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ECONOMIC DEVELOPMENT AND
THE TIMING AND COMPONENTS
OF POPULATION GROWTH

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Economic Development and the Timing

and Components of Population Growth

ABSTRACT

This paper examines the relationship between population growth and
economic growth in developing countries from 1965 to 1985. Our results
indicate that developing countries were able to shift their labor force from
low-productivity agriculture to the higher-productivity industry and service
sectors, and to increase productivity within those sectors, despite the
rapid growth of their populations. We also find that at given rates of
population growth, income growth is related to the time path of population
growth and that population growth due to high birth and death rates is
associated with slower income growth than population growth due to
relatively low birth and death rates. Hence, the timing and components of
population growth are important elements in the process of economic
development.

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Economic Development and the Timing and Components
of Population Growth

I. Introduction.

The population of today's less developed countries increased by roughly
1.3 billion people between 1965 and 1985 -- an increase that is larger than
the 1985 population of all of the more developed countries in the world
combined. [1] Despite the fears of 'population pessimists' that rapid
population growth will hinder the growth of per capita income, and the
counter-claims of 'population optimists' that population growth promotes
economic expansion, the empirical evidence shows little relation between the
growth of population and income per head or related economic variables. [2]
Enough countries have simultaneously experienced rapid population and
economic growth and enough have experienced rapid population growth and slow
or negative economic growth to support a 'population neutralist' point of
view that population growth does not necessarily help or impede economic
development. [3]

Population growth can, however, occur in various ways: through high
birth rates and moderate or even high death rates, through low birth rates
and lower death rates, through mass immigration, and so forth. Similarly,
changes in the rate of population growth may be caused by changes in birth
rates with roughly constant death rates, changes in death rates with roughly
constant birth rates, or by more complex changes in both fertility and
mortality as in the demographic transition. The impact of population growth
on labor supply and economic well-being may well differ depending on the
reasons underlying the growth.

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In their seminal book detailing the economic benefits of reduced population growth, Coale and Hoover (1958) focused attention not on growth per se but rather on declines in fertility, which immediately lower the number of persons below working age without a concomitant decline in the size of the labor force. (Indeed, a fertility decline may even result in an increase in the size of the labor force due to an increase in female labor force participation.) More recently, Coale (1986) has reiterated the point that levels of fertility and mortality are likely to affect the growth of per capita income independently of their difference (which determines population growth). In support of this point, Coale presents three simple pieces of empirical evidence relating to different regions of the developing world between 1960 and 1982: (1) a graph showing little association between rates of population increase and the growth of per capita income; (2) a graph showing a pronounced negative association between total fertility rates and the growth of per capita income; and (3) a graph showing a positive association between the expectation of life at birth and the growth of per capita income. This evidence would seem to provide a clear indication that the growth of income per capita has been weakest in the high fertility/high mortality regions of the world and that these regions do not coincide closely with the regions experiencing the most rapid rates of population growth. It would also appear to constitute evidence in favor of a 'modified population pessimist view' that a demographic transition is an important prerequisite for economic development.

In this paper we explore the relation between the time path of population growth and two major components of population growth -- birth and death rates -- and the growth of labor supply, the ratio of persons of

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working age to nonworking age, and economic well-being as reflected in GNP per capita and other measures of economic development from 1965 to 1985. We seek to determine the extent to which the 'neutralist' finding that we reported in our previous work (Bloom and Freeman, 1986) -- that there is little cross-country association between population growth and economic growth -- should be amended or amplified by taking account of the timing and components of population growth and by considering more recent developing country experience. Our focus throughout is on the labor market consequences of population growth, beginning with population-induced increases in the supply of labor and proceeding to changes in output per worker and the sectoral allocation of the labor force. As the labor market consequences of population growth depend not only on labor market factors but also on the response of capital investment, technology, and the like to population growth, our empirical findings reflect the behavior of various markets and socio-economic agents beyond the labor market as well.

Our major empirical findings, which relate to the time period 1965-1985, are the following: (1) developing countries were able to shift their labor forces from low-productivity agriculture to the higher-productivity industry and service sectors, and to increase productivity within those sectors, despite the rapid growth of their populations; (2) countries with similar average rates of population growth had significantly different patterns of instantaneous population growth and different combinations of birth and death rates; (3) average rates of population growth tended to be unrelated to the growth of per capita income over the entire time period, although they did exhibit a negative relation over the years 1980-1985; (4) the time profile of population growth is significantly related to income

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growth, with countries experiencing a reduction in population growth tending to experience more rapid income growth; and (5) the association between income growth and population growth depends on the level of birth and death rates, with the relation being slightly negative among countries with high birth and death rates, and positive among countries with relatively low birth and death rates.

II. Labor Supply and the Components of Population Growth

The labor supply forthcoming from a population depends on the number of persons in different age and sex groups and on the rate of labor force participation for each of those groups, i.e., the ratio of the number of individuals who are employed or unemployed and seeking work to the total number of individuals in the group. [4]   The history of fertility, mortality, and migration directly determines the number of persons in each age and sex group and is also likely to affect labor supply by influencing labor force participation rates within those groups, though economic and cultural factors also significantly influence those rates. [5]   In discussing the effects of population growth on labor supply, we refer to changes in labor supply due to changes in the size and age structure of the population at fixed labor force participation rates as "accounting effects" and to changes in labor supply due to changes in participation rates as "behavioral" effects.

