Economic Growth Centre
Working Paper Series

Profitability of Vocational vs. Formal Education for Men and Women in Singapore Using Quantile Regressions

by

Chris SAKELLARIOU

Economic Growth Centre
Division of Economics
School of Humanities and Social Sciences
Nanyang Technological University
Nanyang Avenue
SINGAPORE 639798

Website: http://www.hss.ntu.edu.sg/egc/

Working Paper No: 2005/02

Copies of the working papers are available from the World Wide Web at:

Website: http://www.hss.ntu.edu.sg/egc/

The author bears sole responsibility for this paper. Views expressed in this paper are those of the author(s) and not necessarily those of the Economic Growth Centre.

Profitability of Vocational vs. Formal Education for Men and Women in Singapore Using Quantile Regressions

Chris Sakellariou
School of Humanities and Social Sciences
Nanyang Technological University
Singapore
e-mail: acsake@ntu.edu.sg

Abstract. Singapore is among the countries who have well-developed vocational education and training programs. It follows a centralized planning model in which the needs of industry and business are closely matched to the output of the education system. This study examines the pattern of returns to formal vs. vocational education across quantiles. It is hypothesized that heterogeneity in "abilities" which contribute to higher earnings is related to schooling acquisition. It is found that marginal returns to formal education for both men and women as well as to vocational education for women in Singapore are higher for the more able, consistent with the notion that formal education and ability are compliments. Furthermore, women with secondary and post-secondary vocational qualifications enjoy higher wage increments than men with the same qualifications. On the other hand, men with polytechnic diplomas enjoy higher wage increments than women with the same qualifications. Overall, the results suggest that the vocational education system in Singapore has served women as well as men with secondary and post-secondary qualifications well.

Introduction

An important objective of Technical/Vocational education (among others) is to provide industry (job-specific) training. Another desirable outcome, of Secondary Vocational education especially, is the possibility for a better match between skills acquired in school and the industry, although empirical evidence is ambiguous. By matching pre-market skills with the needs of the labor market, vocational education is expected to help graduates ease their way into the labor market. The better the match of vocational skills, the higher the expectation that the labor market would reward vocational skills better than formal education (other factors remaining unchanged).

There is evidence that investments in vocational skills at the secondary school level are beneficial for the individual and for the society (Bennel, 1996; Bishop, 1998; Fiszbein and Psacharoupoulos, 1993; Neuman and Ziderman, 1991). Singapore is among the countries who have well-developed vocational education and training programs (such as Germany, Japan and South Korea). However, there is very little evidence on the profitability of vocational vs. formal education in Singapore.

Most studies estimate the mean return to education using OLS (for Singapore see, Sakellariou 200?), which may be interpreted as the return to additional schooling for an individual with mean ability. Recently, an increasing number of studies investigate the pattern of returns to an additional year of education along the earnings distribution using quantile regression analysis. The idea behind the use of quantile regressions is that it can reveal the pattern of returns across the ability distribution and get at unobservables, such as ability. On average, one would expect less able individuals to be concentrated in the bottom of the earnings distribution and more able ones towards the top (Buchinsky 1994; Chevalier et. al. 2004).

An examination of the results of these studies (several for developed countries and a handful for developing countries), may reveal certain emerging stylized facts. In particular, in developed countries we tend to observe increasing returns with quantiles (see for example, Pereira and Martins 2000; Martins and Pereira 2004; Buchinsky 1998). A likely explanation for the observed pattern of returns in developed countries is the interaction between ability and schooling, which results in an amplification of the impact of ability upon earnings[1].

In middle income countries the evidence is inconclusive and in the few low income developing countries for which evidence exists, we observe decreasing returns with quantiles (see for example, Girma and Kedir 2003; Muabu and Schultz 1996).

There are no studies investigating the pattern of returns to an additional year of formal vs. vocational education along the earnings distribution using quantile regression analysis and this study undertakes this task, with an emphasis on male-female differences. Increasing returns as one goes from the lower to the higher end of the earnings distribution has been interpreted as an indication that ability and education (or skills) complement each other, with more able workers benefiting from additional investment in education.

It is hypothesized that heterogeneity in "abilities" which contribute to higher earnings (along with other factors, such as family background) are related to schooling acquisition. In other words, the response to the "treatment" (schooling) varies across individuals. This study will be addressing the question: "is there evidence of individual

[1] Another possible explanation has to do with school quality differences, in particular, it may be that individuals who do worse in the labor market (for a given school attainment) are those who received lower quality schooling (Martins and Pereira 2004). However, this is an unlikely explanation in the case of Singapore, where quality of education across schools is adequately monitored by the state.

heterogeneity in returns to education?", and what patterns of returns across quantiles are present in the case of formal vs. vocational education and men vs. women using Singapore data[2]. The concept of ability utilized here, is not one based on measures derived from tests (such as "IQ") but rather, one that relates to those unobservable, earnings-enhancing, human capital characteristics of an individual. Such ability characteristics are hypothesized to interact with education.

From a policy perspective if, for example, marginal schooling returns are higher for the less able (assuming that "ability" is captured by the residuals of the earnings function), educational opportunities should be expanded for this section of the population, as education an ability are substitutes. Therefore, a negative relationship between ability and returns to education (decreasing returns with quantile) will be interpreted as evidence of substitutability between education and ability, and a positive relationship (increasing returns with quantile) as evidence of complementarily between education and ability.

Formal and Vocational Education in Singapore

Singapore, over the years, has developed a meritocratic education system, based on the British education system, and has as its main aim to promote rapid economic and industrial development and "nation building". Singapore's education model is a highly centralized one, which links needs of industry to the output of the education system.

Singaporean children fare extremely well at science and mathematics in international surveys. Such successes have lead many U.S.A. schools to adopt

[2] Here I don't handle the problem of possible engogeneity bias. Testing of this hypothesis would require the identification of a proper instrument and the use of instrumental variable estimation. However, no such instrument is available.

