DEMOGRAPHIC TRANSITION AND DEMOGRAPHIC DIVIDENDS IN DEVELOPED AND DEVELOPING COUNTRIES

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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.[1] 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; 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.

[*] This research was supported by NIA, R01-AG025488-01. The author wishes to thank Naohiro Ogawa for his useful suggestions and to Turro Wongkaren for his able research assistance.

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.

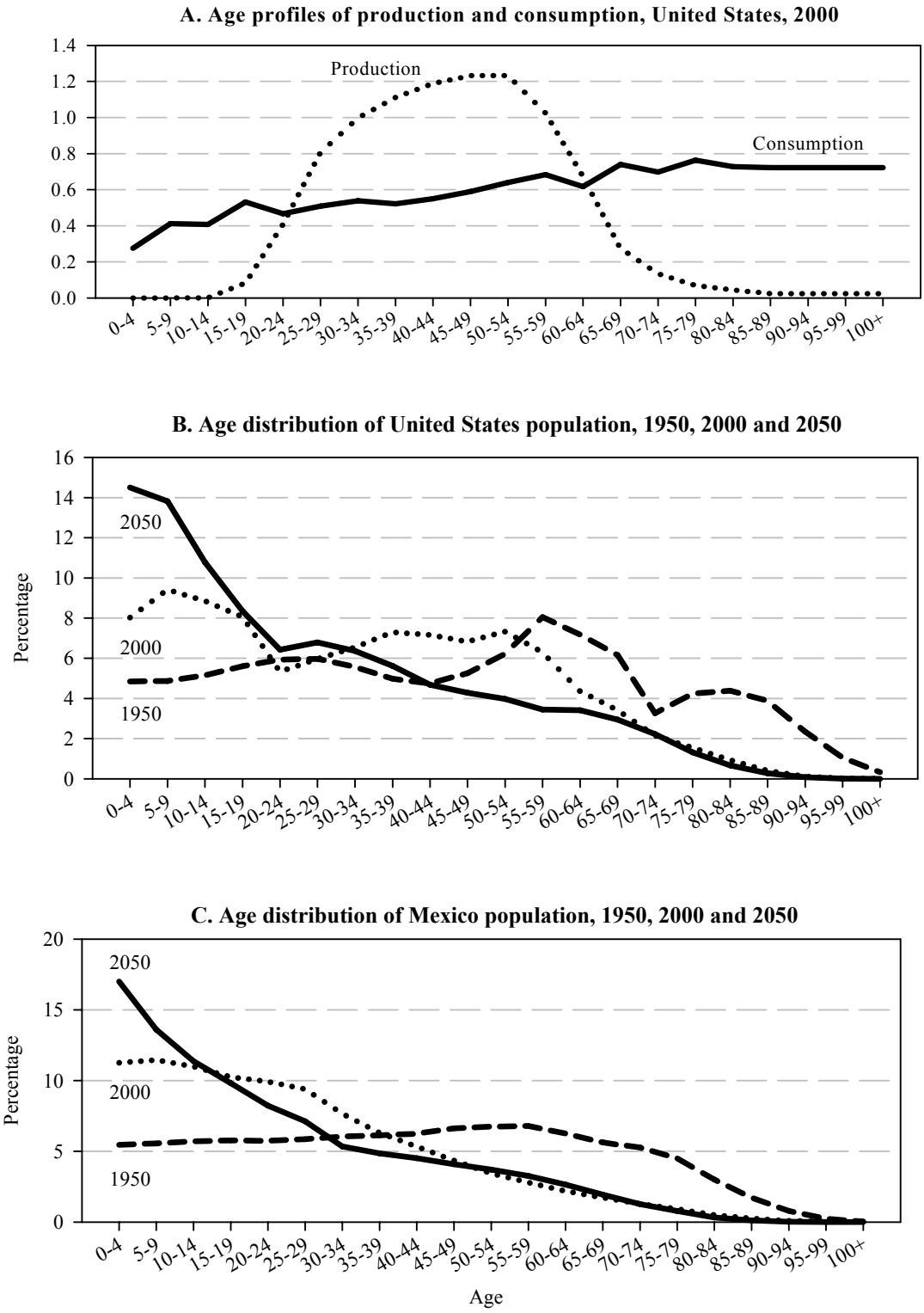
This paper presents a formal approach to quantifying the two demographic dividends drawing on a recent paper by Mason and Lee (forthcoming). Estimates of the first and second demographic dividend are constructed for all countries of the world for which the United Nations World Population Prospects (2005) 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.[2]

A. THE DEMOGRAPHIC DIVIDENDS

The first demographic dividend arises and dissipates as changes in age structure interact with the life cycle 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 life cycle, 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 life cycle, 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.[3]

The manner in which the economic life cycle 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, although 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.

