DEMOGRAPHIC DIVIDENDS AND CHINA'S POST REFORM ECONOMY[1]

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During the last two and half decades, China has witnessed demographic change of historic proportions. China has transformed itself from a "demographic transitional" society, where reductions in mortality led to rapid population growth and subsequent reductions in fertility led to a slower population growth, to a "post-transitional" society, where life expectancy has reached new heights, fertility has declined to below-replacement level, and rapid population aging is on the horizon. In the not-too-distant future -- in a matter of a few decades -- China's population will start to shrink, an unprecedented demographic turn in Chinese history in the absence of wars, epidemics, and famines of massive scales. In this process, China will also lose its position as the most populous country in the world.

Demographic changes in China are monumental not only because of the shifts in these traditional demographic parameters: mortality, fertility, population growth rate, and age structure. During its economic transitions of the last two and half decades, China has also seen migration and urbanization processes that are unprecedented in world history for their sheer magnitudes. Population redistribution is inextricably tied to the broad social and economic transitions that China has undergone during the last two and half decades. At the same time, it also shaped some important underlying conditions, as opportunities and constraints, for China's economic transition.

Two and half decades ago, at the start of China's economic reform, the post-Mao Chinese leadership established population control as one of its top policy priorities. Having witnessed rapid population growth during the preceding decades, the post-Mao leadership believed that population control was as a key measure for ensuring growth in per capita income – its new political mandate. Discourse on population control led to the framing of population as the root of all evils, shifting public attention to

"overpopulation" and away from political and social problems of the late socialist era. This neo-Malthusian perspective (Lee and Wang 1999) led to the elevation of population control, along with economic reform, as a "basic state policy" and to the implementation of the draconian policy of one child per couple (Wang 2005).

Two and half decades later, following the success in China's transition to a market economy and its phenomenal economic growth, public discourse about the adverse development effects of China's large population has faded from view. The discussion, to the extent that it still exists, has shifted to environmental and natural resources issues, subsumed under a new mantle of "sustainable development." The demographic factor, curiously, is almost being "counted out" as far as its relationship with economic development is concerned. Despite the change in discourse, the economic success, the achievement of low fertility, a slower population growth, and a rapidly aging population age structure, China's population policy has remained largely intact. The lack of a serious examination of China's demographic realities and its population policy right now, just as the lack of a serious debate of the China's draconian population control policy two and half decades ago, denies the Chinese public and its policy makers the opportunity to understand fully the role demographic factors have played in China economic transition in the past, and the role it will play in the future.

In this essay, we focus on three aspects of China's demographic change during the course of China's economic reforms of the past quarter century. First, we review and summarize major demographic changes in China during the last two and half decades. Second, we consider whether China's economy experienced a "demographic dividend" that complemented other favorable development forces during the last quarter century. We also consider how future economic prospects are likely to be influenced by

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demographic factors. Third, we identify and highlight a number of social consequences of China's recent demographic changes.

Two and Half Decades of Demographic Change

Substantial reductions in death and birth rates pre-date the implementation of economic reform programs in the late 1970s.[2] Impressive mortality decline raised life expectancy by more than 50 percent, from the low forties to the high sixties, between 1950 and 1982, the first post-reform year for which data are available (Table 1).[3] Under the government's family planning program of later marriage, fewer births, and longer birth intervals (*wan, xi, shao*), the female mean age at first marriage rose from 19.7 to 22.8 during the 1970s. The total fertility rate (TFR) declined from 5.7 births per woman in 1970 to 2.8 births per woman in 1979 (Coale and Chen 1987).[4] By international standards, China had by and large completed its fertility transition, in the absence of its more recent one-child policy, by the time when China's economic reforms began at the end of the 1970s.

[Table 1 about here]

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[2] For a review of demographic changes up to the late 1980s, see Lavely, Lee, and Wang 1990. A more in-depth summary and analysis of the Chinese demographic behaviors can be found in Lee and Wang 1999. Scharping (2003a) provides a comprehensive review and analysis of China's birth control programs.

[3] No reliable estimates of life expectancy exist for the early 1950s. Available estimates of life expectancy at birth based on census and mortality survey data give 42.2 for males and 45.6 for females for the time period of 1953-1964 (Coale 1984, Banister and Preston 1981). Mortality estimates based on a retrospective fertility history survey conducted in 1987, consisting a two-per-thousand sample of China's population, reported life expectancy of 37.9 and 40.0 for the period of 1945-49, and 46.7 and 49.2 for 1950-54, for males and females separately (Yan and Chen 1993). These estimates however have only limited value given the nature of the data and the way these estimates were made.

[4] The total fertility rate is the average number of births per woman given current age-specific birth rates.

Such extraordinary demographic accomplishments did not deter the post-Mao Chinese leadership from adopting a population policy that was in sharp contrast to its economic policy. Economic reforms over the last two decades gradually relaxed the state's control and returned the right of decision-making to families and individuals. Population policy, on the other hand, further asserted the right of the state to regulate reproductive decision-making that previously had been the reserve of couples and their families. In 1980, the one-child-per-couple policy was formally announced and promoted nationwide. Popular resistance led to subsequent policy modifications in the 1980s and spared much of rural China from the one-child policy by allowing a second child (Greenhalgh 1986). Urban China has been subject to a strict one-child policy, despite the initial claim that this was to be an emergency measure, for twenty-five years. Continued state intervention in reproduction, in combination with the state's withdrawal from economic and migration control, form the important institutional background of China's demographic changes of the last two and half decades.

Institutional Background of Demographic Change

Three sets of institutional changes are crucial to understanding the demographic changes occurring in China during the last two and half decades. First, economic and social reforms have shifted the locus of economic decision-making from the state to the family and the individual. Second, strict birth control policy, but with a recent important reorientation of family planning programs, remains in place. Third, a fundamental shift in migration policy has allowed people to move freely across administrative boundaries.

In a sharp contrast to the socialist planned economy era, when much of the cost of childbearing was assumed either by the state or the collective, China's emerging market economy has increasingly placed the financial burden of raising children on the shoulders of the Chinese family. Such changes have profound impacts on behaviors that relate to demographic changes, ranging from health care and mortality, marriage, fertility, to living arrangement. Dissolution of collective farming in rural China and termination of guaranteed life time employment in urban China increased economic risks among adult Chinese, and posed serious concerns for parents planning for their children's economic livelihood. Emergence of a labor market that rewards human capital has clearly intensified the desire and competition in providing more and better schooling for children. With the end of free education beyond a nine-year compulsory schooling requirement by the government, the cost of education has skyrocketed. Collapse of the rural public health system and the abolition of free health care in urban areas also added health care cost as a substantial expenditure borne by Chinese families. Finally, an emerging consumer culture is also encouraging Chinese households to divert expenditures from rearing children to investment and to expenditures in housing, automobiles, consumer durables, clothing, and recreational activities (Davis 2000).

The impact of institutional changes associated with economic reform on demographic behavior is difficult to assess in light of another set of institutional factors: Chinese government's continued policy and efforts in controlling population growth. Already two and half decades in its implementation, China has not signaled if and when it would phase out its one-child policy. The most important change in China's birth control program in the past decade has been in improving how the program is implemented, not changing the policy itself. Starting in the mid-1990s, implementation

of birth control program has shifted from relying purely on administrative coercion to more emphasis on service provision (Kaufman 2003, Winkler 2002, Merli, Qian, and Smith 2004). The stringency of the birth planning policy is revealed by a recent analysis of fertility policies at local levels. By aggregating fertility policies of more than 400 prefectures, the authors report that at the end of the 1990s, the national fertility level as stipulated by local policies should be 1.47, well below the replacement level of 2.1. According to these policies, the majority of Chinese couples, 63.1 percent, could have only one child, 35.6 could have two children, and 1.3 percent could have three children (Guo et al. 2003, Wang 2005).[5] Moreover, the political pressure generated by a 1991 policy that links birth control achievement to cadre evaluation has not only encouraged local officials to compete for lower birth rates within their jurisdictions (Greenhalgh, Zhu and Li 1994), but also resulted in false statistics that have corrupted the nationwide birth reporting system (Smith 1994, Zeng 1996, Merli 1998, Merli and Raftery 2000, Scharping 2003a, 2003b).

Chinese demographic behaviors of the last two and half decades are further affected by a third important institutional change, the huge increase in domestic labor migration following the government's reversal of its earlier migration control policy. The massive volume of migrants from the Chinese countryside to cities and between cities and between rural areas has not only fueled China's economic growth, but has also brought a number of far-reaching demographic consequences. The role of migration in

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[5] Couples who could have only one child include those who reside in the one-child policy regions, who constitute 35.4 of China's population, and those who reside in 1.5 children policy regions but could have only one child because their first child is a son. More than half of China's population, 53.6 percent, live in regions with a 1.5 children policy, where a couple whose first child is a daughter is allowed to have a second birth (Guo et al. 2003).

demographic processes goes far beyond its simple effect of damping fertility by separating young couples. Young and unmarried women and men often choose better earning opportunities over marriage and having children early in their lives. Migration exposed many to the urban consumer culture and the urban low fertility environment. At the same time, as often portrayed by the Chinese official media, population migration has made monitoring and controlling births more difficult. Opportunities of migration have also resulted in a new household division of labor and in new living arrangements both at the origin and the destination.

Major Indicators of Demographic Change

<u>Population Growth and Fertility</u>. Despite the low fertility level already achieved in the eve of China's economic reforms, China experienced a further substantial population increase in the last two and half decades. This increase was due to population momentum resulting from a large number of young people entering the reproductive ages, itself a result of the high fertility and declining mortality of the 1960s and 1970s. Between 1978 and 2000, China's total population rose from less than one billion to more than 1.25 billion, a net increase of 31.5 percent. The population added during these two decades, slightly over 300 million, is roughly equal to the increase during the two preceding decades. The rate of population growth during the 1980s and the 1990s, however, was the slowest in the life span of the People's Republic. During the three decades between 1950 and 1980, the population grew at an annual rate of 1.82, 2.26, and

1.73 percent each decade.   The growth slowed to 1.46 percent per year in the 1980s and to only 1.02 percent in the 1990s.[6]

While one can be certain that China's population growth rate has declined to a low level, the same cannot be said with confidence on the exact level of Chinese fertility levels, mainly due to the fact of a virtual collapse of the birth reporting system in the 1990s. In the 1980s demographic variables were measured with great detail and accuracy. By the 1990s, few could trust demographic data, especially fertility data, collected and released by government agencies. From the early 1990s, scholars report that as many as 30 percent of births were not counted by the family planning registration system in selected locales. Problems in birth reporting and registration started to spread to other official demographic data gathering sources, including the mid-term census, annual population surveys, and special fertility surveys. China's 2000 census, while reporting an underreporting rate of only 1.8 percent, itself a six-fold increase from the 1990 census, revealed many apparent anomalies. For instance, the survival ratio between 1990 and 2000 for males aged 0 to 4 in 1990 was found to be 1.05, and for females 1.07, suggesting either undercount of births in the 1990 census or double- count in the 2000 census, an outcome less likely (Li and Sun 2003, 38). In addition, survival ratios for groups aged 20 to 29 in 1990 are also mostly exceeding 1.0, an impossible demographic outcome in the absence of flawed data (or significant in-migration). Not long into the 1990s, the two main government agencies responsible for collecting fertility information, the State Family Planning Commission and the National Bureau of Statistics, simply gave up in their attempt to provide reliable and detailed

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[6] These numbers are calculated based on annual population numbers published in official Chinese statistical sources.

information on fertility. Instead, fertility was reported to be "around the replacement level of 2.1 births per woman."

