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How much do tax-benefit policies of East Asian countries equalize opportunities among their citizens?

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Abstract

Employing the method of Roemer et al. (2003), the present paper studies the extent to which tax-benefit policies of three East Asian countries – Korea, Japan, and Taiwan – equalize opportunities among their citizens for income acquisition. According to Roemer et al. (2003), equality of opportunity for income acquisition is achieved in a country when it is the case that the distributions of post-fisc income are the same for different types of citizens in that country, where a citizen's type is defined by the socio-economic status of his/her parents.

We classify types according to the level of parents' education. In terms of the optimal tax rates required for equalizing opportunities for income acquisition among citizens, the level of unequal opportunity in Korea and Taiwan are found to be similar to those of Spain, Italy, and the United States reported in Roemer et al. (2003). The observed tax rates in these countries are, however, lower than those of the aforementioned three countries, and there are very large differences between the optimal and the observed tax rates. This implies that the tax-benefit policies of Korea and Taiwan have played very little role in correcting unequal opportunities for income acquisition among their citizens. Japan is different; the EOp tax rate is less than the observed tax rate or equal to zero. This is because the individuals classified as the least advantaged type in Japan are much better off than those in Korea and Taiwan, due to data availability.

Our analysis also implies that relatively equal distribution of outcomes in East Asian countries is not due to small variation in outcomes *across types*, but perhaps due to small variation in outcomes *across effort levels* in each type.

Keywords: Fiscal regimes, equality of opportunity, earnings distribution

JEL Classification: D63, H00

1. Introduction

For the last four decades or so, the economic success stories of East Asian 'miracle' countries – such as Japan, Korea, Taiwan, Singapore, and recently China – have been well documented and widely discussed among scholars and policy makers. These countries have experienced not just fast growth; the fast growth was accompanied by relatively equal distribution of income and a high level of school enrollment.

Little has been known about the extent to which opportunities are equal in these countries among their citizens. The current paper aims at filling this gap by carrying out an empirical analysis for three of these miracle countries. Using micro-survey data sets of Korea, Japan, and Taiwan, we examine how unequal opportunities are in these countries for income acquisition among their citizens, and calculate the extent to which their tax-benefit policies correct those unequal opportunities. To the best of our knowledge, our work is the first systematic empirical investigation of the opportunity-equalizing effect of fiscal policies in East Asian countries.

Inequality in income or wealth has many causes, and there is no *a priori* reason to believe that a country with a relatively low level of inequality of a final outcome will also have a relatively low level of inequality of opportunities for that outcome. Suppose a society's reward scheme is such that it shrinks the variation in outcomes across effort levels while increasing the variation in outcomes due to differential circumstances, such as family backgrounds. That society might have a high level of opportunity inequality and a low level of outcome inequality. The present paper examines the extent to which relatively equal distribution of income of

the three East Asian countries has been accompanied by equality of opportunities for income acquisition among their citizens.

There is a spectrum of views regarding what defines opportunities and what is required for equalizing opportunities (Lefranc, Pistolesi, and Trannoy, 2006). The present paper adopts the conception of equal opportunity proposed by Roemer (1993, 1998).[1]

Roemer's theory of equality of opportunity consists of five vocabularies: objective, circumstances, type, effort, and policy. (See Roemer (1993, 1998) for details.)

The *objective* is the aspect of individual well-being (e.g., income, educational achievement) for whose acquisition a society desires to equalize opportunities. *Circumstances* are attributes of the environment of the individuals (e.g., family background such as the level of parent's education or wealth) that affect the extent of their achieving the objective, and which are beyond their control. A *type* is the set of individuals in the society who share the same circumstances; circumstances partition the set of individuals into types. *Effort* is constellation of behaviors, which, together with circumstances, will determine the value of the objective. The *policy* is an instrument of compensating individuals with disadvantageous circumstances, which a society uses in order to improve their chances of realizing an acceptable level of the objective.

In Roemer's definition, equality of opportunity for a certain objective is achieved when the values of the objective are equal for all those who exercised a 'comparable' degree of effort, regardless of their circumstances. The aim of

[1] See also Arneson (1989), Cohen (1989), and Dworkin (1981a, b) for philosophical discussion on equal opportunity.

Roemer's equal opportunity is not to hold persons responsible for characteristics which are due to their being in a disadvantaged type. Thus a policy equalizes opportunities if it makes the achievement of the objective of individuals be a function only of their efforts, not of their circumstances.

A tricky part in any theory of equal opportunity is to decide when two people in differential circumstances have exercised a 'comparable' degree of effort. Effort is a multi-dimensional set of responsible behaviors, including the acquisition of skill, intensity of job search, etc., which engender the final outcome of income acquisition. It should not merely be 'labor hours' or 'intensity of labor,' for two people, by virtue their different circumstances, may exercise very different amounts of labor. Roemer (1993, 1998) propose that we measure a person's effort by the quantile at which he or she sits on the distribution of his or her type, for the quantile measure ranks a person's effort by comparing him/her only to others of his/her own type. It turns out that effort in the Roemer's theory is the residual that explains differential outcomes, once circumstances have been delineated.[2]

If the number of types is significantly small compared with the total number of individuals, there will usually be a large number of individuals in each type and thus there will ensue some distribution of the objective for each type. If some types have 'better' distributions of the objective than others, this must be due to their better circumstances. On the other hand, the differential outcomes of these individuals within a type are attributed to differential effort.

One advantage, among others, of the Roemer's approach is that it is a *computable* concept of equality of opportunity. Indeed Roemer et al. (2003)

[2] Thus random *luck*, another determinant of an outcome, appears as effort in their theory. But this may not be a bad aspect of their theory, for it may average out across individuals.

empirically examine, for eleven Western countries, the extent to which fiscal policies equalize opportunity for income acquisition among citizens.[3] Kim and Lee (2009) apply Roemer's method to Korean data. The present paper employs the same method to the data sets of Korea, Japan, and Taiwan, and compares the main results with those reported in Roemer et al. (2003).

In section 2, we briefly review Roemer's general theory of equal opportunity, and summarize the specific model that Roemer et al. (2003) and we use in estimating the extent to which fiscal policies equalize opportunities for incomes among citizens. Section 3 describes data, explains our method of data analysis, and reports on our major results. Section 4 concludes.

2. A brief review of Roemer's theory of equal opportunity

In this section, we summarize Roemer's approach to equal opportunity. After briefly outlining the general theory according to Roemer (1993, 1998), we present a specific application explained in Roemer et al. (2003), the model of which is used in the present paper. Readers are referred to Roemer (1993, 1998, 2003) for further details.

To be concrete, we assume circumstances of individuals are given by the level of parents' education. Suppose $v^{\theta}(\pi,\varphi)$ is the value of the objective (e.g., the level of post-fisc income) at the π^{th} quantile of the distribution of the objective in type θ at the government policy φ, where $\pi \in [0,1]$. Roemer (1993, 1998) attribute the variation of the objective among those within a type to differential effort,

[3] See Aaberge et al. (2001), Dardanoni et al. (2005), and World Bank (2008) for related work.

and identify all those who sit at the π^{th} quantile of their type distributions of the objective as having expended effort in the comparable degree.

Conceptually, equal opportunity is achieved by choosing a policy φ that equalizes the value of the objective across types at any given degree of effort π. We may achieve such equalizing *in an efficient way* by maximizing the minimum achievement level of the individuals, across all types, at the specific effort level in question. In other words, we may wish to choose a policy φ that will maximize:

$$\underset{\theta}{Min}\, v^{\theta}(\pi,\varphi). \tag{1}$$

Unfortunately, there will, in general, be a continuum of such policies, one for each $\pi \in [0,1]$. The first-best solution to the problem is achievable only when all these policies, φ^{π}, are identical for all π. Because we cannot expect this in general, we need a compromise. Roemer (1993, 1998, 2003) propose that a policy be chosen that will maximize a social objective function:

$$\int_0^1 \underset{\theta}{Min}\, v^{\theta}(\pi,\varphi)d\pi\,. \tag{2}$$

A policy that maximizes equation (2) is what Roemer calls the policy that equalizes opportunities. An underlying assumption behind this formulation is that the objective function of the citizens in each quantile, namely $\underset{\theta}{Min}\, v^{\theta}(\pi,\varphi)$, receives the same weight in an additive social objective function.[4]

Thus Roemer's program of equal opportunity is 'Rawlsian' with respect to outcomes attributable to differential circumstances, but 'utilitarian' with respect to

[4] We assume that π is a continuum. If we take π to be discrete, running from 1 to 100, then it becomes $\frac{1}{100}\sum_{\pi=1}^{100} \underset{\theta}{Min}\, v^{\theta}(\pi,\varphi)$.

outcomes attributable to differential effort. It puts great value on reducing differences due to differential circumstances, but makes no effort to shrink the variation in outcomes across effort levels. Roemer's conception of justice reflects the view that differences in outcomes due to differential effort are ethically acceptable.

Roemer et al. (2003; p. 545) make a heuristic comparison between his equal opportunity algorithm and a familiar conception of equality of opportunity, one based on mobility matrices. If we think of a mobility matrix whose rows are labeled 'socio-economic status of the family a person comes from' and whose columns are various income levels, element (i, j) of the matrix is the fraction of individuals from families whose parents were of socio-economic status i and who end up earning income level j. If equality of opportunity holds, then the rows of this matrix will be identical; that is, the distribution of income is the same for the types who come from different social backgrounds.

