Lectures in Development Economics
No. 8

ANSLEY J. COALE

Lectures on POPULATION AND DEVELOPMENT

with comments by
Syed Nawab Haider Naqvi

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS
ISLAMABAD

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Biographical Sketch

PROFESSOR ANSLEY J. COALE is widely known through his long association with the Office of Population Research at Princeton University, where he completed his undergraduate degree in 1939, later obtaining the Ph.D. in 1947. Except for short breaks, Professor Coale followed most of his career at Princeton University, starting as a Research Assistant in 1947 and then becoming Director of the Office of Population Research in 1959 and remaining there until 1975. He was concurrently Professor at the Department of Economics at Princeton.

One of the most renowned of world demographers, Professor Coale has written numerous articles and books and has many honours attached to his name. He is most widely known for his contributions to such areas as Stable Population Theory, the development of Model Life Tables, the study of the European Demographic Transition, and the Demography of Tropical Africa. Among the many prestigious positions and honours held by him are the following: President of the International Union of the Scientific Study of Population (1979-81), President of the Population Association of America (1967-68), and Chairman of the Committee on Population and Demography at the National Academy of Sciences (1977-83). Professor Ansley Coale has been an Adviser to many governments, including the United States Government, and was also Foreign Adviser to the Pakistan Institute of Development Economics in 1969.

First published in Pakistan in 1990

ISBN 969-461-002-8

LECTURES IN DEVELOPMENT ECONOMICS

The purpose of this new series is to create useful knowledge about development economics and disseminate it widely. It is not possible to prescribe exactly the topics that will be discussed in this series. Indeed, it would not even be desirable to do so because this subject is still developing. The mystery of the development process is not yet fully understood. The days of chivalry, when economic development was seen as simply a function of physical capital formation, are gone. The importance of such factors as human capital, education, and religion as determinants of both the rate and the composition of economic growth is now gradually recognized. And then there are the efforts to understand more clearly the relationship between economic growth and income distribution. In this connection, the vital role of structural reform is also being realized. The practical (social and political) requirement of alleviating the incidence of absolute poverty has brought to the fore the key role of agricultural development. Furthermore, there is now a greater awareness of the importance of endogenizing the demographic variables in order to understand fully the problem of underdevelopment as well as the many ways of solving it.

In direct proportion to the comprehension of these issues, the intellectual fashions have changed among economists. And - there are no signs - a healthy sign, of course - that economists will remain far behind Valley Girls in their love of fashion. As such, we have left it. to the contributors to this Series to decide on the topics of their lectures. Still, it is to be expected that economists, as if guided by an 'invisible hand', will select areas of enquiry that are most relevant not only theoretically but also for practical policy-making.

The contributors to this Series are all members of the Advisoiy Board of the Pakistan Institute of Development Economics (PIDE) and of the Editorial Board of *The Pakistan Development Review.* The visits of these

outstanding economists have been made possible by a generous grant from the Ford Foundation, which is administered by the Institute of International Education (HE), New York. It is to be hoped that the success ofthis Series, which we can predict with certainty, will lead to greater financial support from the Ford Foundation and other donor agencies. Even more important is the 'fact' that these contributions will serve the cause of knowledge formation in an area where its marginal productivity is most likely to be optimized.

The present volume, containing lectures by Prof. Ansley J. Coale, is the eighth in the Series. Prof. Coale, a member of the International Advisory Board of The Pakistan Institute of Development Economics, is an outstanding authority in the discipline of demography. It is in this area that his intellectual fertility has been at its best. The two lectures published here, along with the lively discussion that follows, should be of great interest to both economists and demographers, as well as to policy-makers. It is hoped that this publication will be read with interest throughout the world by concerned social scientists.

Syed Nawab Haider Naqvi

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INTRODUCING THE SPEAKER

Professor Syed **Nawab Haider Naqvi**

INTRODUCING THE SPEAKER

Professor Syed Nawab Haider **Naqvi**

ladies and Gentlemen:

It is a great privilege for me to welcome an old teacher of mine. I should be grateful to the favourable winds that brought Prof. Ansley Coale to Islamabad to enlighten us about the mysteries of demography. He needs no formal introduction. He is one of the most widely read demographers in the world today because he is so readable. A high degree of expositional lucidity and a masterly organization of his material have earned Prof. Coale a distinguished niche in the general area of demography. But let me put the horse right before the cart - say a few words about the man himself before talking about his contribution to knowledge.

Prof. Coale tells me that he was born on 14 November, 1917 at Baltimore. (He has not revealed to me his age at marriage - *some* lapse on the part of a demographer.) His educational and professional career has centred on Princeton University, where he has remained to date, since 1939 - first as a student and then as a teacher. He won his professorship at Princeton, in 1959; and, in the same year, he also became Director of the world-renowned Office of Population Research (OPR), which has been his hermitage since then. His vast and variegated scientific output continuously poured out of his OPR Office. What he had to offer to the demographic market has been bought by the academia at a 'price' which Prof. Coale - and not some Walrasian 'crier' - set. He dominates that market completely. And this

oligopolistic posture has earned Prof. Coale many an honour. He has been Fellow of the American Academy of Aits and Sciences and a member of the Philosophical Society. He was awarded an honorary doctorate by the University of Louvain (1979). In recognition of his sterling contribution to mathematical demography, he was awarded the Mindel Sheps Prize in Mathematical Demography in 1974. I would be surprised if some historical society or other has not already honoured him for his great work on demographic histoiy.

Prof. Coale, by common consent, is one of the most fertile minds in demography. Indeed, dernographically speaking, his intellectual fertility is as great as the physical fertility of the legendary Hutterites! Among his many contributions to demographic knowledge, one branch is analytical demography; another is historical demography; and a third is the interrelations between population change and social and economic development. In each of these areas, Prof. Coale speaks with an authority that is seldom challenged. Thanks to his mastery of the mathematical aspects of demography, he has been able to enunciate exact demographic laws. For instance, he has shown that the age composition of a given population is uniquely determined in terms of the schedules of mortality and fertility; or that, in general, both age composition and vital rates can be determined from the history and present value of fertility and mortality. I would call this the law of demographic determinism; whereby the past and the present fix the future growth path of a population.

He has also conjectured that two arbitrarily chosen age distributions, no matter how different, will yield populations of the same age distribution, provided they are subjected to identical segments of fertility and mortality. This can be called the Iron Law of demography, which must be respected for what it is in evaluating the possibilities of family planning programmes. Similarly, mixing his mathematical acumen with his unrivalled knowledge of demographic histoiy, he has laid down that the frequency distribution of age at first marriage is similar across countries; even though the mean and standard deviations of the skewed normal curve that the age patterns follow may be veiy much different. His zeal for exactness and his penchant for

scholarly iconoclasm also show up in his original re-formulation of the **phenomenon** of demographic transition. He has refuted the received wisdom on the subject, according to which a decline in fertility is always preceded by a decline in mortality. He showed that both changes could occur simultaneously; that even the opp osite of this thesis may be equally true, i**.e.,** fertility decline may precede mortality decline.

I will now recapitulate more slowly the highlights of Prof. Coale's star-studded career and his seminal contributions to the general area of demography.

When a graduate student at Princeton before World War II, Prof. Coale worked as a research assistant, on a project that the Office of Population Research (OPR) had undertaken under the auspices of the League of Nations, a section of which had moved to Princeton at the outbreak of war in Europe. Part of the project undertaken by the OPR was a study of the future population of Europe (including the Soviet Union). The purpose of this research was to establish what future changes in the European population were implied by pre-war trends, and by the foreseeable effects of the war itself, in order to serve as a solid background for peace settlements so that some of the questionable decisions incorporated in the treaties after World War I could be avoided. Prof. Coale's contribution (prior to entering the Navy early in 1942) to this project was to formulate the techniques used for projecting the population of each European country. The projections included the estimation of age-specific schedules of fertility and mortality from **1940** to **1970** for each countiy. Among the procedures adopted was the construction of corrected life expectancies for higher ages for certain East European populations, because the mortality rate as published was clearly understated. The method was, in effect, an early example of the construction of the "model life tables".

Prof. Coale's first research on returning to the field was to estimate errors in the census of the United States by analytical demographic techniques. Analytical techniques played an important part in a research

project that he later helped to organize at the OPR. This project was a study of the population of Africa south of the Sahara.[1] The results were published in 1968 in a book entitled *The Demography of Tropical Africa.*[2] The project was important both for its substantive results and because a number of methods of extracting valid information from faulty data were perfected and implemented. Two kinds of techniques were brought together. The first was a series of ingenious methods for estimating fertility and mortality from questions about births and deaths asked in censuses or surveys.[3] The second kind of technique was a method of estimating fertility and mortality from age distributions and rates of increase, using model life tables and a model stable population. The substantive results included a summary of the fertility, mortality, nuptiality, and rates of of national populations and sub-populations in many countries of Tropical Africa.[4]

From 1977 to 1983 Prof. Coale served as Chairman of the Committee on Population and Demography of the U. S. National Academy of Sciences. This committee undertook the task of preparing estimates of the true levels and trends of fertility and mortality in major Less Developed Countries. At the same time, the United States Agency for International Assistance in Development (USAID) was providing technical assistance to population programmes in Less Developed Countries and felt frustrated by the lack of information about demographic variables in some of the countries that, the Agency dealt with. The National Academy of Sciences was asked to undertake the responsibility for making authoritative estimates of these demographic trends. The Committee prepared about 30 reports, half of which are estimates of recent trends of fertility and mortality in different countries. The other reports include monographs on leportmg on

'The co-organizer of the project was Professor Frank Lorimer; other participants included William Brass, Don Heisel, Anatole Romaniuk, and Etienne van de Walle.

2 A. J. Coale, Paul Demeny, Don F. Heisel, Frank Lorimer, Anatole Romaniuk, and Etienne van de Walle (1968) *The Demography of Tropical Africa,* Princeton: Princeton University Press.

These procedures were contributed primarily by William Brass.

The methods developed for the African project were extended by A. J. Coale in collaboration with Paul Demeny (1967) *Manual TV: Methods of Estimating Basic Demographic Measures from Incomplete Data* New York : United Nations Population Studies, No. 2.

methods of data collection, and a major manual published by the United Nations on indirect techniques for demographic estimation (Manual X,[5] a successor to Manual IV). He was co-author of reports on estimates of fertility and mortality in Korea and Egypt, and also author of a report on the People's Republic of China. The committee and its various panels drew on and perfected the methods of indirect estimation as well as correction of faulty data that had begun in the earlier study of Tropical Africa.

This sub-field of demography has become a minor industry of considerable utility because of the continuing need to extract useful information from incomplete and inaccurate data. (In teaching graduate students, Prof. Coale refers to these methods as "making bricks without straw").

Another field of interest of Prof. Coale's is the abstract mathematical and analytical study of the structure of populations. He wrote several articles in the mid-1950s on the effects of changes in mortality and fertility on age composition. The most important idea that occurred to him during this period was a conjecture that human populations were subject to "weak ergodicity". This term means that the age distribution of any closed population is determined by the recent history of its fertility and mortality, and is independent of the age distribution in the remote past. This conjecture was an extension of the theory of stable populations; if fertility and mortality rates have not changed for a long time, the age distribution of a population is fixed and completely determined by the unchanging schedules of fertility and mortality. This situation is an example of "strong ergodicity", a special case of "weak ergodicity".[6] In 1972 he wrote his classic work, *The Growth and Structure of Human Population,* which summarized the theory of stable populations, and also described the effect on growth and age structure of the changing rather than the fixed rates of fertility and

5 The United Nations (1983) *Manual X: Indirect Techniques for Demographic Estimation.* New York: United Nations Population Studies, No. 81.

Alvaro Lopez provided the proof of this conjecture and an earlier example of use of the term, as cited by A. J. Coale (1972) *The Growth and Structure of Human Populations: A Mathematical Investigation.* Princeton: Princeton University Press, p. 206.

mortality.[7]

His research on analytical demography includes construction of "models" of mortality, nuptiality, and fertility. The model life tables and model stable populations that Paul Demeny and Prof. Coale constructed in the 1960s are an example. The model life tables mentioned above were designed to provide a flexible alternative to the model life tables published some years earlier by the United Nations. The earlier tables were intended to exemplify at each level of mortality, from very high to very low, the typical age pattern of death rates. In the tables were presented four families of typical age patterns of mortality at each overall level. They also calculated for each life table a set of "stable" age distributions, incorporating the life table in question and a set of annual growth rates ranging from less than zero to a very rapid rate of increase. These tables are now widely used in both analytical and historical demography."

In the 1970s he noticed, and showed, that there must be a uniform frequency distribution of first-marriages in different populations - with the location and scale of the frequency distribution, of course, being different. In other words, the standard schedule of first-marriage frequency is uniform in the same way that the Gaussian normal frequency distribution is uniform in many different contexts. This model schedule of first-marriage frequencies is especially interesting because there is a behavioural explanation for its uniform structure.[9] In all societies, marriage consists of attaining a socially accepted age of being marriageable, searching for a spouse after becoming marriageable, agreeing to get married and undergoing the actual marriage ceremony. The durations of these stages have similar distributions, though they are typically longer or shorter in different societies. The model schedule

More recently, the theory of non-stable populations was extended in an article written by A. J. Coale and Samuel Preston (1982) Age Structure, Growth, Attrition and Accession: A New Synthesis. *Population Index* 48:2.

A. J. Coale and Paul Demeny (1966) *Regional Model Life Tables and Stable Populations.* Princeton: Princeton University Press.

[9]This work was done by A. J. Coale in collaboration with Donald McNeil (1972) The Distribution by Age of First Marriage in a Female Cohort. *Journal of the American Statistical Association* 67:340.

of first-marriage frequencies was combined with an idea of Louis Henry's about "natural fertility" within marriage, and a further idea of systematic departures from natural fertility through voluntary control, to construct (with T. James Trussell) the model age patterns offertility. These schedules, both of nuptiality and fertility, closely fit actual experience in a wide variety of different populations.

Another of Prof. Coale's many and varied concerns is the relation between population change and social and economic progress, especially in the Less Developed Countries. In 1955, Prof. Coale, in collaboration with Prof. Edgar M. Hoover, undertook a study of the relation between alternative population trends in India and Mexico and their prospective economic development.[10] They tried to avoid polemic assumptions: either thai, vapid population growth in the Less Developed Countries was making progress impossible and would soon lead to famine; or that, the continued high birth rate so characteristic of most ofthe Less Developed Countries had no adverse effects. The approach taken in the book was to project the population of India and Mexico into the future under contrasting assumptions of (a) no change in the rate of childbearing, and (b) of a 50 percent reduction over a 25-year period. On the basis of these alternative projections, the authors tried to discern the differences (under similar assumptions about savings rates and the like) in prospective economic changes. They concluded that there would be a substantially - though not spectacularly - greater economic gain if the path followed was the reduced-fertility path. Many other economists and demographers have since extended and modified (and, in some instances, contradicted) this research. Prof. Coale is going to talk about these matters tomorrow, so I will not anticipate him any more on this.

The last general area of Prof. Coale's interest in demography is historical demography. He worked with Prof. Melvin Zelnik on the reconstruction of the true age distribution and the fertility of the white

[10]A. J. Coale with Edgar M. Hoover (1958) *Population Growth and Economic Development.* Princeton: Princeton University Press. See also Ansley J. Coale (1978) Population Growth and Economic Development: The Case ofMexico. *Foreign Affairs* 56:2.

population in the United States on the basis of census enumerations (since birth registration was not adequate until the 1930s);" and with Prof. William Rives he made a similar analysis of the history of age distribution and fertility ofthe U.S. non-white population.

Prof. Coale's most extensive research on historical demography has been the European Fertility Project, a cooperative enterprise he undertook with colleagues at the Office of Population Research and elsewhere in Europe. Since it was initiated in 1963, this project has succeeded in reconstructing measures of overall fertility, marital fertility, the fertility of the non-married and the proportions married, in the more than 600 provinces of Europe, from a time in each province when fertility was approximately constant until the 1960s. The aim of the project is to document the so-called demographic transition in Europe at a more detailed geographical level than mere national analysis, and to examine the social and economic circumstances under which the systematic decline in fertility began. The project has been extraordinarily fertile: it has given birth to seven books on individual countries in Europe, to a large number of additional articles, and to a final summary volume published in 1986.[12] Prof. Coale co-authored the volume on Russia and co-edited the summary volume .[13]

An important fallout of the European Project was the reformulation of the well-known concept of demographic transition as developed by Notestein. The project entailed a detailed examination ofthe commonalities and differences in the experiences of various European societies about the sequence of events that led to the fertility declines there.[14] The main findings

[U]A. J. Coale and Melvin Zelnik (1963) *New Estimates ofPopulation and Fertility in the United States.* Princeton: Princeton University Press.

[2]A. J. Coale and Susan C. Watkins (1986) *The Decline of Fertility in Europe: The Revised Proceedings of a Conference on the Princeton European Fertility Project.* Princeton: Princeton University Press.

[13]A. J. Coale and Barbara Anderson (1979) *Human Fertility in Russia since the Nineteenth Century.* Princeton: Princeton University Press.

"These results are conveniently summarized in A. J. Coale (1973) The Demographic Transition Reconsidered. *Proceedings of the International Union for the Scientific Study of the Population.* Liege.

of the Project were the propositions that "the decline in mortality does not id ways precede the decline *in fertility"; that in many instances "the* declines in fertility and mortality were more or less synchronous"; and that there were a number of populations "in which the decline in fertility came first". Another important finding of the project was that there was a "regional clustering" of fertility change: namely, provinces and regions which were culturally similar and shared a common language were the ones to experience fertility change in quick succession.

I have already taken considerable time introducing Prof. Coale. I can continue on this theme for the remaining one hour or so. But I should not kill him with kindness. Over to Prof. Coale.

Lecture I

THE DEMOGRAPHIC TRANSITION AND ITS IMPLICATIONS FOR POPULATION TRENDS IN THE LESS DEVELOPED COUNTRIES

Lecture I

The Demographic Transition and its Implications for Population Trends in the Less Developed Countries

INTRODUCTION

Thank you veiy much Professor Naqvi. I am grateful to you and to the Institute for the invitation to give these lectures, and am touched by the hospitality I have enjoyed from the minute 1 arrived in Islamabad. Professor Naqvi said that demographic relations are all too often forgotten by economists and policy-makers. They are also forgotten by students between (.lie academic term and the final exam.

There are two kinds of interaction between population and development I hat should be of interest to the Pakistan Institute of Development Economics and to the Pakistan Society of Development Economists. The first, kind of interaction is the effect of development on population; the second is l.lie opposite, or the effect of population trends on development. The best known modern concept of how development affects the evolution of a population is the set of ideas that go by the name of "The Demographic Transition". Briefly, the demographic transition postulates a large reduction in both birth and death rates as occurring when a society is transformed from a traditional form to a developed or modernized form. Death rates are typically reduced first, creating a period of rapid growth before the birth rates also fall. The generalizations that make up the demographic transition - that, rising income, changing technology, urban rather thap rural residence, spreading education, and reduced mortality bring down the birth rate - were the basis of a popular motto at the World Population Conference in Bucharest (1974), namely, "development is the best contraceptive".

There is no similarly well-known set of ideas about how population affects development. Economists often take population as a given, and concentrate quite properly on investment strategies, sectoral balance, monetary policy, the balance ofpayments, and the like. Part ofthe reason for ignoring population is that the effects of population on the development of the economy are rather long-term and gradual. Policy-makers are concerned with the immediate future and, therefore, let the population issues remain in the background. When population is considered in connection with development, thfe discussion too often takes the form of assertions by the pessimists that the LDCs are overpopulated and face worsening poverty, chronic malnutrition or even famine because of rapid population growth; and counter assertions by the proponents of radical reform that; poverty has other roots than population growth, that a new economic order could bring a decent level of living for all, and that population problems would then take care of themselves. In these two lectures I shall address the effects of development on population by undertaking a re-examination of the demographic transition in the light of recent research, and I shall address the effects of population on development by a retrospective look at the relevance of the research that Edgar Hoover and I did 25 years ago on the subject.