Figure 1. Age distribution of production and consumption in the United States in 2000, and age distribution of population in the United States and Mexico in 1950, 2000, and 2050



Source: Panel A: author's calculations; Panels B and C: United Nations (2005).
NOTE: Values in panel A are relative to average level of production at ages 30-59. See text.

The second demographic 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 in 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 improvement in the current account and an increase 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 the effective number of consumers is denoted by N and the effective number of producers by L and

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

where *P(a,t)* is the population aged a at time t and *α(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 logarithm of both sides and taking the derivative with respect to time so that:

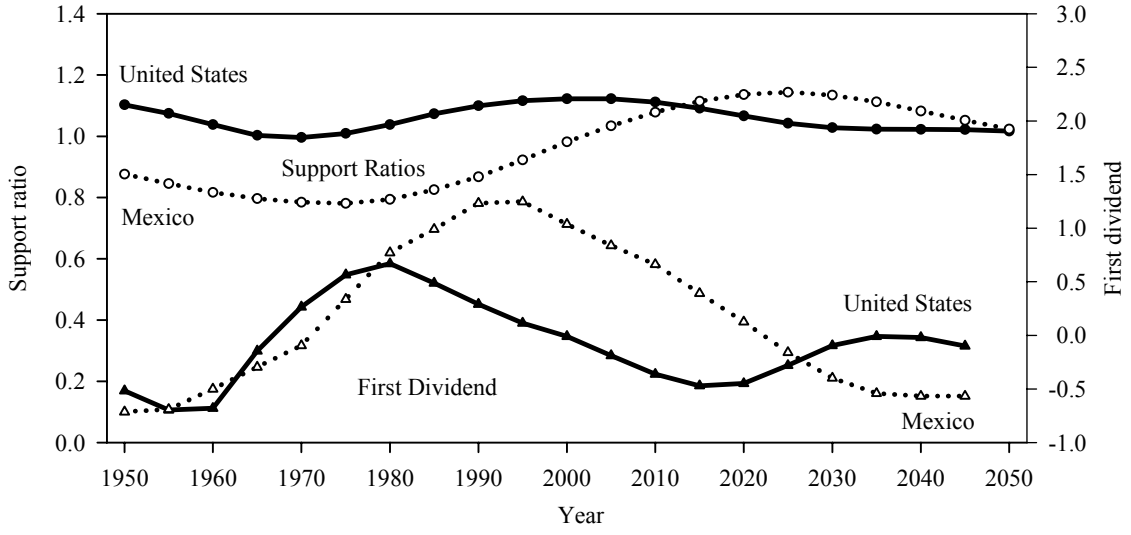
$$\dot{y}^n(t) = \dot{L}(t) - \dot{N}(t) + \dot{y}(t). \tag{3}$$

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.

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, 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 number of producers per consumer is 90 percent of the world-wide value for 1950.

Figure 2. Support ratio and first demographic dividend in the United States and Mexico



Source: Author's calculations.

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 thirty-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: (i) the first demographic dividend became positive at about the same time – in the 1970s – in both countries; (ii) the period over which the first dividend was positive was shorter in the United States than it is expected to be in Mexico – thirty years in the United States versus fifty years in Mexico; (iii) both the total impact and the annual impact of the dividend are and will, expectedly, be substantially higher in Mexico than in the United States; and, (iv) Mexico gained relative to the United States because it began with a relative

