The Economic Lifecycle and Population Age Structure:

A substantive report of work accomplished during the 38th Summer Seminar on Population Workshop on Population, Development, and Policy: The Economic Payoffs of Population Change

31 July 2007

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This report was prepared by and summarizes research conducted at the Workshop on Population, Development, and Policy: The Economic Payoffs of Population Change, 38th Summer Seminar on Population, May 29 – June 28, 2007, Honolulu, HI. Support for the workshop from the John D. and Catherine T. MacArthur Foundation is gratefully acknowledged. We also appreciate valuable input from Ernesto Amaral, Ann Blanc, David Bloom, Jorge Bravo, David Canning, Margaret Greene, Judith Helzner, Ronald Lee, Li Ling, Anju Malhotra, Tom Merrick, Rachel Nugent, Naohiro Ogawa, Joe Potter, Luis Rosero-Bixby, T. Paul Schultz, and Hania Zlotnik.

Introduction

This report describes the first of two linked workshops on the economic payoffs to demographic change held at the East-West Center May 29 – June 27, 2007. (The second workshop will be held in June, 2008.) The workshop brought together teams of researchers from eight countries to learn about and work on the demographic dividend and related policy issues. The main rationale for the workshop was to extend work on the demographic dividend by enhancing existing work, creating a broader network of researchers actively working on this topic, and developing instructional materials. The workshops were funded by a generous grant from the John D. and Catherine T. MacArthur Foundation that will also provide modest support for the work of the teams in the interim between the two workshops.

The countries represented in the workshop—India, China, Indonesia, the Philippines, Kenya, Nigeria, Mexico, and Spain/Brazil—are highly diverse in their levels of development, geographic locations, and demography, including their age structures. For example, while China and Mexico have experienced rapid fertility decline and currently enjoy age structures favorable to economic growth, the two sub-Saharan countries have had modest fertility declines at best and still have age structures dominated by large populations of children and youth. A comparison of results among the eight countries thus offers an opportunity to further document the economic effects of age-structure change. This comparison will be an important focus of the second workshop.

After describing the substantive issues and methodological approaches with which the first workshop dealt, the report goes on to present preliminary results for the eight countries. Annexes provide detailed information on data, methods and workshop participants.

Population Age Structure and the Economic Lifecycle

This section describes the demographic changes on which the workshops focus and outlines their potential economic consequences.

Demographic Transition and Age Structure

For many decades, economists' have addressed the role of demographic change in economic growth. Is rapid population growth a barrier to economic development, as the path-breaking study by Coale and Hoover published in 1958 claimed? Or is population growth a spur to innovation and economic development, as argued by other economists, including Ester Boserup (1965) and Julian Simon (1981)? A panel of distinguished economists and demographers convened by the National Academy of Sciences in the mid-1980s (National Research Council 1986) concluded that the evidence for both points of view was mixed, and that the soundest conclusion was that population size and growth

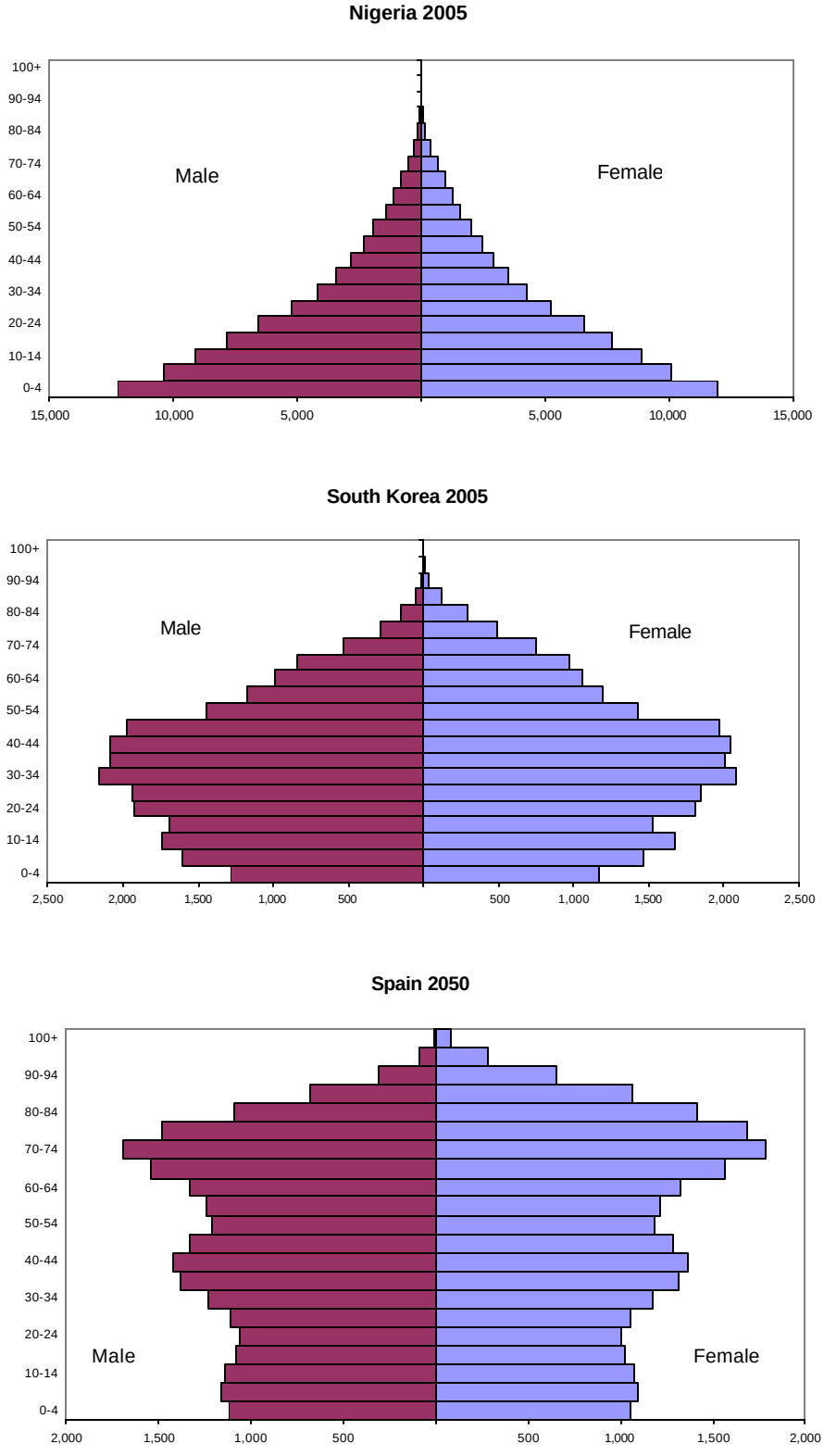
were neither an absolute barrier nor absolute stimulus to economic growth. In particular circumstances, they might have important economic consequences, but generally, such effects were thought to be modest as compared to the other factors that encourage economic growth.

In the past decade, stimulated in part by a desire to explain the extremely rapid economic growth experienced by several East Asian countries, economic demographers have increasingly turned their attention to a different aspect of population change than size or growth rate, namely, to changes in the population's age structure. During the demographic transition, populations first experience a decline in infant and child mortality. This decline increases the number of children surviving to adulthood. In response to this increased survival of children, as well as to social and economic shifts, fertility eventually begins to decline. As it does so, it automatically changes the distribution of the population across the age groups. Initially, the proportion of children declines while the proportion of working-age adults increases—and the proportion of elderly remains small. Eventually, like the pig in the python, the large cohorts of workers reach retirement age, reducing the relative size of the working ages and eventually expanding the proportion of elderly. Improvements in old-age mortality also contribute to this aging of the population.