With regard to accounting effects, there are two main points we wish to make about the interrelation between the components of population growth and labor supply. First, we note that changes in fertility and mortality that have the same effects on population growth can have different effects on the supply of labor, both immediately when the changes occur and later when the population achieves a stable form. This relation exists because fertility and mortality changes have different effects on the age distribution of a population. To illustrate, consider the two West model stable populations presented in McNicoll (1984a, p. 187). The first population has a birth rate of .045 and a death rate of .020 while the second population has a birth rate of .030 and a death rate of .005. The growth rates of population

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are thus the same, but the age distributions of the population are different: in the first model, 54 percent of the population falls between the ages 15 and 64 whereas in the second, 57 percent of the population falls in that working age category. Although this difference in age distributions is not great, it illustrates the point that even in stable populations the magnitude of the components of population growth will affect the age distribution independently of their crude difference (i.e., the crude growth rate). Given different labor force participation rates by age, the magnitudes of the components of growth will therefore also affect the size of the labor force, and, all else the same, per capita output. It also follows that the components of changes in the rate of population growth will exert independent influences on changes in labor supply and, other things equal, on economic well-being.

Second, in any time period, population growth will alter labor supply with a lag whose length depends on the reasons underlying the growth. For example, if population growth is the result of relatively high fertility or of an age distribution that is heavily concentrated in the childbearing years, the growth in any one year will have its impact focused at age 0 of the age distribution. Thus, it will take on the order of 10 to 15 years before the effects of a particular year's population growth begins to affect the labor force, and 20 to 25 years before the net additions to the population have a substantial impact on the labor force. [6] On the other hand, if population growth is mainly the result of substantial in-migration or of declines in mortality that are evenly spread throughout the age distribution (as occurs in middle mortality populations) the effects on labor supply will be more immediate.

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On the behavioral side, we note that fertility increases and mortality declines are likely to have immediate impacts on labor supply by altering labor force participation rates. Because childrearing and labor force participation are both time-intensive activities, declines in fertility could be expected to have immediate impacts on the size of the female labor force due to increases in female labor force participation rates. Empirical evidence on this point is, however, mixed, with participation rates of 30-45 year old women increasing as fertility declines in some countries but not in others -- presumably reflecting the importance of cultural factors and measurement problems related to female labor force participation. [7]

Mortality changes can also affect age-specific labor force participation rates, and perhaps more importantly, the quality and productivity of the work force. To the extent that individuals perceive a decline in mortality as extending their worklife horizons, they may delay entry into the labor force in order to acquire more education. Indeed, one of the most regular empirical patterns of change that occurs with development is the declining rate of labor force participation among the young as they continue in school -- a pattern that would make little economic sense if the young did not forsee increasingly long working lives.

Looking beyond labor supply issues, population growth is also likely to have different effects on investment and savings behavior, the composition of investment, and other broad economic phenonomena depending on the cause of growth. Growth due to reduced mortality among older persons can be expected to affect savings rates and is likely to spur greater investment in medical care facilities. As another example, growth due to increased fertility will tend to induce more investment in housing and education.

In sum, a priori analysis supports the view that the effects of any given level or change in population growth on labor supply and per capita income depend, at least in part, on both the timing and the underlying components of that growth or change in growth.

III. Empirical Patterns

We now present empirical evidence on the relationship between population growth, the components of growth, and changes in population growth and its components, across developing countries in the 1965-85 period. Most of the statistics we analyze are drawn from publications of the World Bank, and our analysis follows the conventional grouping of countries in those publications. Developing countries are classified by level of GNP per capita into three groups: low-income developing countries, consisting of 37 countries whose 1985 per capita GNP was less than $400 (the average per capita income for these countries was $270); lower middle-income developing countries, consisting of 36 countries with per capita incomes between $400 and $1600 (average per capita income of $760); and upper middle-income developing countries, consisting of 23 countries with GNP per capita above $1600 (average per capita income of $1890). We also present figures for 19 industrial market economies whose GNP per capita averaged $11,180. [8]

Table 1 reports several measures of population growth and its components for countries in each income group. First, we present average annual rates of population growth over the years 1965 to 1985. These rates of growth, which are calculated by the World Bank from regressions of the natural logarithm of population size on a time trend, are the standard

measures used in analyses of the relationship between population growth and economic development. Although they reflect a great deal of information about population growth in each year within the intervals they cover (including rates of net migration), they are consistent with a variety of time paths of instantaneous population growth rates (i.e., the rates of change in a particular year) and thus, with instantaneous population growth rates that increase, decrease, or remain stable over time. Based on the arguments of the preceding section, information on the timing of population growth has important implications for the growth of the labor force and therefore for the productive capacity of the population during the time period over which income growth is measured.

Hence, the second set of measures of population growth we report in Table 1 are the instantaneous rates of growth in 1965 and 1985. These growth rates, which are calculated as the differences between crude birth rates and crude death rates in 1965 and 1985, contain no information on the contribution of net migration to population growth. Neither do they reflect information on population growth in the years between 1965 and 1985. However, they convey useful information on the time path of the population growth rate, assuming that path has been approximately linear over time.