Mathematics textbooks developed in Singapore. Furthermore, successful labour market outcomes of Singaporeans with Institute of Technical Education (ITE) training (85 percent of them finding work within 3 months of completing their studies, even in recession years), has prompted private institutes in China and Vietnam to bring ITE-designed courses for their own students.[3]

With its economy growing at high rates with low unemployment, Singapore has encountered skills shortages, mostly at basic skill levels, which it has been filling with workers from overseas.

Primary education in Singapore is completed with the Primary School Leaving Examination PSLE). Secondary education ends at 16, with the student taking the GCE O level examination or the GCE N level examination (which is at a standard below GCE O level). Post-16 education culminates in the GCE A level examination or in vocational qualifications.

Streaming plays an important part in the Singaporean school system. Children enter primary school aged six and are streamed at the age of 10 for the final two years of primary education. Depending on their score in the primary school-leaving examination, they are then placed, at 12 years old, in one of three streams in secondary school, normal, special or express. The normal stream prepares pupils for GCE N level examinations in their fourth year, at 16 or over. The normal stream is divided into normal (academic) and normal (vocational/technical). Normal stream pupils who do well enough proceed for a fifth year, which prepares them for GCE O level at 17 or over. The special and express streams prepare pupils for GCE O levels after four years at 16 or over.

[3] "ITE goes global with links abroad", The Straits Times, February 3rd, 2005.

Pupils from the normal stream whose highest level of attainment is GCE N level normally have two choices; to attend a full-time course at one of the centres run by the Institute of Technical Education (ITE), or to seek employment at 16 or over. The ITE also provides full-time training courses for pupils who leave secondary school before the age of 16. The ITE is the largest single provider of full-time and part-time vocational education and training for secondary school-leavers and working adults. ITE developments are closely co-coordinated with the government's labour supply planning. In its role as an awarding body for vocational and pre-vocational qualifications, the ITE works with companies to develop approved training centres. These train employees and apprentices and test them for certification by the ITE. In 1996, there were 73 approved training centers, with an intake capacity of about 6,500. School-leavers with GCE N or O level qualifications can select from a wide range of courses in electrical and mechanical engineering, mechatronics, electronics, business studies and drafting. Courses usually involve two years of full-time study. Other specialized areas of study include air conditioning and refrigeration, wafer fabrication, video technology, broadcasting electronics, electronic instrumentation and aircraft maintenance. Business areas include accounts, tourism and travel services and office skills.[4]

Pupils with high enough GCE O level scores proceed to a two-year 'pre-university' education at one of Singapore's junior colleges. Pupils without a high enough GCE O level score to study for GCE A levels can enroll for a full-time vocational course at a polytechnic. Singapore has four polytechnics, which offer three-year diplomas, are perceived to be part of the post-secondary sector of education, along with junior colleges

[4] Post-School Education and Training in Singapore, International Report, The further Education Funding Council, 1998 (September).

and the ITE, rather than a part of higher education. Their mission is to produce middle managers and technologists who can support the country's economic development. Within ministerial guidelines, polytechnics are free to decide in consultation with industry which particular courses it will offer.

Students with GCE A levels can apply for degree programs at the National University of Singapore (NUS) or Nanyang Technological University (NTU) or the newly established Singapore Management University (SMU).

Methodology

With respect to methodology, the quantile regression approach will be utilized. The ordinary least squares (OLS) regression relies on the mean of the conditional distribution of the dependent variable. When it is suspected that the response to education varies across individuals, quantile regressions are particularly useful, because they allow the full characterization of the conditional distribution of the dependent variable, rather than the conditional mean only and permit the exploration of a richer pattern of the education-earnings association. In short, the quantile regressions method allows an investigator to differentiate the contribution of regressors along the distribution of the dependent variable. In particular, the estimation of returns to education entails much more than the fact that, on average, one more year of education results in a certain percent increase in earnings.

The quantile regression model (Buchinsky 1994) can be outlined as (for an excellent introduction, see also Koenker and Hallock 2001):

$\ln w_i = X_i\beta_\theta + u_{\theta i}$,

$$X_i\beta_\theta = (\text{Quantile})_\theta(\ln w_i|X_i); \qquad (3)$$

where X_i is a vector of exogenous variables; β_θ is the vector of parameters; $(\text{Quantile})_\theta(\ln w_i|X_i)$ is the θth conditional quantile of ln*w* given *X*, with $0<\theta<1$. The θth quantile is derived by solving the problem (using linear programming):

$$\text{Min}_{\beta \in R^k} \Sigma_i \rho_\theta(\ln w_i - X_i\beta_\theta), \qquad (4)$$

where $\rho_\theta(\varepsilon)$ is the check function defined as $\rho_\theta(\varepsilon) = \theta\varepsilon$ if $\varepsilon \geq 0$, and $\rho_\theta(\varepsilon) = (\theta-1)\varepsilon$ if $\varepsilon<0$. Standard errors are bootstrap standard errors. The median regression is obtained by setting $\theta = 0.5$ and similarly for other quantiles. As θ is varied from 0 to 1, the entire distribution of the dependent variable, conditional on *X*, is traced.

The quantile approach has a number of useful features, in addition to allowing the full characterization of the conditional distribution of the dependent variable, such as: (a) the linear programming representation of the quantile regression model makes estimation easy; (b) the quantile regression objective function is a weighted sum of absolute deviations, resulting in a robust measure of location, so that the estimated coefficient vector is not sensitive to outlier observation on the dependent variable; (c) when the error term is non-normal, quantile regression estimates may be more efficient than OLS estimators (Buchinsky 1998).

Quantile regression estimation will be used to estimate Mincerian (see Mincer 1974) earnings functions, which involve the fitting of a function specified as:

$$\text{LnY} = \alpha + \beta S_i + \gamma_1 EX_i + {}^{\gamma 2}EX^2{}_i + \varepsilon_i$$

Where LnY_i is the natural logarithm of hourly earnings, S is the number of years of schooling (or a set of dummies for different educational qualifications) and EX and EX^2 are the years of potential labor market experience and its square.

