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Rough and incomplete draft.

Individual Earnings and Consumption Profiles:

What Do We Know?

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Recent research on the macroeconomic consequences of population change emphasizes age structure. A population's age structure is important because human populations have long periods of dependency – periods during which individuals are consuming more than they are producing. This feature of human populations figures prominently in the lifecycle saving model (Modigliani and Brumberg 1954; Mason 1987; Mason 1988; Modigliani 1988; Higgins 1994; Borsch Supan 1996; Kelley and Schmidt 1996; Williamson and Higgins 2001), in studies of the demographic dividend (Bloom and Williamson 1998; Mason 2001; Bloom, Canning et al. 2002; Bloom and Canning 2004; Mason and Lee 2004), and studies of the effect of population on financial markets (Poterba 2004). The long-run effect of population growth on per capita income depends on the age profiles of consumption and production (Arthur and McNicol 1978; Lee 1994a). Aging has fiscal implications because taxable resources depend on the size of the productive sector, and consumption of publicly provided goods and services, e.g., education and health, varies with age (Auerbach and Kotlikoff 1987; Auerbach, Gokhale et al. 1991; Auerbach, Kotlikoff et al. 1999; Lee and Edwards 2001; Lee and Edwards 2002).

As discussed in Lee (1997), the effect of a small change in population age structure on the macro-economy can be decomposed into two additive components: the effect of the change in population age structure weighted by the initial age profiles of production and consumption (or other items of interest), plus the induced changes in the shapes of these age profiles weighted by the initial population age distribution. The first effect is compositional or mechanical, and the second is behavioral. In this paper, we will focus on estimates of the initial age profiles of consumption and production.

The interaction between age structure and age profiles of consumption and production is incorporated into economic research in a variety of ways (see Lee (1997) for an overview). The simplest treatment of the compositional effect of changing population age distributions is given by population dependency ratios: the youth dependency ratio and the old-age dependency ratio. This captures the age patterns of consumption and production in a crude but useful way by identifying the relative size of the two groups that are consuming more than they are producing.

Fair and Dominguez (1991) and, subsequently, Higgins (1994) and Williamson and Higgins (2001) use a more refined approach that captures the reality that dependency varies in a continuous rather than a binary fashion. The age profiles of consumption and production and, hence, the difference between consumption and production, are assumed to have an unknown quadratic shape. The quadratic parameters are estimated through a regression of an aggregate outcome on the changing observed population age distribution weighted by the quadratic age profiles. These and other approaches are discussed in more detail in Lee (1997).

An alternative approach is direct estimation of the age profiles of consumption and production. Mankiw and Weil (1989) used a variant of this approach to analyze and project the effect of demographic change on housing markets in the US, by using a first stage regression on household data to estimate the effects of household demographic composition on expenditures for housing. With information in hand on the age profiles of consumption and production, a variety of approaches to analyzing the effects of age structure are possible. Summary measures can be constructed – the support ratio or the mean ages of consumption and production. Or the age profiles can be combined with

detailed population data in simulation analyses. The support ratio is the ratio of the effective number of producers to the effective number of consumers (Cutler, Poterba et al. 1990). The effective number of producers is measured by weighting the population by age-specific productivity weights estimated, for example, using survey data on earnings by age. The effective number of consumers is measured by weighting the population by age-specific equivalence scales, typically estimated using consumer expenditure surveys.

The effect of changing age structure has also been modeled and estimated using the mean ages of the aggregate production and consumption profiles ((Arthur and McNicol 1978; Mason 1981; Mason 1987; Lee 1994a; Lee 1994b). Direct estimates of the consumption and production profiles are also frequently used in simulation models (Deaton and Paxson 2000; Lee, Mason et al. 2001a; Lee, Mason et al. 2001b; Lee, Mason et al. 2003) allowing for a more detailed assessment of the effects of changing age structures.

The advantage of direct estimation is two-fold. The first is that a more detailed and accurate characterization of dependency is possible than can be captured by the dependency ratio or a quadratic. The second is that the relationship between age and dependency varies across countries and over time. A single child dependency ratio or polynomial is hard-pressed to measure dependency in the poorest and the richest countries.

The disadvantage of using direct estimates of consumption and production profiles is that they are difficult to estimate. In the material that follows, we review what we know about consumption and production profiles. The paper is limited to individual profiles rather than household profiles. The individual perspective treats production and consumption as though they are attributes of individuals. In economies where formal sector employment dominates, measuring production (or earnings) for individuals is a relatively straight-forward task. In traditional settings, where employment is informal and production is often organized within a family enterprise, estimating production by age (of individuals) is difficult. In any setting, allocating consumption to individuals is difficult. Most expenditure data are collected for households rather than individuals. Moreover, some goods are jointly consumed so that allocating their consumption to individuals inevitably involves arbitrary rules.

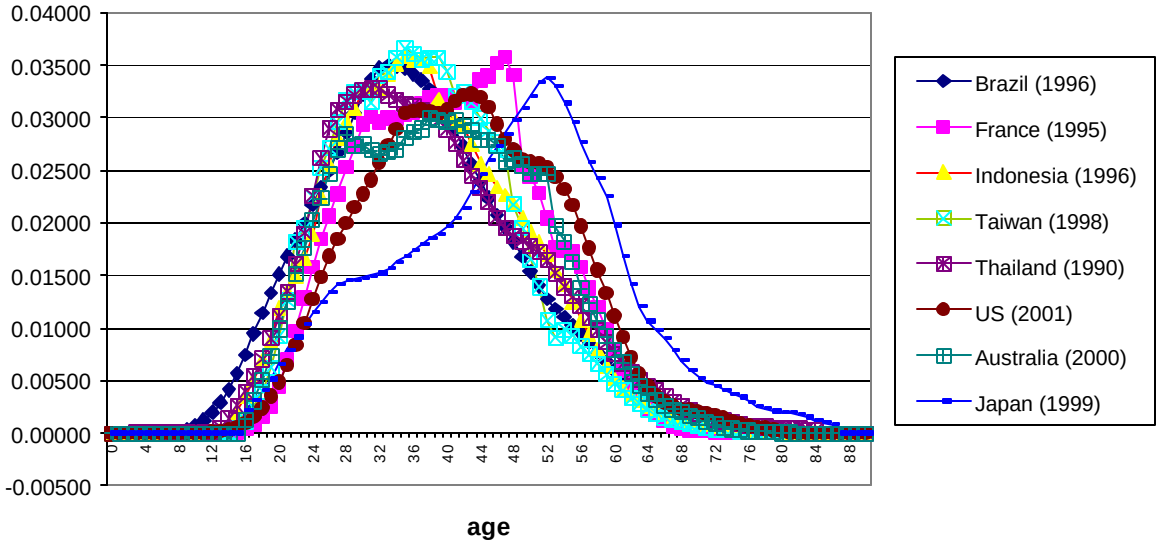
The household perspective treats production and consumption as attributes of households. In this case, age means the age of the household head. Constructing production and consumption profiles is more straight-forward, but there are tradeoffs involved. The first is that the effects of co-resident children and elderly on household consumption and production profiles must be explicitly modeled or – as is often the case – neglected altogether. Indeed, a large share of all societal income redistribution occurs within households, and would therefore be invisible to accounting on a household basis. The second is the difficulty of translating changes in population age structure into changes in the age structure of household heads and household membership. This is far from simple.

