in 1996–97 and 1999–2000. On the other hand, during the period from 1993–94 to 1999–2000, the contraceptive prevalence rate has increased substantially from 44.6% to 53.8% (Mitra *et al.*, 2001). Even in the Matlab experimental area (a research station of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), which was known for its intensive family planning service delivery system

resulting in a sharp increase in the level of the CPR to 70%, the TFR had remained at the vicinity of 3 births for the last several years (Bairagi, 2002). The unchanged level of fertility in Bangladesh since 1993–94, despite a rapid increase in the level of contraceptive prevalence, raises concern among researchers, policymakers and programme managers about the prospect of attaining replacement level of fertility in Bangladesh in the near future.

The fertility decline has been particularly impressive, given that the country lacks many of the socioeconomic and demographic conditions that historically developed countries have marked fertility decline. There has been much interest in Bangladesh because fertility declined despite the absence of improvements in socio-economic conditions, thus raising questions about socio-economic preconditions for the onset of fertility decline. Davis (1959) showed that the intricacies of the interrelationships between socio-economic and demographic variables are a new phenomenon. He said that the demographic changes were both reflective and behavioural. Demographic changes were reflective in that they affected other components of a social system, which in turn brings about changes in those components initiating the change. Demographic changes were behavioural in that they involved human decisions.

In this research multiple logistic regression analysis has been used to estimate the socioeconomic and demographic influence on the human fertility behaviour among the Bangladeshi women. Total number of children ever born per women aged 10–49 has been taken as the dependent as well as the fertility measurement variable. The median of this variable is found to be three (3). The above median has coded as zero (0) to treat disfavourable and one (1) for less or equal to median as favourable human fertility

behaviour. The logistic regression analysis demonstrates among fourteen selected socio-economic and demographic backgrounds such as current marital status, age at first marriage, respondent's education, partner's education, respondent's occupation, partner's occupation, region, residence, religion, index of wealth, index of mass media, ever used any method or choice of contraceptive method, currently breastfeeding, index of child mortality— six variables; age at marriage, educational level, region, mass media, contraceptive method and child mortality have found as the most influential variables on human fertility behaviour.

On the basis of socio-economic variables it has been shown from the logistic regression analysis that increases in education tended to have lower the fertility influence. It has been also shown favourable fertility behaviour have found to be 95.1% less for no education, 91.7% less for primary and 76.1% less for secondary level of educated women in Bangladesh compared to higher level of education. The higher level of fertility for women with no education than educated women may be due to the following reasons: (i) women with no education are not conscious of having a limited family size; (ii) at an age when there are more chances of having fertility, the girls are in the colleges and university and thus do not get children which during this period uneducated girls get; (iii) uneducated women fell very hesitant to use contraceptives to control family size and go on accepting even unnecessary motherhood responsibilities imposed on them; (iv) span of child producing time in the case of uneducated women is quick, as compared with educated women; and (v) in many cases educated women get employed and with employment they can not afford to have more children. It is found from the logistic regression analysis that fertility behaviour of Barisal, Dhaka, Khulna and Rajshahi

divisions are favourable and statistically significant except Chittagong when Sylhet division is assumed as the reference category. The favourable fertility behaviour of Barisal, Dhaka, Khulna and Rajshahi divisions have also found accordingly 1.3, 1.9, 2.2 and 2.3 times more likely than Sylhet. Logistic regression analysis reveals that there are regional variations in fertility of Bangladesh. That may be occurred due to the differences in socio-economic and demographic indicators of that region. Index of mass media has significant ($P<0.01$) positive effect to reduce fertility in Bangladesh. It is shown from the analysis that disfavourable fertility behaviour is 1.9 times less in the women who are not under any kind of media than who are in contact. Islam and Hasan (2000) showed that the persistent strong relationship between mass media exposure and contraceptive use as observed in Bangladesh and elsewhere suggested that the mass media could have an important effect on contraceptive use and reproductive behaviour. They also suggested that both socioeconomic development policies and family planning programs with a special emphasis on mass media, particularly radio and TV, might have a significant effect on fertility control in Bangladesh.

Of the demographic variables logistic regression analysis have regarded age at marriage, contraceptive use and child mortality have received as remarkable attention. Age at marriage has inverse relationship to favourable fertility behaviour. Age groups less than 15 and 15-19 are 77.8% and 66.8% less likely favourable as compared to reference group (25+). It appears that fertility goes down when marriage takes place at a late stage. The average age at marriage (14.8 years) in Bangladesh remains one of the lowest in the world (BDHS, 2004). Logistic regression analysis implies that rising the female age at first marriage decreasing the level of fertility in Bangladesh. Female age at

