

The effects of engineering education on earnings in Taiwan

Dan-Shang Wang[†] & Ben-Jeng Wang[‡]

National Changhua University of Education, Changhua, Taiwan[†]

Tunghai University, Taichung, Taiwan[‡]

ABSTRACT: The purpose of this study is to determine the influence of different levels of engineering education on graduates' monthly earnings. Semi-log regression was used to analyse the effects of four different levels of engineering education (namely: vocational industrial, industrial junior college, four-year university and graduate school of engineering education) on graduates' monthly earning compared with general high school graduates in Taiwan. Data analysed was taken from a labour utilisation survey in Taiwan conducted in May 1999, by the Directorate-General of Budget, Accounting and Statistics (DGBAS). The data was restricted to 7,534 respondents who were currently employed, aged 24 to 55 and not in the armed forces. These graduates had participated in general high school, vocational industrial high school, industrial junior college, four-year university, or graduate school of engineering education, and had completed all of the required data in the earning model. The main finding was that, compared to general high school education, vocational industrial high school education had no significant effect on graduates' monthly earnings. This was not surprising as a higher monthly income is associated with a higher level of engineering related education.

INTRODUCTION

Taiwan has recently undergone educational reform. The number of four-year colleges and universities in Taiwan has grown 120% during the past ten years and this trend may continue in the coming years.

However, according to the report from the Council for Economic Planning and Development, the development of the new economy and the labour market will not be in a state of equilibrium over the next six years (2001-2006). There will be problems of labour shortage for the lower level workers, but, at the same time, more than 9,000 mid-level human resources will not be able to get a job. This means that higher education graduates will soon face the problem of oversupply. Given this predicament of the labour market, one could inquire as to whether the development of higher education in Taiwan adequately responds to the demands of the labour market. This is especially so as engineering education is related to the quantity and quality of technicians and engineers.

The study of the effects of higher education on the economic earnings of graduates can provide information from both sides of supply and demand in the labour market. This may help individual, students' parents and educational decision-makers clarify this important and serious question and improve higher education investment judgement.

LITERATURE REVIEW

The accumulation of human capital plays a critical role in determining economic development. According to *human capital theory*, decisions to invest in education are taken, amongst other things, on the basis of relative value (eg wage rate or earning). However, the relative value results from

economic development [1]. Since educational investment is a core part of human capital, researchers have paid considerable attention to estimate the rate of return to education. Moreover, the rate of return had been found to vary over time and over schooling level [2-4]. This was also found over location in another study [5].

However, there are very few studies that have focused on the return rate of education in terms of different educational major [6]. Some researchers have suggested that the expected earnings in different undergraduate fields is the one important factor that can influence students' considerations in choosing an undergraduate college major. Eide and Waehrer found that liberal arts and science major students, for those with low earnings at the undergraduate level, chose to major in those fields and never intended to terminate their education with an undergraduate degree [6]. Those students intended to enrol in professional or academic graduate programmes (excepting the computer science/engineering major male).

Wang found that in Taiwan, compared with the general high school graduates, vocational high school graduates only had a small short-term monthly earning effect. However, vocational education surprisingly had a worse long-term earning effect [7]. He also found that vocational high school graduates with programme-related employment could also earn significantly more per month [7]. Furthermore, Wang also found that young graduates of junior college earned significantly more per month than their counterparts from general high school [8].

The above study review indicates that there have been only a limited number of papers that have estimated the return rate of engineering education. As such, this paper will focus the estimation of the return rate for engineering major graduates on different educational levels in Taiwan.

ANALYTIC METHOD

Since wage or income is not a pure linear function with its independent variables (see Figure 1), economists often employ the semi-log function to analyse the wage or earning equation. Its regression can be expressed as follows:

$$\ln Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 D_{3i} + e_i$$

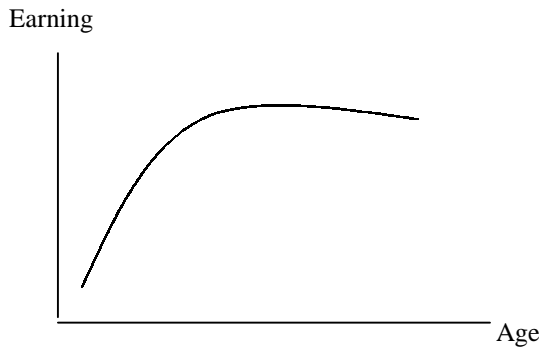


Figure 1: Age-earning profile.