The third set of measures related to population growth reported in Table 1 are crude birth rates and crude death rates. As discussed above, these measures are more informative than instantaneous rates of population growth because they also reveal the position of a population along the spectrum of the demographic transition. In particular, they allow one to distinguish between populations that are growing slowly because they have either not begun the demographic transition (i.e., they have relatively high

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birth rates and high death rates) or because they have more or less completed the demographic transition (i.e., they have relatively low birth rates and low death rates). It is also worth noting that crude birth rates and death rates reflect the influence of a population's age structure on its rate of growth and that these rates are simply and usefully related to the instantaneous population growth rates (i.e., the instantaneous growth rate equals the crude birth rate minus the crude death rate). It therefore seems preferable to analyze the components of population growth in terms of these measures, rather than in terms of the measures used by Coale -- the total fertility rate and the expectation of life at birth -- that have neither of these properties. [9]

The statistics reported in Table 1 reveal several important aspects of recent demographic experience. First, with the marked exception of China, average population growth rates were extremely high in developing countries from 1965 to 1985, with implied doubling times of about 30 years. In comparison, the implied population doubling time for the industrial market economies was roughly 100 years. Second, the instantaneous growth rates show a decelerating trend in population growth. The growth rates in 1985 were below those in 1965 for every country group (except for the low-income countries, excluding China and India). The example of China is especially notable in this regard because the population growth rate in China declined by 1.4 percentage points over just a 20 year period. Such a rapid and substantial decline suggests that the Chinese population -- which grew at the relatively rapid annual rate of 1.9 percent from 1965 to 1985 -- is now increasing at a much slower pace than the Chinese labor force, which would tend to promote the growth of income per capita, other things equal.

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Third, birth and death rates have declined from 1965 to 1985 for all

income groups of developing countries. The declines in the birth rate

ranged from 3 per thousand in the low income countries (exclusive of India

and China) to 20 per thousand in China, while the declines in the death rate

ranged from 2 per thousand in the upper middle-income countries to 8 per

thousand in the lower middle-income countries and India. Moreover, the

birth and death rates do not show similar patterns of decline across country

groups. For example, the decrease in the population growth rate that would

have resulted from just the birth rate declines was offset to widely varying

degrees by the death rate declines across the country groups. Thus, the

structure of demographic change from 1965 to 1985 has not been uniform

across country groups, an indication of the potential importance of taking

account of the components of population growth in studying effects of

population changes on economic development.

It is important to recognize that the averages given in Table 1 mask

substantial country differences in growth rates and in the components of

growth within the same income grouping. With respect to population growth,

among the low-income countries, Kenya and Tanzania had, for example, average

growth rates of 4.1 and 3.5 percent between 1980 and 1985 while Sri Lanka

and Haiti had growth rates of 1.4 and 1.8 percent. As another example,

among upper middle-income economies Iraq and Algeria had population growth

rates of 3.6 and 3.3 percent from 1980 to 1985, roughly five times the rates

in Uruguay and Portugal.

Turning to the components of growth, we present in Table 2 the range of

1985 birth and death rates for countries divided into those above the median

and those below the median in terms of the average annual rate of population

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growth in their income category. The figures reveal a wide range of birth and death rate experiences for countries with comparable population growth rates. The statistics also reveal considerable overlap in the birth and death rate ranges for countries in different income groups. These patterns highlight the empirical significance of the analytical message conveyed earlier: that countries with similar population growth rates have different combinations of birth and death rates and thus may have very different labor supply and economic growth experiences.

To evaluate the significance of demographic transition in the period, we cross-classified developing countries according to whether their crude birth rates increased "significantly" (i.e., by more than 10 percent), decreased significantly, or did not move significantly from 1965 to 1985. Similarly, we divided the countries according to whether their crude death rates did or did not move up or down significantly. At a very simple level, the demographic transition model is consistent with a pattern of cross-classification in which countries experience either (1) significant declines in both their birth and death rates; (2) a drop in the death rate but no significant change in the birth rate; (3) a drop in the birth rate with no significant change in the death rate; or (4) no significant change in either the birth rate or the death rate. Of the 91 countries in our sample, 82 fell into one of these four cells, with the majority of those (54 percent) experiencing significant declines in both crude birth rates and crude death rates (see Table 3). The remaining countries were distributed fairly randomly across the five cells that are not consistent with the demographic transition model, although it is notable that not a single developing country experienced a significant increase in both its birth rate and death

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rate from 1965 to 1985. Insofar as these countries are not unusually concentrated among country income groups, the demographic transition model would appear to provide a reasonable construct for viewing the demographic experience of developing countries over the past two decades.

IV. Population Growth and Economic Outcomes

In this section we turn from the independent variables that reflect population growth experiences to outcome variables likely to depend, at least in part, on population growth. Rather than limiting our analysis to a single outcome measure -- say growth of per capita income -- we examine several variables: labor force growth, the proportion of a population of working age, and labor force participation rates; the sectoral distribution of the labor force and sectoral output per worker; and GNP per worker and per capita. Our concern with the sectoral distribution of the labor force between agriculture, industry, and services reflects the critical role that sectoral reallocation of labor has been shown to play in economic development (see Kuznets, 1965, 1984) and the importance of the traditional sector/modern sector dichotomy in 'dualistic' models of developing country labor markets (see Lewis, 1954). The main implication of these models for the impact of population growth on economic development (discussed at length in our earlier paper) is that rapid population growth is likely to reduce the rate at which "surplus labor" in the traditional sector is absorbed into productive employment and thus to postpone the elimination of economic dualism and the rise of living standards that characterizes modern economic growth.

A. Labor Supply

Table 4 presents growth rates of population and labor force for country groups for the periods 1965-1980 and 1980-1985. The statistics document the fact that changes in the rate of population growth are not immediately translated into changes in the rate of labor force growth: except for the

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upper middle-income countries, labor force growth accelerated between 1965-80 and 1980-85, despite the fact that population growth tended to decelerate or remain steady. This pattern is most accentuated for China, causing the labor force-to-population ratio to increase by 1.3 percent per annum between 1980 and 1985 (i.e., the difference between the growth rates of labor force and population).

