行政院國家科學委員會專題研究計畫　成果報告

教育不均度、所得分配與經濟成長--台灣之實證分析

計畫類別：個別型計畫
計畫編號：NSC93-2415-H-034-002-
執行期間：93 年 08 月 01 日至 94 年 07 月 31 日
執行單位：中國文化大學經濟學系暨研究所

計畫主持人：林俊宏
共同主持人：王淳玄

報告類型：精簡報告

處理方式：本計畫可公開查詢

中　華　民　國 94 年 10 月 24 日

Education Expansion, Educational Inequality, and Income Inequality: Evidence from Taiwan, 1976-2003

Chun-Hung A. Lin

Abstract

The expansion of higher education in Taiwan starting from the late 1980s has successfully raised the average level of education. We find that the distribution of education, defined as the education Gini coefficient, declined as average schooling rose during the period of 1976-2003. The impacts of a rising average schooling and a declining educational inequality are also tested empirically in this paper. The evidence supports that a higher level of average schooling (educational inequality) will generate a lower (larger) income inequality. Skill-biased technological change that shifts the labor demand from unskilled workers toward skilled workers is the most likely cause for the rising income inequality. However, the trend of rising income inequality could be reversed due to possible future over-education and unemployment in the labor market.

Keywords: Education expansion, Educational inequality, Income inequality, Education Gini

中文摘要

我國自 1980 年代後期開始著手於高等教育的擴張政策，此政策亦成功地提升了我國的平均教育水準。然而，我們也進一步地發現我國在 1976 年至 2003 年之間教育不均度(教育吉尼係數)卻逐年下降。本文並以實證分析這兩者對所得不均度所產生的影響。其結果顯示，較高的平均教育水準(教育不均度)會造成較低(高)的所得不均度，而技術的進步是造成所得不均度上升的最主要的原因。我們亦預測未來所得不均度可能會因為過度教育與較高的失業率而下降。

關鍵詞：教育擴張、教育不均度、所得不均度、教育吉尼係數

1. Introduction

The continuous investment in schooling resources has been the key characteristic on the pathway of Taiwan's high economic growth for the past thirty years. Evidence shows a remarkable improvement accumulation and therefore the average educational attainment for the whole population has been lifted. As a result, the stock of human capital, defined as average schooling years, has obviously improved.

The relationship between average education level and the distribution of education, i.e. educational inequality, is not quite clear since the inequality may change with different directions (up, down, or remain unchanged) when average education level increases. On the other hand, if the increase of average education level is caused by a relatively larger expansion in higher education, then inequality is likely to increase. Thus, for the case of Taiwan, we may anticipate that the basic education expansion plan launched in 1968[1] has tended to decrease educational inequality, while the late 1980s' higher education expansion policy is expected to widen the inequality. However, if the rate of growth in a higher-educated population outpaces the rate of decline in a lower-educated population during the higher education expansion, then educational inequality can still be reduced. The result will be left as an empirical issue and it is investigated in the later section.

Furthermore, there is another important issue needed to be addressed in this paper: how much impact does the expansion of education have on Taiwan's distribution of income? This question can be divided into two parts: (i) what is the direction of the impact of an increasing level of schooling on income inequality?; and (ii) how much effect does educational inequality have on income inequality? Education is generally viewed as a social equalizer in terms of income, indicating a positive relationship between educational inequality and income inequality. However, as Kuznets (1955) suggests, a country's income inequality tends to increase first when the country's economy starts growing, and then it starts to decline after reaching a peak.

Many previous empirical studies have included the average level of schooling and educational inequality as independent variables in explaining the change of income inequality. Some of them use cross-country data, while still some use intra-country data. Most of them have found similar evidence and conclusions that increasing the average level of schooling tends to reduce income inequality and increasing the educational inequality will have a positive effect on income inequality. Since the effects of average level of schooling and educational inequality on income inequality go different directions, the real impact of education expansion on the distribution of income for a country would remain somewhat ambiguous.

2. Trends of school attainment and educational inequality in Taiwan, 1976-2003

[1] In 1968, the Taiwan government extended basic education from 6 to 9 years, which allowed primary school graduates to continue their education at the junior high school level without any entrance examination.

We follow the formula that most previous studies used to calculate the average years of schooling:

$$\mu = \sum_{i=1}^{7} p_i E_i \,, \tag{1}$$

where p_i is the proportion of population aged 15 and older with education level *i*,

E_i represents years of schooling for an individual with education level *i*,

i = 1, 2, ……. ., 7.

