Labor Income over the Life-Cycle

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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-two 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.

We closely follow the methodology developed for the National Transfer Accounts (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-two economies. We further discuss the source of differences. 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.

Total labor income in a certain year is determined by the level of productivity and the total number of effective producers, i.e.,

$$Y = \sum_a Y_a \quad \text{where} \quad Y_a = \bar{y}_a L_a \tag{1}$$

Y represents total labor income, $\bar{y}_a$ labor productivity index at age a, and L_a effective producers at age a. Per capita labor income at age a can be similarly formulated as,

$$y_a = \bar{y}_a l_a \tag{2}$$

where l_a represents the proportion of effective producers at age a.

Because working hours are different by age, either the working population or productivity index should be weighted by 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 $\bar{y}_a$, often conditioned on working full time, whereas ours (y_a) is weighted by the proportion of effective producers 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 effective producers 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 (e.g. Gruber and Wise 1999, 2007; 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 (e.g. Duryea, Lam, and Levison 2003). 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 productivity ($\bar{y}_a$). 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 for many countries. However, some of the important factors can vary between countries, leading to important differences 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.

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 (Deaton 1997). 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.[1] More detailed information on other issues and methodology is available from Mason, Lee et al (2009), Lee, Lee, and Mason (2008), or on the project website: www.ntaccounts.org.

3. Estimation Results

The shape of the age profiles of labor income for the twenty-two economies considered here are strikingly similar, at a broad level, and familiar. An inverse U-shape predominates. However, there are important differences in the age earnings profile across countries. To visualize the differences, we average the labor income profile of 22 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 1 presents the grouping results.

<Figure 1A-1E. 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

[1] 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.

features are somewhat related to the level of development. While the profiles of Thailand and Uruguay are the closest to the average shape (Figure 1A), 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 1B). 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.

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 1C). However, it appears that the substantial drop in labor income occurs at earlier ages in Austria 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 22 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 1D). 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 1B, in terms of the share of labor income for very young children. They are also distinguished from the advanced countries depicted in Figure 1C, in terms of the age at which the labor income peaks.

The US is an interesting case (Figure 1E), 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 1. The measures include the average age of labor income, the age at which the labor income peaks, median age of labor income, the share of lifetime earnings for children and older people, and the share of labor income as a source of funding consumption 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 and Labor Income as a Source of Income Funding Consumption

	Mean	Peak	Median	Share 0-19	Share 20-64	Share 65+	% funding consumption 0-19	% funding consumption 65+
Europe								
Austria (2000)	39.6	41	38	3.2	96.4	0.5	12.3	2.5
Finland (2004)	42.6	43	41	0.9	98.3	1.0	3.3	4.8
Germany (2003)	42.5	45	41	0.8	98.6	0.7	3.5	3.2
Hungary (2005)	42.6	39	41	0.1	99.0	1.2	0.5	5.7
Slovenia (2004)	40.5	34	39	0.8	98.6	0.8	2.8	4.2
Spain (2000)	42.6	43	41	0.9	98.1	1.6	4.0	8.9
Sweden (2003)	43.7	46	42	1.0	97.7	1.9	3.6	9.1
Africa								
Kenya (1994)	41.9	39	39	0.8	95.3	4.4	4.2	36.6
Asia								
China (1995)	42.2	44	40	4.1	89.4	7.1	21.1	50.4
India (2004)	44.5	47	43	1.9	93.0	5.7	8.5	34.8
Indonesia (2005)	42.2	45	41	2.9	93.2	4.3	10.6	24.2
Japan (2004)	44.8	47	44	0.3	96.7	3.5	1.1	13.6
Philippines (1999)	44.6	41	42	1.7	91.5	7.7	6.2	42.4
S. Korea (2000)	40.7	35	39	1.3	96.9	2.2	5.2	15.4
Taiwan (1998)	40.9	39	39	1.1	97.0	2.3	3.6	12.2
Thailand (2004)	42.2	40	40	1.9	95.2	3.3	7.1	19.1
Latin America								
Brazil (1996)	43.8	47	42	1.7	93.2	5.8	5.4	19.9
Chile (1997)	43.2	45	41	1.6	93.9	5.3	4.9	23.2
Costa Rica (2004)	43.5	43	41	1.5	93.4	6.0	6.5	27.5
Mexico (2004)	43.6	38	41	2.3	91.9	6.7	6.7	28.5
Uruguay (1994)	42.0	38	40	1.8	95.9	2.9	6.7	13.5
North America								
US (2003)	45.0	47	43	0.7	94.8	5.4	2.5	17.8
Average	42.8	45	41	2.0	94.6	3.9	..	..

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 US, Japan, India, and Brazil at age 47. It is lowest for Slovenia, followed by South Korea, Uruguay, and Mexico.[2]

Surprisingly, the children's share of lifetime earnings is very modest. Even for China in 1995, where it is highest among our study countries, the share of labor income for children under 20 is only 4.1 percent. No developed countries except for Austria have more than 1 percent. The share of lifetime earnings for older people age 65 and above is also 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

[2] The result for age at which labor income peaks should be interpreted with care for some countries. For example, the labor income profile of Slovenia peaks at age 34, but it drops little until early 40s. The difference of labor income between age 34 and 42 is only 3.3 percent. This is also true for South Korea.

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 2 percent. Only for Japan and the US, the elderly share of labor income is above 3 percent, amongst economically most advanced economies. On the contrary, there is no country in other regions where the elderly share of labor income is below 2 percent. On the other hand, most European countries, namely, 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. Obviously, over 90 percent of lifetime earnings is concentrated in the age range of 20 to 64 in almost all economies, which is particularly true for European countries.

