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Labor Income over the Life-Cycle:

Evidence from Twenty-Three Countries

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The economic life-cycle can be summarized by the amount consumed and the amount produced through labor at each age. The reallocations occur because at some ages individuals consume more than they produce, while at other ages individuals produce more than they consume. The objective of this paper is to compare the age profiles of labor income for twenty-three economies. This is basic to the construction of the economic life-cycle because age profiles of labor income across countries offer the broadest available measure of a key element of the economic life-cycle, i.e., the amount produced through labor over the life-cycle.

It is of first importance to understand that our approach is different from the conventional measure of labor income. The major difference between our measure and the usual concept of labor earnings profile is that we estimate the profile using the entire population. Thus, our measure includes non-workers in the denominator, whereas the usual labor earnings profile is typically estimated only for the employed or even for the full-time employees. The literature on the other hand focuses on the age profiles of the labor force participation rate. These approaches are appropriate when the model seeks to explain some particular behavioral question, what determines the age at which men retire, and how earnings changes over the working life. This conventional approach, however, has limited implication for some important policy issues. For example, for poor countries where substantial portion of the elderly participate in the labor market at low productivity levels or part-time working basis, looking at either the age at retirement or the wage of full-time workers misses an important picture of the economic life-cycle. Delaying retirement may not solve the old-age problem in these countries. There is also a huge variation in the labor force participation rates of children or young people even amongst most developed countries. Again, just looking at the labor force participation of these groups can be misleading because output per worker for these groups is very different across countries.

This study is being carried out as part of a larger study of the economic life-cycle, the National Transfer Accounts (NTA). The NTA is a new system of accounts that is consistent with National Income and Product Accounts (NIPA) but provides much-needed age data. The purpose of National Transfer Accounts (NTA) is to measure, at the aggregate level, the reallocations across age of economic resources that respond to the economic life-cycle. The concept of economic life-cycle and intergenerational reallocation of resources is nothing new and there have been several attempts to integrate the tools of formal demography into Samuelson's theory on consumption loan economy (Lee 1980, Willis 1982). There have also been attempt to incorporate prospective changes in age profiles into public programs such as public pension program (Auerbach, Gokhale, and Kotlikoff 1992). However, there is no systematic and comprehensive method for describing the extent to which societies reallocate resources across ages. The absence of such a system limits our understanding of how alternative approaches to social policy influence economic performance, equity, and social welfare. The goal of the NTA is to measure the economic life-cycle in much more comprehensive detail. With its age component, the NTA enables us to measure the intergenerational reallocation of economic resources in a comprehensive detail, in a manner consistent with NIPA.

We closely follow the methodology developed for the NTA. The labor income under the NTA framework provides a comprehensive measure of production, and hence the labor income here is defined as all compensation to workers, including labor earnings of employees (earnings), the portion of entrepreneurial income (self-employment income) which is a return to labor,

employer-provided benefits (fringe benefits), and taxes paid to the government by employers on behalf of employees. In this paper, we focus on the estimation and description of the labor income profile, and comparisons of how it differs across countries and over time within a country. Our measures are averaged across sex.

The paper is organized as follows. The theoretical background, explaining the factors affecting the shape of the profile, is discussed in the next section. It is followed by a section on the concept of the labor income profile and methodology for constructing estimates. Then we go on to present the actual estimates of the labor income profiles for twenty-three economies and over time. We further discuss the source of differences and changing shapes of the age profiles over time. The final section summarizes the main results and provides a few policy implications of the findings.

1. Theoretical Background of Labor Income over the Life-Cycle

The aggregate age profiles of labor income reflect many factors. One of the obvious and most important is population age structure because per capita age profile is weighted by the number of people in each age. Per capita profile of labor income over the life-cycle in large part reflects individual behavior and the factors that influence behavior. The modern economic theory suggests two major behavioral factors which affect the shape of the labor income profiles defined in our paper. One theory is related to individual behavior of labor provision over the life-cycle, and the other is related to individual behavior of human capital investment over the life-cycle. Although the two decision making behaviors are closely related to each other, especially at young ages, it would be useful to explain these two theories respectively in turn.

Per capita labor income at age *a*, as defined in the introductory section, can be formulated as

$$(\frac{Y}{N})_a = (\frac{L}{N})_a * (\frac{Y}{L})_a \qquad (1)$$

Or simply,

$$y_a = l_a * \overline{y}_a \qquad (2)$$

where Y represents labor income, N population, and L indicates the number of working population. Thus, $(Y/N)_a$ (y_a) is per capita labor income at age a, $(L/N)_a$ (l_a) the age specific activity rate, and $(Y/L)_a$ ($\overline{y}_a$) is the average productivity of the working population at each age. Because working hours are different by age, either the working population or average productivity should be weighted by average working hours of the workforce. It is clear from the equation how our definition of labor income differs from the usual concept of labor earnings—equivalent to $\overline{y}_a$, often conditioned on working full time, whereas ours (y_a) is weighted by the proportion of working population at each age. Because the decision of labor force participation varies over the life-cycle and also by gender, our measure of labor income will be influenced by the decision making made by different demographic groups. These are explained in turn.

Several factors affect the proportion of working population at each age (l_a). A typical economic theory characterizes it as an individual's behavioral choice between leisure and working. An individual at each age chooses to work for a certain number of hours at which the gain from marginal utility, through his earnings, is equal to his loss of the marginal utility from the reduced leisure time. Decisions made by three demographic groups are perhaps the most important ones affecting the shape of labor income profiles.

First, older men are withdrawing from the labor force at a younger age. Researchers have explained this long run decline in the age of retirement in several ways, and the prominent explanation has been that an increase in income and pay-as-you-go retirement-pension benefits encourages workers to retire earlier (Gruber and Wise 1999; Anderson, Gustman, and Steinmeier 1999; Börsch-Supan 2000; Clark, York, and Anker 1999). Second, many teenagers and young adults are extending their time in school and delaying their entry into the labor force. According to the theory of quality-quantity trade-off, formulated by Becker and Lewis (1973) and Becker and other, children from a small family get more resources and care from parents for their human capital investment, which in turn leads to higher earnings in the future. In developing countries, the high and increasing returns to education provide a powerful incentive for young adults to opt for school and delay their entry to the workforce. Countries have also been implementing compulsory education policies, which in turn result in a decrease in child labor due to the trade-off between child schooling and child labor (Duryea, Lam, and Levison 2003; Lancaster and Ray 2004). Third, many women are increasing the time spent in the workforce. The opportunity cost of work for women, for example due to child bearing and rearing, has been declining in many countries. Labor market opportunities for women have risen, as education for women has improved, and social and familial barriers for women have been lowered.

Once working, individuals may have to devote time and money through learning-by-doing or formal training, thereby raising their future productivity. This decision affects the average productivity of the working population ($\overline{y}_a$). Human capital theory suggests a concave individual productivity profile (Mincer 1962; Becker 1962). The theory explains that an individual's decision to invest in learning or training depends on the net present value of training. As an individual ages, the marginal benefit of incentive to invest in learning decreases, because the time horizon until retirement decreases. However, the marginal cost of learning increases as an individual's physical and mental condition depreciates. Combined with the decrease in marginal benefit, this makes an individual productivity profile concave. Productivity eventually decreases as the net investment on human capital becomes negative; i.e., gross investment on human capital falls below the depreciation of human capital. Skirbekk (2003) reviews dozens of studies, concluding that the studies point to an inverse U-shaped individual productivity profile, with significant decreases taking place from around 40 years of age. A large body of literature supports the view that mental and physical abilities decline during adulthood. Changes in technological progress have an uneven influence on competencies by age (Autor, Levy, and Munlane 2003). Rapid changes in educational systems might also give older-aged workers a competitive disadvantage over their younger counterparts, especially where there is not much emphasis on training/retraining of workers.

These two behavioral factors—the decision to work and the decision to invest in human capital—are not independent, because productivity of labor conditional on working is closely

related to the decision to work. For example, declining productivity of labor due to poor physical and mental health eventually leads a person to retire (Quinn, Burkhauser, and Myers 1990; Bound 1991; Dwyer and Mitchell 1999). On the other hand, those who are going to retire soon are less likely to invest in their human capital. Because of this interdependence, the productivity of labor conditional on working may not appear to decrease from a certain age, especially around retirement age, if only those who have high productivity remain in the labor market. The degree of selections made by older workers with high productivity might depend on several factors, such as the level of pension benefits they would have received, the labor market conditions, and the types of tasks they perform.

Before we present the estimation results, it should be noted that the real world is much more complex than theory. For example, most older workers retire completely from full-time work with no intervening spell of part-time work. This is incompatible with a model of labor supply or labor force participation in which individuals can freely choose working hours as tastes for work gradually shift with age toward leisure. Indeed, a survey of institutional arrangements leads to the conclusion that most workers face rather limited choices consisting of a high-paying year-round job and low-paying part-time work (Hurd 1993). Therefore, someone approaching retirement who wants to retire gradually from a career type job will have to change jobs to compete for low-paying, easy entry jobs.

Institutions may also constrain wages to rise with age through seniority systems, regardless of productivity. The productivity of labor will depend on macroeconomic conditions that are outside the control and foresight of an individual. Public pension programs may be unexpectedly instituted or terminated, altering the life-cycle budget constraint and perhaps introducing strong incentives, either to retire from the labor force or to return to work. Changes in tax policies may alter the tradeoff between work and leisure. Unemployment may thwart individual plans, and age discrimination or mandatory retirement may prevent older people from finding work.

It is difficult to identify all these factors and examine theories using real-world data sets. Even the basic needed information such as working hours by age is not readily available. However, some of the important factors can vary over time and between countries, leading to important differences and changes in the way per capita labor income varies with age.

2. Methods for Estimating Labor Income by Age

We estimate the individual labor income profile using *cross-section* data. While it would be desirable to depict a longitudinal concept of life-cycle labor income, data limitations often do not allow researchers to employ those measures. Thus, like the usual labor earnings profiles, our measure is a cross-sectional measure of labor income.[1]

[1] Nonetheless, a few data sets allow us to measure the labor income profiles by birth cohort. We briefly examine the cohort trend of labor income profile in Section 3.

As we briefly mentioned above, the NTA is designed to be consistent, when weighted by population and summed, with NIPA totals. The portion of self-employment income which is a return to labor is not reported separately in NIPA. While the NIPA contains information on the mixed income of unincorporated households, it includes returns both to capital and workers who are both paid and unpaid. Gollin (2002) considers three methods for estimating the portion of mixed income that is a return to labor: (1) attributing all mixed income to labor, (2) attributing a share to labor equal to the share of labor income for the rest of the economy, and (3) imputing the labor income of employees to the self-employed. He finds that the first of these methods clearly overstates the labor income of the self-employed. The other methods yield an average labor share that varies from 0.654 to 0.686, depending on the method and sample used. The labor shares in high and low income countries are very similar. Thus, the simple method of allocating two-thirds of mixed income to labor is consistent with the best available evidence on this issue. We carried out a sensitivity analysis using different sharing rules, such as 0.85 instead of two-thirds. This did not affect the labor income profile substantially, suggesting that errors in the estimates of total labor income due to the two-thirds rule are not important.

There is an important issue for estimating the age profile of self-employment income, especially in the context of labor markets in lower income countries (Rosenzweig 1988). Labor markets in developing countries are often characterized by large proportions of labor in the agricultural sector or in family enterprises. Estimating labor income in these economies often entails important errors along with other difficulties, especially when estimating the value of unpaid family workers' productivity. For most countries in our study, household surveys report mixed or self employment income for the household, while we require estimates for individuals. But these surveys do report which individuals in the household engaged in unpaid family labor. We combine these two sources of information to estimate self-employment labor income for individuals in each household. We assume that within a household, the value of labor for unpaid family workers by age is proportional to the labor income by age of employed workers in the total sample. For each household we then calculate the constant proportion that implies a total of self-employment labor income for the household matching two-thirds of reported self-employment income. This provides an estimate of self employment labor income by age for each individual in each household in the survey. This age profile is then adjusted proportionately, so that in combination with the age distribution of the total population, it implies a number equal to two-thirds of the NIPA total for self-employment income.

For purposes of comparison, we normalize each curve by dividing it by the unweighted average labor income for ages 30-49. This age range was chosen to exclude younger ages that might be affected by educational enrollments, and older ages that might be affected by retirement. We have also smoothed the raw age profiles for graphical presentation.[2] More detailed information on other issues and methodology is available from Mason, Lee et al (forthcoming), Lee, Lee, and Mason (2008), or on the project website: www.ntaccounts.org.

[2] Smoothing was performed on the log of population-weighted age-specific averages using SUPSMU in the R statistical package. Smoothing spans were determined on an ad hoc basis. Any ages with a profile value of zero, because of a survey assumption, were left out of the calculation and added to the series after smoothing. For example when a survey covers only ages 14 and above, all values below 14 are set identically to zero.

3. Estimation Results

The shape of the age profiles of labor income for the twenty-three economies considered here are strikingly similar, at a broad level, and familiar. An inverse U-shape predominates (Figure 1).

<Figure 1. Per Capita Labor Income Profile, 23 Countries>

However, there are important differences in the age earnings profile across countries. To visualize the differences, we average the labor income profile of 23 economies by age and compare the average labor income with that of each country. We categorize them into 5 groups based on their shapes. Figure 2 presents the grouping results.

<Figure 2A-2E. Per Capita Labor Income Profile, 5 Groupings>

The two most distinctive features across groups are the shape of the ages at which earnings peak and decline substantially, and the importance of earnings in old age. These features are somewhat related to the level of development. While the profiles of Thailand and Uruguay are the closest to the average shape (Figure 2-A), other developing countries, such as Brazil, Chile, China, Costa Rica, India, Indonesia, Mexico, and the Philippines have labor income profiles with more elderly shares of labor income (Figure 2-B). Also, the children's share of labor income, especially for ages 15-19, tends to be higher for these countries than the average profile. The notable exception is Kenya. Although Kenya might belong to this group economically, their labor profiles show quite different picture. This will be discussed further later.

In stark contrast to the labor income profiles for lower-income countries, those for European countries, namely Austria, Finland, France, Germany, Hungary, Spain, and Sweden show a rapid decrease in old age (Figure 2-C). However, it appears that the substantial drop in labor income occurs at earlier ages in Austria, France, and Finland than in Japan and Sweden. Thus, the share of labor income for the elderly who are age 65 and above appears to be higher for Japan and Sweden than for Austria, France, and Finland. Japan, in particular, shows a much higher share for the late 40s and 50s compared with other countries. The children's share of labor income in these advanced economies also tends to be lower than it is in the developing countries. with the notable exception of Austria. Austria is an interesting case in which the share of labor income for young people ages 15-25 appears to be highest among the 23 countries.

In the cases of Slovenia, South Korea, and Taiwan, the share of labor income for young children is low, but the labor income increases rapidly by age when young (Figure 2-D). Thus the labor income shows a pattern that peaks at a relatively young age and decreases substantially around late 40s, although the labor income in South Korea is larger than in Taiwan and Slovenia. These economies differ from the other developing economies depicted in Figure 2-B, in terms of the share of labor income for very young children. They are also distinguished from the advanced countries depicted in Figure 2-C, in terms of the age at which the labor income peaks.