THE DEMOGRAPHIC TRANSITION

(i) Moderate Growth Characteristics of Traditional Societies

In a very long perspective, the human population has grown from the hypothetical origin of the species (presumably with two persons) about a hundred thousand years ago to about 4-1/2 billion persons today. The increase from 2 persons to 4-1/2 billion has taken so long that the average rate of growth has been only about two tenths of a person per thousand population per year. Any population of ten thousand would scarcely notice an increase of 2 per year. In the first 90,000 years the population grew to perhaps ten million. Ten thousand years ago is an estimate ofthe date wheq the domestication of animals and the cultivation ofland began. The estimate of ten million for the population at that time is based on what historical anthropologists consider to be the likely maximum number that could be

supported by hunting and gathering - without domestication of plants and ·itiimals. A growth in 90,000 years from a hypothetical 2 persons to about ten million implies an average rate of only about 16 per hundred thousand (.16 per thousand). From 10,000 years ago until about 1750 A. D. (the beginning of the period we shall be discussing when we speak of the demographic **transition),** the population grew from about 10 million to about 500 million, ttuch an increase in a little less than 10,000 years implies an average annual **rate** of increase that was still very low - only about half of a person per thousand per year. Since 1750 A. D., in the period in which the demographic **transition** took place, the average rate of increase of world population has Ijoen much more rapid, an average of about 7.5 per thousand, some 15 times higher than in the previous ten thousand years. In the past two centuries, I he growth of world population accelerated, reaching an annual rate of increase in the 1960s **of** about 2 percent, or 20 per thousand. The peak rate is v!;ry much higher than the low average since the origin of the spccics, or in ;my extended period before 1750 A. D. The average increase since 1750 of 7.5 per thousand, though less than the growth rates in the **late** 20th century, was enough to produce a multiplication by a factor of 8 or 9 of the population of the world in a little over two centuries.

The nearly imperceptible average annual growth of the human population until 1750 is an inevitable long-run feature of the population of any long-enduring premodern society. If such a society grew by as little as 5 per i.housand per year - a slow rate by contemporary standards - its size would be multiplied by about 12 in only live centuries. In five centuries a population of 10 million would become 120 million; or, if the growth were negative, it would shrink from ten million to less than a million. Increases by ;i factor of 12 in five centuries rarely occurred. Indeed a population that employs only slowly changing technology, that depends for example on an agriculture using traditional techniques, and that has access to a limited territory, could not support repeated multiplication by a factor of 12 eveiy five centuries. Once the accessible territory is fully settled, further multiplication by such a large factor is not possible with a nearly fixed technology. I think we can take it as approximately correct that in a premodern society, which has stable traditions and long inhabits a fixed

territory, the long-run rate of increase is close to zero, implying a balance in the average biith and death rates.

A very close balance of birth and death rates must have been the average experience of the world population over its long history. For example, from the average rate of increase of about 0.5 per thousand that one can calculate from about ten thousand years ago to about 1750, it follows that if one estimates an average of about 40 births per thousand population per year, the average death rate must have been 39.5 per thousand. The inevitability of slow growth in traditional societies and the implied close balance between birth and death rates leads to this question: How was such a close balance achieved? It seems reasonable to suppose that some kind of homeostatic mechanism was in operation. A homeostatic mechanism is a mechanism that achieves a balance by causing the rates to change in such a direction as will correct any positive or negative deviation from the equilibrium. In other words, there must have been some kind of homeostatic mechanism that caused death rates to rise or birth rates to fall when an episode of rapid growth produced a greatly enlarged population within a given area; and a mechanism that caused lower death rates or higher birth rates when numbers were depleted. In premodern conditions, it is easy to see that mortality can serve as such a balancing force. Overcrowding of a limited territory under premodern conditions can lead quite understandably to higher death rates. In a premodern context, a large population in a limited territory provides a critical mass that can maintain endemic disease and allow the rapid spread of any newly introduced pathological contagious agents. A large premodern population is more liable to infestation with intestinal parasites because of contaminated food and water; ultimately, too large a premodern population suffers worse nutrition because of low per capita availability of food. Similarly, a favourable relation to resources, following a large reduction in population, allows both better nutrition and less contagion. Thus a homeostatic mechanism that operates through variations in the death rate is readily visualized. When the population becomes too dense, the death rate goes up; and when density is less the mortality rates are lower.

In Figure 1, one axis is a measure offertility and the other a measure of

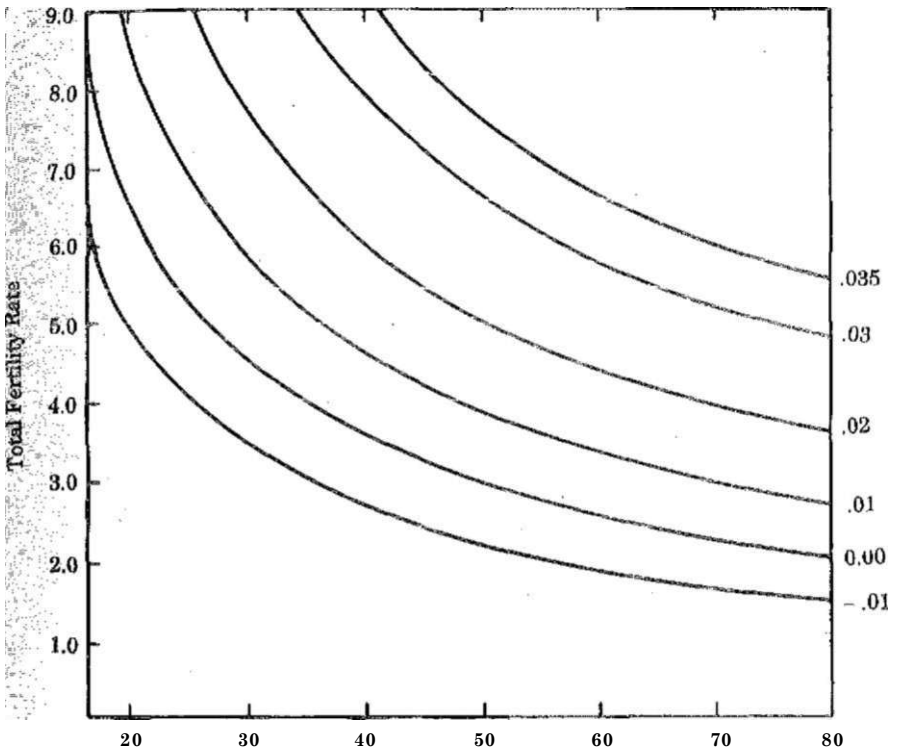

Figure 1. **Combinations of Total Fertility Rate and Expectation of Life at Birth that Produce Various Long-run Growth Rates from -1 Percent to 3-1/2 Percent.**

mortality. There is a series of curves in the figure, each showing the long-run rate of increase that would result from the continued prevalence of a combination of fertility (as shown on the vertical axis) and mortality (as expressed by a measure on the horizontal axis). The measure of fertility is one that has proved most useful to demographers. It is called the total fertility rate, which is simply the average number of children per woman born in a lifetime according to a given regime of childbearing rates by age of mother. In other words, in a population with a total fertility rate of 6, the birth rates experienced by women aged from age 15 to 50 would produce on the average 6 children in a lifetime. The expectation of life at birth is the average duration of life that would be experienced in a hypothetical collection of persons, who from birth - until all are extinct are subject to a specified set of death vales by age. An expectation of life of 20 years means that, according to a given mortality regime, the average, age. at death would be 20 years. At the other extreme (just now being attained by the most advanced populations), an expectation of life of 80 years means that the population would survive to that average age, if subject to a set of very low mortality rates. Figure 1 shows the rate of increase caused by the continued prevalence of a particular combination of the total fertility rate and the expectation of life at birth. The line labelled zero is the locus of combinations of lifetime births and average durations of life that lead to a population that does not grow. For example, if the total fertility rate were about 8.5, an average duration of life of about 15 years would lead to zero growth. If the total fertility rate were about 7 (approximately the rate in Pakistan), an expectation of life of a little less than 20 years would cause the population to remain stationary. At the other extreme, if the expectation of life were as high as has yet been observed, the average number of children born would be a little over 2 to maintain a population that is not growing. Other lines in Figure 1 show combinations of total fertility rate and life expectancy that produce other rates of growth, from minus one percent to 3-1/2 percent per year. The combination in Pakistan today of a total fertility rate close to 7 and a life expectancy around 50 years is consistent in Figure 1 with a growth rate of about 3 percent a year, which is veiy close to the actual rate of increase in Pakistan. Because of the numerical implications of long-sustained growth, in premodern societies one expects a combination of fertility and mortality

consistent with a rate of increase close to zero. Empirical evidence on this point is very sparse because there are few reliable records of fertility and rnorU'lity in pre-industrial societies. There are some scattered data permitting calculation of the approximate total fertility rate and life cx|n:i'iancy in a handful of populations that had not yet begun or had just [j,;f>iui the demographic transition. In Figure 2 the x's represent combinations of estimated fertility and mortality in selected populations not yei much affected by modern industrialization and associated social change. cXVfM nl are European populations in the late 18th century. By the late 18th ccniuiy, the rate of increase had begun to rise in many European populations; the European growth rates in Figure 2 are thus less than one percent, although above zero. The modern decline in the birth rate had not yet begun in these populations. As far as we can judge, they had a total fertility «ate that had prevailed for some time prior to the date shown.

The non-European populations in Figure 2 are the rural population of China about 1930, and the population of India between 1901 and 1911. The total fertility rate in rural China in 1930 was about 5.5 children per woman; the expectation of life was about 24 years; the annual rate of increase was close to zero. In India during the decade from 1901 to 1911, the expectation of life was about 26 years; the total fertility rate was about 6.2 children per woman. In Figure 3 the typical combinations of fertility and mortality in premodern societies fall in the ellipse labelled "pre-transition region". These are combinations of fertility and mortality that lead to a rate of increase not far from zero. Contemporary European populations that have been through the demographic transition have combinations in the small ellipse labelled "post transition region". These populations have a life expectancy of about. 75 years, and total fertility rates that are only about. 2 children per woman; some are just above, but most are below the level that is required for long-run zero growth.

A surprising feature of the pre-industrial combinations of fertility and mortality in Figure 2 (of selected 18th century European populations plus India and China) is that the total fertility rates are so low: just above 4 in some of the European populations, only 5.5 in rural China, and 6.2 in the

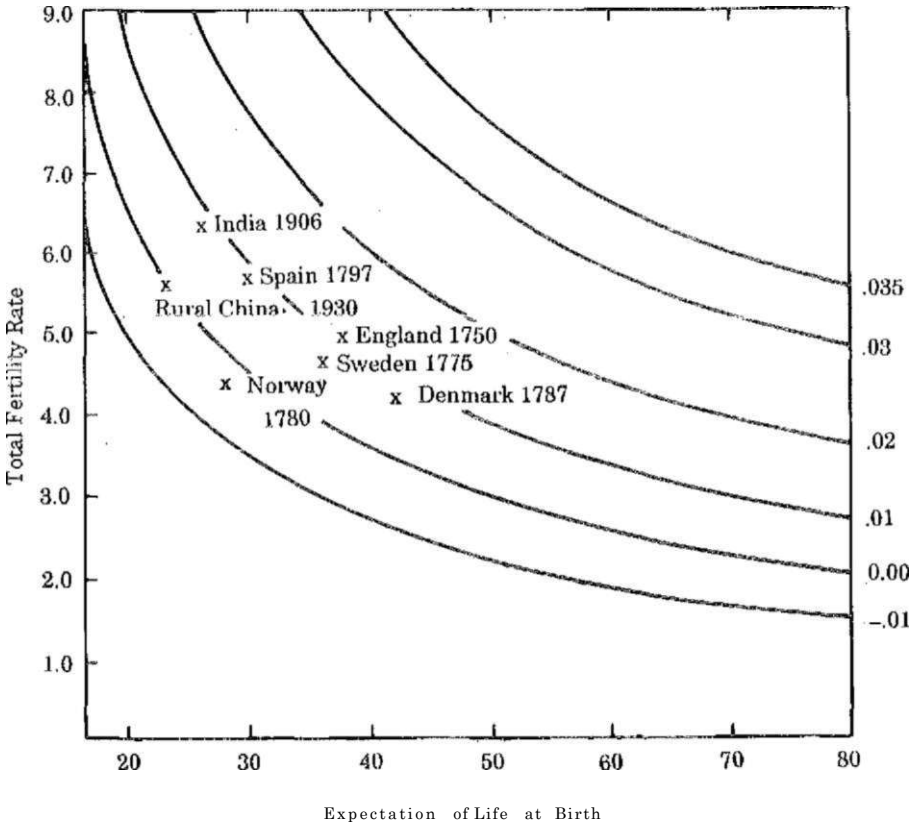

Figure 2. Combinations of TFIl and e° **in** Selected **Pre-**industrial Populations - European Populations in the **18tli Century, India in 1906, and Rural China in 1930.**

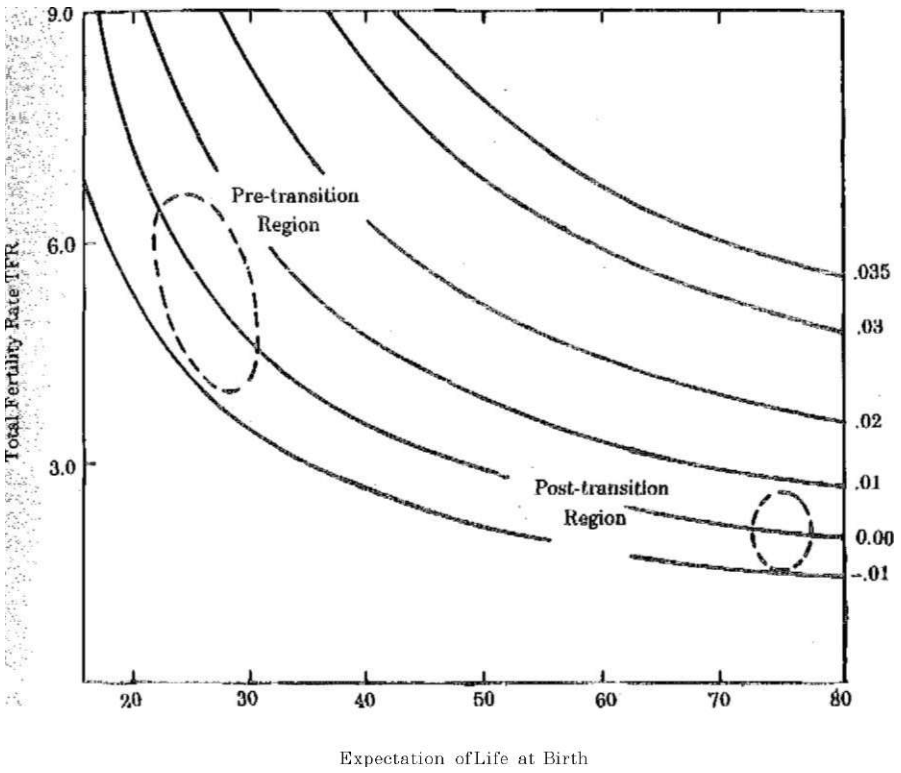

Figure 3. The Typical Locus of TFR and e° in Pre-transitional Populations (Estimated) and Post-transitional (Typical of Contemporary Europe).

Indian subcontinent. This level of fertility is surprising to a demographer because of the much higher fertility rates that have been reliably recorded among certain religious sects in North America in this century, and equally high rates among French Canadians in the 17th century. Although these populations had quite high total fertility rates, they were not as high as they might have been, because marriage occurred at relatively late ages. If the high fertility rates among married French Canadians were combined with the early marriage in India, Pakistan, China, or Egypt, or of many other countries in Asia or Africa, the combination would lead to a total fertility rate of over 10. In other words, it is easy to show that, it would be possible to have a total fertility rate greater than 10 with a combination of demographic characteristics observed in different populations.

Professor Frank Notestein, who was one of the pioneers in the development of the idea of the demographic transition, said that one would expect high fertility to characterize *any* premodern population. I can express his ideas best by reading a short excerpt from what he wrote. He said: "We may take it for granted that all populations surviving to the modern period in the face of inevitably high mortality had both the physiological capacity and the social prganization necessary to produce high birth rates."[1] Thus high mortality was inevitable because the means of making it low had not been developed yet; for survival, birth rates also had to be high. He goes on to say: "Peasant societies in Europe and almost universally throughout the world are organized in ways that bring strong pressures on their members to reproduce. These arrangements, which stood the test of experience throughout centuries of high mortality, are strongly supported by popular beliefs, formalized in religious doctrine, and enforced by community sanctions."

In other words, Notestein (and other originators of the concepts of the demographic transition) said that pre-transition societies must have had high fertility. Yet in examining empirical data on fertility in premodern

[1] Frank W. Notestein (1953) Economic Problems of Population Change. In *Proceedings of the Eighth International Conference of Agricultural Economists.* London: Oxford University Press.

societies, we find that it is not nearly as high as it might be. Rather than total fertility rates of 10 or more, the actual range is from 4.1 in Denmark to 6.2 in India. How can these moderate levels of fertility be reconciled with statements about the demographic transition to the effect that high fertility is inevitable if a premodern society is to survive to the modern period? In re-examining these issues, I have come to the conclusion that a premodern society was most likely to survive to the modern era with *moderately* high rather than *very* high fertility. The rationale for making moderately high rather than very high fertility advantageous is the necessaiy existence of an average rate of increase close to zero over any veiy long period. Such a rate may be achieved by any one ofthe combinations shown in Figures 1-3. Thus there is a choice, or at least there are alternatives, ofvery high mortality and very high fertility or moderately high fertility and moderately high mortality, to achieve a growth rate near zero. *Low* fertility and *low* mortality are not a choice, because, as Notestein noted, low mortality could not be achieved. I have come to realize that a society which developed the customs that promoted the highest fertility possible (with a total fertility rate of 10 or higher) would, over a long period, inevitably have an average duration oflife ofless than 15 years. Only 20-25 percent ofthe women would survive to the mean age of childbeal'ing. Such a combination ofvery high fertility and veiy high mortality would make the population more vulnerable to catastrophes, and would make it poorly competitive with other societies that had lower mortality and fertility. When this idea first, occurred to me, it seemed contrary to the rudimentary ideas I had of evolutionary competition between species. Why would the population with the highest, fertility not swamp out its neighbours? Feeling uneasy about, the conclusion that moderate fertility was advantageous, I called a colleague in Princeton's Biology Department who is a prominent scholar in mathematical biology, and an expert, on reproductive strategies and the theory of evolution. I asked him whether it makes sense to say that a society with moderate fertility would have a better survival chance than one with veiy high fertility. He said, well, if you were talking about large complicated mammals, I would say that you were right. Thus I learned that evolutionary theorists have found two polar strategies for survival in the Darwinian struggle. One is known as "r selection" and the other is known as "k selection". The first strategy - r selection - is what I had

visualized as the essence of evolutionary theoiy from a rather weak grounding in the subject. It is a strategy that entails an inordinately high capacity for reproduction. It is characteristic of species of small body size, short life-span, and short inter-generational intervals, with a limited area of foraging and a highly variable habitat. Such species survive successfully through a capacity for very rapid multiplication. They may be depleted when the environment" is unfavourable, and spring back to large numbers when the environment permits, and do so before competitors might fill their niche.

The second strategy - "k selection" - is characteristic of large complicated animals with long life-spans, long inter-generational intervals, a large area of foraging and a stable habitat. , Such species survive more successfully by moderate fertility which is consistent with a long duration of gestation and maturation, and which avoids overcrowding the habitat. This reproductive strategy is found among large mammals (like elephants) and large birds, such as the wandering albatross, which lays its first egg at an age of 8 or 9 years, and lays only one egg every two years.

Premodern human societies develop socially transmitted and socially enforced customs that lead to moderate reproduction. Moderate reproduction is conducive to better survival of a society in the same way that genetically determined moderate reproduction is favourable to the survival oflarge, slowly maturing animal species.