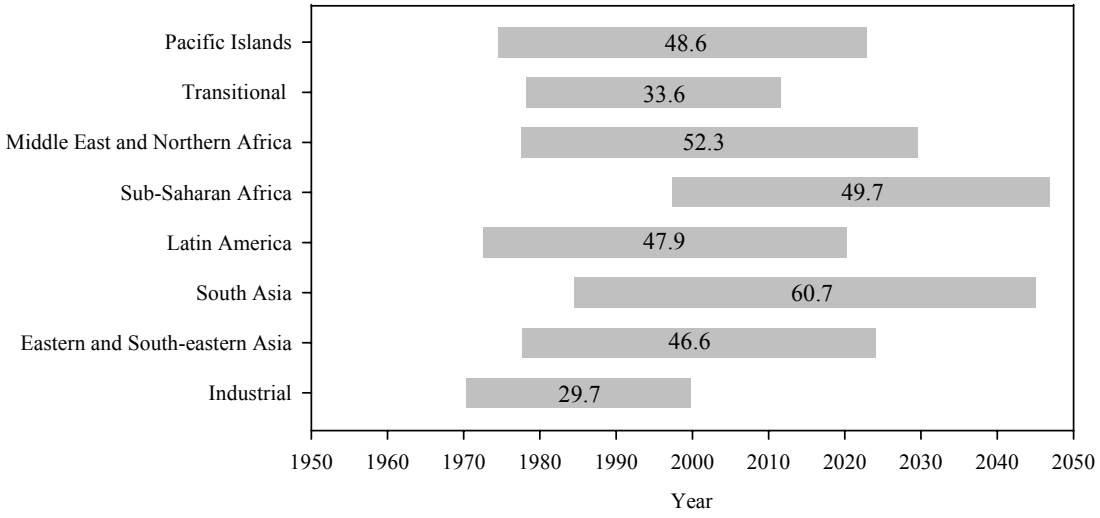
disadvantage. The projections for Mexico anticipate that it will eventually catch the United States by achieving a support ratio of 1.14 in 2025 as compared with the maximum United States support ratio of 1.12 in 2000. As is shown below, similar points of comparison distinguish the developed from the 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 South-East Asia, and the industrial countries. The values presented are simple averages of the values for countries belonging to each group. The appendix 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 South-East 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 thirty years), and in the transitional economies (almost thirty-four years).[4] The duration in other groups of countries varies from about forty-seven years in East and South-East Asia to more than sixty 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 as for South Asia. Table 1 provides information about the extent to which time series are truncated.

Figure 3. Timing of the first demographic dividend in selected regions and groups of countries



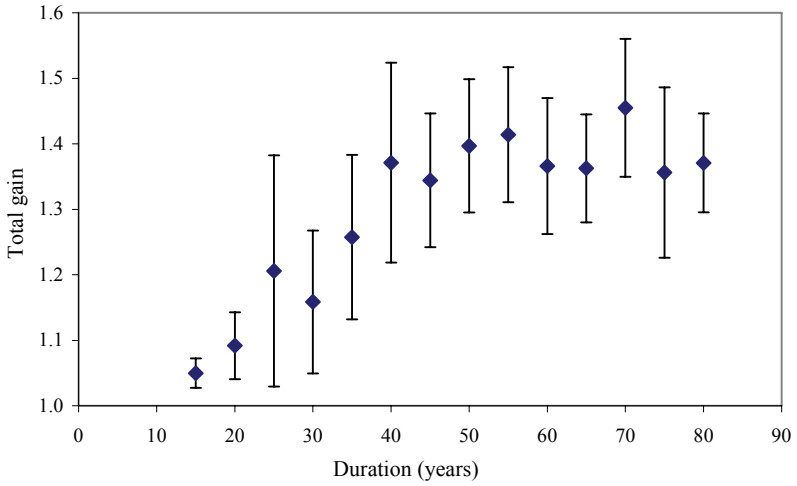
Source: Author's calculations.
NOTE: Values within bars indicate duration (in years) of the first dividend.

TABLE 1. COUNTRIES WITH COMPLETE AND INCOMPLETE FIRST 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

Source: Author's calculations.

Figure 4. Duration and total gain from the first demographic dividend

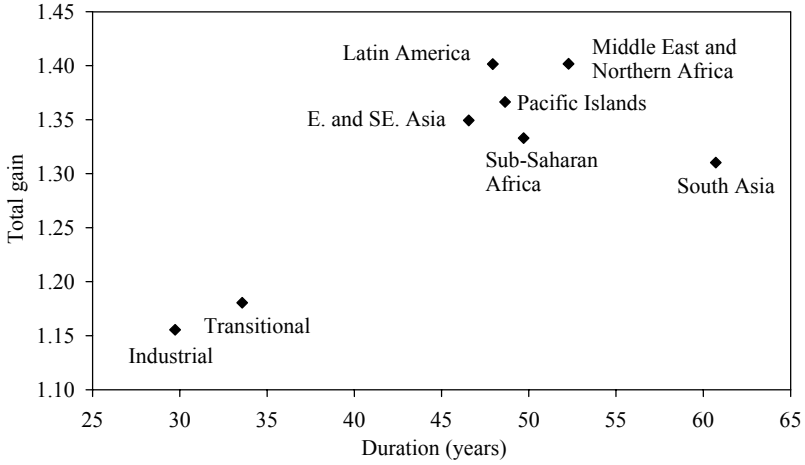


Source: Author's calculations based on estimates for 228 countries.
NOTE: Values are relative to ratio of expected output per effective consumer at the end to output at the beginning of the first dividend.