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 funding consumption, which are presented in the last two columns of the table. The percentage of income by which the consumption of dependent children, defined as those under the age of 20, is funded is relatively modest. With the exception of three countries, i.e., Austria, China, and Indonesia, labor income accounts for no more than 10 percent as a source of funding consumption. Because asset-based reallocation is not an important part of funding consumption for children, this implies that the majority of consumption is funded by transfers. Labor income as a source of funding consumption by the elderly is quite different across countries, ranging from 2.5 percent for Austria to 50.4 percent for China. Work plays little role for the elderly in all European and economically advanced countries, contributing less than 10 percent of consumption for all countries, while it accounts for substantial portion as a source of funding consumption for the elderly in Asian and Latin American countries.

4. Sources of the Differences

What are the sources of the differences across countries? 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, 2007). 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 income 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 plot the ratio of self-employment income to labor income by age for each of the countries. Again, we categorize them into 3 groups based on their share of self-employment income. Figure 2A shows the unweighted share of self-employed income over the individual life-cycle, while other figures present the grouping results by age.

<Figure 2A-2D. Share of Self-Employment Income by Age, 3 Groupings>

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 (52.0%), and the Philippines (50.6%). It is also about 40 to 42 percent for China, India and Thailand and over 30 percent for Brazil, Indonesia, and Mexico. By contrast, it is relatively low in advanced economies. Japan (4.8%), Finland (4.9%), and Sweden (6.1%) have the lowest share of self-employment income over the life-cycle. Chile, Costa Rica, Uruguay, South Korea, and Spain are intermediate.

The shape of the labor income profile is also 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. The share of self-employment income also rises substantially at a certain ages, especially for European countries. For example, Figure 2B shows the rapid increase in the share of self-employment income around ages 60-65 for European countries, which is consistent with the retirement behavior of employees for these countries. Compared to European countries, the share of self-employment income for ages 65 and older tends to be lower for Japan, Taiwan, and the U.S. Chile, Costa Rica, Uruguay, South Korea, and Spain have the share of self-employment income which is much higher than other European countries or the U.S., especially for ages 45-54 (Figure 2C). However, Spain shows the typical European pattern with the rapid increase in the share of self-employment income around ages 60-65, while the other countries do not. The share of self-employment income also rise by age for lower-income countries, namely China, India, Indonesia, Philippines, Thailand, Brazil, Mexico, and Kenya (Figure 2D). The share of self-employment income for children under 20 is also quite high for these countries. In case of India, Kenya, and China, the share of self-employment income for children under 20 is actually higher than that for 50. This might be due to the fact that young children are also more likely to work as unpaid family workers in these low income countries. Thus, our imputation for the value of unpaid family labor brought a substantial change in the self-employment income profile for these countries.

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, the age profile of productivity ($\bar{y}_a$) or the proportion of effective producers at each age (l_a)? To answer these questions, we try to decompose the labor income into two factors. As reviewed in Section 1, per capita labor income (y_a) can be decomposed into two factors, one the proportion of effective producers at each age (l_a), measured by the proportion of working population at each age, and the other, the productivity index of each age ($\bar{y}_a$), measured by the labor income of working population. There are two issues, though. First, the proportion of working population at each age and the labor income 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 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 useful insights. 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.[3] We compare each country profile to average profiles of l_a and $\overline{y}_a$ for 16 countries. These 16 countries are selected to construct average profiles, because information on activity rates is available at least until age 74 for these countries. Figure 3 provides the decomposition results. We report the results for a few countries to examine some particular issues.

<Figure 3. Decomposition of Labor Income: Average Productivity vs. Activity Rates; Austria, Kenya, South Korea, and Taiwan>

Both the age profile of labor force participation and productivity of the working population show inverse-U shapes. Both profiles peak around the mid-40s, quite flat until late 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. The results for a few countries are particularly interesting. For example, the activity rate for people ages 15-24 in Austria is higher than any other European countries. The activity rate of 15-19 is particularly high, even higher than some of lower income countries such as Indonesia, Mexico, or the Philippines. This might be due to the wide-spread apprenticeship in Austria. However, the difference in productivity between Austria and other countries are much more striking. The productivity difference between Austria and other countries are on average over 60% for ages 16-25, which is much larger than the difference in activity rates. This suggests that high per capita income for teenagers in Austria is not entirely due to higher activity rates due to apprenticeship, but it is in fact largely due to high labor income for these apprentices (or working hours), compared to the other countries.

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 amongst our study countries. As we can see from the figure, the activity rate for young and older people are often more than twice of the other countries. However, labor income for children and the elderly are not as high as the productivity, suggesting that the low per capita income for children and elderly is almost entirely to their extremely low productivity. This also implies that there is no selection effect of older workers remaining in the Kenyan labor market. This is quite different from the case of India in which the productivity for older workers remains quite high (not in the figure). It is far from clear what causes this, but it could be related rigid wage system or a strong selection of workers remaining in the labor market in India.

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

South Korea vs. Taiwan is another interesting case. Older people ages 65 and above in South Korea show high activity rate. But their productivity is below average and 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.

The insight from these results is clear. Some governments have considered policies to reduce the pace and depth of future population aging by modifying the age patterns of consumption and labor income in a way that raises support ratios for a given demographic structure. The incentive structure created by a public policy can have an important effect on retirement behavior. Suppose people delay retirement due an increase in the full retirement age. For example, the full retirement age (normal retirement age) had been 65 for many years in the U.S. However, beginning with people born in 1938 or later, that age gradually increases until it reaches 67 for people born after 1959. As people live longer, the increase in full retirement age would be an attractive option for many governments and there are ample evidences that the increase in full retirement age will delay retirement.