The most recent official report of China's fertility level came with the 2000 population census, but with a number that caused more controversy than comfort. The census reported a total fertility rate of 1.22 for China as a whole. While releasing such a number showed courage and candidness on the part of census personnel, no one in China, including the data collectors, believe it. Such a low number would put the Chinese fertility at a level on par with Italy, lower than Japan, and only about a third of the level for less developed countries combined.[7] The result was a surprise and an embarrassment, because it came after repeated government appeals to report births accurately in the census and despite promises of not punishing those who disclosed previously under-reported births. It also confirmed the long-held suspicion that government-released fertility numbers are no longer to be trusted. In a careful political and demographic analysis of six Chinese sources that pour out fertility numbers, Scharping (2003b) makes a convincing case about the confusion and the messiness of Chinese fertility statistics.

The demise of Chinese fertility data gathering system and the unbelievably low fertility numbers based on official statistics, however, should not be used to dismiss the possibility of any genuine fertility reduction in recent years. While the Chinese fertility level in the 1980s showed only a modest downward movement in spite of the forceful implementation of the one child policy (Feeney and Wang 1993), a number of arguments have been made to suggest that in the 1990s fertility indeed declined further. The broad

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[7] China excluded from the group of less developed countries. Data for other countries or region are from the Population Reference Bureau, at http://www.prb.org.

economic changes in the society and a continued stringent population control policy combined have further affected Chinese young couples' fertility preferences (Merli and Smith 2002). A direct piece of evidence to such change is the postponement of marriage and childbearing in recent years. As shown in Table 1, the average age at first marriage for females rose by nearly ten percent in the 1990s, from 22 to 24. Postponement of childbearing due to delayed marriage and further delaying within marriage can result in a substantial reduction in the total fertility level and in the number of births (Guo 2000). Also, while some still believe that current Chinese fertility, at around 1.8 births per woman, remains at a level not far below replacement others have maintained that such a number is simply too high (Zhang 2003, Zhang and Yuan 2004). Among other reasons, a simple argument is that if the national total fertility rate is indeed at a level of 1.8, it would imply that the 2000 census missed a third of all births nationwide, a possibility not many believe. Moreover, results from three recent careful analyses both suggest that the recent fertility level is around 1.6 children per woman (Cai 2005, Zhang 2004, Retherford et al. 2005).

Mortality and Health. Dissolution of the rural public health care system and reform of the urban public health system raised concerns at the start of the reform about their potential detrimental effect on Chinese health status. Early concerns focused particularly on infant and child health, as immunization and other basic care had previously been delivered largely by the public health care system. Indeed, mortality improvements stalled during the 1980s (Table 1). During the 1990s, however, mortality decline apparently continued at a pace that is similar to that found in other developing countries. Life expectancy increased by about 4 years for both men and women during

the decade. The level of life expectancy in 2000, 71 for males, and almost 75 for females,

is well above the average level for less developed countries (61 and 64 in 2003

respectively) and approaching that of developed countries (72 and 79 for males and

females respectively: http://www.prb.org). A major contributor to improvement in life

expectancy has been a further reduction in infant mortality.

There are, however, strong reasons to believe that these most recent mortality

numbers are too rosy due to death underreporting in the 2000 census (Li and Sun 2003).

Hence, it is difficult to assess the extent to which mortality conditions improved during

the 1990s and it is possible that the gains were more moderate than what is revealed by

the 2000 census. Among its many important effects, China's continued one-child policy

may have had a negative impact on female infant and child survival, an issue we will

return to in a later section of the paper. An even more difficult issue to assess is the

extent to which reform of the health care system accounted for the slower declines in

mortality.

Migration and Urbanization. In contrast to fertility and mortality declines that began

before China's reforms, increased migration and an accompanying urbanization process

are clearly the products of the reform era. This is especially the case for a new category

of migrants called the floating population, a unique product of the Chinese political

economy system. Constrained by a number of institutional arrangements, ranging from

household registration control to the land tenure system, these migrants leave their

place of residence for employment elsewhere but do not change their place of household

registration or their place of permanent residence. They are therefore migrants who

float on the surface of the society (Solinger 1999, Chan and Zhang 1999, Wang, Zuo and

Ruan 2002). Over the past two decades, it is the drastic increase of migrants in this category that has accounted for the rapid increase in the overall volume of migrants. At the start of the reforms, the number of Chinese migrants in comparison to its total population was miniscule. Even in 1987, when Chinese census first included information on migration, only 15.2 million out of over one billion, or about one and half percent, reported themselves to be migrants away from place of household registration for more than six months (Chan 2001, 131). By 1990, the size of this population increased to 30 million, and by 1995, to 56 million. The 2000 census counted 80 million Chinese as members of the floating population. Including migrants who had arrived in their destination for less than six months would put the estimated number of temporary migrants at 120 million, up from 88.5 million in 1995 (Liang 2003). Similarly, the annual population sample survey conducted by China's National Bureau of Statistics reports that in 2002, one out of every ten persons was living in a place (town, township, or sub-district) that was not the location of the person's household registration. In the economically most dynamic regions of China, such as Guangdong, Fujian, Shanghai and Beijing, 20 to 30 percent of the current residents had their household registrations elsewhere.[8] Urban population growth during the 1990s was also one of the most rapid in China's history, with a net gain of urban population of 157 million. This increase almost equals the sum of the preceding four decades combined. Massive rural to urban migration was the most important force for urbanization, accounting for 60 percent of all urban population growth during the 1990s (Chan and Hu 2003).[9]

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[8] Calculated from China's Statistical Yearbook 2003, page 102.

[9] The remainder of the growth was roughly equally attributed to rural to urban reclassification and urban natural population growth (Chan and Hu 2003).

Household Type and Living Arrangement. Decreased fertility, increased life expectancy, and increased migration have also contributed to notable changes in the size and composition of Chinese households. In 1982, a history of high fertility, housing shortages, and other conditions led to an average household size of 4.4. By 2000, the average household size had declined to 3.4 (Table 1). For urban China, the average household size was barely above three, reflecting both the rapid decline in fertility over the last two and half decades and changing preferences in living arrangement.

A major contributing factor to the decline in household size has been an increase in the number of one-couple households, not a reduction in the number of multiple generation households, those of three generations or more. One-generation households rose from 4.7 percent of all Chinese households in 1982 to 12.7 percent in 2000. As a result of this change, the percentage of households that are one-generation (including both one couple and one person households) rose from 13.9 in 1982 and 13.5 in 1990 to 22.3 in 2000. While the percentage of three or more generations households hardly changed, the share of two-generation households dropped from 66.6 in 1982 to 55.9 in 2000 (Zeng and Wang 2003). Many of these newly emerged one-generation households are Chinese elderly who live by themselves. In 1982, 10.7 percent of the male elderly population aged 65 and above lived alone, 16.9 percent lived with a spouse only, and 67.9 percent lived with their children. By 2000, these numbers had changed to 8.4, 28.8, and 59.9 percent respectively. Similar changes are also seen for the female elderly population, but with a higher share living alone than males: 13.7 percent in 1982 and 10.7 percent in 2000. In urban China, households with elderly only are more prevalent,

with 33.7 percent of the male elderly in 2000 living with only a spouse in 2000 and only 55.8 percent were living with their children (Zeng and Wang 2003).

Is China's Fertility Decline Yielding Dividends?

The rationale for China's one-child policy was a neo-Malthusian perspective on the relationship between population and development – a view largely dismissed by mainstream economists. The architects of China's population policy can point, however, to the post-reform economic record as evidence of the success of the policy. This assertion can be questioned on two grounds. The first, discussed above, is the extent to which the transition to low fertility was accelerated by the one-child policy. The second, considered in this section, is the extent to which fertility decline, the slow-down in population growth, and changes in age structure contributed to China's economic success.

The demographic transition interacts with a fundamental feature of any economy – its lifecycle variation in consumption and production. Humans have an extended period of economic dependency at the beginning of their lives and, in modern industrial societies, at the end. During these ages of dependency or deficit ages, individuals on average consume more than they produce. During the prime working ages or surplus ages, individuals produce more than they consume. Detailed information about the lifecycle of production and consumption in China is limited. However, the estimated profiles for urban China in 2000 (Figure 1) are similar to those found in other countries.[10]

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[10] The production and consumption values in Figure 1 are estimated from the 2000 Urban Family Income and Expenditure Survey for China. Both profiles are normalized to aggregate to 100. Details of the estimate procedure are available from the authors.

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[Figure 1. Lifecycle of Consumption and Production, Urban China, 2000]

The divergence between production and consumption interacts with changes in population age structure to generate what is called a demographic dividend (Bloom and Williamson 1998; Mason 2001; Bloom, Canning et al. 2002) or more recently described as two demographic dividends (Mason and Lee forthcoming).

The *first* dividend arises because the demographic transition induces changes in population age structure that raise the share of the population concentrated at the productive ages. The *second* dividend arises as individual behavior and public policy respond to anticipated changes in population age structure, e.g., increases in the importance of retirement, as discussed in more detail below. An important point that is emphasized below is that the demographic dividends are not independent of the policy environment in which population change is occurring, especially in China.

The First Dividend

The first dividend measures increases in income per capita that occur because the productive population is growing at a faster rate than the total population over part of the demographic transition. The dividend is not always positive, however. As the demographic transition proceeds, growth in the working-age population will slow relative to the retired population. The effect will be to depress growth in per capita output or per capita consumption.

