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DEMOGRAPHIC TRANSITION AND DEMOGRAPHIC DIVIDENDS IN DEVELOPED AND DEVELOPING COUNTRIES[i]

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A. INTRODUCTION

Both the developed and developing countries are experiencing substantial changes in their age structures with potentially important implications for economic growth. The timing of the changes varies, but essentially every country in the world has experienced or will experience a substantial rise in the share of their population concentrated in the working ages. On its face, this development has a direct, favorable effect on per capita income. Given output per worker, labor force participation rates, and unemployment rates, a rise in the share of the working-age population will lead, as a matter of simple algebra, to an increase in output per capita – the first demographic dividend.

The first demographic dividend typically lasts for decades, but it is inherently transitory in nature. As population aging begins to dominate demographic trends, the share of the population in the working ages will decline. The first dividend will turn negative as population growth outstrips growth in the labor force. Eventually, the share of the population in the working ages may be no greater than before the dividend period began.

The same demographic forces that produce an end to the first dividend, however, may lead to a second demographic dividend (Mason and others, forthcoming). A key economic challenge for aging populations is to provide for old-age consumption in the face of substantially reduced labor income. Some societies are trying to meet this challenge by relying on transfer systems – either public programs or familial support systems. Other societies are responding by increasing their saving rates and accumulating greater physical wealth or capital. It is in this latter response that prospects for more rapid economic growth are enhanced.[ii] Moreover, the second dividend is not transitory in nature. Population aging may produce a "permanent" increase in capital and, thus, per capita income (Lee and others, 2003; Lee and others, 2001).

The renewed interest in the macroeconomic consequences of population change can be traced to new evidence that comes in two forms. First, a series of empirical studies based on aggregate level panel data conclude that demographic factors have a strong, statistically

significant effect on aggregate saving rates (Bloom and others, 2003; Deaton and others, 2000; Kelley and others, 1996; Kinugasa, 2004; Williamson and others, 2001) and on economic growth (Bloom and others, 2001; Bloom and others, 1998; Kelley and others, 1995). In contrast, earlier studies based on shorter time series found little statistical support for strong demographic effects (Kelley, 1988). Second, detailed case studies of the East Asian miracle provide compelling and consistent evidence that the demographic dividend was an important contributor to that region's economic success (Bloom and others, 1998; Mason, 2001b; Mason and others, 1999). Bloom and Williamson (1998) use econometric analysis to conclude that about one-third of East Asia's increase in per capita income was due to the demographic dividend. Mason (2001a) uses growth accounting methods to estimate that the dividend accounted for about one-fourth of the region's economic growth.

Although age structure variables have predictive power and can "explain" a significant portion of economic growth, the relationship between demographic variables and the economy is not deterministic. Rather, the economic outcome from demographic change is policy dependent. The East Asian experience provides very clear evidence in support of this view. A successful export oriented growth strategy produced more than enough jobs to absorb the rapidly growing workforce. A stable macroeconomic environment – until the late 1990s financial crisis struck – provided an attractive investment environment. Large-scale pay-as-you-go pension programs that undermine saving and work incentives were avoided. These and other policies worked in concert with demographic change to produce high rates of saving and investment, rapid growth in employment, and spectacular economic growth. In the absence of complementary economic policies, the demographic dividend cannot be counted on to produce favorable economic results.

This paper presents a formal approach to quantifying the two demographic dividends drawing on a recent paper by Mason and Lee (forthcoming). Estimates of the first and second demographic dividend are constructed for all countries of the world for which the United Nations World Population Prospects (2005) provides estimates and projections. Country estimates are

aggregated into appropriate country groups and used to compare the experience of the developed to the developing world and t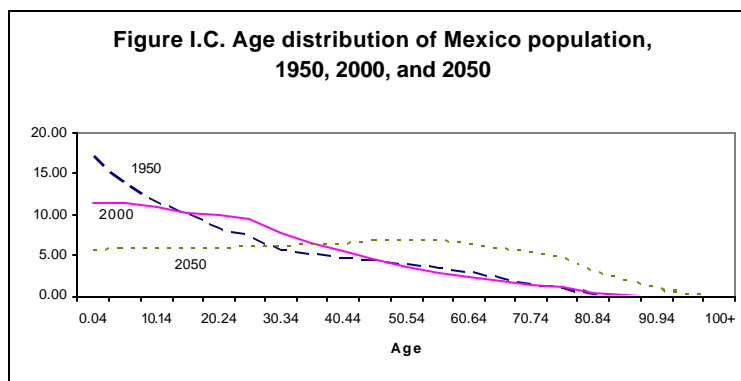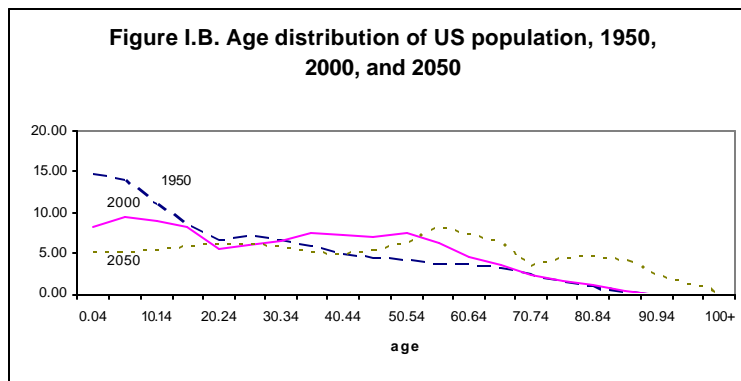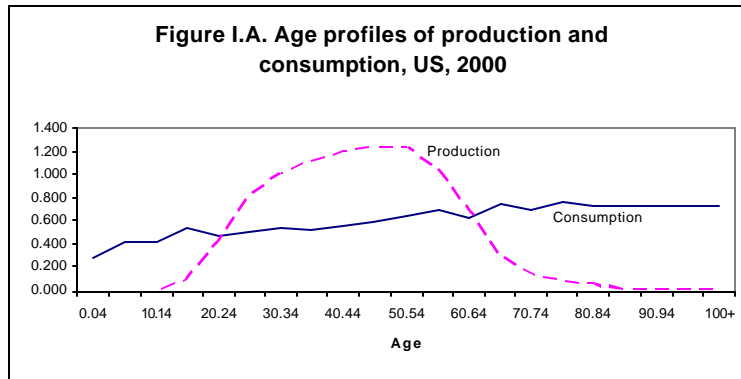o contrast important variation within the developing world. Detailed country estimates are available on the author's website: www2.hawaii.edu/~amason.

B. THE DEMOGRAPHIC DIVIDENDS

The first demographic dividend arises and dissipates as changes in age structure interact with the lifecycle of production and consumption. Children and the elderly produce much less than they consume, whereas working-age age adults, on average, produce much more than they consume. Populations with heavy concentrations at the working ages are advantaged at producing high levels of per capita income. Child and old-age dependency ratios are often used to capture the key features of the economic lifecycle, but more detailed and precise estimates are becoming available. Estimated age profiles of production and consumption for the US in 2000 are shown in the upper panel of Figure 1. The values are broadly consistent with general characterizations of the economic lifecycle, but certain features of the US profiles are striking. First, the ages of dependency are not very close to those often used to delineate the dependent ages (under 15 and 65 and older). In 2000, US residents under the age of 24 and over the age of 57 were dependents. Estimates for Taiwan, for example, are quite similar – residents under the age of 22 and over the age of 56 consumed more than they produced in 1998 (Mason and others, 2005). Second, the estimates in Figure 1 imply a gradation of dependency. Those who are 25 and those who are 60 are dependents, but to a much smaller degree than those who are 18 and those who are 75.