The US is an interesting case (Figure 2-E), because it is not similar to any of the countries or does not belong to groups we describe above. It shows a low share of labor income for young people, which distinguishes it from Slovenia, South Korea, or Taiwan. It is also different from most European countries and Japan, because the profile is not as steep in old age.

To quantify and compare the various profiles, we calculate several measures using Figure 2. The measures include the average age of labor income, the age at which the labor income peaks, quartile percentiles, and the share of lifetime earnings for children and older people. The results are provided in Table 1. These cross-sectional per capita calculations are conditioned on survival; that is, the cross-section is treated as a synthetic cohort assumed to survive until age 90. They are calculated using survival weights of the US 1984-89.

Table 1. Summary Statistics of Per Capita Labor Income Profile

	Mean	Peak	Median	25th pctile	75th pctile	Share 0-19	Share 0-24	Share 65+
Austria (2000)	39.6	45	38	29	47	3.2	12.4	0.4
Brazil (1996)	43.8	39	42	32	52	2.7	7.7	6.3
Chile (1997)	43.2	45	41	32	51	1.6	7.1	5.3
China (2002)	42.3	42	40	31	49	2.3	8.4	4.9
Costa Rica (2004)	43.6	42	42	32	51	1.5	7.3	5.9
Finland (2004)	42.5	43	41	32	50	0.9	6.0	0.9
France (2001)	42.3	49	41	32	49	0.8	5.6	0.8
Germany (2003)	42.5	45	41	32	50	1.1	6.3	0.8
Hungary (2005)	42.4	41	41	32	50	0.5	4.8	1.0
India (2004)	44.5	47	43	33	52	1.9	6.4	5.7
Indonesia (2005)	42.2	45	41	31	49	2.9	9.3	4.3
Japan (2004)	44.8	47	44	34	52	0.4	4.7	3.5
Kenya (1994)	41.9	39	39	32	48	0.8	5.4	4.4
Mexico (2004)	43.6	42	41	32	52	3.2	9.2	7.4
Philippines (1999)	44.6	41	42	33	53	1.7	7.1	7.7
Slovenia (2004)	40.5	34	39	31	47	0.8	5.5	0.8
S.Korea (2000)	41.8	36	39	31	49	1.5	8.3	3.7
Spain (2000)	42.4	42	41	32	49	0.9	5.9	1.5
Sweden (2003)	43.5	44	42	33	52	0.8	6.6	1.4
Taiwan (2003)	42.1	41	40	32	49	0.6	5.4	2.9
Thailand (2004)	42.2	40	40	31	50	1.9	8.1	3.3
Uruguay (1994)	42.0	38	40	31	50	1.8	8.2	2.9
US (2003)	45.0	47	43	34	53	0.7	5.1	5.4
Average	42.8	42.3	40.9	31.9	50.2	1.5	7.0	3.5

The average age of labor income varies from 39.6 to 45.0—a difference of 5.4 years. The average age of labor income is highest for US (45.0), followed by Japan (44.8), Philippines (44.6), and India (44.5). It ranges from 42 to 44 for most countries. Only for four countries—Austria, Slovenia, South Korea, and Kenya—it is below 42.

The age at which earnings peak is the highest for France (49), followed by US, Japan, and India at age 47. Interestingly, all economically advanced study countries, namely Finland,

France, Germany, Japan, Spain, Sweden, and US, peak ages equal to or greater than 42. Slovenia, South Korea, Uruguay, Kenya, and Brazil peak at ages below 40.[3] Other countries are intermediate. Surprisingly, the share of lifetime labor income of the elderly age 65 and above is modest in most countries. Even in the Philippines, where income is relatively low and agricultural employment dominates, the contribution to lifetime earnings of work after age 65 is still modest—although highest among the study countries at 7.7 percent of the total. This is not a direct consequence of mortality, because these results are conditional on survival. The elderly share of labor income for all European countries is very little—below 1.5 percent. Only for Japan and the US, the elderly share of labor income is above 3 percent, amongst economically most advanced economies

The children's share of lifetime earnings is also very modest. Even for Mexico, where it is highest, the share of labor income for children under 20 is only 3.2 percent. No developed countries except for Austria have more than 1.5 percent. France, Finland, Germany, Hungary, and Slovenia have not only the lowest elderly share of labor income, but also the lowest children's share of labor income among our study countries. The variation across countries is also relatively small. The share of children ages below 25 falls between 4.7 and 12.4 percent for all countries. Obviously, the largest share of lifetime earnings is concentrated in the age range of 25 to 64 in all economies.

Sources of income are a standard and useful descriptive measure in reports on the economics of aging. The NTA system yields a more complete measure of the sources of support for the dependent populations that includes familial, intra-household transfers and dis-saving. In this paper, we only compare the labor income as a source of financing consumption for 23 countries. Table 2 presents the result.

[3] The result for age of peak labor income should be interpreted with care for some countries. For example, the labor income profile of South Korea peaks at age 36, but it remains quite flat until age 44. The difference between age 36 and 44 is trivial. Also, the survival weighted profile provides a strikingly different result for some countries. For India, for example, earnings peak at 57, instead of 47, if we do not use the survival weighted profile.

Table 2. Labor Income as a Source of Financing Consumption

	0-19	65+
Austria (2000)	12.2%	1.8%
Brazil (1996)	8.5%	20.6%
Chile (1997)	4.9%	21.3%
China (2004)	12.5%	35.5%
Costa Rica (2004)	6.5%	24.2%
Finland (2004)	3.2%	4.1%
France (2001)	3.0%	3.9%
Germany (2003)	3.9%	3.2%
Hungary (2005)	1.7%	10.9%
India (2004)	8.5%	32.5%
Indonesia (2005)	10.6%	22.9%
Japan (2004)	1.6%	11.7%
Kenya (1994)	4.2%	34.2%
Mexico (2004)	9.3%	28.1%
Philippines (1999)	6.2%	38.9%
Slovenia (2004)	2.9%	3.5%
S.Korea (2000)	6.2%	23.8%
Spain (2000)	3.6%	5.8%
Sweden (2003)	3.0%	4.7%
Taiwan (1998)	2.3%	14.7%
Thailand (2004)	7.2%	17.4%
Uruguay (1994)	6.1%	10.0%
US (2003)	2.5%	15.4%

The percentage of income by which the consumption of dependent children, defined as those under the age of 20, is financed is relatively modest. With the exception of three countries, i.e., Austria, China, and India, labor income accounts for no more than 10 percent as a source of financing consumption. Because asset-based reallocation is not an important part of financing consumption for children, this implies that the majority of consumption is financed by transfers. Labor income as a source of financing consumption by the elderly is quite different across countries, ranging from 1.8 percent for Austria to 38.9 percent for the Philippines. Work plays little role for the elderly in all European and economically advanced countries, contributing less than 10 percent of consumption, while it accounts for substantial portion as a source of financing consumption for the elderly in Asian and Latin American countries.

All the results presented so far are snapshots for a single year and they are not longitudinal data. In the absence of more extensive data for many years, we cannot track cohorts over time. The inability to do so limits the extent to which we can explain the cross-sectional patterns that we observe. In particular, we can only speculate about the extent to which the results reflect distinctive features of the years for which the accounts were constructed—for example, substantial cohort effects, or the effects of age. To fill this gap, we use Taiwan's time series data, which is an interesting extension of our analysis. Figure 3 plots the age profile of per capita labor income for Taiwan over time. It is clear from the figure that the share of labor income for young people and the elderly decreased substantially over time. Figure 4 presents

results by birth cohorts. It is also clear from the figure that there have been substantial changes at older ages; among early cohorts earnings declined fairly gradually at older ages. For later born cohorts the decline appears to be faster and to begin at a younger age.[4]

<Figure 3. Per Capita Labor Income over Time: Taiwan 1977-2003>
<Figure 4. Per Capita Labor Income: 5 Year Birth-Cohorts, Taiwan 1889-1974>

4. Sources of the Differences and Change

What are the sources of the differences across countries and changes over time? A range of explanations is possible and the patterns are intriguing. To some extent the share of labor income for the elderly is broadly consistent with studies of the effects of pension and tax systems on labor incentives (e.g. Gruber and Wise 1999, 2001). In Japan, the labor income increases moderately for young people and peaks at late ages, which is consistent with the notion of the seniority based wage system. The children's share of labor income also appears to be inversely related to the level of development, which is consistent with the ample evidence on quantity-quality trade-off literature.

On the other hand, the comprehensive measure of labor production defined here—for example inclusion of labor income for the self-employed—might provide a different perspective, compared with more narrowly prescribed analyses that emphasize the earnings profile of employees. To examine this, we present the labor income profiles for earnings and self-employment income, respectively, in Figure 5. The percentages in the figure are the unweighted share of self-employed income over the individual life-cycle.

<Figure 5. Earnings vs. Self-Employment Income>

There is a large variation across countries in terms of the share of the self-employment income. It should come as no surprise that the share of self-employment income is very large for poor and developing economies. The share of self-employment income is highest for Kenya (52.9%), and the Philippines (52.0%). It is also about 43 percent for India and Thailand and over 30 percent for China, Indonesia, and Mexico. By contrast, it is relatively low in advanced economies. Sweden (3.6%) and Finland (4.6%) have the lowest share of self-employment income over the life-cycle. The US, Japan, Germany, and Taiwan form the next group. South Korea, Chile, Uruguay are intermediate.

[4] The longitudinal data provides other interesting features. For example, while per capita labor income for children ages 15-20 declined over the entire period 1977-2003, labor income for young adults ages 21-24 started to decline around 1990. This might reflect Taiwan's development and education policy in the 1980s and 90s. During the 1980s Taiwan government substantially increased vocational high schools and 2-year colleges with increased demand for technical skills in the workplace. In the 1990s, Taiwan government aimed to reduce the proportion of vocational students and increase the higher, academic education to meet the demand for more intellectual skills associated with the new industries (Ashton et al. 1999. p. 135).

The shape of the labor income profile is closely related to the share of self-employment income, mostly because older people are more likely to work as self-employed or in the agricultural or service sector, whereas a young person is more likely to work in the manufacturing sector as an employee. Because returns to human capital investment are high when young and also for employees compared with the self-employed, wages peak at younger ages than self-employment income does.[5]

Unlike self-employment income, adding fringe benefits does not alter the shape of labor income although the information on fringe benefits to this point is available for only seven economies: Finland, Austria, US, Costa Rica, Slovenia, Uruguay, and the Philippines (Figure 6). The share of fringe benefits in the labor income over an individual life-cycle varies substantially, ranging from 4.6 percent for the Philippines to 22.4 percent for Finland.

<Figure 6. Earnings vs. Fringe Benefits Profile>

Why is the share of lifetime earnings for children so high for Austria while it is not so high for Kenya? Which factor is more important in shaping the labor income profile, activity rates by age or average productivity of workers by age? As reviewed in Section 1, per capita labor income (y_a) can be decomposed into two factors, one the proportion of working population at each age (l_a), and the other, the average productivity of working population ($\overline{y}_a$). To answer these questions, we try to decompose the labor income into those two factors. There are two issues here. First, the proportion of working population at each age and the average productivity of working population are not estimated separately for the NTA. But activity rates by age are available for most study countries from different sources, and hence, it is possible to calculate the average productivity of working population by dividing the per capita labor income by activity rates by age. While it may not provide very accurate decomposition results, it may provide some intuitions. Second, activity rates are also available by five-year age groups for most countries. In order to get the average productivity profile by single year of age, we have smoothed the activity rates profile using the population age structure as a weight. Furthermore, for three countries, namely Kenya, China, and India, the year of two survey data sets, one for activity rates, and the other for the per capita labor income does not match. Thus, we select the year of survey for activity rates in a manner that it is closest to the year of the NTA data.[6] Again, we average the profiles of l_a and $\overline{y}_a$ for 23 countries to compare with each country profile. Figure 7 provides the decomposition results.

<Figure 7. Decomposition of Labor Income: Average Productivity vs. Activity Rates>

Both the age profile of labor force participation and average productivity of the working population show inverse-U shapes. Both profiles peak around the mid-40s, quite flat until late

[5] Very young workers and women are also more likely to work as unpaid family workers in low income countries. Our imputation for the value of unpaid family labor brings a substantial change in the labor income profile for some countries, such as Thailand, the Philippines, and Indonesia. However, the imputation method barely changes the profile for countries with a moderate share of self-employment income, such as Japan and Taiwan.

[6] The activity rates by 5-year age groups and by gender, the year of survey, and the original source of information for these activity rates are available upon request.

50s, and then declines. While the age profiles of labor force participation show a uniform picture, an inverse-U shape, the age profiles of average productivity working population varies a lot across countries. For Chile, France, Hungary, Spain, and Taiwan, the average productivity increases after age 65, while in other countries it is either flat or decreasing. For some countries, the age profiles of activity rates are similar to the age profiles of average productivity. The results for a few countries are particularly interesting. For example, the labor force participation rate for teenagers, ages 15-19, in Austria is 41 percent, which is not only higher than any other European countries, but it is also higher than that of Indonesia, Mexico, or the Philippines. This might be due to the wide-spread apprenticeship in Austria. However, as is appeared in Figure 8, labor force participation rates for this age group is just as high as the average activity rates of 23 countries. This suggests that high per capita income for teenagers in Austria is not due to higher activity rates due to apprenticeship, but it is largely due to their high productivity (or working hours).

Kenya is an opposite case. According to Kenya's National Census in 1999, the labor force participation is 34 percent for children ages 5-14 and 72 percent for elderly ages 65-69—both of which are the highest in the study countries. However, labor income for children and the elderly are not as high as the average productivity, suggesting that the low per capita income for children and elderly is not due to low activity rates, but due entirely to their extremely low productivity. This also implies that there is no selection effect of older workers remaining in the Kenyan labor market. On the contrary, the average productivity for older workers in India appears to be quite high. It is far from clear what causes this, but it might not be due to the seniority based wage system. Instead, this could be related with the strong selection or rigid wage system in India.

South Korea and Taiwan are other interesting cases. South Korea is similar to the Philippines in terms its higher labor force participation of elderly ages 65 and older; but their productivity is lower than average. However, the effect of low productivity dominates the effect of high labor force participation in shaping the labor income profile. Taiwan is the opposite. Taiwan's labor force participation for the elderly is below average, but their productivity is quite high, and the effect of labor force participation dominates. Thus, although the labor income profiles of South Korea and Taiwan are similar to each other, the reasons are quite opposite. It appears that Korean elderly may have to work more, at low average earnings per worker.

This decomposition analysis can be applied over time within a country. Figure 8 shows the result for Taiwan over time. For Taiwan, the per capita labor income increased at annual real rates of about 4% per year. The slowest growth was at the youngest ages – among teenagers in Taiwan. The most rapid growth was at older ages – those 65 and older. Note that for the elderly, labor income is relatively low and a large percentage increase does not translate into a large absolute increase. In Taiwan, the labor income of adults near conventional retirement age grew much more slowly than the labor income of younger adults. The decomposition result shows that the slowest growth of labor income among teenagers in Taiwan is mostly due to a decrease in the proportion of the working population in those age groups. By contrast, the rapid growth of labor income among older people, those in their mid-seventies and older, in Taiwan is entirely due to a rapid increase in the average productivity of labor for those ages, dominating the negative effect of the activity rate on per capita labor income. This might imply that the selection effect among

older workers in Taiwan is quite strong in the labor market. Thereby only those who have high productivity might remain in the labor market regardless of their age.