Analysis that emphasizes only the variation in productivity with age is incomplete. Consumption also varies with age. If age groups with low productivity and high consumption increase, the aggregate effects are magnified in comparison to growth in an age group with low productivity and low consumption. Thus, the analysis

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presented here uses the support ratio – the ratio of the effective number of producers to

the effective number of consumers – to quantify the first dividend (Mason and Lee

forthcoming). The support ratio is the ratio of the effective number of workers, the

population weighted by age-specific productivity weights, and the effective number of

consumers, the population weighted to allow for variation in consumption by age

(Cutler, Poterba et al. 1990).[11] Given age-profiles of productivity and consumption,

output per effective consumer increases at the same rate as the support ratio grow which

depends, in turn, entirely on changes in population age structure.

The magnitude and sign of the first dividend vary substantially over three

periods that can be clearly distinguished (Figure 2). From 1982 to 2000, the demographic

dividend was especially favorable as changes in the support ratio had a strong positive

effect on output per worker. The support ratio increased by 28% or at an average annual

rate of 1.3% (Figure 2-a). During the same period real GDP per capita (PPP adjusted)

grew at an annual rate of 8.4% per year (World Bank 2004). Thus, the first demographic

dividend accounted for 15% of China's economic growth between 1982 and 2000.

[Figure 2. Support ratio and its rate of growth]

For the most part the gains from the first demographic dividend have been

reaped in China. Between 2000 and 2013 the projected support ratio continues to rise

but at a much slower pace. For the entire period the first dividend yields an increase in

output per capita of 4% – an annual growth rate of 0.3%. The support ratio reaches a

peak in 2013 and then begins a sustained, gradual decline. By 2050, the projected

[11] The effective number of producers is measured using the age-profile of productivity shown in
Figure 1 to weight the population. The effective number of consumers uses the age-profile of
consumers. Rural profiles are not available although we hope to explore this more in the future.
See appendix for details.

support ratio is only 85% of the level reached in 2013. Growth in output per capita is reduced by 0.45% per year between 2014 and 2050 as the first demographic dividend unwinds.

Trends in the support ratio combine the changes in the effective labor force and the effective number of consumers that are of interest in their own right. These are decomposed in the lower panel of Figure 2. The growth rate in the effective labor force – producers – peaked in the late 1980s and early 1990s at 3 percent per annum. Currently the rate of growth is about half that at 1.5 percent per annum and declining steadily. Growth will cease altogether by 2020 and turn strongly negative thereafter.

These broad demographic trends conceal important sub-national variation. In urban China, where population aging is more rapid, the supply of new labor market entrants from within cities has already started to shrink. In rural China, a more lenient birth control policy and a later start of fertility decline imply a slower aging process and a stronger labor supply. Thus, better job growth in urban China combined with urban-rural demographic differences will continue to fuel urban-rural migration.

In China – and elsewhere – the first dividend is a persistent but ultimately transitory phenomenon. In China, output per capita is higher by about 10% in 2050 than in 1982 due to the first dividend. Were the projection extended further into the future the net effect would be even smaller. The contribution to annual growth in output per worker during the roughly seven decades tracked is negligible. However, output per capita is substantially elevated over the demographic transition. This is an event of considerable economic significance to those alive during this era. Moreover, the first dividend can have long-lasting effects if it is re-invested in the form of capital, human

capital, and/or institutional development. This possibility is explored in more detail in the next section.

China's experience is not dissimilar from that of other East Asian economies (Mason and Lee forthcoming). In order to compare China's demography with that of others, we have constructed the support ratio using the same productivity and consumption weights employed in the analysis of China, but demographic data for each of the economies shown in Table 2. Taiwan's pattern is very similar to China's although its transition occurred somewhat earlier. Japan also experienced a dividend, but it came much sooner than in other East Asian countries. Throughout the 1982-2050 period, Japan's support ratio is in decline – depressing growth in per capita output by 0.4 percent per annum for the entire period. Many countries in the West also experienced rapid growth in their support ratios primarily because of the baby boom, but many, as illustrated by the experience of France and the US, are now in a period of decline (Table 2).

[Table 2 about here]

Population Aging and the Second Dividend

The first dividend quantifies the effects of the support ratio holding output per worker constant. The second dividend arises because changes in age structure influence the processes that lead to the creation of wealth. A possibility – one that has occurred in other East Asian economies – is that population aging will lead to rapid accumulation of capital. If this occurs, the capital-intensity of the economy and, hence, output per worker will rise. Traditionally, the effect of population on capital-deepening is considered in the standard neo-classical model that assumes that the saving rate is

constant (Solow 1956). The approach taken here, however, builds on elaborations of the

neo-classical model that treat saving and wealth as endogenous (Tobin 1967; Mason

1987; Willis 1988; Lee 1994).

A second possibility is that population aging will produce a rapid increase in

transfer wealth rather than capital. This will be the outcome if the consumption needs of

retirees are met through familial or state-sponsored transfer programs. Such programs

can effectively redistribute resources across age groups, but they do not create capital

and often they involve tax policies that undermine work incentives.

With increases in life expectancy the expected duration of retirement rises.

Individuals must accumulate additional wealth or face substantial reductions in

standards of living during old age. The wealth can come in several forms, however.

One possibility is the accumulation of additional capital. The other is the accumulation

of transfer wealth – increases in the obligations of future generations to provide old age

support either through public pension plans or as part of familial support systems.

Either form of wealth can meet the retirement needs of a growing elderly population,

but increases in capital influence the level of output and economic growth, while

increases in transfer wealth do not (Lee 1994). A third possibility is that neither transfer

wealth nor capital is accumulated. In this case, favorable effects on productivity are not

achieved and standards of living among the elderly deteriorate.

The analysis presented here relies on a highly stylized model of the economy.

Suppose that the cross-sectional age profiles of production and consumption – the shape

but not the level – are held constant. The profile of production reflects persistent effects

of experience and obsolescence. We abstract from changes in labor force behavior, e.g.,

changes in retirement behavior and changes in returns to experience related to increases

in educational attainment or other forces. The profile of consumption reflects

preferences about own consumption and preferences about the consumption of others

reflecting altruism or political processes.

Under these conditions changes in population age structure lead to a substantial

decline in the resources that must be reallocated from working generations to children

and a substantial increase in the resources that must be shifted from workers to the

elderly. The shift is quite evident in Figure 3 which shows the distributions of aggregate

consumption and labor income by age for 1982, 2000, and 2050 and the associated age

reallocations. These charts are constructed using the profiles and population age

distributions shown in Figure 1.[12]

[Figure 3. Aggregate production, consumption, and reallocation, China, 1982, 2000, and

2050.]

Two inter-age flows, from workers to children and from workers to the elderly,

are summarized by the arrows shown in the figures. The foot of the arrow is located at

the mean age of the outflow from workers and the head of the arrow is at the mean age

of the inflow to recipients. The width of the arrow is the per capita reallocation. Given

golden-rule, steady state growth the area of each arrow is equal to aggregate lifecycle

wealth that must be maintained to support each age reallocation (Lee 1994; Lee 2000). In

the case of downward flows, flows from older to younger age groups, the lifecycle

wealth is negative. It is negative because those who are alive are obligated to make

transfers to those who have not yet been born.

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[12] For a detailed discussion of the theoretical underpinnings of intergenerational transfers see Lee (1994).

The effects of age structure on lifecycle wealth are quite pronounced (Table 3). In 1982, transfers are strongly downward from workers to children and total life cycle wealth is more than nine times total labor income and negative – dominated by the downward flow to children. As population aging proceeds, flows to children decline and are dominated by flows to the elderly. By 2050, steady state lifecycle wealth will be 2.6 times labor income. Steady state lifecycle wealth required to support consumption by the elderly will rise to 7.1 times labor income. The important implication of Table 3 is that population aging in China must lead to rapid growth in the capital stock, to an enormous expansion of public or familial-based transfer programs, or to a significant decline in living standards among the elderly.

[Table 3. Lifecycle Wealth in China, 1982, 2000, and 2050.]

The magnitude of the second demographic dividend thus depends on the particular mechanisms used to reallocate resources. Economic reform complicates the picture in China because the institutions and mechanisms used to achieve reallocations are a fundamental feature of reform.

Resources can be reallocated from surplus ages to deficit ages in different forms and relying on different institutions (Table 4). Three forms are available in complete economies: capital, transfers, and credit. Capital can be accumulated at surplus ages; later, at deficit ages it yields capital income and can be liquidated. An important point to note is that capital can only be used to reallocate resources from younger to older ages. Second, those in deficit ages can rely on current transfers from those in surplus ages. Third, individuals can rely on credit markets. Those at surplus ages can lend to children relying on loan repayments later in life when they are at deficit ages. Credit markets

play a small role in inter-age reallocation systems, however, because of constraints on indebtedness.[13]

In a market economy, three institutions are involved in reallocations. In many societies, the family is the principle institution responsible for reallocating resources across age groups, and in virtually all societies, families dominate reallocations to children. Two other institutions, the market and the state, vary in their importance depending on the economic system. In pre-reform China, market institutions played little or no role and the state played a dominant role. In post-reform China, the emergence of a market economy and the recognition of private property have expanded the mechanisms available for resource reallocations with important economic implications.

[Table 4 here]

Suppose that the reallocation system for the elderly relied entirely on capital throughout the entire history under consideration. Prior to reform this would assume that the state was implicitly funding pensions by investing in state enterprise. After reform capital accumulation became a combined responsibility of the family, the market, and the state. Demographic conditions in 1982, under steady-state golden rule assumptions, would imply a capital-output ratio of 2.6. Demographic conditions in 2050, again under steady-state golden rule assumptions, imply a capital-output ratio of 7.1. Given simple assumptions, an increase in the capital-output ratio of this magnitude

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[13]Credit could play an important role if children financed their own consumption by borrowing from adults with a lifecycle surplus. The debt would be repaid when children reached lifecycle surplus ages and their creditors reached lifecycle deficit ages. When children's consumption is financed through transfers from parents and, to a lesser extent, the state, there is little demand for credit for lifecycle purposes.

would lead to a doubling of output per worker.[14] The impact on the rate of growth of output per worker depends on the time frame over which the capital deepening occurs. Evenly spread over a century, output per worker would have to grow at 0.7 percent per year. Spread over 50 years, output per worker would grow at 1.4 percent per year as a result of capital deepening.[15]

These calculations are suggestive and there are many complexities that are not addressed. One is that in pre-reform China a large portion of lifecycle wealth, perhaps all, was held as transfer wealth rather than as capital. Lifecycle wealth represented the pension obligations or the implicit debt of future generations as embodied in the state and its organs, e.g., state owned enterprise. To an unknown extent economic reform destroyed that lifecycle wealth. A continuing issue in China will be through what mechanisms and to what extent lifecycle wealth should be replenished. Transfer wealth will necessarily play a major role, because the greatest obligations are to those who are near or who have already reached retirement. For them, accumulating capital is not an option, only transfer wealth. The question then is the extent to which pension obligations are absorbed by the state (taxpayers), shifted to private firms including SOEs that are privatized, or shifted to families.