The manner in which the economic lifecycle interacts with the age distribution is illustrated in the lower panels of Figure 1, which display the age distributions of the United States and of Mexico in 1950, 2000, and 2050. These two countries – though neighbors – have very different demographic histories. Changes in the US age distribution are dominated by the baby boom of 1946 to 1964 and its echoes. Changes in the Mexican age distribution are dominated by fertility decline. Both are influenced by steady improvements in life expectancy. Although

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differences are important, both countries experienced a significant decline in their child populations and a significant rise in their productive populations between 1950 and 2000 – giving rise to their first demographic dividends. Both countries show a clear shift in their populations from the productive ages to old ages between 1950 and 2000. As this occurs, the advantage of having a population concentrated in the productive ages will dissipate.

Figure I.A. Age profiles of production and consumption, US, 2000

Figure I.B. Age distribution of US population, 1950, 2000, and 2050

Figure I.C. Age distribution of Mexico population, 1950, 2000, and 2050

The second dividend arises to the extent that consumers and policymakers are forward-looking and respond effectively to the demographic changes that are coming. With a rise of the

elderly dependent population on the horizon, consumption in the future can be maintained only through the accumulation of wealth in some form. One possibility is that individuals and/or firms and governments acting on the behalf of consumers accumulate capital. If invested in the domestic economy, the result will be capital deepening and more rapid growth in output per worker. If invested abroad, the result will be an increase in the current account and national income. In either case, per capita income will grow more rapidly.

The first and second dividend are formalized in Mason and Lee (forthcoming). Define the effective number of consumer (N) and the effective number of producers (L) as:

$$N(t) = \sum_a \mathbf{a}(a)P(a, t)$$
$$L(t) = \sum_a \mathbf{g}(a)P(a, t)$$

(1)

where $P(a,t)$ is the population. Output per effective consumer (Y/N), is given by:

$$\frac{Y(t)}{N(t)} = \frac{L(t)}{N(t)} \times \frac{Y(t)}{L(t)},$$

(2)

Equation (2) is readily converted from levels to rates of growth by taking the natural log of both sides and taking the derivate with respect to time:

$$\dot{y}(t) = \dot{L}(t) - \dot{N}(t) + \dot{y}^l(t).$$

(3)

The rate of growth in output per effective consumer ($\dot{y}$) is the sum of the rate of growth of the support ratio ($\dot{L}(t) - \dot{N}(t)$) and the rate of growth of productivity ($\dot{y}^l$). The first dividend is defined as the rate of growth of the support ratio. The second dividend operates through productivity growth by inducing the accumulation of wealth and capital-deepening as discussed more extensively below.


1. *The First Demographic Dividend*

The support ratio and the first dividend have been calculated for countries of the world for which the United Nations Population Division reports estimates and projections in its most recent

release of *World Population Prospects* (United Nations Population Division, 2005). The support

ratios are calculated using the production and consumption weights presented in Figure 1. The

equivalence values for production have been scaled to average one for ages 30-59. Thus, a value

of 0.5 indicates that members of that age group are 50% as productive as persons aged 30-59.

The equivalence values for consumption have been scaled so that the 1950 population of the

world had a support ratio of 1.0. A value of 0.5 indicates that members of an age group are

consuming 50% of what the average worker is producing (where the average is calculated using

the world's age distribution in 1950).

Before turning to regional comparisons, the experience of Mexico and the US sets the

stage. Figure 2 reports the support ratios for both countries and the first demographic dividend,

calculated as the rate of growth of the support ratio for the five-year period following year *t*.

Figure II. First demographic dividend, US and Mexico
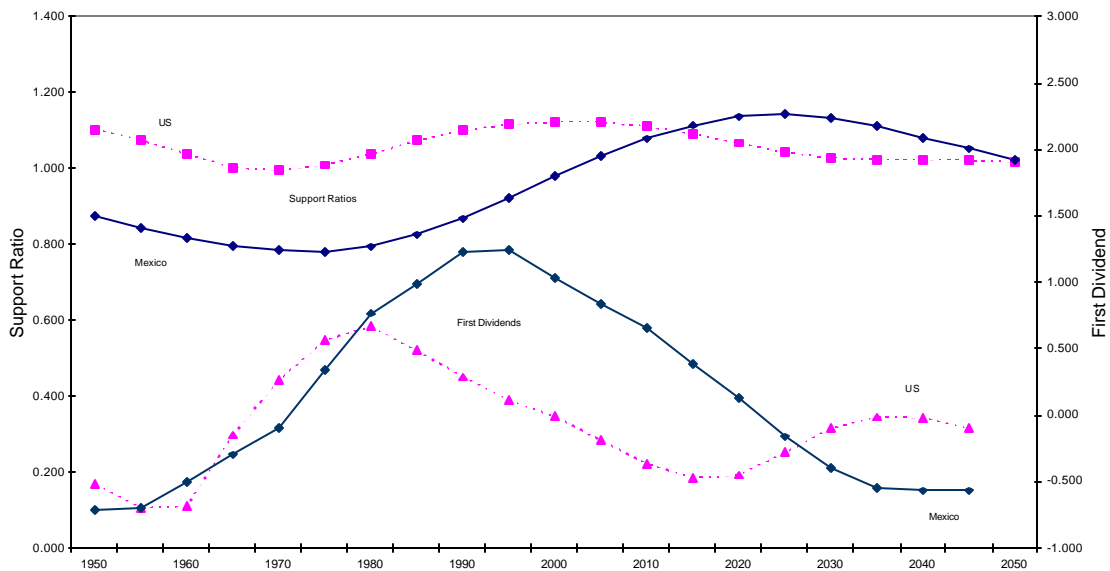
The US support ratio in 1950 exceeded 1.1 effective workers per effective consumer as

compared with a support ratio in Mexico of less than 0.9. Thus, the US had a significant

advantage in 1950 and an advantage that is expected to persist until 2015. During the 1950s and

the 1960s, the support ratio was deteriorating in both countries because high fertility and,

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especially in Mexico, declining child mortality were leading to an increase in the number of children. The support ratio began to rise in the US in 1970 and in Mexico in 1975 in response to fertility declined. The US support ratio reached its peak in 2000. In total, the support ratio and, hence, output per effective consumer increased by 12.7 percent during the 30 year period. The Mexican support ratio is projected to reach its peak in 2025. Over the 50 year period, output per effective consumer will increase by 46.4 percent – a gain substantially larger than experienced in the US.

The first 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. On average, output per effective consumer grew by an additional 0.4 percentage points per year between 1970 and 2000 in the US and by 0.76 percentage points per year between 1975 and 2025 in Mexico because of changes in age structure. 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 similarities and differences between Mexico and the US are worth emphasizing: (1) the first demographic dividend began at about the same time – in the 1970s – in both countries; (2) the duration of the first dividend was shorter in the US than in Mexico – 30 years in the US versus 50 years in Mexico; (3) both the total impact and the annual impact of the dividend were substantially greater in Mexico than in the US; and, (4) Mexico gained relative to the US because Mexico began with a relative disadvantage. The projections for Mexico anticipate that it will eventually catch the US achieving a support ratio of 1.14 in 2025 as compared with the maximum US support ratio of 1.12 in 2000. As is shown below, similar points of comparison distinguish the developed from the developing countries, but the experience of the developing world is quite varied.

The comparisons presented here emphasize eight country groups that have been defined to capture commonalities in economics, geography, and demography. The eight groups are the Pacific Islands, Transitional Economies, Middle East and North Africa, Sub-Saharan Africa, Latin America, South Asia, East and Southeast Asia, and the Industrial Countries. The values presented are simple averages of the values for countries belonging to each group. Appendix table A.1 provides a full listing of the countries belonging to each group.