<Figure 8. Decomposition of Annual Growth of Labor Income by Age: Average Productivity Growth vs. Activity Rates: Taiwan, Real, 1978-2003>

Our NTA profiles are averaged across sex. While the age profiles of labor force participation of males are similar across countries, the decision to participate in the labor market by age varies substantially for females across countries and also over time (Figures 9 & 10). In general, because of high opportunity cost of work, women's labor force participation is low for countries with high fertility rates. Thus, as fertility declines, women's labor force participation has been increasing in most countries. This different labor force participation for females might contribute shaping different age profiles of the labor income over the life-cycle.

<Figure 9. Activity Rate by Age and by Gender: 22 Countries>
<Figure 10. Activity Rate by 5-Year Age Groups: Taiwan, by Gender, 1977-2003>

Are these differences across countries and changes over time related with economic development and other characteristics of countries? There is ample literature to show that labor income for specific age groups are related with institutions demographic characteristics, and economic development. They include, but not limited to, the trade-off between child labor and schooling, the trade-off between social security and age at retirement, and the relationship between human resources accumulation and economic development. To assess this, we relate the quantitative measures of labor income profiles with demographic and macro-economic indicators. The year of the macro indicators sometimes do not match with the survey year of labor income profile. Again, we use the year of macro indicators which is closest to the survey year of labor income profiles. Table 3 shows simple correlation coefficients between two measures.

Table 3. Correlation Coefficients between Quantitative Measures of Per Capita Labor Income and Economic/Demographic Indicators

	Mean age	Share self-emp.	Share 0-19	Share 65+	Source 0-19	Source 65+
Mean age	1.000					
Share self-emp.	0.099	1.000				
Share 0-19	-0.218	0.416	1.000			
Share 65+	0.580	0.638	0.423	1.000		
Source 0-19	-0.278	0.466	0.935	0.385	1.000	
Source 65+	0.322	0.829	0.357	0.865	0.458	1.000
	Economic Structure/ Development (23 obs)					
% rural	0.024	0.486	0.198	0.119	0.387	0.364
% agri. value added	0.036	0.851	0.116	0.436	0.267	0.738
Per capita GDP	-0.038	-0.835	-0.470	-0.621	-0.526	-0.789
	Education/Labor Quality (15 obs)					
% secondary labor	-0.259	-0.381	-0.558	-0.606	-0.617	-0.454
% tertiary labor	0.538	-0.291	-0.476	0.069	-0.491	-0.103
Enroll-secondary	0.014	-0.819	-0.403	-0.551	-0.530	-0.780
Enroll-tertiary	-0.115	-0.790	-0.645	-0.659	-0.705	-0.755
	Social Security (18 obs)					
% Social Cont. revenue	-0.059	-0.844	-0.346	-0.624	-0.412	-0.847
% Social Cont. GDP	-0.258	-0.850	-0.406	-0.818	-0.444	-0.928
	Demographic Indicators (23 obs)					
TFR	0.241	0.762	0.157	0.564	0.164	0.654
Old age dep.	-0.113	-0.839	-0.538	-0.808	-0.572	-0.900
Young age dep.	0.213	0.821	0.262	0.671	0.263	0.766

Source: World Development Indicators. 2007. World Bank.

Note: the highlighted numbers are the variable with highest correlation for each summary variables. Selected economic and demographic variables are as follows.

% rural	Rural population (% of total population)
% agri value-added	Agriculture, value added (% of GDP)
Per capita GDP	GDP per capita, PPP (current international $)
% secondary labor	Labor force with secondary education (% of total)
% tertiary labor	Labor force with tertiary education (% of total)
Enroll-secondary	School enrollment, secondary (% gross)
Enroll-tertiary	School enrollment, tertiary (% gross)
% Social Cont. revenue	Social security contributions (% of total government revenue)
% Social Cont. GDP	Social security contributions (% of GDP)
TFR	Total fertility rate
Old (young) age dep.	Old- (young-) age dependency ratio

The table presents a couple of interesting findings. Most of all, except for the mean age of production, other summary statistics of per capita labor income profiles are somewhat strongly correlated with the level of development. Not surprisingly, the share of self-employment is strongly positively related with the value added of the agricultural sector as the percentage of GDP, while the share of labor income for children ages 0-19 is most strongly and negatively related with the gross school enrollment rate at the tertiary level. Perhaps most interestingly, the elderly share (source) of labor income appears to be strongly correlated with the amount of social security contributions—made by employees, employers, self-employed individuals, and other unidentified sources—as a percent of GDP (Figure 11). Also the elderly share of labor income is highly and negatively correlated with old-age dependency ratio.

<Figure 11.Social Security Contribution as a Percent of GDP vs. Labor Income as a Source of Financing Consumption for People 65+>

5. Conclusions and Implications

Estimating economic life-cycle is fundamental to the study of economic resources reallocation because it identifies which age groups within the population are producing the dependents in the society and the extent of that dependency. The estimated cross-sectional age profiles of labor income are broadly similar, and the hump shape is consistent with our expectations. However, there are interesting contrasts in the mean age, in the timing of the earnings peak over the life cycle, in the share of self-employment income among labor income, in the lifetime earnings share of elderly and children, in the importance of labor income as a source of financing consumption, and so on. We have presented a broadest measure of production by age for a wide range of economies here, which provides a basis for constructing economic life-cycle. Here are two important policy implications.

First, the fact that some elderly are earning relatively less, even though their elderly have relatively higher labor force participation, is really an interesting result. This suggests that the conventional way of looking at either labor force participation rates or earnings of workers do not provide a comprehensive picture for the economic life-cycle. For some of our study countries, children also do work more but output per child in these countries is very low. Hence, the young- and old-age support problems do not go away only because people stay in the labor market. The lesson to be learned from this is the importance of policies that maintain the productivity of workers for these groups. The solution to the aging problem in these countries might not be jobs for the elderly at a low wage. Rather it may have to be a more fundamental change, including retraining program for the elderly.

Second, the labor force behavior of young and older people and females will become increasingly important as labor force growth slows and labor shortages emerge. In part, older workers will be more important, simply because a larger share of the population and the workforce will be old. Particularly in less developed countries, the high and increasing returns to education will provide a powerful incentive for young adults to opt for school and delay their entry to the workforce. Increased labor force participation among women will moderate the influence of slower or negative growth of the working age population.

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Figure 1. Per Capita Labor Income Profile: 23 Countries

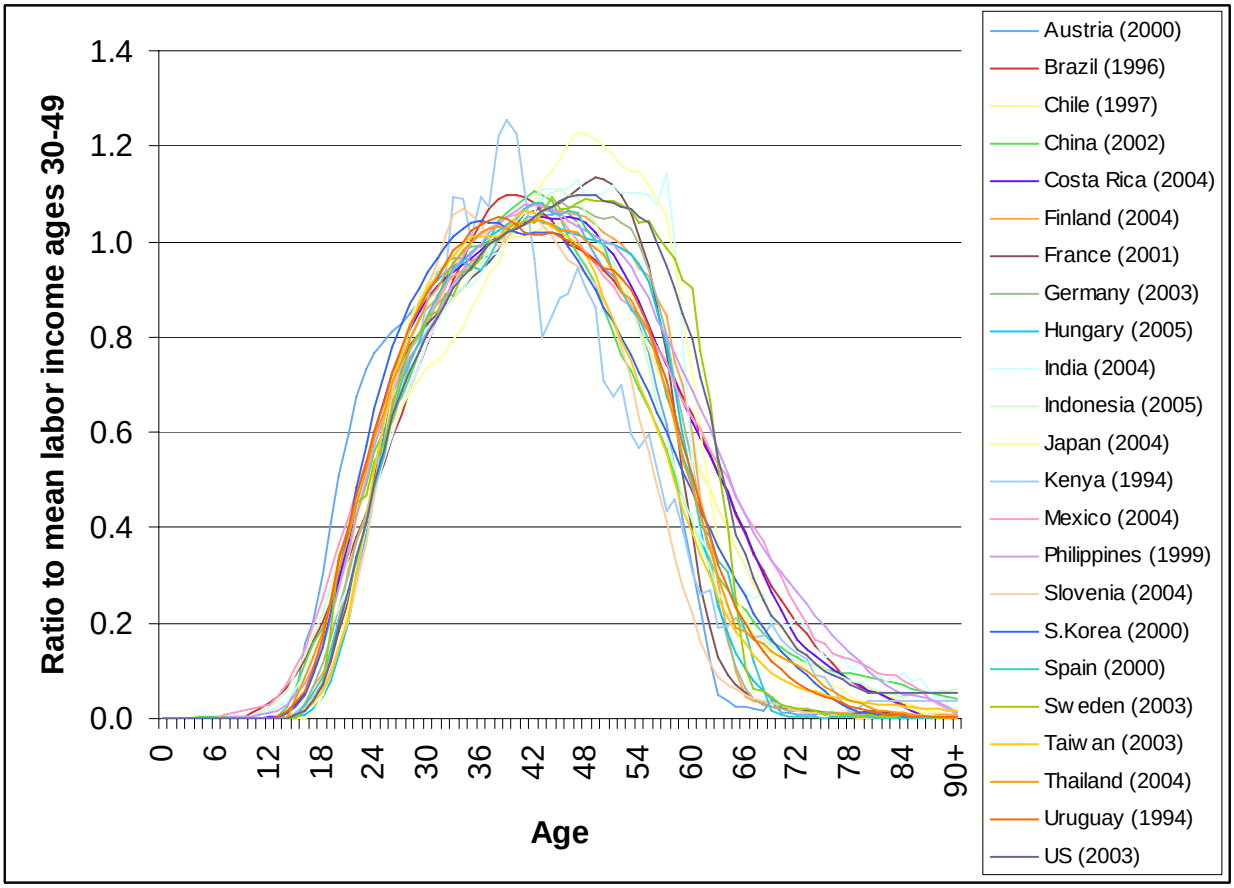
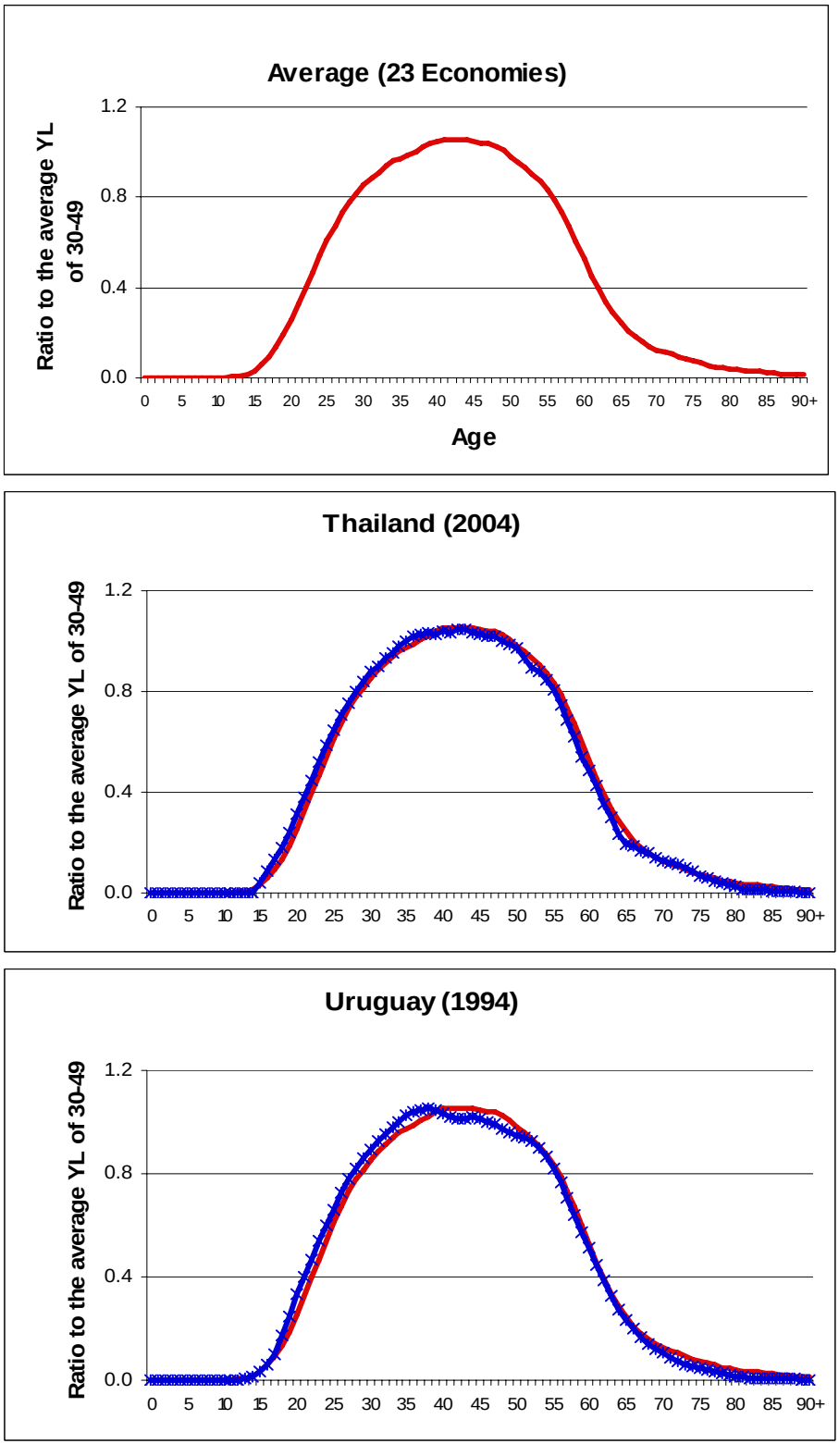
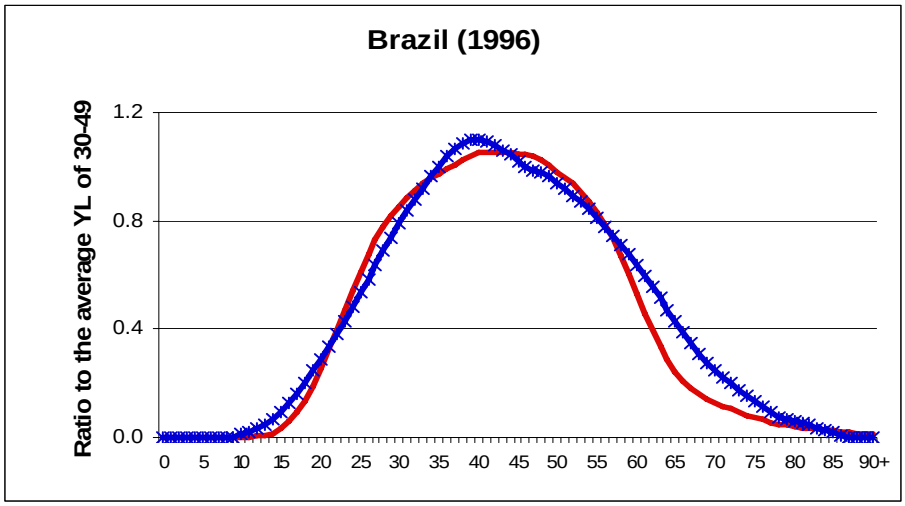