How did premodern societies maintain a moderately high rather than a very high level of fertility? Different methods of attaining a moderately high level offertility have prevailed in different societies. In 18th century Western Europe, where total fertility rates were from four to five and a half, there was a source of moderate fertility not found in premodern times in other-societies: late marriage, and a surprisingly high proportion ofthe population that remains unmarried. The mean age at first marriage in Western Europe varied from 23 to 28 years for women. The proportion remaining permanently single was at least 10 percent, and sometimes as high as 20 or 30 percent. As a result, only about 50 percent of the women in the childbearing ages from 15 to 50 were married at any given moment, keeping

fertility about 50 percent below what it might have been if marriage were universal. Thus postponement of marriage or permanent celibacy was one way of keeping fertility only moderately high. The prohibition of widow remarriage has a similar, though a smaller, effect. Women still in the fertile ages in India are kept from the possibility of childbearing by not being allowed to remarry. The combination of the extremely early marriage that was traditional in India, including infant marriage, with a prohibition of remarriage meant that a substantial fraction (8 to 10 percent) of women in India in 1901 were widowed, even at ages fifteen to twenty. Twelve to fifteen percent of all women of childbearing age were kept from possible reproduction by the prohibition of the remarriage of widows. In Asia and Africa, marriage has traditionally been early and universal; less than one percent of women remain single at age 30 and above; and the mean age at first marriage is less than 20 years, so that restricted participation in marriage has not been an important factor.

Nevertheless, the total fertility rate in these populations has not been 10; but only 5.5 in China, and a little over 6 in India. When most women of childbearing age are married, there are a variety of practices that limit marital fertility well below the high levels recorded among the French Canadians in the 17th century. The most important, one is. extensive lactation. Breastfeeding prolongs the period of post-partum amenorrhea, and postpones the resumption of ovulation, thus lengthening the interval between births. In addition, in many societies there is a taboo on intercourse while a child is being nursed. Such a taboo is typically based on a folk belief that sperm poisons the milk, or is bad for the child in various other ways. Louis Henry, a French historical demographer, while citing the beliefs that sperm poisons mother's milk, said that such beliefs were common in Asia and Africa but not in Europe. Etienne and Francine van de Walle examined European medical literature from the 17th and 18th centuries and found, to the contrary, that such ideas were common. A particularly amusing example is the advice which they found had been given by a German doctor to his patients. He said that while the woman is nursing, there should be no intercourse because the sperm might curdle the milk and give the child a lifelong distaste for cheese.

Another factor that can lower fertility is periodic separation. Agriculturalists who migrate for seasonal work will be separated from their wives for as much as halfthe year. Shepherds and fishermen are away from home as part of their regular work. Reduction in the probability of conception is approximately proportional to the fraction of the time the couple is separated. Lastly, sterility is caused by venereal disease and certain forms of tuberculosis; other forms of ill-health reduce fecundability and raise the frequency of intrauterine mortality.

(ii) The Absence of Parity-related Restriction of Fertility before the Demographic Transition

The important, distinction between the moderate fertility that characterized premodern populations and the low fertility that was introduced during the demographic transition is this: all ofthe customs that, led to moderate fertility in traditional societies, whether late marriage, prolonged lactation or periodic separation, are not what demographers call parity-specific limitation of fertility. Parity is a term (borrowed from medicine) that means how many children a woman has born. A nulliparous woman has had no children; a one-parity woman has had one child; and a five-parity woman has had five. In many premodern societies lactation is prolonged; in much ofAfrica the taboo on resumption of intercourse extends beyond the point, ofweaning. Yet these customs that reduce the total fertility rate are followed after the first birth just as they are after the sixth. They differ from the restraint on fertility in post-transition populations, where couples change their practices after a certain number of children are born in order not to have any more. That kind of restraint on fertility is parity-specific, which is behaviourally different from non-parity-specific limitation, although it may have a numerically similar effect.

An extreme example of non-parity-specific limitation of fertility has been observed among the Kung tribesmen in the Kalahari Desert in Southwestern Africa. The Kung are an anthropologist's delight., since they are still dependent on hunting and gathering, rather than settled agriculture. They live on vegetables and nuts that are gathered by the women and the irregular supply of meat brought in by the men. The

interbirth intervals among the Kung have been closely observed by anthropologists who have lived among them for several years at a time. The interbirth interval averages about four years. The total fertility rate of a little over four is about as low as the lowest listed for a West European population in the eighteenth century, restrained by late marriage and permanent celibacy. The Kung achieve such low fertility by veiy prolonged and intense breastfeeding. The children are nursed for more than three years. Medical anthropologists have observed that the average interval between nursing bouts is only about 15 minutes, and the children sleep with the woman and have access to the breast at night. These anthropologists have taken daily blood samples to measure variation in the prevalence of hormones that inhibit the resumption of ovulation. There is a positive association between the frequency ofbreastfeeding and the presence of such inhibiting factors. A social anthropologist who lived among the Kung reports that the women themselves want many children, and say that God is cruel because He does not give them more children. Note that prolonged breastfeeding was not a conscious effort to have few children, but was a consequence of the specific way of life. The proportion of the caloric intake ofthe Kung infants that the women provide is about 70 percent. The round-trip to gather the nuts and fruit is 2-12 miles. The women must cany any infants they have with them. Carrying two children plus the gathered food would be impossible. On these trips there is a very close relation between mother and the child, who is at. the mother's heels even when able to walk. The custom of prolonged and intense nursing is veiy functional in this setting.

Premodern societies thus do not achieve biologically maximal fertility, but restrain it by one or another of these sets of measures. How is the absence of parity-specific limitation inferred, since there are few detailed observations of premodern fertility? The direct, observation of the Kung is veiy unusual. In premodern European populations, there were no fertility surveys. Women were not asked whether they were practising contraception; its absence must be inferred indirectly. The kind of evidence that shows the absence of parity-related methods is that the mean age of the woman at the birth ofthe last child does not change, just as we observe in the populations oftoday that do not practise contraception. Parish records show that women

in the 17th and 18th century European populations bore the last child at a mean age of about 40 years. We know from modern observations that such a mean age at last birth is characteristic of populations that do not practise contraception. Women using parity-related restraint of fertility bear the last child well before age 40. Other indirect evidence (especially the pattern of age-specific marital fertility) shows that parity-related control was not characteristic of premodern populations in the aggregate. Small segments of the population may resort to deliberate contraception, but not the majority.

Since moderately high rather than very high fertility is usual in premodern societies, and since, moreover, a total fertility rate of only four to six-and-a-half is advantageous in these countries, why was it not achieved by parity-related methods? Effective forms of contraception are known, at least to some, in almost every culture. Withdrawal or *coitus interruptus* was the predominant method of contraception in Europe in the 19th centuiy and at least until World War II. It is quite effective when practised scrupulously, but is not a modern invention. It is mentioned in the Old Testament, and in seven different branches of medieval Islamic Law.

If moderate fertility was advantageous - and the techniques of parity-related restraint of fertility were known, why were they not widely used? My unscientific conjecture is that from time to time in premodern societies contraception was used by segments of the population, but that they died out. Recall Notestein's statement that high fertility is a must for societies in which mortality is high. I have argued that moderate fertility is advantageous to the traditional society, but if fertility becomes too moderate, or falls below the combination with the lowest attainable mortality that is consistent with replacement, the population does not last. My conjecture is this: that periodically members of a group within a society will say: Why should I worry about posterity? Why shouldn't we have only one or two children, enjoy our life more, allow the mother in the family to keep her figure, live more comfortably, and eat better? Why worry about the maintenance of the family name? Why do not we stop after we have had a small number of children? But if parity-related restriction diffuses among a group in a premodern society, that group disappears. If they produce too few

children to be consistent with the lowest mortality level attainable, they gradually vanish. When I outlined this argument to John Hajnal, he said: "It is like a lethal mutation". Prior to the development of conditions that make low mortality possible, parity-related fertility may be too attractive to its practitioners so that they carry it to a point that is inconsistent with replacement of the parents. This conjecture is reinforced by the results of contraceptive practice in a few premodern societies where it has occurred.

Some *departements* in France attained quite low marital fertility beginning in the late 18th centuiy. As early as 1830 the birth rate was only 20 per thousand, a level characteristic of other parts of Europe only in the 20th century. At that time infant mortality was still high, and the expectation of life at birth still low. One such *departe.me.nt,* Lot-et-Garonne, in Southwestern France, had a persistent negative rate of increase in the 19th century and lost 25 percent of its population from 1830 to 1900, without out.-migrat.ion. There was a similar pathology in Hungary in the 19th centuiy. Low fertility in some villages was known at the time as the one-child family; it was denounced vigorously in the churches as selfish. Villages where the "one-child family" was common also had a strong negative rate of increase.

(iii) **The Demographic Transition** in **Europe**

A full account of the European demographic transition would require a description and explanation of the decline in mortality. I shall say only a few words about the reduction of mortality in Europe since the middle of the 18th centuiy. The technological revolution that is generally considered the basis for the demographic transition, i.e., the so-called industrial revolution, produced many changes that made lower death rates possible. It coincided with the opening up of the Western hemisphere, which greatly expanded the food supply. The regularity of the food supply was further insured by increases in agricultural productivity in Europe and by the development of transportation, both transoceanic and internal, with canals, improved roads, and later railroads. There was an improvement in personal sanitation; people began to take baths and wash their hands. Later a clean-water supply

was provided, sewage disposal plants were built, and urban environmental sanitation generally improved. Thus technological change and increases in food supply made it possible for the death rate to go down; and some specific improvements in medicine helped, such as vaccination against small-pox. A natural implication of the technological changes that characterized the industrial revolution was thus a reduction in mortality. The less obvious part of the transition is the explanation of the universal decline of the birth rate in Europe.

We can characterize the fertility transition in Europe as the replacement of a regime of moderate fertility maintained by late marriage and non-parity-related methods within marriage, by a regime of low fertility within marriage attained by parity-related contraception. Parity-related restriction of fertility was initiated sooner or later in eveiy part of Europe, spread through the population, and produced an extraordinary decline in fertility.

We have conducted a twenty-year research project at Princeton called the European Fertility Project. It was a study consisting of a documentation, and then an analysis, of the decline in fertility in all the 700 provinces of Europe. With almost no exceptions (the only exceptions being a few provinces in Ireland and some impoverished areas in the Balkans), there has been at least a 50 percent reduction in marital fertility in all the provinces. The fertility transition has thus been virtually universal. It has clearly been a reduction in marital fertility caused not by more intensive or prolonged breastfeeding or abstinence or other non-parity-related practice, but caused by contraception. The intellectual challenge of the demographic transition is to explain what caused this universal adoption of voluntary control of fertility among married women. The underlying idea that Notestein and others suggested was that fertility declined because the social and economic changes that are part of modernization make a reduction in fertility inevitable. In a traditional society the locus of production is the family; social standing is determined mostly by family membership. In an agricultural setting, children make a contribution to production while still very young by feeding the chicken or bringing in the sheep or cattle; they also help take

care of younger children, and run errands for adults. Families are extended, so that care of the young children can be shared not only among older children but also with other relatives. Education is not an important expense, as few children go to school. Thus children contribute a lot but do not cost much. There are religious and cultural supports for having children. The proper role of women is to have children, and the proper sign of true masculinity is to sire a large number. There are both ideological and practical advantages in large families.

Industrialization changes all of these factors. When people work in factories their status is determined by what they do rather than who t.hey are. Children must be trained and, typically, do not start working as early as on a farm. Part of modernization is the development of universal education, ultimately compulsory education. Instead of enjoying the economic services of children, parents have to support them for a long time before they become productive. With impersonal employment and urban residence, the influence of others' opinions becomes less. If it is considered improper to practise contraception, and if it is admirable to have a lot of children, village residents feel the pressure to conform. In the impersonal life of a city, individuals become indifferent about what the neighbours think; and if they find contraception advantageous, they do not hesitate to use it. The changes that are an inevitable part of adapting to large-scale production, such as moving to a city, etc., include a reduced motivation for having children. Notestein affirmed that it was a change in motivation, not the development, of new techniques, that caused the decline in fertility.

One of the lessons of the European fertility study is that both new preferences for a smaller numbers of children and an improved knowledge of effective techniques are important. For example, although *coitus interruptus* was known previously, it was burdened with much false information, such as the belief that it causes idiocy. In fact, many individuals did not know about it, or lacked the degree of self-discipline that is required to make it effective. The prevalence of illegitimate births in the 18th and 19th century Western Europe and the parallel reduction of marital and extra-marital fertility rates in the late 19th century suggest the diffusion of a new skill through the

population. Presumably the desire to avoid illegitimate births did not newly arise. The desire to limit the number of children by married couples doubtless did grow stronger during the transition, but the ability to restrict fertility by contraception was also strengthened.

The European Fertility Project documented the decline in marital fertility in most European provinces from a pre-transition plateau in which there was little parity-related limitation through a period of sustained decline (typically at least 50 percent) as contraception was introduced and then more extensively and more effectively used. An almost universal feature of this reduction in marital fertility is that once it started in a province it continued without major reversals to a level no more than half as high as the pre-transition plateau. A major difference among provinces was in the date at which the decline in marital fertility began, and the pace at which it fell. We have estimated a date for each province when marital fertility had fallen by 10 percent from its pre-decline plateau in a sustained

The earliest date of the initiation of decline was the late 18th centuiy in a few *departements* ih France. In much of France the decline began before 1830, but except just across the border from France as in Geneva, scarcely any other provinces of Europe experienced this systematic decline in fertility until after 1870. Indeed 50 percent of the European provinces experienced the decline between 1890 and 1920.

We expected to find that fertility declined first in provinces where mortality had been reduced, in provinces where literacy was the highest, in provinces where non-agricultural employment had grown, and in the urban parts of provinces before the rural. In some countries such associations between fertility and socio-economic characteristics did hold, but no fixed list of factors associated with the initiation of a fall in fertility there was found.

For example, I mentioned the decline in fertility in Lot-et-Garonne that began before 1800. It Was a rural *departement* with a peasant population; its infant mortality rate was high, and the proportion of literates

not low, yet it was an early pioneer in the reduction of fertility. In England, which *was* the pioneer in the industrial revolution, the decline did not begin until after 1870. The expected close association of fertility with industrialization and urbanization was not found when we looked at the picture in detail. It is a more complicated picture than that.

It remains true that when a society is fully transformed to a modern way of life, parity-related fertility restriction is always prevalent. Massimo Livi Bacci, who contributed studies of Portugal, Spain, and Italy to the. European project, puts it this way: if a population lives in apartment houses and has radios, television sets, telephones, refrigerators, and automobiles, it never has an average of eight children per couple. While full modernization seems almost always to connote reduced fertility, it has not been possible to make a checklist of levels of literacy, mortality, proportion' in non-agricultural employment, and the like, that constitutes a sure sign that the fertility decline must have started.

A complicating factor that emerged in our detailed look at European experience is an apparent cultural element in the decline of fertility, an element that we can observe though not veiy satisfactorily explain. One of the first studies of the demographic transition at an intensive geographical level was by a graduate student (William Leasure) writing his doctoral dissertation at Princeton. Leasure decided to analyze the decline of fertility in Spain, since it was somewhat surprising that there had been a major reduction by 1930 in conservative Catholic Spain. He made a colour-coded map of marital fertility in the 49 provinces of Spain in 1911, in the middle of the transition. A striking feature ofthis map was that the provinces that had the same colour were geographically clustered, although they were not identical in social, economic, or educational characteristics. For example, Catalonia, an area on the Mediterranean near the border with France, that contains Barcelona as one of its provinces, had low fertility earlier than any other region, and the lowest fertility in Spain in 1911. Catalonia as a region includes some rural provinces that had veiy little industiy and also were not veiy high in literacy. Yet these provinces were low in fertility as well as Barcelona, which *was* industrialized. In contrast, the Basque region, the

locus of the steel industry, had high fertility. Not being able to understand this regional clustering, I suggested to Leasure that he take his map to someone in the modern languages department who specialized in Spanish culture and language. When the professor of Spanish looked at the colour-coded but unlabelled map, he said it was a linguistic map of Spain. Perhaps one of the reasons for regional clusterings being similar to linguistic regions is that the spread of contraceptive practice and deliberate limitation of family involve both a change in ideas and a mastery of technique. These social changes are probably accomplished by a combination of person-to-person communication and imitation. If the community leaders limit their families, then contraception becomes socially sanctioned. If the next-door neighbour reports that, her husband "takes care" (the folk expression for withdrawal) and that he remains mentally stable, a housewife can learn that there is a feasible way of avoiding pregnancy. Both imitation $md intimate communication naturally have linguistic boundaries. It is hard to imagine a Frenchman imitating a German, and the transmission of intimate information is difficult for persons speaking different languages. Another possible reason for the regional clustering of fertility patterns is that regions in Spain that, have different, dialects also have very different histories. Originally they were different kingdoms, with different legal and social traditions.

Livi Bacci, in his study of Italy, examined the relation between marital fertility by province in each census year from 1911 to 1961 and the vote in 1974 in a national referendum on the liberalization of laws governing divorce. There was a significant association - the provinces in which the vote went against the church were those in which at earlier dates (including 1911) marital fertility was low. From 1931 to 1961 the correlation among the Northern provinces between marital fertility and the divorce rate was higher than the multiple correlation with six socio-economic variables. Why was marital fertility in 1931 (or 1911) so closely associated with a vote on divorce legislation in 1974? Doubtless it was conservative adherence to the position of the Catholic Church that led to a vote against the liberalization of divorce laws in 1974; a similar adherence to the precepts of the church in the same provinces several decades earlier impeded adoption of contraception. Ron

Lesthaeghe has found that secularization (as indicated by the proportion of votes cast for socialist or social-democratic parties) is strongly correlated in several European countries with the date of initiation and the pace of fertility decline,

Additional evidence from the European Fertility Project about the importance of cultural factors in the decline of fertility comes from the book on the decline in fertility in Russia, of which I was co-author. (The book on Russia extended beyond Europe, including Asiatic as well as European Russia.) In Russia we found a strong correlation between the nationality composition of the population of each province and the timing of the decline in marital fertility. The Baltic provinces of Russia that are the most western in culture, strongly influenced by Swedish or German ties, were the first to reduce fertility. Next were provinces in the West of Russia with non-Great Russian populations (such as Ukrainian, White Russian, Polish, or Rumanian). Next were the provinces with Great Russian populations, although those with a large representation of eastern Finnish, or other non-Slavic groups, were generally later. Finally, the Central Asian area had not experienced a decline in marital fertility as late as 1970, despite greatly reduced mortality rates, and impressive progress in education (more than 90 percent of women 20-29 had at least primary schooling). These peoples - the Tadzhiks, Kirgiz, Turkmen, and Uzbeks had veiy low levels of female literacy, and very high mortality rates, and predominantly agricultural or pastoral occupations in 1926. They also had a culture in which the position of women was veiy subordinate, and in which high rates of childbearing, especially of male children, were greatly valued.

The failure of fei tility to decline in the Central Asian Republics (in the rural areas, the absence of a reduction in the birth rate as late as 1980 suggests that a decline has not occurred yet) leads me to suspect that the muslim culture in these republics and elsewhere may be particularly resistant to lower fertility. I am not suggesting that there is an official Islamic religious doctrine like that of the Roman Catholic Church, stating that artificial contraception, is contrary to natural law and, thus, sinful behaviour. Rather it is the traditional culture that has developed in Islamic

populations that retards the decline in fertility as modernization begins. The cultural elements involved include an extremely subordinate position for women, and a belief that their proper role is childbearing and child-rearing.

The European fertility project leads me, then, to the following tentative conclusions:

(1) A sufficiently complete degree of modernization (including universal education for both males and females through secondary school, predominantly urban residence, employment in large-scale non-agricultural industries, advanced scientifically based techniques of manufacturing, transport, and communications, and widespread ownership of modern amenities) is accompanied by the general use of parity-related methods of controlling fertility, and much reduced rates of childbearing by married women.

(2) The initiation of a decline in fertility is often associated with lowered mortality, increased education, and changes in occupation. No checklist of such characteristics can be formed that defines a threshold indicating that fertility reduction will begin.