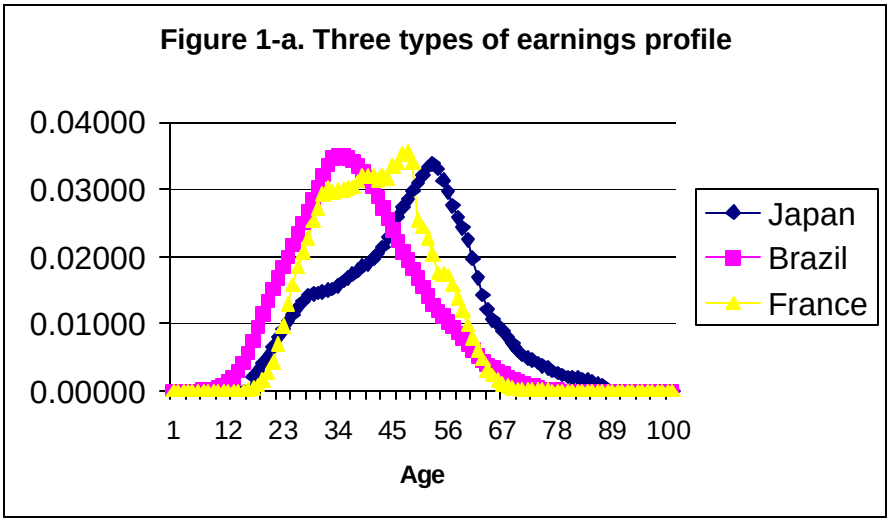
Here we opt for the individual perspective, but irrespective of the methodology employed, the age patterns of consumption and production are central to understanding the role of population in the macroeconomy.

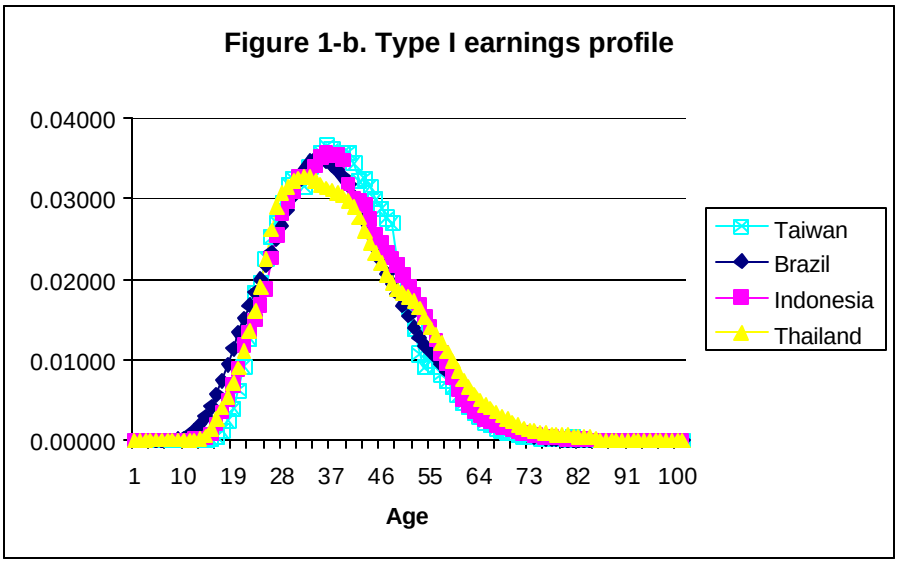
Production Profiles

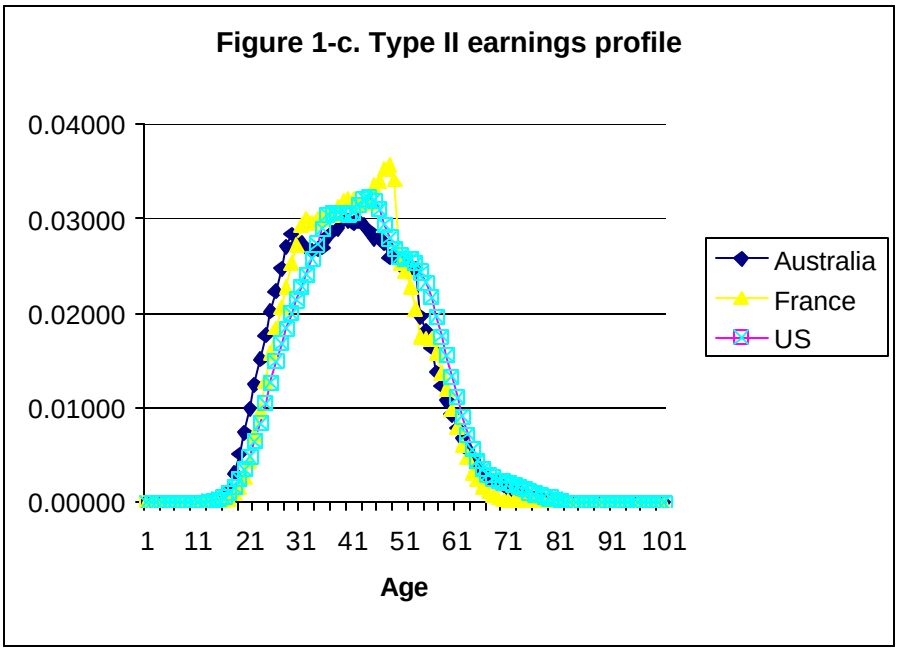
Figure 1 shows the share of aggregate labor income by age for eight countries. Labor income is defined as earnings plus an estimated portion of the household's entrepreneurial income if available. Every country exhibits the same broad pattern – an inverse U-shape with production concentrated among prime age adults. However, the young and the elderly also represent a substantial portion of the productive population in some countries. In some countries, the aggregate earnings increase very rapidly and peak at very young ages, but in other countries earnings are much more heavily concentrated at older ages.

Figure 1. Share of aggregate labor income of selected countries by age, normalized to one









The age-earnings profiles fall into one of three types:

- Type I: Brazil, Indonesia, and Thailand (and Taiwan): the young accounts for a su bstantial portion of aggregate earnings. The share of earnings increases very rapid ly with age, peaking in the early 30s and dropping sharply after that.

