

---

UN/POP/PD/2005/2  
28 July 2005  
Revised 25 January 2006

---

**UNITED NATIONS EXPERT GROUP MEETING ON SOCIAL  
AND ECONOMIC IMPLICATIONS OF CHANGING  
POPULATION AGE STRUCTURE**

Population Division  
Department of Economic and Social Affairs  
United Nations Secretariat  
Mexico City, Mexico  
31 August – 2 September 2005

**DEMOGRAPHIC TRANSITION AND DEMOGRAPHIC DIVIDENDS  
IN DEVELOPED AND DEVELOPING COUNTRIES<sup>1</sup>**

Andrew Mason  
Department of Economics  
University of Hawaii at Manoa  
and  
Population and Health Studies  
East-West Center

## 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, favourable effect on per capita income. Given fixed output per worker, labour 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 ageing 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 labour 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 Lee, forthcoming). A key economic challenge for ageing populations is to provide for old-age consumption for older persons who typically have substantially reduced labour income. Some societies are trying to meet this challenge by relying on transfer systems – either public programmes 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.<sup>2</sup> Moreover, the second dividend is not transitory in nature. Population ageing may produce a “permanent” increase in capital and thus on per capita income (Lee, Mason and Miller, 2001, 2003).

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, Canning and Graham, 2003; Deaton and Paxson, 2000; Schmidt and Kelley, 1996; Kinugasa, 2004; Williamson and Higgins, 2001) and on economic growth (Bloom and Canning, 2001; Bloom and Williamson, 1998; Kelley and Schmidt, 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 miracle economies of Eastern and South-eastern Asia provide compelling and consistent evidence that the demographic dividend was an important contributor to that region’s economic success (Bloom and Williamson, 1998; Mason, 2001b; Mason, Merrick and Shaw, 1999). Bloom and Williamson (1998) use econometric analysis to conclude that about one-third of Eastern and South-eastern 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” (in the statistical sense) 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 experience of the Asian Tigers 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 financial crisis of the late 1990s struck – was attractive to investment. Large-scale pay-as-you-go pension programmes 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

favourable 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 and the developing world and to contrast important variations within the developing world. Detailed country estimates are available on the author's website: [www2.hawaii.edu/~amason](http://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 adults of working age, on average, produce much more than they consume. Countries with heavy concentrations of populations in the working ages have an inherent advantage to produce 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 United States 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 United States 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 or older). In 2000, United States residents under the age of 24 and over the age of 57 were economically dependant in the sense that they consumed more than they produced. Estimates for Taiwan Province of China, 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 or those who are 60 are economically dependant, but to a smaller degree than those who are 18 or those who are 75.<sup>3</sup>

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 neighbours – have very different demographic histories. Changes in the age distribution of the United States are dominated by the baby boom of 1946 to 1964 and its echoes. Changes in the age distribution of Mexico are dominated by fertility decline. Both are influenced by steady improvements in life expectancy. Although differences are important, both countries experienced a significant decline in the share of their populations under the age of 15, and a significant rise in the share of the population in the productive ages between 1950 and 2000 – giving rise to their first demographic dividends. Both countries show a clear shift in their population age distribution from the productive ages to older ages between 1950 and 2000. As this change proceeds, the advantage derived from having a population concentrated in the productive ages will dissipate as that concentration disappears.

The second dividend arises to the extent that consumers and policymakers are forward-looking and respond effectively to the demographic changes that are foreseen. With a rise of the share of the elderly 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 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 in national income. In either case, per capita income will grow more rapidly than it would otherwise.

The first and second dividends are formalized in Mason and Lee (forthcoming). If we denote the effective number of consumers by ( $N$ ) and the effective number of producers by ( $L$ ) and let

$$\begin{aligned}
N(t) &= \sum_a \alpha(a)P(a,t) \\
L(t) &= \sum_a \gamma(a)P(a,t)
\end{aligned}
\tag{1}$$

where  $P(a,t)$  is the population aged  $a$  at time  $t$  and  $\alpha(a)$  and  $\gamma(a)$  are age-specific coefficients reflecting relative levels of consumption and production, respectively. Output per effective consumer ( $Y/N$ ) is given by:

$$\frac{Y(t)}{N(t)} = \frac{L(t)}{N(t)} \times \frac{Y(t)}{L(t)},
\tag{2}$$

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 so that:

$$\dot{y}^n(t) = \dot{L}(t) - \dot{N}(t) + \dot{y}(t).
\tag{3}$$

Thus, the rate of growth in output per effective consumer ( $\dot{y}^n$ ) is the sum of the rate of growth of the support ratio ( $\dot{L}(t) - \dot{N}(t)$ ) and the rate of growth of output per worker ( $\dot{y}$ ). The first dividend is then 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 by age and sex 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 per cent as productive as persons aged 30-59. The equivalence values for consumption have been scaled so that the 1950 population of the world has a support ratio of 1.0. A value of 0.9 indicates therefore that the effective producers per consumer is 90 percent of the world-wide value for 1950.