(3) There are cultural factors that help determine the start and spread of controlled fertility. In the European experience, populations with a more secular, less religious orientation seem to have been more prone to begin the deliberate reduction of the rate of childbearing.

In summarizing the preliminary findings ofthe project in 1973,1 listed three prerequisites for a sustained reduction in fertility caused by parity-related use of contraception: (1) that fertility must be within the calculus of conscious choice - i.e., the deliberate decision to have a certain number of children must be viewed as morally and socially acceptable; (2) that reduced

fertility must be viewed as advantageous; and (3) that effective techniques of fertility reduction must be available. When a less developed countiy becomes fully transformed by modernization, these three preconditions come to prevail. But some cultures and traditions are more resistant than others to the emergence of these prerequisites.

(iv) The Demographic Transition in the Less Developed Countries

In Figure 3, the transition in fertility and mortality in two European countries is represented by pre transition and post-transition regions of combinations of total fertility rate and expectation of life at birth. The classical pattern of the demographic transition is an increase in expectation of life while fertility remains fixed, followed by a further increase in expectation of life accompanied by a decline in fertility. This pattern is approximated in the experience of Sweden. The rise in expectation of life while fertility remains constant causes a period of accelerated growth in populations; the later stage of declining fertility restores a low rate of population increase. In France, the decline in mortality and fertility were nearly synchronous; the combination oftotal fertility rate and expectation of life were never far from the point of zero growth.

In all less developed countries some part of the i ise in avei r^Ab duration of life that characterizes the transition in mortality has occurred. In many instances, the decline in mortality is shamefully short ofwhat it might be; nevertheless, even the most isolated countries in Tropical Africa now have a life expectancy substantially higher than it was 20 years ago. There have been two categories of mortality transition in the LDCs. In one (category, the possibilities provided by modern medicine and public health have been progressively realized, and major gains in life expectancy have continued. A few areas - for example, Hong Kong, Singapore, and Taiwan - now have mortality rates by age which are indistinguishable from the rates found in many European countries. In these same areas, however, increases in income and progress in education make the term "less developed" no longer veiy apt.

The second category of LDC mortality experience (found, for example, in India, Pakistan, Bangladesh and, approximately, in Egypt) is a large increase in expectation of life from about 30 to 50 years in the middle years ofthis centuiy. In this second category, the increase in expectation oflife has decelerated - mortality may still be falling, but not so rapidly. Mortality has fallen in the LDCs for several reasons. Deaths from famine have been avoided by increased agricultural productivity, plus improvements in the internal and international distribution of food, which softens the impact of local crop failures. Most important in attaining an expectation of life around 50 years rather than 30 or 40 has been the scientific and technical progress in low-cost prevention and treatment of disease. Smallpox has been eradicated; it was a major cause of death. Vaccines now reduce the incidence of many childhood diseases; insecticides have drastically lowered mortality for malaria and other high-mortality ailments transmitted by insects. Antibiotics can cure many formerly fatal illnesses, and can be inexpensively distributed.

The increase in expectation oflife at birth has slowed because ofthe absence, in the second categoiy of LDC mortality experience, of basic changes in the environment and the sanitary habits ofthe population. Water and food are contaminated with bacteria and intestinal parasites. Children are subject to diarrhea and enteritis as soon as supplementation of mother's milk begins; mortality rates from age six months to five years are very high as a result. Unsanitary obstetrical practice causes infant mortality from umbilical tetanus. Such sources of high mortality can be changed only by fundamental changes in attitude and day-to-day behaviour as well as provision of new facilities in the villages.

Some countries in which per capita incomes remain veiy low have risen above the apparent barrier that seems to retard the increases in expectation of life once an average duration of life of about 50 years is reached. Two such countries in Asia are China and Sri Lanka. In both, health programmes have been effective although average income is probably no higher - is indeed less - than in Pakistan. Emphasis on health education, on extension to the rural population of availability of medical services, on

training in basic medicine of millions of "barefoot doctors", and on the development of thousands of epidemiological centres has increased the expectation oflife in China to nearly 68 years.

The expectation oflife at birth has increased by a large margin in all LDCs, but there is no similar uniformity in recent fertility trends. In Table 1 there is a list of LDC populations in which there has been a recent major decline in fertility. The countries are ordered from the greatest to the least proportionate reduction in the total fertility rate. The ordering is imprecise because not all ofthe data are highly accurate; moreover, the time interval is different from country to country. The top six countries on the list are all in East Asia, and either have a predominantly Chinese population, or a culture (S. Korea) strongly influenced by Chinese traditions. Also' Singapore, Taiwan, Cuba, Mauritius, and Puerto Rico are islands; all eight populations with a 50 percent reduction are East Asian, or islands, or both. The large reduction in fertility in the East Asian populations under quite different governmental structures and economic conditions supports the view that culture is important in fertility reduction. Moreover, in all of these populations a combination of a major increase in age at marriage and the wide practice ofcontraception or abortion accounts for the decline.

There are 9 populations listed in Table 1 with a drop in TFR of 30 to *50* percent, and 9 more with a reduction of 10 to 25 percent. The 26 populations listed total 2.4 billion persons; about 900 million live in LDCs with a decrease ofless than 10 percent, no decrease at all, or some increase in fertility. The 900 million live in Tropical Africa, and a belt extending from Bangladesh through Nepal, Pakistan, Afghanistan, Iran and most Arab countries to Morocco -with exceptions such as Egypt and Tunisia.

Is the demographic transition in Europe a key to explaining demographic changes in the LDCs and a guide to estimating future fertility trends? The basis for the decline in mortality in 19th centuiy Europe and 20th centuiy Asia, Africa, and Latin America is different, and so is the pace of change. Gradual economic improvement and slow changes in preventive and curative medicine caused a slow rise in expectation oflife in Europe; the

Table 1

Recent Reductions in Fertility (Total Fertility Rate) in Selected Less Developed Countries

Country	Earlier TFR		Later TFR		Percent Reduction
Singapore	6.3	1959)	1.9	1977)	70
Taiwan	6.5	1956)	2.5	1980)	61
China	5.9	(1966-70)	2.6	(1977-81)	55
Hong Kong	5.1	(1960)	2.4	1977)	53
S. Korea	6.0	(1960)	2.9	(1976-80)	52
Cuba	4.7	(1960-64)	2.3	1977)	52
Mauritius	6.4	1952)	3.1	1977)	52
Puerto Rico	5.0	(1950-54)	2.4	1975-79)	51
Costa Rica	7.4	(1960)	3.8	1976)	49
Thailand	6.6	(1965)	3.9	1979)	41
Chile	5.3	(1955-59)	3.1	1975-79)	41
Colombia	6.8	(1964)	4.2	1978)	38
Malaysia	6.9	(1957)	4.3	1976)	38
Sri Lanka	5.9	(1950-54)	3.7	(1970-74)	37
Mexico	7.2	(1965)	4.7	1979)	35
Brazil	6.2	(1945-49)	4.3	1975-79)	31
Venezuela	6.8	(1960-64)	4.8	1975-79)	30
Turkey	6.8	(1945-49)	5.1	(1970-74)	25
Philippines	6.6	1960)	5.1	1976)	23
Dominican Republic	6.7	(1960-64)	5.3	1975-79)	23
India	6.2	(1951-60)	4.9	1979)	21
Tunisia	7.3	(1965-66)	5.9	(1974-75)	19
Panama	5.9	(1960-64)	4.8	1975)	19
Egypt	6.7	(1959-60)	5.5	1975-76)	18
Peru	6.6	1964)	5.5	1974)	17
Indonesia	5.5	1968)	5.0	(1977)	10

sharp impact of the transfer of modern technology in medicine, sanitation, agriculture, transport, and communications has brought a much more abrupt recent increase in the average duration of life in the LDCs. The pace of the mortality component of the transition in the LDCs is thus much more rapid than in any European population. In those LDCs in which the fertility component of the transition has already occurred, the reduction in fertility has also been at a pace more rapid than that in Europe. There are a number of possible reasons for the unprecedented speed of decline in the eight LDCs in which the TFR has fallen by at least 50 percent (generally in less than 20 or 25 years). In most of these populations there has been a veiy rapid social and economic transformation, with mAjor declines in mortality, large ino16HS@s in school enrolment, and impressive gains in per capita income. A novel element absent in 19th centuiy Europe is family planning programmes, governmental and private, with clinics that offer modern contraceptive techniques more effective and easier to use than any forms of contraception known before World War II, and other supporting educational and informational activities.

The LDCs that have had a large and steep decline in fertility differ from those that have had only a modest and gradual decline, and from those that have had none at all, in one or more of the following characteristics:

(1) In the rapidity and pervasiveness of general social and economic progress, especially in reducing mortality and attaining universal education.

(2) In the presence or absence of an effective family planning organization (public, private, or both) providing distribution of contraceptives, clinics for various related medical services, information, and education.

(3) In the existence or non-existence of incentives and penalties that favour couples who restrict their childbearing.

(4) In the compatibility of voluntary decisions to limit childbearing

and the choice of small families with the general culture and strongly held beliefs.

Only the first and the fourth factors Were operative in the demographic transition in Europe. A thorough look at European experience has revealed that social and economic changes affect fertility differently in different cultural contexts. The absence of fertility reduction in the central Asian parts ofthe Soviet Union suggests that in Pakistan, in the next two or three decades, attainable progress in health and education might by itself bring little reduction in the rate of childbearing.

In terms ofthe evolution from a combination of a high TFR and a low expectation of life consistent, which near zero growth to a combination oflow TFR and a high expectation of life with the same low growth potential, Pakistan has moved far along the path to longer life (from a mean duration ofless than 30 to more than 50 years), but has hardly moved at all towards lower fertility rates. The Pakistan Fertility Survey revealed very low rates of contraceptive practice (with only five percent of married women currently practising). A slight reduction in the total fertility rate has probably resulted from a recent increase in age at marriage, but the rate remains close to 7 children per woman. Therefore, to interpret the demographic transition as implying that economic development will soon bring a lower birth rate, and a rate of increase less than three percent, is unwarranted.

DISCUSSION

Mr Mazahir Hamadani: Professor Coale, I don't think inuslim culture has been against voluntary adoption of family planning measures. There may be two views when population control is considered as a cutting down of the population, but factors such as education, industrialization and urbanization are contributing to a lowering of fertility even in the Muslim countries. According to Sir Roy Harrod's economic theory, for stable and optimal economic growth the rate of economic growth should be equal to the population growth rate. Is it not a contradiction that we have been making efforts to cut down the population growth rather than keeping economic growth consistent with population growth?

Prof. Coale: Tomorrow's lecture is on the economic effects of population growth. With respect to "warranted growth", there is a crucial difference between economic growth and the growth of population. You can readily imagine national income increasing at an annual rate of 3 percent for ever, because as it increases, it needn't weigh anymore. A national income ten times as large might weigh less than the current national income does. Physical products of great utility can be made of tiny slivers of silicon; they can get smaller and still be more and more valuable. But at 3 percent current rate of population growth, the population of Pakistan would be multiplied 32 times by the end of the next centuiy to reach more than two billion. In 230 years the population would be multiplied by a thousand; there would be 80 billion Pakistanis. I don't believe a 3 percent "warranted growth rate" of population would stand up to critical scrutiny. In another 230 years the population would be 80 trillion. I would not like to propose an economic growth lower than 3 percent, but I don't think there is any justification for continuing a growth rate of that, sort for the population. In fact, it is a physical impossibility. People are not much concerned with what is going to happen in 230 years, but it is nevertheless true that a sustained growth of population is impossible.

I have never felt that population is the dominant economic problem, certainly not in the short run. If I were a benevolent dictator and had a choice between putting all the resources into some kind of family planning effort, or all of them into a sensible economic development programme, I would choose the latter, but that isn't the choice. Both programmes should be implemented. As we say in U.N. conferences, an effective population policy is an integral part of development; it's not an alternative. What I've been trying to say - using the Central Asian Republics as an example - is that if education is fostered, and so on, the birth rate does not automatically come down. At least it doesn't always do so. I think it is not irrational, nor counter-productive, (but the opposite) to have sensible population policies as well. Singapore, at the top of the list in having reduced its fertility, has an effective family planning programme with all kinds of incentives, as well as a successful programme of general development. The question involves another misunderstanding of what I would advocate. I feel that, is a sensible

policy to make effective contraception available and to have education to inform people about what the best choices are for their own welfare. When I advocate those kinds of things, I'm not thinking about reducing the number of people, just the growth rate. That's a veiy different thing. If the rate of childbearing in Pakistan were to be reduced in 20 years to the point where couples were having an average number of children just sufficient to replace themselves, the population of Pakistan would meanwhile just about double. I think that would be better than tripling or quadrupling. I'm thinking about a slower growth rate, not a negative growth rate.

Mrs Khalida Zaki: I am seeking further elaboration in the context of the last part of your lecture, where you mentioned that in comparison to the premodern European countries today's developing countries are passing through a different type of premodern era. The question is that in the context of historical demographic transition, how would you like to categorize the developing countries? And what path do they follow while moving towards the low fertility and low mortality values? I would like you to answer this question especially with reference to Pakistan.

Prof. Coale: In general terms, the difference in the Third World situation today and that in Europe in the 19th century is that, first of all, the reduction in morality that occurred gradually in Europe is occurring in a much shorter time in the Third World. In Europe, the sanitary habits changed veiy slowly, and medicine was ineffective. A medical historian said that it wasn't until late in the 19th centuiy that a European improved his chances of survival by seeing a doctor, and it wasn't until the 20th century that he improved his chances of survival by being in a hospital. The doctors used to bleed and purge their patients and do all kinds of things that were probably bad for the patients rather than good. The progress of curative medicine itself didn't contribute very much to the prolongation of life until after the 1930s, with the coming of chemotherapy and antibiotics, although I guess a lot of help came from earlier vaccines. In contrast, there began in the 1930s a period of genuinely scientific medicine and effective scientific medical technology with antibiotics and insecticides, chemotherapy - really extraordinarily sustained and effective improvements in medicine. Much

research was directed to tropical medicine; there has been a worldwide international development of effective preventive and curative medicine that can be imported at fairly low cost. The mortality part of the transition in

mortality can be reduced does depend on general social progress. That means that the high growth rate that gradually developed in Europe (never as rapid as growth in the Third World now) came about through the gradual introduction of lower mortality. The current situation and prospects of the LDCs include serious implications of rapid growth, precisely because it is more rapid than that in 19th century Europe. There may be a corresponding difference in the pace of reduction in fertility. There is a possibility of a more rapid introduction of the decline of fertility through modern communica-

Thio possibility may be the hardest to realize, not in Pakistan, but in Tropical Africa. In the Pakistan Fertility Survey, nearly 50 percent of women who had 3 children said they wanted no more, and two-thirds of those who had four living children said they wanted no more; so that there is at least a verbal expression of an interest in having fewer children, which suggests that with the proper kind of education and provision of facilities, there is a latent demand for reducing fertility ih a parity-specific way. In Tropical Africa, in Kenya, Senegal and Ghana, the same World Fertility Survey's questionnaire shows that not until 8 or 9 living children do as many as 50 percent of the women say they want no more. With 8 living children, more than 50 percent say they still want more. It seems to me that it is going to be a long time, starting from such strong attitudes in favour of additional childbearing, before anything is likely to happen to the birth rate. Kenya's current rate of population increase is nearly 4 percent. I think it impedes development if the GNP must increase by 4 percent eveiy year just to stay even; but that is an issue I want to take up tomorrow.

Dr Sultan Hashmi: Professor Coale, first my regards, and then my compliments for a very informative lecture. If we view the current demographic situation in the developing countries and then look at the theoiy of demographic transition, which was developed on the basis of the

data in Europe, do you think that the situation is very different? For example, in Europe the development of technology was indigenous, whereas in the developing countries it is mostly being transferred from the developed countries. In those days, there were no developed countries from which to transfer technology. Secondly, today the less developed countries have the organized family planning programmes making their services available at the doorstep, which was not true of most European countries of those days. Thirdly, the modern contraceptives, which are available today, were not available in those days. Also the pressure of family size is greater now than it used to be in the Europe of those days. So viewing these factors, do you think that the theory of demographic transition which was developed in Europe is quite applicable to the conditions which prevail now? I have another question with regard to muslim fertility. You referred to the differentials in Soviet Russia. Now, if the other factors, such as the level of education, the level of income, the level of monetization, and the fear of being a minority, are controlled, what are the differentials between the muslim and the other provinces?

Prof. Coale: I want to return your greetings. I like to see the face of an old friend. You're asking me, in effect, to give a new lecture. I think I agree with the general premise that underlies your first set of questions. I think it is indeed a very different environment. Professor Hermalin put it very nicely in talking about the applicability of the history of fertility decline in Europe. He said that the Third World has to move from the 18th century to the 20th, but there is no need to make it go through the 19th. The factors that you mentioned are exactly the reasons why it may not be necessary. It is true that not only has mortality reduction been more rapid; there is the possibility of a more rapid and an earlier reduction in fertility for similar reasons – because of the availability of modern methods of contraception and techniques of communication and education that simply didn't exist in the old times. In Europe, changes in motivation were more important than a new technology of contraception. The decline in fertility in many parts of Europe occurred before rubber was vulcanized, so that the control of marital fertility was not by condoms or diaphragms, but by *coitus interruptus*. The European experience does not mean that effective contraceptives make no

difference. New forms of contraception require less motivation to be used effectively. For example, the IUD requires a single insertion; then there needn't be constant care and precautions taken unless it is removed. In countries where it is acceptable, and in many it is, the use oftubal ligation or male sterilization means that further precautions are not needed. So the need for sustained motivation is less. Certainly it is true that education and government programmes can make a difference. The countries listed in Table I are proofthat fertility can go down much more rapidly than it did in any ofthe European areas, just as mortality did. My concern, especially with regard to Tropical Africa, is that there is resistance of one sort or another to Lhe reduction of fertility, including a pro-fertility tradition that is probably stronger than it was in most of Europe. There need to be new ways to speed ihe process, because I think the very high growth rate makes the situation more acute.

In answer to your question about the Central Asian Republics in Russia: I wasn't comparing the fertility in those areas to the fertility in the rest of Russia; I was just commenting that their fertility is veiy high, given their education and low mortality. Consider the view that I sense is present among many people here, that development is the best contraceptive. I think iL is going to be a long time before many ofthe areas we are talking about can hope to match the development level of the Central Asian Republics, with 90 percent ofthe women 20-29 literate, and a crude death rate of about 6 or 7 per thousand. It is remarkable that so much social change has taken place without fertility changing. I know veiy well that the economic conditions in those republics are not as favourable as those in Latvia or Estonia.

Perhaps one of the reasons for the maintenance of high fertility in Central Asia is a conscious resistance to the Russification of those populations. That is, they resent the closing ofthe mosques, and they resent the attempts to transform their culture, and defensively they stick to their old customs.

Mr Yasin Soomro: While describing demographic transition, you cited

examples of the fertility decline in some European countries and in the United. States. I think the real anomaly is in describing the postwar baby boom, for which Easterlin has tried to give some explanation: that it was the work of the cohorts of the 20s and the 30s, and to test that we have to wait for another thirty years. I would like to know your views on the United States postwar baby boom in the light of the demographic transition theory. Another point is the restatement of the demographic transition theoiy by Caldwell in terms of the inter-generational flow of wealth. I would like to know how far this theoiy works in terms of old age security, especially in the South Asian countries.