Roemer et al. (2003) apply the above-mentioned general theory to a specific example; they compute the opportunity-equalizing tax policy, and compare it with the actual – i.e., observed – tax policy to evaluate the extent to which fiscal policies in a country equalizes opportunity for income acquisition among its citizens.

Roemer et al. (2003) assume that individuals are equipped with the following quasi-linear utility function:

$$u(y, L) = y - \alpha L^{1+\frac{1}{\eta}}, \tag{3}$$

where *y* is post-fisc income (i.e., consumption) and *L* is the amount of labor hours.

Assume that a fiscal policy is well approximated by an affine tax-transfer scheme. Suppose $y = (1-t)wL + T$ is the post-fisc income of a citizen who earns a wage of w, and faces a tax policy of $\varphi = (t, T)$, where t is the marginal income

tax rate and *T* is the per capita transfer payments.

Given a tax policy of $\varphi = (t, T)$, his/her optimal labor supply is

$$L(w;t) = \left(\frac{(1-t)w}{\alpha(1+1/\eta)} \right)^{\eta}, \tag{4}$$

and the associated optimal pre-fisc income is

$$x(w;t) = wL(w;t) = \left(\frac{1-t}{\alpha(1+1/\eta)} \right)^{\eta} w^{1+\eta}. \tag{5}$$

We have $y(w;t,T) \equiv (1-t)x(w,t) + T < y$ if and only if

$$w < \left(\frac{(y-T)(\alpha(1+1/\eta))^{\eta}}{(1-t)(1-t)^{\eta}} \right)^{\frac{1}{1+\eta}}. \tag{6}$$

Thus the distribution function of post-fisc income in type θ at policy t is

$$G^{\theta}(y) = F^{\theta}\left(\left(\frac{(y-T)(\alpha(1+1/\eta))^{\eta}}{(1-t)(1-t)^{\eta}} \right)^{\frac{1}{1+\eta}} \right), \tag{7}$$

where F^{θ} is the wage distribution in type θ.

Roemer et al. (2003) restrict their search to the opportunity-equalizing policies that are *revenue neutral*, by keeping constant the government revenue used for non-transfer-payment purposes. If *S* is the value of government services (capturing non-transfer payments) per capita and *F* is the entire distribution of wages, then the government budget constraint is

$$T + S = t \int \left(\frac{1-t}{\alpha(1+1/\eta)} \right)^{\eta} w^{1+\eta} dF(w), \tag{8}$$

and thus

$$T(t,S) = t\left(\frac{1-t}{\alpha(1+1/\eta)}\right)^{\eta}\int w^{1+\eta}dF(w) - S\,. \tag{9}$$

This means that for *S* and *F* given, the policy space is uni-dimensional.

Now post-fisc income at the π^{th} quantile of the distribution in type θ at the policy t is $v^{\theta}(\pi,t)$ defined by:

$$\pi = F^{\theta}\left(\left(\frac{(v^{\theta}(\pi,t)-T(t,S))(\alpha(1+1/\eta))^{\eta}}{(1-t)(1-t)^{\eta}}\right)^{\frac{1}{1+\eta}}\right). \tag{10}$$

The equal opportunity fiscal policy is then the tax rate that maximizes

$$\int_0^1 \underset{\theta}{Min}\, v^{\theta}(\pi,t)d\pi\,. \tag{11}$$

In general, the distribution function of pre-fisc income of the worst-off type will cross with the distribution functions of other types. In our application as well as Roemer et al. (2003)'s, however, the empirical distribution function of pre-fisc income of the worst-off type *does not* cross with the empirical distribution functions of the other types in almost all cases. (See Figure 2 of the present paper.) This means that the equal opportunity tax policy is equivalent to the tax policy that maximizes the average post-fisc income of the worst-off type at policy t:

$$\begin{aligned}&\int_0^{\infty}\Big((1-t)x(w;t)+T(t,S)\Big)dF^1\\ &=(1-t)\left(\frac{1-t}{\alpha(1+1/\eta)}\right)^{\eta}\int w^{1+\eta}dF^1 + t\left(\frac{1-t}{\alpha(1+1/\eta)}\right)^{\eta}\int w^{1+\eta}dF(w) - S.\end{aligned} \tag{12}$$

Thus the opportunity-equalizing fiscal policy is

$$t^{EOP} = Max[1-\frac{\eta B}{(1+\eta)(B-A)},0]\ \ , \tag{13}$$

where $A=\int w^{1+\eta}dF^1$ and $B=\int w^{1+\eta}dF$.

Typically *B* will be significantly larger than *A*. In this case $t^{EOP} > 0$. But if the distribution of wages of the worst-off type is not very different from the distribution of wages of the whole society, then $B - A$ will be small, and thus $t^{EOP} = 0$. This means that there should be no redistributive taxation to equalize opportunities for income; there is so little inequality of opportunity, pre-fisc, and thus any taxation would be counter-productive, given the deadweight losses incurred.

Roemer et al. (2003) compute one more tax rate, which they call a benchmark policy. A benchmark policy is the tax rate such that

$$T = t\left(\frac{1-t}{\alpha(1+1/\eta)}\right)^{\eta} \int w^{1+\eta} dF(w) - S = 0\,. \tag{14}$$

Thus the benchmark tax rate, t^{Bench}, is one that would just suffice to raise government expenditures of *S* per capita and make no inter-citizen transfers.

Roemer et al. (2003) also construct an index of measuring the extent to which fiscal regimes equalize opportunities for income acquisition as follows. Suppose $Y(t^{Obs})$, $Y(t^{EOp})$, and $Y(t^{Bench})$ are the average post-fisc income of the worst-off type at the observed (actual) policy, the EOp policy, and the benchmark policy, respectively. They define a measure:

$$\nu = \frac{Y(t^{Obs}) - Y(t^{Bench})}{Y(t^{EOp}) - Y(t^{Bench})}. \tag{15}$$

If $\nu = 0$, then the observed fiscal policy is the benchmark policy, and if $\nu = 1$, the the observed policy is the EOp policy. Thus ν can be thought of as the extent to which the observed policy achieves EOp, relative to the benchmark of no transfers.

Roemer et al. (2003) also inquire into the efficiency cost of achieving equality of opportunity. They ask: how much would national income shrink (expand)

if we were to pass from the present policy to the EOp policy? They define the efficiency of the EOp policy as:

$$\varepsilon = \frac{\int x(w;t^{EOp})dF}{\int x(w;t^{Obs})dF}, \tag{16}$$

which is just the ratio of average pre-fisc incomes at the EOp and the observed policies. If $\varepsilon < 1$, then there is some cost in moving from the observed policy to the EOp policy, and if $\varepsilon > 1$, there is an increase in average incomes in that move.

3. Data analysis

3.1 Data sets

Our empirical analysis uses three micro survey data sets: (i) the Korea Labor and Income Panel Study (KLIPS), compiled by the Korea Institute of Labor Studies; (ii) the Keio Household Panel Survey (KHPS), compiled by Keio University of Japan; and (iii) the Pane Study of Family Dynamics (PSFD), compiled by Academia Sinica of the Republic of China (Taiwan).

The three data sets contain the information about pre-fisc incomes of individuals and households, personal and household characteristics (age, years of schooling, the number of household members, etc.), and family backgrounds (such as parents' education).

The years studied are 2003-2006 for Korea, 2004 for Japan, and 2003 for Taiwan. Thus the data set of Korea covers four years, while those of Japan and Taiwan cover only one year. In the case of Korea, we construct three estimation periods by pooling samples of two adjacent years: 2003/04, 2004/05, and 2005/2006.

Pooling samples over two adjacent years would remove year-specific and transitory variation of incomes.

Our samples consist of individuals who are male household heads and 30-55 years old. They are people born approximately between 1950 and 1975. The sample sizes are 1643 for Korea (per year), 1193 for Japan, and 1038 for Taiwan.

Tax payments are surveyed in the Keio Household Panel Survey, but are not surveyed in the other two data sets. To maintain consistency, we thus simulate tax payments in all countries, using tax codes of individual countries.[5] Social benefits received are, on the other hand, surveyed in all of the data sets.

Table 1 summarizes our data sets.

[Table 1 about here]

3.2 Incomes

As in Roemer et al. (2003), we use two definitions of income: standard income (ST-income) and equivalence income (EQ-income).

Pre-fisc standard income is the sum of the individual's labor income and his/her household capital income per adult. Capital income is the sum of interest income, dividend income, rental income, and other financial income. Capital gains/losses, fringe benefits, imputed rents, and incomes from home production are not included; information on them is not available. Most individuals in our sample

[5] The reported taxes in surveys are often inaccurate. The reported tax payments are very likely to under-estimate the taxes paid by high income groups and those paid by the self-employed, whose tax evasion is widespread in East Asian countries. If we used reported tax payments, tax payments would be under-estimated and thus the extent to which actual tax systems achieve equalization of opportunities for income acquisition would probably be more than what our estimates would indicate.

have no capital income; the median capital income in Korea is, for instance, zero. The average number of adults is 2.335 in Korea (as of 2004), 1.93 in Japan, and 1.98 in Taiwan.

Pre-fisc equivalence income is the sum of household labor and capital income adjusted by the equivalence scale (the square root of the household size). Thus the EQ-income takes account of differences in household needs. The average household size is 3.20 (as of 2004) in Korea, 3.36 in Japan, and 3.80 in Taiwan.[6]

Post-fisc incomes are calculated by adding cash transfers and social insurance benefits to, and subtracting income taxes and social insurance contributions (such as pensions, health insurance premiums, unemployment insurance premiums, etc.) from, pre-fisc incomes.

