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Changing Returns to Education in Taiwan: 1978–91

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Summary. — We find that private rates of return in Taiwan are highest for higher education levels (for example, university) and lowest for lower education levels (for example, junior high school), and that private returns are higher for women than men at all education levels. Unlike most other studies of changing returns to education over time in developing countries, we find that private returns for all education levels are remarkably stable during 1978–91 in Taiwan.

1. INTRODUCTION

Taiwan has had one of the more rapid economic growth rates in the world in the past 30 years. During 1978–91, for example, per capita GDP grew by an average annual rate of 6.4% (CPD, 1993). Accompanying this rapid growth has been a rapid decline in income inequality.¹ Taiwan, along with other East Asian economies with similar experiences, is used as an example to developing countries of how to bring about growth with equity.

One important cause of this rapid growth with equity was a policy of educational expansion. Educational expansion was not only one of the “principle engines of growth” (World Bank, 1993), but there is also broad agreement that “the increasingly high level of education of Taiwan’s population has helped to reduce income inequality” (Lau, 1986, p. 5).² Educational expansion focused, at least initially, on providing universal primary and secondary education.

Educational expansion affects inequality in the distribution of earnings in two ways: if returns to education stay the same, the increase in the proportion of more highly paid (more highly educated) workers will lead to an initial increase in income inequality, followed by a falling inequality; and the increase in the relative supply of more highly educated workers will cause a decline in returns to higher education, narrowing the gap between high-wage workers and low-wage workers (Knight and Sabot, 1983). Demand considerations may also affect the way in which educational expansion affects earnings inequality. For example,

growing demand for less-educated workers will lead to an increase in the earnings of those workers, causing a decrease in inequality while a growing demand for better educated workers (relative to less-educated workers) will increase the gap between low-paid and high-paid workers.³

Changes in rates of return to education in the process of development are therefore of importance in determining the impact of educational expansion on earnings inequality. Falling rates of return for more highly educated workers can counteract the pressure of educational expansion to cause an increase in earnings inequality. The role of changing rates of return to education in Taiwan could be of interest to other developing countries interested in replicating the Taiwanese experience of educational expansion, rapid economic growth, and decreasing income inequality.

2. STRUCTURE OF THE EDUCATION SYSTEM IN TAIWAN⁴

In Taiwan the first nine years of schooling are compulsory and free. Children enter primary school when they are six years old, and stay for six years (ages 6–12). Next come three years of junior high school (which was made compulsory in 1968). All students who wish to continue schooling after junior high school must sit an exam. The exam determines whether the student enters junior college or one of two types of senior high school. The two types of senior

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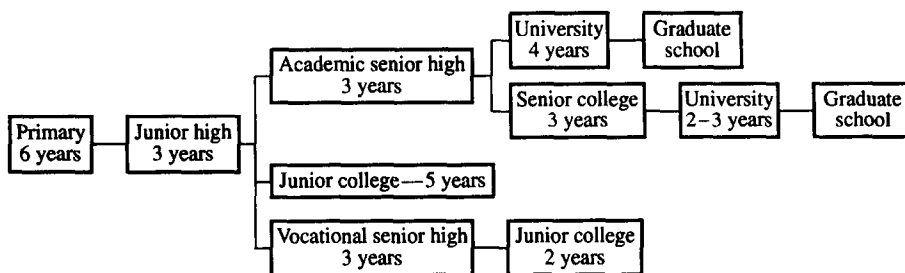


Figure 1. Education system in Taiwan.

high school are academic senior high school and vocational senior high school. Students who enter vocational senior high school may then terminate their schooling or continue on to junior college. Students who enter the three-year academic senior high school generally continue on to university (or to senior college and then to university — “senior college” is equivalent to what is called “junior college” in the United States). “Junior colleges” are advanced vocational schools (which were introduced in 1965). Students who enter the five-year junior college do not generally continue to university. Tuition is charged for senior high school, junior college and university⁵. The structure of the education system in Taiwan is summarized in Figure 1.

Decisions to continue schooling are made at three points: (a) for students who graduated primary school before 1968 (when junior high school was made compulsory) a decision had to be made to go to junior high school, (b) junior high school students decide to go to junior college, academic senior high school or vocational senior high school and (c) academic senior high school students decide to go to university.⁶ For this reason, we estimate five rates of return: (i) a rate of return to junior high school (comparing junior high school graduates with primary school graduates), (ii) a rate of return to academic senior high school (comparing academic senior high school graduates with junior high school graduates), (iii) a rate of return to vocational senior high school (comparing vocational senior high school graduates with junior high school graduates), (iv) a rate of return to junior college (comparing junior college graduates with junior high school graduates), and (v) a rate of return to university education (comparing university graduates with academic senior high school graduates).

Public schools dominate the levels of primary school, junior high school and academic high school (during 1950–68, 95–98% of primary and junior high school students were enrolled in public schools). At the vocational senior high school and junior college levels private schools make up over one-half of the total. Private high schools and vocational schools are managed independently but are strictly regulated by

the government, which dictates enrollments, curricula, degree requirements and fees and provides some funding. Private universities and colleges enroll over 50% of university and senior college students (all numbers reported in this paragraph are from Woo, 1991).

3. ESTIMATING THE RATE OF RETURN TO EDUCATION IN TAIWAN:

We adopt three distinct approaches to estimate returns to education. In this section we will describe these three approaches, in order of increasing complexity. The empirical results of the three approaches are presented in section 4.

(a) Average earnings by education level⁷

In our first, simplest, estimate of the returns to education we calculate the percentage difference in mean wages between each education group (junior high graduates vs. primary graduates, academic senior high graduates vs. junior high graduates, vocational senior high graduates vs. junior high graduates, junior college graduates vs. junior high graduates and university graduates vs. academic senior high graduates).

(b) Coefficients on the education dummy variables in earnings equations

Looking at differences in average earnings is only a first approximation to the rate of return to education at different levels. Some of the difference in average wages between education levels could be due to differences between the workers at each education level in other earnings-determining characteristics. For example, the average university graduate could be older than the average academic senior high school graduate. In that case, university graduates could be earning more than academic senior high graduates because they are older and more experienced, not only because they have more education. To address this problem we estimate an earnings equation using a variety of controls for other earnings determining

characteristics as well as dummy variables for each education level.