The formula we use to calculate educational inequality is the so-called "Education Gini" coefficient (Thomas et al., 2001):

$$Gini_E = \left(\frac{1}{\mu}\right)\sum_{i=2}^{7}\sum_{j=1}^{i-1} p_i \left|E_i - E_j\right| p_j \,, \tag{2}$$

where μ, $p_{i(j)}$, and $E_{i(j)}$ are the same definitions as Equation (1). Equation (2) can be expanded as

$$\begin{aligned} Gini_E = \frac{1}{\mu}[\ & p_2(E_2 - E_1)p_1 \\ & + p_3(E_3 - E_1)p_1 + p_3(E_3 - E_2)p_2 \\ & +\text{…….} \\ & +\text{…….} \\ & + p_7(E_7 - E_1)p_1 + p_7(E_7 - E_2)p_2 + p_7(E_7 - E_3)p_3 + p_7(E_7 - E_4)p_4 \\ & + p_7(E_7 - E_5)p_5 + p_7(E_7 - E_6)p_6\,]. \end{aligned} \tag{3}$$

As we review the past literature regarding the distribution of education, some of them use the standard deviation of schooling as the index of educational dispersion.

Equation (3) is used herein to calculate education Gini for Taiwan using the data obtained from DGBAS for the period of 1976-2003 in order to see how the trend of educational inequality has changed in this period and also to compare it with various countries. We find a very steady trend for both average years of schooling and educational inequality for Taiwan over the period of 1976-2003. The educational inequality keeps declining while average schooling continues to rise, except in 2000 when both lines act differently in their trends. Average schooling increases from 7.14 years in 1976 to 10.98 years in 2003, and education Gini decreases from 0.341 in 1976 to 0.197 in 2003.

The distribution of education can also be shown by a country's "education Lorenz curve". The relationship between the education Gini coefficient and the education Lorenz curve can be described as the following formula.

$$\text{education } Gini = \frac{Area\ \ between\ education\ Lorenz\ \ curve\ \ and\ \ 45^0\ \ line}{0.5}. \tag{4}$$

We show the education Lorenz curve for Taiwan in 1976, 1990, and 2003 in Figure 1. For over almost three decades, we can see a lot of improvement in Taiwan's education equality, suggesting a less social loss from an underutilization of human capital stock.

Comparing the educational progress of Taiwan with that of other countries in the world, we refer the studies by Thomas et al. (2001).[2] Although they only analyze various countries during the period of 1960 to 1990 (1976 to 2003 for Taiwan in our study), we still can observe the trends of average education attainment and educational inequality over time for these countries and make proper comparisons with Taiwan. Thomas et al. (2001) find that the average years of schooling have been increasing for most countries with only one exception (Afghanistan), and educational inequality has declined for most countries except Colombia, Costa Rica, Peru, and Venezuela.

In 1990 the United States had the highest average schooling with more than 12 years and the lowest education Gini with less than 0.2. On the other hand, Mali and Afghanistan had the lowest average schooling with less than 2 years and the highest education Gini with more than 0.8. Table 1 shows a part of the results from Thomas et al. (2001) and the results of Taiwan for the year 1990 in our study. We can see that more-developed countries tend to have higher average schooling and more equitable education, while less-development countries are likely to achieve lower average schooling and higher educational inequality, indicating educational inequality declines as the average education levels increase. Taiwan is among those countries that have a higher average level of education attainment and a lower dispersion in distribution of education in the year 1990. We believe that Taiwan will also belong to this category once the data for other countries are available for more recent years.

The relationship of average schooling and educational inequality is investigated using the following regression equation, according to the discussion in the last section.[3]

$$Gini_{E_t} = \beta_1 \cdot \mu_t + \beta_2 \cdot \mu_t^{\,2} + \varepsilon_t , \tag{5}$$

where $Gini_{E_t}$ is the education Gini at period *t*, μ_t is the average years of schooling at period *t*, and ε_t is the error term.

If the estimated results are consistent with the hypothesis proposed by Ram (1990), i.e. an inverted U-shaped curve, then we would expect $\hat{\beta}_1 > 0$ and $\hat{\beta}_2 < 0$. This pattern in educational development is the so-called "education Kuznets curve", as suggested by Londoño (1990) and Ram (1990). The regression result for the case of Taiwan is shown as follows.

$$Gini_{E_t} = 0.09682 \cdot \mu_t - 0.00737 \cdot \mu_t^{\,2} \tag{6}$$

$$(41.47) \qquad (-29.86) \qquad \overline{R}^2 = 0.95 .$$

We have obtained $\hat{\beta}_1 = 0.09682$ and $\hat{\beta}_2 = -0.00737$ as expected with *t*-statistics in the