The dividend period began first in the Industrial countries in 1970 and soon thereafter in the Pacific Island, the Transitional Economies, the Middle East and North Africa, Latin America, and East and Southeast Asia (Figure 3). The onset of the first dividend was substantially delayed only in South Asia – around 1985 – and Sub-Saharan Africa – around 1995.

**Figure III. The Timing of the first demographic dividend: all country groups**
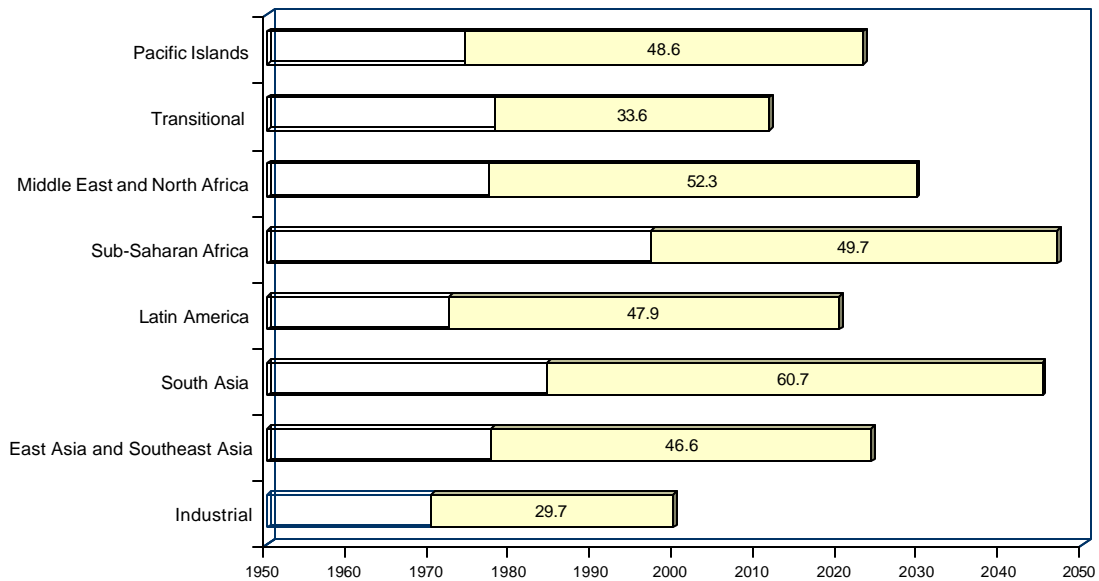
The duration of the first dividend was relatively short in the Industrial countries, approximately 30 years, and in the transitional economies, almost 34 years.[iii] The duration in other country groups varied from about 47 years in East and Southeast Asia to more than 60 years

in South Asia. Unfortunately, the durations reported in Figure 3 are flawed (downward biased) for some country groupings, because the dividend period begins prior to 1950 for a few countries and extends beyond 2050 for many countries. The duration for Sub-Saharan Africa, in particular, is affected by the truncation and it would be reasonable to expect a duration as long or longer than South Asia's. The appendix provides information about the extent to which time series are truncated.

What are the implications of the duration of the dividend period for the magnitude of the dividend? Mexico enjoyed both a longer dividend and a greater annual dividend than the US, but how will the dividends in South Asia and Sub-Saharan Africa compare with those in Latin America and East and Southeast Asia?

This question is addressed by figure IV which plots the magnitude of the dividend, the support ratio at the end of the dividend period divided by the support ratio at the beginning of the dividend period, against the duration of the dividend. The high and low points plotted for each dividend value represent the mean plus and minus one standard deviation.

Figure IV. The Duration and total gain from the first demographic dividend
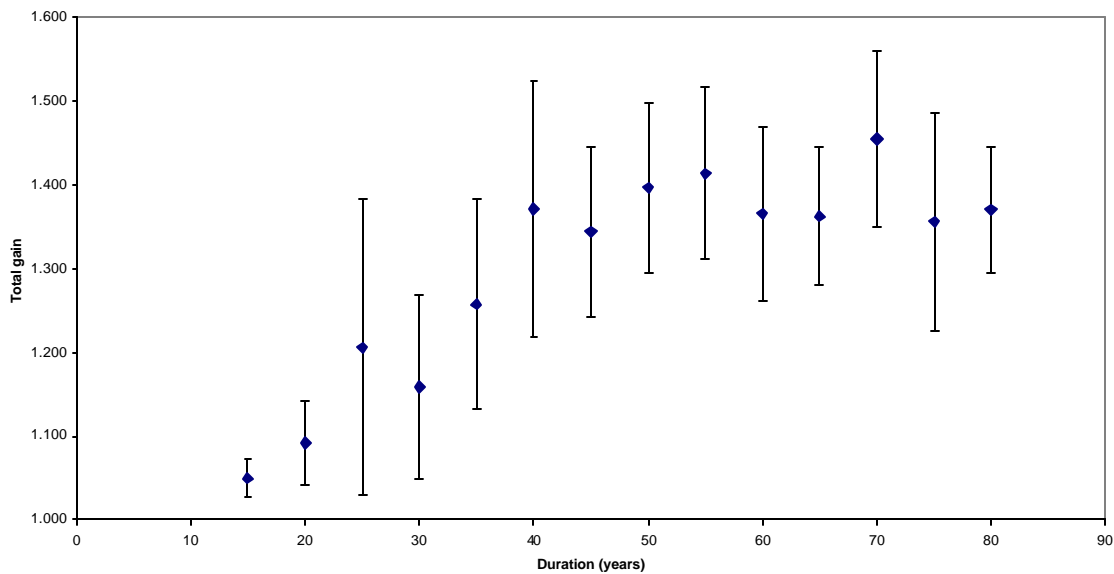
For countries with a dividend period lasting less than 40 years, the total gain from the dividend and the duration of the dividend are closely linked. If the dividend period was only 15 years, for example, the support ratio rose only 5 percent from the start to the finish of the dividend period. If the dividend period lasted 35 years, in contrast, the support ratio rose by 25 percent between the beginning and the end of the dividend period. On average the transitional economies and the industrial economies fall have relatively short dividend periods with relatively small total gains.

For countries with a dividend period lasting 40 or more years, there is no apparent relationship between the magnitude and the duration of the dividend. The total increase in the support ratio from the beginning to the end of the dividend averaged between about 35 and 40 percent. Countries with slow transitions, those mainly in South Asian and Sub-Saharan Africa, can eventually reap a dividend as large as countries with rapid transitions, those mainly in Latin America and East and Southeast Asia. However, because the gains are spread over a much longer period, the annual boost to economic growth during the transition period is much smaller in the slow transition countries.

The total gain and the average annual gain for each region are plotted against the average duration for the region in figures V and VI. The total gain is lowest for the industrial and transitional economies – between 15 and 20 percent. The developing regions are clustered at a considerably higher total gain ranging from a low of 32 percent for South Asian countries to a high of 39 percent for Latin American countries and Middle East and North African countries. Note that the total gain for South Asia and Sub-Saharan Africa are downward biased because the population projection to 2050 does not cover the entire dividend period. The actual values are located somewhere to northeast of those plotted.

The average annual gains experienced by the Industrial and Transitional economies exceed 0.5 percent per year. The average annual gains experienced in the developing world ranged from 0.49 percent per year in South Asian countries to 0.77 percent per year in Latin

American countries. For the developing countries there is a clear relationship between the

average gain and the duration of the dividend period.