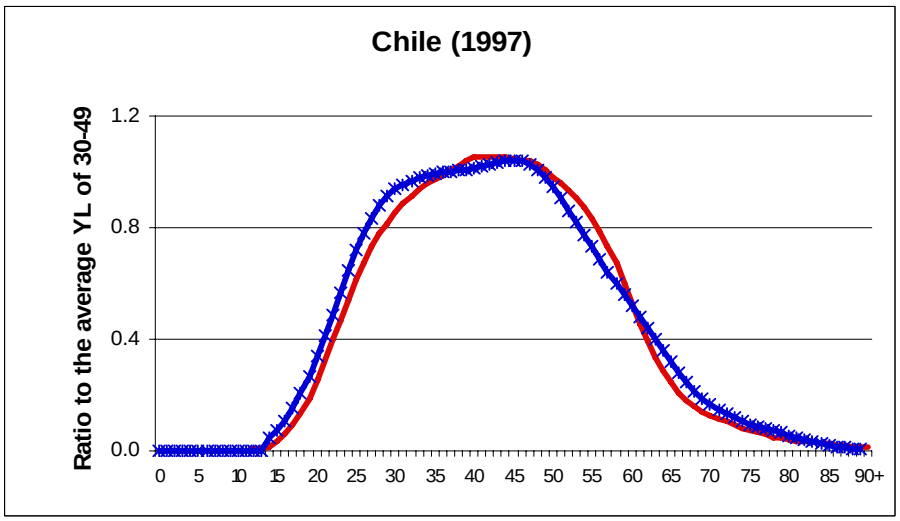
Figure 2. Per Capita Labor Income Profiles: 5 Groupings

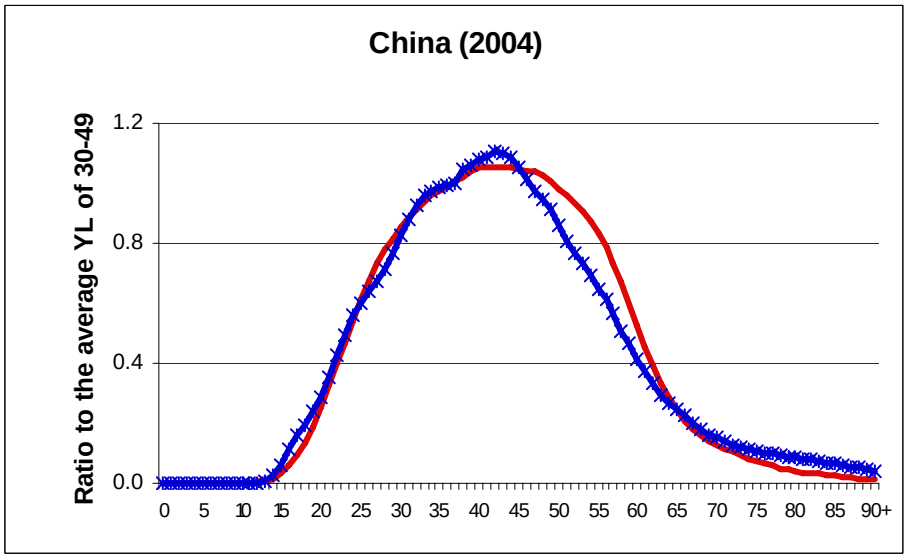
2-A. Closest to Average Profile: Thailand, and Uruguay

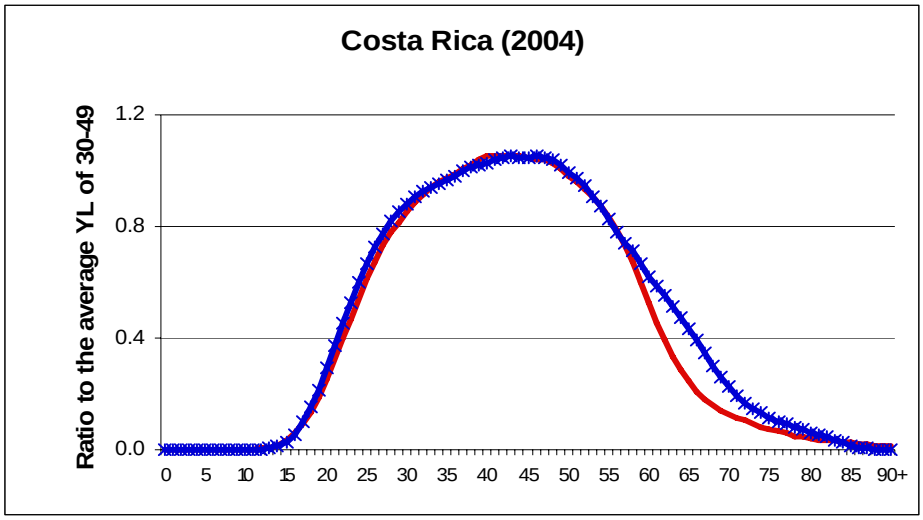


2-B. Large Elderly and Children's Share of Labor Income, Brazil, Chile, China, Costa Rica, India, Indonesia, Mexico, and the Philippines; Plus Kenya








Costa Rica (2004)
Ratio to the average YL of 30-49
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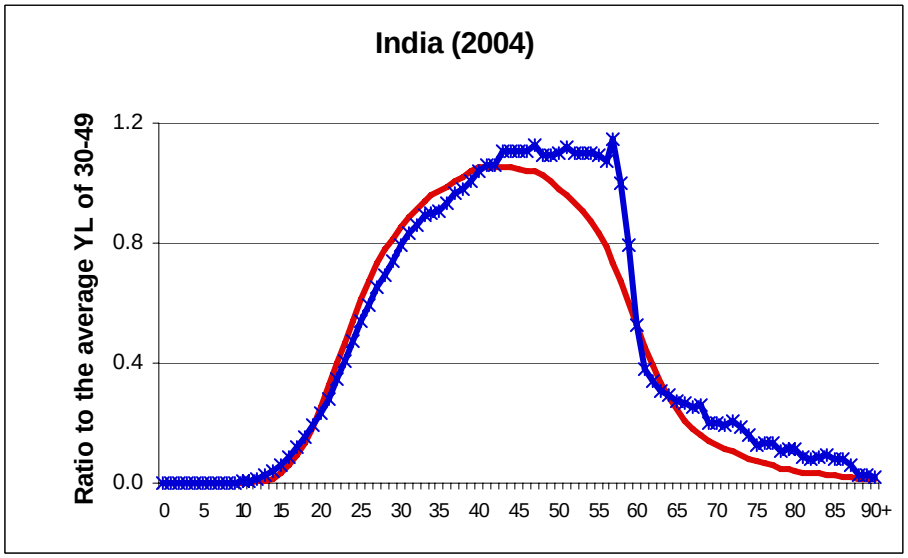
India (2004)
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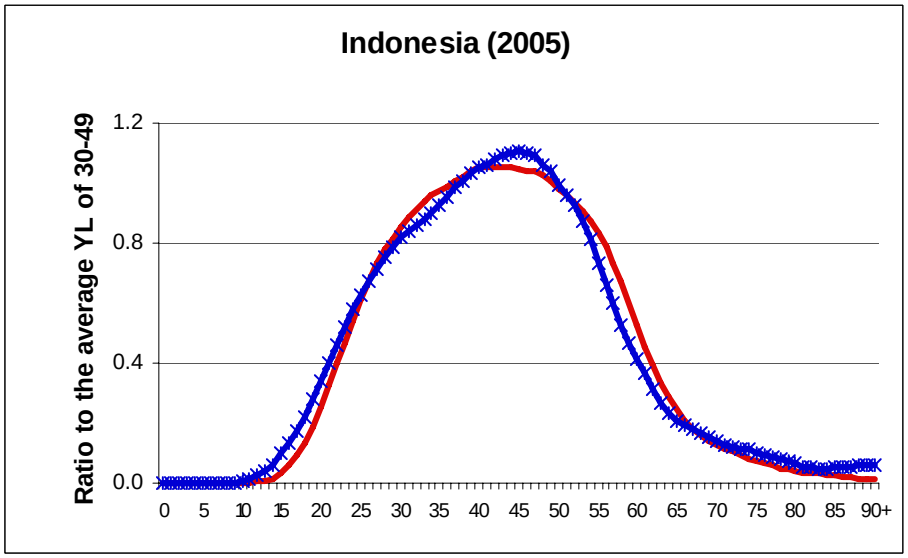
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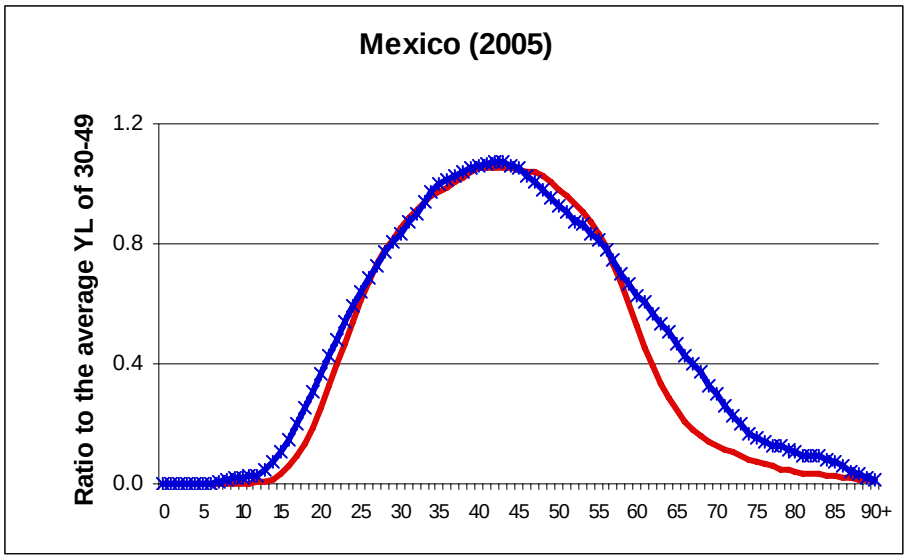
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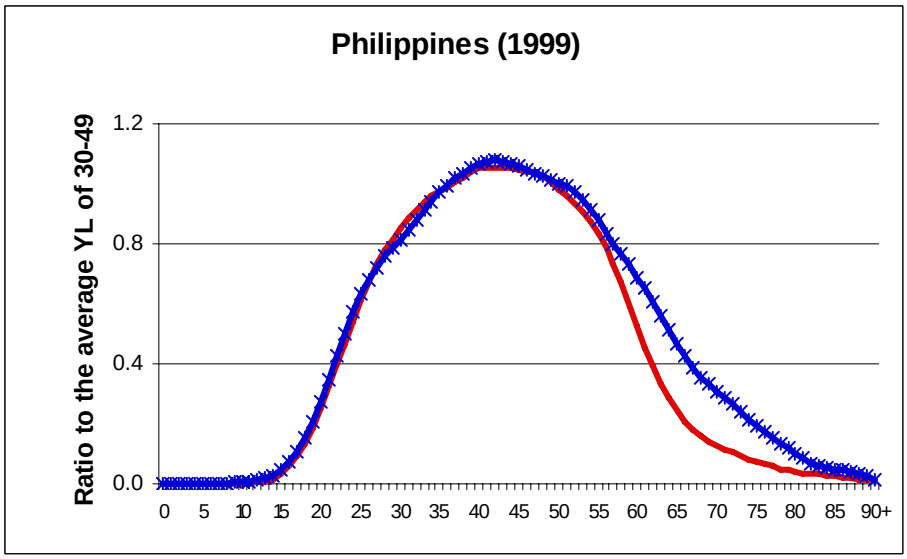
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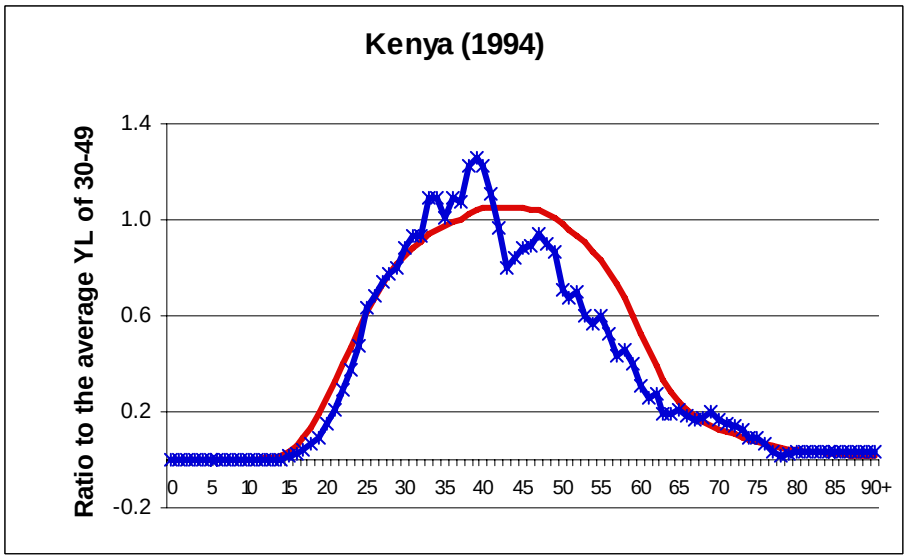
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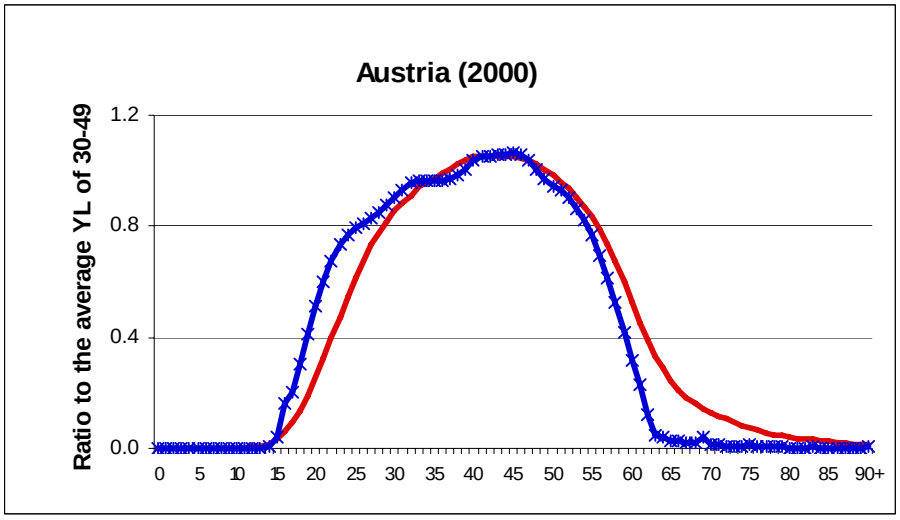
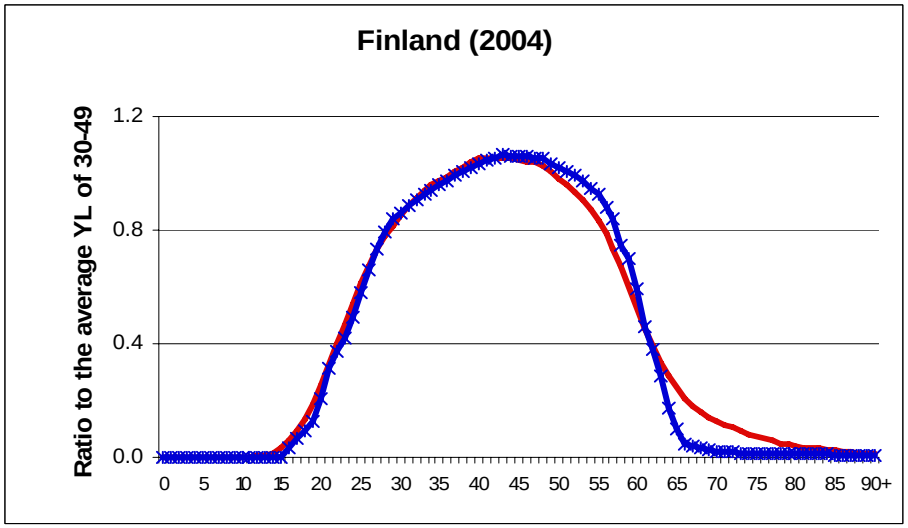
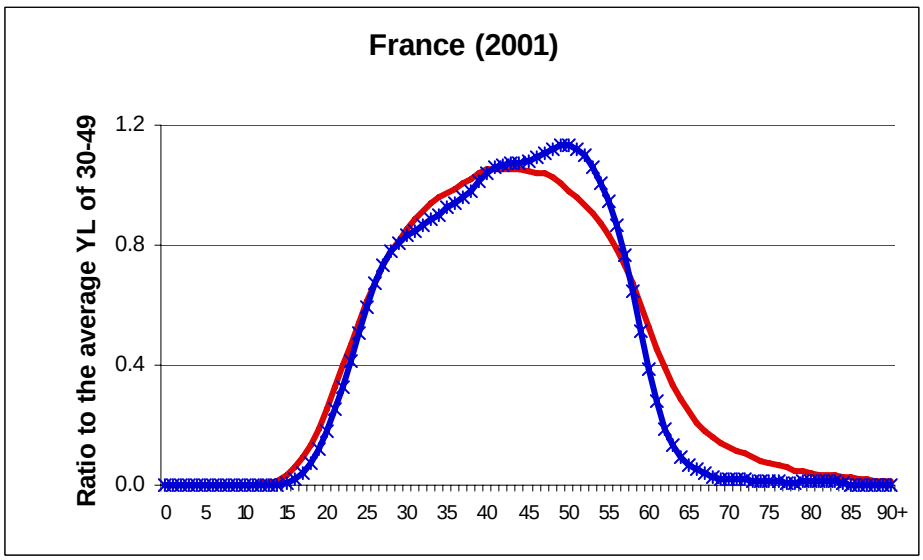
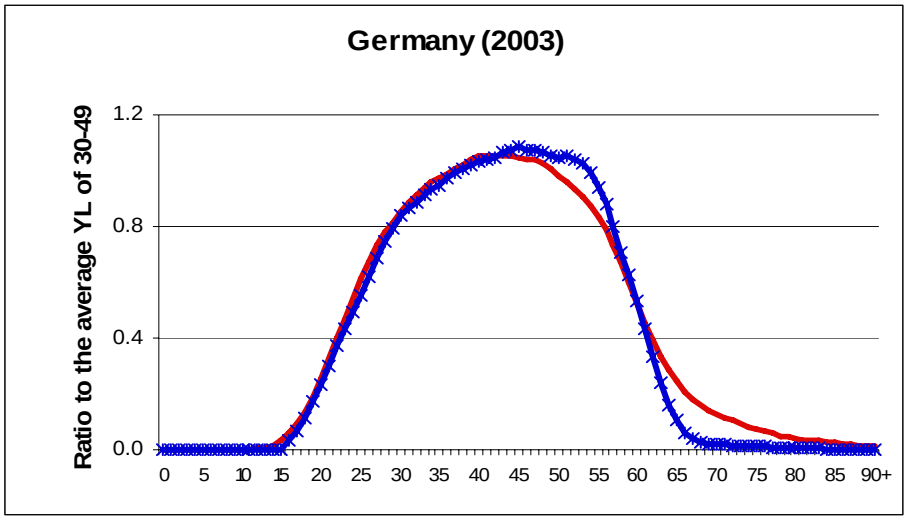
2-C. Rapid Decrease in Old Age: Austria, Finland, France, Germany, Hungary, Japan, Slovenia, Spain, and Sweden