Data and results

Data

The data to be used in the analysis is a random sample of 15,000 observations from the mid-1998 Labor Force Survey. For the analysis on the effects of training, use will be made of the detailed "Educational Attainment" classification in the LFS (i.e., at the Lower-Secondary level: Pre-Vocational Training, Basic Vocational Training, Institute of Technical Education (ITE), Artisan Certificate/Certificate of Competency, at the Secondary level: NTC Grade 3, ITE/Builder Certificate, Certificate of Vocational Training, ITE/Certificate in Service Skills for Certificate in Health Care, Certificate in Retailing, and at the post secondary level: Industrial Technician Certificate, Teachers Training Certificate, Certificate in Business Studies, Advanced Builder Certificate, Certificate in Service Skills, ITE for Certificate in Computer Operations, Certificate in Travel Cervices, Certificate in Office Skills, ITE-Preliminary Certificate in Business Studies.

The working sample of majority (Chinese) individuals employed for wages between the ages of 18 and 65 was divided between those with formal secondary education and those with vocational/technical secondary education, and between men and women for each type of education. Returns to an additional year of schooling are estimated using simultaneous quantile regressions for five different quantiles (0.10, 0.25, 0.50, 0.75, 0.90).

Results

Average hourly earnings of employees with formal education are about 15 percent higher than average hourly earnings of those with vocational education and this

difference is higher for women, at about 20 percent (Table 1). Those with formal education have, on average, 1.7 more years of education and this is more pronounced in the case of women (2.5 years) compared to men (1.2 years). On the other hand, women with vocational education are an older group compared to women with formal education (26.7 vs. 23.5 years of potential labor market experience), while this is not the case for men. Finally, the dispersion of earnings across the earnings distribution is higher in the case of employees with formal compared to those with vocational education.

Tables 2-7 present the OLS and quantile estimates of the return to an additional year of education for employees with formal (Tables 2-4) and vocational/technical education (Tables 5-7). Within both formal and vocational education, average returns (from OLS) are approximately equal for men and women, at about 12 percent and 10.5-11 percent respectively.

Table 1: Descriptive Statistics, Singapore 1998

	Formal			**Vocational**		
	All	Male	Female	All	Male	Female
Hourly earnings ($S)	11.87	14.10	9.88	10.12	11.99	7.76
	(12.97)	(17.00)	(7.18)	(7.75)	(7.79)	(5.33)
Log(hourly earnings)	2.25	2.41	2.10	2.11	2.30	1.88
	(0.63)	(0.63)	(0.59)	(0.61)	(0.59)	(0.56)
Education (in years)	9.54	9.40	9.67	7.80	8.22	7.23
	(4.01)	(4.08)	(3.95)	(4.92)	(4.79)	(5.03)
Experience (in years)	24.70	26.02	23.52	26.54	26.41	26.70
	(11.62)	(11.02)	(12.02)	(13.80)	(12.81)	(14.96)
Hourly earnings$_{\mathbf{q90}}$ / Hourly earnings$_{q10}$ ($S)	4.99	5.00	5.00	4.98	4.44	3.97

Standard deviation in parentheses.

The quantile regression estimates explore the variation of returns across the ability distribution. They help explain where in the income/ability distribution the impact of education is more pronounced. We see that in formal education returns continuously increase with quantiles and more so for women. The return at the highest (90^{th}) quantile is 1.6 times that at the lowest (10^{th}) quantile for men and 2.2 times for women. Marginal returns to education in Singapore are, therefore, higher for the more able, consistent with the notion that formal education and ability are compliments. The policy implication is that educational opportunities of the more able should be expanded in order to maximize the private returns to education, with a particular emphasis on women's schooling opportunities.

Table 2: Return to an Additional Year of Education: OLS and Quantile Regression Estimates - Formal (All)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.120**	0.072**	0.107**	0.125**	0.133**	0.137**
Experience	0.032**	0.004	0.019**	0.031**	0.049**	0.062**
Experience ^{2}	-0.0004**	-0.0001	-0.0002**	-0.0004**	-0.0006**	-0.0008**
Constant	0.627**	0.927**	0.636**	0.557**	0.548**	0.589**
N			5,880			
R^2/Pseudo R^2	0.432	0.157	0.221	0.271	0.301	0.304

** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 3: Return to an Additional Year of Education: OLS and Quantile Regression Estimates - Formal (Males)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.118**	0.088**	0.109**	0.115**	0.123**	0.137**
Experience	0.038**	0.014**	0.030**	0.037**	0.053**	0.058**
Experience ^{2}	-0.0005**	-0.0002*	-0.0004**	-0.0005**	-0.0007**	-0.0007**
Constant	0.739**	0.834**	0.640**	0.760**	0.738**	0.786**
N			2,778			
R^2/Pseudo R^2	0.450	0.168	0.234	0.271	0.297	0.311

** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 4: Return to an Additional Year of Education: OLS and Quantile Regression Estimates - Formal (Females)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.120**	0.070**	0.094**	0.123**	0.143**	0.151**
Experience	0.021**	0.003	0.002	0.019**	0.040**	0.048**
Experience ^{2}	-0.0002**	-0.0000	-0.0000	-0.0002**	-0.0005**	-0.0005**
Constant	0.639**	0.990**	0.881**	0.593**	0.411**	0.436**
N			3,102			
R^2/Pseudo R^2	0.468	0.174	0.237	0.302	0.341	0.350

** indicates significance at the 1% level; * indicates significance at the 5% level.

Estimates of the return to an additional year of vocational education exhibit a somewhat different pattern from the pattern found in the case of formal education. Male returns are essentially flat across quantiles while female returns are increasing, with the rate of return at the highest quantile being 1.6 times that at the lowest quantile. In the case of men, therefore, vocational education and ability seem to be unrelated and the OLS

estimate (return to an additional year of education for an individual of mean ability) is a sensible characterization for any level of ability. On the other hand, for women vocational education and ability are compliments as was the case for women (and men) with formal education.

Comparing rates of return between formal and vocational education, returns are about 15 percent higher in formal education for both men and women. Across quantiles, differences in returns are rather small at lower quantiles, at about 10 percent or less, and higher at higher quantiles, especially for women.

Looking at the returns to an additional year of experience, two observations emerge: First, male returns to experience are significantly higher than female returns, a common finding in the literature. In particular, women in the lower quantiles of the earnings distribution (10^{th} and 25^{th} quantile for women with formal and 10^{th} quantile for women with vocational education) do not enjoy any returns to experience. Second, returns to experience are significantly higher for both male and female employees with vocational education.