The rapidity and extent of the demographic transition varies across populations. While the countries of Europe and North America experienced the demographic transition over a century or more, many of the developing countries in Asia, Eastern Europe, and Latin America experienced rapid mortality decline after World War II, followed by rapid fertility decline in the last quarter of the twentieth century. Still other countries have yet to experience the second part of demographic transition, namely, the decline in fertility.

Because of the compression of the demographic transition in many East and Southeast Asian and Latin American countries, the changes in age structure that invariably follow the decline of fertility were far more dramatic than in the history of the Western countries. Many developing countries that have had broad-based age structures like the one for Nigeria in 2005 shown in the first panel of Figure 1 quickly shifted to an age structure with a middle-aged bulge like the one for South Korea shown in second panel. In the future, these countries will develop top-heavy age structures like the one for Spain projected for 2050 shown in the lower panel.

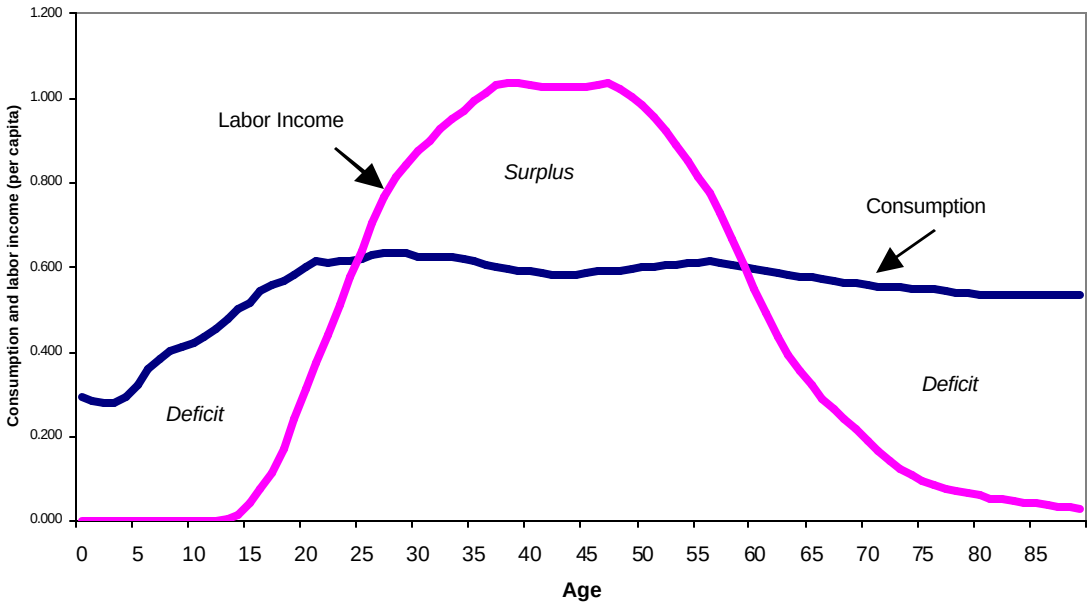
Figure 1
Population Pyramid, selected countries



Economic Lifecycle

The changes in age structure that result from the demographic transition have economic consequences. These consequences reflect the long periods of dependency that are characteristic of the human life span. In most settings, human children are unable to support themselves until they are in their mid-teens to early twenties, and the elderly gradually lose their ability to support themselves as they experience the disabilities and diseases associated with normal aging. A substantial proportion of any human population thus consists of dependents—individuals who are not fully independent, economically. Because the periods of dependency occur at the beginning and end of the life span, the shape of a population's age structure determines its dependency burden, that is, the number of working-age adults relative to the number of children and the elderly. The decline of fertility that occurs during the demographic transition reduces the proportion of children in the population while the proportion of the elderly remains small, a shift that is favorable to economic growth. This shift lowers the dependency burden on working age adults, and unless other forces bar an expansion of the labor force, it increases the relative size of the labor force and hence the economy's total output.

Figure 2
The economic life-cycle profile for the developing world



Source: Lee and Mason (2007); UN (2007).

Many previous studies have emphasized dependency and have used dependency ratios or other crude measures of population age structure in relation to economic change. Relatively little is known, however, about the ages during which people are dependent and whether the extent of that dependency varies in important ways by the age of dependents. Estimates of the economic lifecycle can be used to answer these questions

and, more importantly, to assess how public policy influences the economic lifecycle. Figure 2 illustrates the economic lifecycle for developing countries (Lee and Mason, 2007; UN 2007). It shows that consumption rises steeply during early childhood and remains relatively constant throughout the adult years into old age. In contrast, productivity (as measured by labor income) is zero at birth and rises above consumption only in the early 20s, and remains well above consumption until the late 50s. It falls in the older adult years, becoming lower than consumption in the late 50s or early 60s. Thus, throughout an extended period of childhood as well as an extended period in old age, the average consumption of individuals exceeds the income they are producing through their labor.

It is widely believed that the ages of dependency vary considerably with economic development, specifically, that child dependency lasts longer and old-age dependency begins earlier in higher income countries. The evidence on these points is partial and incomplete, however. To a great extent this view is based on labor force participation data and other labor supply measures that show that the age at labor force entry rises and the age of withdrawal declines as incomes rise. (Evidence on this is more clear-cut for males than females.) Labor force participation and labor supply do not, however, provide a complete measure of productivity. The extent to which productivity rises and declines, at what ages, and how this varies with income levels remain poorly understood.

Also poorly understood is how public policy concerning such areas as education, labor force participation, retirement, investment, trade, and the rights of males vs. females affects the economic lifecycle. Such policies could conceivably either reinforce or mitigate the impact of changes in population age structure on economic growth. For examples, it is widely believed that publicly funded retirement systems in which current workers support current retirees discourage saving for old age, something that in turn may undermine the beneficial economic effects of a favorable age structure. In contrast, an asset based public pension system that, in effect, forces workers to save for their retirement may provide additional capital that amplifies the economic growth that a favorable age structure produces.

How the age profile of consumption changes with development is less well understood than how the production profile changes—and because dependency reflects both consumption and production, our ignorance of age-specific consumption contributes to our ignorance about dependency. Also poorly understood is how policy affects consumption profiles.

National Transfer Accounts as a Tool to Study the Economic Lifecycle

How changes in population age structure affect the rate at which the economy grows is an inherently macro-level issue. It concerns the entire population and economy, ideally incorporating both individual features of households or persons and market factors such as wages and interest rates. There are basically two approaches used to study the links

between age structure change and economic growth. One is the traditional regression-based growth equation approach in which data for a large number of countries are used to estimate equations in which growth of gross domestic product per capita is a function of a variety of factors of production plus population age structure and changes therein. Use of such models is largely associated with David Bloom and David Canning and their colleagues at Harvard (e.g., Bloom, Canning, Malaney 2000). These models directly estimate the impact of age structure or age structure changes on GDP per capita growth, net of a variety of other factors that are thought to influence economic growth. These models are conceptually straightforward and provide a strong empirical basis for assessing the overall effects of changing age structure.