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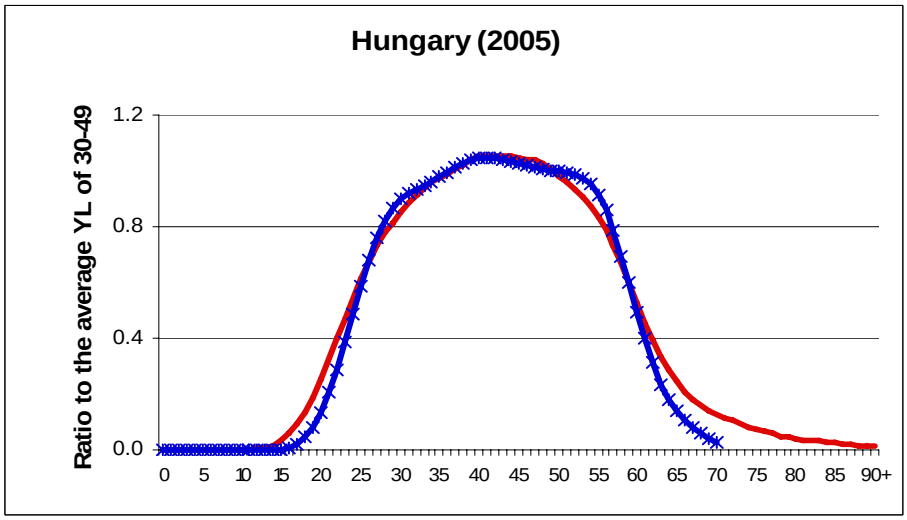
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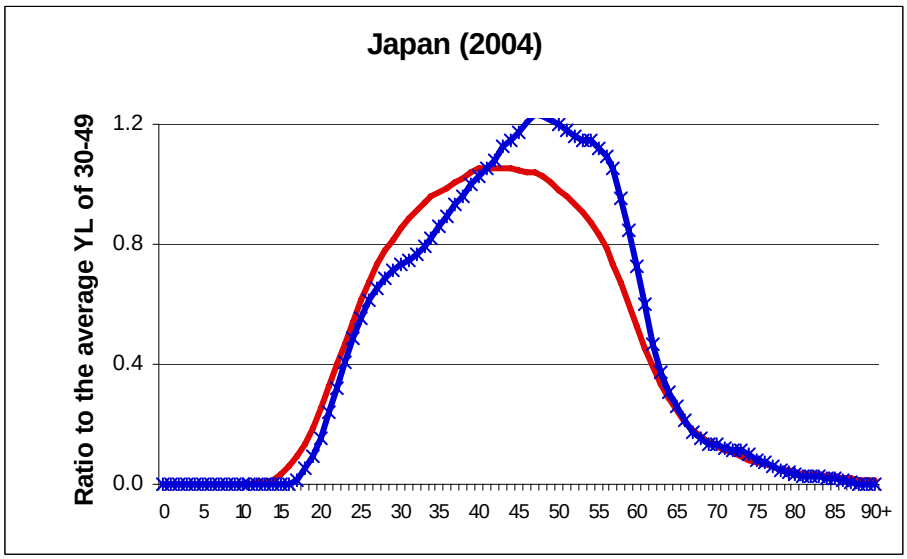
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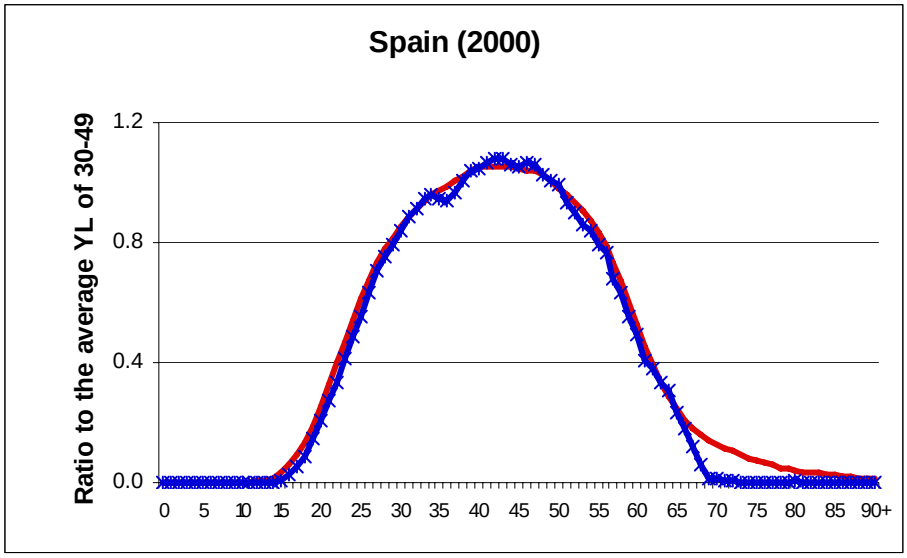
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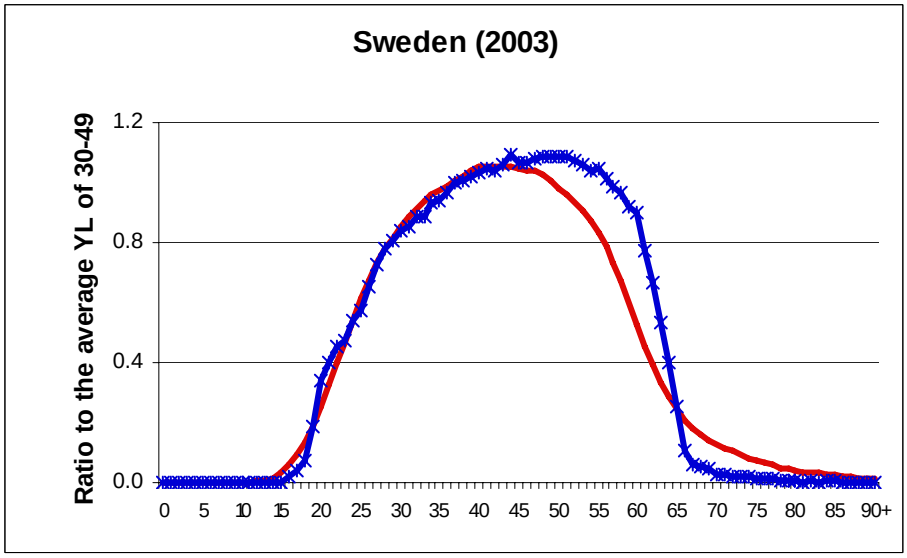
Sweden (2003)
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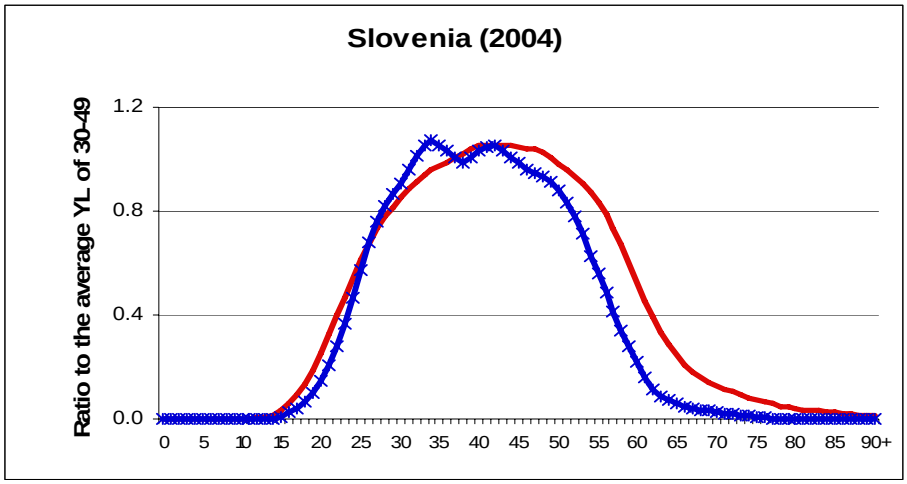
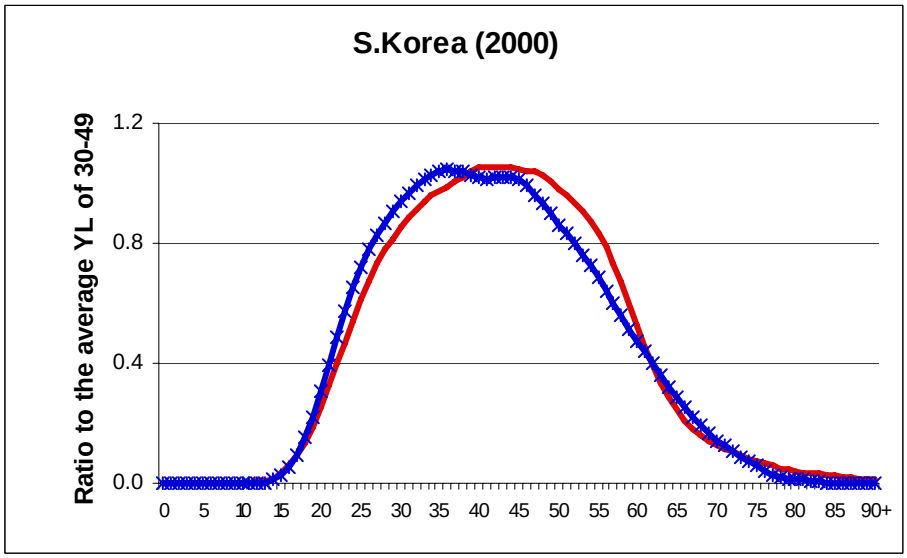
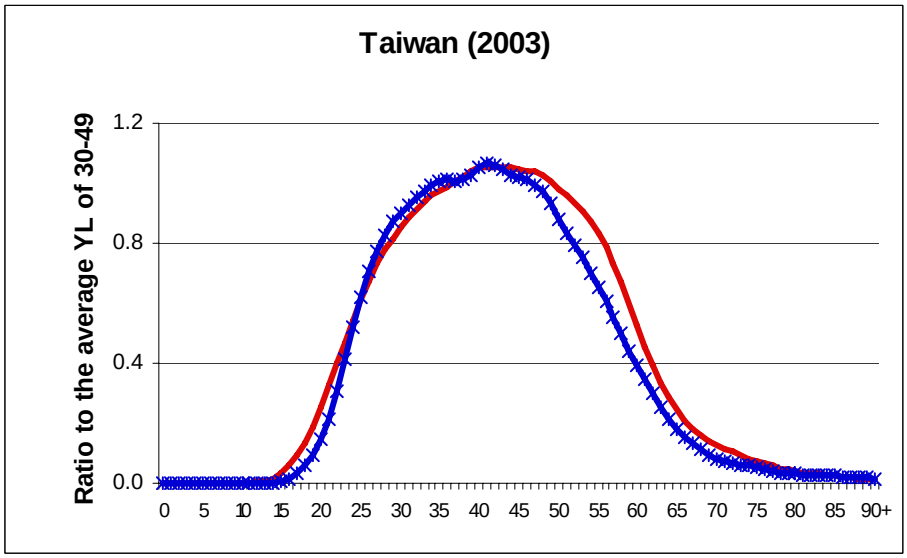
2-D. Rapid Increase and Reach at Young Age: Slovenia, S. Korea, and Taiwan