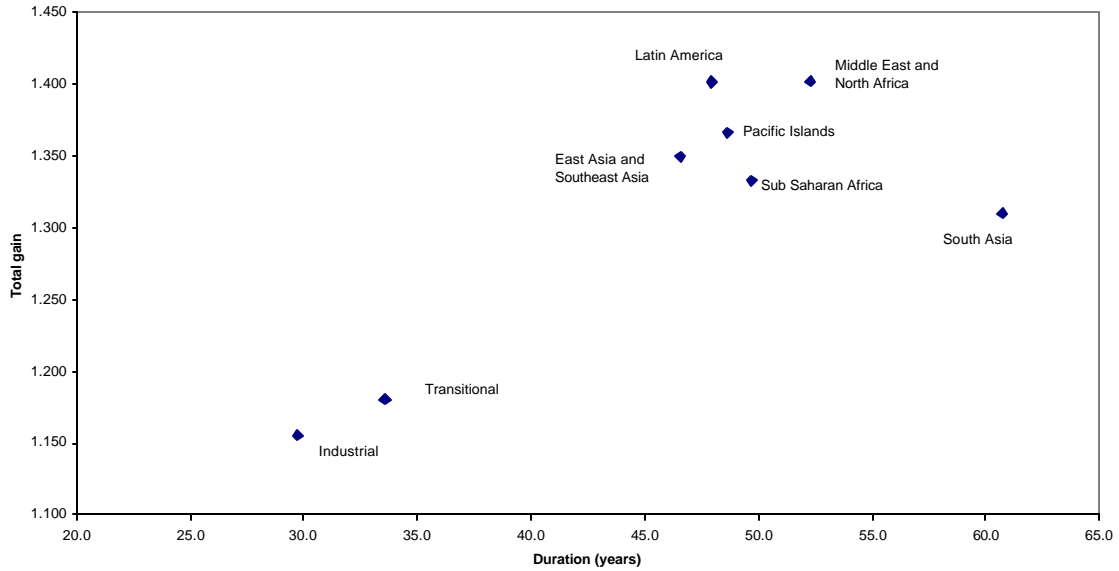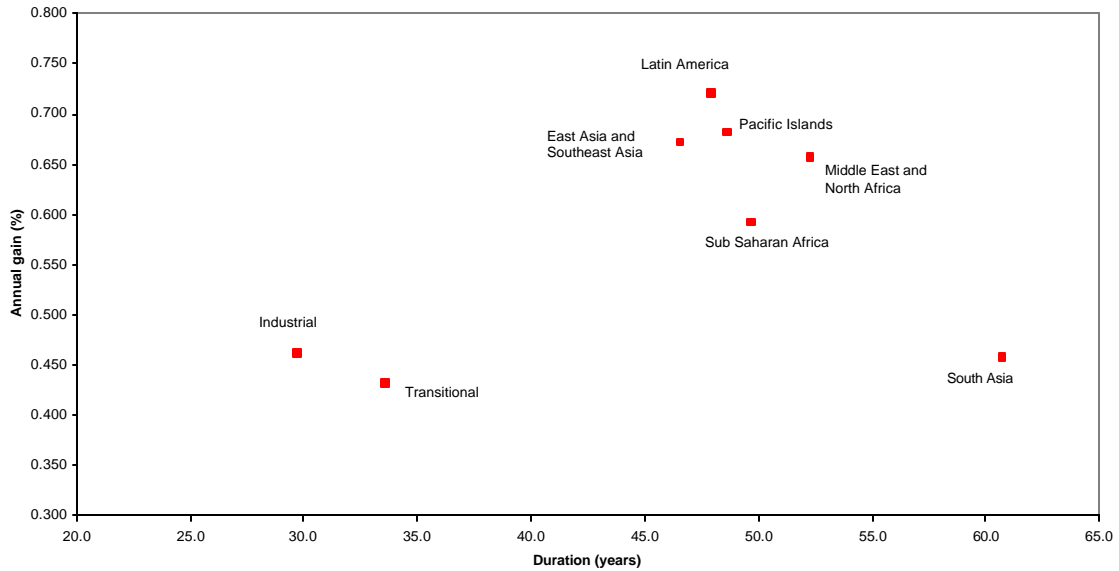**Figure V. The Total gain by duration, regional averages**

Figure VI. The Average annual gain by duration, regional averages

The country groupings conceal a considerable degree of heterogeneity. Thus, table 1

presents the annual increase in the support ratio and the total increase in the support ratio for the

top 10 and the bottom 10 countries. Only countries with a population exceeding 3 million in 2000 are included in the table. The top 10 countries in annual increase are drawn primarily from Southeast Asia and North Africa and the Middle East. Singapore ranks number 1 with a first dividend just exceeding 1 percent per year. Jordan and Viet Nam rank 2nd and 3rd. Among Latin American countries only Mexico makes the top 10. The bottom ten countries are all European, either industrial or transitional economies.

Table 1. Annual and Total Increases in the Support Ratio: The top and bottom 10 countries.

Annual Increase in the Support Ratio (%)					
Top 10			Bottom 10		
1	Singapore	1.02	124	France	0.26
2	Jordan	0.94	125	Croatia	0.26
3	Viet Nam	0.90	126	Serbia and Montenegro	0.26
4	Algeria	0.85	127	Bulgaria	0.25
5	United Arab Emirates	0.83	128	Lithuania	0.23
6	Thailand	0.82	129	Belgium	0.22
7	Tunisia	0.79	130	Greece	0.20
8	Armenia	0.79	131	Hungary	0.20
9	Syrian Arab Republic	0.79	132	Sweden	0.16
10	Mexico	0.76	133	Uruguay	0.15

Total Increase in the Support Ratio (%)					
Top 10			Bottom 10		
1	United Arab Emirates	64	124	Italy	6
2	Syrian Arab Republic	54	125	Georgia	5
3	Jordan	53	126	Croatia	5
4	Algeria	53	127	Serbia and Montenegro	5
5	Yemen	50	128	Bulgaria	5
6	Tunisia	48	129	Russian Federation	5
7	Nicaragua	48	130	Uruguay	5
8	Kenya	48	131	Hungary	4
9	Mexico	46	132	Lithuania	4
10	Uzbekistan	46	133	Sweden	3

Source: Calculated by author.

Note: Countries with population of 3 million or more in 2000 and that complete their dividend period by 2050 are included.

North Africa and the Middle East have a large presence in the top 10 countries for their total increase in the support ratio. United Arab Emirates is ranked number 1 with an increase of 64 percent. Nicaragua and Mexico are Latin American representatives on the list. The only

Asian country to make the top 10 list is Vietnam with a total increase of 44 percent. Again the bottom 10 consists of European countries – either industrial or transitional economies.

<center>2. *The Second Demographic Dividend*</center>

Changes in population age structure produce a second demographic dividend that depends on how the accumulation of wealth is related to population aging. First, there are compositional effects. A growing share of the population consists of individuals who are nearing or who have completed their productive years. These individuals must have accumulated wealth in order to finance consumption in excess of labor income for many of their remaining years. Second, there are behavioral effects. The rise in life expectancy and the accompanying increase in the duration of retirement leads to an upward shift in the age-profile of wealth.

This wealth can take different forms, however (Lee, 1994a, 1994b). One possibility is that retirees will rely on transfers from public pension and welfare programs or from adult children and other family members. In this case, individuals are accumulating transfer wealth as a method of financing consumption during their retirement years. A second possibility is that individuals will accumulate capital during their working years and that this will serve as the source of support during retirement years. Both of these forms of wealth can be used to deal with the lifecycle deficit at older ages, but capital also influences economic growth, i.e., the productivity term in the economic growth model presented above (equation (3)). The pro-growth effect of capital accumulation is the source of the second demographic dividend.