All incomes are expressed per annum terms in local currencies; they are expressed in ten thousands of Korean Won, thousands of Japanese Yen, and thousands of New Taiwanese dollar. As of 2004, one Japanese Yen is approximately 10 Korean Wons and one Taiwanese dollar is about 34 Korean Wons. One US dollar is approximately 1145 Korean Wons, 108 Japanese Yens, and 33.4 Taiwanese dollars. (See Table A-1 for some macroeconomic statistics for the three countries at 2004.) Korean incomes are expressed in real terms using the consumer price index (with 2004=100).

Table 2 reports summary statistics of pre-fisc ST- and EQ-incomes for the

[6] For Korea, we include all household members. For Japan and Taiwan, on the other hand, household members are restricted to a couple (if married) and their children (if they have children). We exclude parents and other household members, for the surveys do not provide detailed income information of each household member. Adults also include only a male head and his wife in Japan and Taiwan.

three countries.

[Table 2 about here]

The mean ST-income is 29,047,500 Wons (about $25,361) for Korea (2004/05), 5,832,710 Yens (about $53,911) for Japan, and 609,840 NT dollars (about $18,242) for Taiwan. The ratio of median ST-income to mean ST-income is 0.86 for Korea (2004/05), 0.86 for Japan, and 0.82 for Taiwan. Income inequality, measured by the Gini coefficient, is the lowest in Japan (0.2733), followed by Taiwan (0.3742). Korea has the highest level of income inequality (0.3809) in terms of the Gini coefficient.

Our data sets show that Taiwanese income ($18,242) is much lower than Korean income ($25,361), although actual GDP per capita of Korea and Taiwan is very close each other. According to Table A-1, for instance, real GDP per capita of Korea is $21,330.22 and that of Taiwan is $23,693; Taiwan's real GDP per capita is slightly bigger than that of Korea. There are two reasons for this discrepancy. First, the GDPs in Table A-1 are adjusted by the Penn World Table's international price index, whereas the numbers in Table 2 are not adjusted. Indeed, unadjusted GDP per capita (calculated from the World Development Indicators) is $15,243 for Korea and $14,985 for Taiwan in 2004; thus Taiwan's unadjusted GDP per capita is slightly lower than that of Korea. Second, incomes in our data sets are those for male household heads. Female labor participation rate and female wages are higher in

Taiwan than in Korea.[7]

3.3 Types

Roemer et al. (2003) partition the entire sample into types using two typologies: one according to the level of education of the more highly educated parent and the other according to the parents' occupation (farmers, unskilled manual workers, skilled manual, and professionals and self-employed). In this paper, we use only the former typology.

We partition the sample into three types (Edu_Pa1 to Edu_Pa3) according to the level of education of the more highly educated parent in Korea, and that of father in Japan and Taiwan. Mother's schooling years are surveyed in the KHPS and the PSFD, but using them reduces sample sizes significantly. In East Asian countries the more highly educated parent is usually a father. The probability that the level of father's education is greater than or equal to the level of mother's is 90.8% in Korea, 88.3% in Japan, and 84.6% in Taiwan. Information on whether one's parent is a school dropout is available in Korea, while this information is not available in Japan and Taiwan. We use the school dropout information only in Korea.

In contrast with many Western countries, the level of parents' education in these countries is very low for the individuals born between 1950 and 1975, reflecting the low level of economic development of the three countries in those years. Indeed many individuals in Korea and Taiwan have parents who have no formal education at all. (Most of their parents are born before 1945.)

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[7] Note that GDP per capita is equal to $w_m \frac{L_m}{Pop} + w_f \frac{L_f}{Pop}$, where w_i is gender i's average wages and L_i / Pop is gender i's labor force participation rate.

In Korea, Edu_Pa1 consists of those individuals whose parent (the more highly educated one) has schooling years less than 6 (no formal education or incomplete primary education), Edu_Pa2 consists of those whose parent has primary and junior-high school education (6-9 years of schooling), and Edu_Pa3 consists of those whose parent's schooling years are greater than or equal to 10 (at least one year of high school education and above). In Taiwan, the three types are classified as follows: Edu_Pa1 consists of individuals whose father's schooling years are less than 6 (no formal education or incomplete primary education), Edu_pa2 consists of individuals whose father's schooling years are between 6 and 12 (primary school, junior high school, or high school education), and Edu_Pa3 consists of individuals whose father's schooling years are greater than 12 (more than high school education). In Japan, Edu_Pa1 consists of those individuals whose father has schooling years less than or equal to 11 (no formal education, primary school education, junior high school education, or high school dropouts), Edu_Pa2 consists of those individuals whose father has 12-15 years of schooling (high school education and college dropouts), and Edu_Pa3 consists of those whose father's schooling years are greater than or equal to 16 (college education or higher).

The cutoff schooling year between Edu_Pa1 and Edu_Pa2 in Japan is very high, compared with those in Korea and Taiwan. This is mainly due to data availability. The KHPS does not provide detailed information about parents' education; it surveys the level of father's education starting only from junior high school graduation. Even if we take into account the fact that Japan has always been more advanced than Korea and Taiwan at least for the last 150 years, we suspect that this cutoff level is somewhat high. Because of this high cutoff level, the individuals

in the least advantaged type in Japan (Edu_Pa1) are, we conjecture, much better off than those in the least advantaged types in Korea and Taiwan. Our results in Japan must be interpreted with some caution.

Descriptive statistics by type are reported in Table 3.

[Table 3 about here]

Table 3 clearly shows that mean pre-fisc incomes are quite different across types in all of the three countries. In other words, circumstances significantly affect individual and household incomes in Korea, Japan, and Taiwan. The ratio of the average type 1 ST-income to the average type 3 ST-income is 0.73 in Korea (for 2004/05), 0.79 in Japan, and 0.52 in Taiwan. The same ratio for EQ-income is 0.67 in Korea, 0.87 in Japan, and 0.47 in Taiwan.

One might wonder whether this difference reflects different labor market experience of the individuals across types. This is not the case. In our samples, individuals in Edu_Pa3 are somewhat younger than those in Edu_Pa1; the higher average income of the former group cannot be due to more labor market experience. Rather, because of this age discrepancy, our sample is more likely to underestimate the degree of unequal opportunities among the three types. That is, were our samples to contain Edu_Pa3 type individuals of the same age as Edu_Pa1 type individuals, observed income differences would be greater.

Figure 1 plots estimated kernel density functions of pre-fisc incomes (log transformed incomes) for the three types, and Figure 2 plots empirical distribution functions of pre-fisc incomes for each of the three types. In both figures, the top

panels correspond to ST-incomes and the bottom panels correspond to EQ-incomes.

[Figures 1 and 2 about here]

In all of the three countries, density functions are distinctively different across types. Also the distribution function of type 1 is first-order stochastically dominated by the distribution function of the other two types (except in Japan, where distributions functions slightly cross at very low levels of income). We also find that in Korea, where four years are covered, the gap between the distribution function of type 1 and the distribution functions of the other types has been widened over time.

The importance of circumstances on individual achievement is shown also in Table 4, which reports on the conditional probabilities of education.

[Table 4 about here]

The probability that a type 1 individual will have the highest level of education is very low (18% in Korea, 24% in Japan, and 11% in Taiwan), while the probability that a type 3 individual will have the highest level of education is very high (71% in Korea, 75% in Japan, and 62% in Taiwan). Conversely, the probability that a type 1 individual will have low levels of education is very high and the probability that a type 3 individual will have low levels of education is very low.

We also examined the relationship between parents' education and respondent's income. In Korea, the probability that a type 1 individual will belong to the first quartile of ST-income distribution is 32.8%, whereas the probability that the

same individual will belong to the fourth quartile of the ST-income distribution is 18.22%. On the other hand, the probability that a type 3 individual will belong to the first quartile of ST-income distribution is 18.22%, while the probability that the same individual will belong to the fourth quartile of the same income distribution is 33.01%. Similar patterns are observed in Japan and Taiwan. (See Table A-3 for details.)

Summarizing, parents' education has a great impact on individual incomes in all of the three East Asian countries.

3.4 Observed tax functions

In order to obtain estimates of the actual mapping of pre-fisc incomes into net taxes, we regress individuals' net taxes on their pre-fisc incomes:

$$\text{Net taxes} = -a + b * (\text{Pre-fisc income}). \tag{17}$$

The estimated value of a is the observed value of T and that of b is the observed value of the marginal income tax rate (*t*).

In Roemer et al. (2003), t is the marginal 'income' tax rate. One might argue that indirect taxes are as important as income taxes in Korea, Japan, and Taiwan.

We can easily incorporate indirect taxes into the model so that t measures the 'effective' marginal income tax rate. Suppose the total amount of transfer payments, T, is divided into 'cash transfers', $T_1 = \gamma T$, and 'non-cash transfers,' $T_2 = (1-\gamma)T$, where $\gamma \in [0,1]$ is the proportion of cash transfers in total transfers. Then given the marginal income tax rate t_W, the disposable income is

$(1-t_W)x+T_1$, and the post-fisc income is obtained by subtracting indirect taxes paid from and adding non-cash transfers to the disposable income. Thus if d is the proportion of indirect taxes paid in the total disposable income, then we have:

$$\begin{aligned} y &= (1-t_W)x+T_1-d((1-t_W)x+T_1)+T_2 \\ &= (1-t_W-d+t_Wd)x+(1-\gamma d)T. \end{aligned} \tag{18}$$

Thus the effective marginal tax rate is t_W+d-t_Wd and the effective amount of transfer payments is $(1-\gamma d)T$. Alternatively speaking, each individual pays taxes of $(t_W+d-t_Wd)x+\gamma dT$ and receives transfer payment of T. Because t_Wd is usually small, the effective marginal tax rate is close to $t=t_W+d$.