Finally Tables 1-6 in the appendix report estimates of the return to an additional year of education from regressions which, in addition to years of education, experience and experience squared, control for marital status and length of tenure. The results are qualitatively identical and quantitatively almost identical to those in Tables 2-7.

Chart 1: Return to One More Year of Education by Quantile - Formal

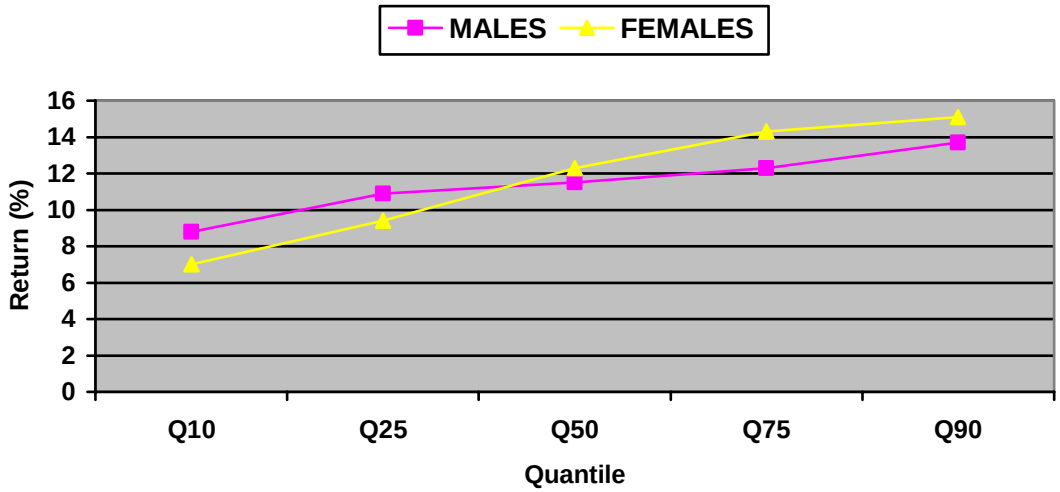


Chart 2: Return to One More Year of Education by Quantile - Vocational

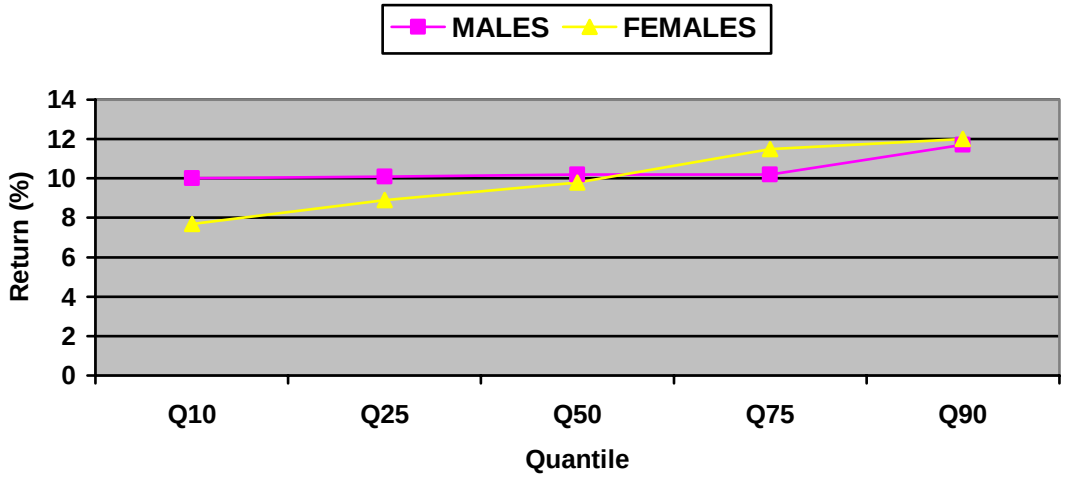


Table 5: Return to an Additional Year of Education: OLS and Quantile Regression Estimates - Vocational (All)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.109**	0.094**	0.104**	0.114**	0.113**	0.114**
Experience	0.050**	0.019**	0.037**	0.054**	0.065**	0.072**
Experience ^{2}	-0.0007**	-0.0003**	-0.0005**	-0.0008**	-0.0009**	-0.001**
Constant	0.543**	0.603**	0.509**	0.427**	0.555**	0.669**
N			2,519			
R^2/Pseudo R^2	0.575	0.266	0.329	0.382	0.389	0.375

** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 6: Return to an Additional Year of Education: OLS and Quantile Regression Estimates - Vocational (Males)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.103**	0.100**	0.101**	0.102**	0.102**	0.117**
Experience	0.055**	0.036**	0.050**	0.054**	0.061**	0.080**
Experience ^{2}	-0.0008**	-0.0005**	-0.0007**	-0.0008**	-0.0009*	-0.001**
Constant	0.652**	0.458**	0.493**	0.667**	0.799**	0.597**
N			1,407			
R^2/Pseudo R^2	0.564	0.264	0.319	0.373	0.379	0.356

** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 7: Return to an Additional Year of Education: OLS and Quantile Regression Estimates - Vocational (Females)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.103**	0.077**	0.089**	0.098**	0.115**	0.120**
Experience	0.031**	0.0000	0.019**	0.025**	0.046**	0.056**
Experience ^{2}	-0.0004**	0.0000	-0.0003**	-0.0003**	-0.0006**	-0.0008**
Constant	0.669**	0.881**	0.776**	0.753**	0.562**	0.654**
N			1,112			
R^2/Pseudo R^2	0.609	0.260	0.325	0.406	0.428	0.427

** indicates significance at the 1% level; * indicates significance at the 5% level.

The results reported in Tables 8-11 (wage effects by educational qualification) focus on the quality rather than quantity of schooling. For those with formal education the estimated returns are for Secondary (O-levels) vs. Primary, Post Secondary (A-levels) vs. Secondary and University vs. Post-Secondary. For those with vocational education the estimated returns are for Secondary Vocational vs. Primary, Post-Secondary Vocational vs. Secondary Vocational and Polytechnic Diploma vs. Post-Secondary Vocational. In both cases the reference category is a common group of individuals with primary education.