In the above equation, $\ln Y_i$ is the logarithm of monthly earning, X_i are the continuous variables; D_i is the categorical variables, and e_i is the error term. For example, in order to discuss the effect of X_2 on monthly earnings, while controlling the other variables as constant, the partial derivative can be utilised to interpret it.

$$\partial(\ln Y) / \partial X_2 = \beta_2$$

$$\partial(\ln Y) / \partial X_2 = 1/Y \times (\partial Y / \partial X_2)$$

$$\partial(\ln Y) / \partial X_2 \cong (\Delta Y / Y) / \Delta X_2 = \beta_2$$

The above formula means that while controlling the other variables as constant, a change of one unit in the independent variable X_2 will make the monthly earning Y change $\beta_2 \times 100\%$ [9].

SAMPLING CHARACTERISTICS

This study analysed the data from a labour utilisation survey conducted in May 1999 in Taiwan by the Directorate-General of Budget, Accounting and Statistics (DGBAS). The sample was restricted to those respondents who were currently employed, aged 24 to 55 and not in the armed forces. The respondents had participated in general high school, vocational industrial high school, industrial junior college, four-year university or at a graduate school of engineering education, and had to complete all the required data in the earning model. In total, there were 7,534 samples in the analysis model.

Table 1 shows the average monthly income of different engineering education by gender. It was found that no matter what the gender of the respondents, the higher education one attained, the higher monthly income one earned. Furthermore, graduates of vocational industrial high school earned slightly more income per month than their general high school counterparts. Table 1 also shows that male respondents earned more money than the female respondents. However, there was only a limited number of respondents with Master or Doctoral degrees; as such these were pooled together as the graduate group.

Table 1: Average monthly income (in NT\$) by different education and by gender.

Variable	High School	Vocational School	Junior College	4-year University	Graduate School
Female	\$27,924	\$25,471	\$29,964	\$38,235	\$48,533
N	743	180	176	34	15
Male	\$39,019	\$37,690	\$42,283	\$53,566	\$64,995
N	1,604	2,716	1,504	399	163
Average	\$35,507	\$36,930	\$40,993	\$56,362	\$63,608
N	2,347	2,896	1,680	433	178

Table 2 illustrates the means and standard deviations of each variable in the analysis models. The average monthly earning was calculated at NT\$38,909 (approximately US\$1,100).

Table 2: Characteristics of the sample.

Variable	Total	
	Mean	Std. Dev.
Monthly earning	38,909.2	25,243.9
\ln Earning	10.4640	0.44740
Vocational school	0.38358	0.48629
Junior college	0.22279	0.41615
4-year university	0.05765	0.23309
Graduate school	0.01891	0.13621
Male	0.84755	0.35948
Age 24-30	0.32553	0.46860
Age 31-35	0.21076	0.40787
Age 36-45	0.34854	0.47654
Age 46-55	0.11133	0.31456
Single	0.32857	0.46973
Met city	0.10908	0.31176
Big city	0.12667	0.33262
Mid city	0.21433	0.41039
Job tenure	6.80903	6.19664
Working hours	47.5543	8.24041
1 st Industry	0.02841	0.16620
2 nd Industry	0.46767	0.49899
3 rd Industry	0.50390	0.50002
Scale 1-9	0.42179	0.49388
Scale 10-49	0.23708	0.42532
Scale 50-199	0.12363	0.32918
Scale 200+	0.21751	0.41258
Administrator	0.06783	0.25147
Professional	0.05117	0.22036
Clerk	0.08872	0.28436
Service	0.14267	0.34976
Fisher	0.02724	0.16278
Skilled	0.15232	0.35936
Operator	0.20402	0.40301
Non-skilled	0.02605	0.15929
Employer	0.08277	0.27556
Owner	0.14016	0.34717
Gov't. hire	0.10670	0.30876
Job changed #	0.07418	0.30018
Intend to quit	0.05646	0.23082
Sample size	7,534	

The biggest group in the sample consisted of vocational industrial high school graduates; 32% of the sample accounted for general high school graduates, 22.2% were from industrial junior colleges, four-year college engineering graduates

constituted 5.8%, while graduate level engineering major graduates occupied less than 2% of the total sample. Because of the nature of engineering major, most of the sample was male (84.75%). The average age was around 35 years old. Over two thirds of them were married and most of the sample lived in the rural areas.