The dependent variable in the earnings equations is the natural logarithm of yearly earnings. The independent variables include experience (age minus years of formal education minus six), experience squared, hours worked in the week of the survey, a dummy variable that is one if the worker is female, a variable that is one if the worker is married, tenure (years in the current job), a dummy that is one if the worker has changed jobs in the past five years, and five dummy variables for education level: a dummy variable which is one if the worker has graduated from junior high school, a dummy for graduates of academic senior high school, a dummy for graduates of vocational senior high school, a dummy for graduates of junior college, and a dummy for graduates of university (including workers with graduate degrees). In the earnings equations, the coefficients on the dummy variables for education are the differences between the earnings of workers with this level of education and the earnings of a worker with less than a junior high school education (including workers with no education and those with only a primary school education).⁸

(c) *Calculations of the internal rate of return to education*

The coefficients on the earnings equations are incomplete measures of rates of return to education in several ways. First, these estimates do not take into account the private cost to education. Second, the benefits to education are based on the average earnings in a single year. A more appropriate formulation would be to calculate the net benefits to education based on discounted streams of lifetime earnings. We do this in the estimation of "internal rates of return to education" described in this section.

To calculate the internal rate of return to education we first estimate an earnings equation for each education level (primary, junior high school, junior college, academic senior high school, vocational senior high school and university — that is, we estimate six earnings equations, each using data from workers with that level of education). The dependent variable in the earnings equation is the natural logarithm of yearly earnings. The independent variables include: an intercept, age, age-squared, sex (a dummy that is one if the worker is female), a dummy that is one if the worker is married, hours worked in the week of the survey, a dummy which is one if the worker has a second job, years of tenure in the current job, a dummy which is one if the worker has changed jobs in the past five years, and a variable which is one if the worker has a degree in a technical field (only for graduates of senior high school, junior college and university).⁹

Next, we construct (simulate) an age-earnings profile that is valid for the average worker in Taiwan for each education level. We do this by multiplying the estimated coefficients from the earnings equation by the mean of each right hand-side variable (the mean used is the mean for all workers)

$$E(\ln \text{Yearly Earnings}) = B_0 + B_1 \times \overline{\text{Age}} + B_2 \times \overline{\text{Age}^2} + B_3 \times \overline{\text{sex}} + B_4 \times \overline{\text{married}} + B_5 \times \overline{\text{major}} + B_6 \times \overline{\text{hours worked}} + B_7 \times \overline{\text{second job}} + B_8 \times \overline{\text{tenure}} + B_9 \times \overline{\text{changed job}}$$

A bar over the variable indicates that we use the mean of this variable.¹⁰ This gives the expected natural logarithm of earnings for each age and education level for a worker with the mean characteristics. Next, we take the exponent of the log of earnings to get the age-earnings profiles for each education group.

We then use these constructed (simulated) age-earnings profiles by education to calculate the internal rate of return (IRR) to education. The internal rate of return to education is the interest rate (i) that makes the following equation equal to zero (we calculate the IRR with the LOTUS spreadsheet).

$$0 = \sum_{t=0}^T \frac{B_t - C_t}{(1+i)^t}$$

Where t is time, $t = 0$ is the year the student enters the education level, and $t = T$ is the retirement age (65). B_t is the benefit to the education level at time t . We estimate the private benefit to each education level as the increase in yearly earnings brought about by more education. C_t is the cost of each education level at time t . We estimate the private cost of education as the earnings foregone by going to school (assuming that it is illegal to work until one is 16 years old — we assume that primary school lasts six years, junior high school three years, junior college five years, academic and vocational senior high school three years, and university four years). We estimate a rate of return for each education level (the benefits to junior high school are the differences between the wage one earns if one is a junior high school graduate and the wage one earns if one is a primary school graduate, and the foregone earnings are what one would earn with a primary school education, and so on).¹¹

(d) *Data*

The data to carry out our research are from the May Labor Force Survey of the Taiwan Area from 1978–91.¹² For each May during 1978–91 data are available on 20,000–25,000 workers. These surveys are run by the Directorate-General of the Budget,

WORLD DEVELOPMENT

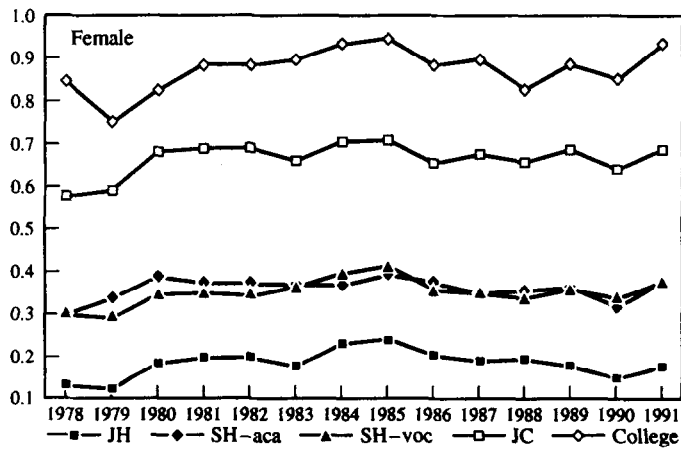
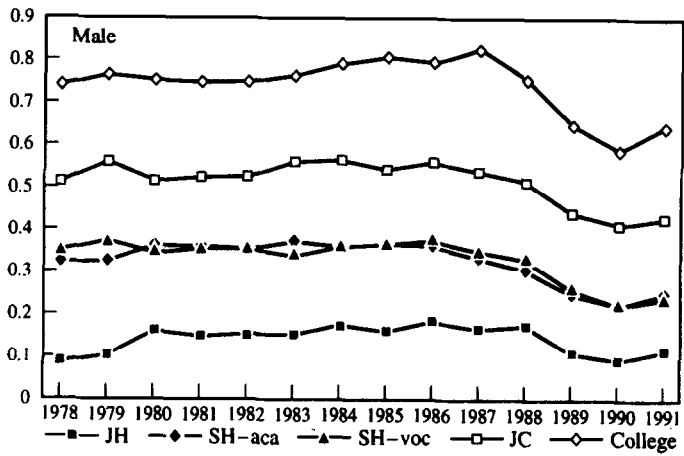
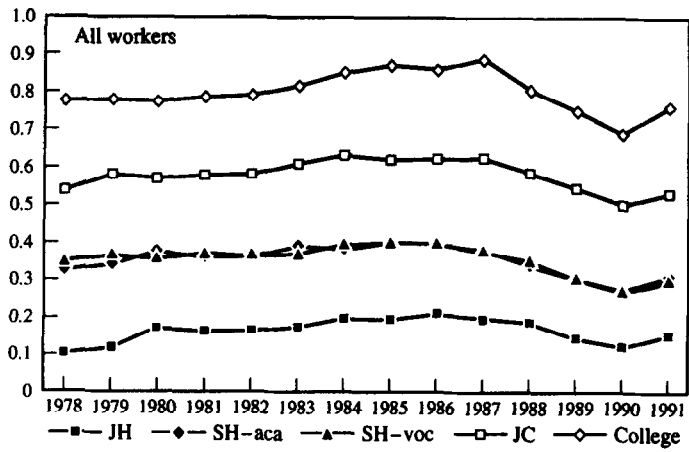


Figure 2. Coefficients from the earnings equations.