Table 5 reports values of d and γ as well as those of S, estimated using the National Income and Product Accounts and the Government Revenue Statistics.

[Table 5 about here]

Table 6 reports observed affine tax functions, estimated according to equations (17) and (18). The first row reports the tax rate in (17) and the second in (18). Figure 3 plots tax functions estimated according to equation (17), together with a quadratic and non-parametric fits.

[Table 6 about here]

[Figure 3 about here]

We find that fiscal policies in the three East Asian countries are somewhat

progressive; Figure 3 clearly shows that estimated tax functions are convex. Coefficients for quadratic regression equations are also all statistically significant. Nonetheless the affine fit is very good. The R^2 is greater than 0.8 in all countries, and the regression with the quadratic or cubic terms does not add much explanatory power. (See Table A-4.) If we eliminate some excessively high incomers, then the affine fit, the quadratic fit, and a non-parametric fit would almost coincide.

The estimated marginal income tax rates are 22-23% (ST-income) and 20-23% (EQ-income) in Korea, 28% (ST-income) and 31% (EQ-income) in Japan, and 28% (ST-income) and 25% (EQ-income) in Taiwan. Recall that in the case of Korea, where several years are covered, we pooled samples of every two adjacent years; the time variation in estimated tax rates is due neither to varying sample sizes nor to sample units.

It is well known that OLS regressions are not robust; OLS regression results are highly sensitive to a small number of outliers. Figure 3 shows that there are a small number of observations with very high income. To see whether our estimated tax rates are influenced by these observations, we ran median regressions as well. (See Table A-5.) Median regressions somewhat reduce the estimated tax rates. The estimated tax rates are 15.3-16.3% (ST-income) and 15.1-15.2% (EQ-income) in Korea, 24.1% (ST-income) and 25.9% (EQ-income) in Japan, and 20.0% (ST-income) and 19.2% (EQ-income) in Taiwan.

We conjecture that the actual tax rates lie somewhere between the OLS and the median regression estimates. For the sake of comparison with the results reported in Roemer et al. (2009), we choose the OLS regression estimates.

3.5 EOp tax rates

We now estimate the EOp tax rates using equation (13). For that, there appear to remain two parameters to be estimated: η and α.

Note that parameter η is the elasticity of labor supply with respect to the wage. (Recall equation (4).) Accurate estimation of the elasticity of labor supply is extremely difficult; estimated elasticities greatly vary depending upon the methods and the data sets employed. As in Roemer et al. (2003), we thus choose, rather than estimate, the parameter values of η between 0.03 and 0.09. The benchmark value of η is 0.06.

Roemer et al. (2003) estimate the parameter value of α by assuming that the individual with median income work 1 unit of time: $\left(\frac{(1-t^{obs})x_{med}}{\alpha^{obs}(1+1/\eta^{obs})}\right)^{\eta^{obs}} = 1$. Using the estimated values of α^{obs}, and t^{obs}, they then deduce the distribution of wages from the distribution of pre-fisc incomes. We argue that this step is unnecessary for the calculation of the EOp tax rate. Although *A* and *B* in equation (13) depend upon the estimated values of α^{obs} and t^{obs}, the optimal EOp tax rate is independent of the estimated values of these parameters.

To see this, define $K^{obs} \equiv \left(\frac{1-t^{obs}}{\alpha^{obs}(1+1/\eta^{obs})}\right)^{\eta^{obs}}$. Roemer et al. (2003) calculate wages from the following equation: $w^{1+\eta} = \frac{1}{K^{obs}}x$. Thus estimated wages depend on the estimated values of α^{obs} and t^{obs}. But if we denote the distribution function of x by $\Phi(.)$, then

$$A = \int_0^\infty w^{1+\eta} dF^1(w) = \frac{1}{K^{obs}} \int_0^\infty x d\Phi^1(x), \qquad (19)$$

and

$$B = \int_0^\infty w^{1+\eta} dF(w) = \frac{1}{K^{obs}} \int_0^\infty x d\Phi(x). \qquad (20)$$

Thus, although the estimated values of *A* and *B* depend on the estimated values of α^{obs}, and t^{obs}, their ratio, *A/B*, is independent of them. Because the optimal tax rate depends only upon *A/B* and η, the optimal tax rate is also independent of the estimated values of α^{obs} and t^{obs}.

In like manner, one can easily show that the estimated value of t^{Bench} does not depend upon the estimated value of α^{obs}, although it depends upon the estimated values of t^{obs} and η^{obs}.

Tables 7 and 8 report the calculated EOp tax rates, as well as other statistics, for three chosen values of η: $\eta = 0.03$, 0.06, and 0.09. For the sake of comparison, we also present the estimates for a few Western countries, reported in Roemer et al. (2003).

[Tables 7 and 8 about here]

The EOp tax rates are greater than observed tax rates in Korea and Taiwan. With the assumption of $\eta = 0.06$, the EOp ST-income tax rates are 61.3-64.0% in Korea and 80.9% in Taiwan. The EOp EQ-income tax rates are, on the other hand, 67.7-69.2% in Korea and 83.1% in Taiwan.

The levels of the EOp tax rates in Korea are similar to those of Spain (60.5% for ST-incomes and 55.6% for EQ-incomes), Italy (81.9% for ST-incomes and 82.9% for EQ-incomes), and the United States (64.7% for ST-incomes and not available for

EQ-incomes). Out of the eleven countries studied in Roemer et al. (2003), they are the three countries that have the highest EOp tax rates and the lowest level of equal opportunity. Our analysis thus indicates that opportunities in Korea and Taiwan are as unequal as those in the three countries.

The observed marginal tax rates in Korea and Taiwan are, however, about the same as or smaller than those in the three Western countries. In the case of ST-income, Korea has the lowest marginal tax rate (22.2-22.7%), followed by Italy (23.2%), the United States (24.3%), Taiwan (26.7%), and Spain (37.6%). This implies that tax-benefit policies in Korea and Taiwan have played very little role in correcting unequal opportunities for income acquisition among their citizens.

Japan is somewhat different from the other two East Asian countries. In terms of ST- and EQ-incomes, Japan's EOp tax rates are lower than its observed tax rates for both $\eta = 0.06$ and $\eta = 0.09$. Japan is certainly an egalitarian country, but this result is largely an artifact of an unusually high level of the cutoff schooling years that defines the least advantaged type in Japan.

Our assertion that Japan's cutoff schooling year between Edu_Pa1 and Edu_Pa2 is high can be confirmed from two sources.

First, the ratio of the average type 1 income to the average income is very high in Japan. The ratio of the average type 1 ST-income to the average ST-income is 0.84 in Korea (for 2004/05) and 0.71 in Taiwan, but is 0.93 in Japan. The same ratio for EQ-income is 0.82 in Korea and 0.68 in Taiwan, and 0.96 in Japan. Indeed, type 1 and type 2 distributions in Japan are almost identical according to Figure 2.

Second, the fraction of individuals in Edu_Pa1 is 0.22 in Korea and 0.28 in Taiwan, but is is close to 0.5 (0.49) in Japan.

Thus the results obtained from Japan are somewhat an artifact of the data availability, rather than the reflection of real equal opportunity in Japan.

4. Conclusion

Employing the method of Roemer et al. (2003), we estimated the extent to which tax-benefit policies of Korea, Japan, and Taiwan equalize opportunities among citizens for the acquisition of income. As in Roemer et al. (2003), we proceeded by singling out one obvious circumstance (i.e., parents' education), and attributing all remaining variation in incomes to differential effort. We find that opportunities in Korea and Taiwan are as unequal as those in Spain, Italy, and the United States, but the current fiscal policies in these East Asian countries have much smaller opportunity equalizing effects than the three Western countries.

We make two final remarks

First, it is well known that wage schemes in East Asian countries are largely determined by seniority, and wages across different occupations and effort levels are highly compressed. Such a highly compressed wage structure is one of the main reasons for why inequality is relatively low in East Asian countries. On the other hand, our analysis indicates that opportunities in these countries are not so equal. Thus our analysis implies that relatively equal distribution of outcomes in East Asian countries is not due to small variation in outcomes *across types*, but perhaps due to small variation in outcomes *across effort levels* in each type.

Second, one might argue that our exercise defines the feasible set of policies as affine taxation which is revenue neutral, with respect to the funding of non-

transfer payment government spending. Much of that spending will also have an equal-opportunity effect, such as money spent on education and health, and we have not attempted to estimate that effect. We can, however, observe the relative magnitudes of this spending by considering the benchmark situation, in which there are no cash transfers. The benchmark tax rate is in the range of 6.5%-6.7% in Korea, 6.2% in Japan, and 6.1% in Taiwan, and these benchmark tax rates are again no higher than those in the three countries. Thus potential equal-opportunity effects from general government services would not be large in East Asian countries.

Due to data availability, our calculation in this paper is limited to only three East Asian countries. Studying the subject with a more comprehensive set of East Asian countries and comparing the results with Latin American countries is left for future research.