The second dividend is more complex to estimate than the first dividend, in part because the accumulation of wealth is intrinsically forward looking. Individuals accumulate wealth in anticipation of future needs to support consumption, to finance bequests, and to respond to other uncertain events. The analysis presented here emphasizes the lifecycle motive, i.e., the accumulation of wealth over the lifetime necessary to finance future consumption in excess of future labor income. The relevant demography is captured by the projections of the equivalent

numbers of consumer and producers for each cohort. Each cohort's lifecycle wealth increases as the future person-years of consumption rises relative to the future person-years of production, both appropriately discounted.

A technical problem is immediately apparent. Constructing complete lifecycle wealth estimates in year t requires a population series that extends many decades into the future. These data are not available for individual countries. Moreover, there is enormous uncertainty about long-range population projections. Fortunately, the nature of the economic lifecycle provides assistance with this problem. For the most part, capital accumulation is concentrated among older working-age adults who are approaching their peak earnings and have completed their childrearing responsibilities. Thus, we use the wealth held by those age 50 and older to measure the effect of demography on lifecycle wealth and the second demographic dividend.

Let $N(\leq b, t+x)$ be the number of effective consumers born in year b or less who are alive in year $t+x$. Letting $b = t - a$, then $N(\leq b, t+x)$ is the effective number of consumers a years or older in year t who are still alive in year $t+x$. If the relative per capita cross-sectional age profile of consumption is fixed and shifting upward at rate g_c, then the total consumption of the cohort born before age b in year $t+x$ is equal to $\bar{c}(t)e^{g_c x} N(\leq b, t+x)$, where $\bar{c}(t)$ is consumption per effective consumer in year t.[iv] The present value of the future lifetime consumption of the cohort born in year $b = t - a$ or earlier is:

$$\bar{c}(t)\, \mathrm{PVN}(<b,t) = \bar{c}(t) \sum_{x=0}^{w-a} e^{(g_c - r)x} N(\leq b, t+x). \qquad (4)$$

In similar fashion, if the shape of the per capita cross-sectional age profile of production is fixed and shifting upward at rate g_y, then the total production of the cohort born before age b in year $t+x$ is equal to $\bar{y}^l(t)e^{g_y x} L(\leq b, t+x)$ where $\bar{y}^l(t)$ is production or labor income per effective

producer. The present value of the future lifetime production of the cohort born in year $b = t - a$ or earlier is:

$$\overline{y}^l(t)\text{PVL}(<b,t) = \overline{y}(t)^l \sum_{x=0}^{w-a} e^{(g_y-r)x} L(\leq b, t+x). \tag{5}$$

In the absence of bequests, the lifetime budget constraint insures that the wealth in year t of those born in year b or earlier equals the difference between the present value of future lifetime consumption and future lifetime production, i.e.,

$$W(\leq b,t) = \overline{c}(t)\text{PVC}(\leq b,t) - \overline{y}^l(t)\text{PVL}(\leq b,t). \tag{6}$$

Algebraic manipulation yields an expression for the ratio of wealth to total labor income,
$w(<b,t) = W(<b,t)/Y^l(t)$:

$$w(\leq b,t) = [C(t)/Y^l(t)]\text{PVC}(\leq b,t)/N(t) - \text{PVL}(\leq b,t)/L(t), \tag{7}$$

or, alternatively:

$$w(\leq b,t) = [\overline{c}(t)/\overline{y}^l(t)]\text{PVC}(\leq b,t)/L(t) - \text{PVL}(\leq b,t)/L(t). \tag{8}$$

$\text{PVC}(\leq b,t)/L(t)$ is the present value of future lifetime consumption of all persons born in year b of earlier per effective producer in year t. $\text{PVL}(\leq b,t)/L(t)$ is the present value of future lifetime production of all persons born in year b or earlier per effective producer in year t.

Under golden-rule, steady-state growth, equation (7) can be readily evaluated: the ratio of consumption to labor income is equal to 1 and drops out; the rate of productivity growth and the rate of growth of equivalent consumption, g_y and g_c, are constant and equal to each other.

The situation is more complex under the dynamic conditions that characterize the current world. If the ratio of wealth to income is rising over time, because for example it is below its steady-state level, the ratio of consumption to labor income will be less than one and g_c will exceed g_y. In addition, the rate of growth of labor income will be varying in response to changes in the capital intensity of the economy. Interest rates may be declining as the ratio of

wealth to labor income rises. And whether and the extent to which these variables change will depend on whether or not the economy is open or closed to capital flows and whether or not it is large enough to influence world capital markets. To fully incorporate all of these complexities would require a detailed, country-specific simulation model. The calculations here abstract from these many complexities and emphasize only the demographics.

To calculate the second dividend, g_y and g_c are assumed to equal 0.015, the rate of interest to equal 0.03, and the ratio of consumption to labor income to equal 1.0. The ratio of wealth of those 50 and older to total labor income is used to approximate the ratio of total wealth to total labor income.[v]

The results for 1950 to 2000 are summarized by Figure VII, which reports regional averages of the ratio of lifecycle wealth (of those 50 and older) to output. In 1950 the wealth output ratios varied from a high of 2.2 for the Industrial countries to a low of 0.4 for the Pacific Island nations. All of the developing country regions had wealth ratios below 1. The transitional economies were in an intermediate position with a wealth ratio of 1.6.

Figure VII. Wealth(50+)/output, regional averages, 1950-2000

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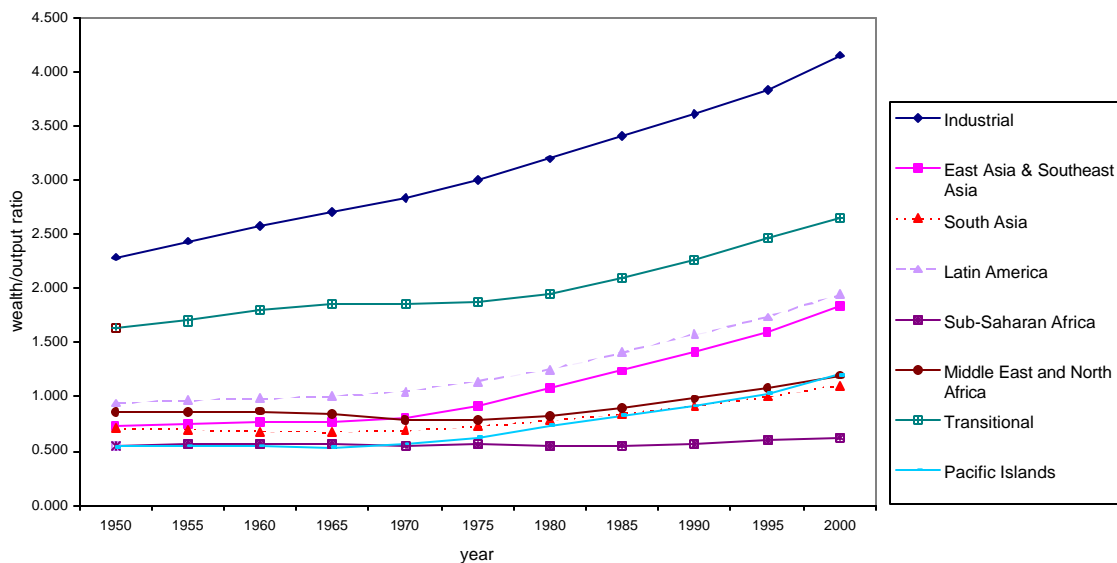
Between 1950 and 2000, the wealth ratios grew substantially in most regions of the world. The Industrial countries continued to lead with their average lifecycle wealth ratio exceeding 4 in 2000. Only the Pacific Island nations and Sub-Saharan African nations continued to languish with lifecycle ratios below one. The rapid gains are particularly evident for East and Southeast Asia and for Latin America, but the percentage increase in South Asia's wealth ratio was also substantial

The increase in the lifecycle wealth ratio was not evenly distributed across the 2nd half of the Twentieth Century. Between 1950 and 1975, the most rapid growth occurred in the Industrial world. After 1975, the most rapid growth occurred in the Third World (Figure VIII). Particularly impressive is the average rate of increase for the countries of East and Southeast Asia – just under 3 percent per year between 1975 and 2000.