Table 1. *Income differentials associated with schooling*

	Junior High*	Academic Senior High†	Vocational Senior High‡	Junior College§	University¶
	(%)	(%)	(%)	(%)	(%)
Sample: All workers					
1978	-5.5	33.5	18.3	42.2	49.6
1979	-6.9	30.3	17.2	46.4	47.5
1980	-3.0	21.6	10.5	30.6	49.3
1981	-8.3	26.5	13.7	48.4	73.1
1982	-6.2	29.0	12.8	44.1	44.5
1983	-2.8	28.3	11.0	43.7	44.3
1984	-0.9	23.6	8.8	41.3	46.8
1985	-2.1	24.7	11.3	42.1	51.0
1986	-1.0	23.8	10.3	46.2	56.8
1987	0.7	19.4	5.6	36.8	58.8
1988	-0.2	14.9	6.6	34.7	50.9
1989	3.8	11.8	3.1	31.7	48.8
1990	4.6	12.4	2.3	29.9	44.3
1991	6.5	9.6	3.2	29.0	48.7
Sample: Male only					
1978	-4.1	33.1	26.6	41.8	47.6
1979	-5.1	27.9	27.0	45.6	48.8
1980	1.1	17.7	17.4	22.8	48.3
1981	-7.1	26.3	21.3	46.4	75.2
1982	-3.1	28.1	18.9	40.2	41.7
1983	-0.3	28.8	16.6	42.0	39.9
1984	0.5	25.4	15.2	39.9	42.2
1985	-0.7	27.2	18.4	40.8	47.6
1986	0.9	24.1	17.0	42.6	54.8
1987	1.6	21.0	12.5	35.5	56.9
1988	1.4	16.4	14.4	34.3	53.7
1989	4.4	14.7	8.8	29.7	44.2
1990	4.6	15.5	8.3	30.2	39.8
1991	-0.7	19.6	16.2	38.2	45.2
Sample: Female only					
1978	-0.8	20.8	19.3	48.7	60.3
1979	-2.1	28.5	10.1	54.8	40.2
1980	-3.4	30.2	13.8	65.1	46.0
1981	1.1	18.4	12.4	62.0	53.0
1982	-4.3	25.5	15.3	64.7	51.4
1983	-0.8	21.0	13.7	58.2	56.6
1984	3.9	13.5	9.8	55.5	64.0
1985	1.9	15.7	10.8	54.9	60.5
1986	0.9	20.8	12.3	64.5	67.8
1987	2.0	19.2	7.7	56.2	62.7
1988	-0.3	12.4	5.1	48.4	51.0
1989	3.0	14.7	9.0	54.0	58.1
1990	3.1	13.1	9.6	49.8	62.9
1991	3.8	11.8	8.5	47.9	64.5

*The column titled "Junior High" is the difference between the average earnings of a worker with a junior high school education and the average earnings of a worker with a primary school education, as a percentage of the average earnings of a primary school graduate. The negative numbers in this column imply that average earnings for junior high school graduates are less than average earnings for primary school graduates.

†The column titled "Academic Senior High" is the difference between the average earnings of a worker with an academic senior high school education and the average earnings of a worker with a junior high school education, as a percentage of the average earnings of a junior high school graduate.

‡The column titled "Vocational Senior High" is the difference between the average earnings of a worker with a vocational senior high school education and the average earnings of a worker with a junior high school education, as a percentage of the average earnings of a junior high school graduate.

§The column titled "Junior College" is the difference between the average earnings of a worker with a vocational junior college education and the average earnings of a worker with a junior high school education, as a percentage of the average earnings of a junior high school graduate.

¶The column titled "University" is the difference between the average earnings of a worker with a university education and the average earnings of a worker with an academic senior high school education, as a percentage of the average earnings of an academic senior high school graduate.