To what extent are the observed changes in gross labor force participation rates the result of "accounting" effects that arise from shifts in the age distribution toward age groups with relatively high participation rates and to what extent are the changes the result of behavioral effects due to changes in labor force participation rates? Table 5 presents evidence that addresses this question. It reports the relative size of the working age population in different country groups and the ratio of the labor force (including persons aged less than 15 and over 64) to the working age population. The figures reveal an increase in the working age share of population in all income categories from 1965 to 1985 (except the low-income countries excluding China and India, where the share remained unchanged), with a remarkable ten point increase in China that brought its share to levels comparable to those of the industrial market economies. By contrast, the ratio of the labor force to the population aged 15-64 declined across country groups, except for a modest increase among the upper middle-income developing economies. Part of the decline in developing countries is likely to reflect increased attendance in school. At any rate, both the "accounting effects" and the "behavioral effects" of population growth on labor supply are sizable, although they work in opposite directions and tend to cancel each other -- perhaps for the reasons stressed by Easterlin (1968)

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-- the result being that the labor force-to-population ratio in developing
countries has remained fairly constant over the past two decades.

B. Sectoral Allocation of Labor

We examine next the rate at which the labor force in developing
countries shifted from agricultural to nonagricultural activities and the
level and changes in output per worker among sectors. As in our analysis of
population and labor force, we use World Bank data to examine patterns
across income groups. The three sectors on which the Bank provides data
are: agriculture (encompassing forestry, fishing, and hunting, as well as
agriculture) [10]; industry (manufacturing, mining, construction, and
utilities); and services (defined as a residual category of all economic
activity beyond agriculture and industry). Our focus on the shift of labor
out of agriculture does not imply that agricultural development is
unimportant in the growth process. To the contrary, the shift out of
agriculture is generally accompanied or preceded by sizeable increases in
productivity in agriculture, placing agricultural development at the center
of the labor adjustment process. [11]

The key findings of our analysis are that, despite the unprecedented
magnitude of population growth in the 1965-85 period, developing countries:
(1) shifted their work forces from low-productivity agriculture to the
higher-productivity service sector and to a somewhat lesser extent to the
high-productivity industrial sector; and (2) raised output per worker in all
sectors. In the following section we will examine whether countries with
greater or lesser population growth, or different sources of such growth,
were more or less successful along these dimensions of development.

Table 6 contains the evidence for our first claim: that developing

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countries shifted their work forces out of agriculture during the years 1965 to 1980. It reports the distribution of the labor force across economic sectors in 1965 and 1980 by country income categories. While we would have preferred to carry the analysis forward through 1985, 1980 is the latest year for which we are able to obtain data on the sectoral distribution of the labor force. Whatever changes occurred from 1980 to 1985 are, in any case, unlikely to have reversed the pattern of the preceding 15 years.

Comparing the fraction of the labor force engaged in agriculture across country income groups confirms the well-established fact that agriculture's share is inversely related to the level of economic development. Examing the agricultural share over time shows that the time-series pattern is roughly consistent with the cross-sectional pattern: the agriculture share of the labor force fell. Still, agriculture remains the largest employer of labor in the developing world (save for countries in the upper middle-income group). [12] Finally, the figures on industry and services show that the declining share of labor in agriculture coincided mainly with a shift in labor to the service sector, which tended to be larger than industry in both 1965 and 1980, though here as elsewhere China is exceptional. In the case of China, the industry share of the labor force increased by 75 percent between 1965 and 1980 to exceed the services share.

Declines in the share of workers in agriculture in a period of growing labor supply does not, of course, imply declines in the absolute number of workers in the sector. Indeed, in the developing world taken as a whole, the size of the agricultural labor force increased by nearly one-fourth from 1965 to 1980, from 668 million to 823 million individuals. It is notable, however, that the upper middle-income countries experienced a 10 percent

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decline in the size of their agricultural labor force during this period.
[13]

Shifts in the distribution of the labor force from agriculture to services and industry contribute (all else the same) to increasing income per capita because sectoral output per worker tends to be higher in industry and services than in agriculture. We document the differences in output per worker in Table 7, where we report ratios of gross domestic product per worker by sector in 1965 and 1980 to the economy-wide gross domestic product per worker. Figures greater than 1.0 indicate that a sector has above-average labor productivity. Figures below 1.0 indicate the reverse. In all of the developing country groups, agriculture has markedly below-average labor productivity whereas industry has the highest product per worker. In the industrial market economies, by contrast, and to a growing extent in the upper middle-income developing countries, output per worker in industry is roughly at the economy-wide average.

To estimate the contribution of shifts in the distribution of the labor force to the growth of GDP per worker in the economy as a whole, we have used the 1965 and 1980 relative GDP per worker figures as "productivity weights", and calculated the percentage change in GDP per worker attributable to the observed changes in the distribution of the labor force: this is simply the sum of the productivity weights multiplied by the change in shares. The results, summarized in Table 8, show that the changes in the sectoral distribution of labor contributed importantly to observed productivity growth, whichever set of weights is used. This pattern is especially strong in China, where between one-third and one-half of the growth in GDP per head from 1965 to 1980 is attributable to the shift in

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labor force out of agriculture.

C. Output Per Worker

In the pessimists' scenario, population-induced increases in labor supply have adverse consequences for productivity per worker, particularly in the 'labor surplus' agricultural sector. Did the 1965-1980 increase in labor force reduce sectoral productivity in developing countries in accord with this view?

The figures in Table 9 suggest that it did not. Indeed, exactly the opposite occurred in this period of rapid population growth: for each sector, the growth of GDP exceeded the growth of the labor force -- for all income groups of economies. The net result of increasing output per worker by sector and shifts in the distribution of the labor force towards more productive sectors are increases in GDP per worker in the overall economy.