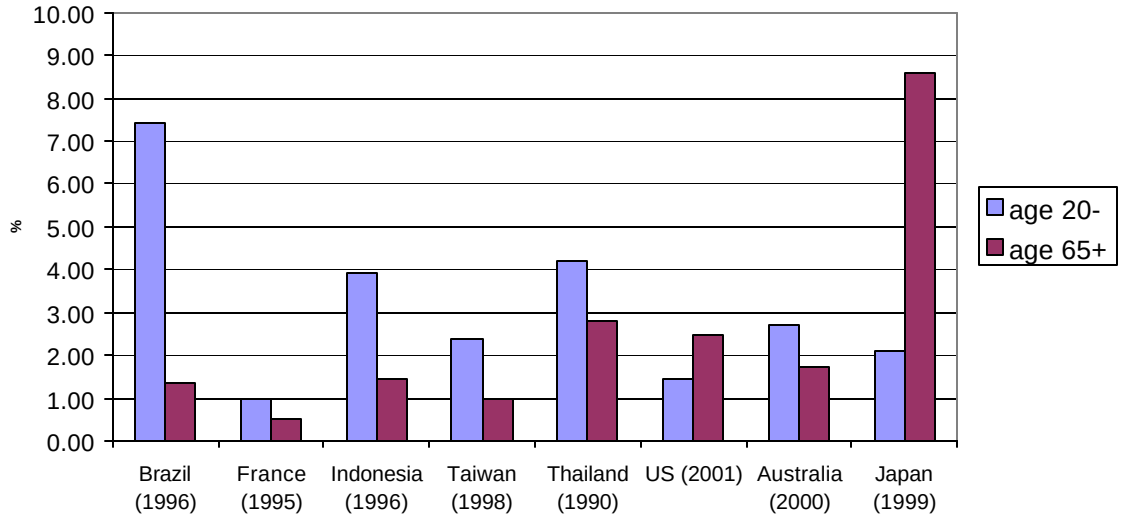
- Type II: US, France, Australia (and Taiwan): the young and the elderly accounts f or a small share of aggregate earnings. The share increases rapidly and then slowl y, peaking in the early or mid 40s. Taiwan shares characteristics of both Type I an d Type II.

- Type III: Japan: People aged 60 and over account for substantial portion of aggreg ate earnings. The share of young workers is much less than any other countries; th

e share reaches its peak at age 52, which is the latest among our study countries.

Figure 2 presents the share of earnings for ages 20 and under (20-) and ages 65 and older (65+). The share of 20- is much higher in Brazil, Thailand, and Indonesia than France and US. The share of 20- in Taiwan, Australia, and Japan is higher than France and US but it is lower than in the rest of countries. The share of 65+ in Japan is much higher (8.6%) than the rest of the group. Obviously this is due to both their highest proportion of people aged 65+ (19%) and the high activity rate of the elderly (35%) (Clark and Ogawa et. al. 2004). It is also possible that the seniority-based pay system leads to a divergence between productivity and earnings in Japan, an issue we discuss in more detail below.

Figure 2. Share of aggregate earnings for youth (20 and under) and elderly (65 and over)



Population structure and labor force by age

To a great extent the shape of the age-earnings profile reflects the underlying age distribution of the population. As the share of elderly in the population increases, so does the share of older worker in the labor force. The probability of surviving from birth to age *x*, *p(x)*, plays an important role here. As life expectancy rises in the future, the gains in survival rates will be increasingly concentrated at older ages. As a consequence, older age groups grow more rapidly during their high growth period than do younger age groups. Likewise, if population growth ceases and turns negative, older age groups will decline more gradually than will younger age groups. Declining mortality reinforces the effect of declining fertility in the shift to an older population.

To the extent that old and young workers differ in the inputs that they supply, the earnings they receive, and the social safety net they face, changes in activity rates by age are also expected to have an effect on the shape of age-production profile. Activity rates vary widely among countries, reflecting varying labor market conditions, industrial

structures, educational systems, preferences toward leisure, and pension systems. However, the activity rates of three demographic groups in particular are critical in determining the age structure of working population. First, many teenagers and young adults are extending their time in school and delaying their entry into the labor force. Second, activity rates among women have increased as rates of childbearing have declined. Third, activity rates among older males have dropped with few exceptions.

The changing age-profile of production reflects changes both in the underlying population and in activity rates. Among the young, declining activity rates and declining population shares are mutually reinforcing in countries where fertility decline is well underway. Growth in the share of elderly populations is offset by the decline of activity rates among the elderly found in many countries. For example, in Table 1 the share of earnings of elderly ages 65 and older in Thailand is approximately the same as in the US. Although the percentage of the people ages 65 and older is much higher in the US, activity rates are much lower in the US than in Thailand.

The net effect of population aging on the share of the earnings of the older population is far from clear. As activity rates decline, the older population will depend more on private and public transfers and on their financial assets and less on labor earnings. Many studies have investigated the effect of pension and social security programs on retirement decision. Most conclude that the growth of pension and social security programs has led to earlier retirement, but no consensus has emerged about the magnitude of the effect. For example, Gustman et al. (1994) find small effects; Lumsdaine et al. (1997) substantial ones. Studies that have focused on social security rule modifications conclude that their impact is modest. Simulations using firm data show that changes in social security policy in the U.S. will have little impact on the age at which workers accept their private pension, mainly because private pension wealth in the US is substantially larger than social security benefits (Stock and Wise, 1990; Lumsdaine et. al., 1997). Of course, many workers in the US do not have private pensions on which they can draw. Studies of the impact of pensions on retirement usually find that workers with generous pensions retire earlier than those with smaller pensions, but the magnitudes of the effects vary considerably across studies (see Gruber and Wise, 1999, 2004).

Productivity by age and other institutional factors

Individual productivity varies by age. Skirbekk (2003) reviews a dozen studies and concludes that previous studies generally point to an inverse U-shaped individual productivity profile, with significant decreases take place from around 50 years of age.

Reasons for declining productivity are several-fold. A large body of literature supports the view that mental abilities decline during adulthood (Autor, 2002, Maitland et. al. 2000, Verhagegen and Salthouse, 1997). Poor physical and mental health is also strongly related to early retirement (Quinn et. al. 1990; Bound, 1991, Dwyer and Mitchell, 1998; Schonbaum, 1997). Rapid technological progress has an uneven influence on skills and competencies by age (Autor et. al. 2003). Rapid changes in educational systems might also give middle-aged and younger workers a competitive advantage over their older counterparts.

Although previous studies show a uniform picture, that individual productivity begins to decline during adulthood, estimates of the age at which the decline begins even among developed countries using similar empirical methodology. Productivity is

estimated to reach a peak in France between the ages of 25 and 34 (Crépon et. al, 2002), in Finland (Ilmakunnas et. al, 1999) and Norway (Hægeland and Klette, 1999) at around age 40, and at approximately age 50 in Sweden (Anderson et. al. 2002).

Unfortunately, the empirical methodology for estimating individual productivity is far from obvious (see Skirbekk, 2003 for a review). Approaches based on supervisors' ratings are subject to supervisors' evaluations on workers' loyalty and past achievements rather than current true productivity (Salthouse and Mauer, 1996). Directly measuring job performance based on work samples have limited empirical implication due to selection problems (Kate and Perloff, 1992). A frequent approach is to analyze employer-employee matched data sets, where firms' value added is conditioned on the composition of workers by age (see Abowd and Kramarz, 1999, for a review). Unfortunately, it is hard to separate the age effects from all other factors that influence the productivity of firms.