A second approach in wide use is based on National Transfer Accounts (NTA) associated primarily with Ron Lee at Berkeley and Andy Mason at Hawaii (Mason et al. forthcoming). National Transfer Accounts are a refinement of National Income and Product Accounts (NIPA) that attribute all economic outputs and inputs (income and consumption) to specific single year age groups. NTAs used income, consumption and labor force surveys along with NIPA information and population estimates to derive the level of private and public consumption for education, health care, and other goods and services at each age in the population. They also use similar sources to estimate the level of labor income at each age. The primary output from these estimates is the Life Cycle Deficit—a portrait of economic dependency that measures the extent to which consumption exceeds labor income at each age. The LCD can be used to understand the demographic dividend (how changes in population age structure affect economic growth) and how policies can influence the magnitude and timing of the dividend. Further details on NTA methods can be found on the NTA website: www.ntaccounts.org.

Support Ratio and the First Demographic Dividend

Changes in population age structure produce changes in economic support ratios. The economic support ratio is obtained by dividing the effective numbers of producers (L) by the effective numbers of consumers (N). The effective numbers come from the multiplication of the labor income profile (L) or consumption profile (N) by the population. Both labor income and consumption age profiles are obtained from the NTA. The economic support ratio, thus, is:

$$\frac{L_{(t)}}{N_{(t)}} = \frac{\sum_{a=0}^{v} g_{(a)} P_{(a,\,t)}}{\sum_{a=0}^{v} q_{(a)} P_{(a,\,t)}} \qquad (1)$$

where g is the labor income profile, q the consumption profile, and P is the population of a certain year. Note that income per effective consumer, a measure of per capita income adjusted for age- variation in consumption, is the product of the support ratio and income per worker:

$$\frac{Y}{N} = \frac{L}{N}\frac{Y}{L} \qquad (2)$$

In growth terms, the growth rate of income per effective consumer depends on an age structure effect and a productivity effect that measures the income (or output) produced by the "average" prime age (30-49) adult:

$$g\left[\frac{Y}{N}\right] = g\left[\frac{L}{N}\right] + g\left[\frac{Y}{L}\right] \qquad (3)$$

Given productivity (output per effective worker), an increase in the support ratio yields a percentage-point-for-percentage-point increase in income per effective consumer. When the rate of growth in the support ratio is positive, we have what we call the (first) demographic dividend.

The demographic dividend emphasizes the relationship between *changing* age-structure and economic growth. When the dividend is positive, the support ratio is increasing and, given productivity gains, producing more rapid growth in output per effective consumer. Mason (2005) found that, at its peak, the dividend contributed 0.67 percentage points per year to economic growth in the US (1985-90) and 1.25 percentage points per year to economic growth in Mexico (1995-2000).

The changes in age structure bring about another potential dividend. As the population age structure becomes older, more working-age adults face the possibility of living longer. Unless they expect their family or the state to provide fully for their retirements years, they have incentives during their working years to save for their retirement at higher rates and accumulate additional assets. Such behavior, in turn, encourages higher economic growth by providing investment capital. This change in savings and investment behavior encouraged by the anticipation of retirement is called the second demographic dividend. Note that this potential dividend is not automatically realized, as it depends on the implementation of effective policies.

To summarize, the first demographic dividend yields a transitory effect on the economy, while the second demographic dividend provides a potential sustained boost to economic growth. The current workshop focused on the economic lifecycle and the first demographic dividend. The second demographic dividend will be one focus of the second workshop and of research during the interim period.

Key Results

Economic Lifecycle

The economic lifecycle measures how consumption, labor productivity, and hence economic dependency vary with age. For comparison purpose, the numbers are normalized on the average labor income for prime-age adults (ages 30-49). Note that

these estimates and all others presented in this report are preliminary and should not be reproduced without the permission of the authors.

Figure 3 shows the economic lifecycle for different countries. In all of these countries, productivity (measured by labor income) has the same inverted-U shape with production concentrated among the working-age adults. In most countries, the peak in productivity is reached somewhere between ages 40 to 50. Productivity in India peaks at somewhat higher age, at around 50 years with many elderly still contributing. In comparison, productivity in China and Spain are almost zero by the time individuals reach age 70. In Kenya, productivity reaches its peak at a relatively young age (age 39), but the elderly continue to make substantial contributions.

Generally, the consumption profiles of these countries share a similar pattern: a steep rise during childhood with relatively stability among working adults and the elderly. In China, however, young age consumption rises more steeply compared to other countries. In some countries, such as Kenya and the Philippines, consumption of the elderly is relatively high as compared with consumption during the working ages. In others, such as in Indonesia, consumption of the elderly is somewhat lower than consumption by those in the working ages.

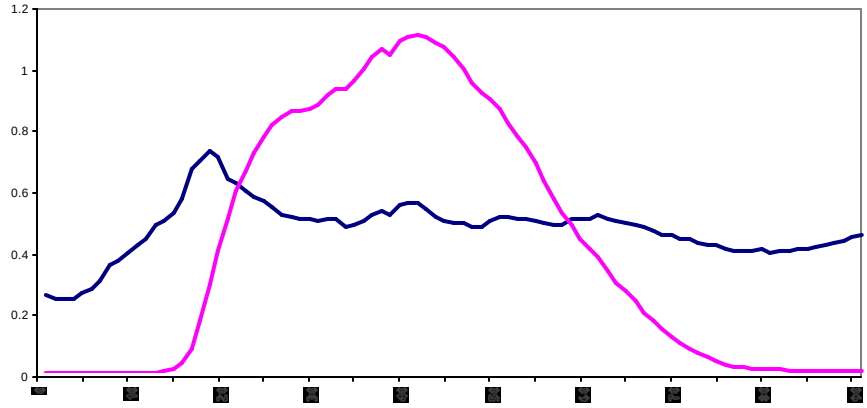
The differences in patterns of consumption and productivity affect the ages during which people are dependent. In China, childhood dependency ends at age 21 and old-age dependency starts at age 58. This end to childhood dependency is quite early compared to the other countries, where it typically is between ages 25 and 29. Generally, old-age dependency starts around age 60.

The Lifecycle Deficit, measured by the difference between consumption and labor income at each age, gives us an empirically-based, continuous measure of economic dependency. Figure 4 shows that the deficit for young adults is much greater in Indonesia and India than in China. The deficit at old ages is much greater in India than in China or Indonesia.

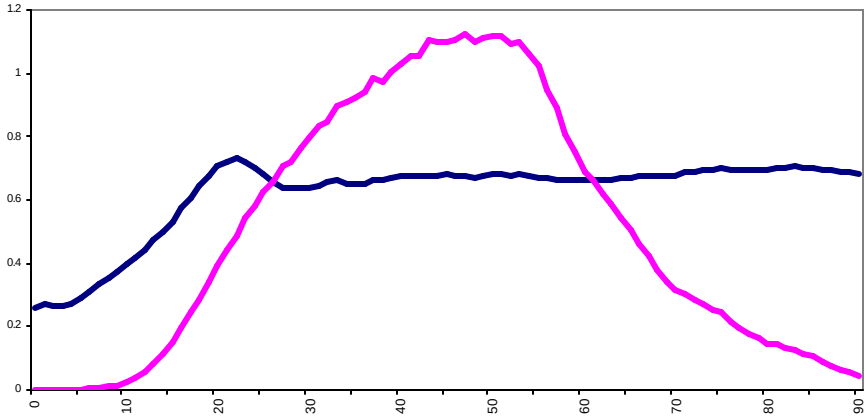
The different patterns and magnitudes of the lifecycle deficit come from differences in consumption and labor income for each country. In turn, differences in consumption and labor income are influenced by differences in their components, to which we now turn.