Finally, while there was some decline in labor force per capita from 1965 to 1985 in developing countries, its effect on per capita output was dwarfed by the increase in per worker output, the net result being a large increase in per capita output. While this pattern does not imply that population growth over this period contributed to economic development, nor rule out the possibility that it hindered development, it certainly gainsays the worst fears of the population pessimists. Despite population increasing rapidly -- more rapidly than the labor force until the 1980s -- developing countries managed, on the whole, to improve their economic positions significantly.

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V. Effects of the Timing and Components of Population Growth

In this section, we turn our attention to the following two questions:

(1) Whether over the past two decades, countries with more rapid population growth had relatively better or worse rates of economic development than countries with less rapid population growth?

(2) Whether differences in the timing and components of population growth had affected the rate of economic growth in countries with the same overall rate of population growth?

As both of these questions relate to differences in performance among countries, we change analytic focus and technique. Instead of examining averages for groups of countries, we use a multiple regression model to relate indicators of economic development for individual countries to growth rates of population, and to levels of birth and death rates. Our observations consist of all developing countries in the World Bank data set for which the requisite data are available. To differentiate between countries with differing levels of income and other circumstances, we include in all of our specifications the log of 1965 per capita GNP and a vector of dummy variables relecting each country's regional location.

Table 10 presents the results of regressing the rate of growth of several economic outcomes on the rate of growth of population for the periods 1965-85, 1965-80 (recall that labor force distribution figures are available only through 1980) and, for 1980-85. While the statistical analysis shows some positive and some negative associations between population growth and economic outcomes, the overriding pattern of results provides no support for the population optimist point of view, and some support for both the neutralist and pessimist views. The best single

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summary measure of outcome -- growth of GDP per capita -- is essentially unrelated to the growth of population over the long run. Labor force per capita is negatively related to the growth of population from 1965 to 1980 and from 1965 to 1985, but its effect on the growth of per capita output is offset by the statistically weak but positive relation between the rate of growth of population and the growth of GDP per laborer shown in the third row of estimates.

In the 1980-1985 period, by contrast, population growth is negatively associated with growth of GDP per capita, with an increased negative coefficient on the growth of labor force per capita and a negative rather than positive association with growth of GDP per worker. This pattern of results suggests that, in a weak world economy, countries with rapid population growth (which cannot be "turned off" readily) may be at greater risk of suffering setbacks in economic growth than countries with less rapid population growth. [14] Although we are reluctant to extrapolate or generalize from this relatively short period of time, this evidence does favor the population pessimist view.

Looking within sectors, the data reject strongly the implications of the dualistic labor market model that faster population growth reduces the movement out of agriculture and retards growth of labor productivity in agriculture. The regression estimates show exactly the opposite: more rapid reductions in the share of the labor force in agriculture and more rapid increases in GDP per worker in agriculture in countries with faster rates of population growth, though neither relation is exceptionally strong. The most sensible interpretation of these regressions is that population growth has little or, at most, a weak relation to the sectoral allocation of

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labor and to labor productivity within sectors.

We now turn to the relation of per capita income, labor force, and productivity to the timing and components of population growth. First, we replace the average population growth rate with the instantaneous population growth rates in 1965 and 1985 in the regression equations in Table 10. This specification provides us with a measure of the association between the acceleration/deceleration of population growth and the indicators of economic development. As can be seen in the first panel of Table 11, past population growth is positively associated with labor force participation, labor productivity, and GNP per capita while the present rate of population growth is negatively associated with those same variables. Second, in panel 2 of Table 11 we replace the 1965 and 1985 population growth rates by their difference and control for the average rate of population growth. Here we see that while average population growth has no relation to the growth of per capita income, countries with more sharply declining rates of population growth tend to have a higher rate of per capita income growth, both because they are able to enjoy higher rates of labor force per capita and because of increases in GDP per worker. In part, these findings reflect the lag between growth of population and labor force, as countries with declining rates of growth will tend to have an older population, and thus a higher proportion of their population concentrated in the working ages and generating savings that can be used to finance investments in both human and physical capital that will generate returns relatively quickly. Overall, these results provide strong evidence that the time path of population growth exerts an influence on economic development that is independent of the level of population growth. The results modify, but do not contradict,

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the population neutralist view that we expressed in our earlier work, as different steady states of population growth are estimated to have essentially no effect on per capita income growth.

In panel 3 of Table 11 we report the results of regressions with crude birth rates and crude death rates in 1965 and 1985 included as regressors. These specifications essentially break up the instantaneous growth rates in panel 1 into their components. However, the estimates provide relatively little additional insight beyond that gained from the constrained estimates reported in panel 1. At the margin, high birth rates in the past are associated with higher growth rates of labor force, labor productivity, and output per capita, while high birth rates in the present are associated with slower growth of labor force, productivity, and output per capita. Death rates tend to have an association with labor force growth that is opposite in sign to that of birth rates, but of greater magnitude. This pattern is probably due to the fact that changes in the death rate in most developing countries partly reflect improvements in infant and child mortality, which are demographically similar to increased birth rates, and partly reflect reduced mortality in the working ages that has a more immediate effect on the size of the labor force. The one puzzling result in the table is that the coefficients on the death rate in 1985 do not have equal and opposite signs to those on the birth rate in 1985 in the regressions for GNP per capita and per worker. Perhaps further decomposition of death rates by age is needed here.