What would be the impact of delaying retirement? The effect can be implemented by extending the hazard rate of retirement by adding more years of activity rate at the peak and shifting the profile after the peak to the right, weighted by the productivity of each age group. The results are presented in Figure 4 for older people ages 65-74.[4] For example, delaying retirement by 2 years has a substantial impact on labor incomes to elderly, but the impact varies a lot depending on our study countries. Obviously, work still plays smaller role for the elderly in all European and economically advanced countries, but the increase in the importance of labor income is quite substantial for these countries. The gain is greatest for Spain after delaying retirement by 2 years, which is as large as current level of U.S. The effect is also quite big for countries like Sweden, Finland, and U.S. On the other hand, the effect is quite small for countries like India, Mexico, or South Korea. The effect is relatively small for these countries, either due to high activity rate, low productivity of older people, or both. That is, the effect of reducing unused productive capacity is small for these countries and hence increasing labor force participation of elderly cannot be a panacea for these countries. This might be also true for Kenya, Philippines, and Indonesia, although we could not construct data for these countries due to lack of information on activity rate for older people.

<Figure 4. Labor Income as a Source of Funding Consumption for Older People Ages 65-74: Before and After Delaying Retirement by 2 Years>

Are these all differences across countries related with economic development and other characteristics of countries? There is also ample literature to show that labor income for specific age groups are related with institutions, demographic characteristics, and economic development. The literature 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 examine the relationship, we relate the

[4] Note that this analysis is possible for countries which have information on activity rates at least until age 74.

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. A couple of findings are particularly interesting. 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. Also, the elderly share of labor income is highly and negatively correlated with old-age dependency ratio. Perhaps most interestingly, labor income as a source of funding consumption for elderly 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, which is somewhat consistent with what previous literature suggest (Figure 5).

<Figure 5. Social Security Contribution as a Percent of GDP vs. Labor Income as Old Age Support System>

5. Conclusions and Implications

All the results presented here 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. Nevertheless, the hump shape is consistent with our expectations, and the estimated cross-sectional age profiles of labor income are broadly similar.

There are still 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 activity rates, 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 the 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 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 may moderate the influence of slower or negative growth of the working age population.

References

Anderson, P., A. Gustman, and T. Steinmeier. 1999. “Trends in Male Labor Force Participation and Retirement: Some Evidence on the Role of Pensions and Social Security in the 1970s and 1980s,” *Journal of Labor Economics* 17 (4): 757-83.

Autor, D.H., F. Levy, and R.J. Murnane. 2003. "The Skill Content of Recent Technological Change: An Empirical Exploration." *Quarterly Journal of Economics* 118(4): 1279-1334.

Becker, G.S. 1962. "Investment on Human Capital: A Theoretical Analysis", *Journal of Political Economy* 70 (5): 9-49.

Becker, G.S. and H.G. Lewis. 1973. "On the Interaction Between the Quantity and Quality of Children." *Journal of Political Economy* 18(2):S279-S288.

Börsch-Supan, A. 2000. “Incentive Effects of Social Security on Labor Force Participation: Evidence in Germany and Across Europe,” *Journal of Public Economics* 78: 25- 49

Bound, J. 1991. "Self-reported versus Objective Measures of Health in Retirement Models." *Journal of Human Resources* 26(1):106-138.

Clark, R., A. York, and R. Anker. 1999. “Economic Development and Labor Force Participation of Older Persons”, *Population Research and Policy Review* 18 (5): 411-32.

Deaton, A. 1997. *The Analysis of Household Surveys : A Microeconomic Approach to Development Policy*. Baltimore: Johns Hopkins University Press.

Duryea, S., D. Lam, and D. Levison. 2003. Effects of economic shocks on children's employment and schooling in Brazil. *PSC Research Report. Univ. of Michigan* 03-541.

Dwyer, D.S. and O. Mitchell. 1999. "Health Problems as Determinants of Retirement: Are Self-Rated Measures Endogenous?" *Journal of Health Economics* 18(2):173-193.

Gollin, D. 2002. "Getting Income Shares Right", *Journal of Political Economy* 110: 458-74

Gruber, J. and D.A. Wise. 1999. "Introduction and Summary." in *Social Security and Retirement around the World*, edited by J. Gruber and D.A. Wise. Chicago: The University of Chicago Press.

Gruber, J. and D.A. Wise. 2007. "Introduction." in *Social Security Programs and Retirement around the World*, edited by J. Gruber and D.A. Wise. Chicago: The University of Chicago Press.

Hurd, M.D. 1993. "The Effect of Labor Market Rigidities on the Labor Force Behavior of Older Workers" NBER Working Papers 4462.

Lee, R.D., S.-H. Lee, and A. Mason. 2008. "Charting the Economic Life Cycle", Population Aging, Human Capital Accumulation, and Productivity Growth, edited by A. Prskawetz, D. Bloom, and W. Lutz, *Population and Development Review* 34 (supplement): 208-237. Also *NBER Working Paper*, No. 12379.

Mason, A., R. Lee, A.-C. Tung, M.-S. Lai, and T. Miller. 2009. "Population Aging and Intergenerational Transfers: Introducing Age into National Accounts in Economics of Aging Series", edited by D.A. Wise (Chicago: NBER and University of Chicago Press)

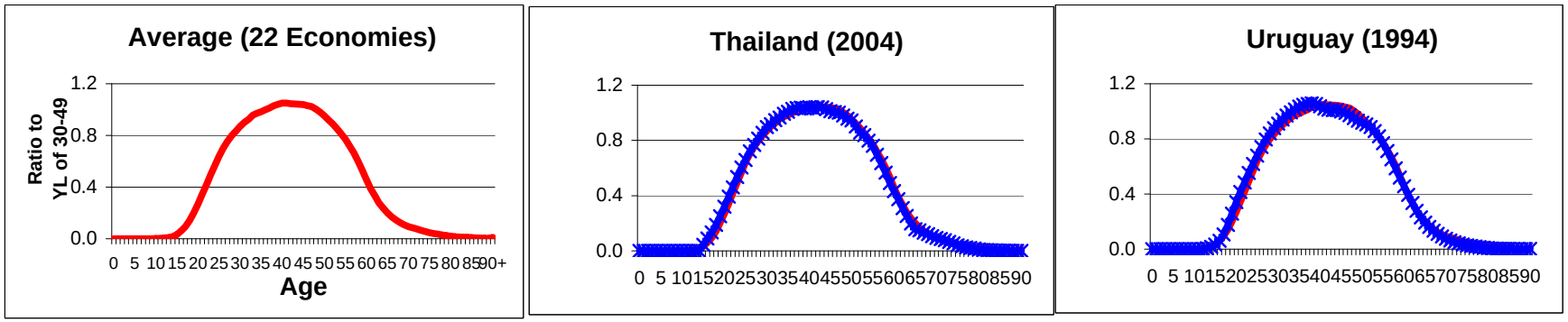
Mincer, J. 1962. "On-the-Job Training: Costs, returns and some implications" *Journal of Political Economy* 70 (5): 50-79.