marriage is becoming an important demographic variable due to its influence on fertility and population growth, especially in developing countries where contraceptive use rate is very low (Aryal, 2005a). A delayed marriage may affect fertility indirectly due to some contributory factors linked with higher age at marriage, such as women's education, which may relate to family size preferences and use of contraception, etc. (Adhakha *et al.*, 1991; Isiugo-Abanihe, 1994; Aryal, 2002, 2004a; Leone *et al.*, 2003; Choe *et al.*, 2004). Researchers have shown that low age at marriage in Bangladesh is directly related to poor socio-economic conditions and many cultural factors (Chaudhury, 1984; Ahmed, 1981). Most married adolescent females in Bangladesh are economically poor and uneducated; moreover, their status in the family and in society is very low. Because they are normally not very active economically outside the home, they have little say in decision-making in the family (Islam and Mahmud, 1995). The logistic regression coefficient of never used any contraceptive method is found to be 0.929 which is positive in sign, significant ($P < 0.01$) and its odds ratio is 2.532. It mentions disfavoured fertility behaviour is 2.5 times higher among the women of Bangladesh who never used any contraceptive method than others. It has been highlighted fertility-reducing effect due to contraception is one of the dominant factors in human fertility behaviour of Bangladesh. Although the contraceptive use rate is gradually increasing in Bangladesh, it is still very low compared with any developed country and many developing countries (BDHS, 2004). The effectiveness of contraceptive use can be improved and play a crucial role, especially among the women with no or little education, in reducing the gap between desired fertility. The logistic regression coefficient of the index of child mortality is -2.176, which is significant ($P < 0.01$) and it indicates favourable fertility behaviour is

88.7% less among the women when child mortality is occurring in a family than else. Hossain *et al.* (2005) have shown if childhood mortality increases the hazard of birth-interval closure, impact of fertility increases as the demographic transition progresses. A widely accepted hypothesis holds that high childhood mortality contributes to parental desires to have many children. Conversely, declining childhood mortality increases the number of surviving children, leading couples to compensate with fertility control.

Empirical investigation of the interrelationship of reproductive behaviour and childhood mortality has focused on two specific domains of fertility responses to childhood mortality: an insurance effect that arises from the tendency of couples in high-mortality settings to anticipate mortality risks and a replacement effect in which parents experiencing the death of a child adjust their subsequent reproductive preferences and behaviour. So, considerable attention has been directed to estimate the relationship between childhood mortality and fertility behaviour in Bangladesh. Logistic regression analysis focuses index of child mortality has emerged as one of the important demographic variable in this study.

Every couple increases their family. To give birth of a child is a general characteristic of a woman. But the capacity of giving birth is not the same for all women. Generally it varies from region to region in a country. At a time the variations in the fertility rate which is seen in different regions and within the same region is called the differential fertility. To identify the regional variations in the fertility behaviour of Bangladesh on the basis of some of the selected quantitative socio-economic and demographic variables of six divisions of Bangladesh path model analysis have been utilized. It is found from the path analysis that there are 36 paths for Barisal, 39 for

Chittagong, 39 for Dhaka, 39 for Khulna, 36 for Rajshahi and 33 for Sylhet divisions out of 49 hypothesized paths are statistically significant. Path analysis reveals some of the variables have significant direct positive and some of the negative effects on the index of fertility. Among them respondent's current age, number of household members, number of living boys as well as son preference, number of living children at first contraceptive use as well as decision making of contraceptive use and the number of children who have died as well as index of child mortality have found to be significant direct positive effect on the index of fertility for all the divisions. On the other hand respondent's age at first marriage has found to be significant direct negative effect in all the divisions except Sylhet and respondent's wealth index has also significant direct negative effect for all the divisions on the index of fertility. The effect of respondent's education has found to be significant directly negative only two divisions in Dhaka and Rajshahi on the index of fertility. It is demonstrated from the path analysis that the respondent's current age and the number of household members are found to be the common statistically significant variables out of 6 exogenous variables in the six divisions. The exogenous variable, respondent's education is found to be statistically significant for two divisions Dhaka and Rajshahi.

The path model of Barisal division reveals out of 13 variables, 8 are found to have significant direct effect on the index of fertility. The significant direct positive effects of respondent's current age, number of household members, index of son preference, decision making of contraceptive use and index of child mortality on the index of fertility are 53%, 58%, 69%, 81% and 100% respectively. The significant direct negative effects of husband's age at first marriage, respondent's age at first marriage and respondent's

wealth index on the index of fertility are 32%, 49% and 100% respectively. Path results of Barisal division also represent the highest indirect positive impact of respondent's current age on the index of fertility via decision making of contraceptive use is 40% and 50% is negative via respondent's age at first marriage. The highest indirect positive effect of the number of household members on the index of fertility via number of living boys is about 30%.

The path model of Chittagong division reveals out of 13 variables, 9 are found to have significant direct effect on the index of fertility. The significant direct positive effects of respondent's current age, number of household members, son preference, decision making of contraceptive use and index of child mortality on the index of fertility are 72%, 64%, 72%, 87% and 100% respectively. The significant direct negative effects of the respondent's age at first marriage, respondent's wealth index, wealth index of a family and body mass index of respondent on the index of fertility are 48%, 61%, 36% and 58% respectively. Path results of Chittagong division also represent the highest indirect positive impact of respondent's current age on the index of fertility via the number of living boys is 43% and 63% is negative via respondent's age at first marriage. The highest indirect positive effect of the number of household members on the index of fertility via number of living boys is 30% and 12% is negative via the wealth index of a family.