Previous studies demonstrate that a comprehensive understanding of the age earnings profile must look beyond age variation in productivity to consider institutional factors that lead to labor market rigidities. Labor market rigidities refer to structural impediments created by firms, labor unions, or governments that reduce the flexibility of employment and compensation practices. The seniority-based wage system in some Asian countries, especially in Japan, is an example. Lazear (1979) argues that the monotonically upward sloping earnings profile is a feature of a deferred wage system that discourages shirking and worker turnover. Workers post a bond by accepting wages below their marginal product when young. They receive repayment in the form of wages above their marginal product when old. The repayment sometimes takes a form of a large retirement bonus. This raises some conceptual issues. Should the retirement bonus be counted as deferred compensation and spread over the working life? Is there a transfer component in wages from younger workers to older workers? What is the implication of population aging for this type of wage system?

Population aging has potentially interesting implications for the seniority wage system that depends on the manner in which firms finance any difference between productivity and wages. Lazear (1990) argues that if the deviation is funded on a pay-as-you-go basis, i.e., by transfers from younger workers to older workers, then population aging will lead to a funding shortfall. The reduction in young workers' wages below marginal product will no longer cover the excess of older worker's wage above it. Thus population aging will lead to a reduction in the wages of one of the groups of workers. The loss of earnings for young workers cannot be fully recovered when they are old. On the other hand, if firms fully fund the deferred compensation system by investing the gap between productivity and compensation for young workers, then aging need not affect the wage profile.

The seniority wage system could affect the earnings profile in a different manner. The seniority wage system creates a disincentive for employers to retain older employees. Employers may adopt mandatory retirement rules and discriminate against older workers in other ways. Firms may also resist adopting flexible employment rules are adapting in other ways to the needs of older workers. The desired amount of working time may decline as aging brings shifts in the taste for leisure. Inflexibility on the part of employers may lead to complete withdrawal from the labor force by those who would prefer continued employment at some reduced intensity. The combined effect of these

factors is to reduce the labor force participation of older workers, which, in turn, affects the shape of the age-earnings profile.

Decomposition Analysis

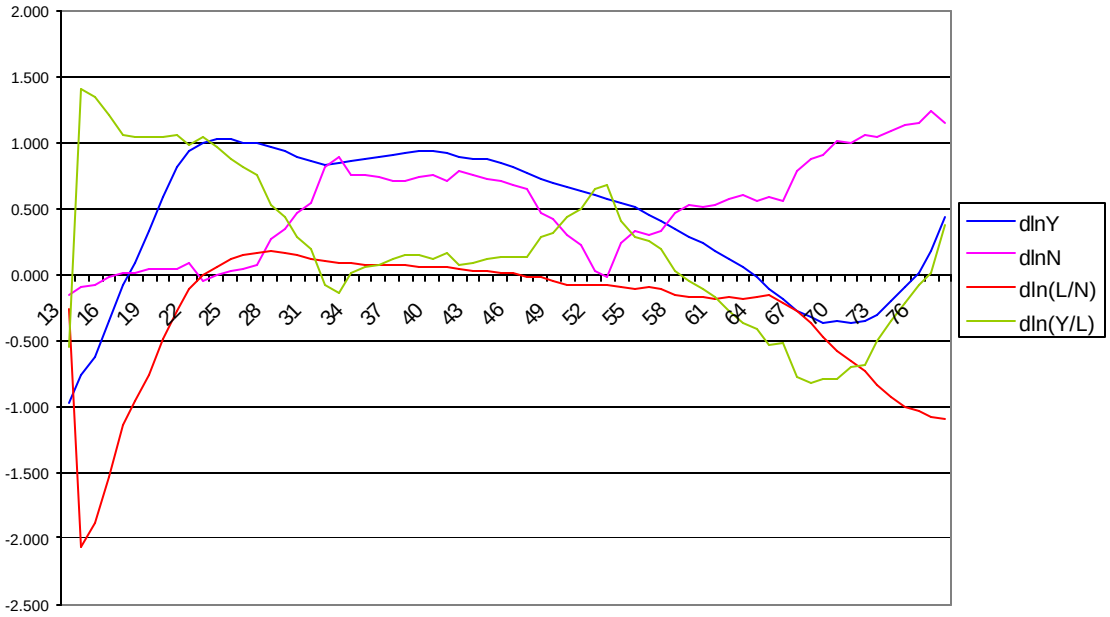
A simple exercise allows us to assess the importance for the age distribution of labor income of changes in population age structure, labor force participations, and earnings per worker. Using data for Taiwan in 1978 and 1998, we decompose the changes in aggregate earnings (in real term) by age into three components. That is,

$$\Delta \ln Y = \Delta \ln N + \Delta \ln(L/N) + \Delta \ln(Y/L)$$

where Y is aggregate labor income by age, N is population by age, and L is workers by age.

The results are shown in Figure 3. Aggregate labor income in Taiwan was increasingly concentrated at the prime adult ages between 1978 and 1998. Labor income declined at the youngest working ages and the older ages: $\Delta \ln Y$ was negative only for people ages 13-18 and 64-76.[1] At all other ages, labor income increased. No single

Figure 3. Decomposition of the change in lnY by age, Taiwan 1978-1998



factor plays a dominant role in explaining the changes in the age profile of labor income. The decline in labor income among teenagers is due to a sharp decline in their labor force activity. Labor force activity also declined among young adults but was dominated by the large increase in output per worker at these ages. The young adult population was relatively stable during this period.

[1] It is zero for age 0-12 because no children of that age worked during the period.

Population played a dominant role in determining the labor income share of those in their 30s, 40s, and, to a lesser extent, 50s. At these ages participation rates and output per worker changed little during this period, but the population in these age groups increased substantially. Finally, the changes at the older ages were an outcome of the interplay between changes in population and labor force activity. The older population grew rapidly in Taiwan, but at the same time the activity rates declined by equally large percentages. At most ages, the decline in activity rates were sufficiently great to depress the total labor income of older workers.

The factors that drove the changes in population and labor activity in Figure 3 are relatively well-understood, but it is not obvious what factors drove the changes in per worker earnings shown in Figure 3. Increases in educational attainment varied by age. Changes in economic structure and production techniques may have favored some age groups over others. Changes in hours worked may have differed by age. The gap between productivity and earnings may have changed during this period. Implementation of the minimum wage law of 1984 might have benefited teenagers and young workers.

In the coming months, we intend to replicate this decomposition analysis in other countries in order to reach some general conclusions about how population aging and other changes are influencing the age profile of productivity.