Quinn, J.F., R. Burkhauser, and D.A. Myers. 1990. *Passing the Torch: The Influence of Economic Incentives on Work and Retirement*. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

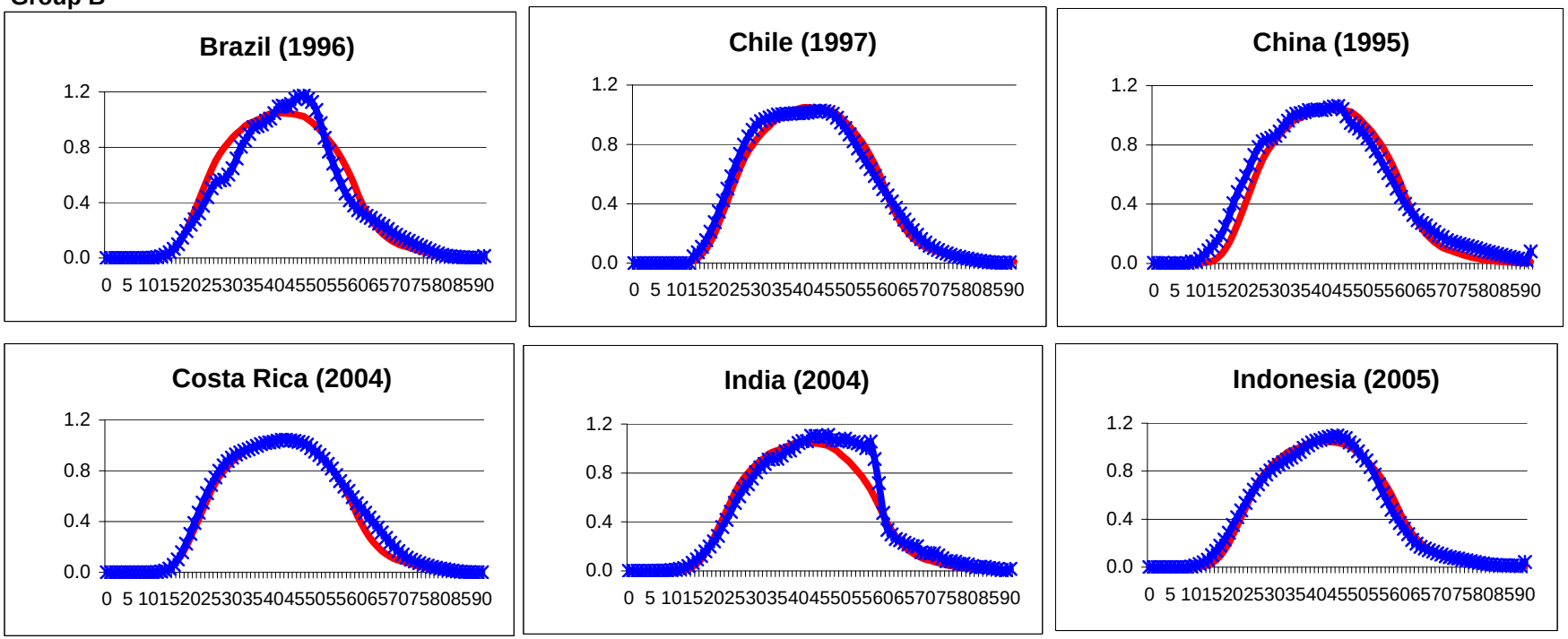
Skirbekk, V. 2003. "Age and Individual Productivity: A Literature Survey." *MPIDR Working Paper* 2003-028. (Max Planck Institute for Demographic Research, Rostock.)

Figure 1. Per Capita Labor Income Profie, 5 Groupings

Group A



Group B



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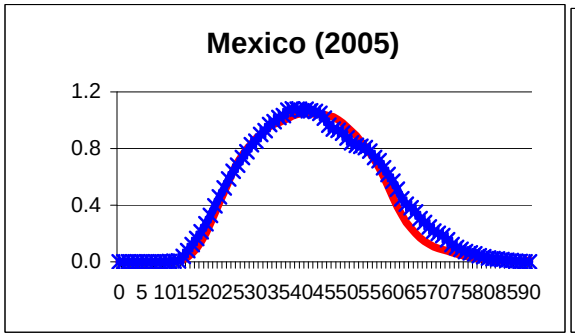