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[14] Given a Cobb-Douglas production function, the relationship between output per worker and the capital-output ratio is:

$$\frac{Y}{L} = \left(\frac{K}{Y} \right)^{\frac{b}{1-b}}$$

Given an elasticity of output with respect to capital (b) of 0.35 a rise in the capital-output ratio from 2.0 to 7.1 would produce essentially a doubling of output per worker.

[15] See Lee, Mason, and Miller (2003) for a dynamic simulation analysis of Taiwan. The simulated transition from a low to a high capital-intensive economy required closer to fifty than to 100 years.

A second complication for China is separating the transitional issues associated with economic reform from the ongoing issues that arise with population aging. Establishing a large-scale PAYGO pension system would most readily meet the short-term objective of fulfilling obligations to current pensioners. Such a strategy, however, could commit China to a path that foregoes the second demographic dividend.

Direct econometric support for the existence of a second demographic dividend comes in the form of studies of the effect of demographic factors on aggregate saving. Saving rates must rise above their equilibrium level to produce an increase in the capital-output ratio. There is no doubt in East Asia that aggregate saving rates are well above equilibrium, but there are many competing hypotheses about why saving rates are so high in East Asian economies. A number of studies have found evidence to support the view that saving rates have been influenced by changes in age structure (Mason 1987; Mason 1988; Kelley and Schmidt 1996; Higgins and Williamson 1997; Deaton and Paxson 2000) and life expectancy (Bloom, Canning et al. 2003; Kinugasa 2004). The magnitudes of estimated effects are sensitive to the methods and data employed.

The available evidence supports the conclusion that the demographic transition has led to more rapid growth in output per capita in many East Asian countries where the demographic transition has been especially rapid. China has clearly enjoyed significant gains in output per effective consumer as a result of the first dividend. Whether or not China will enjoy a second dividend remains to be seen. Demographic change offers an opportunity for significantly more rapid economic growth, but only if the policy environment is supportive. It would be a serious error, however, to reach any welfare conclusions about demographic change, in general, and fertility decline, in

particular. Two reasons for this seem to be particular important to emphasize. The first

is that capital deepening is achieved by reduced consumption. The resulting growth in

output per worker is not a free lunch but comes at the expense of reduced material

standards of living among those who are saving at such high levels. The second point is

that rapid fertility decline in China may have involved an enormous sacrifice on the part

of parents forced to have a single child. We do not know how many children would

have been born in the absence of the one child policy. Nor do we know how to value the

costs imposed by the loss of reproductive freedom.

Social Consequences of Demographic Change

In addition to the real and potential economic impacts we have examined above,

demographic changes in China have also resulted in social consequences that shall have

a broad and lasting impact on Chinese society. In the paragraphs above, we discussed

the economic consequences of a rapid aging process in China in terms of capital

accumulation and output. The same aging process shall also have other economic and

social consequences, including health care expenditure and family support of the elderly.

In the following, we highlight three other social consequences of China's recent

demographic change: the rising sex ratio at birth and excess female infant and child

mortality, social stratification in marriage, and increasing regional demographic

disparities.

Rising Sex Ratio and Female Child Survival

Following China's One-Child policy, especially the gender-specific fertility policy that

permits rural couples with a firstborn daughter to have a second child, both the sex ratio

at birth and excess female infant mortality shot up in the past two decades (Cai and

Lavely 2004; Zhu and Li 2003).[16] In 1982, the sex ratio at birth was 108.5, only marginally

above the normal range of 104-106. After 1982, it rose sharply, to 114.1 in 1990 and 117.1

in 1995 (Figure 4). The most recent census reported a sex ratio at birth of 116.9 in 2000

(not shown in the figure). While some female babies are missing due to either sex

selective abortion or heightened female infant and child mortality, many are simply

hidden from government officials and unrecorded in government censuses and surveys.

The 2000 census, for instance, revealed more surviving individuals aged 10 to 14 in 2000

than those counted at ages 0-4 in the 1990 census. It also showed a more balanced sex

ratio among the same birth cohorts as time has passed.

[Figure 4, sex ratio and excess female IMR]

Under-reporting, however, cannot account for all of the missing girls, and

certainly not most of the sharply increased female excess infant mortality. It is common

not to report the birth of a female child, but much less common to fake a female infant

death. As shown by the numbers in Table 1, while male infant mortality declined

consecutively for two decades by a large margin, roughly 40 percent, female infant

mortality declined by only about 15 percent, with all the reduction occurring only in the

1990s. While in 1982 Chinese female infant mortality was lower than male, similar to

most populations without deliberate practices of gender discrimination against female

babies, in 1990 and 2000, the pattern was reversed. Reversing a declining trend that can

be traced to at least to the mid 1930s (Coale and Banister 1994), excess female mortality

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[16] A preference for sons will influence the sex ratio at birth to any significant degree only if
couples are resorting to sex-selective abortion.   The *reported* sex ratio at birth may be influence by
gender-specific infanticide. Thus, the one child policy affects the sex ratio to the extent that it
encourages the use of these mechanisms to achieve the desired sex.

at young ages has been on the rise following the implementation of the one-child policy.

As shown in Figure 4, excess female infant mortality increased sharply, from around 10

percent in the late 1970s to 60 percent in 1995.[17] Whereas underreporting of female

births may inflate female mortality rate at young ages, it cannot explain most of the

increase in the ratio between male and female infant mortality, as underreporting exists

for both male and female births. Moreover, female excess mortality is not confined to

the first year of life, but extended to the young ages of 1-4 as well (Choe, Hao, and Wang

1994; Zhu and Li 2003).[18]   Such an injustice to females so early in life is one of the most

glaring forms of social inequality directly resulting from China's birth control policy.

Social Stratification in Marriage

Such demographic abnormalities caused by state policies will combine with other social

forces to produce other forms of social inequality. One such form is social stratification

in marriage. Public attention has focused on the likely effects of the rising sex ratio on

marriage prospects for men. The reality is that only poor Chinese men will be the likely

victims of the shortage of women.

In the last two decades, there has been a return of a sharply stratified marriage

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[17] Female excess infant mortality is calculated as the percentage of observed female infant mortality level that is above the expected level. In the absence of deliberate human intervention, male infant mortality is normally higher than female infant mortality rate, by about 20 percent. The expected level of female infant mortality is calculated by multiplying male infant mortality for the same time period by a factor of 0.833.

[18] One encouraging exception to this disturbing reversal of gender pattern is an observed greater improvement in female adult mortality. Between ages 25 and 50, while male mortality rates calculated from the 2000 census are no more than 10 to 20 percent below that in the 1990 census, female mortality rates are consistently more than 30 percent below the levels a decade ago (Li and Sun 2003, 41, Figure 4). Reduced childbearing and improved maternal health care can both be credited for such an improvement.

pattern by social status. Following decades of rising male marriage, as reflected in a

declining proportion of male bachelors by age 40 and the declining significance of social

status in the likelihood of marriage (Wang and Tuma 1993), male marriage once again

has become an indicator of social privilege. In the early 1980s, whereas only 0.5 percent

of university-educated men were unmarried by age 40, 15 percent of illiterate or semi-

illiterate peasants of the same age were still single. In 1990, the share of unmarried

bachelors among the rural poor at age 40 rose to 19 percent (Lee and Wang 1999, 80-81).

The most recent census reports that in 2000, nationally only 3.8 percent of males aged 40

were never married. Among those residing in the countryside with no formal schooling

other than adult education, the percentage was 26.5.[19] At the highest level of educational

attainment, college and higher, only one percent of men were bachelors. Such a social

concentration of unmarried males may well grow worse as cohorts with increasingly

imbalanced sex ratios reaching marriage age. In 2000, for instance, among the least

educated 30 year old males, about two in five, 44.8 percent, were still unmarried.

Regional Disparities

Regional demographic differences have become more pronounced in China as economic

stratification has taken place following the reforms. Differences between urban and

rural areas and between rich and poor provinces portray a demographic profile that

resembles the whole world. China's most urbanized provinces have fertility levels that

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[19] This and other numbers on marriage are calculated from China's 2000 population census
tabulations (Table 5.3, Long Form). The 2000 census used schooling level instead of literacy level
as a measure of education for those below primary school educated. The least schooling group
here includes those who never attended school or only went to adult schools. Adding primary
school educated in this group decreases the percentage to 10.98, a number nearly three times as
high compared with the national average.

are well below the replacement level, and are increasingly relying on a large influx of migrant laborers to sustain their economic growth. These provinces are also years ahead in terms of the health status of their populations.

Estimates of life expectancy based on the 2000 census, for instance, show a coexistence of a first and a third world in parts of the same country. In 2000, rural male and female Chinese residents had a life expectancy that was 7.4 and 8 percent below city residents (5.6 and 6.3 years respectively).[20] In 1981, the gaps were 5 and 6 percent, and in 1989-90, 3.6 and 5.5 percent.[21] These numbers can not be interpreted simply as evidence of a growing health gap between urban and rural China, because of changes in the urban-rural definition in the data. There is little doubt, however, that a persistent gap has existed.[22] In 2000, just as in 1981 or in 1990, life expectancy in China's most urbanized regions, the three centrally controlled municipalities, exceeded that in China's poorest and minority population concentrated provinces by more than ten years.

Moreover, as shown by the numbers in Table 5, over a nearly twenty-year time period, the mortality gap between these two extreme groups of Chinese provinces has not closed. Whereas the poorest provinces are among the ones that had the largest gains in life expectancy, the richest ones are also in the same group. Given that it is more

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[20] Chinese resided in cities (*shi*) had a male life expectancy of 74.95 and a female life expectancy of 79.2. Those residing in the countryside (*xian*), had 69.4 and 72.88 (Li and Sun 2003, 43).