Some interesting results emerge. Looking at gender differences within each type of education, women with formal secondary and post-secondary education enjoy higher wage increments (compared to having primary and secondary qualifications) than their male counterparts, while men with university qualifications enjoy higher wage increments (compared to having post-secondary qualifications) than their female counterparts. This is the case for both mean returns as well as across quantiles. Likewise, women with secondary and post-secondary vocational qualifications enjoy even higher wage increments than men with the same qualifications. On the other hand, men with polytechnic diplomas enjoy sharply higher wage increments than women with the same qualifications. Furthermore, male returns to post-secondary vocational education and female returns to acquiring a polytechnic diploma decrease sharply with quantiles. These results suggest that for these levels of vocational education, education and ability are substitutes rather than complements.

Comparing wage effects across types of education, we see that wage effects to secondary and post-secondary vocational education are comparable to the wage effects to formal education (at the mean as well as across quantiles) and are higher at lower quantiles. On the other hand, wage effects to university education are significantly higher than returns to polytechnic diploma, and this difference is very large in the case of women.

Concluding, the vocational education system in Singapore, a centralized system with ties to the industry, has served women as well as men with such secondary and post-secondary qualifications well.

Table 8: Wage Effects by Educational Qualification: OLS and Quantile Regression Estimates - Formal (Males)

	OLS	Q10	Q25	Q50	Q75	Q90
Secondary (vs. Primary)	0.421**	0.230**	0.363**	0.382**	0.509**	0.690**
Post-Secondary (vs. Secondary)	0.315**	0.288**	0.299**	0.341**	0.362**	0.338**
University (vs.Post-Secondary)	0.666**	0.673**	0.691**	0.654**	0.619**	0.624**

Based on regressions which include experience and experience squared.
** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 9: Wage Effects by Educational Qualification: OLS and Quantile Regression Estimates - Formal (Females)

	OLS	Q10	Q25	Q50	Q75	Q90
Secondary (vs. Primary)	0.523**	0.254**	0.294**	0.523**	0.751**	0.773**
Post-Secondary (vs. Secondary)	0.366**	0.301**	0.384**	0.338**	0.405**	0.357**
University (vs.Post-Secondary)	0.527**	0.526**	0.483**	0.591**	0.478**	0.573**

Based on regressions which include experience and experience squared.
** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 10: Wage Effects by Educational Qualification: OLS and Quantile Regression Estimates - Vocational (Males)

	OLS	Q10	Q25	Q50	Q75	Q90
Secondary (vs. Primary)	0.394**	0.266**	0.354**	0.369**	0.453**	0.529**
Post-Secondary (vs. Secondary)	0.372**	0.436**	0.384**	0.397**	0.383**	0.255**
Polytechnic (vs.Post-Secondary)	0.376**	0.357**	0.376**	0.321**	0.359**	0.511**

Based on regressions which include experience and experience squared.
** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 11: Wage Effects by Educational Qualification: OLS and Quantile Regression Estimates - Vocational (Females)

	OLS	Q10	Q25	Q50	Q75	Q90
Secondary (vs. Primary)	0.639**	0.389**	0.646**	0.643**	0.781**	0.740**
Post-Secondary (vs. Secondary)	0.496**	0.370**	0.339**	0.555**	0.540**	0.432**
Polytechnic (vs.Post-Secondary)	0.117**	0.249**	0.177**	0.062**	0.073**	0.111**

Based on regressions which include experience and experience squared.
** indicates significance at the 1% level; * indicates significance at the 5% level.