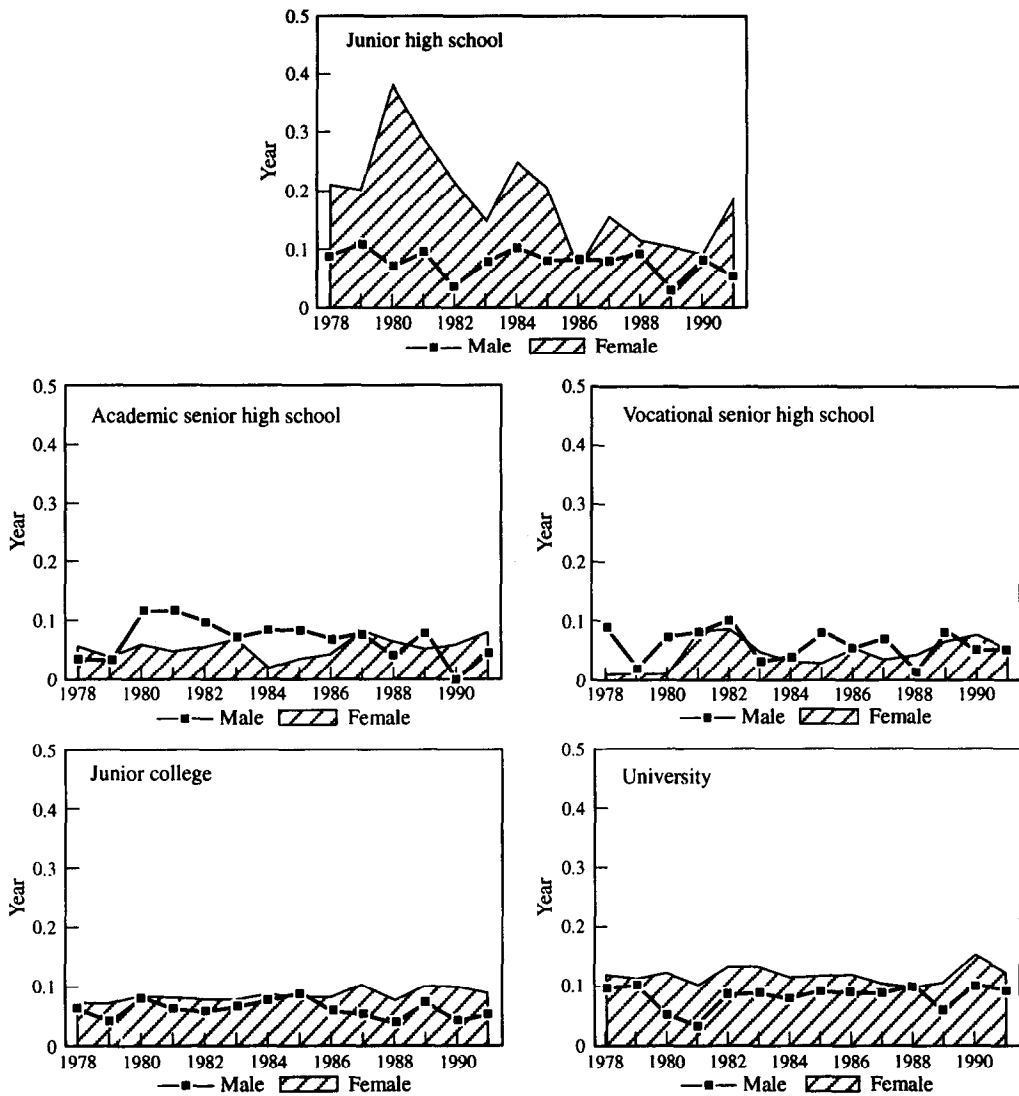


Figure 3. Internal rates of return.

Table 2. Internal rates of return (taking into account income taxes)

Year	JH	ASH	VSH	JC	College
Sample: All workers					
1982	0.092	0.033	NA	0.062	0.077
1987	0.109	0.072	0.025	0.061	0.107
1991	0.104	0.044	NA	0.071	0.077
Sample: Male only					
1982	0.112	NA	NA	NA	0.076
1987	0.069	0.078	0.067	0.040	0.092
1991	0.068	0.079	0.065	0.076	0.054
Sample: Female only					
1982	0.201	0.060	0.045	0.070	0.114
1987	0.142	0.080	0.064	0.095	0.108
1991	0.169	NA	0.051	0.059	0.152

NA = not available; JH = Junior High; ASH = Academic Senior High; VSH = Vocational Senior High; JC = Junior College.

Accounting and Statistics (DGBAS), Executive Yuan, Republic of China.¹³

4. ESTIMATES OF RETURNS TO EDUCATION IN TAIWAN¹⁴

(a) Average yearly earnings by education levels

Appendix Table A3 presents the average yearly earnings at each education level for 1978–91. Using Table A3 we calculate the earnings differentials between each education level as a percentage of the average earnings of the lower education level. These income differentials associated with schooling are reported in Table 1.

When we compare the mean yearly earnings of workers at different education levels we conclude that, during 1978–91, returns decreased for junior college graduates, academic senior high school graduates and vocational senior high school graduates. On the other hand, returns to junior high school increased and returns to university education did not change significantly over this period (see Table 1).¹⁵

For example, for all workers (men and women) during 1978–91, the percentage difference in average yearly earnings between junior college graduates and junior high school graduates fell from 42.2% to 29.0%, while the percentage difference between academic senior high school graduates and junior high school graduates fell from 33.5% to 9.6%. On the other hand, the percentage difference between the earnings of college graduates and academic senior high school graduates went from 49.6% to 48.7%.

There are some differences between men and women. Women have higher returns to education for university and junior college than do men. Moreover, in the late 1980s and early 1990s, the return to university education for men did not change significantly (or may have declined) while for women it increased.¹⁶

(b) Coefficients on the dummy variables for education in earnings equations

Figure 2 presents the coefficients on the education dummy variables from the earnings equations estimated with Ordinary Least Squares (OLS). For women, the coefficients on the education dummy variables grew slowly (but steadily) between 1978 and the mid-1980s, then fell somewhat in 1988 and then rose from 1989 to 1991 (these results are very sensitive to the change in 1988). In general, for women the coefficients on all of the education dummies were slightly, but not significantly, larger in 1991 than in 1978.¹⁷

For men, the coefficients on all education dummy variables stayed steady (or increased slightly) between 1978 and the late 1980s. Then, in 1987–88 the coefficients on all education dummy variables declined, and remained low through 1991. In general, for men the

coefficients on all education dummy variables are slightly, but not significantly, smaller in 1991 than they were in 1978.¹⁸

(c) Internal rates of return

Figure 3 presents our estimates of the private internal rates of return to education.¹⁹ In general, the internal rates of return to college and junior college for women are bigger or equal to that for men.²⁰ Returns to junior high school for women were often double or triple those of men. Returns to academic and vocational senior high school were for some years higher for men, and for other years higher for women.

For men, returns to junior college and university education remained fairly steady during 1978–91 (even though there were some cyclical variations).²¹ For women, on the other hand, returns to university and junior college education increased in 1978–91 (the increase in returns to university education was slight and highly variable — the increase in returns to junior college education was more noticeable).²²

Private internal rates of return to junior high school remained relatively steady during 1978–91 for men. During this period, returns to junior high school for women decreased.