[21] In 1981, city population had a life expectancy of 69.08 and 72.74 for males and females respectively and countryside had 65.56 and 68.36. In 1989-90, life expectancy for males and females were urban 70.1 and 75.05, versus rural 67.6 and 70.9 (China population statistics).

[22] Urban life expectancy numbers in 1981 and 1989-90 included population residing in towns (*zheng*), whereas the numbers in 2000 only included population in cities, not towns. Population living in townships, who are not included in the 2000 urban numbers, had slightly lower life expectancy than those in cities (73.18 and 77.68 for males and females, compared with those in footnote 8 above).

costly and more difficult to reduce mortality at a higher level of life expectancy, the improvement in life expectancy in China's poor provinces are rather modest in comparison with the richer provinces. [23]

In addition, published data on causes of death report that death due to respiratory diseases nearly doubled in rural China between 1980 and 2000, rising from 79 to 142 per 100,000, and became the leading cause of death in the last decade. In urban areas, it only ranked fourth, after cancer, cerebrovascular, and heart diseases. In 2000, the death rate in rural China due to injury, trauma, and toxicosis more than doubled as compared with 1980, and was twice as high compared with urban areas (Zhao 2003). These and other demographic disparities across China will no doubt further shape China's regional economy, and require more inter-regional links.

[Table 5 about here]

Conclusion

In many ways, China has always been a demographic early achiever. Its mortality declined early and rapidly under a socialist planned economy and public health system. In this regard, China was much more successful than most other countries at similar income levels. China's fertility also declined much more rapidly and earlier in the development process than elsewhere - due partly to a government birth control program that finds no equal for the extent to which it intruded on the reproductive decisions of couples.

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[23] According to the 2003 World Population Data Sheet published by the Population Reference Bureau (www.prb.org), life expectancy for developed world averaged 76 years and for less developed world (excluding China), 63.

Such a compressed demographic transition positioned China to reap a relatively large demographic dividend at an opportune time. China's first demographic dividend, deriving from fertility decline, materialized at the same time that China underwent its most radical economic transitions and faced the strongest unemployment pressures. The demographic factor thus was a favorable factor in China's economic growth during the last quarter century.

Should one conclude that China's one-child policy was the right course of action? On several counts, the answer is no. First, fertility was declining rapidly in China even before the one-child policy was implemented. Thus, only a small portion of the first dividend can be attributed to the policy *per se*. Second, more rapid economic growth came with a potentially large and unmeasured cost. Parents were forced to have fewer children than they wanted. There is no reason to suppose that the economic gains outweighed the direct costs on parents who suffered under the one-child policy. Third, analysis that focuses exclusively on the record to date would also be fundamentally flawed, because the economic implications of demographic change will be felt for decades to come.

Being an early achiever brings with it a cost. As we have discussed above, as consequences of such a forced demographic transition, China will soon enter a long period of decline in labor supply, and will face a rapid increase in the elderly population that cannot be reversed easily and quickly. Whereas this aging process may bring with it a second demographic dividend, such an event depends heavily on the right institutional environment. State-enforced fertility decline has also resulted in a collapse of the birth statistics collection system, and caused a sustained and sharp increase in sex

ratio and in female excess mortality at young ages. These social costs are not only severe but also long lasting.

Moreover, many of the demographic challenges that China faces in the future will vary sharply by region. China's rapid aging process, for example, will not take place evenly across the country, but will vary widely across different locales due to the state's differential birth control policies in the past. Urban and rural China, as well as China's different regions vary in almost every aspect demographically: fertility, mortality, age structure, and migration patterns. These demographic differences will play an important role in defining the local economic and social landscape in future China, and will also at the same time increase the need for inter-regional exchange and interdependence.

Appendix: Calculating Demographic Dividend

The First Dividend

Given the age profile of production, an increase in the population concentrated at high-productivity ages must lead to an increase in per capita output. The extent to which the standard of living rises as a consequence may be exaggerated, however, because consumption, indeed physiological needs, also vary by age.

The effects of age variation in production and consumption are easily incorporated into a simple neo-classical growth model (Cutler, Poterba et al. 1990; Mason and Lee forthcoming). Define the effective number of producers as $L(t) = \sum_a w(a)P(a, t)$ where *w(a)* measures age-variation in productivity and *P(a,t)* is the population of age *a* in year *t*. The effective number of consumers is defined in similar fashion as $N(t) = \sum_a c(a)P(a, t)$. Output per effective consumer, *y(t)*, is:

$$\frac{Y(t)}{N(t)} = \frac{L(t)}{N(t)} \times \frac{Y(t)}{L(t)} \tag{1.1}$$

or the product of the support ratio (*L/N*) and output per worker (*Y/L*).

The rate of growth in output per effective consumer ($\dot{y}$) is equal to the rate of growth of the support ratio (the excess of the rate of growth in the effective labor force over the rate of growth of the effective number of consumers) and the rate of growth of output per effective producer ($\dot{y}^l$):

$$\dot{y}(t) = \dot{L}(t) - \dot{N}(t) + \dot{y}^l(t). \tag{1.2}$$

The first dividend is captured by changes in the support ratio, i.e., the first two right-hand-side terms in equation (1.2).

Computation of the support ratio requires estimates of age-specific productivity and consumption weights. These are estimated for China using the 2000 Urban Survey of Income and Expenditure. The productivity weights are assumed to be proportional to labor income and the consumption weights are assumed to be proportional to estimated consumption.

The Second Dividend

The concept of lifecycle wealth and its relationship to population age structure is central to understanding the second demographic dividend. The lifetime budget constraint implies that the current lifecycle wealth of an individual, a cohort, or a population must equal the present value of the future stream of consumption less the present value of the future stream of labor income.[24] In the absence of intergenerational transfers (familial support, PAYGO pension systems, bequests, etc.), lifecycle wealth consists entirely of capital, i.e., real assets held by each individual, a cohort, or the population. Capital represents one form of lifecycle wealth.

Transfer systems create another form of lifecycle wealth for its participants – transfer wealth, the present value of net lifetime transfers received by an individual, a cohort, or a population. A familiar example of transfer wealth is social security or pension wealth that arises from PAYGO pension programs and consists of the present value of benefits to be received in the future less the present value of taxes to be paid in the future. A less familiar example of transfer wealth arises from childrearing. During childhood individuals receive transfers directly from parents or indirectly from taxpayers – schooling, for example. When they become adults individuals make

[24] Any bequests are included in consumption.

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transfers to children, directly to their own children or indirectly to all children in their capacity as taxpayers. Childrearing transfer wealth is the net present value of all transfers associated with childrearing.

Lifecycle wealth is closely related to the direction of resource flows. The lifecycle wealth associated with upward flows – from younger age groups to older age groups – is positive. Current members of the population can expect to receive more in benefits than they pay in costs in present value terms. This is possible because the current population is receiving net transfers from generations that are not yet born. The flip side of transfer wealth is the implicit debt imposed on future generations.

The lifecycle wealth associated with downward flows – from older age groups to younger age groups – is negative. Many members of the population have already received benefits but they have not yet incurred the costs associated with downward transfers. A newly married couple, for example, faces childrearing costs but may anticipate few additional transfers from their parents. Hence, their childrearing lifecycle wealth is strongly negative.

Changes in age structure have a major influence on aggregate lifecycle wealth. As shown above, China's young age structure in 1982 must have led to resource flows that were strongly downward. China's projected age structure in 2050 will lead to resource flows that are strongly upward under the assumptions stated above. As a result, the changes in age structure will lead to a shift from negative to positive lifecycle wealth.

The relationship between lifecycle wealth and age structure can be readily summarized given sufficiently strong assumptions. Lee (1994) has shown that given steady-state golden rule growth, the ratio of lifecycle wealth (W) to labor income (or

consumption) is equal to the difference between the mean age of producing and the

mean age of consuming ($A_{Y^l} - A_C$):

$$\frac{W}{Y^l} = \frac{W}{C} = A_{Y^l} - A_C,$$ (1.3)

where the mean ages of producing and consuming are:

$$A_{Y^l} = \int_0^w aN(a)Y^l(a)da / \int_0^w N(a)Y^l(a)da$$

$$A_C = \int_0^w aN(a)C(a)da / \int_0^w N(a)C(a)da.$$ (1.4)

The mean ages are "dollar-weighted" average ages. The difference between the

two measures the lag in years between the age at which a dollar is earned and the age at

which it is consumed. The greater this lag the greater is lifecycle wealth. If the

population consumes before it produces, on average, its lifecycle wealth is negative.

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Table 1 Summary Demographic Indicators, China, 1950 -2000

Indicator	Year			
	1950	1982	1990	2000
Population Size (millions)	551.96	1016.54	1143.33	1265.83
Percent urban	11.18	21.13	26.41	36.22
Birth Rate (per thousand)	37	22.28	21.06	14.03
Death Rate	18	6.6	6.67	6.45
Rate of Natural Increase	19.00	15.68	14.39	7.58
TFR	----	2.9	2.3	1.6*
Mean Age at First Marriage (F)	----	22.4	22.1	24.15
Life Expectancy (M)	42.2	66.43	66.91	71.01
Life Expectancy (F)	45.6	69.35	69.99	74.77
Infant Mortality Rate (M)	145.85	36.47	32.19	20.78
Infant Mortality Rate (F)	130.18	34.54	36.83	29.15
Mean Household Size	----	4.41	3.96	3.44

Sources and notes: population size, percent urban, and crude vital rates are from various published
official Chinese sources; TFR before 1995 are from China Population Yearbook, 1995 and 2000 see discussions
in the text; marriage age from China Population Yearbook 2003; life expectancy under 1950 is for 1953-64
and is from Coale 1984, infant mortality rates under 1950 are for 1950-54 and from Yan and Chen 1993,
other mortality numbers are from Li 2003.

Table 2. Average annual rate of growth in the support ratio (%), 1982-2050, China and other selected societies

	1982-2000	2000-2013	2013-2050	1982-2050
China	1.28	0.28	-0.45	0.15
Taiwan	1.07	0.01	-0.60	-0.04
Japan	-0.18	-0.24	-0.60	-0.42
United States	0.44	-0.46	-0.04	0.01
France	0.40	-0.41	-0.17	-0.06

Notes: All values calculated using the income and consumption profiles for 1999 Urban China. Sources: For China population data see text; for Taiwan population data Department of Manpower Planning (personal communication); for Japan, US, and France the United Nations (2003). Single year of age data interpolated using Sprague multipliers.