Chart 3: Secondary Formal vs. Secondary Vocational by Quantile - Males

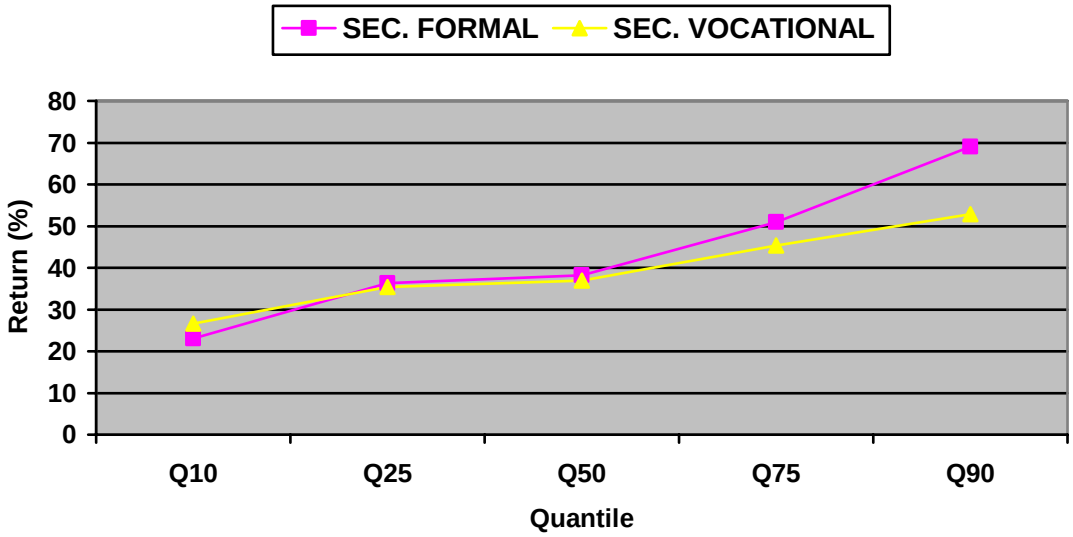


Chart 4: Secondary Formal vs. Secondary Vocational by Quantile - Females

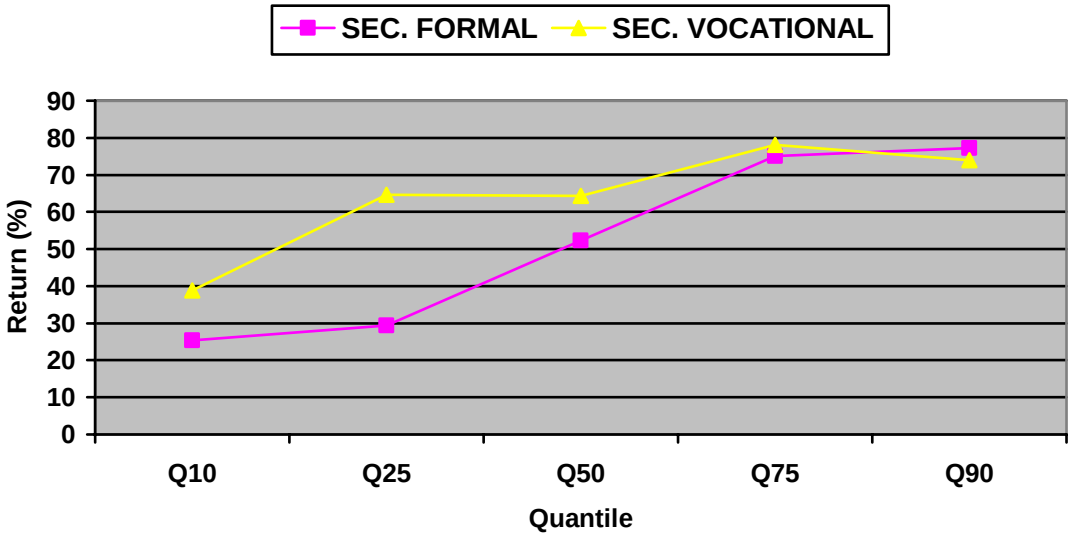


Chart 5: Post-Secondary Formal vs. Post-Secondary Vocational by Quantile - Males

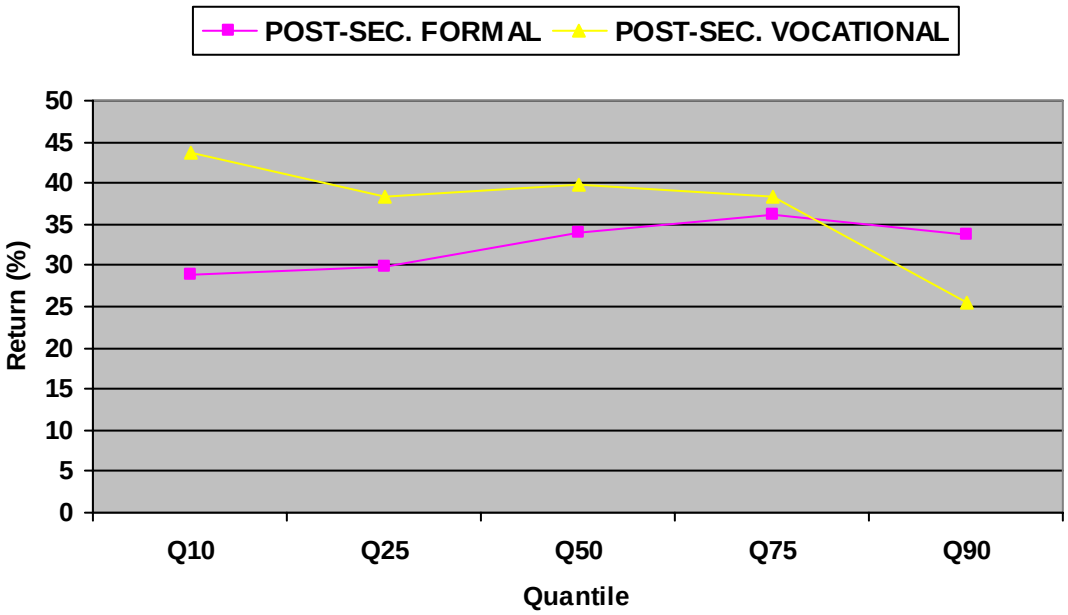


Chart 6: Post-Secondary Formal vs. Post-Secondary Vocational by Quantile - Females