The path model of Dhaka division reveals out of 13 variables, 10 are found to have significant direct effect on the index of fertility. The significant direct positive effects of respondent's current age, number of household members, index of son preference, decision making of contraceptive use and index of child mortality on the

index of fertility are 71%, 61%, 78%, 84% and 100% respectively. The significant direct negative effects of husband's age, respondent's education, respondent's age at first marriage, respondent's wealth index, wealth index of a family and body mass index of respondent on the index of fertility are 34%, 17%, 53%, 79%, 18% and 71% respectively. Path results of Dhaka division also represent the highest indirect positive impact of respondent's current age on the index of fertility via the decision making of contraceptive use is 37% and 73% is negative via the respondent's age at first marriage. The highest indirect positive effect of respondent's education on the index of fertility via the wealth index of a family is 28%. The highest indirect effect of number of household members on the index of fertility via the number of living boys is 30%.

The path model of Khulna division reveals out of 13 variables, 7 are found to have significant direct effect on the index of fertility. The significant direct positive effects of respondent's current age, number of household members, index of son preference, decision making of contraceptive use and index of child mortality on the index of fertility are 65%, 50%, 50%, 82%, 92% and 100% respectively. The significant direct negative effects of respondent's age at first marriage and respondent's wealth index on the index of fertility are 45% and 98%. Path results of Khulna division also represent the highest indirect positive impact of respondent's current age on the fertility via the number of living boys is 35% and 52% is negative via the respondent's age at first marriage. The highest indirect positive effect of number of household members on the index of fertility via the number of living boys is 39% and 8% is negative via the wealth index of a family.

The path model of Rajshahi division reveals out of 13 variables, 8 are found to have significant direct effect on the index of fertility. The significant direct positive effects of respondent's current age, number of household members, son preference, decision making of contraceptive use and index of child mortality on the index of fertility are 60%, 61%, 76%, 86% and 100% respectively. The significant direct negative effects of respondent's education, respondent's age at first marriage and respondent's wealth index on the index of fertility are 33%, 47%, and 94% respectively. Path results of Rajshahi division also represent the highest indirect positive impact of respondent's current age on the index of fertility via the number of living boys is 42% and 57% is negative via the respondent's age at first marriage. The highest indirect positive effect of respondent's education on the index of fertility via the respondent's age at first marriage is 39% and 6% is negative via decision making of contraceptive use. The highest indirect positive effect of number of household members on the index of fertility via the number of living boys is 28% and 9% is negative via the wealth index of family.

The path model of Sylhet division reveals out of 13 variables, 6 are found to have significant direct effect on the index of fertility. The significant direct positive effects of respondent's current age, number of household members, index of son preference, decision making of contraceptive use and index of child mortality on the index of fertility are 47%, 63%, 70%, 90% and 100% respectively. The direct significant negative effect of respondent's wealth index is 100% on the index of fertility. Path results of Sylhet division also represent the highest indirect positive impact of the respondent's current age on the fertility via the number of living boys is 70% and 85% is negative via respondent's age at first marriage. The highest indirect positive effect of number of household

members on the index of fertility via the number of living boys is 52% and 20% is negative via the wealth index of a family.

The fertility rate of Bangladesh has not been uniform in different regions. There are variations in fertility among the six divisions of Bangladesh. It has seen the evident in the BDHS 2004 data that the fertility rate is highest in Sylhet and Chittagong divisions (TFR=4.2 and TFR=3.7 respectively) and lowest in Rajshahi division (TFR=2.6) other divisions Khulna, Dhaka and Barisal are in intermediate level (TFR=2.8, TFR=2.9 and TFR=2.9 respectively) (BDHS, 2004, p.52). It is quite surprising that the level of fertility of Rajshahi division is approaching towards the replacement level (TFR=2.1) that is to be declined 19% only. On the other hand Sylhet, Chittagong, Dhaka, Barisal and Khulna divisions have to be declined their fertility rate 50%, 43%, 28.5%, 28.5% and 25% respectively to reach the replacement level of fertility. Researcher has tried to identify the variables that are associated with the regional variations of fertility in different divisions of Bangladesh using path model analysis. BDHS 2004 data demonstrate that the TFR of Sylhet division is 61.5% more than Rajshahi that is 2.6 to 4.2.

The larger TFRs of Sylhet and Chittagong divisions may depend on the indices of son preference, decision making of contraceptive use and the index of fertility. It is observed in Tables 2, 3, 4, 5, 6 and 7 that the average number of living boys of Chittagong, Sylhet, Barisal, Dhaka, Rajshahi and Khulna divisions are 1.42, 1.41, 1.31, 1.23, 1.22 and 1.15 respectively. Number of living children at first contraceptive use for Sylhet, Chittagong, Barisal, Dhaka, Rajshahi and Khulna divisions are 2.28, 1.93, 1.65, 1.54, 1.50 and 1.38 respectively and the number of children who have died in Sylhet,

Chittagong, Barisal, Dhaka, Rajshahi and Khulna divisions are 0.57, 0.43, 0.43, 0.42, 0.37 and 0.31 respectively.

It is observed from the analysis that Sylhet and Chittagong divisions have the highest average number of living boys are 1.42 and 1.41 and the lowest in Rajshahi and Khulna are 1.22 and 1.15 that means fertility is higher in the division where more boys are appeared in the family. Again, Sylhet and Chittagong have the highest average number of living children at first contraceptive use are 2.28 and 1.93 and the lowest in Rajshahi and Khulna are 1.50 and 1.38 that means fertility rate is higher when quick decision of contraception use is later in the couple. Similarly, Sylhet and Chittagong have the highest average number of children who have died are 0.57 and 0.43 and the lowest in Rajshahi and Khulna are 0.37 and 0.31 that means where child mortality rate is higher fertility is higher. Clearly, child mortality affects fertility because after the death of a child family will like to add one, so that there should be surviving children in the family.