Private costs and benefits to education should be based on comparisons of after-tax earnings. While we do not have data on tax rates for each year, we were able to estimate private rates of return to education including consideration of income taxes for the years 1981, 1982 and 1991. For each year, age and education level we calculated the yearly after-income tax income for a single person who received the standard deduction and standard exemption.²³ The results of these calculations are listed in Table 2. The internal rates of returns which include considerations of taxes are similar in magnitude to the internal rates of return when taxes are not taken into account; some are slightly lower, some are slightly higher. The main conclusions made in the beginning of this section about changes in returns to education in the 1980s still hold: returns are remarkably stable, returns to women are higher than returns to men, during 1982–91 returns to university education rose for women while they fell for men, and during 1982–91 returns to junior high school for women fell.²⁴

5. CONCLUSIONS AND COMPARISONS WITH OTHER DEVELOPING COUNTRIES

In three of the four approaches we use, private returns to education are highest for college, next highest for junior college, and lowest for academic and vocational senior high school and junior high school (the exception is for our calculations of the internal rate of return where for men there is no obvious difference between returns to junior college, the two types of senior high school or junior high school and where

for women the returns to junior high school are often the highest of all education levels). These results are different from those generally reported in the literature, where returns to lower levels of education are higher than returns to university education, but similar to those reported in Ryoo, Nam and Carnoy (1993) for South Korea.

The magnitude of the private returns to education are very different depending on which approach we use. Specifically, estimated returns are highest when we compare average earnings of workers at different education levels, next highest when we use the coefficients on the education dummy variables as measures of returns to education, and smallest when we calculate the internal rate of return to education. This is as expected: the estimated earnings equations control for differences in average wages between education levels not controlled for when we compare average wages, and the internal rate of return calculations include considerations of both the costs and benefits of education (while the earnings equations consider only benefits).²⁵

In general, regardless of the approach we use to estimate returns to education, we find that private returns are higher for women than for men at all education levels (with the exception of the internal rate of return estimates for academic and vocational senior high school). Deolalikar (1993), who finds that returns to secondary and university education are higher for women than for men in Indonesia, speculates on several possible explanations for the result that returns are higher for women. One possible explanation is differences in selection into the different education levels between men and women. For example, because it may be more difficult for better educated women than better educated men to find good jobs, only those women whose inherent intelligence or productivity is very high decide to enter the next higher education level. Therefore, the sample of females at higher education levels may be (relative to the female population as a whole) more inherently productive (in ways that we cannot measure) than the sample of males at higher education levels (relative to the male population as a whole). Unfortunately, because of the lack of availability of appropriate data, we cannot correct our estimates from Taiwan for selectivity bias resulting from selection into different education levels.²⁶ A second possible reason why returns to education were higher for women is that unmeasured gender differences in traits such as manual dexterity, stamina or strength may be valued highly by the market at lower education levels (Deolalikar, 1993). In this case there may be large wage premiums for less-educated men compared to less-educated women. If this were true, we would expect less-educated men, compared to less-educated women, to be found in those industries where there are wage premiums for strength, stamina, etc. One

example of such an industry is construction. There is some evidence to support the contention that men are found disproportionately in jobs that require strength and stamina; in 1991, for example, over 25% of Taiwanese men with no education or a primary education worked in construction, while less than 10% of women at these education levels did.²⁷

A third possible explanation is that labor market discrimination against women could be greater at lower education levels, causing the male-female wage gap to be much greater at lower education levels than at higher education levels. This may especially be true if more highly educated workers are found in the public sector where we might expect women to be paid similar wages to equally productive men.

In general, regardless of the approach we use, private returns to education were remarkably stable during 1978-91.²⁸ This is a different conclusion than that reached by Schultz (1993) and Psacharopoulos (1989) in reviews of the literature on changing rates of return over time in developing economies. Schultz (1993) notes that "the majority of such studies confirm that private returns (to education) tend to decrease over time" (p. 717). Psacharopoulos (1989) presents estimates of rates of return to primary, secondary and higher education for 22 countries.²⁹ Returns to primary education fell in four of six countries, returns to secondary education fell in 11 of 15 countries, and returns to higher education fell in six of 14 countries.³⁰

Schultz (1993) and Psacharopoulos (1989) argue that we might expect falling returns to education with economic growth because educational expansion causes the relative supply of more educated workers to increase. Since there was clearly educational expansion in Taiwan over the period of our study, in order to keep returns to education stable, relative demand for more educated labor must have increased. Relative demand for more educated workers may have increased in Taiwan because of exogenous skilled labor intensive technological change. This explanation is consistent with recent research on the causes of the increase in returns to education in the United States from the mid-1970s. For example, Katz and Murphy (1992) and Bound and Johnson (1992) conclude that the increase in returns to education in the United States was due to an increase in relative demand for skilled labor caused by skilled-labor intensive technological change (i.e. the development of computers and robotics, see Krueger, 1991).

Alternatively, the increase in demand for more educated labor may be related to the change in the composition of employment from less-skilled intensive manufacturing to more skilled-intensive services and manufacturing, which in turn may be due to changes in Taiwan's comparative advantage as average labor costs increased. This explanation is, also, consistent with the findings of research in the United States. For

example, Murphy and Welch (1992) argue that the change in the structure of employment away from manufacturing toward services in the United States may

also have contributed to rising returns to education in the United States. Further research on the causes of changing returns to education in Taiwan is needed.

NOTES

1. For example, during 1965–76 the Gini coefficient fell from .32 to .29, and Taiwan today has one of the most equal distributions of income of any country in the world (Lau, 1986).

2. Also cited as important influences on Taiwan's successful and equitable development are policies that maintained macroeconomic stability, low population growth rates, policies to increase the stability of the banking system, etc. (see World Bank, 1993). An important influence occurred before 1958. During 1895–1945, Japanese colonizers financed the public infrastructure and modern agricultural techniques, ushering in a "Green Revolution" (Lau, 1986). There were extensive land reforms in 1949 and 1955. During 1949–58 the government of Taiwan enacted import substitution industrialization policies. Slow economic growth rates led to the abandonment of these policies in favor of export promotion. During 1958–64 tariffs and quotas were eliminated or reduced. At the same time, exchange rates and interest rates were kept at or near equilibrium levels. In part because of these policies, GDP growth in Taiwan occurred through rapid export growth, and was financed through domestic savings. At least initially, exports were labor intensive — employing large numbers of primary and secondary school graduates. By the 1980s, however, the structure of exports was becoming more capital- and skilled-labor intensive.

3. If there are only two types of labor — educated and uneducated — educational expansion would at first bring about increased income inequality, and later decreased income inequality. This is one theoretical justification for the Kuznets (1966) inverted-U hypothesis (Knight and Sabot, 1983).

4. This section draws heavily on Woo (1991) and Chang (1992).

5. There is financial help, however, available for poorer students.

6. Most students who finish academic senior high school but do not go on to college failed the university entrance exams.