Before turning to regional comparisons, the experience of Mexico and the United States sets the stage. Figure 2 shows the support ratios for both countries and the first demographic dividend calculated as the rate of growth of the support ratio for each of the five-year periods following year  $t$ .

The support ratio for the United States 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 United States had a significant advantage in 1950—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, especially in Mexico, declining child mortality were leading to an increase in the number of children. The support ratio began to rise, in the United States in 1970 and in Mexico in 1975, as a result of fertility decline. The United States support ratio reached its peak in 2000. In total, the support ratio and hence output per effective consumer increased by 12.7 per cent during the 30-year period. The Mexican support ratio is projected to reach its peak in 2025. From 1975 to 2025, output per effective consumer in Mexico will increase by 46.4 per cent – a gain substantially larger than experienced in the United States.

The first dividend measures the relationship between *changing* age-structure and economic growth. When the dividend is positive, the support ratio is increasing and, given productivity gains, it leads to 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 United States and by an additional 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 United States (1985-1990) and 1.25 percentage points per year to economic growth in Mexico (1995-2000).

The similarities and differences between Mexico and the United States are worth emphasizing: (1) the first demographic dividend became positive at about the same time – in the 1970s – in both countries; (2) the period over which the first dividend was positive was shorter in the United States than it is expected to be in Mexico – 30 years in the United States versus 50 years in Mexico; (3) both the total impact and the annual impact of the dividend are and are expected to be substantially higher in Mexico than in the United States; and, (4) Mexico gained relative to the United States because it began with a relative disadvantage. The projections for Mexico anticipate that it will eventually catch the United States by achieving a support ratio of 1.14 in 2025 as compared with the maximum United States 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 countries within the developing world is quite varied.

The comparisons presented here focus on eight country groups that have been defined to capture commonalities in economics, geography and demography. The eight groups are the Pacific Islands, transitional economies, the Middle East and North Africa, sub-Saharan Africa, Latin America and the Caribbean, 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, that is, the period over which the first dividend is positive, began first in the industrial countries in 1970 and soon thereafter in the Pacific Islands, the transitional economies, the Middle East and North Africa, Latin America and the Caribbean, and East and Southeast Asia (figure 3). The onset of the first dividend was substantially delayed only in South Asia – to around 1985 – and sub-Saharan Africa – to around 1995.

The duration of the first dividend was relatively short in the industrial countries (approximately 30 years), and in the transitional economies (almost 34 years).<sup>4</sup> The duration in other groups of countries varies 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 downwardly biased for some groupings, because the dividend period begins prior to 1950 for a few countries and extends beyond 2050 for many countries and the data available cover only the 1950-2050 period. The duration of the dividend for sub-Saharan Africa, in particular, is affected by the truncation in 2050 and it would be reasonable to expect a duration as long or longer for that region or for South Asia. 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 United States, 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 4, 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 for each group of countries.

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 is only 15 years, for example, the support ratio rises by only 5 per cent from the beginning to the end of the dividend period. If the dividend period lasts 35 years, in contrast, the support ratio rises by 25 per cent between the beginning and the end of the dividend period. On average the transitional economies and the industrial countries have relatively short dividend periods with relatively small total gains.

For countries with a dividend period lasting 40 years or more, 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 period averaged between about 35 per cent and 40 per cent. Countries with slow transitions, mainly those in South Asia and sub-Saharan Africa, can eventually reap a dividend as large as countries with rapid transitions, such as those in Latin America and the Caribbean or in 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 shorter in the countries with slow fertility declines.

The total gain and the average annual gain for each region are plotted against the average duration for the region in figures 5 and 6. The total gain is lowest for the industrial countries and transitional economies – between 15 and 20 per cent. The developing regions are clustered at a considerably higher total gain ranging from a low of 32 per cent for South Asian countries to a high of 39 per cent for countries in Latin America and the Caribbean or in the Middle East and North Africa. Note that the total gains for South Asia and sub-Saharan Africa are downwardly biased because the population projection to 2050 does not cover the entire dividend period. The actual values should be located somewhere to the northeast of those plotted.