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Table 1: Summary of surveys used

	Korea	Japan	Taiwan
Survey name	Korea Labor and Income Panel Study (KLIPS)	Keio Household Panel Survey (KHPS)	Panel Study of Family Dynamics (PSFD)
Years studied	2003-2006	2004	2003
Selected samples	Male household heads aged between 30-55	Male household heads aged between 30-55	Male household heads aged between 30-55
Sample size per year	1643	1193	1038
Taxes	Simulated	Simulated	Simulated

Table 2: Summary statistics

		Korea			Japan	Taiwan
		2003/04	2004/05	2005/06	2004	2003
Pre-fisc ST income	Obs.	3286	3286	3286	1193	1038
	Median	2466.09	2500.00	2676.82	5020.00	498.00
	Mean	2799.86	2904.75	3044.50	5832.71	609.84
	Gini	0.3789	0.3809	0.3828	0.2733	0.3742
Pre-fisc EQ income	Obs.	3286	3286	3286	1193	1038
	Median	1889.11	1985.78	2095.28	3464.10	346.41
	Mean	2226.50	2314.11	2435.66	3914.55	446.28
	Gini	0.3655	0.3618	0.3554	0.2787	0.3756

Source: Korea Labor and Income Panel Study (Korea), Keio Household Panel Survey (Japan), and Panel Study of Family Dynamics (Taiwan)

Notes:
(1) Standard income is the sum of the individual's labor income and his household capital income per adult.
(2) Equivalence income is the sum of household labor and capital income adjusted by the equivalence scale (the square root of household size).
(3) Korean income is expressed in real terms (2004=100) and in ten thousands of Korean Won.
(4) Japanese income is expressed in thousands of Japanese Yen.
(5) Taiwanese income is expressed in thousands of NT$.

Table 3: Summary statistics, by type

Country	Year	type	Pre-fisc ST income (mean)	Pre-fisc EQ income (mean)	Age (mean)	School year (mean)
Korea	2003/2004	Edu_Pa1	2373	1836	45.0	11.2
		Edu_Pa2	2806	2197	40.8	13.0
		Edu_Pa3	3211	2672	39.1	14.7
	2004/2005	Edu_Pa1	2448	1889	46.0	11.2
		Edu_Pa2	2899	2278	41.8	13.0
		Edu_Pa3	3366	2803	40.1	14.7
	2005/2006	Edu_Pa1	2599	2009	47.0	11.2
		Edu_Pa2	3020	2391	42.8	13.0
		Edu_Pa3	3535	2943	41.1	14.7
Japan	2004	Edu_Pa1	5419	3747	45.6	12.7
		Edu_Pa2	6030	4002	42.3	13.8
		Edu_Pa3	6857	4306	40.8	15.4
Taiwan	2003	Edu_Pa1	429	297	47.5	9.1
		Edu_Pa2	600	436	44.3	11.7
		Edu_Pa3	830	632	43.1	13.8

Source: Korea Labor and Income Panel Study (Korea), Keio Household Panel Survey (Japan), and Panel Study of Family Dynamics (Taiwan)

Notes:
(1) Standard income is the sum of the individual's labor income and his household capital income per adult.
(2) Equivalence income is the sum of household labor and capital income adjusted by the equivalence scale (the square root of household size).
(3) Korean income is expressed in real terms (2004=100) and in ten thousands of Korean Won.
(4) Japanese income is expressed in thousands of Japanese Yen.
(5) Taiwanese income is expressed in thousands of NT$.
(6) Using the level of education of the more highly educated parent (Korea) or of father (Japan and Taiwan), we classify the three types as follows:

	Edu_Pa1	Edu_Pa2	Edu_Pa3
Korea	0~5	6~9	≥ 10
Japan	0~11	12~15	≥ 16
Taiwan	0~5	6~12	≥ 13

Table 4: Conditional probabilities of education

Korea		Respondent's schooling years			
		0-9 yrs.	10-12 yrs.	13 and higher	sum
Parent's schooling years	0-5 yrs.	0.342	0.475	0.183	1.0000
	6-9 yrs.	0.117	0.487	0.396	1.0000
	10 & higher	0.019	0.267	0.714	1.0000
All		0.145	0.433	0.422	1.0000

Japan		Respondent's schooling years			
		0-9 yrs.	10-15 yrs	16 & higher	sum
Father's schooling years	0-11 yrs.	0.121	0.641	0.238	1.000
	12-15 yrs.	0.068	0.503	0.429	1.000
	16 & higher	0.007	0.241	0.752	1.000
All		0.086	0.538	0.376	1.000

Taiwan		Respondent's schooling years			
		0-9 yrs.	10-12 yrs.	13 and higher	sum
Father's schooling years	0-5 yrs.	0.664	0.221	0.114	1.000
	6-12 yrs.	0.284	0.418	0.298	1.000
	13 and higher	0.081	0.297	0.622	1.000
All		0.339	0.333	0.328	1.000

Source: Korea Labor and Income Panel Study (Korea), Keio Household Panel Survey (Japan), and Panel Study of Family Dynamics (Taiwan)

Notes: In Korea, parent's schooling years is the level of education of the more highly educated parent, while in Japan and Taiwan it is father's education level. Even in Korea, however, the more highly educated parent is usually father (90.8%).

Table 5: Estimated values of d, γ, and S

Country	Year	d	γ	S
Korea	2003/04	0.045	0.822	188.9 (10,000 Won)
	2004/05	0.045	0.822	195.2 (10,000 Won)
	2005/06	0.046	0.822	201.3 (10,000 Won)
Japan	2004	0.045	0.644	365.3 (1000 Yen)
Taiwan	2003	0.073	0.459	38.0 (1000 NT$)

Source: Various sources (such as the National Income and Product Accounts, the Government Revenue Statistics, etc.)

Notes:
(1) *S* is the value of government services (capturing non-transfer payments) per capita. (It is calculate from the identity, Total Revenue=Transfer Payments + S.)
(2) d is the proportion of indirect taxes paid in the total disposable income, where the disposal income is the income after income taxes are paid and government transfers are received.
(3) γ is the proportion of cash transfers in total government transfers. (Total government transfers consist of cash transfers and non-cash transfers (in-kind benefits).)

Table 6: Estimated affine income tax functions

ST income

Country	Year	*t*	*T*	R^2	Obs.
Korea	2003/04	0.222	292.38	0.865	3286
		0.257	281.57		
	2004/05	0.227	317.45	0.869	3286
		0.262	305.71		
	2005/06	0.224	317.90	0.871	3286
		0.260	305.88		
Japan	2004	0.279	601.79	0.872	1193
		0.311	584.35		
Taiwan	2003	0.267	78.27	0.834	1038
		0.321	75.65		

EQ income

Country	Year	*t*	*T*	R^2	Obs.
Korea	2003/04	0.221	254.71	0.801	3286
		0.256	245.29		
	2004/05	0.226	278.67	0.814	3286
		0.261	268.36		
	2005/06	0.207	250.67	0.770	3286
		0.243	241.19		
Japan	2004	0.313	444.10	0.843	1193
		0.344	431.23		
Taiwan	2003	0.246	46.91	0.835	1038
		0.301	45.34		

Notes:

(1) We compute the observed income tax function by running the following regression: $\text{Net taxes} = t * x - T$, where x is the pre-fisc income. In calculating net taxes, we add payroll taxes and subtract social benefits. Such estimates are reported in the first low. The second row estimates are by equation (18).

(2) Standard income is the sum of the individual's labor income and his household capital income per adult.

(3) Equivalence income is the sum of household labor and capital income adjusted by the equivalence scale (the square root of household size).

(4) Korean income and net taxes are expressed in ten thousands of Korean Won. It is expressed in real terms using the consumer price index (2004=100) .

(5) Japanese income and net taxes are expressed in thousands of Japanese Yen.

(6) Taiwan income and net taxes are expressed in thousands of NT$.

Table 7: EOp policy, EDU typology, ST income

$\eta = 0.06$

Country	year	t^{obs}	t^{EOp}	T^{EOp}	t^{Bench}	ν	ε
Korea	2003/04	0.2215	0.6288	1495.04	0.0667	0.4026	0.9565
	2004/05	0.2268	0.6399	1580.44	0.0664	0.4062	0.9552
	2005/06	0.2235	0.6132	1589.07	0.0654	0.4230	0.9591
Japan	2004	0.2790	0.2020	819.92	0.0617	0.6442	1.0061
Taiwan	2003	0.2670	0.8091	417.18	0.0614	0.3643	0.9224

Comparison with other countries (Roemer et al. (2003)): $\eta = 0.06$

Country	year	t^{obs}	t^{EOp}	T^{EOp}	t^{Bench}	ν	ε
Spain	1991	0.376	0.605	663.9	0.080	0.748	0.973
Italy	1993	0.232	0.819	21.3	0.156	0.160	0.920
USA	1991	0.243	0.647	13578.0	0.182	0.200	0.955
Belgium	1992	0.531	0.535	158.0	0.316	0.999	0.999
Sweden	1991	0.524	0	-30207.0	0.203	overtax	1.046

$\eta = 0.03$

Country	year	t^{obs}	t^{EOp}	T^{EOp}	t^{Bench}	ν	ε
Korea	2003/04	0.2215	0.8090	1982.65	0.0671	0.2760	0.9587
	2004/05	0.2268	0.8148	2072.11	0.0668	0.2822	0.9580
	2005/06	0.2235	0.8009	2139.63	0.0658	0.2859	0.9600
Japan	2004	0.2790	0.5894	3014.72	0.0621	0.5812	0.9833
Taiwan	2003	0.2670	0.9018	479.78	0.0618	0.2968	0.9415