Consumption Profiles

What do we know about age-profiles of consumption over the entire life cycle on an individual basis? A number of studies have constructed measures of household consumption by age of household head, but these do not attempt to separate out the consumption by each individual within the household (Kotlikoff and Summers 1981; Fullerton and Rogers 1993; Liberati 2000; Gourinchas and Parker 2002). Only a very few studies have constructed individual age profiles of consumption. In a recent review, Lee (2000) identifies one US study (Lee 1994b), one study of Cote D'Ivoire (Stecklov 1997) and two studies of pre-industrial societies (Kaplan 1994; Dodds, Friou et al. 1996). There are many studies, however, that address important related questions. How much do children consume? Which age groups benefit from public programs? What is the cost to the parents of a child? And so on.

Answering any of these questions involves difficulties that arise in large part in attributing or allocating consumption to individuals. Part of the problem is in the nature of consumption itself – the existence of public goods, joint consumption, and scale economies. Part of the problem is the way in which data are collected and organized. Most information about private consumption comes from household expenditure surveys that infrequently attribute consumption to individual household members. Government agencies may or may not collect information about the age of program beneficiaries and the cost of services provided. Despite these technical problems, there is a considerable body of research on which to draw.

Private Consumption

An extensive literature is concerned with the problems related to allocating household consumption to the members of the household. Consider the case of children. There are two distinct questions. First, what share of a given household income is allocated to a specified child? This is the question we must answer to compute consumption over the

life cycle. Second, what is the cost to parents with a given household income of a specified child? The answer is the amount by which the parents' household income would have to be raised in order that their level of consumption with the specified child present is exactly equal to their level of consumption in the absence of the child given the original household income. Thus the two questions are closely linked through the allocation rules, yet the answers will often be different numerically.

Almost all research in this area is concerned with the allocation of consumption between adults and children. Much less is known about the allocation of consumption between prime age adults and the elderly. This issue is not important in societies where the elderly live independently because their consumption can be directly observed. In societies where multigenerational living arrangements are common, the issue is an important one about which relatively little is known.

Estimation of allocations to children have most commonly been made by the direct approach, which involves the analysis of household consumption expenditures in order to allocate specific expenditure items to specific family members. For example, spending on education and children's clothing is assigned to children; spending on tobacco, alcohol, and adult clothing is assigned to adults. Food might be allocated among household members using information from food surveys or caloric needs. Other items might be allocated using a per capita rule or a rule that allocates a larger share to adults than to children. The US Department of Agriculture use this approach, although they claim it produces estimates of the costs of children rather than expenditures on them, a claim most economists would view as mistaken.

The second approach addresses the cost of children, rather than the allocation of income to children, but through the linkage mentioned above it can also be used to derive answers to the allocation question. A welfare metric is used to assess the cost to households with different compositions. The cost of a first-born child, for example, is estimated by comparing a couple with one child to a childless couple. The cost of the child is the compensation required by the one-child parents that would leave them as well off as the childless couple—that is, we find the amount by which their income would have to be augmented so that after subtracting the amount allocated to their children, their consumption would be as much as with the original household income and without the child in question. Engel's method uses the share of food in the household budget as the welfare metric. The Rothbarth method uses spending on adult goods, e.g., tobacco, alcohol, and adult clothing.

Engel's method has been used extensively (e.g. Espenshade, 19**) but is widely criticized on conceptual grounds. The difficulty with the method is that children may be more intensive consumers of food than are adults. If so, families with more children would spend a larger share of their budgets on food because their real income is lower, but also because the household's preferences are different. Thus, children would appear to reduce the household's welfare, i.e., cost more, than is actually the case. The consensus among researchers is that Engel's method yields an upward biased estimate of the cost of children. On *a priori* grounds we can only say that Engel's method will generally yield a biased result (Deaton 1997).

The Rothbarth method does not suffer from the same problem as Engel's method because the metric used to compare households consists of goods that are not consumed by children. Thus, the amount consumed does not depend in any direct way on the

presence of children. Problems arise, however, if the presence of children affects the preferences of adults for adult goods. The Rothbarth method rests on the assumption that this is not the case, i.e., that consumption of adult goods are demographically separable in the household's utility function. Under this assumption, the presence of children in the household affects the consumption of the adult good only because the total expenditure available to adults declines when children are present. Changes in expenditure on adult goods are used to infer changes in total expenditure on adults and children. If the presence of children induces parents to smoke and drink more because of stress, for example, the Rothbarth method yields an under-estimate of the cost of children. If parents smoke and drink less out of concern for the effects on the health of their children, the Rothbarth method yields an over-estimate of the cost of children.

Views vary as to whether demographic separability is an implausible assumption or not. Bourguignon describes it as a strong assumption (p. 506). Deaton (1997) states that there are "problems with the Rothbarth identifying assumption, but they are less severe than those associated with … the Engel method." (p. 258)

There are several practical difficulties with the Rothbarth method that limit its application. First, in some instances the only adult goods available are tobacco and alcohol. If the expenditure elasticity is close to zero – as would be expected for an addictive good and as appears to be the case in some developed countries – expenditure on the good cannot be used as an indicator of welfare and, thus, can not be used to generate equivalence scales (Deaton 1997). A similar problem arises in societies where alcohol and tobacco are not consumed. Second, the method cannot be used to allocate consumption among adults and, often, older children. The difficulty with older children apparently arises because the adult goods used are, in fact, consumed by older children. This leads to an underestimate of the cost of these children. Deaton and Paxson encounter this problem estimating the costs of US children aged 12-17. Our own application of the method to Taiwan yields implausible estimates for children 10-14, i.e., estimates that were negative or close to zero.

Despite the difficulties with the methods, one possibility is that the methods bracket the true costs of children. If the Engel method is upward biased and the Rothbarth method is downward biased, then the true value would lie somewhere in between. It is true that the Engel estimates are generally higher than the Rothbarth method, but it cannot be conclusively demonstrated that the true value lies between the two estimates.

Alternative Methods

A number of alternatives have been suggested or employed. (1) collective approach; (2) demographic method; (3) *ad hoc* approach.

Collective Approach. Recent studies employing the collective approach to household consumption behavior, rather than a unitary model, have made some headway in allocating consumption among adult household members using information on how expenditure patterns are affected by the distribution of income among household members. Recently Bourguignon has discussed the possibilities of using the collective model to estimate the cost of children. He concludes that to do so requires a separability assumption that lies at "the heart of the Rothbarth approach".

Demographic Method. The "Demographic Method", a term used by de Santis, is similar to Engel's method, but differs in two ways (de Santis 2004). First, it relies on a more direct method for estimating the relationship between household composition and budget shares. Second, it uses budget shares for several expenditure items rather than just food. The idea in its simplest form is that budget shares (w_j) are determined by:

$$w_j = a_j + b_j \ln \frac{X}{A + kC} \tag{1}$$

where *a*, *b*, and *k* (the equivalent adult unit) are parameters to be estimated, *X* is total household expenditure, A is the number of adults, and C is the number of children. Rather than food share, however, the model employs several budget shares, e.g., food, housing, clothing, etc. The model involves a non-linear system of equations.