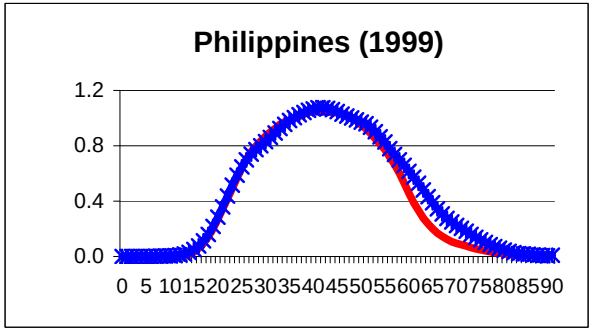

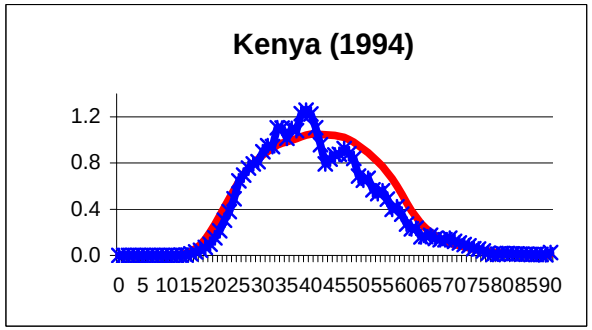

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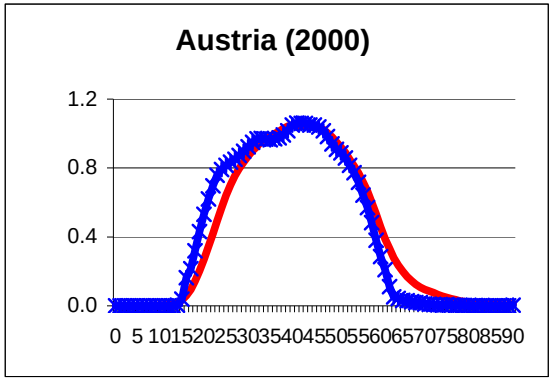

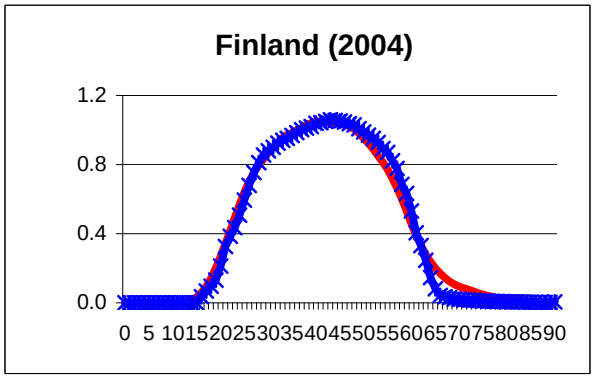

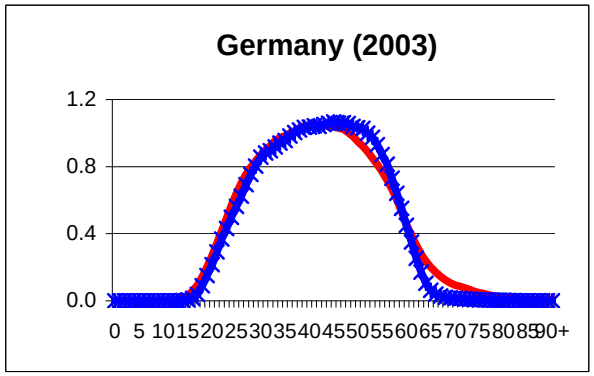

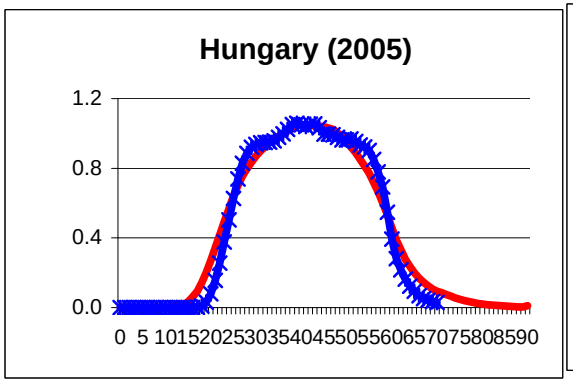

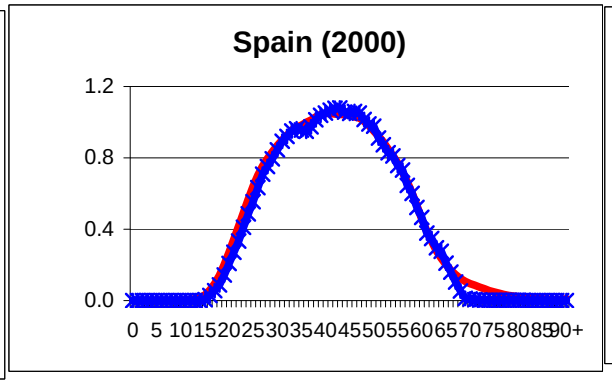

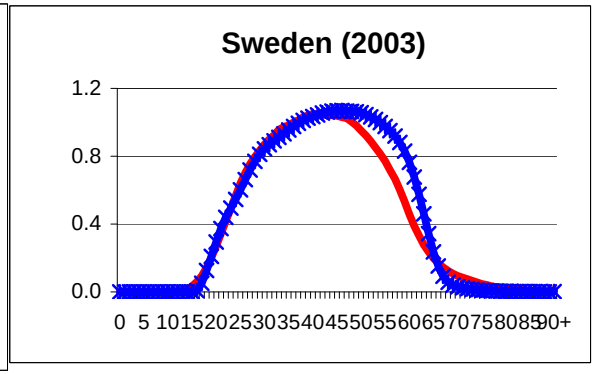

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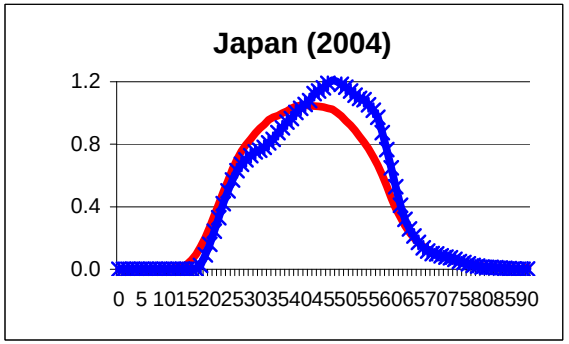