Figure VIII. Annual growth, wealth(50+)/output, 1950-1975 and 1975-2000
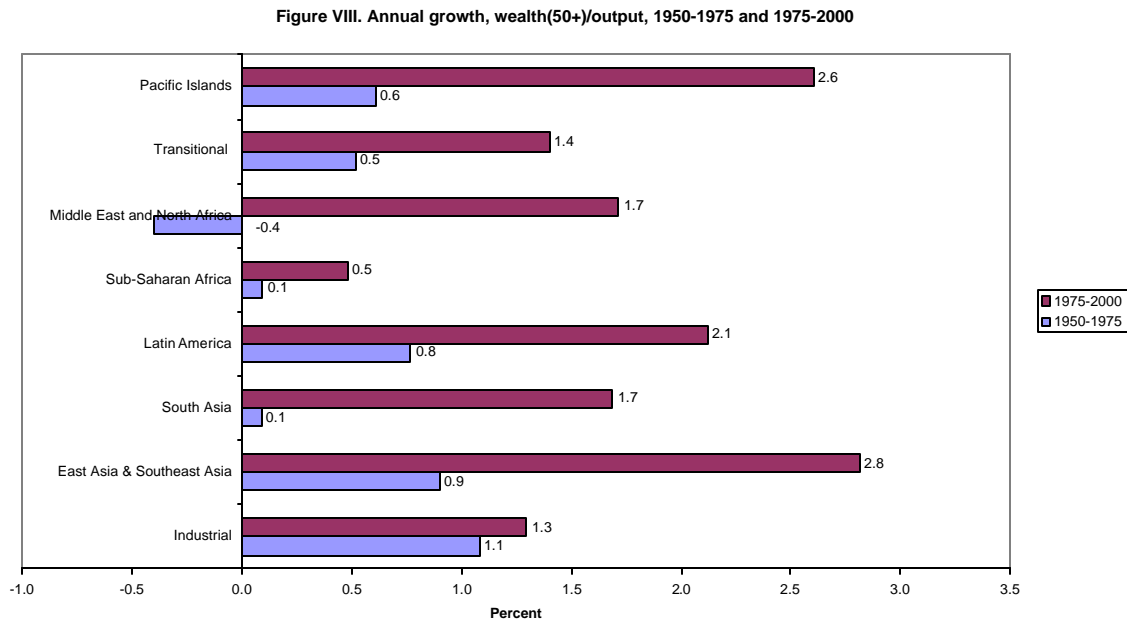
As emphasized above, the economic implications of the rise in lifecycle wealth induced by population aging depends on the form of wealth. Intergenerational transfer policy is defined as the proportion $\tau(t)$ of total wealth $W(t)$ held as transfer wealth at each point in time, so that:

$$K(t) = (1 - t(t))W(t) \qquad\qquad t(t) \le 1. \qquad\qquad (9)$$

If transfer policy is constant, the rate of growth of the capital stock will be equal to the rate of growth of wealth. Likewise, capital deepening will be determined by the rate of growth of wealth. If intergenerational transfer policy is undergoing change, however, capital deepening will occur more rapidly or more slowly than the underlying change in wealth (Lee and others, 2003).

The relationship between lifecycle wealth, capital, and economic growth can be clarified further by assuming that output depends only on capital and effective labor and that the production function is Cobb-Douglas. Under these conditions it is straight-forward to show that the growth in output per worker is proportional to the growth in the ratio of capital to *labor income* ($\dot{k}$):

$$\dot{y}^l = \frac{b}{1-b}\dot{k} \tag{10}$$

where b is the elasticity of output with respect to capital (Solow, 1956). Note that capital deepening in this formulation is measured as an increase in capital relative to labor income rather than capital relative to labor. Given a typical value for b of one-third, an increase in the growth rate of ratio of capital to labor income by one percent yields an increase in productivity growth (and growth per effective consumer) of 0.5 percent. A more general formulation of the production process that incorporates human capital does not alter estimates of the effect of capital deepening (Mankiw and others, 1992).

Estimates of the second dividend are calculated holding the transfer policy constant, so that the growth rates of the capital and lifecycle wealth are equal, and assuming that the elasticity of labor income with respect to capital is 0.5. Regional estimates for the 1970-2000 period are presented in Table 2 and compared to estimates of the first dividend for the same period. The second dividend is positive for all regions and substantially larger than the first dividend for the period in question. In East and Southeast Asia the second dividend was 1.3 percent per year in additional income growth – the largest of any region. But the second dividend was also very

large in the Pacific Islands and in Latin America – 1.15 and 1.08 percent per year, respectively.

In the Middle East and North Africa, South Asia, and the Industrial countries the second dividend

was about 0.7 percent per year. Only in Sub-Saharan Africa was the second dividend small at

0.17 percent per year.

Table 2. Estimates of the first and second dividends,
actual growth in Gross Domestic Product per effective consumer (GDP/N),
1970-2000.

Region	Demographic Dividends			Actual growth in GDP/N	Actual - Dividend
	First	Second	Total		
Industrial	0.34	0.69	1.03	2.25	1.22
East Asia & Southeast Asia	0.59	1.31	1.90	4.32	2.42
South Asia	0.10	0.69	0.80	1.88	1.08
Latin America	0.62	1.08	1.70	0.94	-0.76
Sub-Saharan Africa	-0.09	0.17	0.08	0.06	-0.02
Middle East and North Africa	0.51	0.70	1.21	1.10	-0.11
Transitional	0.24	0.57	0.81	0.61	-0.20
Pacific Islands	0.58	1.15	1.73	0.93	-0.79

The complexity of the relationship between the demographic dividends and economic

performance is brought home by comparing the total dividend to the actual growth of gross

domestic product per effective consumer (GDP/N). In three regions, countries were able to

achieve economic growth that exceeded the demographic dividend. In the Industrial countries

and South Asia, GDP/N grew faster than the dividend by 1.2 percent and 1.1 percent, respectively.

In East and Southeast Asia, GDP/N grew faster by a striking 2.4 percent per annum.

The picture is very different in other parts of the world where per capita output growth

was less than the dividend. Latin America and the Pacific Islands, in particular, failed to exploit

their demographic potentials. Growth in GDP/N was less than the dividend by 0.76 percent in

Latin America and by 0.79 percent in the Pacific Islands. In Sub-Saharan Africa, the Transitional

economies, and the countries of the Middle East and North Africa, growth in output per effective

consumer was relatively close to the total dividend. One should not on the basis of this simple

comparison conclude, however, that growth rates in these three regions were *determined* by the sizes of the dividend.

C. QUALIFICATIONS

Changes in age structure have potentially very important implications for macroeconomic performance. There are, however, many important caveats and qualifications that should be considered.

First, all of the analysis presented here is concerned with the relationship between age structure and per capita income or variants of per capita income. However, per capita income is not a reliable indicator of welfare and the effects of age structure on per capita income may be quite different than their effects on welfare.

Second, calculations of the first and second dividend both assume that the cross-sectional profiles of consumption persist into the future. In a sense we are assuming that the costs (or benefits) of aging are anticipated and shared across generations in the same manner as they are at present. Capital accumulation rises, transfer programs expand, families provide more support, and the elderly adjust their needs to the demographic realities. Alternative scenarios are clearly possible. As the elderly become more numerous they might use their political power to increase their consumption relative to working-age adults and children. Taxpayers and families might renege on their intergenerational contracts and solve the aging problem by reducing support for the elderly. The calculations presented here do not capture the costs that these possible generational crises would impose on societies.