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 South-East 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.

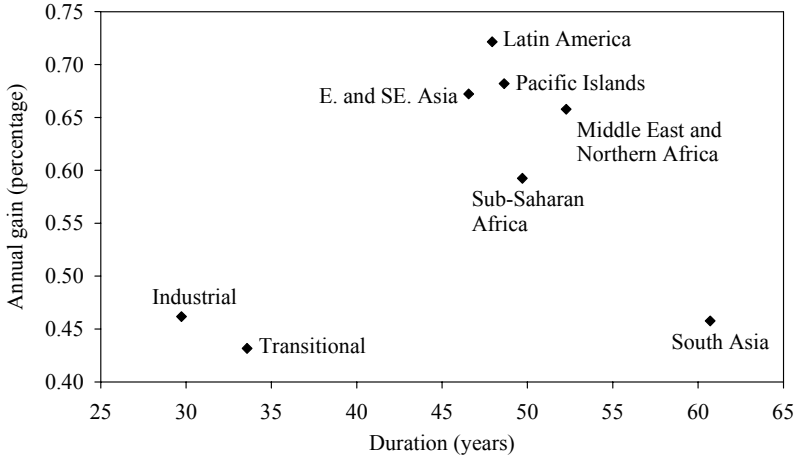
Figure 5. Total gain by duration of the first demographic dividend, regional averages



Source: Author's calculations.

NOTE: Values are relative to ratio of expected output per effective consumer at the end to output at the beginning of the first dividend.

Figure 6. Average annual gain by duration of the first demographic dividend, regional averages



Source: Author's calculations.

For countries with a dividend period lasting less than forty years, the total gain from the dividend and the duration of the dividend are closely linked. If the dividend period is only fifteen 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 thirty-five 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 forty 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 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 South-East 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 31 per cent for South Asian countries to a high of 40 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 country groupings conceal a considerable degree of heterogeneity. Thus, table 2 presents the annual increase in the support ratio and the total increase in the support ratio for the top ten and the bottom ten countries. Only countries with a population exceeding 3 million in 2000 are included in the table. The top ten countries in annual increase are drawn primarily from South-East Asia or the Middle East and North Africa. Singapore ranks first with a first dividend just exceeding 1 per cent per year. Jordan ranks second and Viet Nam, third. Among Latin American countries, only Mexico makes the top ten. All of the bottom ten countries but Uruguay are European, either industrial countries or transitional economies.

Countries in the Middle East and North Africa have a large presence in the top ten 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 ten. No country from South, East or Southeast Asia makes it to the top ten list. Again, except for Uruguay, the bottom ten consists of either industrial countries or transitional economies

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 lead 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 life cycle 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

TABLE 2. 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: Author's calculations.

NOTE: Includes countries with population of 3 million or more in 2000 and that will complete their dividend period by 2050.

analysis presented here emphasizes the life cycle 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 life cycle 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 life cycle 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 life cycle 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 child-rearing responsibilities. Thus, we use the wealth held by those age 50 and older to measure the effect of demography on life cycle 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.[5] Given discount rate r, the present value of the future lifetime consumption of the cohort born in year $b = t - a$ or earlier is:

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

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:

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

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.,

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

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

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

or, alternatively:

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

$\mathrm{PVN}(\leq b,t)/L(t)$ 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. $\mathrm{PVL}(\leq b,t)/L(t)$ 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[6] 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 1 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. 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.[7]

The results for 1950 to 2000 are summarized by figure 7, which shows regional averages of the ratio of life cycle 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 0.5 for the Pacific Islands and sub-Saharan Africa. 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 life cycle wealth ratio exceeding 4 on average in 2000. Sub-Saharan Africa continued to lag behind, with a life cycle wealth ratio below one. The rapid gains are particularly evident for East and South-Eastern Asia and for Latin America and the Caribbean.

The increase in the life cycle 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 South-East Asia – just under 3 per cent per year between 1975 and 2000.