Prof. Coale: I'll see if I can recall your questions and answer them as best I can. First, with regard to the baby boom, it is a demographic phenomenon that requires explanation. I feel the necessity to explain it because one of my early professional activities was to construct the population projections in 1941 for a book called *The Future Population of Europe and the Soviet Union.* I foresaw a continuation of the decline of fertility in all European countries. Instead, fertility rose sharply. The baby boom happened in Europe as well. Demographers looking at the history of the demographic transition up through the 1930s expected a continuation of the decline, because the practice of effective parity-related control had not diffused through the whole population. There are elements in the population that had not yet begun to control fertility, and we expected they would. The baby boom was an unexpected phenomenon, the kind of humiliation that people need once in a while to make them realize that not everything is certain. But it is not really a contradiction of the demographic transition. I say that because the demographic transition postulates a development of voluntary control of fertility within marriage as a characteristic of a highly modernized society. Voluntary control was not abandoned. People did not give up birth control; they chose to have more children. The principal factors were that marriage became earlier and more universal, the first child became much more universal, and the second also more frequent. But the fraction who went from a third to a fourth never increased. The fraction who went from a fourth to a fifth, and from a fifth to a sixth continued to go down. Very large families did not come back in style. What needs to be explained is not a

return to a traditional society in which people didn't control the number of children, but why, while controlling, they chose voluntarily to have more, and to get married earlier? Easterlin has an explanation that I think has some merit, although I don't agree that there is going to be a self-sUstaining cycle of ups and downs as he suggests. On Caldwell's inter-generational transfer: yes, I think that argument is sensible. It is actually not so very different from the standard transition theoiy. In fact, Notestein said that children go from being an asset to an expense, which can be rephrased as saying that the transfer of income used to be from the children to the parents because they were worth more than they cost, and now it is the other way around.

What do Caldwell's ideas imply for South Asia? One question is the extent to which high fertility is based on a calculation of how many children one needs in order to have old-age support. It is an appealing theoiy. There has been one study in Taiwan that verified it, in that there was a positive association between the intended family size and the strength of the belief that it was the son's duty to support the parents. But I'm not sure how strong that motivation is, and how explicit it is. One answer is that modernization tends to weaken this motive, too, because ofthe development of more effective provisions for old age. Professor Kenneth Boulding was asked many years ago whether people have children in order to be supported in their old age. He replied that he had made a study of the economics of philanthropy and generosity, and that as a result he did not allow himselfto think about how much he had spent in raising his children. He said it would be too depressing. Then he added, ". . . and as far as my old age is concerned, I'm depending on TIAA and GREE". (Two faculty retirement schemes).

Mr Naseem Farooqui; I have a feeling there is a confusion in the developing countries that their mortality has declined to such a low level that in accordance with the demographic transition theoiy it should have been followed by a decline in fertility. Keeping in view the problems of data in reflecting the levels and changes, it seems that the mortality decline may not have been as fast as the data-generating agencies and even the international agencies have been showing. It seems that mortality levels have yet to

decline to a level from which a consequent decline in fertility would follow.

Prof. Coale: I mentioned earlier the disappointing levelling off of the decline in mortality (and the corresponding rise in life expectancy). I agree that mortality projections by the U.N. and WHO and others have overstated the rise in life expectancy in the LDCs. As I will say tomorrow, in making population projections for India 25 years ago, I anticipated a rapid increase and then a tapering off in the expectation of life at birth. The point is that, with a certain minimal change in the organization of society, slight improvements in education and health facilities, a reduction in mortality from certain causes of death can be rather easily attained. These possibilities have been realized and the additional gains are harder to make. I think that is the situation that Pakistan is in now. Unless there are further radical changes in medical technology, it is going to be difficult to raise the life expectancy much above the current 52 years, or to get the death rate below 13 or 14 per thousand, because to do so would involve changing the sanitary habits of the public, and to have everyone use latrines, dig wells, and so on. As a tourist with a sensitive stomach, I know that in travelling in Pakistan, if I make a single mistake and drink water from the public supply, I am going to get sick. Babies have that happen to them as soon as they get supplementary feeding. There may be radical further improvements in the form of new treatments that come from the fundamental biochemistry that is just now being explored, which might make illnesses caused by viruses as readily treated as bacterial disease. I talked to a doctor from the Harvard School of Public Health many years ago who had worked in a jute mill north of Calcutta, as the company doctor, so to speak. While there, he had analyzed stool samples from every worker. One hundred percent had intestinal parasites, and the mean number of different parasites per person was five. The management was upset because they provided dormitories for the workers with flush toilets and clean water; but the workers went home to their village over the weekend. Doubtless, a similar situation exists in many villages in South Asia now. Until the situation is changed or a cure is found for such infections, further mortality reduction will be slow.

SUMMING UP

Mohammad **Afzal**

SUMMING UP

Mohammad Afzal

Professor Coale's first lecture and his answers to various questions thet followed provide an excellent exposition of the process of demographic transition in Europe and its relevance to the population dynamics of less developed countries. Regarding the interaction between population and development as a focus of his two lectures, Professor Coale selected the phenomenon of demographic transition and its implications for the current demographic prospects for less developed countries as the theme of his first lecture to describe how development affects the evolution of a population. In the second lecture, he discusses the effects of population trends on development.

The European demographic transition, for which the stage was set by the Industrial Revolution, was a demographic phenomenon which replaced the pattern of veiy low population growth rates, maintained over centuries by high levels of birth and death rates, by a new type of equilibrium of low growth rates brought into being with a significant lowering of mortality and fertility rates. This transition, according to Professor Coale, was initiated in the middle of the eighteenth century with the technical breakthrough coming as a result of the Industrial Revolution. This Revolution helped to bring about the necessary infrastructural changes, such as increased agricultural productivity for expanded food supply, improved means of transportation to facilitate migration, better medical facilities and sanitation alongwith provision of clean-water supply to improve health conditions, which had a rather prompt response in reducing the death rates.

In the European premodern era the economic organization of relatively self-sufficient agrarian communities revolved predominantly around the family, which encouraged the bearing of more children for support and security. In that era, there was little scope for an individual's advancement because in the peasant societies of those days the family as a whole was a more secure and important social and economic unit than an individual. This type of set-up of high mortality risks was maintained by the cultural and social norms, religious beliefs, and customs. It was, therefore, veiy difficult for an individual or a family to deviate from their traditional economic and social role. With the Industrial Revolution, entirely new possibilities opened up, under which families and individuals could survive independently and strive for their economic and social advancement. Thus the Industrial Revolution was a societal transformation, from traditionalism towards modernity, under which people' gradually started to break away from the pressures of conformity and other constraints linked with the social and economic life in the rural-agricultural setting. All this was to prepare themselves for an industrialized and urban way of life which held the promise of enhancing their economic and social status. The most important feature of these changes, for demographic transition was the lowering of the inducement to have many children and the adoption of the new ideal of small family size. This was considered to be a requirement under the changed circumstances because of the higher social and economic cost of rearing of children and providing them for a long period of time the requisite education and other skills needed for their employment. The other important reason for realizing the need for exercising control over reproduction was to nullify the rapid increase in family size, which was taking place due to the falling of death rates.

The decline in mortality which preceded the decline in fertility created a lag, which resulted in the rapid growth of populations during the nineteenth and early twentieth centuries. While France was among the earliest initiators of fertility decline in the late 18th centuiy, in England and some other countries fertility started to decline after 1870. Professor Coale mentioned that in about half of the European populations fertility began to decline as late as the 1890-1920 period. The delay in the adoption of small

family norms in most of the European populations was, of course, linked with the varied time taken by different populations in breaking the age-old inertia of social and economic institutions for a universal adoption of contraception, in spite of.the fact that some forms of contraception are known to have been practised for centuries.

Professor Coale has pointed out a surprising feature of some selected 18th centuiy pre-industrial populations of Europe: the fact that their total fertility rates were just above 4. He has also given similar examples of pre-industrial rural China (1930) and India (1906) with their respective total fertility rates as 5.5 and 6.2, although in their case marriages were taking place at much younger ages.

Professor Coale says that the levels of premodern "natural" fertility, in spite of being unaffected by any parity-related methods of restriction, were not uniform in all the populations. In explaining the mechanism which did not let their fertility levels go veiy high even without the use of contraceptive practices in whatever form they existed in those days, he gave the example of the populations of Western Europe where the customs of delayed female age at marriage and permanent celibacy kept only half of the females in reproductive ages exposed to the risk of child-bearing. For the majority of the populations in the rest of the world, where marriage was nearly universal and females were married at veiy young ages, like India and China, fertility remained substantially lower than the highest levels observed for some countries. Here the mechanism of restriction was prolonged by intensive breast-feeding, pathological sterility due to various diseases, abstinence from intercourse during the period of breast-feeding or due to periodic separation of spouses, etc.

From the above examples it is clearly implied that premodern fertility in most of the world populations remained much below the real natural upper limits without any deliberate effort on the part of the spouses to keep the number of their children at any specific limit (i.e., parity-related control of fertility). Thus it was the decline in mortality, and not so much the already existing moderately high fertility, which subsequently led to the

beginning of parity-related control of fertility in Europe during the transition period (using whatever methods of contraception were available at that time). However, the technical advancement after the Industrial Revolution also led to the development of improved means of contraception, the availability and use of which gradually led to a more effective fertility control. The universal declines in fertility, which were ultimately achieved in the populations of the developed countries, were thus a parity-related control of marital fertility through the use of a variety of modern contraceptives and also by induced abortions.

The study of fertility decline through the European Fertility Project showed that the change in motivation from having more children to a preference for a smaller number of children through contraception came with the social and economic transformation and the gradual spread of knowledge of effective contraceptive techniques. Professor Coale pointed out that the importance of cultural factors is also supported by the more recent rapid fertility declines of fifty percent or more in some less developed countries (less only in a relative sense) like Singapore, Taiwan, China, South Korea, Cuba, etc. Such unprecedented fertility declines were achieved by a combination of major increases in age at marriage, abortion, and the use of modern contraceptives made available by effective family planning programmes.

In explaining the implications of the European demographic transition for the less developed countries, Professor Coale pointed out that mortality declines in the less developed countries during the twentieth centuiy have been much more rapid than in the past, due to the combined impact of the transfer of technology in medicine, sanitation, agriculture, transportation, and communications. Similarly, the decline of fertility from moderately high to low levels has also been brought about more rapidly than in the past. Professor Coale, however, emphasized the role of culture in combination with a major increase in age at marriage, a wide practice of modern contraceptives made available through efficient family planning programmes, and abortion, in sustaining the unprecedented speed of decline of fertility in these countries. He said that in the European experience the

differentials by cultural variations were clearly indicated in the impact of social and economic changes on fertility. Particularly, there was a strong cultural influence on the time taken by married couples for initiating the measures for the control of fertility. In this connection, he gave the example of some parts of Italy, where initiation of contraception was slow because of the adherence by people to the traditional Catholic attitudes.

Professor Coale made the important point that rapid declines in mortality have taken place in the less developed countries irrespective of the pace of industrialization, but such is not the case for fertility decline in many of these countries. In other words, the fertility reduction part of the demographic transition in the less developed countries is still lagging far behind the mortality part. Pakistan is among such countries, where life expectancy has nearly doubled but there is only a slight reduction of fertility, which, perhaps, has been due more to recent increases in the age at marriage. He hoped that there would be a possibility of a more rapid decline of fertility in Pakistan by making use of modern contraceptives, because the Pakistan Fertility Survey (1975) shows that there is a latent demand for reducing fertility in a parity-specific way. He considered that a conscious choice of parity-related reproduction on the part of couples, a firm realization of the lower number of children as being advantageous, and the availability of effective contraceptives were the pre-requisites for a sustained reduction of fertility. He made the important point that economic development, as such, would not lower the birth rates unless it was accompanied by an appropriate cultural change. In this regard, Professor Coale also emphasized the need for adopting a more rational attitude towards the choice of having a lower number of children who are better educated and trained. By learning from the experience of those less developed countries where large and steep declines in fertility have already taken place, the need for effective family planning programmes at the government and non-government levels and incentives favouring a lower number of children were also suggested.

But I believe that while cultural factors may have contributed to the veiy fast declines in fertility in developing countries - especially Singapore, Hong Kong, Taiwan and South Korea - the role of the economic and social

transformation as an important factor in inducing appropriate cultural norms should not be underestimated.

Lecture II

POPULATION GROWTH AND **ECONOMIC DEVELOPMENT:** COALE AND HOOVER **RE-EXAMINED AFTER 25 YEARS**

Lecture II

Population Growth and Economic Development: **Coale and Hoover Re-examined after 25 Years**

INTRODUCTION

Today I shall talk about a relation complementary to the one discussed yesterday. Then the subject was the effects of social and economic development on population trends; today the topic is the effect of population characteristics and population growth on development. The framework for this discussion is a study conducted more than twenty-five years ago. This research project was actually started by an initiative from outside the university where I teach.

Eugene Black, the president of the International Bank for Reconstruction and Development, had felt beginning in the early 1950s that the Bank should tiy to persuade any developing country applying for a loan that a lower birth rate would improve the likely success of its development plans. I am not sure what the basis of his conviction was. He asked Professor Notestein, who was then the Director of the Office of Population Research, to write a pamphlet explaining the advantages of lower fertility; the Bank could then use this pamphlet in negotiating with its clients. Notestein's reply was that there was not enough known to write a sensible pamphlet. If the Bank was interested in having a cogent statement, it should support research to provide a better understanding of the effect of population trends on economic development. The Bank then offered to provide financial support for just such a study.

At that time I had returned to the study of demography after a long period of working on other topics, and had rejoined the Office of Population

Research. I was happy to address myself to this question, which was an important issue at the time as it is still today. An arrangement was made whereby I would concentrate primarily on the demographic aspects of the relation between population growth and economic development. It was agreed that the Office of Population Research would in addition employ a qualified economist to serve as a partner in this enterprise. We were fortunate to find Edgar M. Hoover, who had been a Professor of Economics at Michigan, had served on the President's Council of Economic Advisers in Washington, and was prepared to leave the government position he then held. He agreed to serve as the co-investigator on the project. Together we devised a research plan, put it into operation, and in two or three years completed the study.

THE COALE AND HOOVER STUDY

The general plan that we generated was a hypothetical comparative study of the future. The hypothetical aspect was the different assumptions we made about future population trends. We tried to make the project realistic by beginning with actual populations and actual economies. The two economies that we decided to study were those of India and Mexico, and these were chosen because their population size was very different and each was at a different stage of development in terms of per capita income and the rate of economic growth already achieved. Our idea was to postulate for each countiy two different courses of the future development of the population, and to calculate what the development of the economy would be in these two different contexts.

Before I describe our strategy in more detail, I would like to say something about the tone of the discussion current at the time we began our research. As is still true today, there were then two opposing schools of thought on the implications of population growth for economic development in less developed countries. One position was that the continuation of population growth, even for a short period, produces calamitous effects in the developing countries. The pessimists viewed such countries as already suffering from overpopulation. They believed that continued growth would

be disastrous. The opposite point of view was to deny any adverse consequences of population growth and to say that the problems of poverty in the less developed countries had other origins - the effect, for example, of colonialism. What was needed (according to this second point of view) was a redistribution of income, an effective economic plan, government ownership of the means of production, and so on. From this position it was felt that concern for population was misplaced because it did not really constitute a problem. There were debates between these two positions, with neither side listening to the other. We decided to take a different approach.

We did not tiy to show that population growth was catastrophic, or that it was not a problem at all. Rather we asked how much difference it would make if a population (either of India or of Mexico), were on the one hand, to continue to have an unchanging birth rate (or unchanging total fertility rate, to use the measure that I introduced yesterday), and, on the other, it were to reduce fertility by fifty percent in twenty-five years. We were not saying there was going to be a catastrophe if fertility were unchanged, nor saying that a paradise would be achieved if it were reduced, but only tiying to determine how much difference it would make if fertility were reduced as opposed to maintained.

As a further preliminary, I want to repeat a point that I made yesterday and to push the point to a deeper level. The point was that a long continued growth of population is impossible. Over the 100,000 years of human life, the average rate of increase was necessarily veiy little different from zero. Even a veiy low rate (such as one per thousand per year) would have been a physical impossibility. This is a general point with implications for considering the future as well as for analyzing the past. If you will indulge me, I shall illustrate the underlying arithmetic.

The natural logarithm of 2 is equal to 0.693. Consequently, if r is the annual rate of increase in population, and T is the number of years during which this growth rate prevails, whenever rT is equal to 0.693, the population will have doubled: Alternatively, the time for a population to double is 0.693/r. In Pakistan, the growth rate is about three percent per

year. If we divide 0.693 by .03 we get 23: therefore, the population of Pakistan would double every twenty-three years at the current rate of increase. The next piece of arithmetic is that 2 raised to the tenth power is 1024, or approximately one thousand. If a population doubles ten times, it is multiplied by a thousand. At a growth rate of three percent, the population doubles eveiy twenty-three years; it doubles ten times and is multiplied by a thousand in 230 years, by a million in 460 years, and by a billion in 690 years. That is a mathematical result that cannot be denied. At a three percent annual rate of increase, there would be one Pakistani for eveiy square foot of the earth's surface, including the ocean, in five hundred years. This of course will not happen; the calculation shows that the population of Pakistan cannot grow for five hundred years at this rate. It is not that such growth would be unfavourable; it is a physical impossibility. In a thousand years, if a three percent growth rate were to continue, the Pakistani population would outweigh the earth. Even with economic miracles, endless green revolutions, and limitless new sources of energy, the population cannot continue to grow at three percent a year for very long. It is a physical impossibility. At three percent annual growth, in 5,800 years the Pakistan population would exceed the total number of atoms in the universe, assuming it consists of a trillion galaxies, each containing a trillion stars 100 times as big as the sun.

To repeat: in the long run, either the birth rate will come down or the death rate will go up. If you are opposed to one outcome you must be prepared to accept the other (in the long run). The expectation of life at birth of more than 70 years now attainable under favourable conditions can be maintained in the long run only if couples have an average of a little more than two children.

That, however, is the case in the long run. One cannot say that a growth rate close to zero is essential in the short run; it was in the fairly short run of 30 years that Hoover and I examined alternative prospects. Our intention was not to predict the future course of fertility but merely to suppose, on the one hand, that fertility would remain constant, and to suppose, on the other hand, that it would fall by 50 percent in twenty-five years. Those alternative

suppositions or assumptions, about fertility were combined with a best estimate of what was likely to happen to mortality in order to generate from the initial population recorded in a census the projected future population, including its age composition. We made a single estimate of how mortality would change, as realistic an estimate as we could construct.

I will digress to describe the basis of our mortality assumptions. The mortality projections are relevant to the discussion yesterday of the levelling off of the increase in life expectancy in Pakistan. We foresaw just such a slowing down of mortality reduction in our projection for India. In estimating the likely future course of mortality in India, we began with a calculation of the approximate expectation of life at birth at the time of the most recent Census, in 1951. We assumed that after that date mortality in India would he affected by the nationwide anti-malarial campaign that was being implemented as part of the First and Second Five-Year plans in India. For guidance on what, effect on mortality that anti-malarial campaign might have, we examined the impact of the anti-malarial campaign that had taken place in Sri Lanka from 1946 to 1950. This campaign played a big part in the 50 percent reduction of the death rate that occurred in Sri Lanka in only three years. By comparing the extent of mortality reduction in Sri Lanka with the prevalence of malaria, province by province, before the campaign, we estimated what the impact of the campaign had been. Then we assumed that in a decade the effect of controlling malaria on mortality in India in every region, subject to endemic malaria, would be the same as the effect had been in Sri Lanka. We also postulated a reduction in mortality from other kinds of public health campaigns by examining the effect of such campaigns in other low income countries, where they had been implemented. In this way we made an estimate, partially based on empirical evidence of the reduction in mortality, that could be expected in India in the 20 years beginning in 1951. On the basis of our discussions with public health experts, both in India and elsewhere, we concluded that further reductions in mortality after 1970 might be hard to achieve. We estimated a more gradual increase in life expectancy after 1970, in the belief that the easier measures, such as innoculations and the reduction of malaria and plague by insecticides, would have had their effect by then. These improvements could

be achieved at a low cost and with a modest infrastructure, but further improvements would require changes in the sanitary habits of the population, which we thought would be much slower coming; so we postulated a rise in life expectancy that would level off. The expectation of life for India in 1951 was approximately 32 years. We estimated that by the 1970s it would rise to 52 years and subsequently increase only very slowly.

On the other hand, in Mexico the expectation of life was already 55 years in the mid-1950s, higher than we thought it was going to be in India by 1980. In Mexico a wholly different tactic was used in estimating the future trend of mortality. We looked at the rise in life expectancy typically from before World War II until the early 1950s, or from the late 1940s until the mid-1950s, in countries in which mortality was accurately recorded. We then examined the relation between the average annual increase in life expectancy and the level of life expectancy. There was a veiy close correlation. The higher the life expectancy, the more slowly it rose; and the lower the life expectancy, the more rapidly it rose. The relation between the annual increase in life expectancy and the level was linear. This linear relation between the rate of increase and the level of expectation of life implies a single general path along which the expectation of life rises.