It is obvious from the path analysis that the index of child mortality, decision making of contraceptive use and the son preference are the most influential positive factor that play a vital role to increase the fertility rate in all the divisions of Bangladesh. Positive effect of the index of child mortality on the index of fertility means that mothers who have experienced of child mortality are found to have higher fertility. That is mothers always try to replace their dead child as early as possible. Such behaviour is a result of variations of fertility in the different regions of Bangladesh. The direct effect of number of living children at first contraceptive use on fertility is positive means the decision of using contraceptive is later. When the attitude towards the contraceptive use is delayed in a couple as well as in region there fertility rate would be higher. It may be

argued that with the presence of son preference in the regions, fertility is likely to remain high or low. Recent statistics have shown that sex preference, and particularly son preference, is no longer an issue in fertility decision-making. Son preference is one of the factors of high fertility in developing countries particularly Bangladesh. It has been shown that the presence of son preference in Bangladesh has actually increased the desired number of children; as a result fertility is increasing. The expectation of old age security is one of the dominant motivations for son preference of couples in Bangladesh which directly affect the fertility. As a result fertility has been increasing. Sons are considered not only as insurance for old age security but also expected to contribute in family income and share parental responsibility in maintaining family. Sons are always desired for family strength as well as for maintaining lineage. A greater number of sons are considered as a source of strength in the family. On the other hand respondent's age at first marriage except Sylhet and respondent's wealth index have the fertility reducing effect in all the divisions of Bangladesh. It is also observed from the descriptive statistics in Tables (2-7) that the mean age of first marriage of respondent of Sylhet, Chittagong, Barisal, Dhaka, Khulna and Rajshahi divisions are 15.75, 15.49, 15.03, 15.02, 14.65 and 14.49 respectively and the wealth index of respondent of Khulna, Rajshahi, Dhaka, Chittagong, Barisal and Sylhet divisions are 137.54, 132.32, 129.88, 129.45, 127.32 and 123.69 respectively. In Bangladesh the legal age of marriage is 18 years for women; however a large proportion of marriages still take place before the legal age. Marriage in most Asian societies defines the onset of the socially acceptable time for childbearing. Women who marry early will have, on average, a longer period of exposure to pregnancy, often leading to a higher number of children ever born. The mean age at first

marriage is found to be about fifteen for the six divisions of Bangladesh in the 2004 BDHS data. In the society of Bangladesh there is no alternative to produce a child without marriage so it is strictly related to fertility behaviour. Generally fertility may go down when marriage takes place at a late stage. But in this analysis the mean age at first marriage has created contradiction on the assumption. As researcher has shown fertility rate is lowest at Rajshahi when mean age at first marriage is lowest and fertility rate is highest at Sylhet when mean age at first marriage is highest than other divisions. Though the researcher has investigated the standard deviations of age at first marriage is lowest at Rajshahi ($SD=2.43$) and highest at Sylhet ($SD=3.04$). The difference may be attributed to wider spacing of births at Rajshahi, as compared to the spacing of births in Sylhet division. It indicates that lower age at marriage can be linked with increased progression to next birth at short intervals. This implies that it is not delayed marriage but increasing birth intervals which reduces the level of fertility. This means that in regions like Sylhet, in the absence of delayed marriage, the level of fertility would be even higher. On the contrary, in Rajshahi, if the age at marriage was higher, the decline in the level of fertility would be much faster. The effect of female wealth index on fertility shows negative means fertility depends on social status of the women and is a result of her work status as well as economic status. The mean value of the respondent's wealth index shows the second highest at Rajshahi and lowest in Sylhet that means women in Sylhet division are least likely to be employed than women in the other divisions. As a developing country like Bangladesh the scope of suitable work for a woman is not homogenous in six divisions due to various geographical, social and economic constraints. So in the divisions where women are confined only to household jobs, these are considered suitable

environment for producing children and as such those women who are held in high esteem. The effect of respondent's education is found to be significant direct negative only for two divisions Dhaka and Rajshahi on the index of fertility. The analysis reveals though the level of fertility of Rajshahi division is close to the replacement level the mean value of the index of child mortality, decision making of contraceptive use and son preference represent the second lowest among the six divisions. It is found from the mean value of respondent's education in Tables (2-7) that women education is lowest in Sylhet division and path analysis say it has not any significant effect on the index of fertility when it is playing significant negative role to reduce fertility at Rajshahi. As the TFR of Rajshahi division is approaching near to the replacement level the researcher has suggested in order to achieving the replacement level of fertility in Rajshahi as well as the other remaining divisions of Bangladesh special attentions to be given to reduce the child mortality rate, to take decision quickly in married couple at first contraceptive use, to be more active about son preference and women education must be increased at the desired level.