As emphasized above, the economic implications of the rise in life cycle 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:

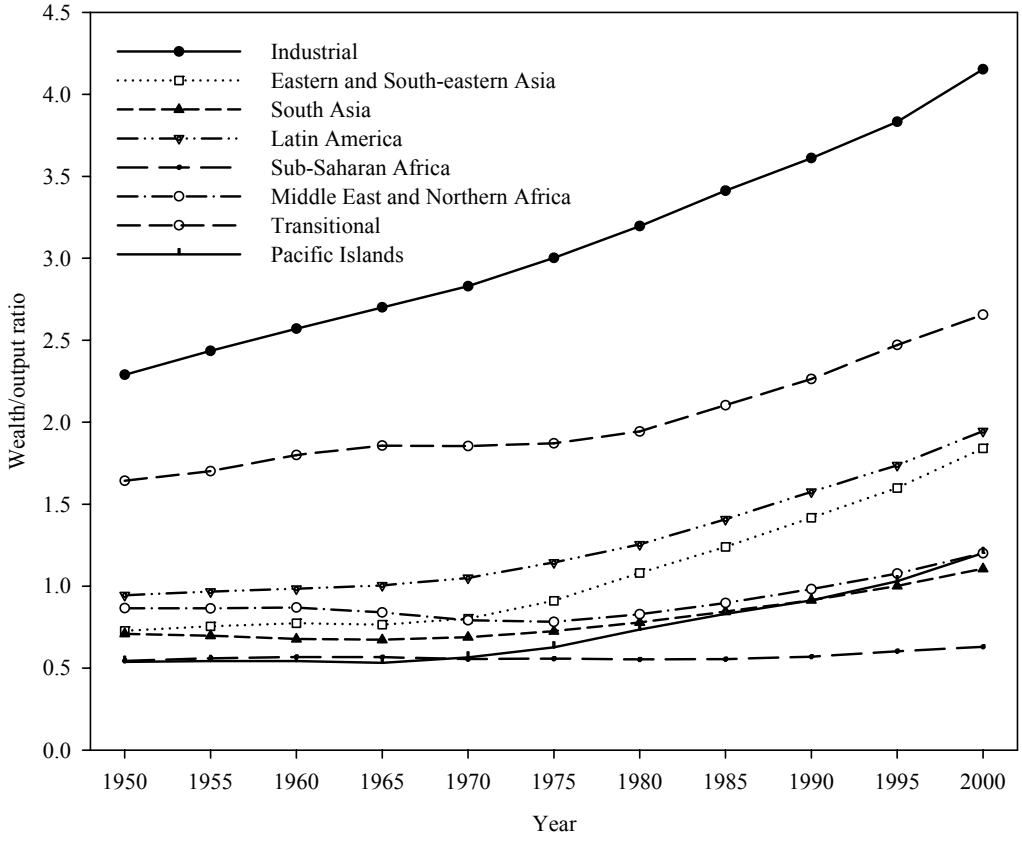
$$K(t) = (1-\tau(t))W(t) \qquad \tau(t) \leq 1. \tag{9}$$

If proportion of life cycle 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 life cycle 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.[8] 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, $\dot{k}$:

$$\dot{y} = \frac{\beta}{1-\beta}\dot{k} \tag{10}$$

Figure 7. Ratio of wealth at ages 50 or over to output, regional averages, 1950 – 2000



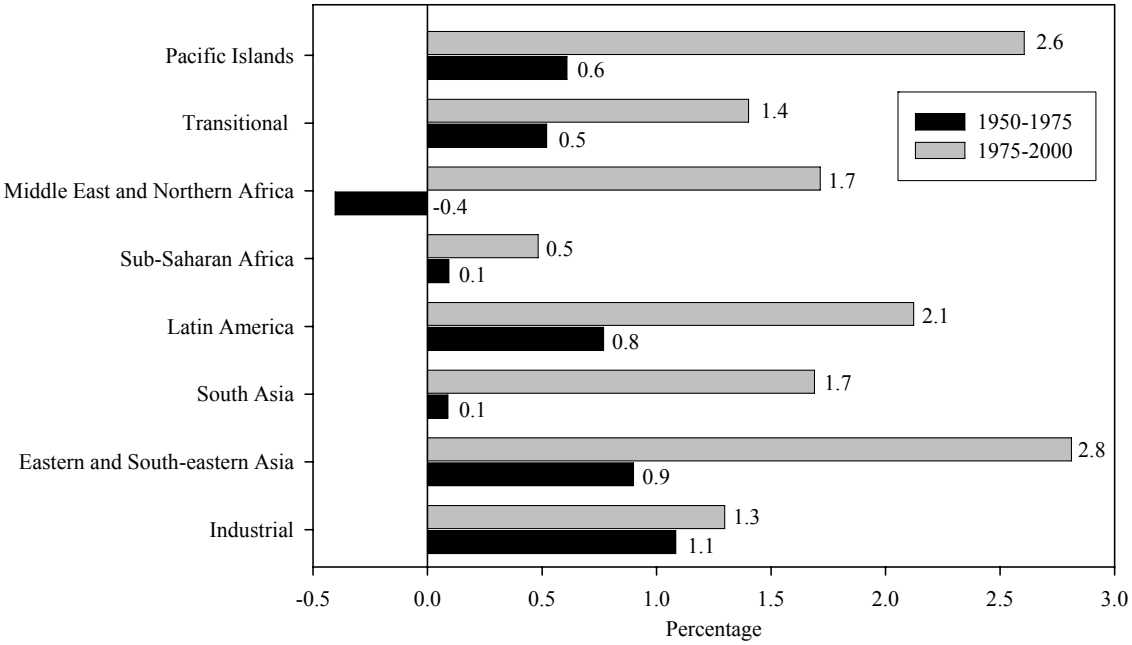
Source: Author's calculations.