7. We consider only people who worked at their regular job this week of the survey. We exclude those workers who "worked during vacation" the week of the survey or those who "worked after housework or school." Combined, these two excluded categories never represent more than 3% of those individuals who report nonzero earnings.

8. We estimate two sets of equations: one which includes dummy variables indicating the industry of the worker, and another which does not. It is unclear which set of variables

should be used. The justification for including the industry variables is that many studies have found wage premiums for certain industries. These wage premiums may, therefore, represent wage advantages for workers that are not due to the education level of the worker, but to the good fortune of the worker in finding a job in a high-wage industry. The justifications for excluding the industry variables are that: these premiums do not exist, or that education levels are important in securing a job in an industry which pays higher wages and therefore the higher wage should be part of the benefits to higher education. In this paper we report only the results from the regressions which do not include the industry variables. The results from the regressions which include the industry variables as right-hand side variables are available from the authors.

9. The coefficients on the right hand side variables are generally significantly different from zero at the 10% level except for those on whether a worker has a second job and whether the worker changed jobs in the past five years. To examine the influence of these last two variables on our results we estimated internal rates of return excluding these variables from the analysis for three years. The results did not change substantially.

10. We also calculated an internal rate of return using right-hand side variables which are means for the population as a whole for three years of data. The estimates of the internal rates of return to education which use population averages are lower than the estimated internal rates of return reported in the body of this paper. For example, the internal rates of return estimated were 6.2%(JH), 5.8%(JC) and 3.6%(College) for 1982, 8.0%(JH), 3.5%(JC) and 7.3(College) for 1984.

11. In calculating the private rate of return to education we should, in theory, measure expected returns. These expected returns would include not just the estimated increase in earnings brought about by increased education but also some measure of the probability that a worker at a higher education level will be able to find a job. We do not do this. This may be especially important for the calculations of the rate of return to university education because the unemployment rate for university graduates is higher than the average unemployment rate for workers (for example, in 1986 the average unemployment rate was 2.66% while the unemployment rate for university graduates was 3.76% — *Monthly Bulletin of Manpower Statistics*, Taiwan Area).

12. The surveys were carried out each month; however, only in the May survey are earnings reported.

13. Our results use unweighted data. There are several anomalies with the data that we wish to report. First, for 1980

and 1981 reported earnings appear to be divided by 10. We assume that because of rapid inflation in 1979 and 1980 not enough spaces were available on the data tapes to report the incomes of all workers. Therefore, to maintain consistency in the documentation between 1979 and 1980 "earnings" were coded by dropping the last digit. Second, in 1985 a small number of individuals who are coded as "not working" report positive earnings. We assume that these individuals have zero incomes. Finally, in the data tape for 1989 the number of observations is much smaller than the number of observations of other years (for example, while the number of observations for 1988 was 54,666, the number of observations for 1989 was 37,400).

14. In addition to the results presented in this section, we calculate returns to education using data for only full-time employees (paid workers). These results are available from the authors. We define full-time workers as those who work 40 hours or more a week. Legally, full-time in Taiwan is 48 hours a week (eight hours a day, six days a week). Many full time workers, however, work less than 48 hours (interview with Dr. Shou-po Chao, Minister of Labor, November 24, 1993). For example, while the modal number of hours worked is 48, a significant number of workers also work 44 or 40 hours a week. Therefore, 40 hours a week is a conservative measure of a full-time work week. If we use 48 hours a week as the measure of full-time workers then we are excluding some workers who would consider themselves full-time. Thus, we consider anyone who works 40 hours or more a week to be working full-time.

15. As an approximate test of whether or not changes in returns to education (during 1978–91) were significant we estimate a regression where the left-hand side variable is a measure of returns to education and the right hand side variables are a constant and a time trend. If the coefficient on the time trend is significantly different from zero we conclude that the rate of growth in returns to education was significantly different from zero.

For example, using Table 1 we conclude that, for all workers, the rate of growth in returns to Junior High, Academic Senior High, Vocational Senior High and Junior College were significantly different from zero at 5%, while the change in returns to University education was not significant. For men and women changes in returns to Junior High, Academic Senior High and Vocational Senior High were significant while the change in returns to Junior College was not significant. Changes in returns to university education were significant for women but insignificant for men.

16. In each year men, on average, earned more than women at each education level. For example, in 1978 average women's earnings as a percentage of average men's earnings were 66% for primary school graduates, 68% for junior high graduates, 62% for academic senior high graduates, 64% for vocational senior high graduates, 71% for junior college graduates and 67% for college graduates.

17. For women, changes in the coefficients on all education dummy variables were not significantly different from zero.

18. For men, changes in the coefficients on all education dummy variables were not significantly different from zero.

19. When we use data on only full-time employees the pattern of changes in the private rates of return is different from the pattern described here. Specifically, for men, the rate of return to university education fell, and the rate of return to junior high school rose, during 1978–91 (the pattern of change for women is the same as that described above).

20. Note that our consistent finding of higher private internal rates of return for women relative to men does not imply that the wages of women are higher than the wages of men. For a given educational level, the wages of women are likely to be lower than the wages of men. Therefore, a dollar increase in earnings by education level for women will be a higher percentage increase than a dollar increase for men.

21. For men, changes in the internal rate of return to education for all education levels were not significantly different from zero.

22. For women, changes in returns to Junior High, Academic High and Junior College were significant, while changes in returns to University were not significant.

23. For example, in 1991 the standard deduction for a single person was NT\$33,000, the exemption for a healthy single person with no dependents was NT\$60,000, and marginal rates were 6% for incomes of NT\$0 to NT\$300,000, 13% for incomes of NT\$300,001 to NT\$800,000, 21% for incomes of NT\$800,001 to NT\$1,600,000, 30% for incomes of NT\$1,600,001 to NT\$3,000,000 and 40% for income above NT\$3,000,000 (tax rates are based on the information in Ministry of Finance, 1983, 1988, 1993). We assumed that yearly income consisted of 12 times reported monthly income plus an end-of-year bonus amounting to one month's income.

24. Still, our characterization of the private costs to education is not complete. For example, we do not include the cost of school supplies (books, pencils, etc.), transportation to and from school, or additional living expenses that students may incur at boarding school. Nor does our estimate of costs include an estimate of the tuition a student may pay. In 1993, tuition was approximately NT\$40,000–50,000 per semester for a private junior college, approximately NT\$10,000 per semester for a public junior college, approximately NT\$50,000–60,000 per semester for private university and approximately NT\$10,000 per semester for public university (comments at a seminar at the National Cheng-Chi University, November 25, 1993).