The variable of working experience, on average, involved having a 6.8-year tenure and working 47.5 hours per week. Over half of the sample worked in the service sector. The largest proportion of respondents worked in organisations numbering 1 to 9 people (about 42%), with the next largest working in organisations numbering 10 to 49 people.

Due to the engineering major of the sample, the most common occupation in the sample was as a technician or associated professional (about 28%), then operator, then skilled worker, and then service or shop and market sales worker. Less than 12% of the samples' occupation was as an administrator or professional. Because the semi-log function was utilised in order to analyse the data, respondents whose monthly earning were less than NT\$1,000 were deleted from the sample; hence, there was no sample of unpaid family workers. More than two thirds of the samples were hired by private enterprises.

The survey also asked the respondents: *how many times have you changed your working place during the year of 1998?* The answer was limited from 0 to 3 times. The survey found that there was less than 0.1 times job changed in 1998 for this sample. The survey also revealed that about 5.7% of the sample participants expected to change their jobs.

FINDINGS

Table 3 presents the regression results into three specifications. Model 1 only included the educational variables to examine simple differences with varying levels of engineering education. However, Model 2 adds demographic variables (including gender, age and marital status) in order to examine the net effects of education. The most complete specification, Model 3 (see Table 4), adds the measurements of job experience so as to examine the net effects of education whilst controlling the demographic and job experience variables as constant.

Educational Effect

In Tables 3 and 4, compared with the high school graduates, the value of engineering higher education is substantial and significant, no matter what specification was examined. Moreover, still statistically significant, the higher engineering education the respondents completed, the more earnings they tended to receive. Interestingly, the gap in earnings decreased when the variables of demographic and job experience were added.

For example, engineering junior college participants earned from 15%, 13.6%, to 5.7% higher than general high school participants in Models 1, 2 and 3, respectively. Engineering four-year university participants also decreased their monthly earning effects from 36.9%, 32.7%, to 18.4% higher than their general high school counterparts in Models 1, 2 and 3 respectively.

Table 3: Monthly earning models of the total sample (1).

Variable	Model 1		Model 2	
	β	T-value	β	T-value
INTERCEPT	10.38	1171***	10.36	582.0***
Vocational school	0.043	3.56***	0.003	0.265
Junior college	0.150	10.92***	0.136	10.35***
4-year university	0.369	16.32***	0.327	15.62***
Graduate school	0.487	13.02***	0.476	13.82***
Male			0.292	21.71***
Age 24-30			-0.260	-15.24***
Age 31-35			-0.155	-9.08***
Age 36-45			-0.102	-6.50***
Single			-0.144	-12.93***
Sample size		7,534		7,534
F-value		116.5***		225.5***
R-square		0.058		0.212

***=p<0.01 **=p<0.05 *=p<0.10

Table 4: Monthly earning models of the total sample (2).

Variable	Model 3	
	β	T-value
INTERCEPT	9.792	297***
Vocational school	0.015	1.475
Junior college	0.057	4.70***
4-year university	0.184	9.26***
Graduate school	0.294	8.94***
Male	0.283	22.78***
Age 24-30	-0.060	-3.50***
Age 31-35	-0.006	-0.371
Age 36-45	-0.003	-0.237
Single	-0.088	-8.95***
Met city	0.117	8.41***
Big city	0.008	0.656
Mid city	0.031	3.06***
Job tenure	0.011	13.05***
Working hours	0.007	13.96***
1 st Industry	-0.241	-2.68***
2 nd Industry	-0.017	-1.76*
Scale 10-49	0.056	4.69***
Scale 50-199	0.070	4.64***
Scale 200+	0.131	8.14***
Administrator	0.239	12.52***
Professional	0.080	3.82***
Clerk	-0.090	-5.45***
Service	-0.056	-3.62***
Fisher	-0.381	-4.11***
Skilled	-0.074	-5.03***
Operator	-0.109	-8.31***
Non-skilled	-0.251	-9.36***
Employer	0.215	12.36***
Owner	0.074	4.79***
Gov't. hire	0.063	3.49***
Job changed #	-0.042	-3.07***
Tend to quit	-0.143	-8.14***
Sample size		7,534
F-value		156.8***
R-square		0.399

***=p<0.01; **=p<0.05; *=p<0.10

In contrast, the effects of vocational industrial education were less robust. Graduates with vocational industrial education had significantly higher earnings (Model 1 in Table 3), but much of

this difference can be attributed to the variables of demographic (Model 2) and job experience (Model 3).