2-E. Start Late & Exit Late: the US

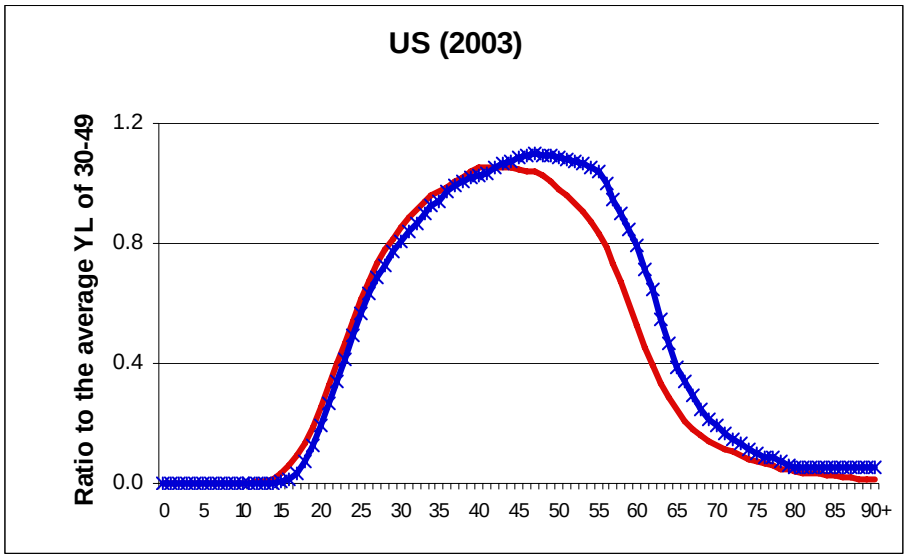


Figure 3. Per Capita Labor Income over Time: Taiwan 1977-2003

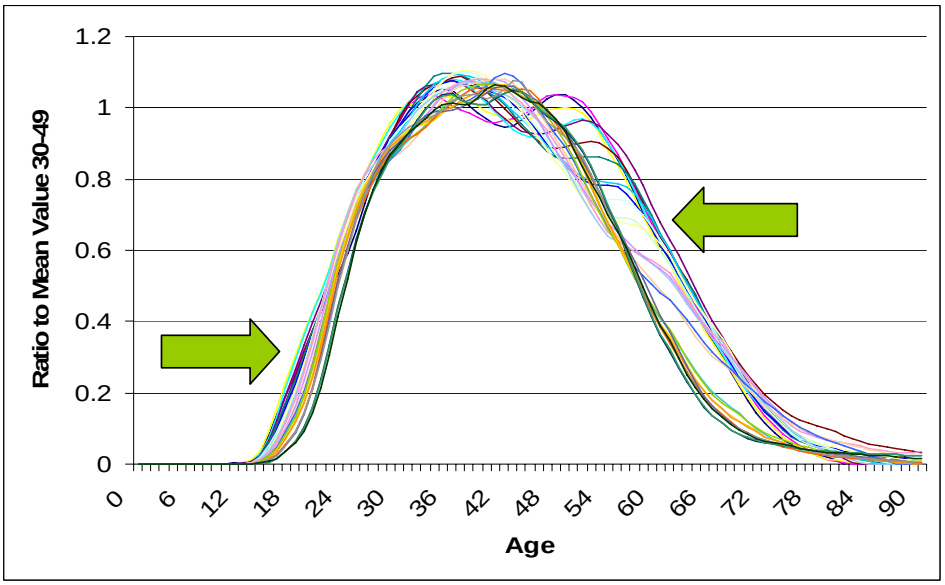


Figure 4. Per Capita Labor Income over Time: 5-Year Birth-Cohorts, Taiwan 1889-1974

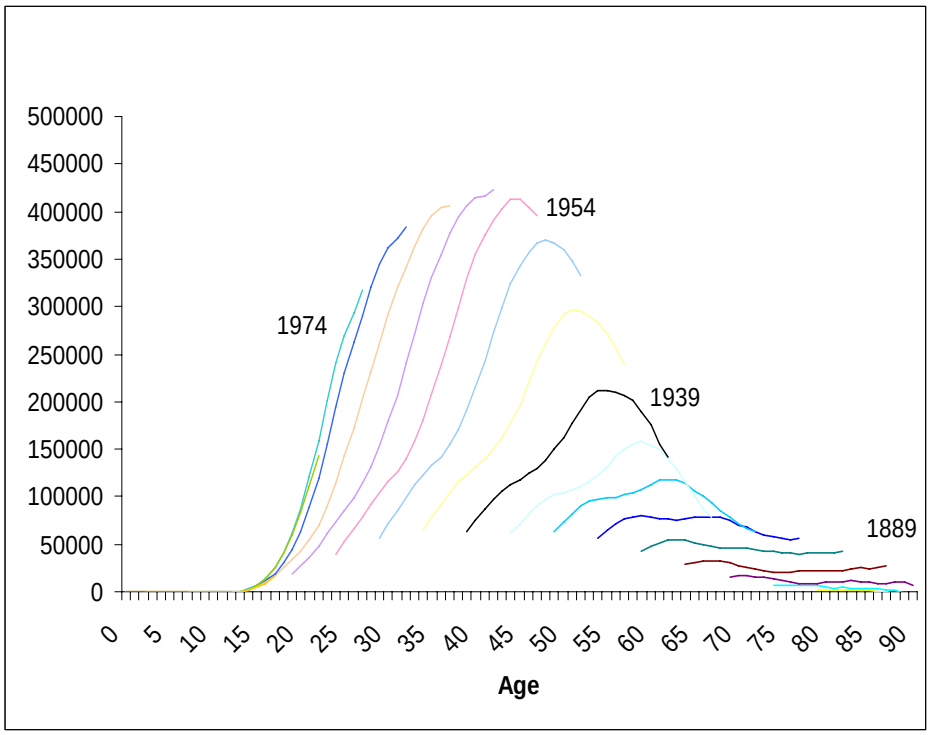
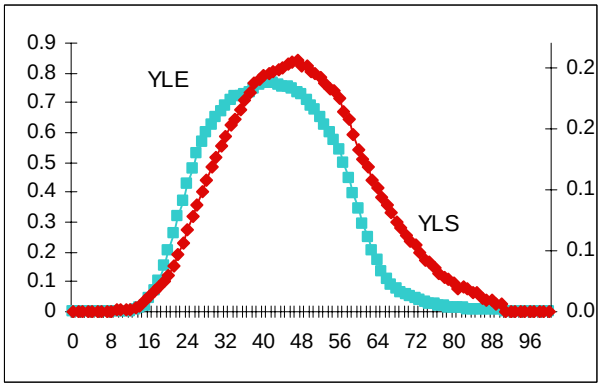
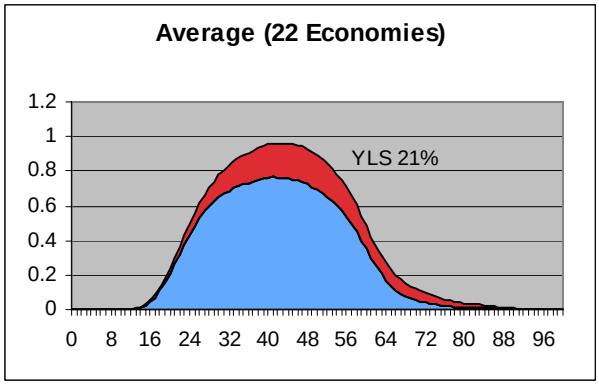
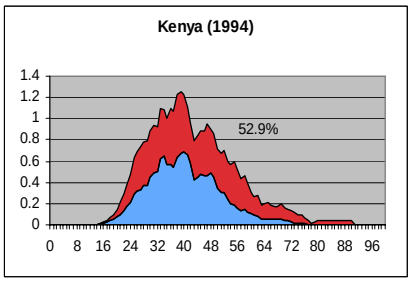
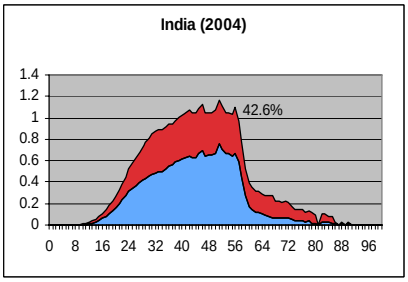


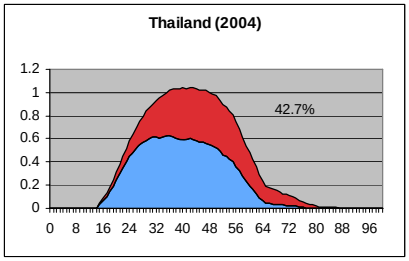
Figure 5. Earnings vs. Self-Employment Income