25. While the rank orderings of returns to education between different levels are the same in all methodologies, the magnitude of the difference between the internal rate of return calculation and the rate of return calculated using the coefficients on the earnings equations is surprising.

26. To adequately correct for selectivity bias resulting from selection into higher education levels we would need information on variables that affect the probability that an individual decides to enter the next higher education level but do not affect wages nor the decision to enter the labor force. Such variables might include parent's education or social status, scores on intelligence tests, etc.

We do present results corrected for selectivity bias resulting from selection into the labor forces (Appendix). The result that returns to education for women are higher than those for men in Taiwan still holds even when we "correct" for selectivity in the estimation of the earnings equations. Unfortunately, the variables that we have available for the labor force participation equation are not comprehensive. "To correct for sample selection bias in estimating returns to education some specific variable must be known that affects the probability that a person works for wages, but this variable cannot affect the worker's productivity as a wage earner or her market wage offer" (Schultz, 1993, p. 718). Many studies have used nonlabor income as this variable. Unfortunately, we do not have such an identifying variable available in our data.

27. On the other hand, it may also be true that the market values traits that favor women at low education levels. For example, there may be wage premiums to the manual dexterity of women in many of the industries which led Taiwan's export boom, such as apparel and electronic assembly.

28. Returns to university and junior college education for women, however, did increase.

29. These countries are Kenya, Malawi, Upper Volta, India, Iran, Pakistan, Philippines, South Korea, Taiwan, Thailand, Brazil, Colombia, Peru, Venezuela, Australia, Cyprus, Greece, France, Germany, Great Britain, Japan, and

the United States. See Appendix Table A1 in Psacharopoulos (1989), pp. 229–300.

30. Two studies which present similar estimates of returns to education to ours are Riveros (1990) for Chile and Ryoo, Nam and Carnoy (1993) for South Korea. Riveros (1990) presents estimates (for five-year intervals) for 1960–85. He finds that, while the coefficient on years of education in a standard earnings equation increased during 1960–85 (from .1122 to .1512), private internal rates of return to education fall (from 33.1 to 27.6 for primary education, from 12.5 to 11.0 for secondary education, and from 11.6 to 10.3 for university education).

In terms of its pattern of development and culture, South Korea is similar to Taiwan. Ryoo, Nam and Carnoy (1993) estimate standard earnings equations and find that the coefficients on dummy variables for workers with different education levels (primary school, high school, junior college and college) fell during 1976–88. Ryoo, Nam and Carnoy (1993) also estimate internal rates of return for these four levels of education. In estimates which used a technique similar to ours, they found that internal rates of return to all levels of education for men fell (from 21.78% in 1974 to 17.90% in 1986 for college, from 11.39 to 11.15 for junior college, from 20.18 to 10.13 for high school, and from 7.32 to 2.75 for primary school). For women, the internal rate of return increased for university (from 16.33 in 1974 to 19.88 in 1986), while it fell for all other education levels (from 17.78 to 14.74 for junior college, from 19.45 to 9.95 for high school, and from 8.42 to 0.98 for primary school). See Ryoo, Nam and Carnoy (1993), Table 3, p. 74.

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APPENDIX

ESTIMATING EARNINGS EQUATIONS WHICH
INCLUDE EDUCATION AS AN INDEPENDENT
VARIABLE, CORRECTING FOR SAMPLE
SELECTION BIAS

One issue in the estimation of earnings equations is "sample-selection bias" (or "self-selection bias"). Sample-selection bias occurs when the sample used to estimate the earnings equation is not a random sample of the population as a whole. In our case, this may occur because only those workers who receive higher wages choose to work, while those who would receive low wages remain out of the labor force (see Maddala, 1984). This may be an especially important phenomenon for women, many of whom do not work for wages.

We use the Heckman (1976) technique to correct for sample selection bias. We estimate

$$E(Y_i/I_i = 1) = B'X_i = F^*/(1-F^*),$$

where F^* is the normal cumulative density function and F^* = probability that the person is in the labor force = $F(D'Z_i)$.

The right-hand side variables in the labor force participation equation (used to estimate D) age, age squared, a dummy variable which indicates if children under six years old are present in the household (data available for married women only), a dummy variable which is one if the individual is married, and a variable which is one if the worker was affected by the Nine Year Compulsory Education Policy (NYCEP).

In addition to allowing us to estimate the coefficients on the earnings equation without bias, this method also tells us about the decision on whether to enter the workforce. The coefficients of the labor force participation equations provide

us with evidence on the variables which influence that decision (positively or negatively) conditional on the other variables. For example, the coefficient on the variable which is one if the worker was affected by NYCEP will tell us the effect of NYCEP on labor force participation rates (conditional on the other right-hand side variables).

Table A1 presents the maximum likelihood estimates of the selectivity corrected earnings for 1978 and 1991 by sex. All of the coefficients in the labor force participation equations are significantly different from zero at the 1% level of significance. For men, the coefficient on the variable which is one if the individual is married is positive, indicating that married men are more likely to be in the labor force than nonmarried men. For women, the coefficients on the variables which are one if the individual is married, and one if children under six are present in the household, are negative, indicating that married women and women with small children are less likely to be in the labor force than nonmarried men. The sign of the coefficient on the variable which is one if the worker is young enough to have been affected by the Nine Year Compulsory Education Policy (NYCEP) is ambiguous; negative in 1978 and positive in 1991.

Table A2 presents the coefficients on the education dummy variables from the selectivity-corrected earnings equations. The coefficients on the education dummy variables in the selectivity-corrected earnings equations are very similar to the coefficients on education in the OLS estimated earnings equation. The estimates from the selectivity corrected equations, however, show less variation from year to year. For men, changes in the coefficients on all education dummy variables were not significantly different from zero. For women, changes in the coefficients were significant for Junior High, Academic Senior High and Junior College, but not significant for Vocational Senior High nor University.