Without the variables of demographic and job experience, the effect of vocational industrial education was significant; however, adding these variables to Models 2 and 3 make this positive significant earning effect disappear.

Demographic Variables

While putting the demographic variables into Model 2, the educational influence became smaller, as already mentioned above. Males earned more than females, older people earned more money than younger people, and married samples also earned more money per month than their single counterparts in the study's sample. However, if the educational, demographic, and job experience variables are put together, as shown in Model 3, then the age effect became less significant. Nevertheless, the factors of marital status and gender still had a very significant effect on people's monthly earnings.

Job Experience Variables

In Model 3, besides the educational and demographic effects mentioned above, people who lived in an urban area usually earned more than those living in a rural area. The longer job tenure one had, the higher monthly earnings one earned. On the average, one year more job tenure could make people earn 1.1% higher monthly earning. Not surprisingly, people who worked longer weekly also earned significantly more.

It was also found that those people who worked in the service sector significantly earned more per month than their counterparts in the first or second industry. As usual, people who worked in organisations of 1 to 9 people significantly earned less than those worked in the larger-scale organisations (10 to 49, or 50 to 199, or 200+ people).

Moreover, those employed as administrators or professionals earned significantly more than those employed as technicians or associate professionals. However, technicians or associate professionals earned more per month than the occupations of clerk, service or shop and market sales, fisher, skilled worker, operator and non-skilled worker. No matter what employment status each had, they all earned more than those who were hired by private enterprises. Those who had changed their job more during the last year earned less monthly. Finally, people who desired to change their job also earned significantly less.

CONCLUSIONS AND RECOMMENDATIONS

This study found that the monthly earning value of engineering graduates from higher education is substantial and significant.

At the start of 2001, the Taiwanese government established the environment of the knowledge-based economy as the first policy priority. This goal fits the current teachings of global and national scholars and experts: knowledge will be the number one important asset for any organisation. Knowledge can make the profits for the enterprises by providing the intellectual capital in the organisation.

In order to reach the above government goal, according to the report from the Council for Economic Planning and Development, only the majors of electrical and optical engineering higher education have space to be expanded. All engineering higher education cannot be expanded universally. Due to the scarcity of resource, efforts should be focused on the quality of engineering higher education, not just from the quantity side.

REFERENCES

1. Ritzen, J.M.M., Human capital and economic cycles. *Economics of Educ. Review*, 6, 2, 151-160 (1987).
2. Grubb, W.N., The returns to education in the sub-baccalaureate labor market, 1984-1990. *Economics of Educ. Review*, 16, 3, 231-245 (1997).
3. Grubb, W.N., Postsecondary education and the sub-baccalaureate labor market: corrections and extensions. *Economics of Educ. Review*, 14, 3, 285-299 (1995).
4. Grubb, W.N., The varied economic returns to postsecondary education: new evidence from the class of 1972. *J. of Human Resources*, 28, 2, 365-382 (1993).
5. Griffin, P. and Ganderton, P.T., Evidence on omitted variable bias in earnings equations. *Economics of Educ. Review*, 15, 2, 139-148 (1996).
6. Eide, E. and Waehrer, G., The role of the option value of college attendance in college major choice. *Economics of Educ. Review*, 17, 1, 73-82 (1998).
7. Wang, D., Interactive effects of long term and program related jobs with vocational education on monthly earnings in Taiwan, ROC. *Proc. 9th Technical and Vocational Conf. of ROC*, Taiwan, 75-84 (1994).
8. Wang, D., Junior college effects on monthly earnings in Taiwan, ROC. *Proc. 16th Technical and Vocational Conf. of ROC*, Taiwan, 19-28 (2001).
9. Studenmund, A.H. and Cassidy, H.J., *Using Econometrics: A Practical Guide*. Boston: Little, Brown and Co. (1987).