$\eta = 0.09$

Country	year	t^{obs}	t^{EOp}	T^{EOp}	t^{Bench}	ν	ε
Korea	2003/04	0.2215	0.4585	1053.48	0.0664	0.5887	0.9679
	2004/05	0.2268	0.4749	1136.89	0.0661	0.5832	0.9658
	2005/06	0.2235	0.4357	1087.71	0.0650	0.6032	0.9717
Japan	2004	0.2790	0	-365.30	0.0612	overtax	1.0299
Taiwan	2003	0.2670	0.7216	365.34	0.0609	0.4350	0.9166

Table 8: EOp policy, EDU typology, EQ income

$\eta = 0.06$

Country	year	t^{obs}	t^{EOp}	T^{EOp}	t^{Bench}	ν	ε
Korea	2003/04	0.2210	0.6773	1241.37	0.0840	0.3348	0.9485
	2004/05	0.2263	0.6919	1319.81	0.0835	0.3375	0.9463
	2005/06	0.2071	0.6769	1360.95	0.0819	0.3066	0.9476
Japan	2004	0.3130	0	-365.30	0.0918	overtax	1.0228
Taiwan	2003	0.2460	0.8308	300.99	0.0841	0.2863	0.9143

Comparison with other countries (Roemer et al. (2003)): $\eta = 0.06$

Country	year	t^{obs}	t^{EOp}	T^{EOp}	t^{Bench}	ν	ε
Spain	1991	0.400	0.556	823.7	0.100	0.840	0.982
Italy	1993	0.247	0.829	16.4	0.154	0.186	0.915
USA	1991	NA	NA	NA	NA	NA	NA
Belgium	1992	0.555	0.661	238.0	0.260	0.900	0.984
Sweden	1991	0.569	0	-24258.0	0.185	overtax	1.052

$\eta = 0.03$

Country	year	t^{obs}	t^{EOp}	T^{EOp}	t^{Bench}	ν	ε
Korea	2003/04	0.2210	0.8339	1583.72	0.0844	0.2384	0.9547
	2004/05	0.2263	0.8415	1661.56	0.0839	0.2441	0.9536
	2005/06	0.2071	0.8337	1736.47	0.0823	0.2177	0.9542
Japan	2004	0.3130	0.3195	885.08	0.0925	0.9990	0.9997
Taiwan	2003	0.2460	0.9129	343.89	0.0846	0.2354	0.9373

$\eta = 0.09$

Country	year	t^{obs}	t^{EOp}	T^{EOp}	t^{Bench}	ν	ε
Korea	2003/04	0.2210	0.5292	937.19	0.0836	0.4669	0.9557
	2004/05	0.2263	0.5505	1017.99	0.0831	0.4609	0.9523
	2005/06	0.2071	0.5287	1027.51	0.0816	0.4294	0.9543
Japan	2004	0.3130	0	-365.30	0.0910	overtax	1.0344
Taiwan	2003	0.2460	0.7532	266.00	0.0836	0.3391	0.9044

Figure 1: Kernel density estimates of pre-fisc income, three EDU types, by country

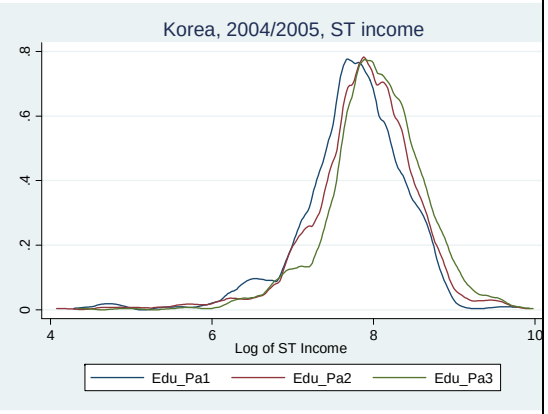
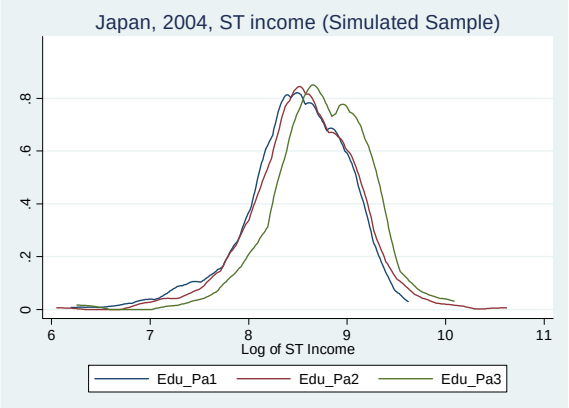
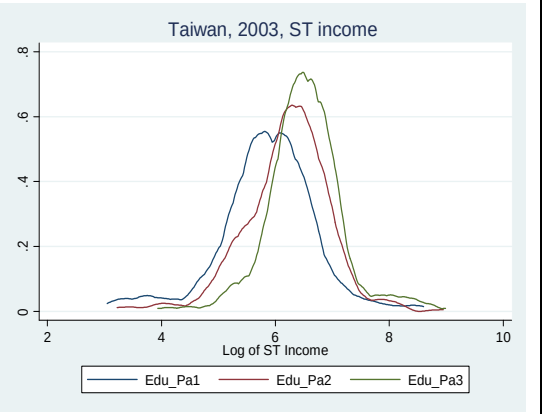
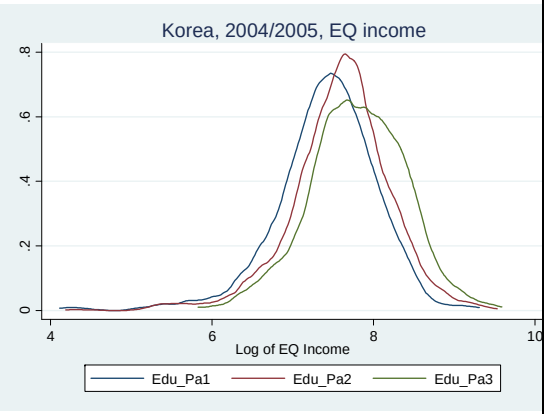
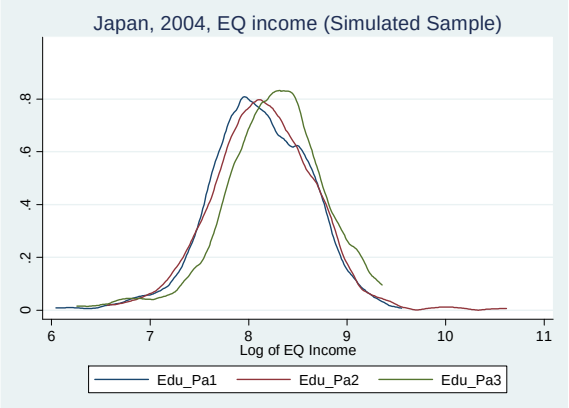
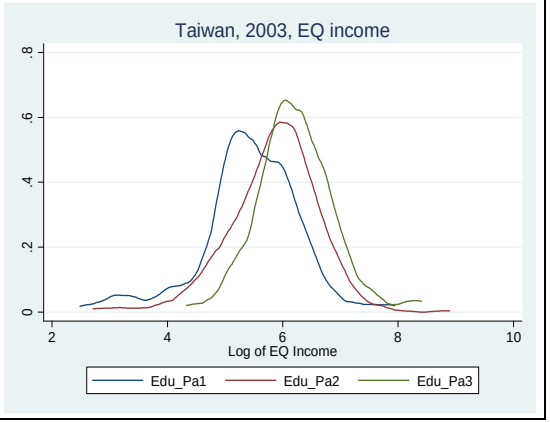
	Korea	Japan	Taiwan
ST income			
EQ income			

Figure 2: Empirical distribution functions of pre-fisc income, three EDU types, by type