where β 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 β 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 life cycle 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 3 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 South-East Asia, the second dividend was 1.31 per cent per year in additional income growth – the largest of any region. 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 0.70 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

Figure 8. Annual growth in the ratio of wealth at ages 50 or over to output, 1950–1975 and 1975–2000



Source: Author's calculations.

TABLE 3. ESTIMATES OF THE FIRST AND SECOND DIVIDENDS AND THE ACTUAL GROWTH IN GROSS DOMESTIC PRODUCT PER EFFECTIVE CONSUMER (GDP/N)
1970-2000

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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

Source: Author's calculations.

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 life cycle 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 life cycle 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 ageing leads to a permanent increase in the demand for life cycle 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 1.22 per cent and 1.08 per cent, respectively. In East and South-East Asia, GDP/N grew faster by a striking 2.42 per cent per annum (table 3).

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. However, one should not, on the basis of this simple comparison, conclude that growth rates in these three regions were determined by the sizes of the dividend.

B. 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.

TABLE 4. SENSITIVITY ANALYSIS: DEMOGRAPHIC DIVIDENDS BASED ON TAIWAN PROVINCE OF CHINA, 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 and 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

Source: Author's calculations.

TABLE 5. IMPLICATIONS FOR SECOND DIVIDEND OF VARYING SEVERAL ASSUMPTIONS

Region	*C/Y=1.0*	*C/Y=0 .9* [a]	$g_c=g_y=0.02$	*Using Taiwan Province of China profiles*
Industrial	0.69	0.74	0.69	0.70
East Asia and 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

Source: Author's calculations.

[a] Growth of consumption is set at 0.017 while growth of productivity at 0.015.

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. Tables 4 and 5 report these results based on the following: (i) using the support ratio on Taiwan Province of China rather the United States; (ii) assuming that the initial ratio of consumption to labour income is 0.9 (C/Y=0.9) rather than 1.0; and (iii) assuming that both productivity and consumption growth rates are 2 per cent per year ($g_c=g_y=0.02$) rather than 1.5 per cent per year. None of the broad conclusions or generalizations appears to be sensitive to variation in the assumptions.

C. 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 life cycle 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 Province of China, life cycle 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 the United Nations long-term population projections show 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 of 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 South-East 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 South-East Asia, transitional economies, and 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 heretofore, 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 South-East 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 developing countries has been quite distinct from the experience in the developed countries and the transitional countries. 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 developing countries. 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 South-East Asia and Latin America, in particular, the duration of the dividend was relatively short and intense. In other parts of the world – South Asia, for instance – 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 twentieth 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 macro-economy are shaped by demographic change will depend, however, on how policies and institutions respond to the challenges and opportunities the future holds.

ANNEX

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

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NOTES

[1] 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).

[2] Detailed country estimates are available on the author's website: www2.hawaii.edu/~amason.

[3] Additional information about estimating the economic life cycle is described in detail in www.ntaccounts.org.

[4] 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.

[5] For the sake of simplicity, it is assumed 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).

[6] Under golden-rule growth the consumption-time profile is at its maximum (Phelps 1965).

[7] As can be seen in Figure 1, labour income substantially exceeds consumption from the mid-twenties. However, the preponderance of this surplus for child-rearing 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.

[8] 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 overstate 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.

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