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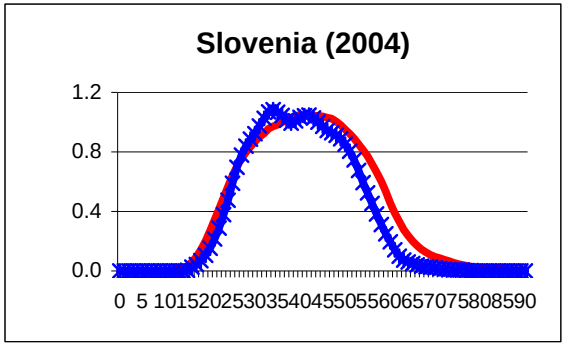

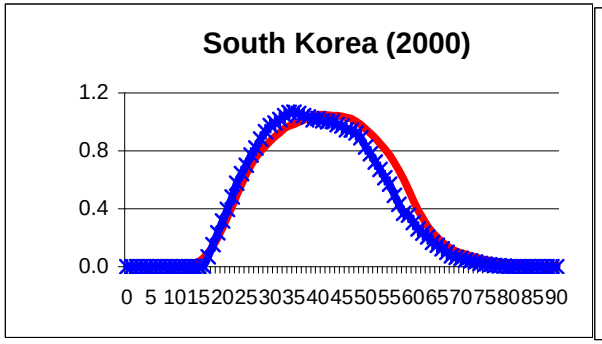

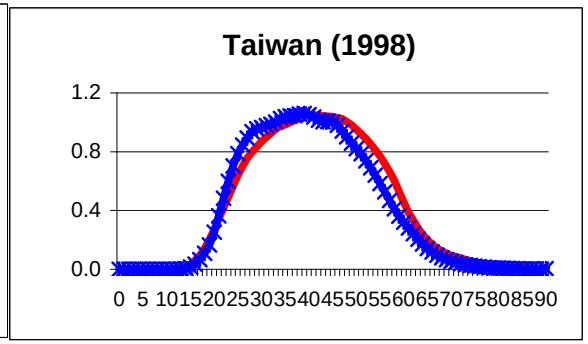

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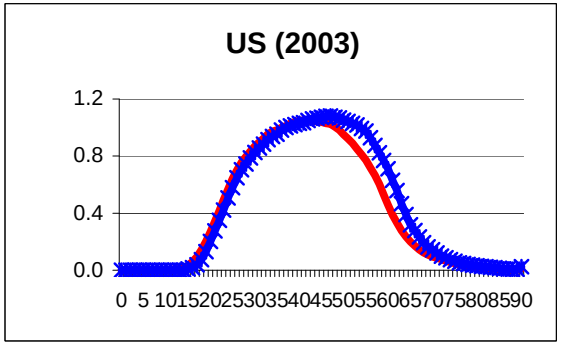
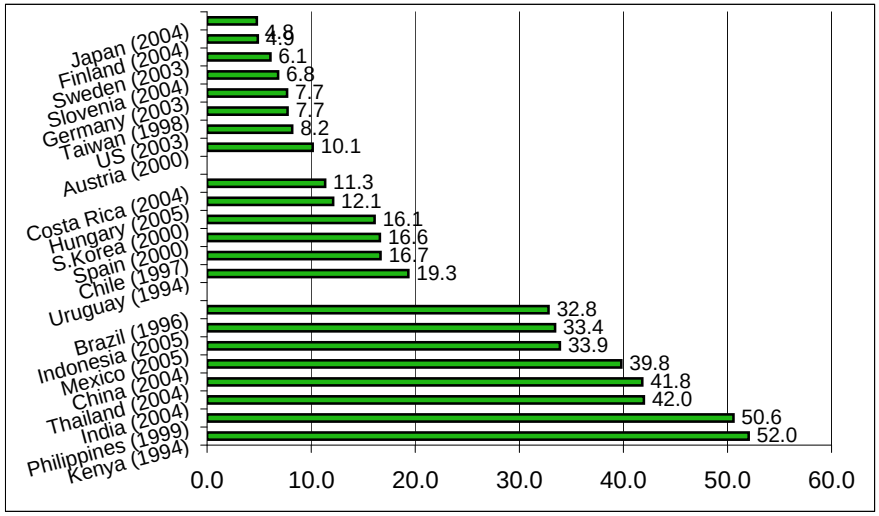


Figure 2. Ratio of Self-Employment Income to Labor Income by Age (%), 3 Groupings

All Group (A)



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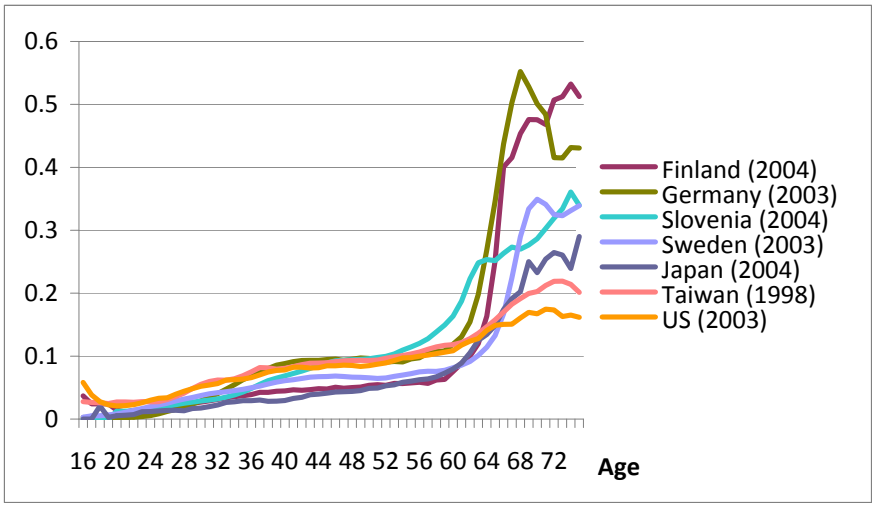