The general form of this path is that it rises steeply when the expectation of life is low, and has a more gradual slope as life expectancy increases. The assumption of a linear relation between the level and the slope implies that ultimately the slope becomes zero, defining the upper limit or upper asymptote of the curve. The upper limit so determined is 84 years for females and 76 for males. These still seem sensible estimates of the expectation of life that might be reached in the next few decades in Japan, Western Europe, or New Zealand.

This general relation provides a veiy easy way of making a projection of mortality because it postulates a quasi-universal curve of increasing life expectancy. All we had to do was to determine where Mexico lay on the curve in 1955; we could then assume that its expectation of life continued to rise along the standard curve for the next 25 or 30 years. Mexico was much

farther along in general social and economic development than India, and in particular was much farther along in its improvement in mortality. We felt, that it would continue to follow the time path of increasing life expectancy that had characterized the recent history of the more developed countries as they capitalized on the scientific improvements in medicine that had occurred between the 1930s and the 1950s.

We combined a uniform assumption about the expected improvement in mortality with two alternative, totally arbitrary, assumptions that fertility would remain constant or it would be cut in half

How did we use these assumptions for population projections to illuminate the relation between population growth and development? For simplicity, I shall concentrate on India. The calculated future evolution of the Indian population under these two different assumptions provided more than the mere projected increase in the total size of the population; it also generated alternative age distributions. In fact, the difference in age distribution is a major feature of the alternative projections. Since the mortality assumptions are the same, after 30 years the population over 30 is exactly the same in the two projections. The only difference between the two is in the number of persons under 30. Because fertility is the same at the outset and then diverges continuously, the principal difference in the projected populations at the end of 30 years is in the child population. After 30 years, one population has a birth rate half as high as the other, so it is producing no more than half as many children (actually less than that because of somewhat fewer mothers). The age compositional difference is crucial. There are fewer children in the low fertility population, not much difference in the number of adults, and *no* difference over 30. One implication of these projections is that during the first 30 years there would be no consequential difference in the size of the labour force between the two populations - a large difference .develops in the long run but not over the first 30-year period. In the projected populations, in the 30th year there are 9 percent more persons in the age range from 15 to 64 in the high fertility population. It is not fully accurate to say that there is no difference after 30 years in the projected number of persons between 15 and 64. However, this

nine percent difference would be offset by the greater availability of women for participation in the labour force. That is, in the projected low fertility population where there are 9 percent fewer people 15-to-64, the women would at that time be having only half as many children. If there is any demand for more persons in the labour force, there would be a greater supply of women to help meet that demand. In our economic analysis over that first 30-year period, we, therefore, ignored the slight projected difference in the number of persons of labour-force age.

There is no reason for supposing any differences in natural resources - the land, minerals, and other resources available for use would be the same. In a simple aggregate neoclassical analysis of an economy, the three factors of production are land, labour and capital. The supply of labour is not consequentially different; the land and other resources are no different. But what about capital? The question is what difference would it make to the capacity of the economy to generate additional capital, whether fertility were reduced or not. It is easier for an economy with fewer dependents (i.e., the economy associated with the low fertility population) to mobilize savings, or to divert resources from consumption into investment. With the same labour force and the same land, the question is, how much national output could be withheld from consumption and added to investment? If there are fewer claimants (consumers), it should be possible to mobilize a larger fraction of the gross national product each year. We used an aggregate economic model, in which it was assumed that the increment in savings per equivalent adult consumer would be proportional to the increase in per consumer income. That is, we invoked a constant marginal propensity to consume on a per consumer basis. On the assumption that the increase in savings per consumer would be proportional to the increase in income, we estimated the investable funds that would be generated. We also allowed for differences in the productivity of capital investments that arise because some of the capital investment is used for social overhead purposes, i.e., for housing, education, health expenditures, and so on. These outlays are productive but at a lower level of productivity, or with a delayed effect. For example, investment in education may be an essential long-run investment, but it takes a while for educated primary school students to increase overall productivity, because of

the interval before they enter fruitful employment. Making allowance for differences in the savings rate and in the productivity of capital, depending on the number of dependents that had to be supported, we came to a conclusion which was at first a surprise: that the economy in which the birth rate had been reduced would have a larger increase over this 30-year period in gross national product than the population that did not reduce its fertility; not on a per capita basis, but in the aggregate, with same labour force, the same resources, and a slightly higher investment level. On a per consumer basis, the difference was substantial not astonishing, but substantial.

That was our basic calculation, using the same assumptions about capital-output ratios, uniform assumptions about a savings function, and sensible assumptions - we thought - about the allocation of capital. Putting this together in a simple Harrod-Domar model for the growth of the economy, we came to a conclusion that surprised us: that the growth in national product would be somewhat greater in the population that reduced its fertility. I hasten to add that this conclusion holds only for the first 30 years. Going beyond that, where allowance must be made for the greater increase in the labour force, it is no longer true that the aggregate output is greater in the low-fertility population.

The principal result of our analysis can be summarized as follows:

Over a 30-year period, there is a somewhat greater increase in the aggregate output with reduced fertility, and substantially fewer consumers to divide the output. We did not summarize our calculations on a per capita basis because that would be unfairly favourable to the low fertility case. There is a substantial difference in the projected total populations, but the difference is mostly children, and children do not consume as much as adults. We counted each child as only half an adult consumer and converted children into equivalent adult consumers with a weight of one-half. We calculated the increase over the 30-year period in aggregate income per equivalent adult consumer with children counted at 50 percent. With high fertility let us say that the income per adult consumer works out to some number 'X'. Our calculations showed (depending on what assumptions we

made - about capital-output ratios and marginal savings rate and other estimated parameters) that if the income per consumer would rise to a value 'X' with no change in fertility, it would rise to 1.3 to 1.5 times 'X' if fertility were reduced by 50 percent. In other words, to take the central figure, there would be about a 40 percent greater increase in per consumer income if fertility were reduced than if it were not. 'X' was a figure that we determined, but it really was not a crucial part of our argument. We did not find that 'X' was going to be less than per consumer income at the start, in the projection with no change in fertility. Actually, we calculated that there was going to be quite a substantial increase in per consumer income over the next 30 years in both economies even if fertility did not change. But if fertility were reduced, the income would be 40 percent greater than would otherwise be attained. Some of our critics have rightly said that 40 percent is not a veiy big difference - a 40 percent increment in 30 years with compound interest is not much more than one percent additional per year. This is a surprisingly small difference. Thus we did not contend that population change is the most important single element in development. In the intermediate time perspective of about 30 years, there is an additional gain of about one percent a year obtained by reducing fertility. Sooner or later fertility must be reduced, if mortality is not to increase; in the first generation there is a gain of about one percent extra a year by reducing fertility as opposed to not reducing fertility.

Before I see how this argument stands up after 25 years, I shall take note of some criticisms that have been made. The criticism that I feel is the most cogent, and that most needs to be acknowledged as correct (at least in some economies), is that in applying a marginal savings rate to increases in per consumer income we are, by implication, assuming that the source of savings is within the households. But in some economies corporations are a dominant source of savings. Savings are generated by increases in corporate income rather than by increases in household income. Persons with high income in Mexico who might supply much of the savings already had low fertility, so changes in family size would not have as large an influence on the development of savings as we postulated. Note first that the major part of the gain in per consumer income comes from a smaller denominator

rather than a larger numerator. The larger numerator was a surprising part of our conclusions, but the argument does not fall apart without that feature. Secondly, even in Mexico there is a non-negligible potential for the greater mobilization of savings and a higher level of investment with lower fertility, even though low-income private households may not be a major source of savings. There is another element in the equation, which is the division of the national product between savers and non-savers. In Mexico, there is surely concern in the government for the welfare of the low-income segment of the population. If the impoverished segment of the population that generates veiy little savings had twice as many children, there would be a diversion of more of the national product to provide a minimum level of living. A safety net to avoid the potential deterioration of living standards would mean a diversion of more of the national product to non-savers.

Another criticism is that the absence of a difference in the labour force - because the population 15-64 is only 9 percent different and women can contribute more - ignores the contribution to the labour force of the children themselves. In developing countries, children start helping with farm-work and caring for younger siblings at an early age; they do contribute. It is a veiy pessimistic argument to assume that over the next 30 years children are going to make a major contribution to the labour force. They are not highly productive; and with reasonable social progress, they will be in school. In short, it is already conceding that development is not going to be very extensive if there is a large allowance for the contribution of children to production.

PROJECTED ESTIMATES AND ACTUAL EXPERIENCE

Now I want to turn to a more concentrated look at how our analysis of the development of the population and the economy in India and Mexico looks now that we have their actual experience over a 25-year period to consider. First, the population projections, in which no change in fertility is assumed, are remarkably close to the actual population change in both countries, at least until the mid-1970s (see Table 2). In both populations, the projected high-fertility population exceeds the *ex post facto* estimate (or

Table 2

Comparison of Projected Population in India and Mexico with Census Data or After-the-Fact UN Estimates

Total Population (in million")

	Mex			India	
	UN Estimates (or Census)	Projected (Coale & Hoover)		UN Estimates (or Census)	Projected (Coale & Hoover)
1955	29.7	30.8	1956	394	390
1960	36.9	36.1	1961	436	430
1965	43,4	42.4	1966	493	480
1970	51., 2	50.1	1971	548	540
1975	60.2	59.5	1976	613	610
1980	68.2	70.9	1981	685	002

enumeration) only at the last date (1980 or 1981). In both instances, there seems to have been a substantial decline in fertility, in India after about 1970, and in Mexico after the mid-1970s, so that population increase finally fell below the high fertility projection. *Ex pdst facto* estimates of the birth rate and death rate in India, by decade, are compared with the high fertility projected rates in Table 3. The projected birth rate declines from 44 to 40 per thousand because the fall in mortality reduces the proportion of the population consisting of women of child-bearing age; thus the projected birth rate is reduced even though fertility rates are assumed constant. The actual decline in the birth rate from the 1960s to the 1970s was greater than the projected, because a reduction in fertility had begun in the later decade.

The accuracy of these projections is a result of two features: the single set of estimates for each country of the future evolution of mortality, intended to be as good an evaluation of prospects as we could make, was close to the actual evolution of mortality; and the assumption of constant fertility, intended only as a tactic in constructing a demographic-economic model, also was close to the actual fertility trend, at least for about. 20 years.

Table 3

Comparison of ex post facto Estimates of Birth Rates and Death Rates in India with Projected Rates

	Births per Thousand Population		Deaths by Thousand Population	
	Ex post facto Estimates	Projected	*Ex post facto* Estimates	Projected
1951-1960	43	44	24	26
1961-1970	41	41	19	19
1971-1980	36	40	14	17

It would be gratifying to claim nearly perfect foresight, but the fertility component of these accurate projections was not intended as prevision of the future. Moreover, any tendency to feel gratified is destroyed by the conclusions of our economic analysis. The projection that comes so close to the actual development of the population is the projection associated with the less favourable course of economic progress.

The surprising validity of the high fertility population projections implies veiy little about the correctness of our economic argument. Wholly fortuitously, our estimate of the growth of GNP in India when fertility was assumed constant was not very different from the *ex post facto* estimates. The World Bank estimates an annual rate of increase of GNP in India of 3.4 percent in the 1960s, and of 3.6 percent ifi the 1970s; our estimates were 3.35 and 3.4 percent for these decades. But there are no after-the-fact data on the economic progress that might have been made if fertility had been reduced by 50 percent beginning in the mid-1950s.

Let us look more closely at changes in Mexico from the 1950s to the early or mid-1970s. Before any large decline in fertility, social and economic progress was remarkable.

In Table 4, selected data show aspects of the growth of the Mexican population and social and economic progress in Mexico. The increase in the population 6-to-14 - the school-age population - was even greater than the increase in the total population. The number of children attending school was multiplied by 3.56 in a twenty-year period - an extraordinary increase. The percent attending rose from 37.5 to 64.4. There was also a large increase in the literate population and a big reduction in the proportion of illiterates.

Table 4

Selected Changes in 20 Years from the 1950s to the 1970s in Mexico

	1950s	1970s	1970s Figure/ Figure 20 Years Earlier	Dates Used
Total Population	29.7 Million	60.2 Million	2.03	1955 - 1975
Population 6-14	6.0 Million	12.4 Million	2.07	1950 - 1970
Attending School	2.25 Million	8.01 Million	3.56	1950 - 1970
Percent Attending	37.5	64.4	1.72	1950 - 1970
Literate, Ages 6+	11.8 Million	27.5 Million	2.34	1950 - 1970
Percent Literate	56.8	71.7	1.26	1950 - 1970
Urban Population	11.0 Million	28.4 Million	2.58	1950 - 1970
Percent Urban	42.6	58.8	1.38	1950 - 1970
Expectation of Life at Birth	48.1 Years	61.4 Years	1,27	1951 - 1970
Growth in Income at Constant Prices			3.69	1955 1975
Income per Capita			1.89	1955 1975

Source: Population data including school attendance, urban population, and literacy from Mexican censuses of 1950 and 1970; expectation of life at birth in 1951 and 1970 from the United Nations *Demographic Yearbook* for 1966 and 1973; growth in income calculated from the United Nations (Department of Economic and Social Affairs, Statistical Office), *Yearbook of National Accounts Statistics* 1963, 1972, and 1975.

The population is now 60 percent urban. The expectation of life rose to 61.4 years by 1970, and is above 65 now. A most remarkable figure is multiplica-

tion of Gross National Product by 3.57, leading almost to a doubling of per capita income in a twenty-year period, while the population itself doubled.

With this remarkable social progress, it might appear that Hoover and I must have been wrong to say that there were greater advantages to be attained from a reduction in fertility; but not at all. The increase in income per equivalent adult consumer was 1.9 with little change in fertility; what we said was that it would have been 1.9 multiplied by 1.4 if fertility had been reduced. I see no reason for discarding this conclusion.

Consider school attendance. One could not ask for more than multiplying the school attendance by 3.6 in a twenty-year period. Yet the number of children *not* in school was greater at the end of the twenty years. That is not a very satisfactory outcome. Had their fertility fallen by 50 percent, *all* the children could have been in school. Mexico devoted about 15 percent of government expenditures to education, only to leave an increased number of children not in school. Universal education does not mean more children deprived of education. So I have little doubt in my mind that there would have been still greater increases in per capita income, and still greater economic progress, if fertility had been reduced.

Population growth in Mexico is like an episode in *Alice Through the Looking Glass.* The Red Queen grabbed Alice's hand and they ran and ran. The Queen kept saying, "Faster! Faster!" and Alice said, "But we are still under the same tree!" "You have to go very fast to stay even," said the Queen. Mexico has gone very fast, but with continued rapid population growth, an enormous effort has to go into staying even.

The additional advantages that would have been gained by reducing fertility would have accrued particularly to the children in the population. We have already noted that universal primary education would have been possible if fertility had followed our other assumption of a 50 percent reduction.

The same is true for other elements of the welfare of the children. With

no reduction in fertility, there has been a great increase in the number of children, not only as a proportion of the population but per family. Historically in Mexico, as in other high-mortality populations, although more than six children were born on the average, only three or four survived to be adults. Now five or six are surviving. Children are growing up in crowded households. If fertility had been reduced, they would have had better housing and better care from their parents, in addition to better education. There have been psychological studies showing that even when all children

who come from large families, after making all allowances for socio-economic differences. The reason is that a first child, or one born after a substantial interval, has more exposure to adult company and less to other children. Such children are more acculturated to adult thinking and to reading more rapidly than others.

With lower fertility, children would have gained many advantages, but the most salient advantage would be the prospects they would face. Had there been 50 percent lower fertility, the smaller number of children would have had much better prospects than do the current large number.

That leads to a point of general importance: a feature of demography known as the momentum of population growth. A fall in fertility began in Mexico in the mid-1970s. The fact that it had not happened before 1975 meant that in 1975 Mexico, without any substantial doubt, could look forward, to a labour force more than twice as big twenty years later. In other words, by 1995 the labour force in Mexico is going to be more than twice as big as it was in 1975. The future course of the birth rate will not affect the outcome so soon; most of the 1995 labour force has already been born. That is the momentum of population growth. When there is a veiy large number of young people, they are going to grow up to be a veiy large number of

Such a great additional growth in the labour force is a difficult prospect. The Mexican economy, in spite of its remarkable progress, has done better in increasing output than it has in increasing employment. There is a severe

problem of under-employment and unemployment now. There is no possible way of providing twice as many productive jobs in twenty years, but twice as many jobs will be needed because Mexico did not reduce its fertility twenty years ago. The employment prospects for the children that were born during a period of sustained fertility are a lot worse than they would be if fertility

In the LDCs as a whole the record of providing increased productive employment is not as good as the record of raising aggregate output. The reason is technological. The ways in which output can be raised involve the increasing use of modern technology, and modern technology makes a lesser demand per unit of output for labour than traditional technology does. I remember a particularly vivid example. Twenty-five years ago 1 talked to a consultant with Aramco, the oil company that at that time had an agreement with Saudi Arabia and other countries for the extraction of oil, before its nationalization. He told me that, the oil company had made a contract with an engineering firm to design a large new refinery for Saudi Arabia. The design was for a fully automated plant.; a handful of workers were enough to operate the big refineiy. The company went back to the designers and said: "You don't realize that we want a plant for an economy that has relatively low wages and high levels of under-employment. It would be better to have a design that made more intensive use of labour. Labour is not as expensive as it is in the United States, for which this design would be suitable." The designers took it back. Later they said: "If labour were free, this would still be the most efficient design. It is cheaper to run oil through this refineiy with everything automated than it is to have one man at every valve. In tact, the output would be less if there were one man at every valve."

That is an extreme example, but the Green Revolution provides others. For instance, one of the advantages of the new crop varieties is that they require less accumulated sunshine to ripen. It is possible to have two crops where there used to he only one. The ground has to be cultivated in a very short time between the crops; it can be done only with mechanization. To realize the advantage of two crops one must mechanize and use fewer workers. There is a tremendous increase in output, but not much use for

additional labour. The same thing happens in textile mills. Again, an automated textile mill is more efficient than one that uses a lot of hand labour; it produces more textile per unit of dollars, or rupees.

There is a general problem of realizing the possibilities for increased output. The general problem is that it does not create as much additional employment as it does additional output. When there is a doubling of the labour force in the next twenty years - inevitable in Mexico - that will create veiy serious problems for economic planners to provide adequate employment. It would certainly be a lot more favourable prospect if the increase was going to be only about 60 percent in twenty years, as it would have been iffertility had been reduced.

Now a further point about the momentum of population growth and how it arises. Suppose a country has decided to reduce the birth rate and reduce the population growth to zero. Suppose it sets as a target an immediate reduction of child-bearing to the point that the number of children born per couple would be the 2.1 or 2.2 on the average - the number necessaiy for each parental couple to replace themselves, with allowance for low mortality. Every couple would have the number of children that in the long run would produce a stationary population. If such a policy were implemented immediately, a high fertility population would still increase by about 50 percent. Why? Because the large number of children under twenty, who had been generated during the previous period of high fertility, would in due time become parents and replace themselves. The size ofthe future population is not determined by the current size ofthe population; it is determined by the size ofthe young generation yet to enter the period of child-bearing. That is population momentum. It is momentum because past growth generates future growth, even after the foot is taken off the accelerator. To bring a train to a stop, the brakes must be applied well in advance. If the brakes are not applied well in advance, building a brick wall across the tracks is not a remedy. The train has momentum and cannot safely he stopped in a hurry.

Provision of adequate employment is handicapped by the initial sectoral

division of the labour force. Suppose the proportion of the labour force in agriculture in Pakistan is 60 percent. Set the current labour force equal to 100, 60 in agriculture and 40 in the non-agricultural sector. Now consider the situation in another 23 years. The total labour force will double to 200; suppose 60 are still in agriculture - there would then have to be 140 in the non-agricultural sector, an increase by 3.5 times in 23 years, or an annual rate of increase of about 5.4 percent.