Table 3. Mean ages and lifecycle wealth variables.

	1982	2000	2050
Mean age of consumption	28.0	32.5	44.4
Mean age of production	37.3	37.8	41.8
Ratio of Lifecycle Wealth to Labor Income			
Total	-9.2	-5.3	2.6
Support of child dependents	-11.2	-7.8	-4.5
Support of elderly dependents	2.0	2.5	7.1

Note: Calculations use age-profiles of household consumption and labor income estimated from the 2000 Urban Income and Expenditure Survey. Estimate of life cycle wealth for the support of child dependents is based on the mean age at childbearing in 2000 from the population projection for China. Lifecycle wealth calculations assume golden rule, steady-state growth.

Table 4. Reallocation System

Form	Institution		
	Family	Market	State
Capital	Housing	Factories	Public infrastructure
	Consumer durables	Inventories	State owned enterprise
	Education	Farms	Funded pension plans
Transfers	Childrearing costs	Public debt	Public education
	Support of elderly		Public health care
	Bequests		Unfunded pension plans
Credit	Familial loans	Consumer credit	Student loans

Note: Adapted from Lee (1994).

Table 5 Mortality Change in China's Provinces during the Reform Era

| Province	Life Expectancy Level			Percent National Level			Percent Change
	Year				Year		
	1981	1990	2000	1981	1990	2000	2000/1981
Shanghai	72.9	74.9	78.1	108%	109%	109%	107%
Beijing	72.0	72.9	76.1	106%	106%	107%	106%
Tianjin	70.9	72.3	74.9	105%	105%	105%	106%
Zhejiang	69.6	71.8	74.7	103%	105%	105%	107%
Shandong	70.1	70.6	73.9	104%	103%	104%	105%
Jiangsu	69.6	71.4	73.9	103%	104%	104%	106%
Liaoning	70.7	70.2	73.3	104%	102%	103%	104%
Guangdong	71.3	72.5	73.3	105%	106%	103%	103%
Jilin	69.0	68.0	73.1	102%	99%	102%	106%
Hainan	----	70.0	72.9	----	102%	102%	----
Fujian	68.6	68.6	72.6	101%	100%	102%	106%
Hebei	70.5	70.4	72.5	104%	103%	102%	103%
Heilongjiang	68.3	67.0	72.4	101%	98%	101%	106%
Anhui	69.4	69.5	71.9	103%	101%	101%	104%
Shanxi	67.8	69.0	71.7	100%	101%	100%	106%
Henan	69.8	70.2	71.5	103%	102%	100%	102%
Guangxi	70.2	68.7	71.3	104%	100%	100%	102%
Sichuan	64.1	66.3	71.2	95%	97%	100%	111%
Hubei	65.7	67.3	71.1	97%	98%	100%	108%
Hunan	65.6	66.9	70.7	97%	98%	99%	108%
Ningxia	65.7	66.9	70.2	97%	98%	98%	107%
Shannxi	65.0	67.4	70.1	96%	98%	98%	108%
Inner Mongolia	66.8	65.7	69.9	99%	96%	98%	105%
Jiangxi	66.1	66.1	69.0	98%	96%	97%	104%
Gansu	65.9	67.2	67.5	97%	98%	94%	102%
Qinghai	61.1	60.6	66.0	90%	88%	92%	108%
Guizhou	61.6	64.3	66.0	91%	94%	92%	107%
Yunnan	61.1	63.5	65.5	90%	93%	92%	107%
Xinjiang	60.7	62.6	64.7	90%	91%	91%	107%
Tibet	--	59.6	64.4	--	87%	90%	----
National	67.67	68.55	71.40				106%

Sources: Life expectancy numbers for 1981 are from Mortality Statistics of CPIRC, for 1990 and 2000 are from China Statistical Yearbook 2003, p. 117. Chongqing and Hainan provinces are not included due to their recent establishment.

Figure 1.a. Age Profiles of Consumption and Production, Urban China, 2000.
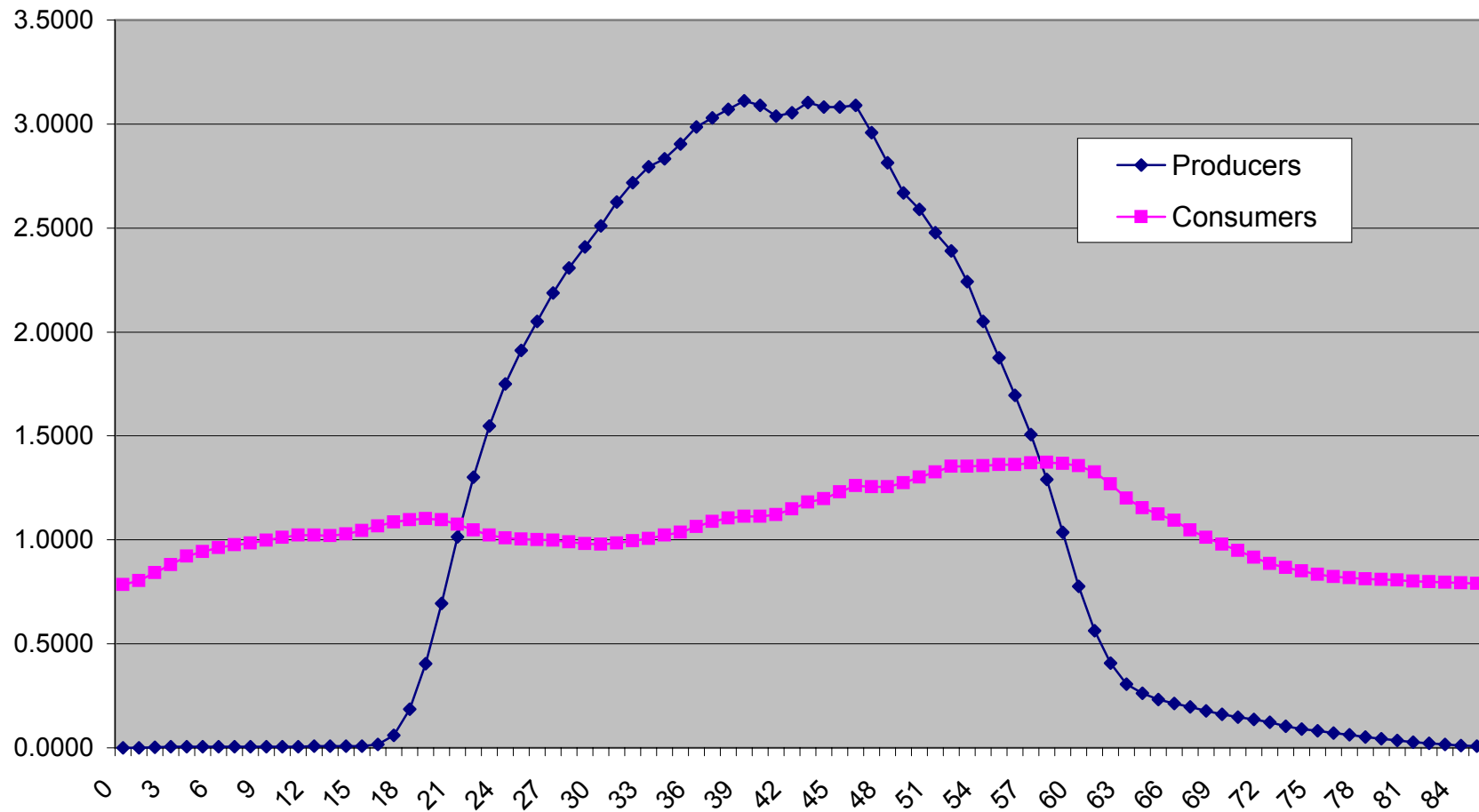
Notes: Profiles normalized to total to one hundred. Source: China National Bureau of Statistics 2000.

Figure 1.b. Population by Age, China, 1982, 2000, 2050
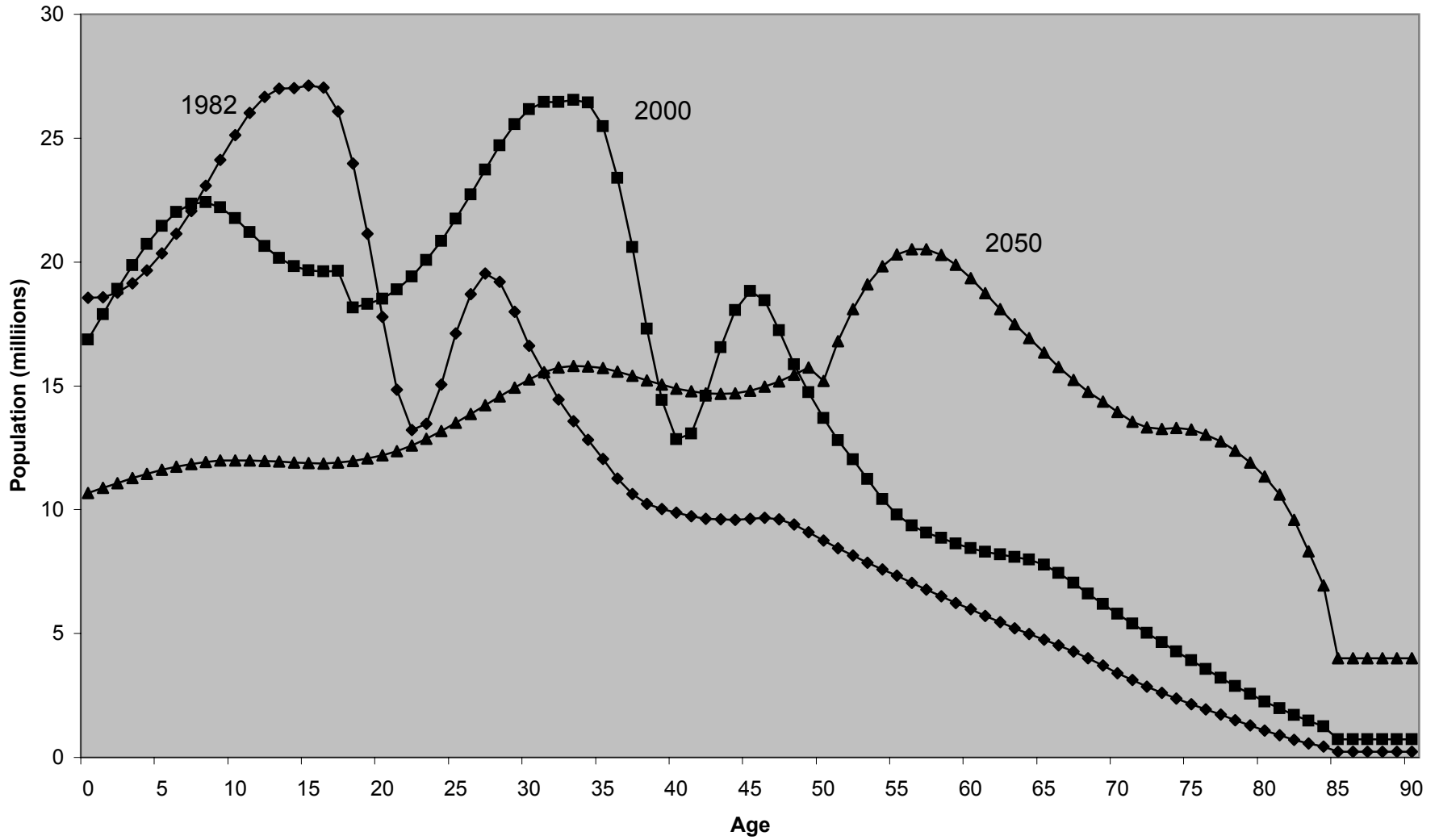
Note: Population 85 and older uniformly distributed in the 85-90 age groups. Sources and methods: See text.