Table A1. *Selectivity corrected earnings equations, 1978 and 1991*

Coefficient (Standard Error)	1978		1991	
	Male	Female	Male	Female
Labor force participation equation				
Constant	-1.526	-1.879	-6.776	-4.900
Married	0.772	-1.310	0.644	-1.050
Children under six	NA	-0.317	NA	-0.192
NYCEP	-0.890	-0.107	0.744	0.468
Age	0.137	0.147	0.360	0.281
Age squared	-0.002	-0.002	-0.004	-0.003
Earnings equation				
Constant	9.889	9.589	11.210	10.950
Junior High	0.109	0.142	0.144	0.193
Academic Senior High	0.328	0.310	0.287	0.405
Vocational Senior High	0.354	0.313	0.281	0.400
Junior College	0.513	0.585	0.469	0.707
University	0.761	0.862	0.712	0.968
Experience (years)	0.039	0.031	0.050	0.033
Experience squared	-0.001	-0.001	-0.001	-0.001
Hours worked per week	0.014	0.014	0.015	0.015

Years of tenure	-0.004	-0.007	-0.007	-0.000
Changed jobs in last five years	-.005†	-0.003†	-.028	0.036
Have a second job	.016†	-.092†	.034†	-.092†
Log-likelihood ratio	-20945	-13482	-24937	-19251

*All coefficients are significantly different from zero at the 1% significance level except where noted. For men, the presence of young children in the household is not reported.

†Coefficient is not significantly different from zero at the 10% level.

Table A2. Coefficients from the selectivity-corrected earnings equations

Year	JH	ASH	VSH	JC	College
Sample: All workers					
1978	0.115	0.341	0.363	0.564	0.810
1979	0.123	0.359	0.386	0.608	0.806
1980	0.152	0.398	0.386	0.607	0.821
1981	0.146	0.379	0.386	0.616	0.817
1982	0.134	0.370	0.361	0.603	0.788
1983	0.165	0.401	0.377	0.623	0.834
1984	0.186	0.382	0.397	0.643	0.864
1985	0.181	0.393	0.405	0.628	0.878
1986	0.199	0.402	0.408	0.642	0.882
1987	0.167	0.362	0.375	0.624	0.886
1988	0.184	0.363	0.393	0.639	0.886
1989	0.146	0.328	0.338	0.582	0.817
1990	0.121	0.278	0.289	0.529	0.737
1991	0.163	0.331	0.326	0.556	0.802
Sample: Male					
1978	0.109	0.328	0.354	0.513	0.761
1979	0.133	0.322	0.363	0.537	0.758
1980	0.162	0.374	0.355	0.508	0.762
1981	0.149	0.355	0.354	0.532	0.742
1982	0.134	0.331	0.316	0.508	0.714
1983	0.169	0.380	0.340	0.554	0.766
1984	0.182	0.360	0.356	0.559	0.790
1985	0.170	0.368	0.369	0.544	0.810
1986	0.202	0.368	0.378	0.562	0.807
1987	0.165	0.338	0.352	0.540	0.834
1988	0.201	0.342	0.387	0.564	0.837
1989	0.141	0.288	0.303	0.488	0.732
1990	0.122	0.255	0.258	0.450	0.647
1991	0.144	0.287	0.281	0.469	0.712
Sample: Female					
1978	0.142	0.310	0.313	0.585	0.862
1979	0.131	0.347	0.302	0.591	0.757
1980	0.161	0.368	0.336	0.673	0.803
1981	0.179	0.369	0.342	0.665	0.865
1982	0.159	0.386	0.355	0.676	0.860
1983	0.182	0.377	0.370	0.661	0.903
1984	0.224	0.363	0.387	0.696	0.921
1985	0.239	0.395	0.401	0.701	0.934
1986	0.218	0.403	0.380	0.689	0.919
1987	0.183	0.344	0.342	0.665	0.885
1988	0.160	0.314	0.297	0.598	0.787
1989	0.206	0.399	0.393	0.718	0.941
1990	NA*	NA	NA	NA	NA
1991	0.193	0.405	0.400	0.707	0.968

*Not available (NA) indicates that the estimates of the likelihood functions did not converge.

Table A3. Average yearly earnings by education level (in current New Taiwan dollars)

	Primary	Junior High	Academic Senior High	Vocational Senior High	Junior College	University
Sample: All workers						
1978	65055	61499	82125	72763	87422	122849
1979	78758	73286	95505	85866	107280	140892
1980	102370	99300	120720	109750	129660	180230
1981	121940	111800	141430	127100	165880	244760
1982	126499	118598	152977	133723	170948	221054
1983	131420	127691	163865	141698	183538	236495
1984	134456	133260	164647	144940	188325	241729
1985	138633	135770	169286	151074	192952	255635
1986	146563	145049	179636	159967	211991	281642
1987	155543	156692	187029	165441	214360	296956
1988	175265	174923	200954	186435	235600	303142
1989	223095	231504	258858	238598	304944	385307
1990	251430	263080	295810	269190	341870	426750
1991	274173	292124	320226	301363	376926	476163
Sample: Male only						
1978	70758	67886	90358	85976.8	96271	133412
1979	85751	81358	104065	103330	118436	154800
1980	113310	114560	134780	134510	140670	199930
1981	134260	124740	157510	151270	182580	276010
1982	137636	133350	170789	158552	186989	241936
1983	143469	143009	184140	166698	203030	257527
1984	147668	148479	186181	171095	207691	264677
1985	151482	150405	191262	178112	211734	282285
1986	161189	162563	201729	190223	231870	312297
1987	172146	174966	211793	196796	237098	332382
1988	192326	194989	226898	223126	261884	348636
1989	247310	258133	296074	280827	334694	426819
1990	279560	292280	337710	316440	380610	472110
1991	305204	303095	362599	352337	418771	526438
Sample: Female only						
1978	46567	46215	55849	55151	68726	89540
1979	55238	54104	69545.7	59586	83739	97509
1980	66210	63930	83240	72770	105560	121560
1981	79950	80830	95700	90860	130920	146430
1982	87884	84135	105552	97001	138531	159816
1983	92025	91301	110505	103781	144414	173002
1984	94310	97964	111153	107529	152330	182237
1985	99508	101417	117369	112389	157087	188334
1986	104054	104948	126809	117899	172607	212730
1987	110964	113180	134930	121887	176820	219577
1988	127089	126676	142401	133180	188047	214997
1989	158448	163164	187072	177822	251311	295774
1990	178540	184070	208210	201760	275780	339140
1991	198984	206448	230879	224084	305392	379760