Examining the trends in fertility of Bangladesh, it is evident that the TFR has declined dramatically from 6.3 children per woman in 1975 to 3.0 in 2004, a decline of 52 percent over about a 30-year period. The pace of fertility decline has slowed in the most recent period compared to the exceptionally rapid decline during the late 1980s and early 1990s. The total fertility rate dropped almost imperceptibly from 3.4 for the period 1991-1993 to 3.0 in 1994-2004 and remained constant during 1997-1999. The completed family size in the case of cohort fertility will give the level of fertility of a particular cohort and it indicates that the mean number of children ever-born per ever-married

woman has been declining overtime and it is slightly lower in recent years in each age group. Moreover, period fertility approach reveals that the level of fertility is still very high in Bangladesh although the age specific fertility rate has been decreasing over time in each age group. The peak age has shifted from 25-29 in 1975 to 20-24 in 2004. It is to be mentioned that although there is an increasing trend in the impact of the marriage component, reflecting the effect of increased proportion non-married and/or increased age at marriage, the rate of change is very slow. The prevailing cultural and social norm in Bangladesh is unlikely to permit a change in the proportion non-married beyond a certain limit and the prospect for an immediate rise in age at marriage for females does not seem to be very bright. The contraceptive prevalence rate in Bangladesh has increased from 8 percent in 1975 to 58 percent of currently married women in 2004. Between the 1999-2000 BDHS and the 2004 BDHS, overall contraceptive use increased by 4 percentage points, from 54 to 58 percent of currently married women. This increase has been almost entirely due to the higher use of modern methods, namely, the pill and injectables.

To improve our understanding of the causes of fertility decline in Bangladesh during early 1990s and then its stabilization, it is important to analyze the role of the proximate determinants in fertility transition in Bangladesh. This understanding is important, because it may indicate ways in which the national population programme could be made even more effective. This study critically examines the fertility change in Bangladesh through a systematic analysis of its proximate determinants. An attempt is made to explore the relative importance of the effect of different proximate determinants on fertility in Bangladesh, and their changing role on fertility decline by Bongaarts'

proximate determinants of fertility model. Bongaarts' model is applied to estimate the fertility inhibiting effect of four important proximate determinants: marriage, contraception, abortion and lactational infecundability. The model clearly indicates that there is a downward trend in all the proximate indices. Data on induced abortion are not available so its effect on the model is about to unmeasurable. Abortion is a sensitive issue in Bangladesh, and many women who have an abortion do not disclose this to others, particularly to outsiders. This makes the situation extremely difficult to get a clear picture of abortion from survey data in this country. Bongaarts' model indicates marriage variable made significant contributions to the overall fertility reduction. Fertility is reduced 14.1%, 21.5% and 21.8% in 1975, 1989 and 2004 respectively by proportion of women married. Contraceptive use has the highest impact on the total reduction of fertility which may be attributed to the increase use of contraception from 7% in 1975 to 48.5% in 2004. The reducing impact of proportion married and lactational infecundability on fertility slightly varies from one time point to another but a completely downward trend is observed in the index of contraception which indicates the effect of contraception use are increasing because of increase in use effectiveness of methods. The Bongaarts' model indicates that the decomposition of the decline in *TFR* between 1975 to 1989 has been nearly 8.6% due to decrease in the proportion of women married, about 23.0% due to an increase in contraceptive use effectiveness but approximately 25.6% increase due to decrease of the duration of lactational infecundability. Again the decomposition of decline in *TFR* between 1975 to 2004 has been nearly 9.0% due to decrease in the proportion of women married, about 44.7% due to an increase in contraception use effectiveness and about 2.7% due to increase of the duration of lactational

infecundability. The model also indicates that during 1975 to 1989 it has declined by 1.427 births per woman due to in proportion married, 1.447 births per woman due to contraception, 1.611 births per woman increased due to decrease in lactational infecundability. Again, during 1975 to 2004 it has declined by 3.289 births per woman of which 0.565 births has declined by proportion married, 2.819 births declined due to contraception, 0.441 births declined due to induced abortion, 0.168 births declined due to increase in lactational infecundability. The analysis of inhibiting effect of marriage on fertility is observed that the effect of marriage on fertility is higher in recent times. The effect of postponement of marriage on fertility in 2004 is 0.274 women of reproductive age, which is higher than any other point of time. It implies that the age at marriage is higher and also the fertility is lower in 2004 than in the other study periods. It also indicates that the effect of marriage on fertility is higher in recent times. Again, divorce and widowhood have a major contribution on fertility reduction. That means the contribution has been decreasing and so that the amount of divorced and widowhood has decreased in recent times. The impact of changing marriage pattern between 1975 and 2004 may have caused fertility decrease. The singulate mean age at marriage (SMAM) of females in 1975 was 16.3 years while in 2004 the SMAM is 18.7 years. During the period 1975-2004 the singulate mean age at marriage (SMAM) has increased about 2.4 years for females. Whatever the causes of changing marriage patterns, their net effect has not been large. The analysis also shows that a downward effect on fertility at young ages caused by rising age at marriage has been balanced by an upwards effect at older ages caused by decreasing widowhood and divorced.