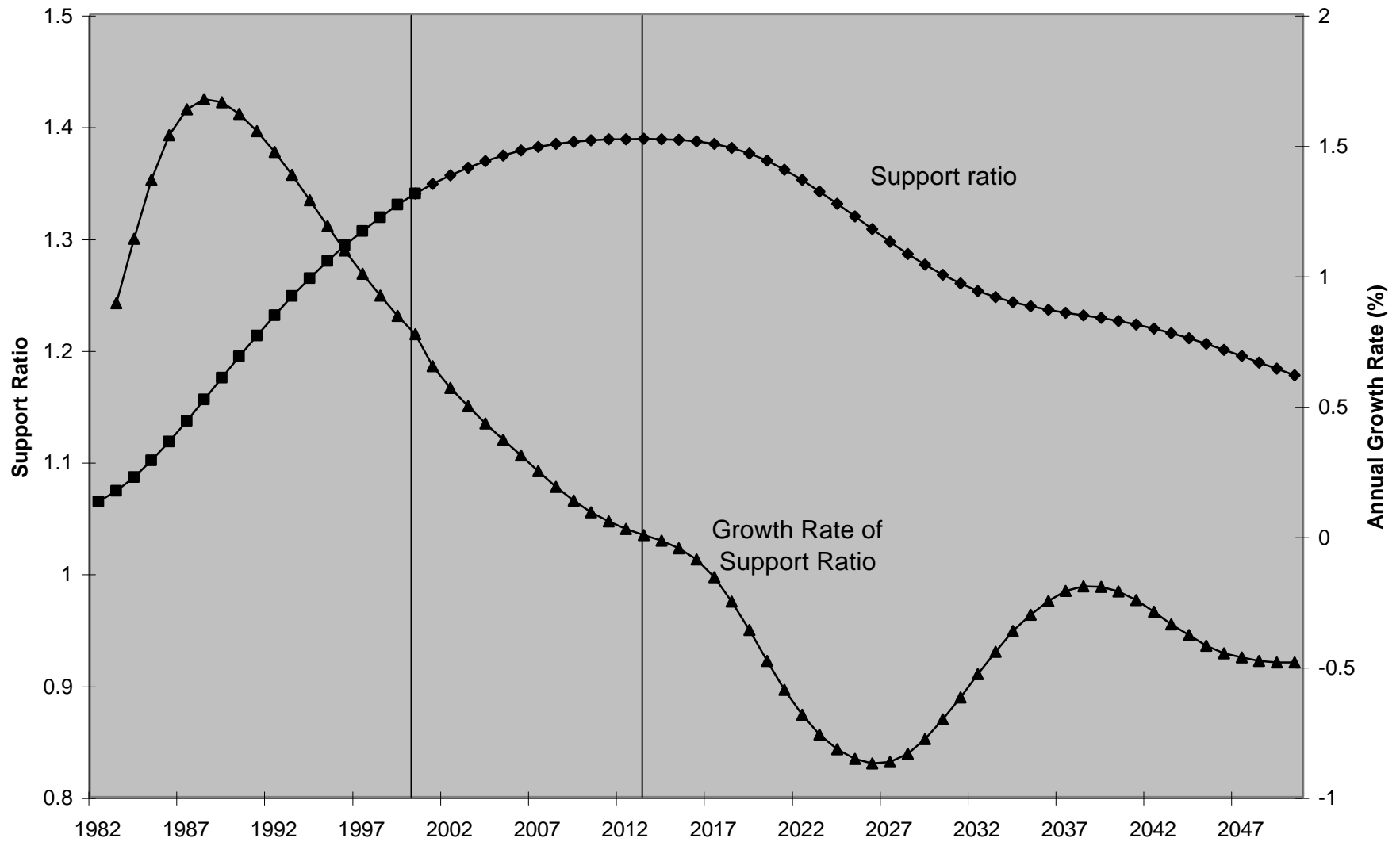## Figure 2.a. Economic Support Ratio, China, 1982-2050

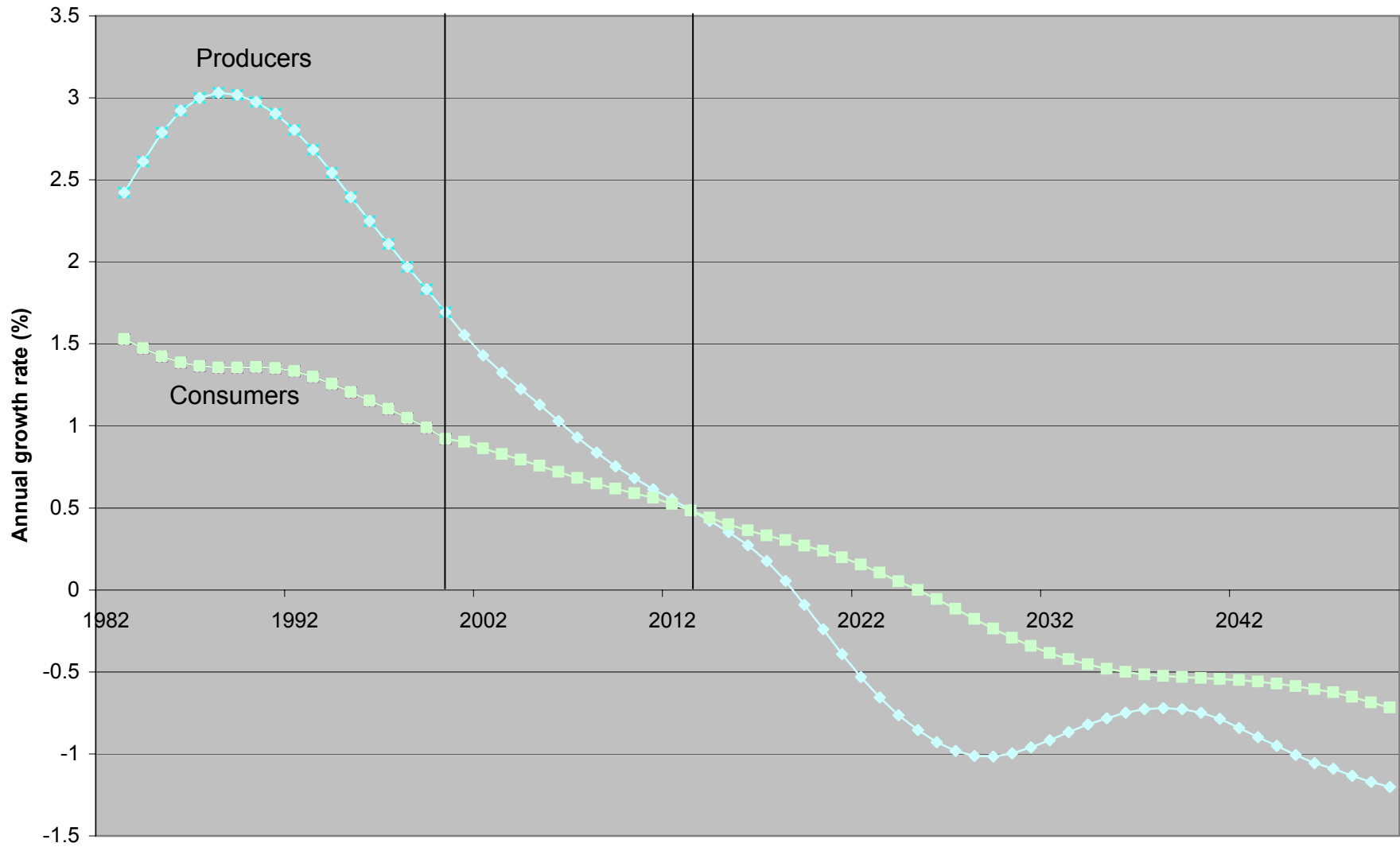**Figure 2b. Effective Producers and Consumers, Annual Growth Rate, 1982-2050.**