Other Issues

The allocation rule that determines how consumption is distributed among family members is an important but not an exclusive determinant of the aggregate (that is average) consumption profile for individuals. A second consideration is that household membership may be systematically related to the household's total consumption. If low income parents have more children, for example, the total consumption of children will be lower irrespective of the allocation rule. Similarly, to the extent that high-income, high-consumption elderly live to an older age, consumption by the elderly will be higher than otherwise. Family size also varies systematically with the age composition of the children. Very young children have fewer siblings because brothers and sisters have not yet been born. As children approach adulthood they may have fewer siblings living at home because they have established independent households. Furthermore, young children are likely to have younger parents, and since income generally rises with age over the life cycle, the income of these younger parents is likely to be lower than the income of the parents of older children.

The bottom line is that an equivalence scale does not translate directly into relative consumption at the aggregate level. If children count as 0.5 and adults as 1.0, it does not follow that the average consumption of children will be 50% of the average consumption of adults. The correct age patterns can be calculated by applying the equivalency scale to actual household level survey data, and then averaging across the imputed consumption by individuals of a given age in all households.

Little consideration has been given to whether or not consumption by adults varies by age. The US official poverty estimates implicitly assume that households headed by an elderly person need to be about 7% less than households headed by non-elderly (Deaton and Paxson). We know from food surveys that the energy consumption by the elderly is less than consumption by prime age adults. Obviously there are other differences. For example, the elderly work less, have more leisure time, have very different health needs, and receive direct provision of goods and services, e.g., health care, that vary across time and country. In the US, Medicare heavily subsidizes private health

care consumption. In many countries, health care is provided directly to the elderly and others.

The Rothbarth method cannot be used to estimate expenditures of the elderly unless goods can be identified that are consumed only by non-elderly adults, an unlikely prospect. The Engel method can be used to estimate age-profiles of adult consumption but the flaws in the method make this a relatively unattractive method. A possibility is to use the collective model. This has been employed to allocate consumption between men and women. Applying the method to estimating consumption of the elderly and non-elderly adults seems to be a straight-forward application so long as individual earnings data are available. This is something worth pursuing.

Estimates

Equivalence scales have been estimated for many countries – both developing and developed – using the methods described above. It would be useful to address several questions. First, are the available methods robust? Do they yield plausible estimates of child costs when applied in varying contexts? Second, do the available methods suggest similar or substantially different equivalence scales when applied to the same data? If so, the biases identified in the literature may be tolerable in practical applications. Third, does the comparison of estimates using the same method across countries or time yield useful information about changes or difference in child costs?

Despite the extensive literature on equivalence scales, it is not yet clear to what extent these questions can be answered. We are in the process of applying alternative methods in a variety of contexts. Below we present preliminary estimates for Indonesia. Additional work will be presented in the final version of this paper.

Table 2.1 reports estimates of equivalence scales for Indonesia based on the 1996 socio-economic survey (SUSENAS).[2] Results from three methods are reported – the Engel method, the Rothbarth method, and Ray's method – a variant of the demographic method discussed above. The Rothbarth method was estimated using tobacco and adult clothing to represent adult goods. Although alcohol is not illegal in Indonesia, the population is predominantly Islamic. Thus, alcohol is not an appropriate variable.

The results are not reassuring. The one consistent finding is that children consume less than adults. Engel's method and Ray's method both yield high estimates for children. The Rothbarth method yields very low estimates, with children under five having a negative cost. The age pattern also varies across methods. Costs decline with age according to Engel's method, increase with age according to the Rothbarth estimates, and are non-monotonic according to Ray's method.

Table 2.1. Alternative estimates of equivalence scales, Indonesia, 1996.

Method	0-4	5-9	10-14	Notes
Engel's	0.87	0.72	0.62	
Rothbarth	<0	0.06	0.32	Cigarettes
Rothbarth	<0	0.22	0.64	Adult clothing
Ray's	0.88	0.91	0.83	

Source: Maliki (2004).

[2] These estimates were prepared by Maliki (2004) and details are available from the author.

Public vs. Private

Estimates of equivalence scales and the costs of children are typically based on private expenditure. For some purposes this may be perfectly appropriate, but for others it is not. Assessing the macroeconomic effects of changes in age structure clearly requires attention to consumption originating in both the private and the public or sectors. A cursory examination of broad patterns indicates the following: The public sector is more important in high income countries, but there is considerable variation across countries. The public sector plays an important role in two areas that are age related: health and education (pensions are not relevant here because they are income, not in-kind transfers). Moreover, the importance of public provision relative to private provision appears to increase with income although the evidence is sketchy for education.

In 2000, government consumption as a share of total consumption averaged 19.5% for the 155 countries for which the World Bank publishes data. The share of government consumption is strongly related to the level of income – rising from around 16 percent for low income countries to 25 percent for countries with a per capita income exceeding $10,000.

Government Share of Final Consumption Expenditure, 2000.

Per Capita GDP, PPP, 1995 Prices	Government Share of Final Consumption Expenditure (%)
Less than $1,000	15.6
$1,000-4,999	16.1
$5,000-9,999	20.7
$10,000 or more	25.4

Source: WDI 2004.

There is wide variation among countries within levels of income, however. Among high income countries, for example, government consumption exceeds 30 percent for several European countries. (Note that government consumption excludes financial transfers such as pension payments, welfare payments, or payments for unemployment or disability insurance).

Some parts of public consumption consist of public goods, e.g., national defense. The benefits may vary by age but as a practical matter it is difficult to say how. Many government programs provide goods or services directly to individuals. Often the level of services received varies with age. The most important examples are education and health care.

In high income countries, public spending on health care is equal to 7 percent of final consumption expenditure – more than one-quarter of total public consumption. A large part of the growth in health care spending that accompanies development is in the public rather than the private sector. For countries with per capita income greater than $1000, there does not appear to be any relationship between income and private health expenditure as a share of final consumption expenditure (public and private combined).

Health Expenditure as a Percent of Combined Public and Private Final Consumption Expenditure, 2000, 152 Countries.

Per Capita GDP, PPP, 1995 Prices	Private	Public	Total
Less than $1,000	2.5	2.2	4.7
$1,000-4,999	2.9	2.9	5.8
$5,000-9,999	3.0	4.6	7.6
$10,000 or more	2.9	7.1	10.0

Source: WDI 2004.

Public spending on education was 5.3 percent of combined final consumption expenditure in 1998 based on data for 111 countries (WDI 2004). We see a substantial increase in the share of final combined consumption expenditure devoted to public education as incomes rise.