United Nations attempted to project a time frame for replacement level fertility of Bangladesh (2.1 children per woman), i.e., when the net reproduction rate (NRR) will equal 1. The medium-variant scenario of the United Nations projection indicates that Bangladesh will reach replacement level of fertility around 2025-30 (UN, 1999, 2001). To achieve the United Nations time frame, this study has been made to forecast the relatively more important socio-economic and demographic variables, which have maximum contribution in determining the fertility rate of Bangladesh. To achieve the United Nations projection of a target level of total fertility rate (TFR) 2.1 by 2030 the research develops a forecasting model for TFR of Bangladesh up to the year 2030 using combined methods of regression and time series forecasting. The results of this analysis demonstrate that TFR of Bangladesh will be reached at the replacement level (2.1 children per woman) in 2030 if mean age at marriage and labor force participation of female is to be increased to 20.3 years and 43.5% respectively while infant mortality rate per 1000 live births to be decreased at 35.6.

CHAPTER 6

POLICY RECOMMENDATIONS AND FUTURE RESEARCH

Bangladesh has in recent years attracted attention from demographers and development specialists because of its fertility decline. A number of earlier studies, notably Demeny (1975), Cain (1977, 1978, 1981), and Arthur & McNicoll (1978), put forward apparently convincing arguments that such a decline was unlikely in the near future despite strenuous efforts to promote family planning. Nevertheless, during the 1980s and early 1990s the TFR halved from over six children per woman to around 3.3 (Mitra et al. 1994; Cleland et al. 1994). The decline occurred at a lower level of economic and social development than any other country as measured by the Human Development Index (HDI) of the United Nations Development Programme (UNDP) and, indeed, Bangladesh is the only nation in the UNDP's category of least developed nations to have experienced a fertility decline (Bongaarts and Watkins 1996). The previous United Nations issued of population projections showed that Bangladesh would reach replacement-level fertility within a few years, indicating that such a goal was within the reach of even the poorest countries. It has consequently been sobering that recent evidence suggests that this decline has slowed or even halted. Revised projections have shown Bangladesh will achieve replacement level fertility by 2025-30 (United Nations 1999, 2001).

6.1 POLICY RECOMMENDATIONS

This research has focused on the exploration of the reality underlying the plateauing of fertility level during the recent past. The exploratory work has been done based on several multivariate statistical analyses in relation to the socio-economic and demographic variables of the measures of fertility. These analyses have revealed some very interesting features that highlight the reasons underlying the apparent plateauing of fertility during the recent past in Bangladesh. Thus, necessary action is called for to reduce the level of fertility of Bangladesh in replacement level in order to achieve better living conditions in future. The important recommendations are summarized below:

Logistic regression analysis has found the effects of some qualitative socio-economic and demographic variables most powerful in explaining fertility behaviour in Bangladesh. Of those variables, important one's are -educational level, region, mass media, age at first marriage, choice of contraceptive method and child mortality. It is suggested that emphasis on socio-economic development policies as educational level, region, mass media and demographic indicators as age at first marriage, choice of contraceptive method and child mortality may produce significant desired effects with regard to fertility control in the national level of Bangladesh.

The path analysis suggests there may be certain specific socio-economic and demographic variables for population control, which are region specific. Researcher has identified among the thirteen important quantitative socio-economic and demographic factors, considering in the analysis, some of them have negative and some are of positive impact on the human fertility behaviour and act as barriers for population control of

different regions in Bangladesh. The effect of these positive factors on fertility behaviour has to be minimised. The present research shows depending on the path analysis there are regional variations in the pattern of the nature of human fertility and extent of the influence of various explanatory variables on fertility behaviour should be control. Therefore, the strategy for the removal for these obstacles should be formulated regionally with the consideration of their priorities in different divisions of Bangladesh. That is regional differentials depict the regional variations in fertility and those may be the result of mainly female education, female age at first marriage, wealth index of female, son preferences, decision making of contraceptive use and index of child mortality of the six administrative divisions of Bangladesh. Thus, while one of the strategies to reduce fertility should be bringing down the desired family size, other strategies to narrow the gap of the regional variations should include efforts to increase education for female to reduce the preference for male children and to lower infant and child mortality, as well as to promote the effective use of contraceptives. Further more ideal children should be ensured in order to achieve a replacement level fertility. Without a rapid improvement of these factors, it would be difficult to achieve replacement level fertility in near future.

As it has been seen throughout the Bongaart's model that there needs to manipulate the proximate determinants of fertility in order to have further and faster fertility drop in Bangladesh. The governmental policies can concentrate on effectively and efficiently increasing contraceptive utilization and effectiveness, on encouraging breastfeeding and on rising the age of marriage.

The empirical results of the time series analysis indicate that the total fertility rate (TFR) is decreasing which is as expected because of government's active role in this issue. This is due to consciousness among the people of planned family. On the other hand TFR will reach at the replacement level (2.1 children per woman) within the desired time period around 2025-2030 and to do so the government shall have to take necessary action- to increase mean age at marriage of female to be 20.3 years; to increase labor force participation of female to be 43.5%; and to decrease infant mortality rate per 1000 live births at 35.6.