Figure 3
Economic Lifecycles, selected countries

China



India



Indonesia

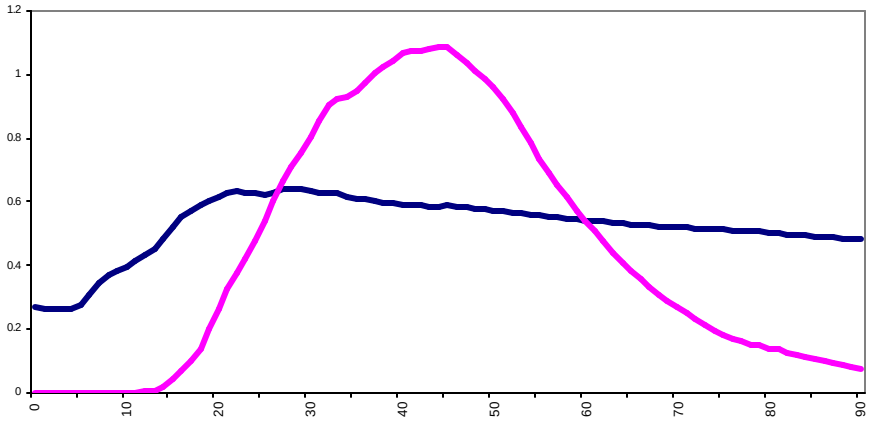
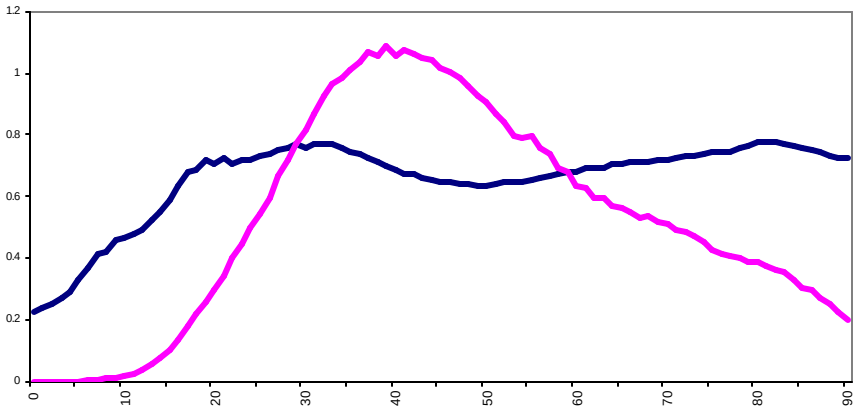
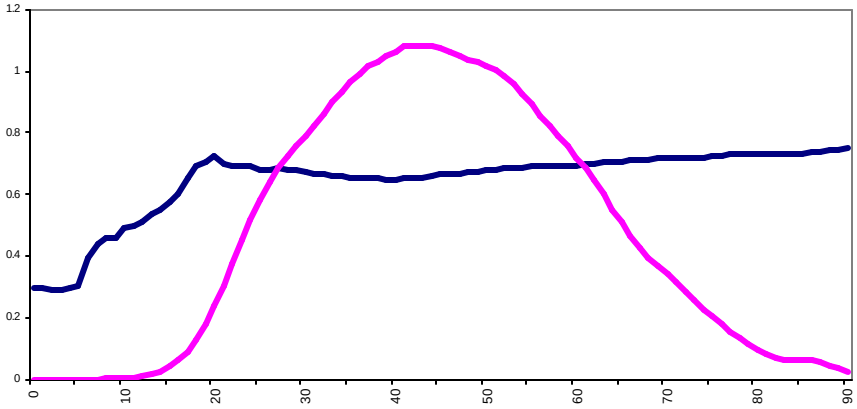


Figure 3
Economic Lifecycles, selected countries (contd.)