Private spending on education was 1.2 percent of final combined consumption expenditure in 1998 based on data for 26 countries that were mostly drawn from higher income countries (World Bank, http://genderstats.worldbank.org/edstats/ThematicDataOnEducation/PrivateEducationExpenditure/tab11.xls.) Information about private expenditure is very limited. Given the small and unrepresentative nature of the sample of private educational expenditure, any characterization would be injudicious. In the high income countries in our sample private education expenditure is a small share of final combined consumption expenditure – less than 1 percent. For the 6 countries in the $3-8 thousand dollar range of per capita income, private expenditure is highly variable – ranging from below 1 percent in Mexico and Turkey to as high as 5.3 percent in Thailand. No data are available from the World Bank on countries with per capita income below $3,000. [3]

Education Expenditure as a Percent of Final Combined Public and Private Consumption Expenditure, 2000.

Per Capita GDP, PPP, 1995 Prices	Private	Public
Less than $1,000	--	3.0
$1,000-4,999	2.7	4.5
$5,000-9,999		5.9
$10,000 or more	0.8	7.0

Source: WDI 2004.
Note: Private based on data for 27 countries; public on data for 111 countries.

Public spending on health and education rises to 17% of final consumption expenditure in the high income countries. A complete picture of the age pattern of consumption cannot neglect these or other public components of consumption.

[3] How education expenditure is defined in World Development Indicators is unclear. The figures for Japan imply that private spending is about 1.6% of final consumption expenditure. The NSFIE reports household spending on education at 5.4% of total household spending in 1994 and 3.9% in 1999.

Components of Consumption

To this point we have emphasized methods and results for estimates of total consumption by age. There are key components of consumption, however, that we know vary by age and for which relatively reliable estimates can be obtained. The following sections consider two important components: education and health.

Education and Age

Education is probably more closely associated with age than any other consumption category of comparable size. Education is not exclusively consumed by children and young adults, but spending on continuing education programs is relatively modest.

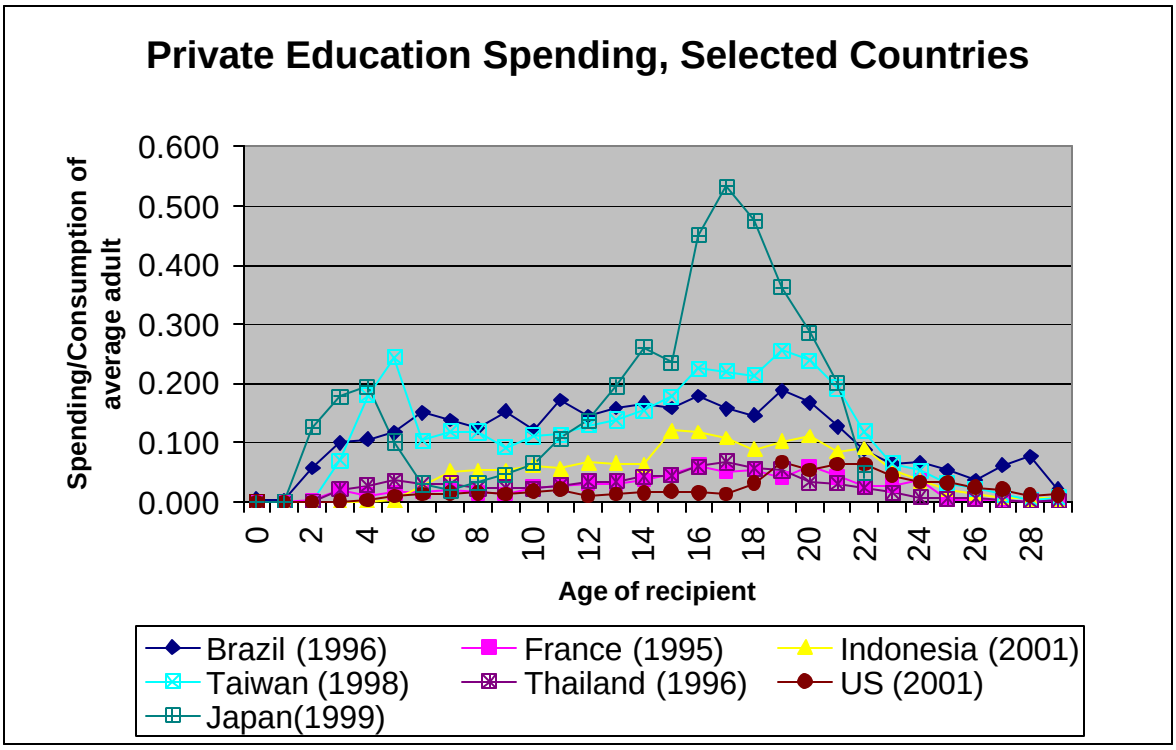
For many countries there is ample information that can be used to construct reasonably accurate estimates of public spending by age. School enrollment rates by age and level of education are widely available or can be constructed from survey data. Public spending by education is also available from administrative records. These are combined to yield estimates of spending by age.

Methods used to estimate total private consumption by age cannot be adapted to estimating private education consumption by age. As noted above, Engel's method has serious methodological flaws that limit its use. The Rothbarth method cannot be reliably used to estimate expenditures on children who are nearing adulthood. A direct approach, however, appears to be reliable. Many household expenditure surveys include household rosters that report the enrollment status of all household members. Regressing total household spending on education on the number of enrolled household members at each age yields plausible estimates of household school spending by age per enrollee, which can be used to estimate unconditional education spending by age. In some instances education expenditures are reported for individuals rather than for households. Analysis in these instances suggests that the regression method is reasonably accurate.[4]

Private spending on education by age estimated from recent expenditure surveys conducted in seven countries is reported in Figure X.[5] To facilitate comparison the estimates are normalized on estimates of average consumption by adults 30-59 during the same year. The enormous variation in the level of private education expenditure across countries is notable with private spending especially high in Japan and Taiwan. Despite the perception by many that higher education costs are onerous in the United States, it is noteworthy that costs relative to consumption by prime age adults are quite low in comparison to many other countries. The age pattern in all cases exhibits a heavy concentration at the college ages except in Brazil.

[4] Analysis of the United States by Pablo Comelatto. Similar analysis could be conducted for Brazil, but this has not yet been done.

[5] Estimates prepared by participants in the 2004 Workshop on Economic Aspects of Population Aging, 35th Summer Seminar on Population Aging, Honolulu, Hawaii co-sponsored by the East-West Center and the Center for the Economics and Demography of Aging based at University of California at Berkeley.



Health and Age

Most information on the relationship between health and age is based on the experience of the industrialized nations. Kinsella and Velkoff (2001) compare population and health expenditure shares for nine industrialized countries and show that expenditures for those 65 and older and especially those 75 and older in 1993 is disproportionate to their numbers. The pattern is very consistent across these nine countries even though they spend substantially different shares of their total consumption on health (Table Z).

Further analysis of the US shows that health expenditures are closely related to years until death rather than age, with a high proportion of expenditures concentrated in the last years of life (Miller 2001). If all health expenditures were devoted to the last year of life, the age distributions of health expenditures and death would be identical. Comparing these distributions in Table Z, we see that deaths are more heavily concentrated in the later years of life than are health expenditure. A simple linear regression of the share of health expenditure on share of deaths for those 65 and older yields a regression coefficient of 0.45 for the nine industrialized countries in Table Z.