Third, the relationship between the demographic dividends and income growth is very policy dependent. This point is emphasized in the introduction but bears repeating. The first dividend arises in part because the working age population is growing rapidly. The economic gains can be realized only if employment opportunities expand as rapidly as the numbers seeking new jobs. The second dividend arises in part because prime age adults save more to provide for

their retirement. Their ability or willingness to save, however, may be undermined by poorly developed financial markets or overly generous publicly funded pension programs. The changes in age structure define possibilities, but by themselves do not determine the outcome.

Finally, the calculations presented here require many simplifying assumptions and are based on highly stylized models of the economic growth process. Because of the imprecision and uncertainty surrounding the calculations, this paper emphasizes broad regional trends and differences. Some of the assumptions have been subject to sensitivity analysis. Appendix tables A.3 and A.4 report these results: (1) basing the support ratio on Taiwan rather the US; (2) assuming that the initial ratio of consumption to labor income is 0.9 rather than 1.0; (3) assuming that productivity and consumption growth are 2 percent per year rather than 1.5 percent per year. None of the broad conclusions or generalizations appears to be sensitive to variation in the assumptions.

D. CONCLUSIONS

This paper has several objectives. The first is to explain the demographic dividends in a conceptual and formal way. This draws on earlier work that identifies two demographic dividends (Mason and others, forthcoming). The first dividend arises because changes in age structure influence the share of the population concentrated in the working ages. The second dividend arises to the extent that anticipated changes in the share of the population concentrated in the retirement ages induce individuals, firms, and/or governments to accumulate capital.

The first dividend is inherently transitory. Demographic transition around the world has led to an increase in the share of the working age population that has lasted for many decades. But when large cohorts of prime age adults pass into their retirement years, the first dividend ends. The share of the population in the working ages begins to decline and the first dividend turns negative. The first dividend can have a lasting effect on economic growth if the gains in per capita income are used to create human capital by investing in health and education, to

accumulate physical capital, to support technological innovation, to create growth-inducing institutions, etc.

The second dividend is permanent in nature because it is driven by the rising share of the elderly in our populations. It is not self-evident that lifecycle wealth would necessarily continue to rise as the share of the retired population increases. The estimates presented here do not extend beyond the year 2000, but detailed simulations to 2150 show that for the US and Taiwan life cycle wealth stabilizes at a high plateau or continues to increase depending on the mortality assumptions employed (Lee and others, 2003). Thus, the second dividend does not turn negative as the demographic transition proceeds.

The second objective of the paper is to construct estimates of the first dividend from 1950 to 2050 and for the second dividend from 1950 to 2000 so as to compare and contrast diverse experiences around the world. These calculations support several important generalizations. First, the demographic dividends are potentially quite important throughout the world. For the 1970-2000 period the demographic dividends – if fully exploited – would have contributed between one and two percentage points to growth in income per equivalent consumer in the Industrial countries, East and Southeast Asia, Latin America, the Middle East and North Africa, and the Pacific Islands. This is a large increase as compared with the actual growth in income per equivalent consumer.

Second, the experience in the Third World has been quite distinct from the experience in the First and Second Worlds. The dividend was substantial in the Industrial countries and the Transition economies while it lasted. However, the duration was much shorter and the total gain was much less than in the Third World. The greater gains in the Third World reflect the fact that they were greatly dis-advantaged in their age structure in 1950.

Third, the experience within the developing world is quite varied. For many countries both the first and second dividends became important in the 1970s, but in other parts of the world – sub-Saharan Africa, for example – the dividend period is just beginning. The duration and

intensity have also varied in the developing world. In East and Southeast Asia and Latin America, for example, the duration of the dividend was relatively short and intense. In other parts of the world – South Asia, for example – the dividend was realized over a more extended period and had a smaller growth effect in any particular year.

Changes in age structure had an enormous influence on the macroeconomic environment for the second half of the 20th Century in both the developed and developing world. Age structure will most likely be an equally important force during the next fifty years. How economic growth, poverty, and other features of the macroeconomy are shaped by demographic change will depend, however, on how policies and institutions respond to the challenges and opportunities the future holds.

REFERENCES

Ahlburg, D.A.and E.R. Jensen. 2001. "Education and the East Asian Miracle." Pp. 231-255 in *Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized*, edited by A. Mason. Stanford: Stanford University Press.

Bloom, D.E.and D. Canning. 2001. "Cumulative Causality, Economic Growth, and the Demographic Transition." Pp. 165-200 in *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World*, edited by N. Birdsall, A.C. Kelley, and S.W. Sinding. Oxford: Oxford University Press.

Bloom, D.E., D. Canning, and B. Graham. 2003. "Longevity and Life-cycle Savings." *Scandinavian Journal of Economics* 105(3):319-338.

Bloom, D.E., D. Canning, and J. Sevilla. 2002. *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change.* Santa Monica, CA: RAND.

Bloom, D.E.and J.G. Williamson. 1998. "Demographic Transitions and Economic Miracles in Emerging Asia." *World Bank Economic Review* 12(3):419-456.

Deaton, A.and C.H. Paxson. 2000. "Growth, Demographic Structure, and National Saving in Taiwan." Pp. 141-173 in *Population and Economic Change in East Asia, A Supplement to Population and Development Review*, edited by R. Lee and C.Y.C. Chu. New York: Population Council.

Jensen, E.R.and D.A. Ahlburg. 2001. "Child Health and Health Care in Indonesia and the Philippines." Pp. 255-279 in *Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized*, edited by A. Mason. Stanford: Stanford University Press.

Kelley, A.C. 1988. "Economic Consequences of Population Change in the Third World." *Journal of Economic Literature* 26(4):16685-11728.

—. 1996. "The Consequences of Rapid Population Growth on Human Resource Development: The Case of Education." Pp. 67-138 in *The Impact of Population Growth on Well-Being in Developing Countries*, edited by D.A. Ahlburg, A.C. Kelley, and K.O. Mason. Heidelberg: Springer-Verlag.

Kelley, A.C.and R.M. Schmidt. 1995. "Aggregate Population and Economic Growth Correlations: The Role of the Components of Demographic Change." *Demography* 32(4):543-555.

—. 1996. "Saving, Dependency and Development." *Journal of Population Economics* 9(4):365-386.

Kinugasa, T. 2004. *Life Expectancy, Labor Force, and Saving, Ph.D. Dissertation.* University of Hawaii at Manoa.

Lee, R., A. Mason, and T. Miller. 2000. "Life Cycle Saving and the Demographic Transition in East Asia." *Population and Development Review* 26(Supplement).

—. 2003. "From Transfers to Individual Responsibility: Implications for Savings and Capital Accumulation in Taiwan and the United States." *Scandinavian Journal of Economics* 105(3):339-357.

Lee, R.D. 1994a. "The Formal Demography of Population Aging, Transfers, and the Economic Life Cycle." Pp. 8-49 in *Demography of Aging*, edited by L.G. Martin and S.H. Preston. Washington, D.C.: National Academy Press.

—. 1994b. "Population, Age Structure, Intergenerational Transfers, and Wealth: A New Approach, with Applications to the US." Pp. 1027-1063 in *The Family and Intergenerational Relations, Journal of Human Resources*, edited by P. Gertler.

Lee, R.D., A. Mason, and T. Miller. 2001. "Saving, Wealth, and Population." Pp. 137-164 in *Population Does Matter: Demography, Poverty, and Economic Growth*, edited by N. Birdsall, A.C. Kelley, and S.W. Sinding. Oxford: Oxford University Press.

Mankiw, G., D. Romer, and D. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics* 107(2):407-437.