Kenya



The Philippines



Spain

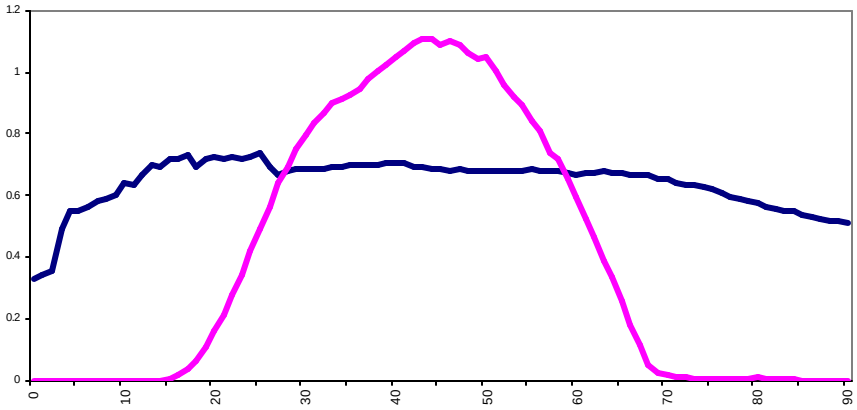


Figure 4
Lifecycle Deficit, China, India and Indonesia

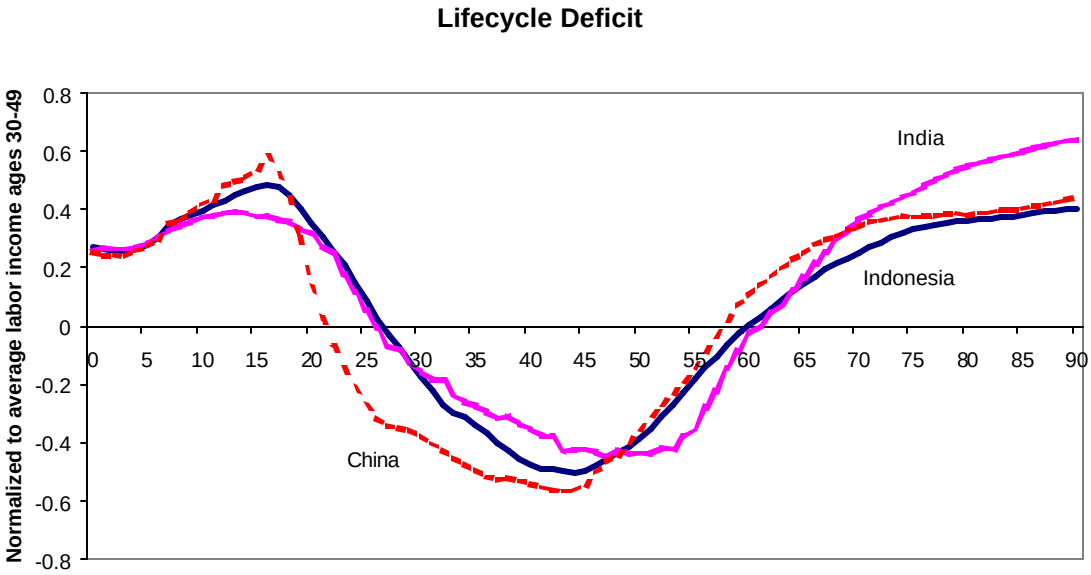


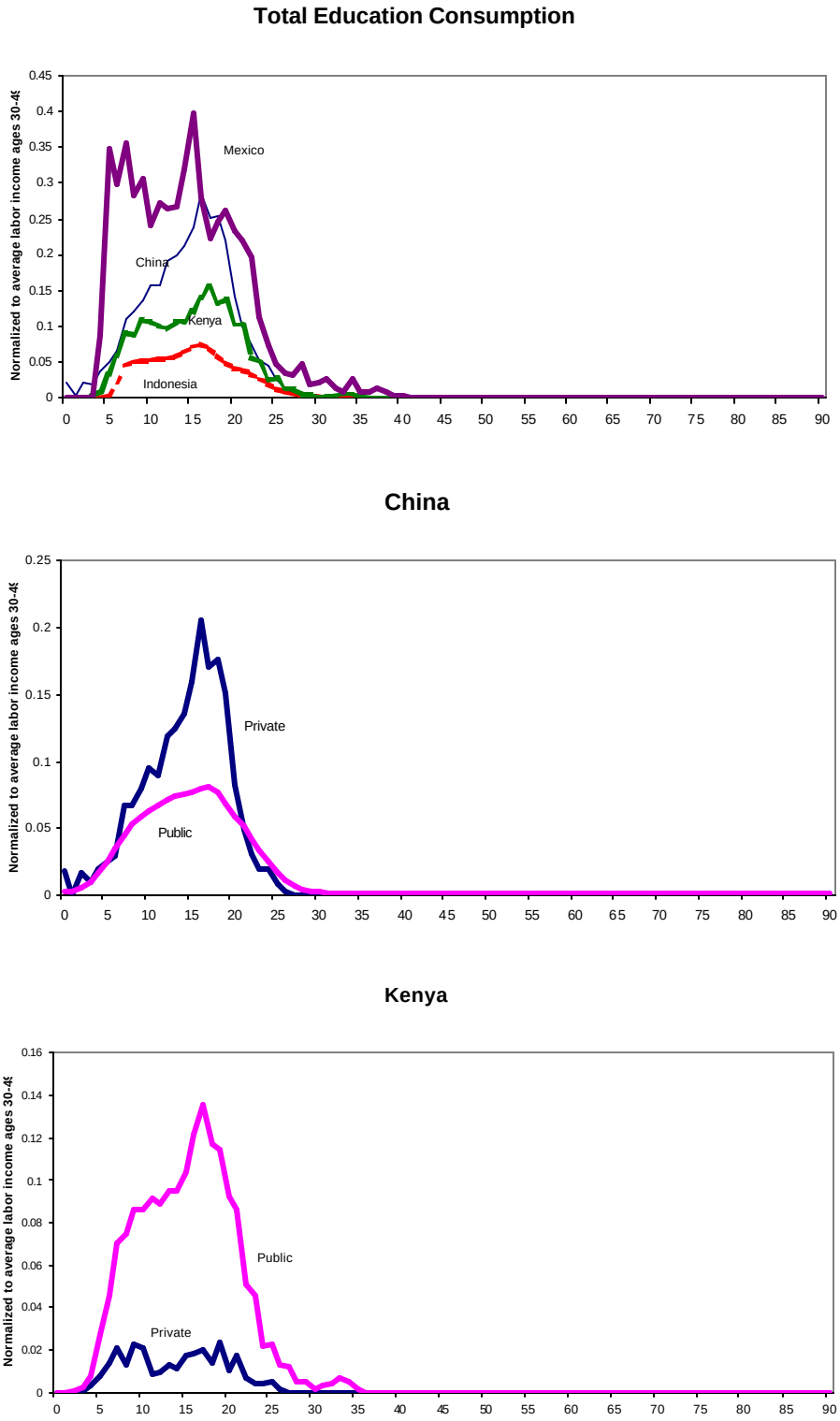
Table 1
Age of Intersection between consumption and labor Income

Country	Early Age	Later Age
China	21	58
India	26	61
Indonesia	26	60
Kenya	29	59
Philippines	27	61
Spain	28	59

Components of Consumption

In the National Transfer Accounts, consumption has three major components: education, health, and other consumption. Of those three, education is the most age-sensitive component. Although adults may consume education through continuing education programs, children are the primary consumers of education. The distribution of education consumption by age, however, varies among countries.

Figure 5
Component of Consumption: Education



The first panel in Figure 5 shows the total education consumption for Mexico, Kenya, China and Indonesia. Mexico exhibits quite high education consumption, about 25-35 percent of the average labor income of a prime-age adult. The age-span during which Mexicans consume education consumption is also quite long: from age 4 to over age 30. Contrast this to the Indonesians, who spend only about 5 to 7 percent of the average labor income on education. Consumption of education in Spain and the Philippines lies between those two countries.

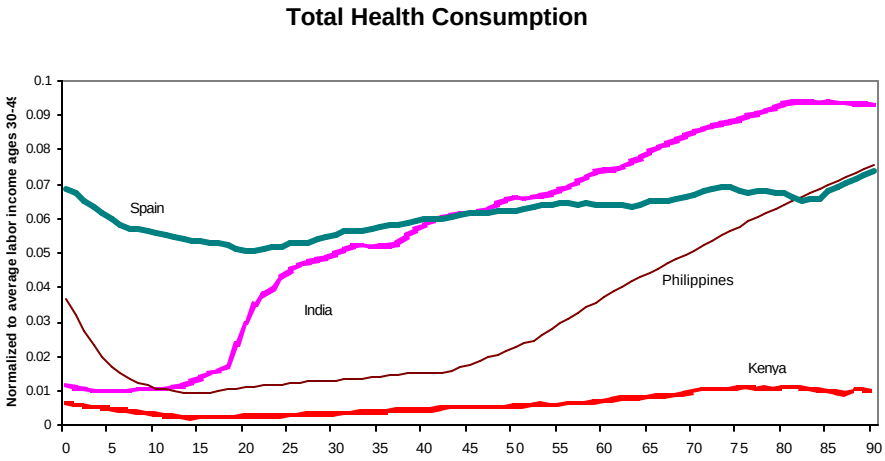
The data on total education alone do not, however, tell the whole story. The NTA allows us to look at education consumption by source of funding: either from public sources or from private sources. The lower panels in Figure 5 show that in China education is funded mostly by families, while in Kenya the situation is reversed: education primarily is funded by government. In Mexico, public and private education spending are about equal.

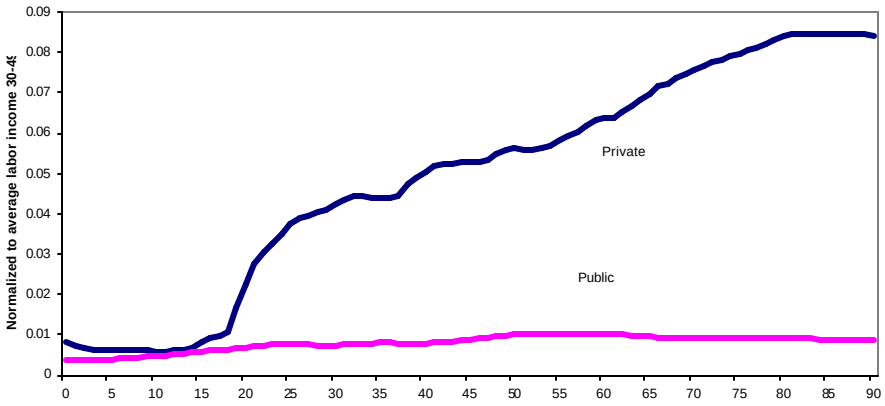
Figure 6 shows health consumption for India, Kenya, the Philippines, and Mexico. In general, those countries share similar pattern: somewhat high consumption in the very early years, a decline and stabilization in the middle years, and an increase in the later years. The relative magnitude and timing of health consumptions, however, varies considerably across countries. Spaniards devote about 5 to 7 percent of the average labor income of a prime-age adult to health consumption, while Kenyans spend only about 1 to 2 percent. Indians' health consumption is quite low in the early years, but jumps substantially when they reach their twenties and continues to rise until old age, where their health consumption is about 9 percent of the average labor income. The Philippines exhibits a J-shape pattern: quite high in the very young ages, a decline until the teenage years, some stabilization during the prime-age adults, and a steep increase after the late forties.