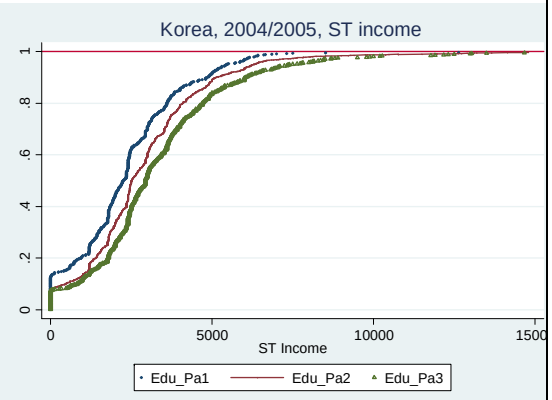
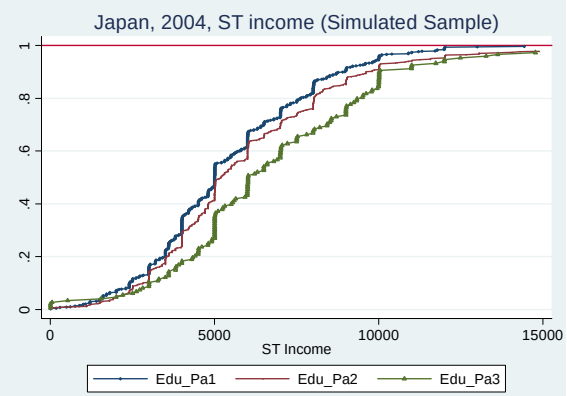
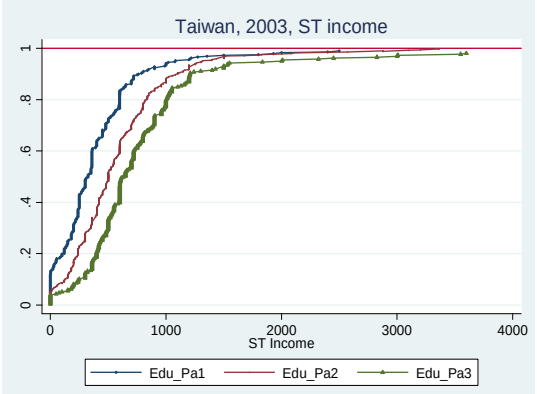
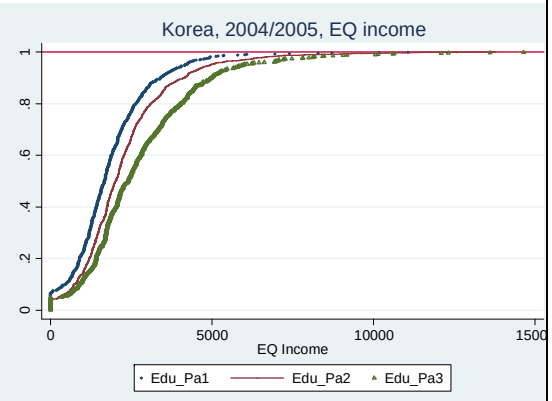
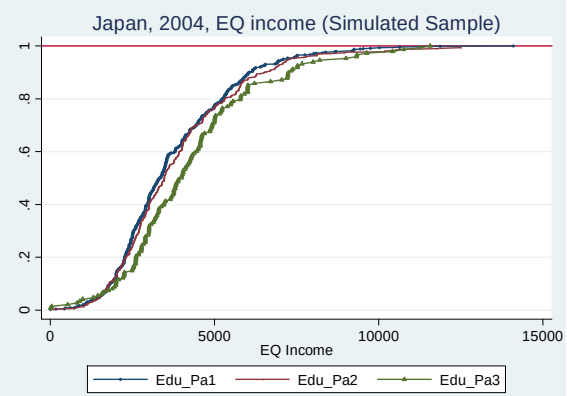
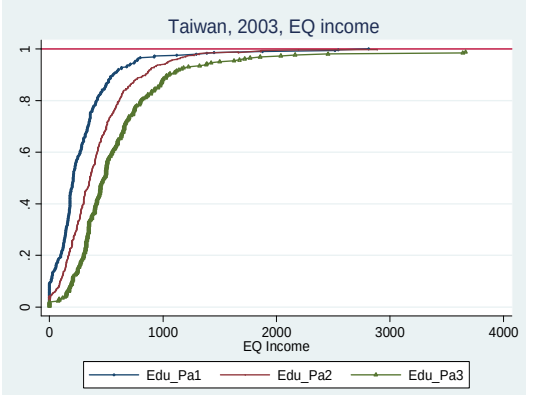
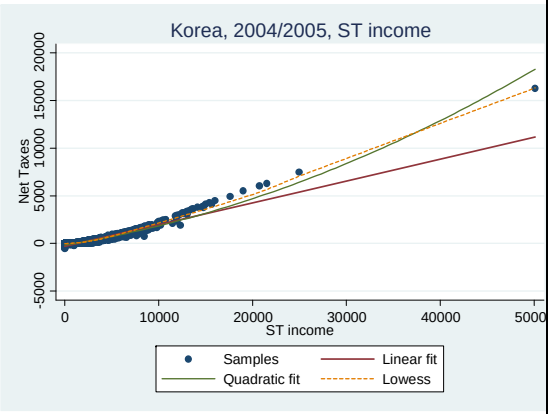
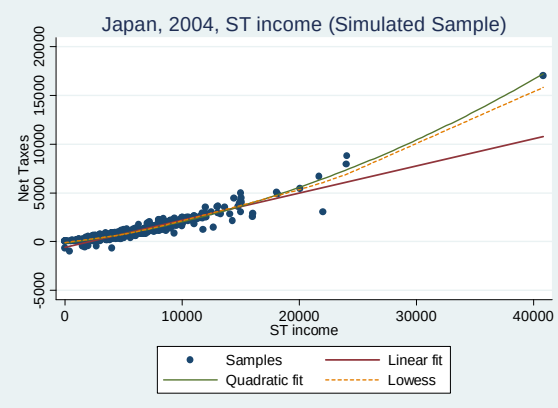
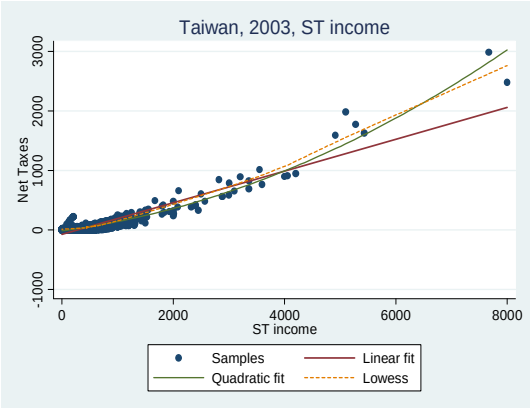
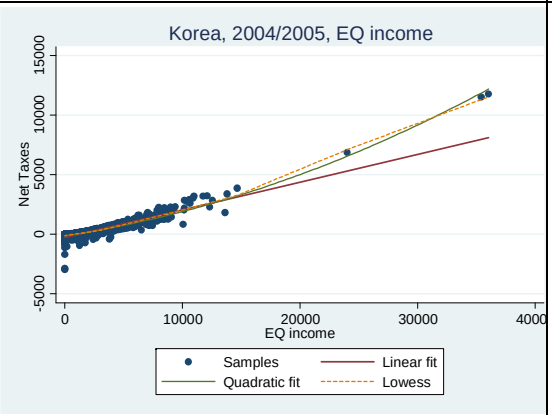
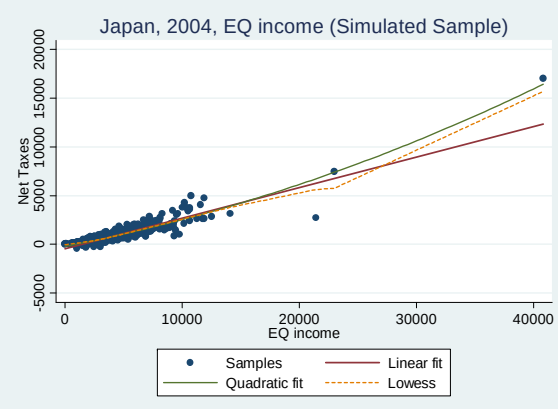
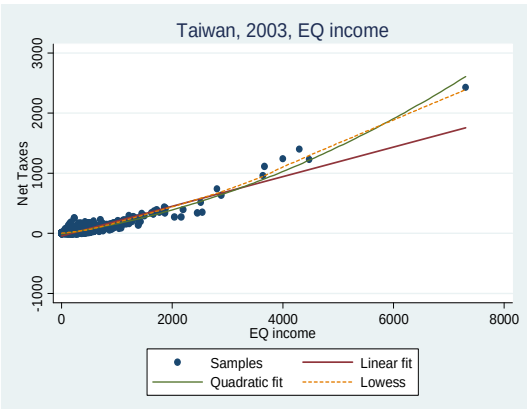
	Korea	Japan	Taiwan
ST income			
EQ income			

Figure 3: Estimated tax functions, by type

	Korea	Japan	Taiwan
ST income			
EQ income			

Appendix A: Additional tables

Table A-1: Korea, Japan, and Taiwan in 2004 at a glance

	Korea	Japan	Taiwan	Ratio(K/J)	Ratio(K/T)	Source
Exchange rate	₩1145.32/$1	¥108.19/$1	NT$33.43/$1	10.59₩/¥	34.26₩/NT$	PWT 6.3
Real GDP per capita ($, chain index)	21330.22	29203.49	23693.82	0.730	0.813	PWT 6.3
Real GDP per equivalent adult ($, chain index)	23655.94	31382.81	26239.60	0.754	0.902	PWT 6.3
Real GDP per worker ($, chain index)	43758.43	56141.31	52235.23	0.779	0.838	PWT 6.3
Secondary school enrollment ratio (net)	0.883	0.999	0.795	0.884	1.111	World Development Indicators
Total tax revenue as % of GDP	14.25	16.50	12.50	0.864	1.14	See note *
Taxes on income and profits as % of GDP	5.82	8.37	4.12	0.695	1.413	See note *
Taxes on goods and services as % of GDP	6.26	5.52	5.79	1.134	1.081	See note *
VAT rate	10%	5%	5%	2.000	2.000	See note *
Total social expenditure as percentage of GDP	3.35	17.30	2.33	0.194	1.438	See note *

*

Source for Korea: World Development Indicators

Source for Japan: Financial Statistics of Japan, Ministry of Finance, Government of Japan,
Cabinet Office, Government of Japan,
National Institute of Population and Social Security Research

Source for Taiwan: Ministry of Finance, Republic of China
Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Republic of China

Table A-2: Education and income

ST income

Korea		Respondent's ST income (4 year average)				
		0-25%	25-50%	50-75%	75-100%	sum
Respondent's schooling years	0-9 yrs.	0.5074	0.3191	0.1234	0.0500	1.0000
	10-12 yrs.	0.2629	0.2818	0.2543	0.2011	1.0000
	13 & higher	0.1517	0.1966	0.2901	0.3616	1.0000