6.2 PROSPECTS FOR FUTURE RESEARCH

A marked regional variation in the total fertility rates are observed in BDHS 2004 data. Path analysis has been performed in this study in order to highlight the factors associated with these regional variations in the level of fertility in different regions of Bangladesh. Research has found some key factors contributing to this phenomenon like low educational levels, continued son preference, delayed decision making of contraceptive use and high child mortality. Out of six divisions, Sylhet (TFR=4.2) shows exactly twice as high as the replacement level of fertility (TFR=2.1). On the other hand the level of fertility Rajshahi (TFR=2.6) is approaching very close to the replacement level. The analysis of fertility reveals fertility rate is lowest in Rajshahi and highest in Sylhet arises some important research questions. Researcher has shown that within Bangladesh, different regions achieved different degree of achievements in the level of fertility. These differences should be analyzed in details in order to provide insights to the

overall status of fertility and its consequences to the future growth of population. Moreover, the total fertility rate involves both cohort and period components. The potential level of fertility, free from any disturbance caused by change in extent and direction of cohort or period components, during the recent past can reveal the factors underlying such change. This may be a good exercise for farther research. Another possible hypothesis is that as the fertility level approaches replacement level, the role of child mortality becomes increasingly important and vice-versa. This hypothesis should be tested explicitly.

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GLOSSARY

Adolescent:

A young person, usually between the ages of 13 and 19.

Adult Literacy Rate:

The percentage of persons (male or female, or both sexes) aged 15 years and over who can, with understanding, both read and write a short simple statement on their everyday life.

Age-Specific Fertility Rates (ASFR):

Age-specific fertility rates are expressed as the number of births per thousand women in the age group and represent a valuable measure for assessing the current age pattern of childbearing. They are defined in terms of the number of live births during a specific period to women in the particular age group divided by the number of woman-years lived in that age group during the specified period.

Body Mass Index (BMI):

The body mass index or Quetelet index is used to measure thinness or obesity. It is defined as weight in kilograms divided by height in meters squared (kg/m^2). The main advantage of the BMI is that it does not require a reference table from a well-nourished population. A cutoff point of 18.5 is used to define thinness or acute undernutrition (i.e., $\text{BMI} < 18.5$). The BMI for women are normal if it is between 18.5 and 24.9. A BMI of 25 or above usually indicates overweight or obesity, and 30 or above indicates obesity. Height is used to identify mothers at nutritional risk. A woman's height can be used to predict the risk of having difficulty in pregnancy, given the relationship between height and pelvic size. The risk of giving birth to low-weight babies is also higher among women of small stature. The cutoff point at

which mothers can be considered at risk because of short stature is normally taken to be between 140 and 150 centimeters.

Cohort Fertility:

Cohort Fertility computed for each age group reflects the actual cumulative fertility rate of the age cohorts which, for women 45-49, may be assumed to be the completed family size. The mean number of live births per ever-married woman are calculated for each age group of women by dividing the total number of live births in each age group by the total number of ever-married women in the corresponding age group.

Contraceptive Prevalence Rate (CPR):

The contraceptive prevalence rate is the percentage of women who are practicing, or whose sexual partners are practicing, any form of contraception. It is usually reported for women ages 15-49 in marital or consensual unions.

Crude Birth Rate (CBR):

Crude birth rate is the number of births per 1,000 populations during a specified period.

Crude Death Rate (CDR):

The number of deaths occurring per 1,000 population in a year.

Demography:

The study of the characteristics of human populations, such as size, growth, density, distribution, and vital statistics.

Dependency Ratio:

The ratio of the population defined as dependent - those under 15 and over 65 - to the working-age population, aged 15-64.

Fertility:

Fertility is the natural capability of giving life. As a measure, "Fertility Rate" is the number of children born per couple, person or population.

General Fertility Rate (GFR):

General fertility rate is the number of live births occurring during a specified period per 1,000 women of reproductive age.

Gross Reproduction Rate (GRR):

The gross reproduction rate is the average number of daughters that would be born to a woman (or a group of women) if she survived at least to the age of 45 and conformed to the age-specific fertility rate of a given year.

Growth Rate:

A population's growth rate is the increase (or decrease) in the number of persons in the population during a certain period of time, expressed as a percentage of the population at the beginning of the time period. The average annual growth rates for all ages as well as for particular age groups are calculated on the assumption that growth is continuous.

Human Development Index (HDI):

Measures the average achievements in a country in three basic dimensions of human development- longevity, knowledge and a decent standard of living. The HDI is a composite index that contains 3 variables: life expectancy, educational attainment (adult literacy and combined primary, secondary and tertiary enrolment) and real GDP per capita (in purchasing power parity or PPP\$).

Human Reproduction:

Human reproduction is the reproduction of humans. It is a form of sexual reproduction, by sexual intercourse between human males and females.

Illiteracy Rate:

The illiteracy rate of a particular age group indicates the proportion of persons in that group who cannot read with understanding and cannot write a short simple statement on their everyday life.

Infant Mortality Rate (IMR):

The number of deaths of infants below one year of age (between 0 and 364 days after birth) per 1,000 live births during a given period of time.

Infecundity/Sterility:

Infecundity is the absence of the biological capacity to produce birth.

Infertility:

The diminished ability or the inability to conceive and have offspring. Infertility is also defined in specific terms as the failure to conceive after a year of regular intercourse without contraception.

Labour Force Participation:

The labour force participation rate consists of the economically active population in a particular age group as a percentage of the total population of that same age group. The active population (or labour force) is defined as the sum of persons in employment and unemployed persons seeking employment.