[2] The study of Thomas et al. (2001) does not include Taiwan in their 85-country sample.
[3] Since educational inequality will be obviously zero when the average years of schooling are zero, there is no constant term in this regression.

parentheses. Both estimated coefficients are highly statistically significant and the fit of regression (adjusted *R*-squared) is quite good. The results of estimation also indicate the turning point of the education Kuznets curve occurs when the average schooling is around 6.57 years for Taiwan. The number is comparable to the results (6.8 years) of Ram (1990) in analyzing 94 countries around the world. It is clear that the turning point has already been passed over the sample period for Taiwan in our study. The average schooling in 1976 was 7.14 years, suggesting that the educational development in Taiwan has been lying past the turning point over this period. Continuous investment in education by Taiwan's government not only increases the average level of human capital, but also makes its educational dispersion more equitable, which in turn by assumption could further reduce income inequality for the society.

3. Average schooling, educational inequality, and income inequality

As Taiwan's educational inequality continues to drop with an increasing average level of education, we can see that income inequality rose steadily over the period of 1976-2003. The income Gini coefficient increased from 0.283 in 1976 to 0.343 in 2003. The 21.2% increase in Taiwan's income Gini coefficient is comparable to that in countries characterized as having experienced rapid increases in income inequality, such as the United States. The income inequality rose despite a rapid increase in the share of educated workers in the labor market, since the higher education expansion took place after the late 1980s which might have been expected to depress returns to college education. As we mentioned in the earlier section, the increasing average level of educational attainment can act as an equalizing effect on income distribution, while the variation in distribution of education goes the opposite direction. We now try to investigate, to what extent, how income inequality responds to changes in the average level of schooling and educational inequality in Taiwan.

We start with an econometric model that integrates previous studies' methodology. First, the control variables in explaining income inequality include the average level of schooling (μ) and the educational inequality ($Gini_E$), according to the above discussion. Moreover, a Kuznets-type quadratic form is typically used to access the relationship between the level of economic development and income inequality. That is, the relationship may be rewritten in the form of

$$Gini_{inc_t} = \alpha_1 + \alpha_2 \cdot \ln(gdp_t) + \alpha_3 \cdot \ln(gdp_t^{\,2}) + e_t, \qquad (7)$$

where $Gini_{inc_t}$ is the income Gini coefficient at period *t*,

$\ln(gdp_t)$ is the log of per capita gross domestic product at period t,

$\ln(gdp_t^2)$ is the log of square of gdp_t, and e_t is the error term.

A positive sign for α_2 and a negative sign for α_3 are expected. After incorporating education control variables, Equation (7) becomes

$$Gini_{inc_t} = \alpha_1 + \alpha_2 \cdot \ln(gdp_t) + \alpha_3 \cdot \ln(gdp_t^{\,2}) + \alpha_4 \mu_t + \alpha_5 Gini_E + e_t . \quad (8)$$

We also consider two other control variables, fertility rate and the ratio of high-tech products on total exports. The reason the fertility rate matters is that a higher fertility rate will lower the relative income of the poor, which in turn enlarges the income inequality. The poor tend to have more children and invest less in education for their children than the rich do. Thus, children of poor people will likely still be poor in the future. If the fertility rate increases, then a larger proportion of the increase will probably come from the poor. As a result, income inequality rises as the fertility rate increases (De La Corix and Doepke, 2003). Adding the variable of the ratio of high-tech products in total exports is based on the theory of North-South trade. The higher this ratio is, the more demand there will be for highly-educated workers. The demand for lower-educated workers at the same time will decrease. As a result, a larger income inequality occurs.

The OLS estimated results are shown in Table 2. We estimate three different models using different combinations of control variables (columns (1), (2), and (3)). Surprisingly, from Table 2 we observe the estimated results which are inconsistent with the Kuznets inverted U-shaped hypothesis. The estimated coefficients of the log of per capita GDP and their square are just opposite to the expectation we made earlier, and both are statistically significant in all three models. On the other hand, as expected, increasing the average level of schooling can significantly reduce income inequality. A higher dispersion of education inequality will widen income inequality in Taiwan, but the estimations are only significant in Model (1). The variable of the fertility rate is significant in Model (2), but not in Model (3). However, an increase in high-tech products' export ratio will significantly make the income inequality larger.