Japan		Respondent's ST income				
		0-25%	25-50%	50-75%	75-100%	sum
Respondent's schooling years	0-9 yrs.	0.4444	0.3535	0.1313	0.0707	1.0000
	10-15 yrs.	0.2890	0.2938	0.2338	0.1834	1.0000
	16 & higher	0.1531	0.1624	0.2900	0.3944	1.0000

Taiwan		Respondent's ST income				
		0-25%	25-50%	50-75%	75-100%	sum
Respondent's schooling years	0-9 yrs.	0.4631	0.3153	0.1648	0.0568	1.0000
	10-12 yrs.	0.2341	0.2572	0.3064	0.2023	1.0000
	13 and higher	0.0794	0.1324	0.3088	0.4794	1.0000

EQ income

Korea		Respondent's EQ income (4 year average)				
		0-25%	25-50%	50-75%	75-100%	sum
Respondent's Schooling years	0-9 yrs.	0.4936	0.3085	0.1468	0.0511	1.0000
	10-12 yrs.	0.2707	0.2921	0.2589	0.1782	1.0000
	13 & higher	0.1499	0.1889	0.2798	0.3814	1.0000

Japan		Respondent's EQ income				
		0-25%	25-50%	50-75%	75-100%	sum
Respondent's Schooling years	0-9 yrs.	0.4747	0.2323	0.1717	0.1212	1.0000
	10-15 yrs.	0.2873	0.2679	0.2388	0.2110	1.0000
	16 & higher	0.1415	0.2181	0.2970	0.3434	1.0000

Taiwan		Respondent's EQ income				
		0-25%	25-50%	50-75%	75-100%	sum
Respondent's Schooling years	0-9 yrs.	0.3722	0.3523	0.1847	0.0909	1.0000
	10-12 yrs.	0.1850	0.2283	0.3150	0.2717	1.0000
	13 and higher	0.0441	0.0971	0.2235	0.6353	1.0000

Table A-3: Parent's education and respondent's income

ST income

Korea		Respondent's ST income (4 year average)				
		0-25%	25-50%	50-75%	75-100%	sum
Parent's schooling years	0-5 yrs.	0.3279	0.2846	0.2053	0.1822	1.0000
	6-9 yrs.	0.2463	0.2531	0.2560	0.2446	1.0000
	10 & higher	0.1822	0.2106	0.2771	0.3301	1.0000

Japan		Respondent's ST income				
		0-25%	25-50%	50-75%	75-100%	sum
Father's schooling years	0-11 yrs.	0.2838	0.2684	0.2342	0.2137	1.0000
	12-15 yrs.	0.2326	0.2522	0.2522	0.2630	1.0000
	16 & higher	0.1689	0.1892	0.2905	0.3514	1.0000

Taiwan		Respondent's ST income				
		0-25%	25-50%	50-75%	75-100%	sum
Father's schooling years	0-5 yrs.	0.4429	0.2664	0.1903	0.1003	1.0000
	6-12 yrs.	0.2388	0.2408	0.2633	0.2571	1.0000
	13 and higher	0.1004	0.1931	0.3282	0.3784	1.0000

EQ income

Korea		Respondent's EQ income (4 year average)				
		0-25%	25-50%	50-75%	75-100%	sum
Parent's schooling years	0-5 yrs.	0.3476	0.2791	0.2087	0.1646	1.0000
	6-9 yrs.	0.2440	0.2568	0.2608	0.2383	1.0000
	10 & higher	0.1705	0.2080	0.2610	0.3605	1.0000

Japan		Respondent's EQ income				
		0-25%	25-50%	50-75%	75-100%	sum
Father's schooling years	0-11 yrs.	0.2803	0.2496	0.2291	0.2410	1.0000
	12-15 yrs.	0.2435	0.2457	0.2696	0.2413	1.0000
	16 & higher	0.1486	0.2500	0.2905	0.3108	1.0000

Taiwan		Respondent's EQ income				
		0-25%	25-50%	50-75%	75-100%	sum
Father's schooling years	0-5 yrs.	0.3391	0.3149	0.1869	0.1592	1.0000
	6-12 yrs.	0.1980	0.2204	0.2469	0.3347	1.0000
	13 and higher	0.0579	0.1429	0.2896	0.5097	1.0000

Table A-4: Observed affine and quadratic income tax functions: OLS regressions

Korea

	Year	*t*	*s*	*T (10,000 Won)*	R^2	Obs.
ST income	2003/04	0.2215		292.3786	0.8652	3286
		0.1329	$6.92*10^{-6}$	131.7186	0.9483	3286
	2004/05	0.2268		317.4488	0.8686	3286
		0.1591	$4.23*10^{-6}$	179.3072	0.938	3286
	2005/06	0.2235		317.9035	0.8709	3286
		0.1579	$4.21*10^{-6}$	181.8411	0.9377	3286
EQ income	2003/04	0.2210		254.7118	0.8009	3286
		0.1416	$6.18*10^{-6}$	128.0378	0.8745	3286
	2004/05	0.2263		278.6741	0.8136	3286
		0.1464	$5.48*10^{-6}$	141.7095	0.8905	3286
	2005/06	0.2071		250.6653	0.7696	3286
		0.1428	$5.70*10^{-6}$	146.1564	0.8247	3286

Japan

	Year	*t*	*s*	*T (1000 Yen)*	R^2	Obs.
ST income	2004	0.279		601.79	0.872	1193
		0.153	$6.68*10^{-6}$	159.41	0.934	1193
EQ income	2004	0.313		444.10	0.843	1193
		0.232	$4.29*10^{-6}$	214.82	0.875	1193

Taiwan

	Year	*t*	*s*	*T (1000 NT$)*	R^2	Obs.
ST income	2003	0.267		78.27	0.8339	1038
		0.126	$31.5*10^{-6}$	18.13	0.9143	1038
EQ income	2003	0.246		46.91	0.8352	1038
		0.141	$29.4*10^{-6}$	12.94	0.9050	1038

Source: Korea Labor and Income Panel Study (Korea), Keio Household Panel Survey (Japan), and Panel Study of Family Dynamics (Taiwan)

Notes:

(1) We compute the observed income tax function by running the following regression: $\text{Net taxes} = t * x + s * x^2 - T$, where x is the pre-fisc income. In calculating net taxes, we add payroll taxes and subtract social security benefits.

(2) Standard income is the sum of the individual's labor income and his household capital income per adult.

(3) Equivalence income is the sum of household labor and capital income adjusted by the equivalence scale (the square root of household size).

(4) Korean income and net taxes are expressed in ten thousands of Korean Won. (One US dollar is approximately equal to eleven hundred Korean Won.) It is expressed in real terms (2004=100).

(5) Japanese income and net taxes are expressed in thousands of Japanese Yen.

(6) Taiwan income and net taxes are expressed in thousands of NT$.

Table A-5: Observed affine and quadratic income tax functions: Median regressions

Korea

	Year	*t*	*s*	*T (10,000 Won)*	Pseudo R^2	Obs.
ST income	2003/04	0.1535		126.16	0.5968	3286
		0.0516	$1.49*10^{-5}$	10.22	0.7200	3286
	2004/05	0.1544		131.78	0.6004	3286
		0.0511	$1.43*10^{-5}$	10.11	0.7122	3286
	2005/06	0.1633		153.22	0.6097	3286
		0.0509	$1.39*10^{-5}$	9.45	0.7172	3286
EQ income	2003/04	0.1511		109.27	0.5274	3286
		0.0812	$1.20*10^{-5}$	36.08	0.5927	3286
	2004/05	0.1511		116.73	0.5354	3286
		0.1068	$7.53*10^{-6}$	67.65	0.5926	3286
	2005/06	0.1522		124.19	0.5368	3286
		0.0852	$1.19*10^{-5}$	51.55	0.5836	3286

Japan

	Year	*t*	*s*	*T (1,000 Yen)*	Pseudo R^2	Obs.
ST income	2004	0.241		415.44	0.666	1193
		0.117	$9.17*10^{-6}$	64.25	0.731	1193
EQ income	2004	0.259		274.52	0.598	1193
		0.215	$5.07*10^{-6}$	193.17	0.618	1193

Taiwan

	Year	*t*	*s*	*T (1000 NT$)*	Pseudo R^2	Obs.
ST income	2003	0.1996		30.26	0.4102	1038
		0.0845	$3.94*10^{-5}$	2.51	0.4974	1038
EQ income	2003	0.1922		26.84	0.4780	1038
		0.1419	$3.03*10^{-5}$	13.71	0.5368	1038

Source: Korea Labor and Income Panel Study (Korea), Keio Household Panel Survey (Japan), and Panel Study of Family Dynamics (Taiwan)

Notes:

(1) We compute the observed income tax function by running the following regression: $\text{Net taxes} = t * x + s * x^2 - T$, where x is the pre-fisc income. In calculating net taxes, we add payroll taxes and subtract social security benefits.

(2) Standard income is the sum of the individual's labor income and his household capital income per adult.

(3) Equivalence income is the sum of household labor and capital income adjusted by the equivalence scale (the square root of household size).

(4) Korean income and net taxes are expressed in ten thousands of Korean Won. (One US dollar is approximately equal to eleven hundred Korean Won.) It is expressed in real terms (2004=100).

(5) Japanese income and net taxes are expressed in thousands of Japanese Yen.

(6) Taiwan income and net taxes are expressed in thousands of NT$.