The estimates in panel 4 of Table 11 are from a regression specification in which the coefficient on the average annual rate of population growth from 1965 to 1985 is allowed to depend on the level of

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fertility and mortality. In particular, we divided the sample into thirds according to the sum of birth rates and death rates for different countries. By interacting the population growth rate with dummy variables reflecting which of the three groups each country falls into, we are able to test whether population growth affects economic development differently for countries at different stages of the demographic transition. The estimates indicate that the insignificant correlation between population growth and the growth of GNP per capita (.01, with a standard error of .36 -- not reported in Table 10 where we focus instead on GDP per capita) is an average of (1) a moderately-sized positive relation among countries with the lowest birth and death rates (i.e., countries that tend to be closest to completing the demographic transition), (2) a small positive (and imprecise) relation among countries that were in the midst of the demographic transition over the years 1965 to 1985, and (3) a small (and imprecise) negative relation for countries that had not begun the demographic transition. For all three groups of countries, population growth is negatively associated with the growth of labor force per capita, with the strength of the association tending to be strongest for those countries with moderate and high birth and death rates. By contrast, productivity growth shows little association with population growth among the high fertility/mortality populations and is positively related to population growth among the low and middle fertility/mortality populations. The positive link between population growth and productivity and per capita income growth for the low fertility/mortality group represents the only evidence we have found that is consistent with the population optimist view that population growth promotes economic development. As the results for the other two country groups do

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not show such a pattern, however, the safest generalization appears to be the neutralist view that the overall effect of population growth on economic development is negligible although its impact seems to differ depending on the levels of birth and death rates.

In sum, the estimates in Table 11 support the view that it is useful to go beyond simple correlations between average rates of population growth and economic development to consider the relation between the timing of population growth and the underlying components of that growth and economic development. The next step in the analysis should be to examine these relations in a broader model that considers not only the impact of population growth on per capita income but also the feedback effects of economic development on population growth.

VI.   Conclusion

This paper has reported the results of research on the relationships between the timing and components of population growth and the economic growth experienced by developing countries from 1965 to 1985. The results indicate that developing countries were able to shift their labor force from low-productivity agriculture to the higher-productivity industry and service sectors, and to increase productivity within those sectors, despite the rapid growth of their populations. We also find that at given rates of population growth, income growth is related to the time path of population growth and that population growth due to high birth and death rates is associated with slower income growth than population growth due to relatively low birth and death rates. Hence, the timing and components of population growth appear to be important elements in the process of economic development.

Notes

1. By developed countries we mean Western Europe, Australia, New Zealand, Japan, Canada, and the United States, as indicated in the World Development Report 1987 (World Bank, 1987). Except for countries with mid-1984 populations below one million, high-income oil exporters, and East European non-market economies, all other countries are considered less developed, despite the wide range of industrialization and income per capita among them.

2. See Bloom and Freeman, 1986.

3. See Bloom and Freeman, 1986.

4. We limit our discussion to the size of the labor force, to the exclusion of other important aspects of supply, such as hours worked and the education, skill, and motivation of the labor force. These characteristics, while imporant determinants of a country's productive capacity, raise issues that are beyond the scope of this paper.

5. Easterlin (1968) presents evidence that rapid growth of the population of working age in the U.S. was associated with slower growth of labor force participation rates.

6. This simple insight into the dynamic relationship between population and labor force growth underlay some of the main results derived by Coale and Hoover (1958) in one of the earliest neoclassical treatments of the relationship between population and economic growth.

7. See Durand (1975) for a thorough empirical study of labor force

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participation rates in less developed countries. See Standing (1976), Dixon (1982), and Anker (1983) for thorough treatments of the problems involved in measuring the labor force participation of women in developing countries.

8. Countries for which per capita GNP data are either unavailable or unreliable are classified on the basis of characteristics likely to be correlated with income. These countries are not included in the regression analyses reported below.

9. See Entwisle (1981) for some further analysis of this issue.

10. Since much agricultural production in developing countries is not exchanged, the World Bank has imputed part of its value for many countries.

11. Ideally, we would also like to analyze the wage effects of rapid population growth. Unfortunately, the sketchy and unreliable nature of wage data for most developing countries render such an analysis beyond the scope of this paper. However, we will analyze variations in a kindred measure -- output per worker -- across sectors and over time.

12. See Kuznets (1984) for a detailed analysis of the decline of agricultural employment.

13. See the data in the 1987 World Development Report.

14. One possible reason for this is that the world economic slowdown may compress rates of growth of GDP across countries, so that given rates of population growth have more adverse effects on per capita income growth. Another possibility is that the 1980-1985 period is simply a short-run aberration.

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Table 1. Growth rates of population and components of growth by type of economy, 1965-85

Type of economy	1985 population (millions)	Average annual population growth rates (percent) 1965-85	Instantaneous population growth rates (percent) 1965	1985	Change
Low-income	2415.3	2.2	2.6	1.9	-0.7
China	1040.3	1.9	2.6	1.2	-1.4
India	765.1	2.3	2.5	2.1	-0.4
Other	609.8	2.7	2.5	2.8	0.3
Lower middle-income	672.0	2.5	2.7	2.5	-0.2
Upper middle-income	567.2	2.1	2.5	1.9	-0.6
Industrial market	737.3	0.8	1.1	0.4	-0.7

Type of economy	Birth rate (per thousand population) 1965	1985	Change	Death rate (per thousand population) 1965	1985	Change
Low-income	43	29	-14	17	10	-7
China	39	19	-20	13	7	-6
India	45	33	-12	20	12	-8
Other	46	43	- 3	21	15	-6
Lower middle-income	44	36	- 8	17	11	-8
Upper middle-income	36	28	- 8	11	9	-2
Industrial market	20	13	- 7	9	9	0

Source: World Bank (1987).