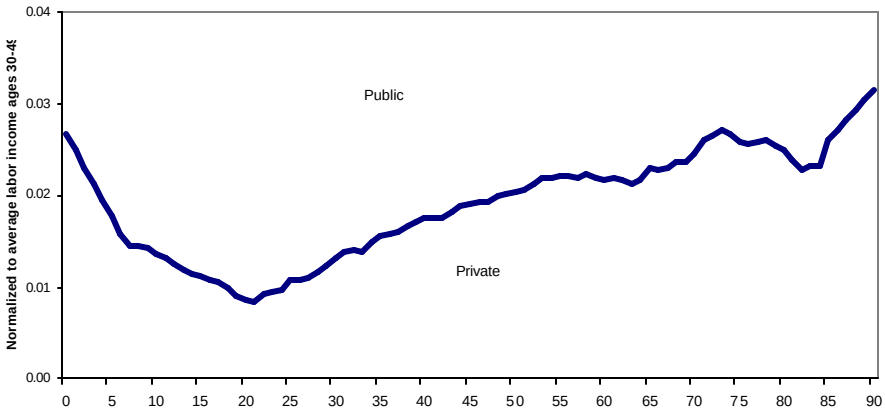
As seen from the subsequent panels on Figure 6, countries vary in the source of funding for health consumption. In a welfare state like Spain, most health consumption is funded by the state. In India, private health consumption is slightly higher than public health consumption in the early years of life, but diverges substantially from the teenage years onward.

The last major component of consumption, called 'other consumption,' basically includes anything beside education and health consumption. As Figure 7 shows, the general shape of the other consumption profile is the same across countries: such consumption grows from age zero until around age 20, then (with some variation) stabilizes. The level of consumption differs among countries, however. Mexicans spend about the same amount of 'other consumption' as their average labor income, while Indonesians spend about 40 percent, and Kenyans, about 60 to 70 percent of their average labor income. The Kenyan data exhibit an interesting M-shape pattern for the adult years, with peaks in consumption at ages 30 and 85.

Figure 6
Component of consumption: health







Note: public health consumption for Spain is to be estimated

Figure 7
Component of consumption: other consumption

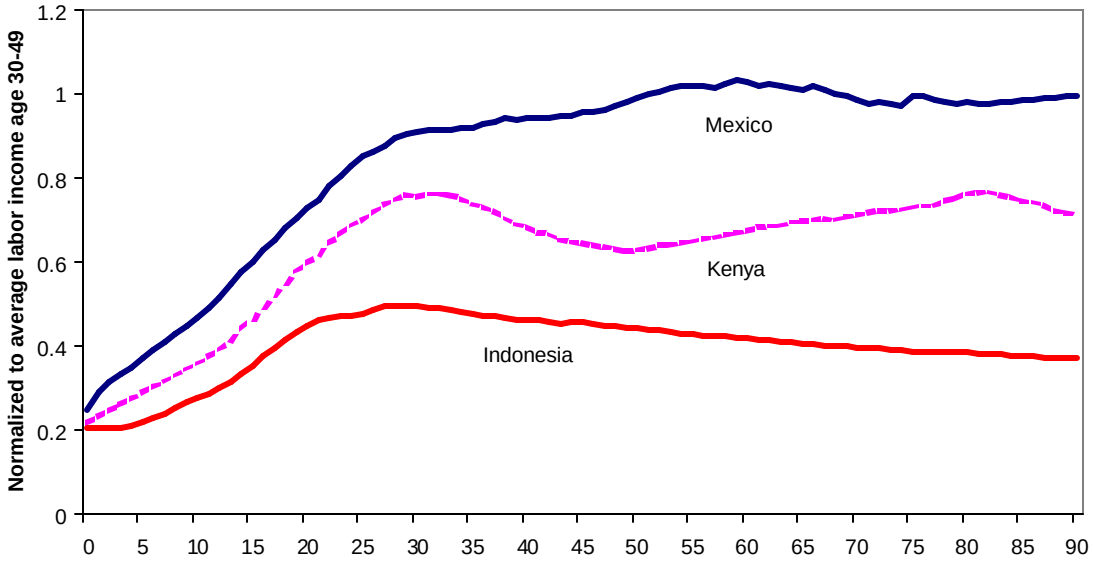
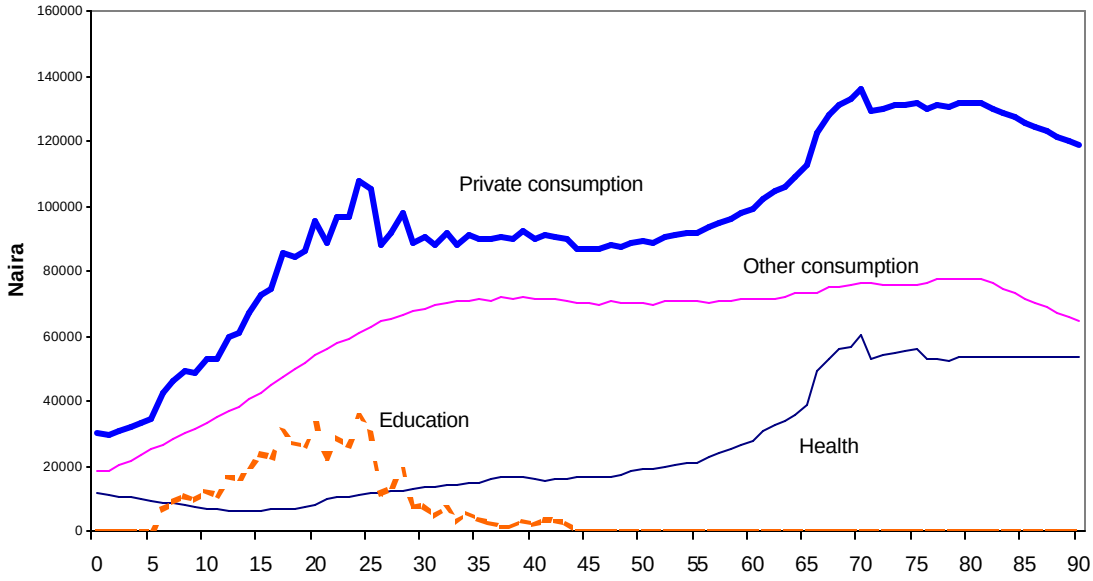


Figure 8
Nigeria, private consumption and its components



Note: Not normalized.

Nigeria's consumption is shown in Figure 8. Because we do not yet have estimates of labor income in Nigeria, we cannot normalize consumption by average labor income as we did for the other countries. Figure 8 therefore shows absolute levels of consumption. Nigeria's private consumption has two peaks. The first is reached around age 25 and the second, around age 70. As the figure shows, the first peak seems to come from education consumption, while the second peak comes from private health consumption.