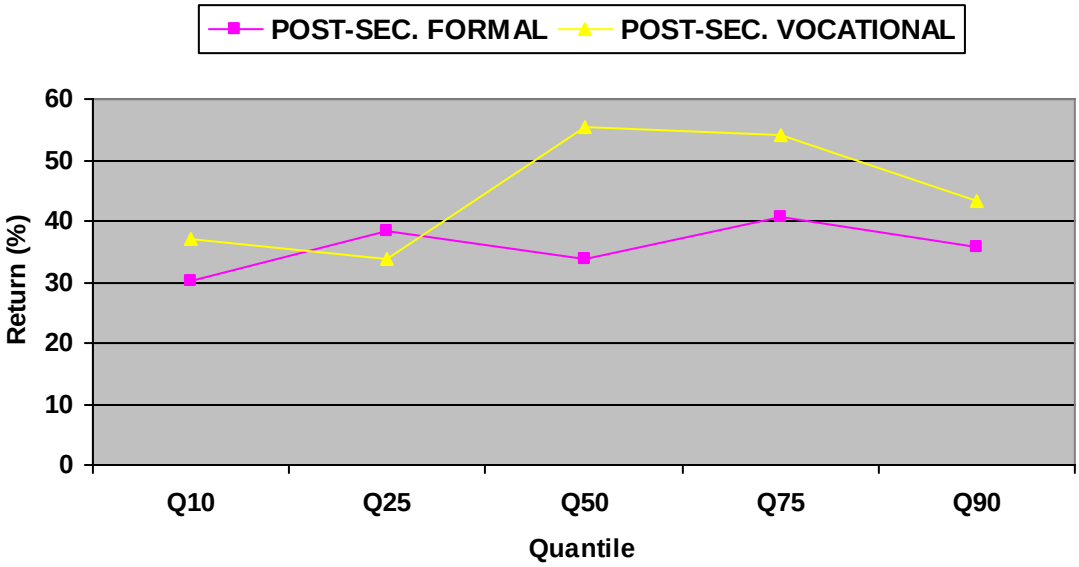


Chart 7: University vs. Polytechnic by Quantile - Males

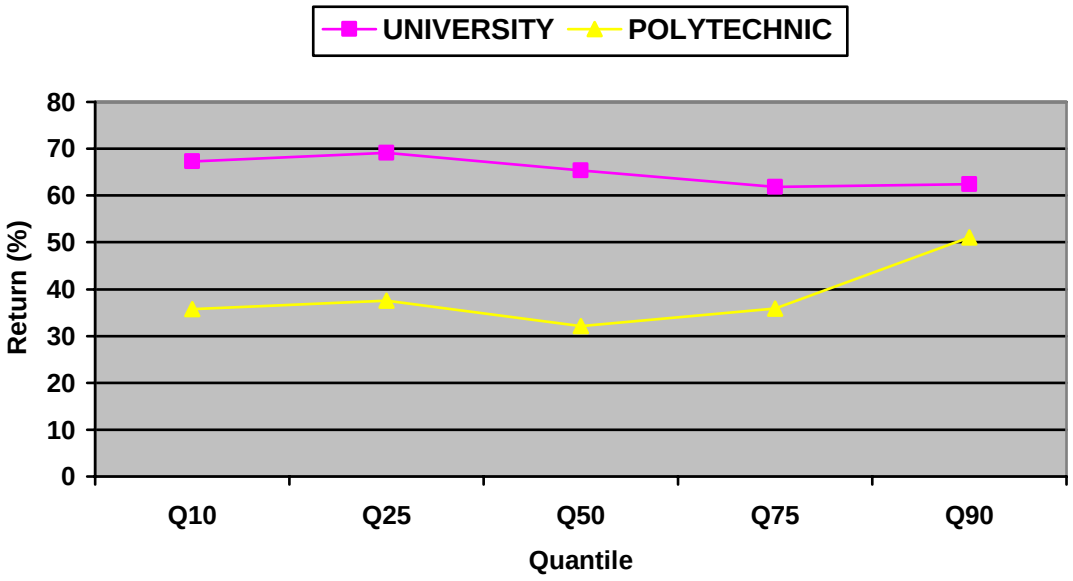
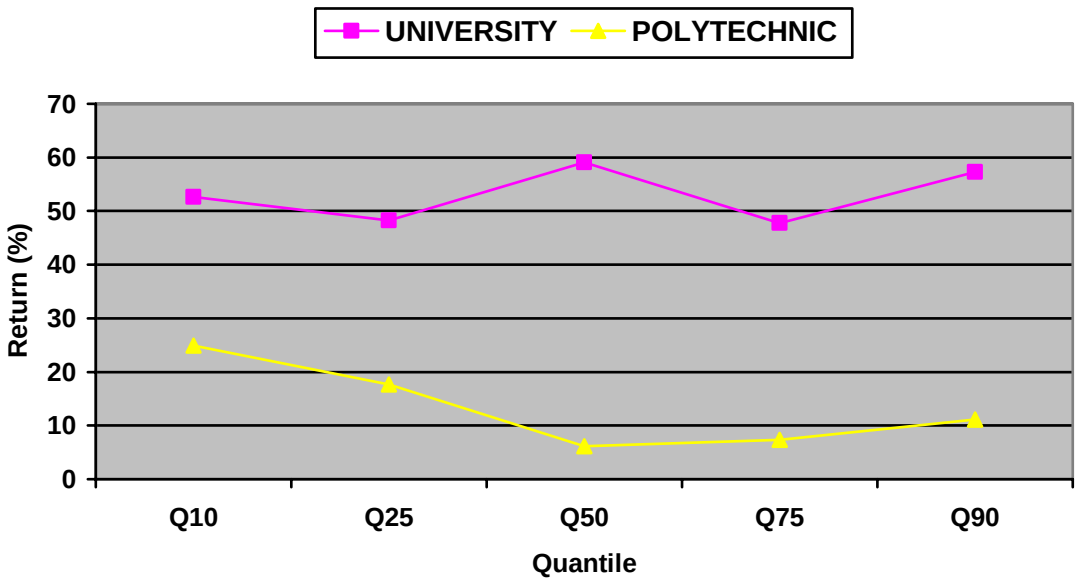


Chart 8: University vs. Polytechnic by Quantile - Females



Conclusions

Singapore is among the countries who have well-developed vocational education and training programs (such as Germany, Japan and South Korea). However, very little evidence exists on the profitability of vocational vs. formal education in Singapore. In particular, there are no studies investigating the pattern of returns to an additional year of formal vs. vocational education along the earnings distribution using quantile regression analysis and this study undertakes this task, with an emphasis on male-female differences.

This study addresses the question: "is there evidence of individual heterogeneity in returns to education?", and what patterns of returns across quantiles are present in the case of formal vs. vocational education and men vs. women using Singapore data. It is hypothesized that heterogeneity in "abilities" which contribute to higher earnings are related to schooling acquisition. A negative relationship between ability and returns to education (decreasing returns with quantile) will be interpreted as evidence of substitutability between education and ability, and a positive relationship (increasing returns with quantile) as evidence of complementarily between education and ability. From a policy perspective if, for example, marginal schooling returns are higher for the less able (assuming that "ability" is captured by the residuals of the earnings function), educational opportunities should be expanded for this section of the population, as education an ability are substitutes.

It was found that, in formal education returns to an additional year of education continuously increase with quantiles for both men and women and more so for women. Marginal returns to education in Singapore are, therefore, higher for the more able, consistent with the notion that formal education and ability are compliments. Estimates of the return to an additional year of vocational education exhibit a somewhat different

pattern with male returns being relativelyh flat across quantiles and female returns increasing. In the case of men, therefore, vocational education and ability seem to be unrelated and the OLS estimate is a sensible characterization for any level of ability. On the other hand, for women vocational education and ability are compliments as was the case for women (and men) with formal education.

Looking at gender differences within each type of education (quality instead of quantity of education), women with formal secondary and post-secondary education enjoy higher wage increments than their male counterparts, while men with university qualifications enjoy higher wage increments than their female counterparts. Furthermore, women with secondary and post-secondary vocational qualifications enjoy even higher wage increments than men with the same qualifications. On the other hand, men with polytechnic diplomas enjoy sharply higher wage increments than women with the same qualifications.