Mason, A. 2001a. "Population and Economic Growth in East Asia." Pp. 1-30 in *Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized*, edited by A. Mason. Stanford: Stanford University Press.

—. 2001b. *Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized.* Stanford: Stanford University Press.

Mason, A. and R. Lee. forthcoming. "Reform and Support Systems for the Elderly in Developing Countries: Capturing the Second Demographic Dividend." *GENUS*.

Mason, A., R. Lee, A.-C. Tung, M.S. Lai, and T. Miller. 2005. "Population Aging and Intergenerational Transfers: Introducing Age into National Accounts." Presented at Annual Meeting of the Population Association of America, Philadelphia, March 30-April 2.

Mason, A., T. Merrick, and R.P. Shaw. 1999. *Population Economics, Demographic Transition, and Development: Research and Policy Implications*. Washington, D.C.: World Bank Institute.

Montgomery, M.R. and C.B. Lloyd. 1996. "Fertility and Maternal and Child Health." Pp. 37-66 in *The Impact of Population Growth on Well-Being in Developing Countries*, edited by D.A. Ahlburg, A.C. Kelley, and K.O. Mason. Heidelberg: Springer-Verlag.

Solow, R.M. 1956. "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics* 70(1):65-94.

United Nations Population Division. 2005. *World Population Prospects: The 2004 Revision.* New York: United Nations.

Williamson, J.G. and M. Higgins. 2001. "The Accumulation and Demography Connection in East Asia." Pp. 123-154 in *Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized*, edited by A. Mason. Stanford: Stanford University Press.

Table A1. List of countries by country groupings

Industrial

Andorra, Australia, Austria, Belgium, Bermuda, Canada, Channel Islands, Denmark, Faeroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Holy See, Iceland, Ireland, Isle of Man, Italy, Japan, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, New Zealand, Norway, Portugal, Saint-Pierre-et-Miquelon, San Marino, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States of America

East Asia and Southeast Asia

Brunei Darussalam, Cambodia, China, China, Hong Kong SAR, China, Macao SAR, Dem. People's Rep. of Korea, Dem. Republic of Timor-Leste, Indonesia, Lao People's Dem. Republic, Malaysia, Myanmar, Philippines, Republic of Korea, Singapore, Thailand, Viet Nam

South Asia

Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka

Latin America

Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, United States Virgin Islands, Uruguay, Venezuela

Sub Saharan Africa

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Dem. Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Réunion, Rwanda, Saint Helena, São Tomé and Príncipe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe

Middle East and North Africa

Afghanistan, Algeria, Bahrain, Cyprus, Egypt, Iran (Islamic Republic of), Iraq, Israel, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Occupied Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates, Western Sahara, Yemen

Transitional

Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Mongolia, Poland, Republic of Moldova, Romania, Russian Federation, Serbia and Montenegro, Slovakia, Slovenia, Tajikistan, TFYR Macedonia, Turkmenistan, Ukraine, Uzbekistan

Pacific Islands

American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia (Fed. States of), Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna Islands

Table A2. Countries with complete and incomplete dividend periods

Region	Number of Countries	Bonus Period			
		Started before 1950	Ended by 2005	Ended between 2005-2050	Not ended by 2050
Industrial	37	2	31	6	-
East Asia and Southeast Asia	16	-	1	13	2
South Asia	7	-	-	7	-
Latin America	46	-	8	37	1
Sub-Saharan Africa	50	-	2	5	43
Middle East and North Africa	22	1	1	17	4
Transitional	28	2	8	20	6
Pacific Islands	22	1	6	10	-
Total	228	6	57	115	56

Table A3. Sensitivity analysis: demographic dividend based on Taiwan 1998

Region	Demographic Dividends			Actual growth in GDP/N	Actual - Dividend
	First	Second	Total		
Industrial	0.42	0.70	1.12	2.25	1.13
East Asia & Southeast Asia	0.66	1.19	1.85	4.32	2.47
South Asia	0.14	0.58	0.73	1.88	1.15
Latin America	0.71	1.00	1.71	0.94	-0.77
Sub-Saharan Africa	-0.06	0.11	0.05	0.06	0.01
Middle East and North Africa	0.57	0.58	1.15	1.10	-0.05
Transitional	0.30	0.57	0.87	0.61	-0.26
Pacific Islands	0.63	1.03	1.66	0.93	-0.73

Table A4: Implications for second dividend of varying several assumptions

	C/Y=1.0	C/Y= .9 [1]	$g_c=g_y=.02$	Using Taiwan profiles
Industrial	0.69	0.74	0.69	0.70
East Asia & Southeast Asia	1.31	1.56	1.29	1.19
South Asia	0.69	0.85	0.68	0.58
Latin America	1.08	1.27	1.05	1.00
Sub-Saharan Africa	0.17	0.26	0.16	0.11
Middle East and North Africa	0.70	0.91	0.68	0.58
Transitional	0.57	0.61	0.57	0.57
Pacific Islands	1.15	1.40	1.10	1.03

Note: [1] Growth of consumption is set at .017 while growth of productivity at .015

[ii] Changes in age structure may have additional important effects Bloom, D.E., D. Canning, and J. Sevilla. 2002. *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change*. Santa Monica, CA: RAND.. Recent studies suggest that demographic change may have favorable human capital effects Jensen, E.R.and D.A. Ahlburg. 2001. "Child Health and Health Care in Indonesia and the Philippines." Pp. 255-279 in *Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized*, edited by A. Mason. Stanford: Stanford University Press, Montgomery, M.R.and C.B. Lloyd. 1996. "Fertility and Maternal and Child Health." Pp. 37-66 in *The Impact of Population Growth on Well-Being in Developing Countries*, edited by D.A. Ahlburg, A.C. Kelley, and K.O. Mason. Heidelberg: Springer-Verlag. although the effects on education are uncertain Ahlburg, D.A.and E.R. Jensen. 2001. "Education and the East Asian Miracle." Pp. 231-255 in *Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized*, edited by A. Mason. Stanford: Stanford University Press, Kelley, A.C. 1996. "The Consequences of Rapid Population Growth on Human Resource Development: The Case of Education." Pp. 67-138 in *The Impact of Population Growth on Well-Being in Developing Countries*, edited by D.A. Ahlburg, A.C. Kelley, and K.O. Mason. Heidelberg: Springer-Verlag..

[iii] The dividend period is defined as the longest time interval during which the dividend is positive. In the event of two periods of equal length, the first period is used. The duration is the number of years elapsed from the beginning of the first period to the end of the last period. For some countries the dividend was underway in 1950 and for other countries the dividend period was not completed until after 2050. In these cases, the calculations are based on a dividend period beginning in 1950 or ending in 2050. Appendix table A.2 provides information about the extent of truncation for the country groups.

[iv] For the sake of simplicity, I assume that the rate of growth of per capita consumption and the interest rate are constant. Although this is a standard steady-state assumption, there is no reason to expect this to be the case during periods of transition. To treat *g* and *r* as endogenous is not a tractable alternative without employing a detailed, country-specific simulation model Lee, R., A. Mason, and T. Miller. 2000. "Life Cycle Saving and the Demographic Transition in East Asia." *Population and Development Review* 26(Supplement), —. 2003. "From Transfers to Individual Responsibility: Implications for Savings and Capital Accumulation in Taiwan and the United States." *Scandinavian Journal of Economics* 105(3):339-357.. A more general formulation that allows for changing growth rates is provided by Mason and Lee Mason, A.and R. Lee. forthcoming. "Reform and Support Systems for the Elderly in Developing Countries: Capturing the Second Demographic Dividend." *GENUS*..

[v] As can be seen in Figure 1 labor income substantially exceeds consumption from the mid-twenties. However, a substantial portion of this surplus for childrearing adults is devoted to transfers to children rather than to capital accumulation.