Components of Labor Income

Labor income consists of three major components: earnings, self-employment income, and other labor income, which includes fringe benefits and the like. A lack of data on other labor income means that only earnings and self-employment income can be estimated at this time.

Figure 9
Earnings and Wages

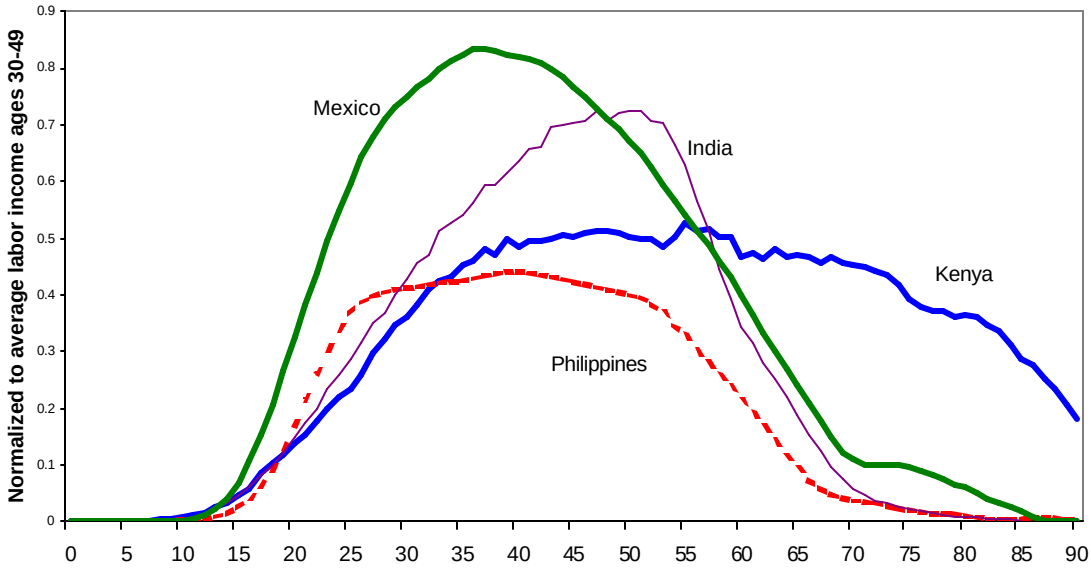
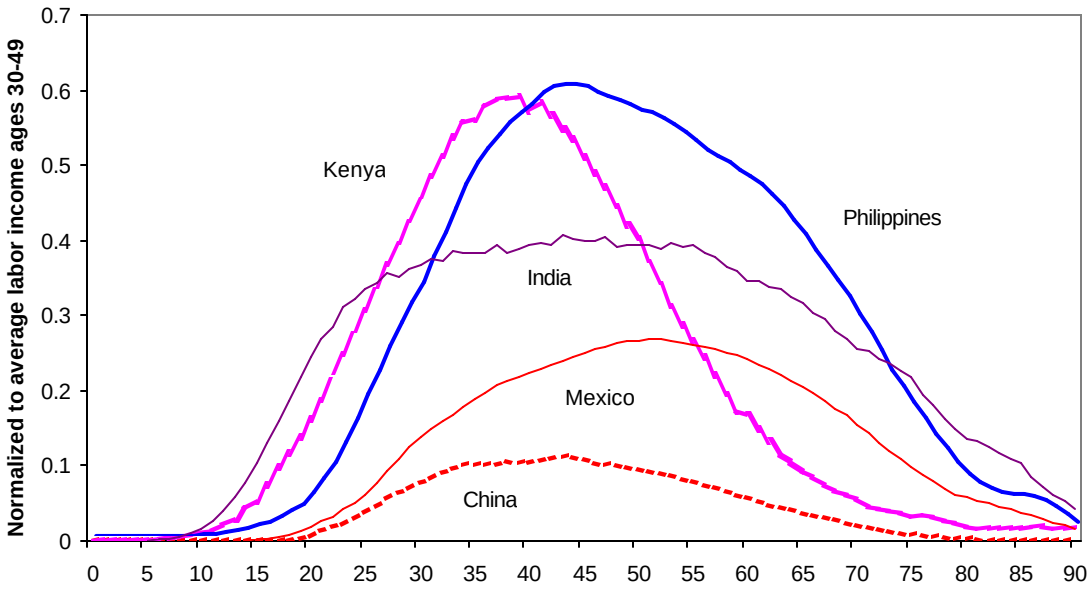


Figure 9 presents the earnings profiles for India, Mexico, Kenya, and the Philippines. The level and pattern in earnings varies considerably among those countries. Although all exhibit a bell-shape pattern of earnings by age, the age at which earnings peak varies. The earnings of Mexicans and Filipinos peak around age 35, while the earnings of Indians reach their peak around age 50. Kenya does not have single peak: the earning profile seems to be quite flat from age 40 to age 60. Kenya also exhibits a longer age-span of earning than the other countries exhibit. The extent to which labor income is composed of earnings also varies across countries. In Mexico, at its peak, earnings constitute about 80 percent of average prime-age adult labor income Mexico, while the proportion is 70 percent in India, 50 percent in Kenya, and about 45 percent in the

Philippines. These difference may reflect variation in the importance of the formal labor sector in those countries.

Figure 10
Self-employment labor income



As Figure 10 shows, self-employed labor income is very substantial in Kenya and the Philippines, where, among prime-age adults, it constitutes about 55 percent of their labor income. In contrast, the figure is less than 10 percent in China. Data for Mexico and India fall between these two countries.

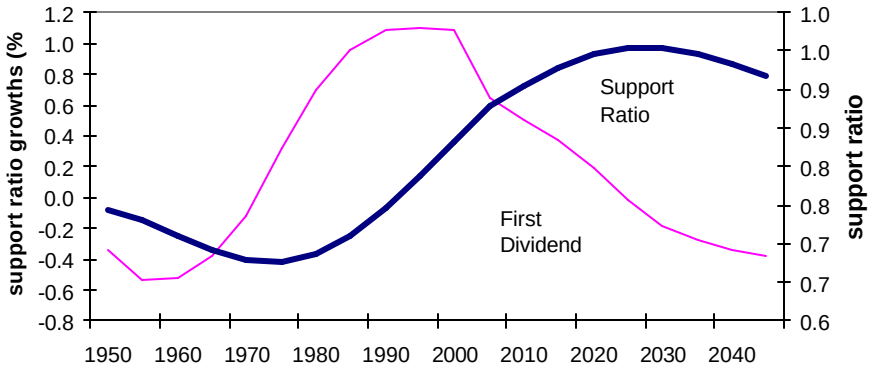
The peak for Mexican self-employment labor income occurs later in life, at age 53, than in the Philippines and Kenya, where the peak occurs at ages 43 and 38, respectively.

Economic Support Ratios and the First Dividend

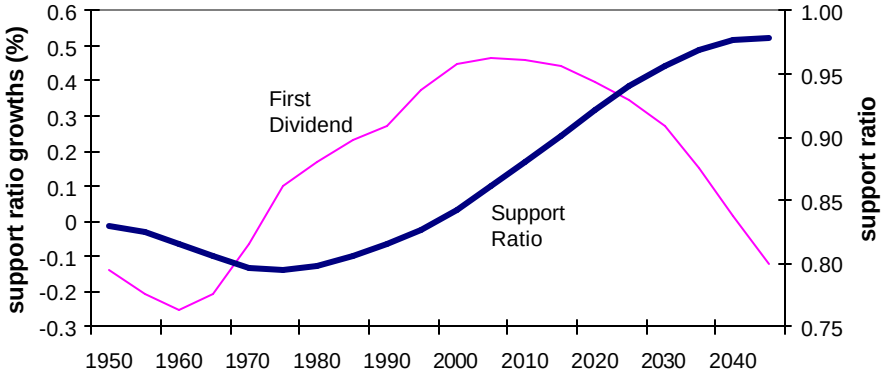
As discussed above, the demographic transition changes the population's age structure. These changes in age structure in turn affect the economic support ratio and create the first demographic dividend. Because the period during which the demographic transition occurs varies across countries, the period during which a country experiences the dividend also varies. Results from three countries, Mexico, India, and Nigeria, illustrate this point (see Figure 11).