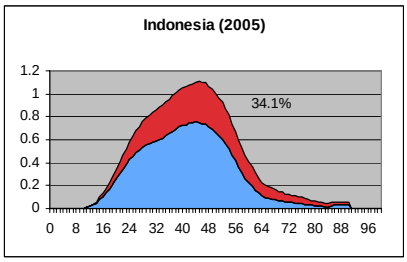


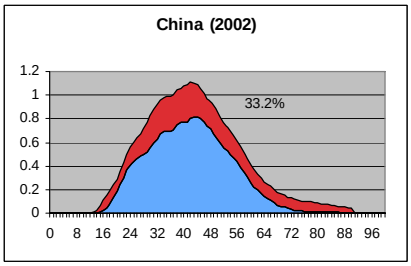


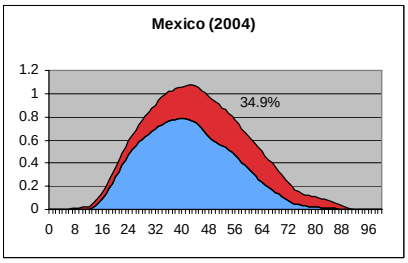

Kenya (1994)
52.9%

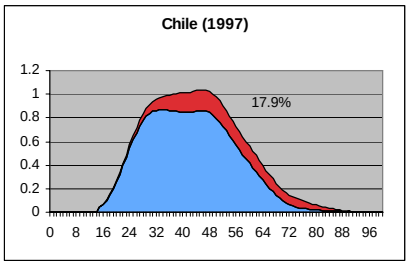

India (2004)
42.6%

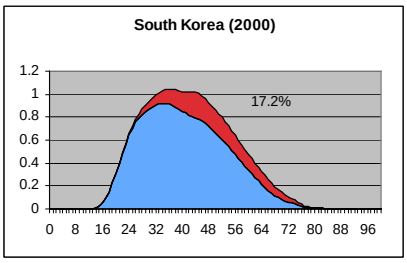

Thailand (2004)
42.7%

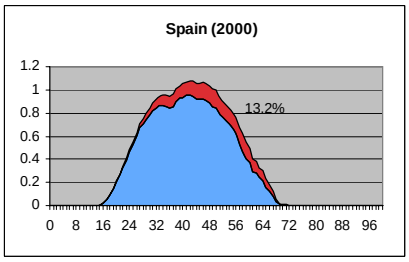

Indonesia (2005)
34.1%

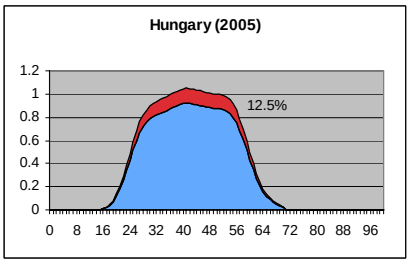

China (2002)
33.2%

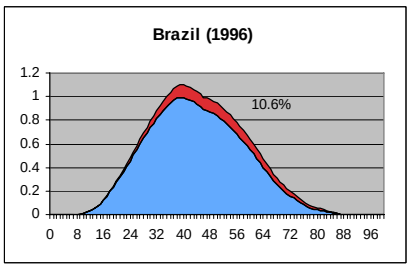

Mexico (2004)
34.9%

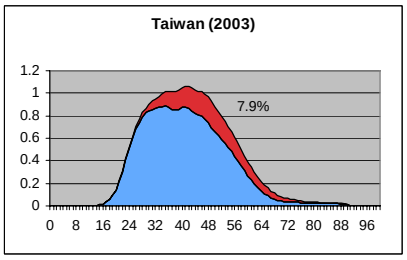

Chile (1997)
17.9%

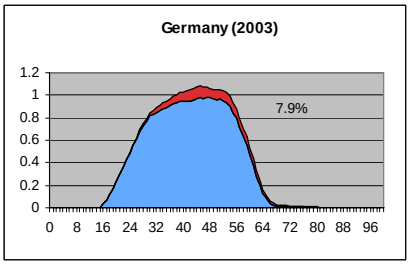

South Korea (2000)
17.2%

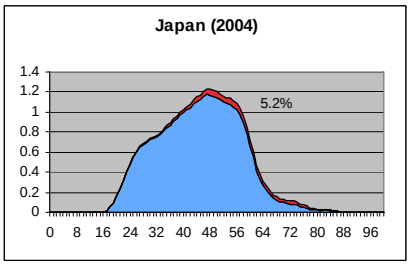

Spain (2000)
13.2%


Hungary (2005)
12.5%


Brazil (1996)
10.6%


Taiwan (2003)
7.9%


Germany (2003)
7.9%


Japan (2004)
5.2%

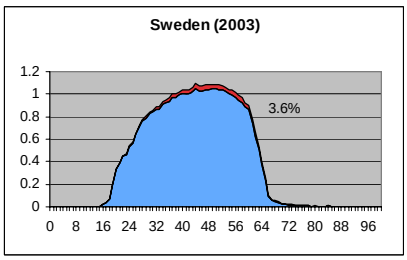

Sweden (2003)
3.6%

Figure 6. Earnings, Self-Employment Income, and Fringe Benefits

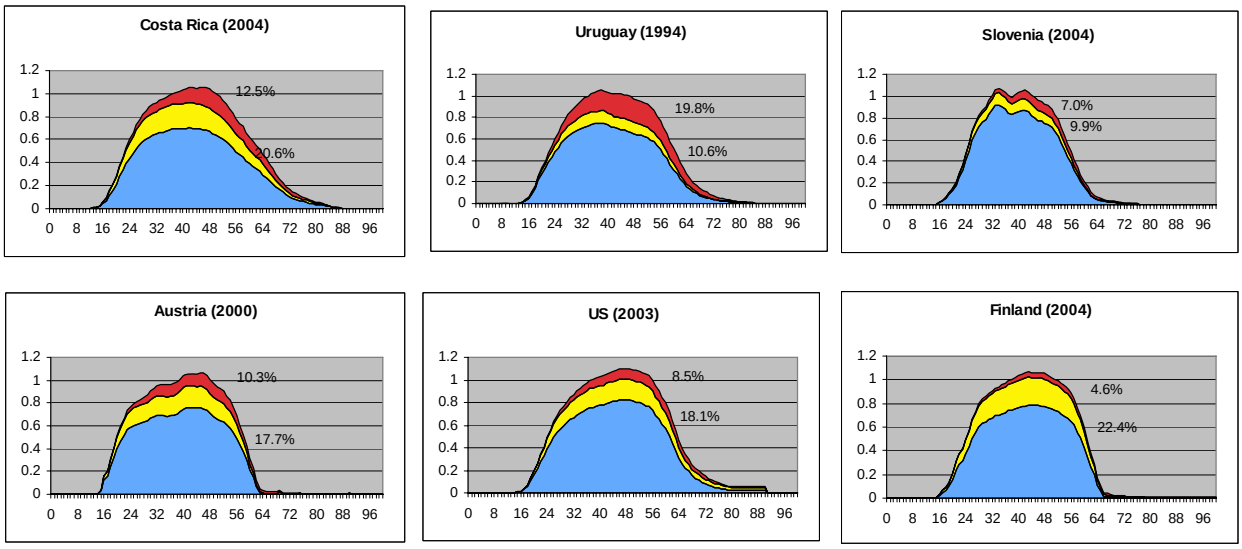
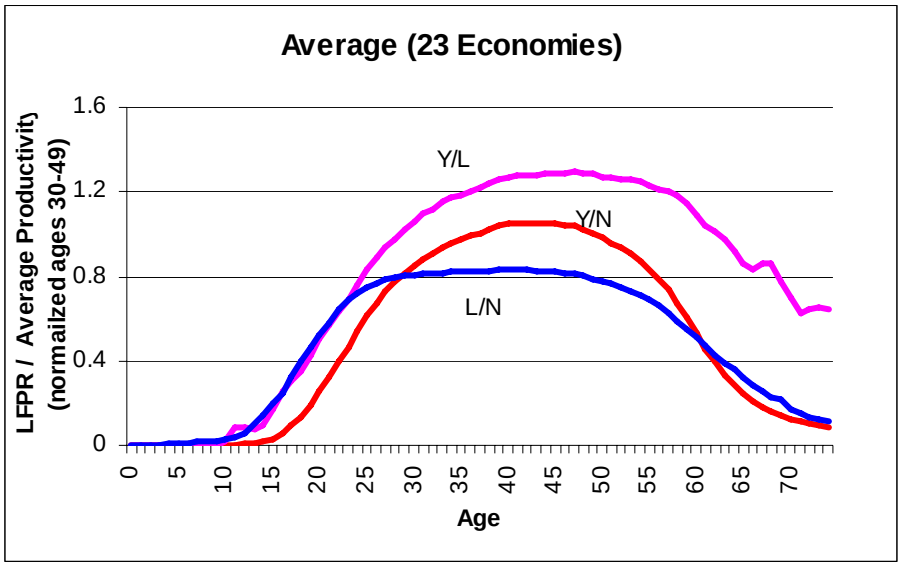
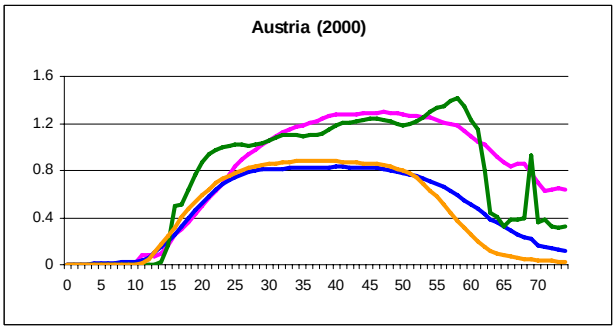
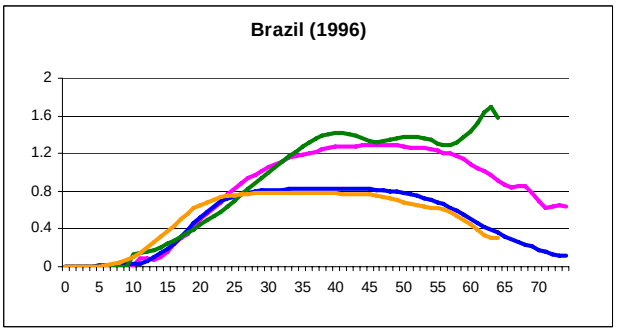
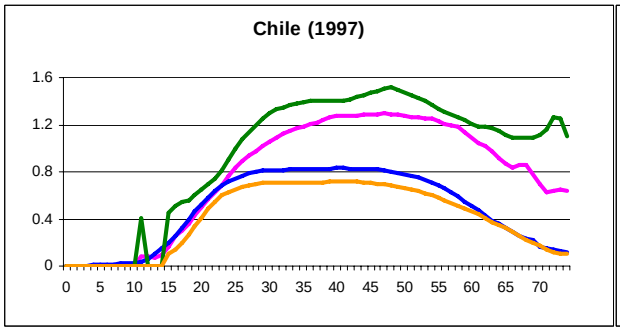


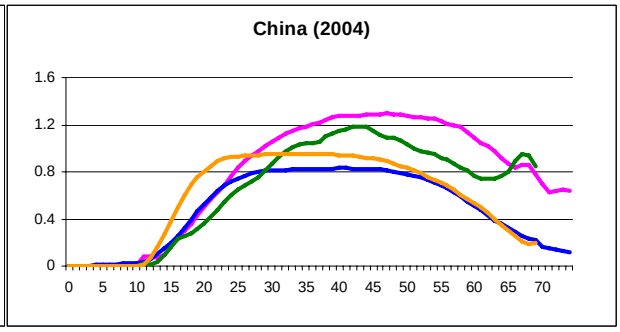
Figure 7. Decomposition of Labor Income: Average Productivity vs. Activity Rates

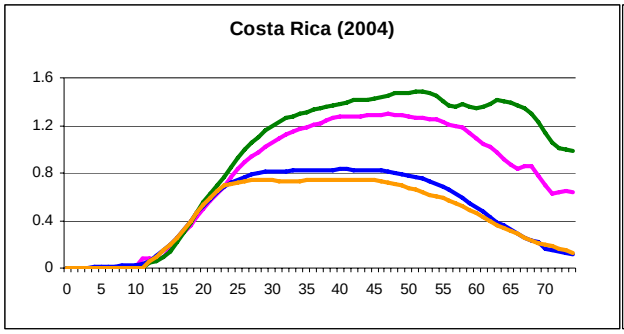


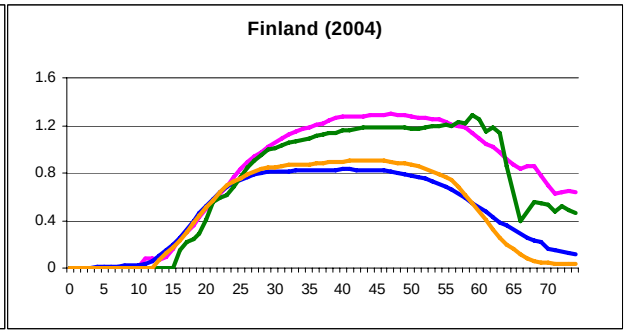


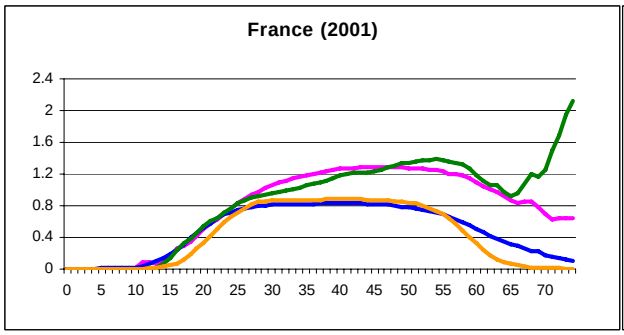


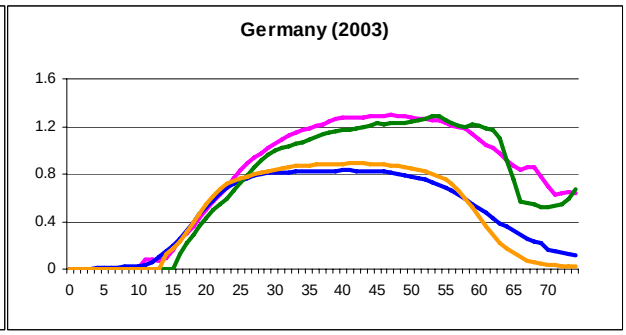


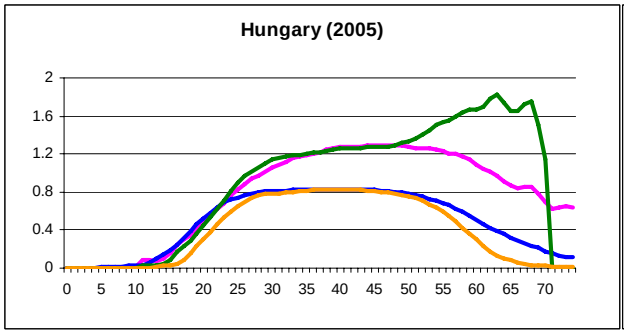


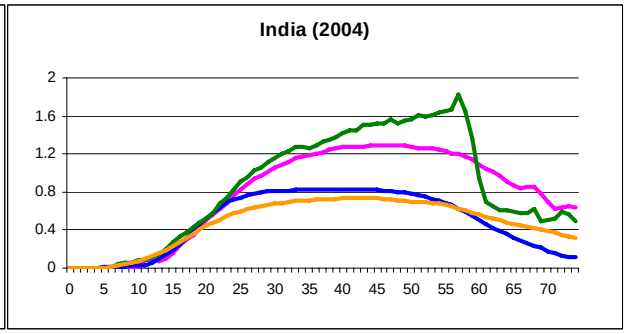

Costa Rica (2004)
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

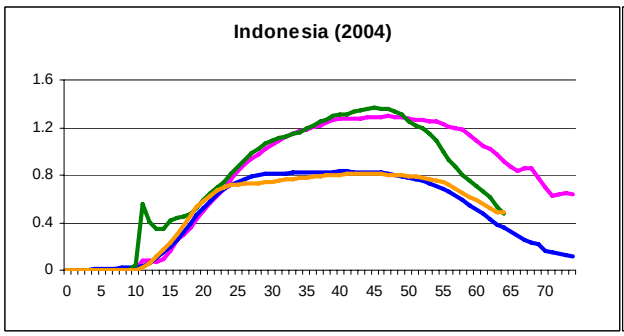

Finland (2004)
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

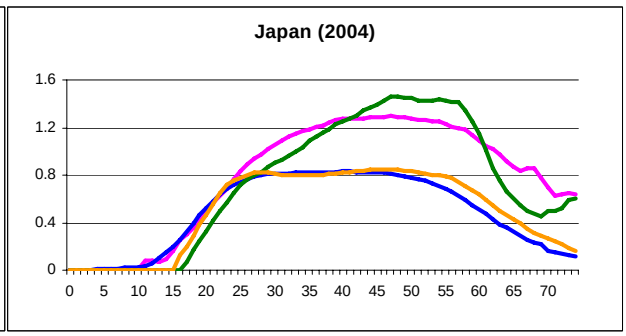

France (2001)
2.4
2
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

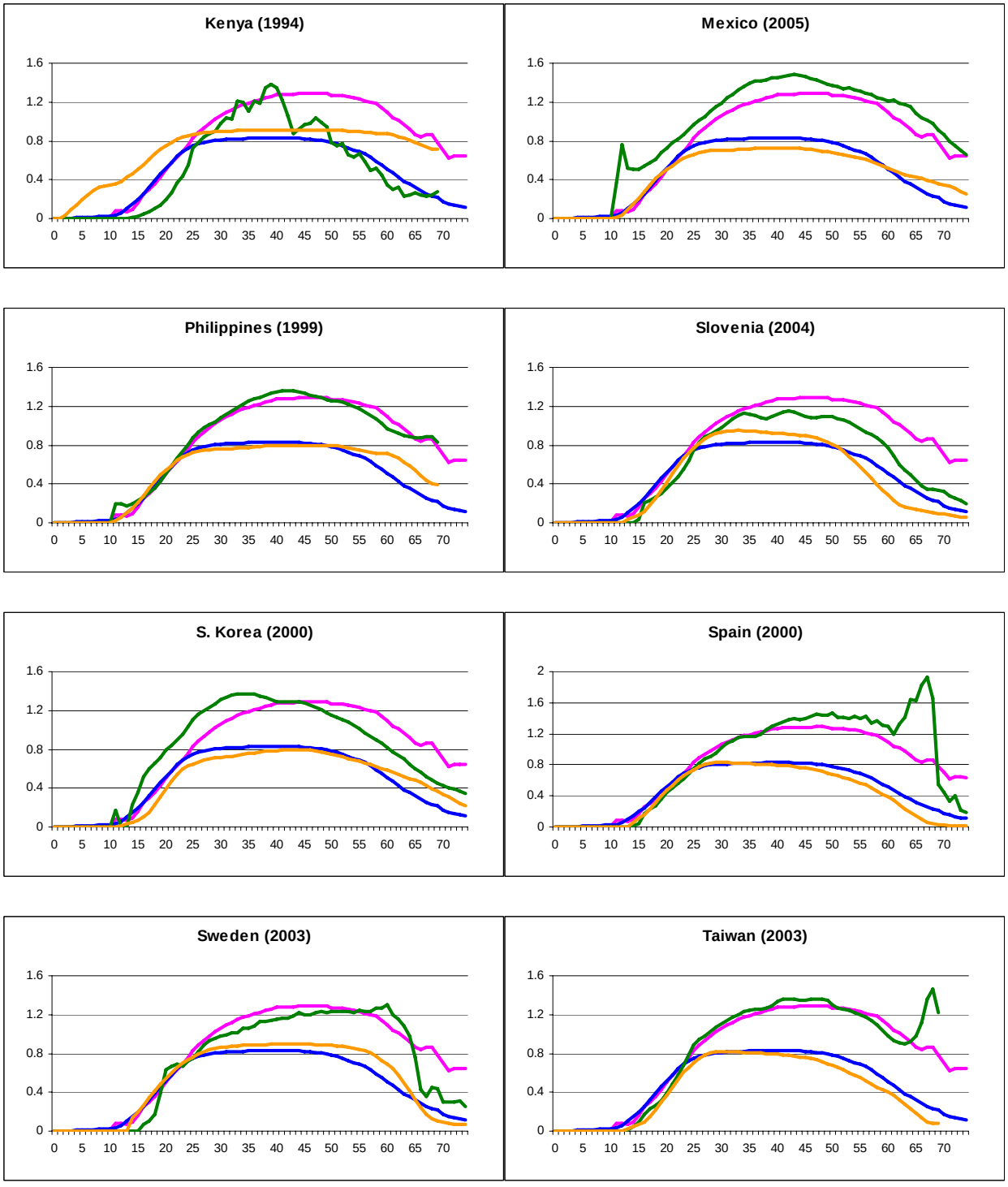

Germany (2003)
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

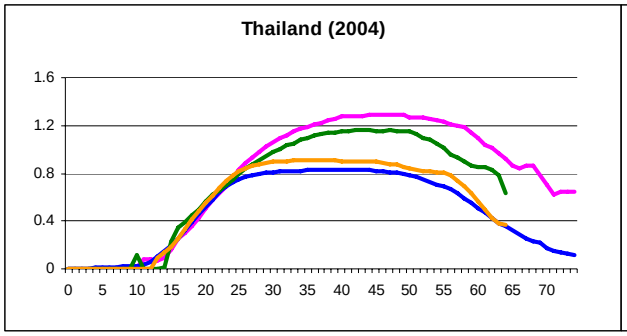

Hungary (2005)
2
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

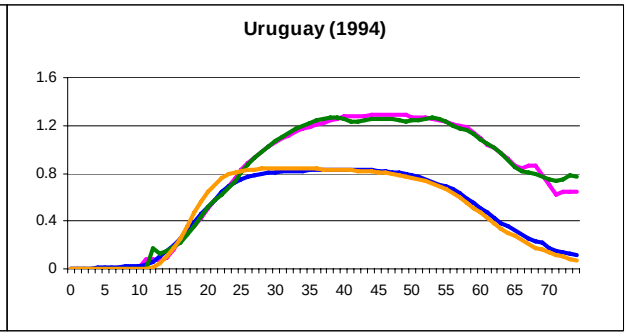

India (2004)
2
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70


Indonesia (2004)
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70


Japan (2004)
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70


Kenya (1994)
Mexico (2005)
Philippines (1999)
Slovenia (2004)
S. Korea (2000)
Spain (2000)
Sweden (2003)
Taiwan (2003)