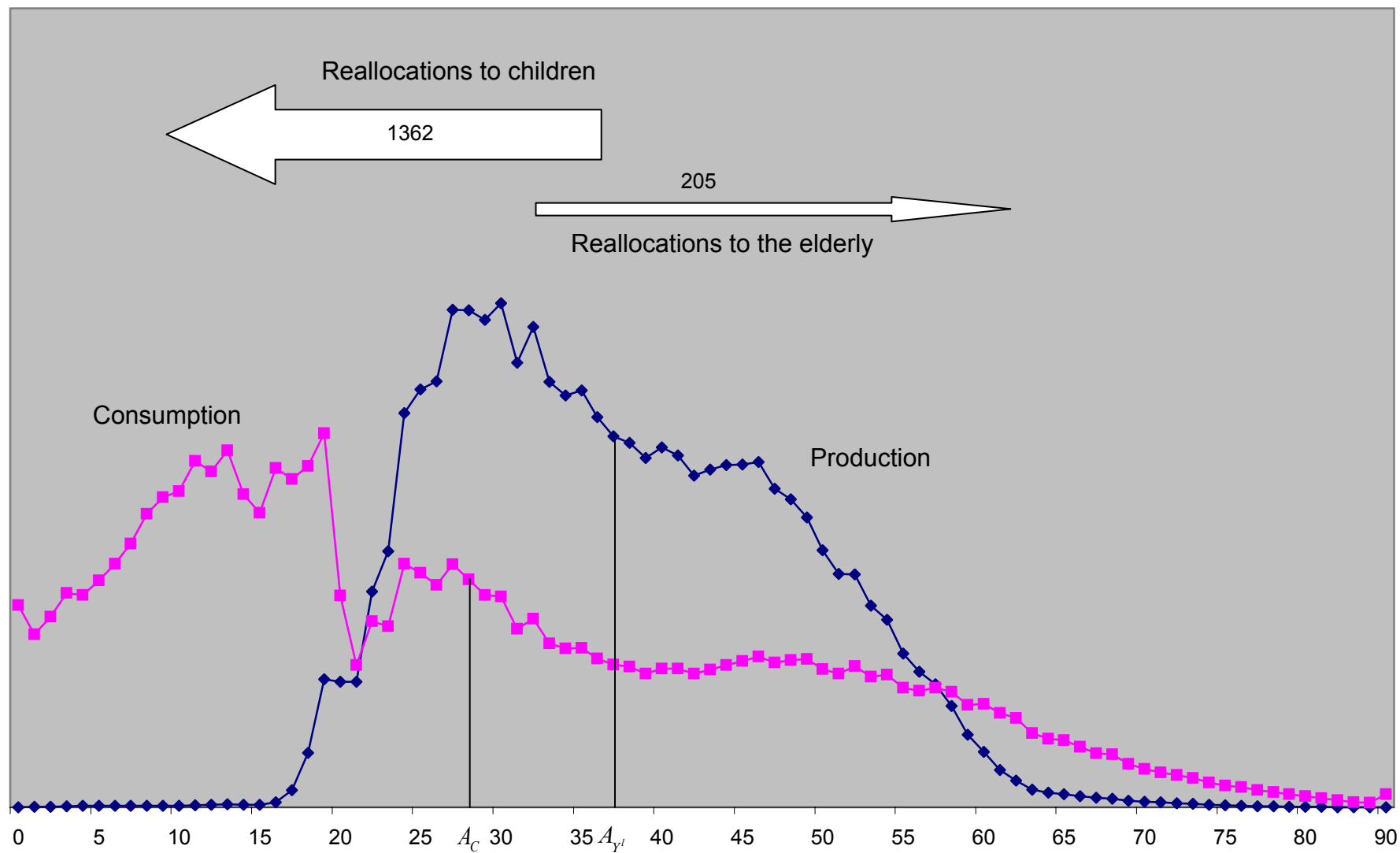Figure 3.a. Consumption and Income Profiles, China, 1982

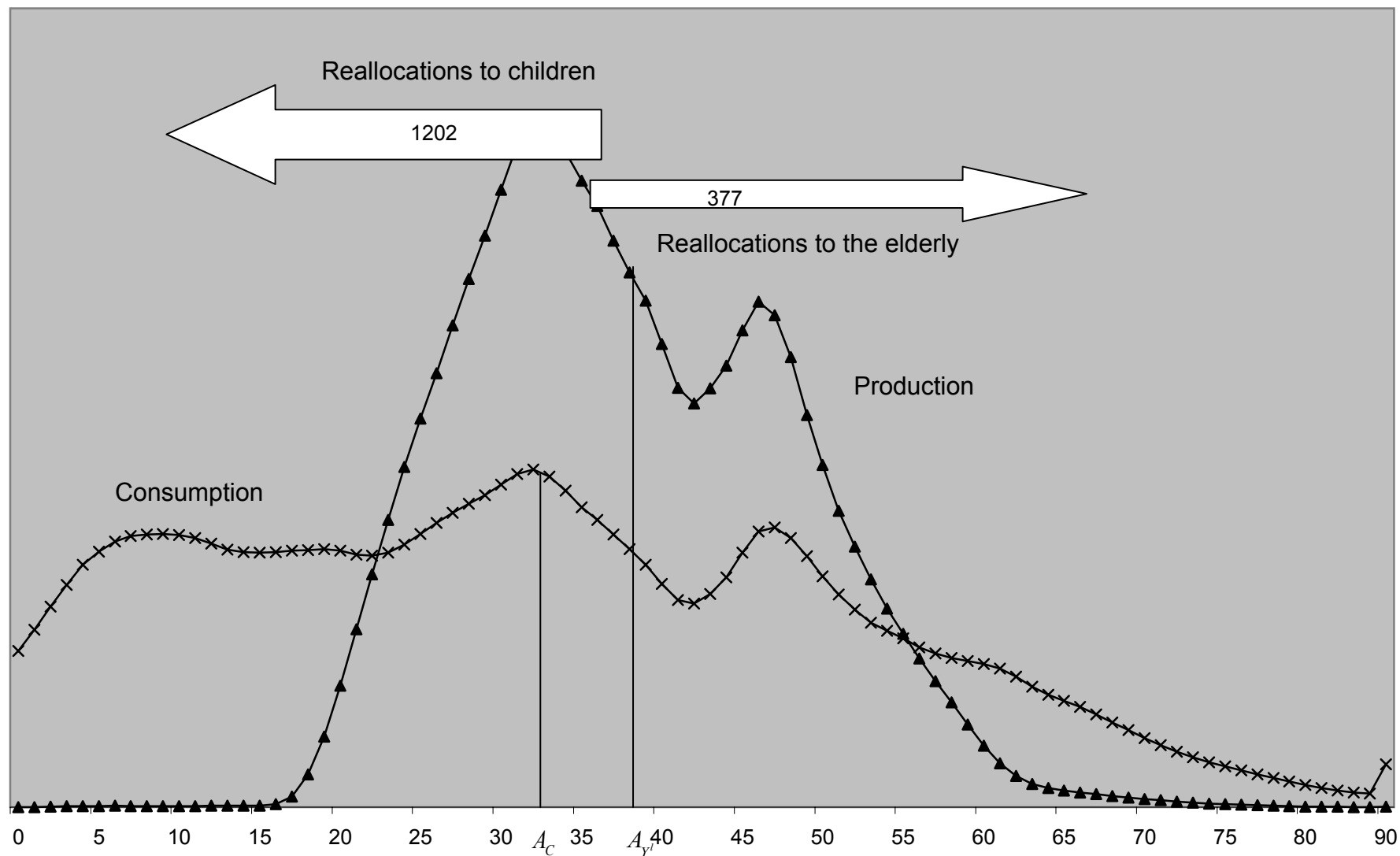# Figure 3.b. Consumption and Income Profiles, China, 2000
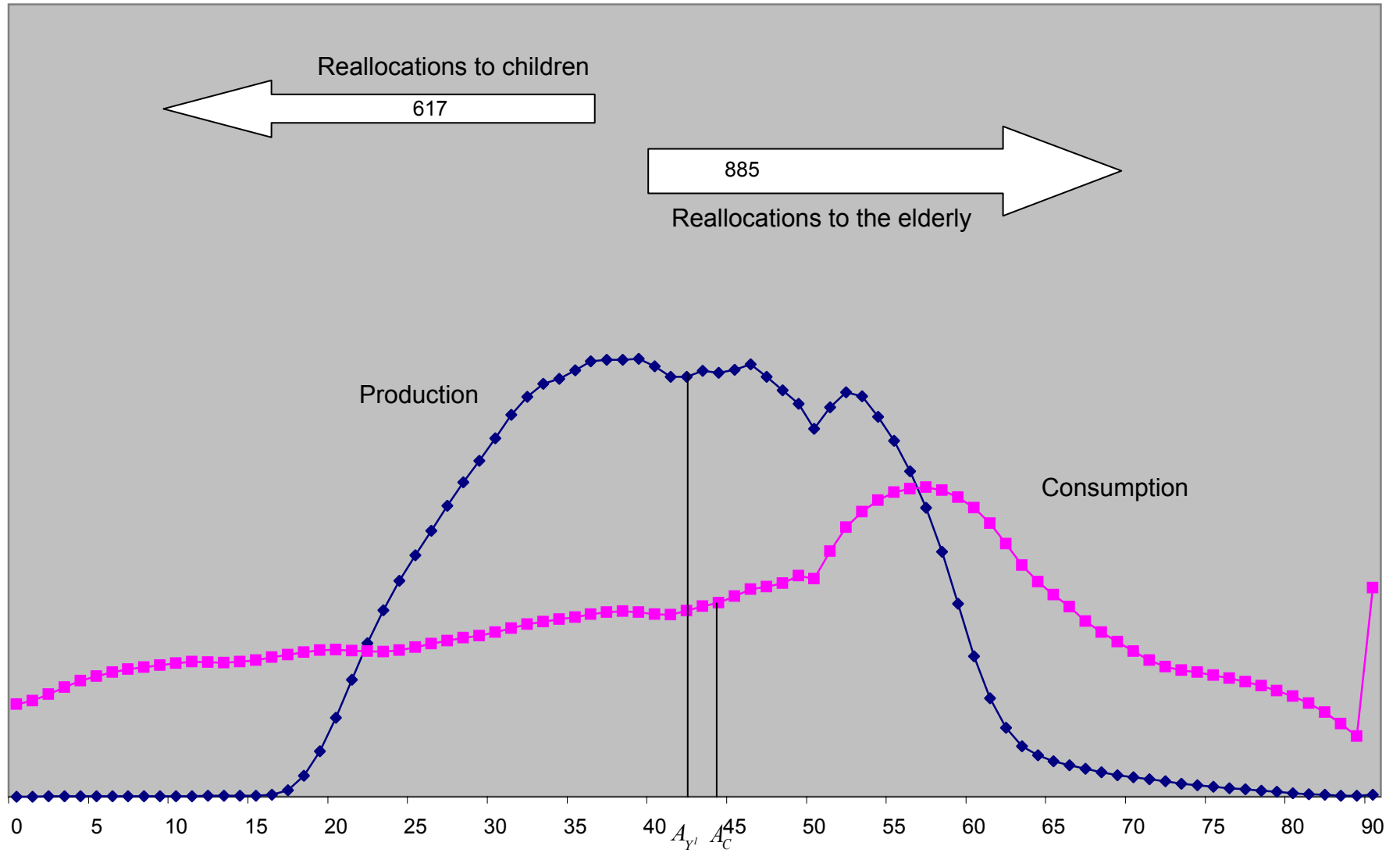
Figure 3.c. Consumption and Income Profiles, China, 2050

Figure 4 Rising Sex Ratio and Excess Female Infant Mortality, China