As we indicated earlier, Taiwan has been experiencing rapid growth in the share of highly-educated workers and its income inequality has also been rising over the period of 1976-2003. The estimated result in Equation (6) suggests that increasing investment in higher education would not only raise the average level of schooling, but also reduce educational inequality, both of which can make income inequality smaller. However, we have ironically observed increasing income inequality in Taiwan over this period. From the estimation in Model (3), a significant proportion of the cause of increasing income inequality appears to be rising labor demand toward skilled (highly-educated) workers due to changes in trade patterns. Despite the higher level of average educational attainment from a large increase in the supply of highly-educated workers, a decrease in educational inequality would not be enough to overcome the effect of trade that causes the shift in relative labor demand from unskilled workers toward skilled workers. Thus, income inequality becomes larger although there is continuous investment in education for Taiwan. As many previous research studies indicated, skill-biased technological change is the most likely cause for the shift. Skilled-biased technological changes increase the relative demand for skilled workers, which in turn increase the earnings of skilled workers relative to the earnings of unskilled workers.

Therefore, income inequality has risen in Taiwan during this period.

4. Conclusions and policy implication

We find, over the last thirty years, that Taiwan's average years of schooling increased more than 50% while educational inequality fell by more than 40%. The impact of educational expansion on income inequality in Taiwan is tested empirically in this paper. The evidence presented here shows strong support that higher average levels of schooling have an equalizing effect on the distribution of income and a somewhat weaker support that an increase in inequality of education will generate a larger income inequality. We find that a significant proportion causing the increasing income inequality in Taiwan during the period of 1976-2003 comes from skill-biased technological changes due to changes in trade patterns, which lead the shift in relative labor demand from unskilled workers toward skilled workers.

The policy of expansion in higher education by Taiwan's government seems to be the right direction in pursuing a more equitable society, although Taiwan's current economic progress still shows a rising income inequality due to the relatively strong demand for highly-educated workers. However, the policy cannot be executed without any negative effect. It will produce a larger supply of highly-educated workers entering the labor market each year and, as mentioned in the last section, the rising income inequality also induces more workers who would originally not like to study further to pursue a higher education degree. Once the supply of highly-educated workers is larger than the demand for highly-educated workers in the future, a proportion of these highly-educated workers will become over-educated or even unemployed in the labor marker, although we might see a declining income inequality in Taiwan.

References

De La Corix, David and Matthias Doepke. (2003), "Inequality and Growth: Why Differential Fertility Matters", *American Economic Review*, 93(4), pp. 1091-1113.

Kuznets, Simon. (1955), "Economic Growth and Income Inequality", *American Economic Review*, 45, pp. 1-28.

Londoño, Juan Luis. (1990), "Kuznetsian Tales with Attention to Human Capital", Seminar paper at the Third Inter-American Seminar in Economics, Rio de Janeiro, Brazil.

Ram, Rati. (1984), "Population Increase, Economic Growth, Educational Inequality, and Income Distribution: Some Recent Evidence", *Journal of Development Economics*, 14, pp. 419-428.

_____. (1990), "Educational Expansion and Schooling Inequality: International Evidence and some Implications", *Review of Economics and Statistics*, 72(2), pp. 266-74.

_____. (1995), "Economic Development and Income Inequality: An Overlooked Regression Constraint", *Economic Development and Cultural Change*, 43(2), pp. 425-434.

Solow, Robert M. (1988), "Growth Theory and After", *American Economic Review*, 78(3), pp.

307-17.

Thomas, Vinod, Yan Wang and Xibo Fan, (2001), “Measuring Educational Inequality: Gini Coefficients of Education”, *Policy Research Working Paper Series*: #2525, The World Bank.