The average annual gains experienced by the industrial countries and the transitional economies exceed 0.5 per cent per year. The average annual gains experienced in the developing world ranged from 0.49 per cent per year in the countries of South Asia to 0.77 per cent per year in the countries of Latin America and the Caribbean. For the developing countries there is a clear relationship between the average gain and the duration of the dividend period.

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 or the Middle East and North Africa. Singapore ranks first with a first dividend just exceeding 1 per cent per year. Jordan and Viet Nam rank second and third. Among Latin American countries only Mexico makes the top 10. The bottom ten countries are all European, either industrial countries or transitional economies.

Countries in the Middle East and North Africa have a large presence in the top 10 countries because of the total increase in their support ratio. The United Arab Emirates is ranked first with an increase of 64 per cent. Nicaragua and Mexico in Latin America are on the list of the top 10. The only Asian country to make the top 10 list is Viet Nam with a total increase of 44 per cent. Again the bottom 10 consists of European countries – either industrial countries or transitional economies.

## *2. The Second Demographic Dividend*

Changes in population age structure also produce a second demographic dividend that depends on how the accumulation of wealth is related to population ageing. First, there are compositional effects.

During the later stages of the transition to low fertility, a growing share of the population consists of individuals who are nearing the completion or who have completed their productive years. These individuals must have accumulated wealth in order to finance consumption in excess of labour income for many of their remaining years. Second, there are behavioural 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 programmes 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 capital will serve as the source of support during the retirement period. 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 labour income. The relevant demography is captured by the projections of the equivalent numbers of consumers and producers for each cohort. Each cohort's lifecycle wealth increases as the future person-years of consumption rise 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 earlier and who are alive in year  $t+x$ . Letting  $b = t - a$ , where  $a$  is age, 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 in year  $b$  or earlier 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  $t$ .<sup>5</sup> Given discount rate  $r$ , the present value of the future lifetime consumption of the cohort born in year  $b = t - a$  or earlier is:

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

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 in year  $b$  or earlier at time  $t+x$  is equal to  $\bar{y}^l(t)e^{g_y x} L(\leq b, t+x)$  where  $\bar{y}^l(t)$  is production or labour income per effective producer. The present value of the future lifetime production of the cohort born in year  $b = t - a$  or earlier is:

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

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.,

$$W(\leq b, t) = \bar{c}(t) \text{PVN}(\leq b, t) - \bar{y}^l(t) \text{PVL}(\leq b, t). \quad (6)$$

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

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

or, alternatively:

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

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

Under golden-rule, steady-state growth<sup>6</sup>, equation (7) can be readily evaluated: the ratio of consumption to labour 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 labour income will be less than one and  $g_c$  will exceed  $g_y$ . In addition, the rate of growth of labour 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 labour 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 demographic trends.

To calculate the second dividend,  $g_y$  and  $g_c$  are assumed to equal 0.015, the rate of interest,  $r$ , to equal 0.03, and the ratio of consumption to labour income to equal 1.0. The ratio of wealth of those 50 and older to total labour income in the United States is used to approximate the ratio of total wealth to total labour income.<sup>7</sup>

The results for 1950 to 2000 are summarized by figure 7, which shows regional averages of the ratio of lifecycle wealth (of those 50 or 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 Islands. All of the country groupings in the developing world had wealth ratios below 1. The transitional economies were in an intermediate position with a wealth ratio of 1.6.

Between 1950 and 2000, the wealth ratios grew substantially in most regions of the world. The

industrial countries continued to lead with a lifecycle wealth ratio exceeding 4 on average in 2000. Only the Pacific Islands and sub-Saharan Africa continued to languish with lifecycle wealth ratios below one. The rapid gains are particularly evident for East and Southeast Asia and for Latin America and the Caribbean, but the percentage increase in South Asia's wealth ratio was also substantial.

The increase in the lifecycle wealth to output ratio was not evenly distributed across the second half of the twentieth century. Between 1950 and 1975, the most rapid growth occurred in the industrial countries. After 1975, the most rapid growth occurred in the developing world (figure 8). Particularly impressive is the average rate of increase for the countries of East and Southeast Asia – just under 3 per cent per year between 1975 and 2000.