Distributions of Health Expenditure, Population, and Deaths by Age, Selected Countries, 1990s.

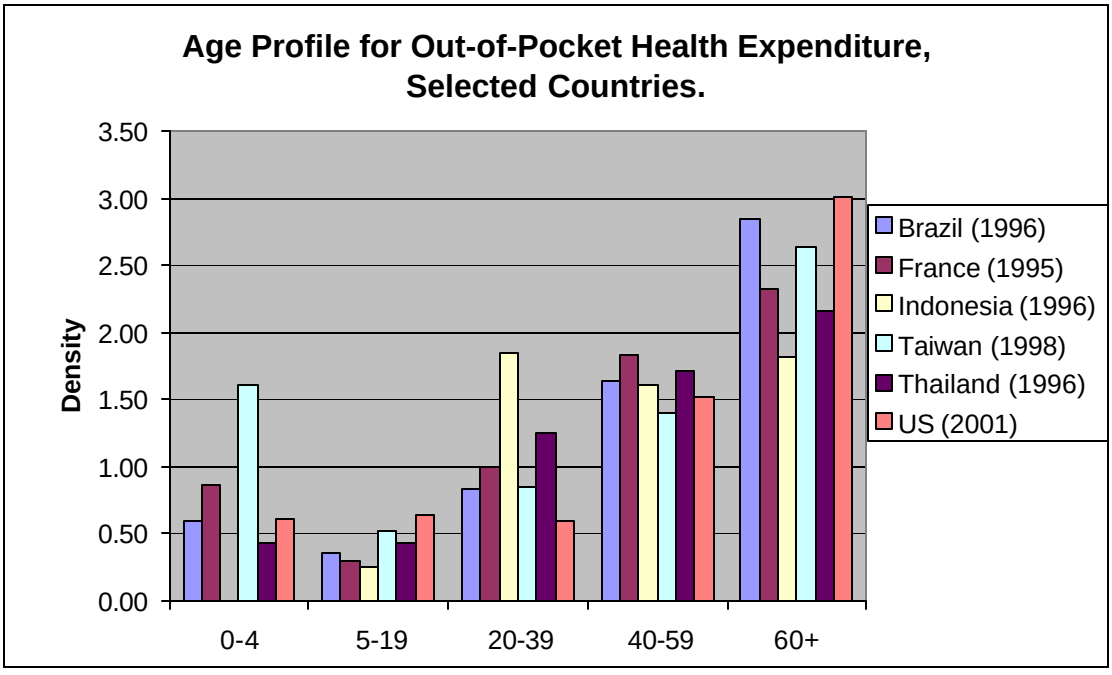
	Share of Health for All Ages Groups in Final Consumption	Share of Health Expenditure by Age (1993)			Share of Deaths by Age (1995-2000)			Share of Population by Age (1993)		
Country	Expenditure (1997)	<65	65+	75+	<65	65+	75+	<65	65+	75+
Australia	11	66	34	20	22	78	57	88	12	4
Finland	10	62	38	22	22	78	57	86	14	6
Germany	14	68	32	16	21	79	58	85	15	6
New Zealand	10	67	33	21	24	76	55	89	11	5

Philippines	4		81	19	-	61	39	22	95	6	-
Portugal	11		64	36	19	23	77	56	86	14	5
Sweden	11		62	38	21	14	86	69	82	18	8
Switzerland	14		60	40	26	20	80	62	86	14	6
United Kingdom	8		58	42	27	17	83	62	84	16	7
United States	16		63	37	21	26	74	54	87	13	5

Sources: Kinsella and Velkoff 2001; UN Population Division 2003; Mason, Russo, and Racelis 2004.
Note: Shares for the Philippines are for 60+. Health data are for 1994.

What is the pattern for lower income countries that are earlier in their health transitions? Estimates for the Philippines are available from a recent study. In 1994, 18.7% of all health expenditures were for those 60 and older although they constituted only 5.5% of the population of the Philippines (Mason, Racelis et al. 2004). Almost 40% of all deaths in the Philippines were to those 60 and older. The pattern for the Philippines is quite similar to the pattern found in the industrialized countries.

Analysis of health expenditure reported in household expenditure surveys in six countries also shows a strong age gradient but there are differences between countries.[6] The heaviest concentrations among those 60 and older are found in Brazil and the United States, followed by Taiwan and France. Health expenditures are considerably less concentrated on the elderly in Indonesia and Thailand than in the US and Brazil. Note that this is a very partial picture because it does not include public sector spending nor spending by employer provided health insurance.



Conclusions

[6] These results were produced by participants in the 2004 Workshop on Economics of Aging. Estimates were obtained using simple regression techniques.

Combining age-profiles of consumption and production gives us an important tool for directly measuring economic dependency and assessing the impact of changing age structure on the macro economy.

Estimating age profiles of labor income or production is a relatively straight-forward task as compared with estimating age profiles of consumption. However, there are important conceptual issues that arise with estimating production profiles. In particular, under the seniority-wage system the gap between labor income and productivity may be substantial.

Research on consumption age-profiles has focused on estimating the cost of children. This is an important enterprise. The research is essential to improving poverty and inequality measures, to designing public programs and tax policies intended to achieve particular redistributive goals, to understanding fertility decline and the emergence of super-low fertility, and to assessing the economic implications of population aging.

Estimating the cost of children is a challenging task. Expenditure surveys as they are currently conducted can be used to directly estimate some of the costs of children, e.g., education. More specialized surveys offer the possibility of directly collecting information about the cost of children and other household members. To a great extent, however, most efforts will continue to infer the allocation of consumption among household members using information about spending patterns, the distribution of income among household members, or other indicators. We know, however, that these indirect methods can be used to estimate the cost of children only if we impose additional restrictive assumptions (reference). The value of the estimates always rest on the plausibility of the restrictive assumption.

Despite these difficulties, research on the cost of children has established a useful empirical base for improved measures of poverty and income inequality. Using equivalence scales – counting children as some fraction of adults – is probably an improvement over using consumption per household or consumption per household member.

There is relatively little research that considers how consumption varies with age among adults. If prime-age adults and the elderly always lived in separate households, there would be little to worry about. But intergenerational co-residence is the norm in many developing countries, common in non-Western industrialized countries, and not unusual in quite a few European countries. This issue will take on increased importance as populations age and the difficulties of estimating the effects of policy reform become increasingly apparent.

The limitations of current research becomes clear when we wonder about the trends and international differences in consumption behavior. Have the costs of children, relative to an adult, increased over time? Declined? Remained about the same? Do developing countries devote a larger or a smaller share of their resources to children? Does a rise in the cost of children account for the decline in childbearing? How have rapid increases in education spending in the US, Japan, Korea, and Taiwan influenced the overall cost of children? Is the increase in the share of health care in national spending leading to a rise in the overall cost of the elderly? We are hard pressed to answer these questions.

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