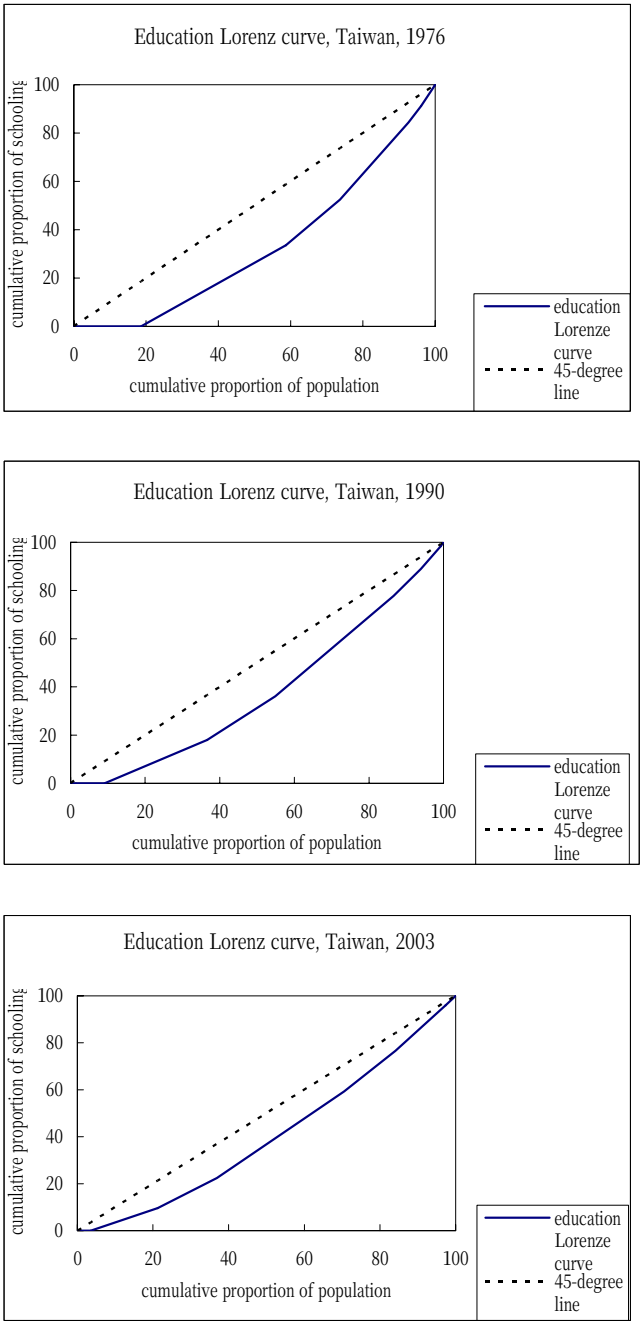

Figure 1. Education Lorenz Curve, Taiwan: 1976, 1990, and 2003

Table 1. Education Gini in 1990 (selected countries from Thomas et al. (2001))

Low 0.0 ~ 0.3	USA, UK, Canada, Australia, Japan, Poland, South Korea, New Zealand
Median 0.3 ~ 0.6	Mexico, China, Switzerland, Spain, Turkey Kuwait, Thailand
High 0.6 ~ 1.0	Mali, Afghanistan, Yemen, India, Iran Pakistan, Sudan, Haiti
0.253	Taiwan

Average schooling in 1990 (selected countries from Thomas et al. (2001))

High 8 ~ 14 years	USA, UK, Japan, Poland, Canada, Romania, Australia, South Korea, Hungary, Bulgaria
Median 4 ~ 8 years	Mexico, China, Philippines, Brazil, Thailand, Malaysia, Colombia
Low 0 ~ 4 years	Mali, Afghanistan, Tunisia, India, Pakistan, Haiti
9.131 years	Taiwan

Note: The results of Taiwan are based on the author's calculation.

The results of other countries are collected from Thomas et al. (2001).

Table 2. OLS Estimated Results for Income Inequality ($Gini_{inc}$)

	(1)	(2)	(3)
constant	0.456	0.475	0.693
	(0.79)	(0.90)	(1.20)
ln(*gdp*)	-0.094*	-0.195***	-0.156**
	(-1.83)	(-3.03)	(-2.04)
ln(*gdp square*)	0.006*	0.013***	0.010**
	(1.95)	(3.13)	(1.94)
μ	-0.022**	-0.036*	-0.021**
	(-2.08)	(-1.82)	(-1.97)
$Gini_E$	0.143*	1.161	0.640
	(1.71)	(1.44)	(0.66)
fertility rate		0.902*	0.607
		(1.75)	(1.13)
high-tech ratio			0.204**
			(2.02)
$\bar{R}^2$	0.908	0.923	0.922
N (sample size)	28	28	28

Note: t-statistics in the parentheses. *** indicates significance at 1% level.
** indicates significance at 5% level. * indicates significance at 10% level.
Per capita GDP are converted to constant 2001 Taiwan dollars. The variable of the fertility rate is obtained from "General Fertility Rate", collected by DGBAS. The definition of General Fertility Rate is the average number of live births per woman aged 15-49 in one year (i.e. total live births / total number of women aged 15-49). High-tech ratio variable is the ratio of high-tech products in total exports in one year. The data can also be obtained from DGBAS.

計劃結果自評：

本計劃之研究結果與原計劃之內容及預期目標大致上一致，其成果與貢獻度在學術上或是在應用上應有一定的價值，尤其是在教育政策的制定上。針對目前頗受各界撻伐的教改政策上，本研究亦可提供高等教育擴張政策之後目前所發生在勞動市場的現況與預測。