Table 2.   Ranges of birth and death rate experiences with different rates of population growth, by type of economy, 1985.

Type of economy	Countries with above average population growth rates within their income group		
	Birth rate (per thousand population)	Death rate (per thousand population)	Birth rate plus death rate (per thousand population
Low-income	34 - 54	8 - 21	42 - 72
Lower middle-income	33 - 49	7 - 16	40 - 65
Upper middle-income	17 - 44	5 - 14	23 - 58
Industrial market	19 - 23	6 - 9	25 - 31

Type of economy	Countries with below average population growth rates within their income group		
	Birth rate (per thousand population)	Death rate (per thousand population)	Birth rate plus death rate (per thousand population
Low-income	19 - 50	6 - 26	26 - 76
Lower middle-income	22 - 50	4 - 21	29 - 69
Upper middle-income	12 - 26	6 - 13	23 - 33
Industrial market	16 - 19	9 - 12	26 - 30

Source: Authors' calculations from World Bank (1987).

Table 3. Number of economies within each income group, by birth and death rate experiences, 1965-85.

	Increase in birth rate	No change in birth rate	Decrease in birth rate
Increase in death rate	0 low-income 0 lower middle-income 0 upper middle-income	1 low-income 0 lower middle-income 2 upper middle-income	0 low-income 0 lower middle-income 4 upper middle-income
	0 all developing	3 all developing	4 all developing
No change in death rate	0 low-income 0 lower middle-income 0 upper middle-income	1 low-income 0 lower middle-income 2 upper middle-income	0 low-income 0 lower middle-income 3 upper middle-income
	0 all developing	3 all developing	3 all developing
Decrease in death rate	1 low-income 1 lower middle-income 0 upper middle-income	22 low-income 9 lower middle-income 1 upper middle-income	9 low-income 24 lower middle-income 11 upper middle-income
	2 all developing	32 all developing	44 all developing

Source: World Bank (1987).

Note: An increase or decrease in the birth or death rate is defined here as a change of ten percent or more from the 1965 birth or death rate.

Table 4. Growth rates of population and labor force, by type of economy, 1965-80 and 1980-85.

Type of economy	Average annual population growth rates (percent)		Average annual labor force growth rates (percent)		Differences in growth rates (labor force minus population)	
	1965-80	1980-85	1965-80	1980-85	1965-80	1980-85
Low-income	2.3	1.9	2.1	2.3	-0.2	0.4
China	2.2	1.2	2.4	2.5	0.2	1.3
India	2.3	2.2	1.7	2.0	-0.6	-0.2
Other	2.7	2.7	2.2	2.5	-0.5	-0.2
Lower middle-income	2.5	2.5	2.4	2.6	-0.1	0.1
Upper middle-income	2.2	2.0	2.6	2.3	0.4	0.3
Industrial market	0.9	0.6	1.3	1.0	0.4	0.4

Source: World Bank (1987).

Table 5. Breakdown of labor force per capita, by type of economy, 1965 and 1985.

Type of economy	Labor force per capita (percent)		Population aged 15-64 (percent (of population)		Labor force per person aged 15-64 (percent)	
	1965	1985	1965	1985	1965	1985
Low-income	46	45	54	59	85	76
China	45	50	55	65	82	77
India	41	37	54	56	76	66
Other	38	35	52	52	73	67
Lower middle-income	38	37	52	55	73	67
Upper middle-income	36	38	56	58	64	66
Industrial market	n.a.	n.a.	63	67	n.a.	n.a.

Source: World Bank (1986, 1987).

n.a. = not available

Table 6. Percent distribution of labor force across economic sectors, by type of economy, 1965 and 1980.

| Type of economy | Percent of the labor force in | | | | | |
| | Agriculture | | Industry | | Services | |
	1965	1980	1965	1980	1965	1980
Low-income	78	72	9	13	13	15
China	81	74	8	14	11	12
India	73	70	12	13	15	17
Other	78	70	8	10	14	20
Lower middle-income	66	55	12	15	22	29
Upper middle-income	45	29	24	31	30	40
Industrial market	14	7	38	35	48	58

Source: World Bank (1987).

Table 7. Gross domestic product per worker, for each sector, relative to gross domestic product per worker in the economy as a whole, by type of economy, 1965 and 1980.

Type of economy [a]	Agriculture		Industry		Services	
	1965	1980	1965	1980	1965	1980
Low-income	0.54	0.50	3.11	2.69	2.31	1.93
China	0.48	0.42	4.75	3.36	2.09	1.83
India	0.64	0.53	1.83	2.00	2.07	2.18
Other	0.53	0.63	2.25	1.70	2.93	2.00
Lower middle-income *	0.44	0.62	2.00	1.55	1.74	1.50
Upper middle-income *	0.33	0.37	1.48	1.46	1.59	1.14
Industrial market	0.36	0.57	1.05	1.06	1.15	1.07

Source: World Bank (1982, 1984, 1987) and Table 6.

* 1980 figures are 1982 GDP share divided by 1980 labor share. GDP figures for 1980 are not separately available for the lower and upper middle-income countries.

[a] Figures are not completely comparable because some countries have changed income groups over the period.

Table 8. Estimates of the percentage change in GDP per worker attri-
butable to shifts in the sectoral distribution of labor, by country
group according to type of economy, 1965-80.