Figure 11
Economic Support Ratio and Demographic Dividends for India, Mexico, and Nigeria

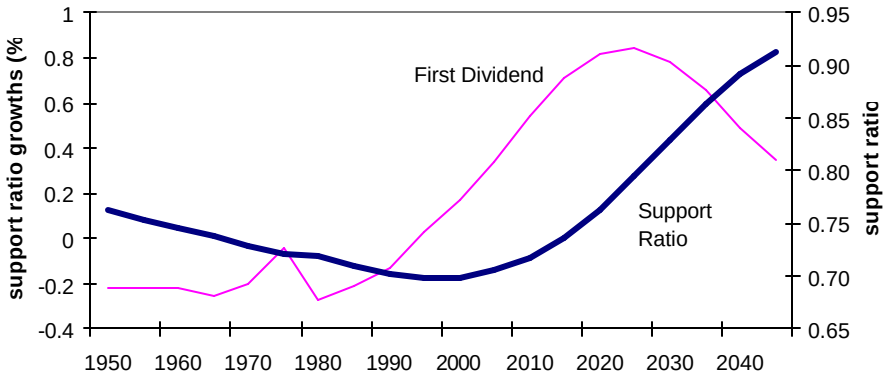
Mexico



India



Nigeria



In Mexico, the demographic transition started in the twentieth century with improvements in health and longevity. The crude death rate (CDR) declined from about 16.6 per 1000 population in the early 1950s to 6.4 in the early 1980s. The total fertility rate (TFR) declined from about 6.7 children per reproductive-age woman in the 1950s to about 4.2 in 1980-85. This change in fertility lowered the population growth rate from 3.2 to 2.6 percent per year. Mexico's population growth rate is expected to continue to decline in the future.

We used the economic lifecycle profiles from the previous section and United Nations' population projections to project Indian support ratios from 1950 to 2050. The economic support ratio started to increase around 1975 in response to the fertility decline. The ratio is expected to keep increasing for the next two decades with the estimated peak occurring in 2025 (see the first panel on Figure 11). At that point, the proportion of people ages 65 and over will be about 10 percent of the population, thereby creating a new economic 'dependency.' The growth in the support ratio is positive from 1975-80 to 2020-25, reflecting the demographic dividend, which is estimated to last about 50 years. During this period, output per effective consumer in Mexico will increase by 42 percent due to favorable changes in age structure.

India's demographic transition also started at the same time as Mexico's. India's CDR in 1950 was 26 and had declined to 12 in 1980, figures that were higher than in Mexico. With a TFR of 5.9 in 1950, India's initial fertility was lower than Mexico's, but had only fallen to 4.5 by 1980, higher than in Mexico. The support ratio for India also started to increase in 1975, and is estimated to peak in 2045, at which point India will have experienced about 70 years of the demographic dividend. The total gain in output per effective consumer over that period will be 23.1 percent.

A full estimate of the economic lifecycle has not yet been completed for Nigeria, but the magnitude of the first dividend can be estimated by using the developing country profile in Figure 1 in combination with Nigeria's population age structure. Nigeria's CDR in 1950 was 27.7, only a little higher than India's in the same year. However, by 1980 India's CDR had fallen to 11.6, while Nigeria is expected to reach that level only in 2030. Nigeria's TFR in 1950 was 6.9, which is comparable to that of Mexico for the same year. Yet, only in 1985 did the country's TFR start to decline. As a result, Nigeria's population growth rate increased from 2.17 in the initial year to 3.0 percent in 1975 and only then started to decline slowly. The economic support ratio only starts to increase in the late 1990s, and is expected to keep rising after 2050. The country will enjoy the demographic dividend from 1995-2000 to 2050 and beyond.

What is the total contribution of age structure changes to productivity? On average, age structure changes are estimated to increase output per effective consumer in Mexico by an additional 0.7 percentage points per year between 1975 and 2025 and in India by an additional 0.3 percentage points per year between 1975 and 2045. At its peak, the dividend will have contributed 1.1 percentage points per year to economic growth in Mexico (1995-2000) and 0.46 percentage points per year to economic growth in India (2005-2010). Nigeria will reach its peak dividend point in 2025-2030. At that time, the

contribution of the dividend will be about 0.85 percentage points per year of additional economic growth. Because Nigeria will finish its dividend period after 2050, the last year for which the United Nations projects population, the figure for the total dividend is not available.

Table 2
Summary of the first demographic dividends

	Mexico	India	Nigeria [1]
Dividend period	1975-2025	1975-1945	1995-…
Length	50 yrs	70 yrs	n.a.
Total Gain	41.60%	23.10%	n.a.
Annual gain during the dividend period	0.69%	0.29%	n.a.
Dividend Peak	1995-2000	2005-10	2025-2030
Annual gain at the peak	1.10%	0.46%	0.85%

1. Values not available because dividend period ends after 2050 the final year of the projection.

These results illustrate clearly the impact of the timing and the length of the demographic transition influence on the period during which a country may enjoy its first demographic dividend. In his study of demographic dividends across countries, Mason (2005) shows that there is a positive relationship between the duration of the demographic transition and the gains from the demographic dividend, although the relationship is not linear. As stated before, the first demographic dividend is transitory. In countries that began their demographic transition earlier, the first dividend period is now coming to a close. Countries that began their demographic transition relatively late are in a good position to reap the dividend in the coming decades.

What will be the role of age structure after the end of the first dividend period? This is an issue that is to be addressed in the coming months and during the next Summer Seminar workshop.

Conclusions, Limitations, and Future Research

In the first workshop, participants produced preliminary estimates of the economic lifecycle for their respective countries. Estimates of the economic lifecycles provide us with an important tool for measuring economic dependency. They can be used to calculate economic support ratios, and in turn, to assess the impact of changing age structure on the economy.

Notwithstanding the considerable progress made during the first workshop, much work remains to be done. The methodology for estimating National Transfer Accounts continues to be refined in light of the new challenges at additional data sources pose.

Also, the effect of different institutions on the economic lifecycle is still poorly understood and needs to be investigated further. For instance, what is the role of social security and pension systems, and of other public policies, in determining the labor income of the elderly? How does culture affect consumption of children and the elderly as compared with prime-age adults? How do gender roles and gender inequalities influence the lifecycle of labor income and consumption?

The collaborative effort by participants from the eight countries participating in the Summer Seminar workshop will allow us to compare different economic lifecycles and the economic support system for each age. The second workshop will be held in June 2008 and will focus, in part, on comparative results and estimation of the second demographic dividend for each country.

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Appendix I. Methods and Documentation

Please consult NTA's website for the methods used in the workshop: www.ntaccounts.org.

Appendix II. Workshop Program

Appendix III. Participant List, Institutional Affiliations and Contact Information