The assumption of no increase in the labour force in agriculture is justifiable on grounds of sensible development strategy. No agricultural economists would contend that more workers are needed in Pakistan agriculture, where the present labour force is under-employed. The history of more developed economies shows that as national product and agricultural output increase, the labour force in agriculture diminishes, not only as a proportion of the total, but also in absolute numbers. In the United States today, the proportion of the labour force in agriculture is a mere three percent. There are more teachers than farmers, yet the United States is exporting grain all over the world. With modern technology agriculture is veiy productive; and with only a modest adaptation of modern techniques, Pakistan would employ fewer hands in agriculture, not more, a generation hence.

Thus the calculation I made a little earlier of a labour force of 100 today (60 An agriculture and 40 in non-agricultural employment) growing to a labour force of 200 in less than 25 years (60 in agriculture and 140 in other sectors) does not include the desirable outcome of a reduced agricultural labour force, which would be needed to reduce under-employment. Yet to provide 3.5 times as many jobs outside agriculture in less than 25 years is a formidable goal. Non-agricultural output can perhaps be increased at about 5.5 percent per year for a generation, but not non-agricultural employment.

To sum up: in the years since Hoover and I analysed the prospective economic progress in India and Mexico, both economies have advanced substantially, despite following the population growth that we foresaw in the absence of a reduction in fertility. In both countries, fertility was not reduced

veiy much until the 1970s. In Mexico, social and economic progress has been impressive. In 20 years primary school enrolment was multiplied by 3.5, expectation of life at birth rose to over 65 years, and per capita incomes nearly doubled. Nevertheless, our conclusion that progress would have been substantially greater had fertility been reduced seems correct. There are more children *not* in school now than a generation ago, despite the big increase in enrolment. Individual households contain more children because child survival rates are much higher; child care as well as education could be better if there were fewer children. Unemployment and under-employment are acute problems in the Mexican economy. Had fertility been reduced, there would have been somewhat fewer persons in the labour force, but a much lower current rate of increase in the adult population. The biggest difference would be in the growth in the labour force anticipated for the next 20 years - it will more than double because fertility was maintained, and would increase by only 60 percent ifthere had been a 50 percent decline in fertility. The provision in twenty years ofproductive job opportunities for 60 percent more persons than today would be a sufficiently troubling responsibility, but a much easier problem than provision ofjobs for twice the current number of adults.

If fertility had fallen 25 years ago in Mexico, a larger population of children today might enjoy 100 percent school attendance, better child care, higher levels of consumption, and much brighter employment prospects than does the veiy large generation of Mexican children today. If fertility does not decline in Pakistan in the next 25 years, the lost opportunity for enhanced progress will be at least as great (and grave) as in Mexico in the last 25 years.

DISCUSSION

Mr Mazahir Hamadani: It may not be correct to assume that muslim cultures are not inclined to having a lower population growth. One reason is that muslim countries have also been making efforts in education, industrialization, and urbanization, which lead to a lower population growth.

Prof. Coale: I would be veiy happy if I could believe that the birth rate could

be reduced rapidly in muslim societies as in others. I was careful to say that my opinion that the culture there is particularly resistant to reduction in fertility is not based on anything in the Islamic religion itself. It is based on the way that muslim societies have developed. I've recently read a book about the place of women in Islamic societies. The problem is that what the Qur'an says about the place of women and the actual place of women are veiy different. That is true of eveiy religion — the societies that, adhere to a religion do not keep all of its tenets. But, empirically, it does seem to me that a veiy high level of material development in a muslim society, according to my observation, does not lead as easily as in others to a reduction in fertility. That, to me, poses a challenge, not an insuperable barrier. It means that programmes that would assist in the reduction of fertility there may have stiffer requirements than in other societies.

I think a lot of the issues that you're posing are not opposed to what I say; I suspect that your interpretation is different from what I intended. I'm not a total pessimist about these things. In my analysis of Mexico, I noted that they made enormous progress without reducing their fertility. They would have made more progress if they had reduced fertility instead of not reducing it. It's not an either/or choice; I'm not saying that one ought to concentrate on population at the expense of other things. I'm a very strong supporter of extending education and of making sound economic plans. In fact, there are two kinds of population policy. One is a policy aimed at modifying what would otherwise be the course of development of the population itself, for example, by trying to guide fertility or migration. Thus, the first kind of population policy is a policy aimed at modifying the future course of population development. The second kind of population policy is accommodating to population changes that can't be affected. An example is accommodation to the fact that there will be twice as large a labour force in Pakistan a generation from now than there is today. The social and economic policies of Pakistan must be directed to try to cope with this increase, since it provides productive employment for such a large growth of the labour force. I don't think one kind of policy is more important than the other. It would be sensible to try to direct the development of population so that the second kind of policy will not be as badly needed a generation hence as it is today. As

I said yesterday, a population policy ofthe sort that tries to modify the future development of population is an integral part of the overall social and economic planning; it shouldn't be neglected.

Mr Naseem Farooqui: Professor Coale, there has been a lot of discussion in the literature that fertility in Mexico has not declined in spite of remarkable social and economic development during the last so many years. You made a projection with the assumption of a constant total fertility rate, and your figures are comparable to those which were officially recorded in that countiy. But Table 4 ofyour report shows that, in the 3 to 4 years after 1975, the total fertility rate declined tremendously. Was this decline real or an artifact of data?

Prof. Coale: The decline in fertility in Mexico is real. What's misleading about the two tables that present Mexican data is that the decline began in the early 1970s. The decline in the early 1970s did not have a consequential effect on the population in 1975 because then it had just begun. When Hoover and I were in Mexico we encountered hospitality comparable to what I've seen in Pakistan on this trip. The Mexicans are very gracious and hospitable people; even though there was a strong anti-U.S. sentiment, it certainly was never directed against us as individuals. We were welcomed at the Mexican Bank and at their Development Authority, shown their projects, and taken to community development villages, and so on. But the intellectual hospitality was not so great. The belief ofthe Mexicans then was pro-natalist; they wanted to have a large population because they thought it was good for them; they would not accept our arguments at all. By 1977, when I gave a lecture in Mexico City, I found that the climate had indeed altered. A substantial change in policy took place in the 1970s. The Mexican government began a veiy serious campaign of providing family planning all over the country, including having government-sponsored television programmes talk about the advantage of smaller families, and having clinics provide birth-control services all over the country. The decline in fertility had already started. The kind of progress that is shown in Table 4 was contributing to a favourable attitude towards reduced fertility in the population. Such an attitude was helped and implemented by the

government programme rather than being initiated by it. If we had a plot of annual total fertility rates in Mexico, it would be veiy nearly constant up until about 1970, whereas in the early 1970s it would begin to fall and would fall more steeply after 1975. This decline does enhance the future prospects of Mexico, especially if it continues.

Mrs Naushin Mahmood: Professor Coale, in your twin lecture of yesterday and today, you mentioned that a sufficient degree of modernization is necessary for a decline in fertility to begin. But the research and empirical work done in this field has not thus far revealed a threshold level of modernization for fertility decline. What degree of modernization is sufficient to have its effect on fertility? Also, I would like you to comment on any causation between development indicators and fertility in the light ofthe transition theory that, you cited yesterday.

Prof. Coale: You have brought up precisely the most difficult point in trying to make a definitive statement about the relation between general social and economic development and the decline in fertility. I tried to escape it yesterday by citing Massimo Levi-Bacci's statement that by the time everybody is living in urban apartment houses with television sets and so on, fertility will have fallen. In no country has the decline waited until that stage. The problem is that the decline has started at one level of any set of indicators you want to name, in say Bulgaria and France, and under a veiy different set of conditions in Germany or Scandinavia. The precise problem is that after this whole study ofthe European fertility project, we are unable I o determine a checklist of conditions indicating when the decline starts. If development goes far enough, it will ultimately start. What I was saying yesterday in an effort to escape that dilemma was that, in addition to the objective factors of literacy, urban life, per capita income, health and so on, I here are other less easily quantified aspects of tradition, culture, and the like that determine the extent to which the material aspects oflife have to be altered before the attitudes change. I think Latin America is a region which is intermediate between a France or a Bulgaria, where the population appeared particularly receptive to these ideas, and an Ireland, where all kinds of changes had occurred before marital fertility had begun to go down.

And, I think, Mexico is an instance of traditions that were resisting the change of fertility. Nevertheless, by the early seventies, the accumulation of all these social and economic changes was causing fertility to begin to fall. The government programme speeded the process' up. Mexico exemplifies another aspect of the demographic transition, which is that certain segments of the population first undergo changes in attitude, values and knowledge which lead to a decline in fertility. Those segments are typically urban and of higher socio-economic status. For a generation, the university-educated or even secondary-school-educated Mexicans have had lower fertility. What is happening now is that those low-fertility values are at last diffusing to the rest of the population.

Dr Khwaja Sarmad: What impact does rapid population growth have on income distribution? Intuitively, I feel that it would make it worse for the simple reason that jobs are not rising as rapidly as the increase in population. Moreover, when there is a rapid population pressure, as in Pakistan, urban rents and property incomes increase faster than the wage levels, which is one of the other effects of population growth, so that income distribution gets worse.

Prof. Coale: I think without the intervention of very strong counter-policies, that is indeed the effect. But I think that there's a direct reason, a lot stronger than the ones you've mentioned, although those are correct. That is that one of the features of the early phases of a fertility transition is that, as I said earlier, the reduction in fertility happens first among the people of higher socio-economic status. As a result, the more privileged members of the society are the first to reduce their birth rate, so they are able to transfer a relatively higher benefit to their children, and the lower income people continue to have large families. Inheritance prospects, the possibilities of child development, and education are all worsened for them. Even in a relatively egalitarian and social-minded society, special efforts have to be made to ensure that differential fertility, which is part of the overall change, does not lead to a worsening of the income distribution by children being born to those who are least able to support them.

Dr Faiz Mohammad: There has been a belief among the classical and the neo-classical economists that this economic system is stable, that it may over-shoot temporarily from its equilibrium or stable position but it subsequently comes back to its equilibrium state. I would like to know whether there is any tendency inherent in the biological system of man to bring back the population growth to the stable or equilibrium position, even if at a different level of population size. If there is anything like that, then the doubling ofpopulation may be a temporary phenomenon

My second point is that in future we should look at the number of persons rather than at the labour supply in terms of the number of hours being put into work.

Prof. Coale: With regard to any biological tendency towards a stable growth in population, I repeat my arithmetic: the stable growth rate in the long run has to be veiy close to zero. One biological check I have already alluded to is: population growth will be kept close to zero by a higher death rate, if by nothing else. There is a long-run automatic adjustment: keep the birth rate at forty-five per thousand long enough and the death rate will ultimately become forty-five as well. That is in the veiy long run. There has indeed been a phenomenal increase in population (from half a billion to four and a halfbillion) in the last two centuries. That cannot continue. It is a temporary episode associated with the development of modern medicine that brought the death rate down. The birth rate did not rise during that period; if anything, it fell. There was a reduction in mortality that made rapid growth possible. The imbalance of a birth rate that remains in a mode compatible with the old death rate and a new low death rate has to be resolved. It can be resolved in either oftwo ways: Either the death rate can go back up to what it used to be or the birth rate can come down to a level compatible with the new biology of low mortality. It's not a statement affected by social development; it's not a statement affected by technological change. Even if it were possible to send people by rockets to other planets, it wouldn't make any difference. With the population doubling GVGiy 2/3 years, once we outweighed the Earth and tried to export our population, it would be impossible. Twenty-five years later, we'd outweigh two earths. There's no way so many

people could be transported away. Compound growth is impossible over the long run — arithmetically impossible. There is indeed an automatic mechanism for bringing it into balance: ifthe birth rate remains high, the death rate will also become high. Technology really doesn't affect that as a long-run argument. It is not a short-run relation, and does not mean that in the next generation there's going to be a terrible tragedy if the birth rate doesn't come down. It is, however, a matter ofinexorable arithmetic in the long run.

Whether there is another kind of automatic mechanism is a moot point that I find veiy interesting. Yesterday I alluded to the fact that the practice of parity-related fertility control, had it occurred in premodern times. Irrespective of what segment of the population practised such limitation, it would lead to reduce their fertility below replacement, given the high death rate. It would cause this segment to vanish. I referred to a friend of mine who said it's like a lethal mutation. Another friend, when I was describing this line of reasoning to him, said: "Is it possible that the modern practice of parity-related birth control, i.e., contraception in the Western countries, is still a lethal mutation?" Almost all of these populations are below replacement despite low mortality. I'm not sure that they will return to replacement fertility. Part of the reason that fertility is so low is equal opportunities or nearly equal opportunities for women, which I strongly approve. They now often prefer a career outside the home to a life in the home. It may require a change in attitudes to get the fertility level in the West, back up to replacement. In short, I'm not sure that once the number of children born to each couple is totally and effectively a matter of voluntary control, couples will choose to have a number that will keep the population in balance. That requires an invisible hand that, is operating pretty well.

As to your question about the labour force, from my observation of circumstances in developing economies, I think there's a lot of underemployment.

Dr Zeba Sathar: The problem is also of a low demand of education in some segments of our society, where parents may be reluctant to send their children to school even ifthere is a school around, perhaps because they are

contributing to the household income. Perhaps, in a way, we are ignoring the factors of high fertility in Pakistan, since in the large agricultural or rural segment of our population a major investment made is in the form of the number of their children. There are veiy few pension schemes and very little else in which to invest, and that is why they are having more children. So, although we would like to hope that this problem will solve itself, yet we are ignoring its roots.

Prof. Coale: I don't disagree with a word you say. Perhaps these arguments belong more in the discussion that we were having yesterday of the factors affecting fertility than they do in the economic discussion today. Part of the resistance that is found throughout the LDCs to a reduction in fertility is the economic contribution that children make. I'm distressed to hear that there is resistance to sending the children to school, resistance that rises from the contributions the children make to the household workload. As long as that attitude is allowed to determine education, development will go veiy slowly indeed. Until that attitude is changed by compulsory education or something else, that reason for maintaining high fertility will continue. An integral part of development is population policy. Without an effective get-the-children-into-school policy, it's going to be a lot harder to get fertility to come down. But the education programme should be pushed for its own sake. I think eveiy child should be educated. I think it's important even if the educated do not produce more. I think education is important to broaden the mind. Educating people so that they can think, read, and so on, for its own sake, is, to me, a veiy crucial part of modern development. Designing and implementing a policy of genuine universal education will reduce the incentive to have many children; people will find that children are expensive when they are in school instead of helping around the home. That will cause them to see the advantage of having fewer. They transfer their ambitions to the children. This happens universally. When education becomes universal, veiy commonly parents begin to change their utility maps. They share in the ambitions of their children and get gratification when their children become educated and get good jobs, and so on. All of that is part of the social change that has to take place.

Prof. M. Rasheed: Professor Coale, a point arising from the picture you gave of the large number of children not in school, in spite of the efforts made to increase literacy. There is a school of thought, which came from Mexico actually, which suggests that in the poor countries with such a large number of children not going to school - and even those going to school getting such bad education _ such children later become unemployable because of the poor quality of education. It is suggested that we should have a de-schooling society in the poor countries. You know the man called Ivan Ilich in Mexico, carrying on this experiment of de-schooling, who suggested that instead of sending the children to formal educational institutions we should start them on some productive work, using their hands, skills, etc. What do you think of the strategy called de-schooling?

Prof. Coale: Well, Professor, I'm afraid you've touched on a deep prejudice of mine, which is that I think of knowledge, acquiring knowledge, and the ability to use knowledge as being an invaluable good on its own. I~j©t me give an analogy. One of the strongly anti-social attitudes that was common early in my professional life, an attitude that I heard expressed by some public health officials, is that it is a mistake to put a lot of technical assistance resources into health measures because lower mortality accentuates the growth in population and makes the situation worse. I believe that the only reason people have such an opinion is that they don't count better health in the GNP or in the utility maps of the individual concerned. If you offered a poor peasant in this subcontinent a choice between having his income increased by fifty percent while continuing to be subject to chronic malaria, and having some of his children die, or to have his income unchanged but be free of fevers and have his children survive, I'm sure he would accept the latter. Yet better health doesn't count in per capita income. One of the few accomplishments that this century can view with pride is that the incidence of disease and death rates of children have been reduced throughout the world. I think that's important, and I feel the same way about education. When I was a student, I hitch-hiked everywhere. I was asked: "What do you do?" I'd say: "I am a college student." Next: "What are you studying?" and I said, "Economics". Then, "What are you going to do when you graduate?" and I said, "I don't know". "Well, then, why are you studying economics?" and I

said, "Because I want to be able to read the *New York Times.*" If I was going to be a shoe clerk, I wanted to read the *New York Times.* I want poor children to get the best kind of schooling they can, for its own sake.

Dr Zaheer: A point of information: there is a phenomenon called the stress phenomenon, but it is found in the animals and not in the human beings.

Prof. Coale: That is a question I'd like to respond to because I've read that literature with a great deal of interest. The extreme instance that I remember reading about is foxes. If there are more than one per square mile, they don't breed as much. They sense the presence of another fox and have fewer cubs, which helps preserve the species. It's a nice Darwinian argument. But there is no evidence of such a tendency in humans. The people in the slums of Calcutta breed just as rapidly as the rural population. There is a footnote to that. Some demographers and biologists have noticed that under famine condition - not malnutrition, but famine conditions - amenorrhea develops and fertilization can't happen. In a study of starvation by Ancel Keys, using prisoners who volunteered in order to get their paroles earlier to undergo a starvation diet, the males lost their libido when subsisting on such a diet. This suggests a kind of Darwinian effect; when malnutrition is acute, the species escapes the loss of women who might not. survive if they became pregnant.

Mr *Ayub:* My question essentially relates to the execution of the population planning programmes in Pakistan and other countries. Since you have a vast experience in many countries, I wonder if you could tell us about how best can a really good programme be executed?

Prof. Coale: The most difficult problem of all is tp design an effective programme for different countries. It would be very rash for me to try to give detailed advice on what might be done in Pakistan. The problems are these: there's the cultural context, to consider, there is an economic context to consider, and there is the whole organization of the society and of the government to consider.

Let me discuss a situation with which I'm more familiar. In India, population programmes were in the First Five Year Plan. One of the problems in India is that they've changed the targets and the system or organization with each new five-year plan. They first were emphasizing periodic continence, the so-called safe period, as a method, thinking it would fit in with Gandhian ideals. It was totally ineffectual. Because of the opposition of the Indian Medical Association they have never authorized the use of pills. Pills are more dangerous for anemic women than for others, and many Indian women are anemic. They hadn't considered the greater health risk to an anemic woman from carrying a child to full term than from taking the pill.

To reduce fertility requires an effective education programme that generates better appreciation of the advantage of lower fertility on the part of the whole public. It also involves changing incentives. For example, when compulsory primary education is really effective, the economic advantage of having many children is reduced.

Another aspect of an effective programme is that it should be integrated into a broad development programme; in particular, the improvement of health. Suppose there is an effective maternal-child health programme that reaches all the rural communities as well as the cities, such that the average woman who is pregnant gets good pre-natal care, is guaranteed a safe and effective delivery of her child, and has good post-natal advice and medical help. In that context, which is difficult and expensive to implement, the same people who are providing the good maternal and child health care can effectively offer advice to the prospective mother about the health advantages of postponing the next pregnancy and the advantage to the children of fewer siblings, because they will listen to someone who has helped them with health about further help in health.

Singapore is an example of a veiy stringent programme, too stringent in some respects. Many of the things they have done are right and, perhaps, on balance, it's the correct policy. I can't imagine implementing in Pakistan the measures used in Singapore; there are may direct benefits given to those with few children, and there are strong economic penalties for

having many. An official would not last in office with such measures in Pakistan. There has to be a change in popular attitude before incentives and penalties can be used. A government can't impose something against the popular will, except maybe in China.

I would really need to know more than I do about the society, the economy, and the organization of the government before making specific suggestions effectively for Pakistan. It's not enough to impose a sudden change in policy in which the prime minister or the cabinet suddenly decides they're going to do something about, family planning and issue an edict and then don't implement anything.