Type of economy	Assuming 1965 relative GDP per worker	Assuming 1980 relative GDP per worker
Low-income	14.0	13.3
China	48.5	31.0
India	2.3	3.5
Other	10.3	10.9
Lower middle-income	16.8	15.8
Upper middle-income	19.3	16.4
Industrial market	6.5	0.5

Source: Tables 6 and 7, calculated by applying 1980 distribution of
labor force to 1965 relative GDPs per worker and 1965 distributions of
labor force to 1980 relative GDPs per worker.

Table 9. Percent increase of real GDP and of the labor force by sector from 1965 to 1980 by type of economy.

	Real GDP			
Type of economy	Overall	Agriculture	Industry	Services
Low-income	102.0	49.1	200.0	107.9
Middle-income	157.2	67.5	200.0	164.5
Industrial market	72.5	19.6	70.0	77.5
	Labor force			
Type of economy	Overall	Agriculture	Industry	Services
Low-income	36.6	27.7	97.3	46.4
Middle-income	44.8	11.2	95.9	82.3
Industrial market	21.4	-39.3	11.8	46.6

Source: Authors' calculations using data contained in World Bank (1987).

Table 10. Regression estimates of the effect of population growth on measures of economic growth and development in developing countries, 1965-80, 1980-85, and 1965-85. [a]

Measure of economic growth or development	Coefficient of population growth [b]		
	1965-80	1980-85	1965-85
Growth rates of:			
GDP per capita	0.24 (0.33)	-0.86 (0.49)	-0.05 (0.34)
Labor force per capita	-0.30 (0.09)	-0.42 (0.10)	-0.30 (0.09)
GDP per laborer in			
All sectors	0.55 (0.32)	-0.44 (0.48)	0.36 (0.32)
Agriculture	1.00 (0.46)		
Industry	0.60 (0.79)		
Services	-0.03 (0.52)		
Change in the percent of the labor force in			
Agriculture	-0.52 (0.88)		
Industry	0.24 (0.55)		
Services	1.22 (0.77)		

[a] The coefficients are from regressions of the measure of economic growth or development on the average annual percentage increase in population, the natural logarithm of GNP per capita in 1965, and six regional dummy variables. The measures of economic growth or development are average annual growth rates except for the changes in the percent of the labor force by sector, which are raw differences in the percent of the labor force in each sector. All dependent variables, as well as the average annual growth in population, are measured in percentage points. The regions used in the regressions are Sub-Saharan Africa, Middle East and North Africa, East Asia and Pacific, South Asia, Latin America and the Caribbean, and Southern Europe.

Care was taken to use the most complete set of data possible. The regressions of growth rates of GDP per capita, labor force per capita, and GDP per worker in the whole economy are regressions from samples with of 75 observations. Because of the nature of the data constraints, however, the sample sizes for the sectoral regression estimates range from 61 to 77 observations.

[b] Estimated standard errors are reported in parentheses.

Data source: World Bank (1982, 1983, 1987).

Table 11. Regression estimates of the effect of demographic variables on measures of economic growth and development in developing countries, 1965-85. [a]

Estimated coefficients [b]	Dependent variables (Average annual growth rates)		
	GNP per capita	Labor force per capita	GDP per worker
Model 1:			
POP65	1.58 (0.50)	0.61 (0.11)	0.92 (0.49)
POP85	-1.79 (0.50)	-0.69 (0.11)	-0.80 (0.49)
Model 2:			
AVPOP	0.24 (0.33)	-0.22 (0.07)	0.49 (0.32)
(POP85 - POP65)	-1.74 (0.46)	-0.60 (0.10)	-0.98 (0.44)
Model 3:			
BIRTH65	0.50 (0.59)	0.54 (0.14)	0.06 (0.59)
BIRTH85	-1.10 (0.59)	-0.58 (0.14)	-0.35 (0.59)
DEATH65	-0.70 (1.00)	-0.92 (0.24)	0.29 (1.00)
DEATH85	-1.30 (1.21)	0.91 (0.28)	-2.24 (1.21)
Model 4:			
AVPOP * LOW	0.73 (0.47)	-0.13 (0.11)	0.78 (0.43)
AVPOP * MID	0.30 (0.39)	-0.33 (0.09)	0.59 (0.37)
AVPOP * HIGH	-0.20 (0.36)	-0.30 (0.09)	0.21 (0.34)

[a]   The coefficients are from regressions of the dependent variable on the listed independent variables.   In addition, all four models also include, as independent variables, six regional dummy variables and the natural logarithm of 1965 GNP per capita.   The regions used in the regressions are the same as those used in Table 10, and each regression was fit on a sample of 75 observations.

[b]   Estimated standard errors are reported in parentheses.

Data source: World Bank (1983, 1987).

Definitions of independent variables used in regressions in Table 11.

Independent variable	Explanation
AVPOP	Average annual population growth, 1965-85 (percentage points)
POP65	Annual population growth rate, 1965 (percentage points)
POP85	Annual population growth rate, 1985 (percentage points)
BIRTH65	Annual birth rate, 1965 (births per hundred population)
BIRTH85	Annual birth rate, 1985 (births per hundred population)
DEATH65	Annual death rate, 1965 (deaths per hundred population)
DEATH85	Annual death rate, 1985 (deaths per hundred population)
LOW	A dummy variable equal to one for countries in the lowest third of developing countries ranked by values of birth rate plus death rate (average of 1965 and 1985 values), and equal to zero otherwise.
MID	A dummy variable equal to one for countries in the middle third of developing countries ranked by values of birth rate plus death rate (average of 1965 and 1985 values), and equal to zero otherwise.
HIGH	A dummy variable equal to one for countries in the high third of developing countries ranked by values of birth rate plus death rate (average of 1965 and 1985 values), and equal to zero otherwise.