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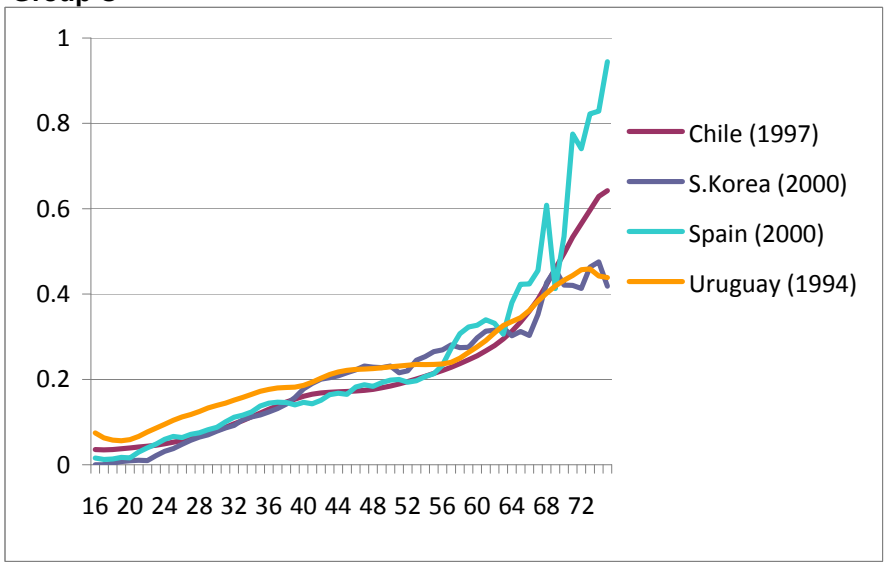

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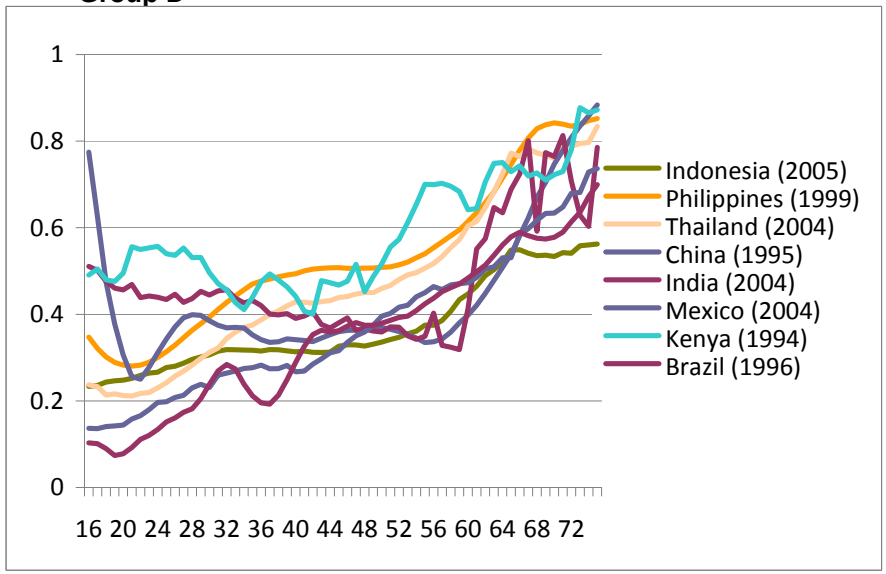

Figure 3. Decomposition of Labor Income: Avergage Productivity vs. Activity Rate: Austria, Kenya, South Korea, and Taiwan