As emphasized above, the economic implications of the rise in lifecycle wealth induced by population ageing depends on the form of wealth. Intergenerational transfer policy involves the holding of a proportion  $\tau(t)$  of total wealth  $W(t)$  as transfer wealth at each point in time, so that the capital stock at time  $t$  is:

$$K(t) = (1 - \tau(t))W(t) \quad \tau(t) \leq 1. \quad (9)$$

If proportion of lifecycle wealth held 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. However, if intergenerational transfer policy is undergoing change, and  $\tau(t)$  changes over time, capital deepening will occur more rapidly or more slowly than the underlying change in wealth (Lee, Mason and Miller, 2003).

The relationship between lifecycle wealth, capital, and economic growth can be clarified further by assuming that output depends on capital and effective labour only and that the production function is Cobb-Douglas.<sup>8</sup> Under these conditions it is straightforward to show that the growth in output per worker is proportional to the growth in the ratio of capital to *labour income*,  $\dot{k}$  :

$$\dot{y} = \frac{\beta}{1 - \beta} \dot{k} \quad (10)$$

where  $\beta$  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 labour income rather than capital relative to labour. Given a typical value for  $\beta$  of one-third, an increase in the growth rate of ratio of capital to labour income by one per cent yields an increase in productivity growth (and growth per effective consumer) of 0.5 per cent. A more general formulation of the production process that incorporates human capital does not alter estimates of the effect of capital deepening (Mankiw, Romer and Weil, 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 labour 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 per cent 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 per cent per year, respectively. In the Middle East and North Africa, South Asia, and the industrial countries the second dividend was about 0.7 per cent per year. Only in sub-Saharan Africa was the second dividend small at 0.17 per cent per year.

What path should the second dividend take in the future? Will it turn negative as the first dividend? Or is it likely to persist? Answering these questions requires longer term population projections than the ones employed in this paper, but several studies relying on long-term population projections conclude that the second dividend does not turn negative to any important degree (Lee, Mason and Miller 2003, Mason 2005). The explanation for this lies in the demographics. The bulge in the working ages, which drives the first dividend, is a transitory feature of demographic transitions. The rising share at older ages, which drives the second dividend, is a “permanent” state of affairs. If populations stabilize at replacement fertility and high life expectancy, the demand for lifecycle wealth will stabilize at a high level. If life expectancy continues to increase and populations continue to age, the demand for life cycle wealth will continue to rise. If the population age distribution stabilizes, the second dividend will be zero. It is possible for the demand for lifecycle wealth to overshoot the steady-state level producing periods during which the second dividend is negative. In simulations carried out to date the overshoot has been modest and the period of decline relatively unimportant. The key point is that population aging leads to a permanent increase in the demand for lifecycle wealth. To the extent this is satisfied by capital accumulation, the result is a permanent increase in the capital intensity of the economy and a permanent increase in output per worker.

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 per cent and 1.1 per cent, respectively. In East and Southeast Asia, GDP/N grew faster by a striking 2.4 per cent 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 per cent in Latin America and by 0.79 per cent 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 ageing are

anticipated and shared across generations in the same manner as they are at present. Capital accumulation rises, transfer programmes 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 ageing 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 programmes. 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 Province of China rather than the United States; (2) assuming that the initial ratio of consumption to labour income is 0.9 rather than 1.0; (3) assuming that productivity and consumption growth are 2 per cent per year rather than 1.5 per cent 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 Lee, 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 United States and Taiwan lifecycle wealth stabilizes at a high plateau or continues to increase depending on the mortality assumptions employed (Lee, Mason and Miller, 2003). Long-term simulations for India, Japan, and the United States using UN long-term population projections shows that wealth continues to rise relative to income and that the second dividend is positive for the foreseeable future and beyond (Mason 2005). 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. Most of this potential gain comes from the second rather than the first dividend. In every region the second dividend exceeds the first. In the Industrial countries, East and Southeast Asia, the Transitional economies, and the Pacific Island nations the second dividend was twice the size of the first dividend. In South Asia, the second dividend amounted to 0.69 percentage points of growth per year as compared with only 0.10 for the first dividend.

Second, favourable (or unfavourable) demographics do not automatically translate into strong (or weak) economic growth. This is clear on *a priori* grounds. In the many ways delineated above policy interacts with demographic change to generate economic outcomes. This point is reinforced by comparing the potential effects of demography with actual economic experience. For example, between 1970 and 2000 the combined effects of the first and second dividend were very favourable in East and Southeast Asia, Latin America, and the Pacific Island nations, but in Latin America and the Pacific Islands economic growth fell well short of the demographic dividends.