Life Expectancy:

Life expectancy at a specific age is the average number of additional years a person of that age could expect to live if current mortality levels observed for ages above that age were to continue for the rest of that person's life. In particular, life expectancy at birth is the average number of years a newborn would live if current age-specific mortality rates were to continue.

Net Reproduction Rate (NRR):

The net reproduction rate is the average number of daughters that would be born to a woman (or a group of women) if she passed through her lifetime conforming to the age-specific fertility and mortality rates of a given year. This rate is similar to the gross reproduction rate but takes into account that some women will die before completing their childbearing years. An NRR of one means that each generation of mothers is having exactly enough daughters to replace itself in the population.

Offspring:

The offspring are strictly speaking the progeny, or young, born to a person.

Per Capita Gross Domestic Product:

Gross domestic product (GDP) divided by midyear population.

Per Capita Gross National Income:

Gross national income (GNI) divided by midyear population. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad.

Per Capita Gross National Product:

The per capita gross national product (GNP) is obtained by dividing the total gross national product by the total population. The gross national product comprises: (a) the gross domestic product (GDP), which measures the total output of goods and services for final use produced by residents and non-residents, regardless of the allocation to domestic and foreign claims, plus (b) net factor income from abroad, which is the income residents receive from abroad for factor services (labour and capital) less similar payments made to non-residents who contributed to the domestic economy.

Per Capita Income:

Income per person in a population. Per capita income is often used to measure a country's standard of living.

Period Fertility:

Period Fertility is measured by the total fertility rate (TFR) based on the age specific fertility rates of women of different age groups in the reproductive period (15-49 years of age) during a year. Period fertility gives the current picture of the actual fertility performance in recent times (generally the year preceding the

census or survey) by women of different age groups in the reproductive period within a population.

Population Growth Rate:

Population growth is the change in population over time. A measure of population growth (in the absence of migration) comprising addition of newborn infants to the population and subtraction of deaths. The result, known as natural rate of increase, is calculated as $[(\text{Live births during the year} - \text{Deaths during the year}) \times 1000] / [\text{Mid-year population}]$

Population Momentum:

Population momentum is an effect which causes population growth. This phenomenon refers to the percentage of the population that are in their child bearing years who have not yet had child, and thus are scheduled to eventually have children which add to the population through reproduction. The higher the percentage of people aged, for example 18 and under, the larger the population growth will be because there is such a large percentage of the population capable of having children. This means the population will continue to grow, even if the fertility rate reaches replacement level. The reason that population momentum would have an effect is that high fertility levels in the past caused a largely young population which still has to reach child-bearing years. Its main purpose is to show the rapid growth of the population.

Pregnant:

The state of carrying a developing fetus within the body.

Qualitative Variable:

Variables that express a qualitative attribute. Some examples of qualitative variables are hair color, eye color, religion, gender, and so on. The values of a qualitative variable do not imply a numerical ordering. Values of the variable "religion" differ qualitatively; no ordering of religions is implied. Qualitative

variables are sometimes referred to as categorical variables. Values on qualitative variables do not imply order, they are simply categories.

Quantitative Variable:

A quantitative variable is naturally measured as a number for which meaningful arithmetic operations make sense. Some examples of quantitative variables are height, weight, age, GPA, salary, temperature, area, air, etc.

Replacement Level Fertility:

Replacement fertility is the total fertility rate at which newborn girls would have an average of exactly one daughter over their lifetimes. In more familiar terms, women have just enough babies to replace themselves that is net reproduction rate $NRR=1$. The replacement fertility rate is roughly 2.1 births per woman.

Reproduction:

The term reproduction encompasses the entire variety of means by which plants and animals produce offspring. Reproductive processes fall into two broad groupings: sexual and asexual, the latter being the means by which bacteria and algae reproduce. Many plants reproduce sexually by means of pollination, and some plants alternate between sexual and asexual forms of reproduction. Other creatures, such as bees and ants, reproduce through a form of reproduction called parthenogenesis, which is neither fully sexual nor asexual.

Sex Ratio:

The sex ratio is calculated as the number of males per one hundred females in a population. The sex ratio may be calculated for a total population or for a specific age group.

Singulate Mean Age at Marriage (SMAM):

Marriage formation can be determined by the age people usually get married. In terms of fertility, the younger the age at marriage, the greater the chance of having more children. The SMAM is an indirect method used to estimate the mean

number of years lived by single males or females before they get married for the first time.

Survival Rate:

The survival rate to a specific age X is the proportion of newborns in a given year that would be expected to survive at age X if current mortality trends were to continue for at least the next X years. Survival rates are derived from the life table, which is an analytic procedure designed to produce estimates of life expectancies and other measures of mortality, based on prevailing age-specific death rates.

Teenager:

A person between the ages of 13 and 19; an adolescent.

Total Fertility Rate (TFR):

Total Fertility Rate is defined as the total number of births a woman would have by the end of her childbearing period (normally between the ages of 15 and 49) if she were to pass through those years bearing children at the currently observed rates of age-specific fertility. The TFR is obtained by summing the age-specific fertility rates and multiplying by five.

Under-5 Mortality Rate:

The number of deaths of children below 5 years of age, expressed per 1,000 live births during a given period of time.

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