Prof. Cornelisse: In your model, you obtained an additional increase of income per capita of one percent, at no cost at all. Is that realistic?

Prof. Coale: First of all, I don't really think that the 40 percent additional gain that comes from reduced fertility over a thirty-year period is negligible. It is true that critics have made that point. What they were commenting about was this: in considering alternative development strategies there are choices that make a bigger difference than that. That doesn't disturb me. We must do them both: choose wise economic policies *and* reduce fertility. Because of the arithmetic that I spent a lot of time on today, the reduction in fertility is ultimately essential. In addition, to reduce it soon provides an immediate economic advantage that is not negligible.

As to costs, I'm sorry that in remembering objections I didn't remember that one. Actually, a former student of mine, Paul Demeny, now Vice President of the Population Council, wrote his dissertation on that very subject. He said the model that Coale and Hoover generated had no allowance for the cost of the reduction of fertility. He made as realistic an estimate as he could of the allocation of time and expert man-hours to a family planning programme that might be needed. If you assume that it. requires a population policy and then try to make a realistic estimate of the cost, it doesn't make a very big difference to the outcome. Allowing for the slight costs of a population programme doesn't make a big difference.

Dr Mohammad Irfan: In response to a question you said that population policy should be an integral part of the socio-economic policy formulation. I think everybody has been saying this for the last so many years. The question is how? As father of a model which has been around for two generations, you must have followed the subsequent progress made on that. Today we have a number of economic-demographic models. The problem is that I don't think any of these models has ever been implemented, except possibly in Yugoslavia and in one or two other countries. What are the reasons that these models are not accepted as a planning framework? Is it because of the weak empirical basis of these models? Is it because the political implications of the models are not acceptable, as in the case of Bachhue Philippines? Or is it because the population policy as such has been a means to an end, and hence is subservient to other policies? Or is it because the models are inconsistent, in the sense that while in terms of consequences we are talking at the level of macro-economy, on the determinant side we are dealing at the level of the family? Or, as remarked by someone, the role of demographic modelling is very limited?

Prof. Coale: A policy for increasing income and a policy aimed at reducing the birth rate are not incompatible. In fact, one reinforces the other. There is no contradiction between a population policy and a policy to extend education, or to increase the rights of women or to redistribute the land; any of those things. Any effective means of increasing welfare that people advocate is not incompatible with having a population policy at the same time. In fact, the aims of getting better income, and so on, are reinforced by having a population policy.

My own view about population policy is that it is ultimately an essential part of a modernized society in which freedom of choice is extended over a whole range of opportunities. People know more because they're educated, employment opportunities are more extensive, and generally people have more control over their lives. Part of that knowledge is to know the advantages to themselves and their children of fewer births more widely spaced, and part of that freedom is to exercise their knowledge in the conscious regulation of child-bearing.

CONCLUDING REMARKS

Professor Syed **Nawab Haider Naqvi**

CONCLUDING REMARKS

Professor **Syed Nawab Haider Naqvi**

At the end of the day, it now remains for me to recapitulate the highlights of these two days' authoritative, clear, and concise discussion of the two-way relationship between population dynamics and economic growth. Focusing on this relationship has been most enlightening. This is so for the economist because he is weaned away, if only for a moment, from the neoclassical preoccupation with the existence and dynamic stability of the steady states in which demographic variables don't really appear, to a world in which these variables do appear. The great merit of Professor Coale's intellectual *tour de force* is to convince us of the need for endogenizing the demographic variables to understand the full complexities of the process of economic growth. Professor Coale's discussion should also provide food for thought to the demographer because of the latter's normal concern with demographic variables alone. Indeed many more people, the politician as well as the policy makers, should also be listening to the oracle - to Professor Coale, I mean - because he has shown by his words and deeds that he is not a doomsday prophet: he does not think that demographic realities are such that no matter what we do to improve the economic realities, they will only lead humanity to starvation and death. He is also not a stereotypical optimist who would say, 'Let, the economic growth proceed according to a certain schedule and the population problem will take care of itself. Instead, he has proved to be a hard-nosed realist who listens quite clearly to the inexorable grind of the population dynamics, and who understands that unless man does something veiy purposive about his reproductive behaviour the fate of mankind is really sealed; also that the gains of economic development may

be completely nullified by an inordinate increase in population growth. Yet he remains clear about the way out of the perennial trade-off between population growth and economic development. So, being a pacifist, Professor Coale has tried to assuage the intellectual curiosity of all and sundry.

But to make sure that these gentlemen, especially the politicians and the policy-makers, do not start living happily ever after receiving the hopeful news, Professor Coale has a lot of disturbing things to say. He makes clear the reasons why man has kept - so far, at least - the ghost of our great-great-grandfather, Malthus, from undoing his achievements in order to survive in a hostile (natural) environment.. But there are some who have done better than others, and there are some who have not made it at all (e.g., the African Continent). Professor Coale relates man's history of success (and failures) in fighting the demographic demon with scientific precision, detachment, and simplicity for all who care. In his first lecture, he starts out by asking the question whether the process of development is in itself sufficient to limit the pace of population growth, without the conscious parity-related use of contraceptive devices. His answer to this question is a definite no, although he is careful to point out that, of course, to some extent, it is true that development provides the overall framework within which it is possible to reduce fertility. Economic growth is a necessary, but not. a sufficient, condition of recreating the European situation - namely, where low levels of mortality and fertility are achieved in a parity-related (modern) situation. In this context, he discusses at great length the concept of demographic transition. He points out that the phenomenon of demographic transition has two characteristics. The post-transition regime is characterized by low mortality and low fertility, which is achieved as a result of the *conscious decision* of the married couples to have a target number of children. This is in sharp contrast to the pre-transition period of high mortality and high fertility with very little planned effort to limit fertility. He points out that mankind has somehow kept, on the average, a balance between mortality and fertility so that over the centuries the rate of population growth has remained almost zero. In the pre-transition period, the approximate balance between fertility and mortality was maintained with high levels of mortality. By contrast, in the post-transition period, the approximate balance between the two factors

of natural increase has been kept by managing low levels of fertility. This means that if we want to grow further, and if we want to really enrich the quality of life, it is the second kind of scenario that has to prevail. Professor Coale further says that, in the process of demographic transition, it has not so far been possible to locate the exact threshold level of a consequent decline in fertility in response to the decline achieved in mortality. Historically, in the premodern societies, the differentials in fertility across countries have been greater than those assumed to characterize the period oftransition.

According to Professor Coale, there are three pre-conditions which are necessary for successful achievement of the fourth stage of demographic transition in the Third World. The first is that the subject of fertility reduction ought to lie within the calculus of a conscious choice made by the parents to determine the size of their families. The second is that those married couples who try to have lower fertility must perceive the advantages that will accrue from a smaller number of children. And the third is that there must be a sufficient supply of contraceptives. He feels that unless *all* these conditions are satisfied there is no hope for mankind of achieving the balance at low levels of fertility and mortality in order to keep the rate of natural increase in population at an acceptably low level.

In the case of less developed countries, it is true that the levels of mortality have declined to some extent; but the same cannot be said of the fertility reduction, which may have been due to a number of factors, the more prominent being the cultural factors. Learning from the experience of Europe, Professor Coale has also listed the following conditions which played a crucial role in affecting the demographic transition from the premodern times to the modern times. These are: a shift away from an over-emphasis on family, changes in the traditional mores and attitude towards fertility, universal education, urbanization, the onset of secularism, and the emergence of appropriate cultural attitudes that are consistent with reduced fertility. So unless all or most, of these conditions are met - particularly, if the attitudes towards fertility are not changed sufficiently and the supply of contraceptives is not enough to meet their demands - the LDCs may not be

able to achieve the goals of demographic transition which were accomplished in Western Europe. Keeping in view the European experience of decline in fertility, Professor Coale shows that whatever you do by way of economic growth, it will *not* by itself affect the hard core of the population problem. To the great discomfort of all who are concerned with these types of questions (and answers), Professor Coale has this 'shocker' to offer: "To interpret the demographic transition as implying that economic development will soon bring a lower birth rate, and a rate of increase of less than three percent, is unwarranted." With this observation, based on a veiy wide experience with historical, empirical and theoretical evidence, goes down the hope of those who would not like to deal with population growth *per se,* but would leave it. to the 'invisible' hand 6f growth-related market, forces to do it for them.

In his second lecture, Professor Coale addresses another central question; whether there are any solid reasons to prefer a growth path with lower fertility to the path of unchanged fertility. Since there are countries, like Mexico, which have developed in spite of the fact that their levels of fertility continue to remain on the high side, a satisfactory answer to this question is obviously a non-trivial exercise. Professor Coale's reply to this question is this: yes, this may be so but we have eveiy reason on earth to believe that a growth path with a lower fertility is superior to the growth path with a high fertility. He has calculated in the case of India and Mexico (which estimates are also relevant for Pakistan) that if the fertility levels of today are reduced by fifty percent, then over a period of thirty years or so the per capita income will increase by about forty percent. I think this is a very decisive advantage, and yet it is only a part of the stoiy, since these estimates of the induced gains in growth rates do not take into account the advantages of lower fertility that would accrue in terms of improvements in the quality of life due to better educational facilities, better employment opportunities, and the possibility of universal education both at the primaiy level and at the higher level. Professor Coale finds that., in Mexico or India, where some development gains have been achieved in terms of economic growth, per capita income, education, etc., their populations have also continued to grow rapidly. He thinks that such gains would have been much bigger if their

fertility levels had also been reduced. In this connection, he points out that if over the next twenty-five years or so fertility is reduced by fifty percent or so, it would not affect the labour force, nor would it affect the supply of natural resources. The only gain that we will have in this way is the greater productivity of capital, which will lead to greater gains in economic growth. Another important fact which emerges from Professor Coale's exposition should make us aware ofthe paradox that ifwe effect a decisive reduction in fertility today, then the labour force will be almost the same after twenty-five years. This follows from the demographic law that the growth path ofpopulation in future is determined uniquely by its past growth rates and the present levels of fertility. This is r^ACsi rod "to as the momentum of population growth. It follows that the less developed countries in general should address the population problem now instead of postponing the matter further, even though the demographic momentum already developed will not allow the population growth to be reduced in the short run.

The upshot of Professor Coale's lectures, which appears to be quite clear, is that there is a distinct need, due both to economic and demographic reasons, for taking urgent steps to reduce fertility in Pakistan and other less developed countries; otherwise it would be too late. If this is not done, then in Pakistan, with the present three percent annual growth, the size of the population will not only double in twenty-three years, but would multiply further to unprecedented dimensions within the next century. (Of course, it has to be remembered that when Professor Coale was talking about limiting population growth, he was referring only to reducing the rate of its growth and not the absolute size of population). Another hard lesson is also clear: that economic growth by itself is *not* enough to bring about a reduction in fertility. This underlines the need for tackling the problem of rapid population growth *directly,* by the conscious use of parity-related contraception; also that such reduction in population growth comes about only if people recognize for themselves the benefits of having a smaller rather than a larger family size.

In the end, Professor Coale has also pointed out - and I think there is a lesson for us to be learned from this - that a conscious effort must be made

to modify the cultural mores in our countries so that these become consistent with the reduction of fertility to a reasonable level. Overall, I think that it is a message of hope, and not of despair - a message which says that if only we restrain our reproductive instincts a little to slow down the game of multiplication, it will not only make us more productive, but the quality of life will also be enriched.

In the end, I would like to say that it has been a great pleasure for all of us to hear the master himself about the mysteries of the demographic universe; and that we are the wiser for his lectures about the critical factors which can bring us closer to the ultimate goal of bringing about the demographic transition in those Third World countries where this wondeiful phenomenon has not already taken place. We know also that aiming at this goal is not to ask for the moon. Thank you.

PROFESSOR ANSLEY J. COALE

A Biographical Sketch

Appendix

BIOGRAPHICAL SKETCH

OF

PROFESSOR **ANSLEY** J. COALE

Date of Birth: November 14, 1917

Education:

B. **A.,** Princeton University		1939
M. A., Princeton University		1941
Ph. D., Princeton University		1947

Experience:

1941-1942	**Research Assistant,** Office of Population Research
1943-1944	**Instructor,** Electrical Communications, Massachusetts Institute of Technology
1947-1954	**Assistant Professor,** Department of Economics, Princeton University
1954-1959	**Associate Professor,** Department of Economics, Princeton University
1954-1959	**Assistant Director,** Office of Population Research
1959-1975	**Director,** Office of Population Research
1959-1986	**Professor,** Department of Economics, Princeton University
1964-1986	**Professor,** Public Affairs, William Church Osborn
1975-1986	**Associate Director,** Office of Population Research
1986-	**Senior Research Demographer,** Office of Population Research

1987 Visiting **Professor,** Graduate Program in Demography, University of California, Berkeley

Professional Affiliations and Activities:

Radar Officer, United States Navy Reserve, 1941-1946

Secretaiy, Committee on Social Implications of Atomic Energy, Social Science Research Council, 1946-1947

Member, Institute for Advanced Study sponsored by the S. S. R. C. and the National Research Council, 1948-1950

Chairman, S. S. R. C's. Committee on Social Aspects of Technological Change, 1950-51

Consultant, The Rand Corporation, 1951-1953

Research Mission to India, on Population Growth and Economic Development, 1955

Research Mission to Mexico, on Population Growth and Economic Development, 1956

Rapporteur, U. N. Roundtable on the uses of Census Data for Social and Economic Planning in the ECAFE Region (Bombay), 1960

United States Representative, Population Commission of the United Nations, 1961-1968

Visiting Lecturer, Harvard University, 1962-1965

Member, Population Committee, National Academy of

Sciences, 1963-1966

Member, Research Advisoiy Committee, Office of Scientific Personnel, National Research Council, 1964

Consultant to U. N. Special Fund with respect to support of program at CELADE, in Santiago (Latin American Demographic Training Center, Santiago), 1964

Member of Population Council Mission to Kenya, invited by government to evaluate demographic situation and recommend policies.

Member, Technical Advisory Committee for Population, U. S. Bureau ofthe Census, 1965-1969

Consultant to Population Institute at Haceteppe University (Ankara) on research and training program, 1967

Member of Population Council Mission to Morocco, invited by government to evaluate demographic situation and recommend policies, 1967

Member, Population Council Fellowship Selection Committee, 1968-1970

Consultant to Ford Foundation on its population program in Latin America (Brazil, Chile), 1968

Visit to Indonesia to advise AID on assistance in population to that country, 1969

Adviser for AID on Assistance in Population to Indonesia, 1969

Member, Advisory Council, National Institute of Child Health and Human Development, 1969-1973

Member, International Advisoiy Committee, East-West Population Institute, 1969-1970

Invited Expert, U. N. Conference on the measurement of changes in fertility (Budapest), 1971

Member, President's Commission on Federal Statistics, 1970-1971

Member, Population Council Advisoiy Committee, 1970-1971

Head ofmission to Zaire for U. S. National Academy of Science, for exchange of technical information on population, 1971-1972

Invited Expert, U.N. Ad Hoc Committee on Model Life Tables (New York), 1972

Chairman, Organizing Committee for Conference on Economic Demography of the International Economic Association, 1973

Senior Adviser, United States Delegation, World Population Conference, Bucharest, 1974

Chairman, IUSSP Committee on Comparative Analysis of Fertility, 1975-1978

Consultant, International Institute for Applied Systems Analysis, Vienna, 1976

Chairman, Committee on Population and Demography, National Academy of Sciences, 1977-1983

Member, Program Steering Committee, World Fertility Survey, 1977-1984

Chairman, Ad Hoc Committee on Illustrative Analyses of World Fertility Survey Results, 1978-1980

Member of Panels on Thailand and Egypt, National Academy of Sciences Committee on Population and Demography, 1978-1981

Consultant UNFPA, on establishment of research and training in Demography in the People's Republic of China, 1980

Member, Advisoiy Committee, International Awards Program on the Determinants of Fertility in Developing Countries, Population Council, 1981-1984; Chairman, 1981-1983

Elected Offices in Professional Societies:

Vice President, Population Association of America, 1963-1964

President, Population Association ofAmerica, 1967-1968

Vice President, International Union for the Scientific Study of Population, 1973-1977

President, International Union for the Scientific Study of Population, 1977-1981

Honours and Awards:

Fellow, American Academy ofAits and Sciences, American Statistical Association, American Association for the Advancement of Science

Member, American Philosophical Society, American Academy of Aits and Sciences, National Academy of Sciences

Awarded Mindel Sheps Prize in Mathematical Demography, 1974

Doctoral, *Honoris Causa,* University of Louvain, 1979

Honorary Member, Czechoslovak Demographic Society, 1981.

Fellow, Center for Advanced Study in the Behavioral Sciences, Stanford, California, September 1982 - June 1983

Docteur Honoris Causa, University of Liege, 1983

LLD., University of Pennsylvania, Philadelphia, Pennsylvania, 1983

Corresponding Fellow, British Academy, 1984

Publications

of

Professor Ansley J. Coale

A. Books - Author

The Problem of Reducing Vulnerability to Atomic Bombs. Princeton: Princeton University Press. 1947. 116.

The Growth and Structure of Human Population. Princeton: Princeton University Press. 1972. 227.

B. Books - Co-author

The Future Population of Europe and the Soviet Union. Geneva: League of Nations. 1944. 315.

Population Growth and Economic Development in Low-income Countries. Princeton: Princeton University Press. 1958. 389.

New Estimates of Population and Fertility in the United States. Princeton: Princeton University Press. 1963.186.

Regional Model Life Tables and Stable Populations. Princeton: Princeton University Press. 1966. 869.

Methods of Estimating Basic Demographic Measures from Incomplete Data. New York: United Nations, Population Studies. No. 42. 1967. 126.

The Demography of Tropical Africa. Princeton: Princeton University Press. 1968. 539.

Human Fertility in Russia Since the Nineteenth Century. With Barbara Anderson and Erna Harm. Princeton: Princeton University Press. 1979.

C. Books - Contributor

Principles ofRadar. **New York: McGraw-Hill, 1946.**

Activity Analysis ofProduction and Allocation. New York: John Wiley. 1951. 277-279.

Introduction and The Effect of Population Change in Aggregate Demand, Prices, and the Level of Employment. In National Bureau of Economic Research, *Demographic and Economic Change in Developed Countries.* Princeton: Princeton University Press. 1960. 3-14, 163-166, 352-371.

D. Books-Editor

Regional Model Life Tables and Stable Populations (Second Edition). With Paul Demeny. Academic Press. 1983.

E. Books - Co-editor

The Decline of Fertility in Europe. Princeton: Princeton University Press. 1986. 484.

F. Articles

The Problem of Reducing Vulnerability to Atomic Bombs. *American Economic Review* XXXVII-.2. May 1947. 87-97.

The Population of the United States in 1950 Classified by Age, Sex, and Color - A Revision of the Census Figures. *Journal of the American Statistical Association* 50:269. March 1955. 16-54.

The Calculation of Approximate Intrinsic Rates. *Population Index* 21:2. April 1955. 94-97.

The Effect of Declines in Mortality *on* Age Distribution. *Trends and*

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The Effects of Changes in Mortality and Fertility on Age Composition. *Milbank Memorial Fund Quarterly* XXXIV: 1. January 1956. 79-114.

Age Distribution as Affected by Changes in Fertility and Mortality - A Further Note. *Milbank Memorial Fund Quarterly* XXXV:3. July 1957. 302-307.

How the Age Distribution of a Human Population is Determined. *Proceedings of the Cold Spring Harbor Symposia on Quantitative Biology.* June 1957.

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of Korea. With Lee-Jay Cho and Noreen Goldman. Committee on Population and Demography. National Research Council. Washington, D. C.: National Academy of Sciences. 1980. 77.

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Age Patterns of Mortality for Older Persons. With Shiro Horiuchi. Papers presented at 1983 Meetings ofthe Population Association ofAmerica.

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Manila. December 1981.

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A Biography of Frank W. Notestein. *Population Index* 49:1. Spring 1983.

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Population. *Population Index* 50:2. 1984. 193-213.

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