Thailand (2004)
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70


Uruguay (1994)
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

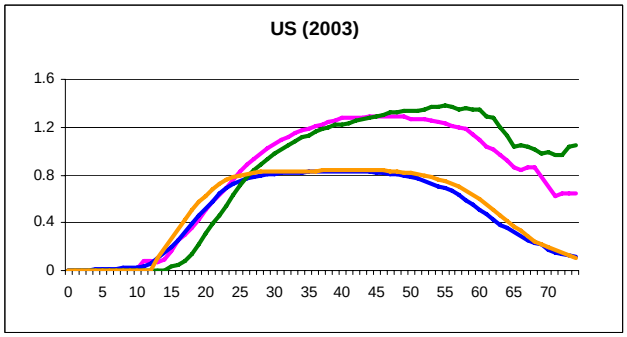

US (2003)
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

Figure 8. Decomposition of Annual Growth of Labor Income by Age: Average Productivity Growth vs. Activity Rates: Taiwan, Real, 1978-2003

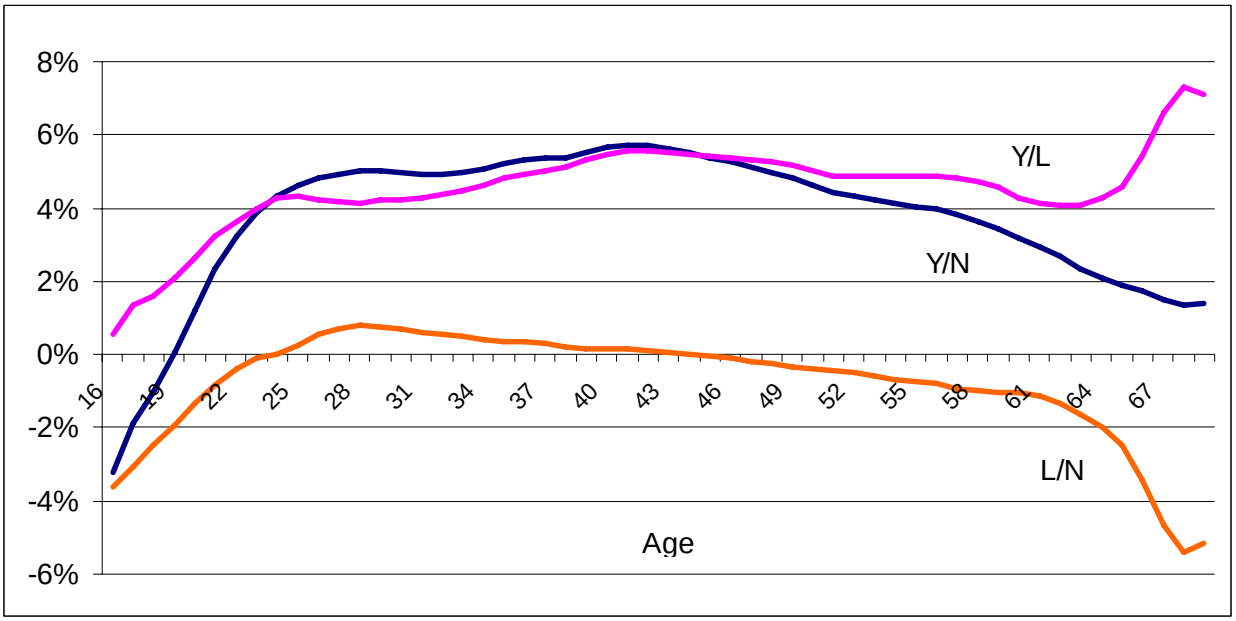
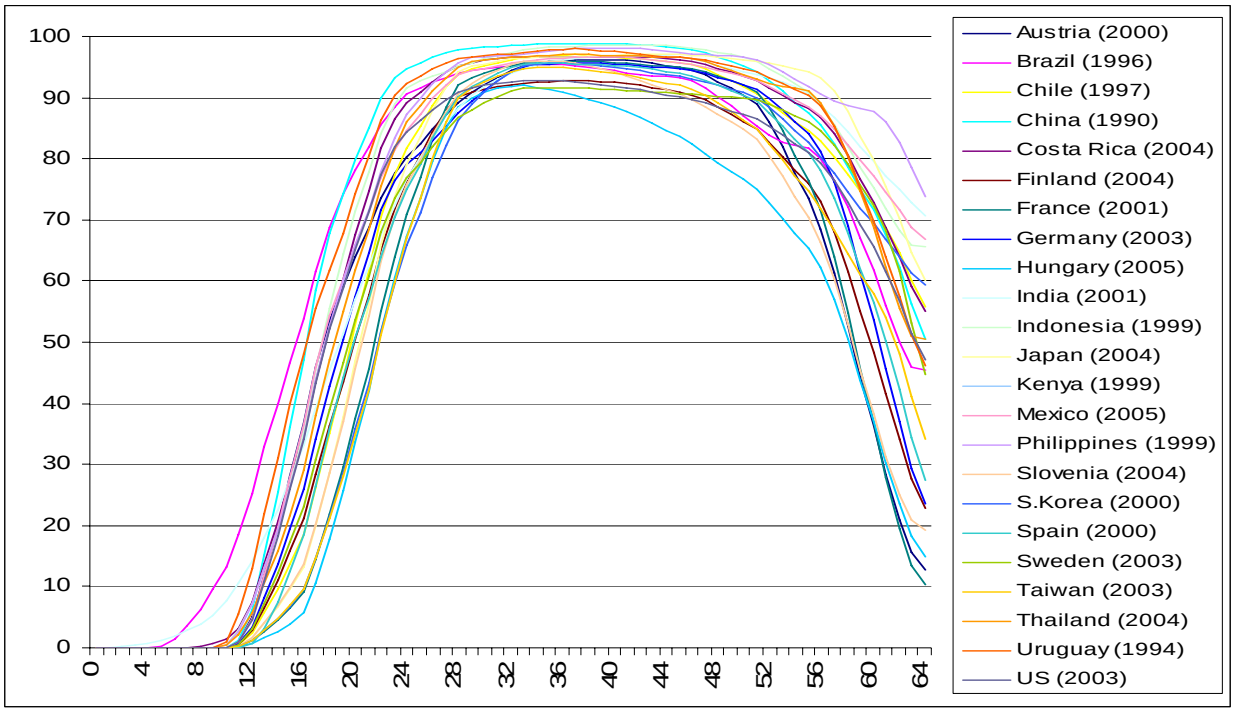


Figure 9. Activity Rate by Age and by Gender: 22 Countries

Male



Female

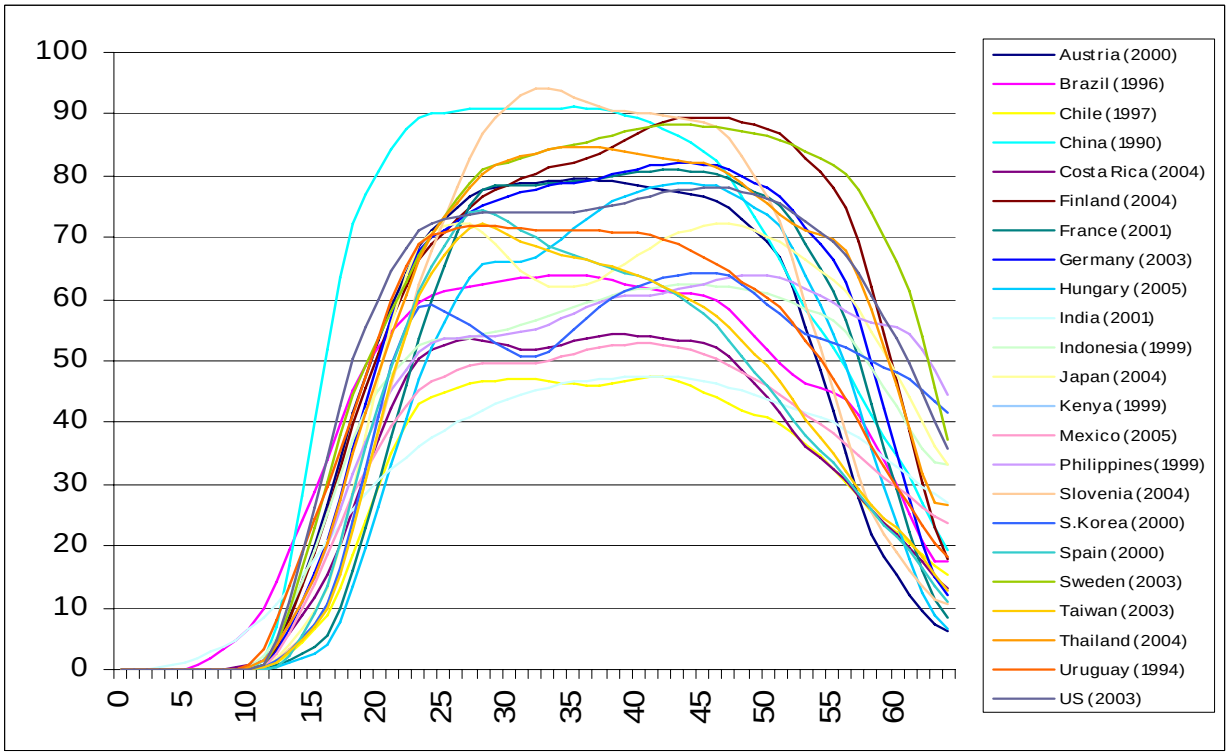
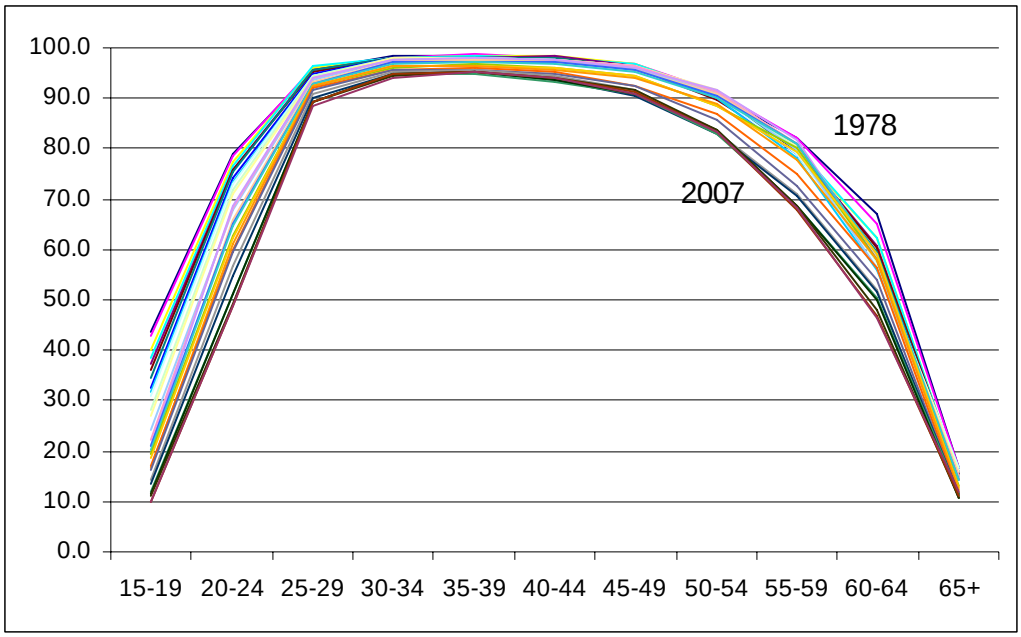


Figure 10. Activity Rate by 5-Year Age Groups: Taiwan, by Gender, 1977-2007

Male



Female

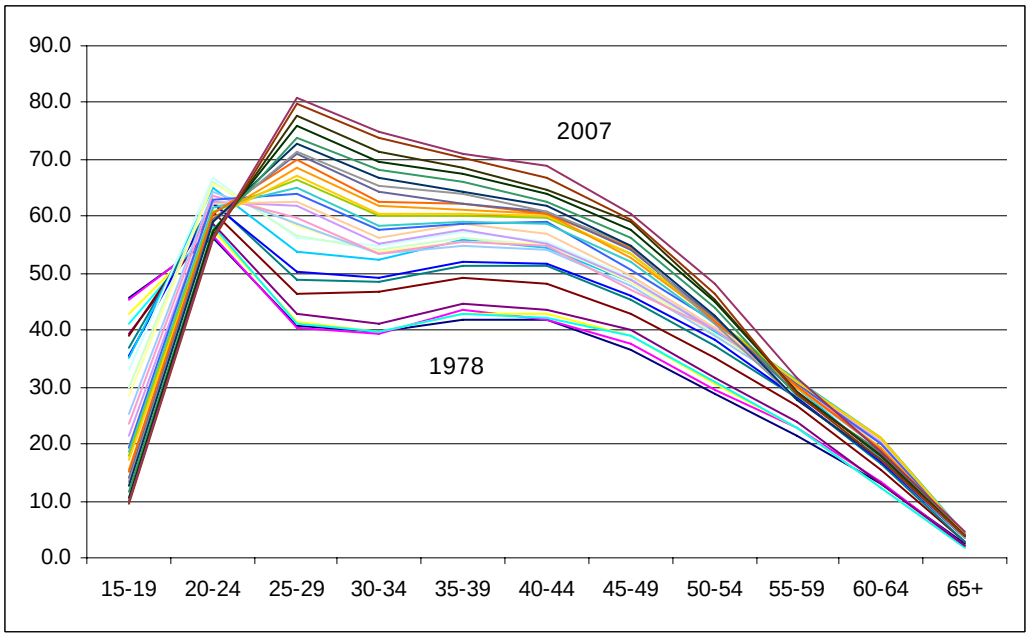


Figure 11.Social Security Contribution as a Percent of GDP vs. Labor Income as a Source of Financing Consumption for People 65+