Third, 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 developing countries reflect the fact that they were greatly disadvantaged in their age structure in 1950.

Fourth, 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 during the second half of the 20<sup>th</sup> 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 Eastern and South-eastern Asian Miracle." Pp. 231-255 in *Population Change and Economic Development in Eastern and South-eastern 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 Eastern and South-eastern 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 Eastern and South-eastern 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.
- Kinugasa, T. 2004. *Life Expectancy, Labour Force, and Saving, Ph.D. Dissertation*. University of Hawaii at Manoa.
- 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 United States." Pp. 1027-1063 in *The Family and Intergenerational Relations, Journal of Human Resources*, edited by P. Gertler.
- Lee, R., A. Mason, and T. Miller. 2000. "Life Cycle Saving and the Demographic Transition in Eastern and South-eastern Asia." *Population and Development Review* 26(Supplement).
- 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.
- . 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.
- 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 Eastern and South-eastern Asia." Pp. 1-30 in *Population Change and Economic Development in Eastern and South-eastern Asia: Challenges*

- Met, Opportunities Seized*, edited by A. Mason. Stanford: Stanford University Press.
- 2001b. *Population Change and Economic Development in Eastern and South-eastern Asia: Challenges Met, Opportunities Seized*. Stanford: Stanford University Press.
- 2005. "Demographic Dividends: The Past, the Present, and the Future." Joint International Conference of the 21st Century COE (Center of Excellence) Program of Kobe University and the Japan Economic Policy Association (JEPA), Awaji Yumebutai International Conference Center near Kobe, Japan, December 17-18.
- 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 the 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.
- Phelps, Edmund S. 1965. "Second Essay on the Golden Rule of Accumulation" *American Economic Review* 55(4):793-814.
- Schmidt, R.M and A.C. Kelley. 1996. "Saving, Dependency and Development." *Journal of Population Economics* 9(4):365-386.
- 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. CD-ROM-ST/ESA/SER.A/243.
- Williamson, J.G. and M. Higgins. 2001. "The Accumulation and Demography Connection in Eastern and South-eastern Asia." Pp. 123-154 in *Population Change and Economic Development in Eastern and South-eastern Asia: Challenges Met, Opportunities Seized*, edited by A. Mason. Stanford: Stanford University Press.

---

<sup>1</sup> This research was supported by NIA, R01-AG025488-01. My thanks to Naohiro Ogawa for his useful suggestions and to Turro Wongkaren for his able research assistance.

<sup>2</sup> Changes in age structure may have additional important effects (Bloom, Canning and Sevilla, 2002). Recent studies suggest that demographic change may have favourable human capital effects (Jensen, and Ahlburg, 2001; Montgomery, and Lloyd, 1996) although the effects on education are uncertain (Ahlburg, and Jensen, 2001; Kelley, 1996).

<sup>3</sup> Additional information about estimating the economic lifecycle is summarized in [\[\[insert reference to note\]\]](#) and described in detail in [www.ntaccounts.org](http://www.ntaccounts.org).

<sup>4</sup> 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.

<sup>5</sup> 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, Mason, and Miller, 2000, 2003).

---

A more general formulation that allows for changing growth rates is provided by Mason and Lee (forthcoming).

<sup>6</sup> Under golden-rule growth the consumption-time profile is at its maximum (Phelps 1965).

<sup>7</sup> As can be seen in Figure 1, labour income substantially exceeds consumption from the mid-twenties. However, the preponderance of this surplus for childrearing adults is devoted to transfers to children rather than to capital accumulation. The calculations of the second dividend depend on the growth rate of wealth rather than the level. Hence, they are unaffected if wealth of those over age 50 is a constant proportion of total wealth. As populations age wealth of those over age 50 is likely to increase as a proportion of total wealth and, consequently, the use of wealth over age 50 probably errs on the side of understating the magnitude of the second dividend. This issue will be explored further in research that is underway.

<sup>8</sup> An alternative approach would be to assume a constant rate of return to wealth. This would be more consistent with the assumption that interest rates are established in global markets and not influenced by the amount of wealth or capital supplied in an individual economy. However, this would over-state the effect of increased wealth on national income if rates of return to capital decline as the economy's capital intensity increases. The approach employed here is adopted because it yields more conservative estimates of the income gains associated with the second dividend. A complete general equilibrium economic model, however, would also incorporate the effects of declining interest rates on saving. This is a drawback of the simple approach employed here, but it should also be noted that empirical research usually concludes that saving rates are quite insensitive to changes in interest rates.