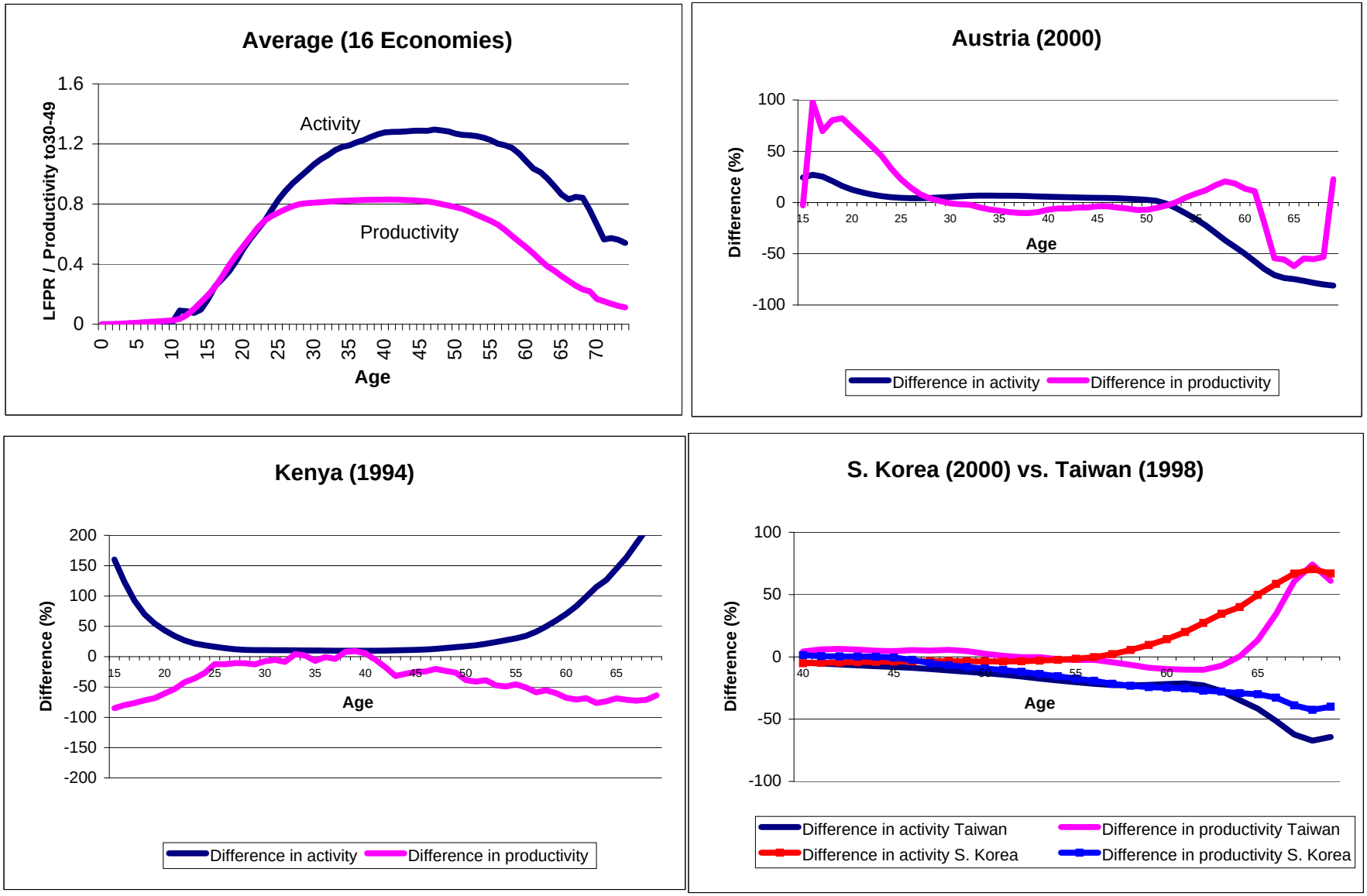

Figure 4. Labor Income as a Source of Funding Consumption for Ages 65-74: Before and After Delaying Retirement by 2 Years

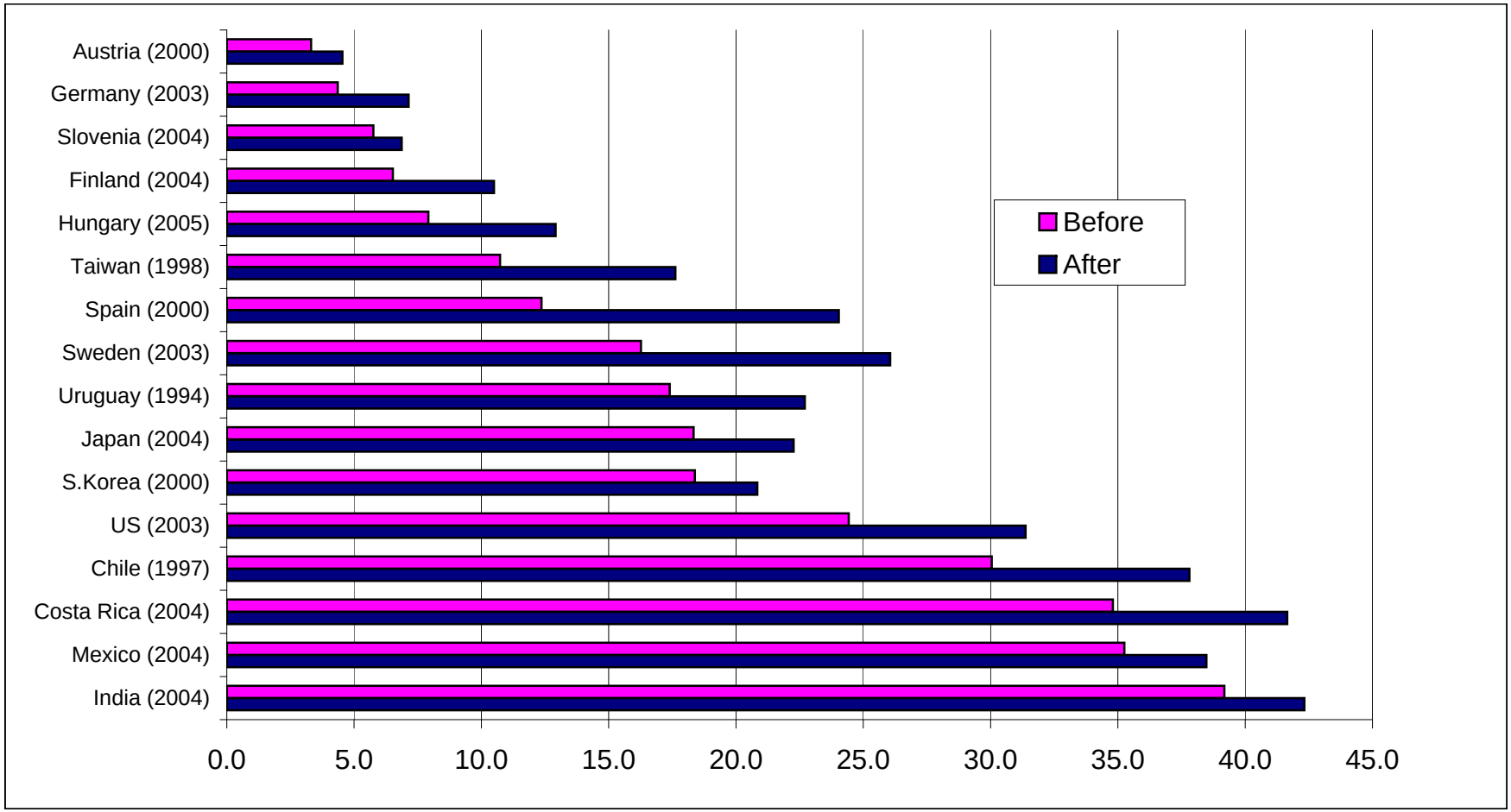

Figure 5. Social Security Contribution as a Percent of GDP and Labor Income as Old Age Support System