Comparing wage effects across types of education, we see that wage effects to secondary and post-secondary vocational education are comparable to the wage effects to formal education and are higher at lower quantiles. On the other hand, wage effects to university education are significantly higher than returns to polytechnic diploma, and this difference is very large in the case of women.

Singapore has developed a competitive, meritocratic education system which has the aim of promoting rapid economic and industrial development. Helped by its size, Singapore has encouraged the development of a highly centralized planning model in which the needs of industry and business are closely matched to the output of the

education system. The vocational education system in Singapore has served women as well as men with secondary and post-secondary qualifications well.

References

Bennell, P. (1996) "General versus Vocational Secondary Education in Developing Countries: A Review of the Rates of Return Evidence," *Journal of Development Studies*, 33 (2): 230-47.

Bishop, J. (1998) "Occupation-Specific versus General Education and Training," *Annals of the American Academy of Political and Social Science*, 559 (0): 24-38.

Buchinsky, M. (1994). "Changes in the U.S. Wage Structure 1963-1987: An Application of Quantile Regression." *Econometrica* 62 (2): 405-458.

_____ (1998). "Recent Advances in Quantile Regression Model: A Practical Guide for Empirical Research." *Journal of Human Resources* 33 (1): 88-126.

Chevalier, Harmon, A. C, Walker, I and Y. Zhu (2004). "Does Education Raise Productivity, Or Just Reflect It?" *The Economic Journal* 114 (November): F499-F517.

Fiszbein, A. and G. Psacharopoulos (1993) "A Cost-Benefit Analysis of Educational Investment in Venezuela: 1989 Update," *Economics of Education Review*, 12 (4): 293-98.

Girma, S. and A. Kedir. (2003)."Is Education More Benficial to the Less Able? Eocnometric Evidence from Ethiopia." Discussion Papers in Economics from Department of Economics No 03/1, University of Leicester.

Koenker, R. and K. Hallock (2001). "Quantile Regression." *Journal of Economic Perspectives* 15: 143-156.

Muabu, G. and T. P. Schultz (1996). "Education Returns Across Quantiles of the Wage Function: Alternative Explanations for Returns to Education by Race in South Africa." *American Economic Review* 86 (2): 335-339.

Neuman, S. and A. Ziderman (1991) "Vocational Schooling, Occupational Matching, and Labor Market Earnings in Israel," *Journal of Human Resources*, 26 (2): 256-82.

Pereira, P. T. and P. S. Martins (2000). "Does Education Reduce Wage Inequality? Quantile Regressions Evidence from Fifteen European Countries." IZA Discussion Paper No. 120, Institute for the Study of Labour (February).

Martins, P. S. and P. T. Pereira (2004). "Does Education Reduce Wage Inequality? Quantile Regression Evidence from 16 Countries." *Labour Economics* 11: 355-371.

Sakellariou, C. (2003). "Rates of Return to Investments in Formal and Technical/Vocational Education in Singapore." *Education Economics* 11 (1): 73-87.

The Further Education Funding Council. 1998. “Post School Education and Training in Singapore.” International Report (September).

Appendix

Table 1: Return to an Additional Year of Education: OLS and Quantile Regression Estimates, Formal (Males)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.110**	0.081**	0.095**	0.107**	0.116**	0.131**
Experience	0.025**	0.007	0.013**	0.024**	0.035**	0.050**
Experience ^{2}	-0.0004**	-0.0001	-0.0002*	-0.0004**	-0.0005**	-0.0006**
Married	0.241**	0.199**	0.257**	0.242**	0.264**	0.269**
Long Tenure	0.127**	0.159**	0.106*	0.104**	0.116**	0.076
Constant	0.724**	0.769**	0.767**	0.769**	0.775**	0.676**
N			2,778			
R^2/Pseudo R^2	0.474	0.194	0.261	0.290	0.315	0.324

** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 2: Return to an Additional Year of Education: OLS and Quantile Regression Estimates, Formal (Females)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.117**	0.070**	0.092**	0.120**	0.136**	0.148**
Experience	0.017**	0.0000	0.0000	0.016**	0.036**	0.047**
Experience ^{2}	-0.0002**	-0.0001	-0.0000	-0.0001*	-0.0004**	-0.0005**
Married	-0.011	0.011	0.0000	0.006	-0.020	-0.001
Long Tenure	0.207**	0.242**	0.231**	0.186**	0.147**	0.155**
Constant	0.544**	0.741**	0.729**	0.516**	0.430**	0.351**
N			3,102			
R^2/Pseudo R^2	0.484	0.196	0.251	0.314	0.348	0.356

** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 3: Return to an Additional Year of Education: OLS and Quantile Regression Estimates, Vocational (Males)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.094**	0.086**	0.089**	0.094**	0.097**	0.110**
Experience	0.041**	0.021**	0.031**	0.040**	0.051**	0.068**
Experience ^{2}	-0.0006**	-0.0003**	-0.0005**	-0.0006**	-0.0007**	-0.001**
Married	0.223**	0.197**	0.247**	0.232**	0.196**	0.216**
Long Tenure	0.090**	0.117*	0.078*	0.049	0.091*	0.054
Constant	0.697**	0.569**	0.644**	0.724**	0.755**	0.651**
N			1,407			
R^2/Pseudo R^2	0.585	0.287	0.348	0.389	0.391	0.370

** indicates significance at the 1% level; * indicates significance at the 5% level.

Table 4: Return to an Additional Year of Education: OLS and Quantile Regression Estimates, Vocational (Females)

	OLS	Q10	Q25	Q50	Q75	Q90
Education	0.101**	0.073**	0.090**	0.095**	0.112**	0.117**
Experience	0.029**	0.0000	0.016**	0.022**	0.048**	0.056**
Experience ^{2}	-0.0004**	0.0000	-0.0003**	-0.0003**	-0.0007**	-0.0008**
Married	0.029	-0.031	0.029	0.049*	0.066**	0.141**
Long Tenure	0.096**	0.014	0.055	0.087**	0.089*	0.128
Constant	0.622**	0.920**	0.721**	0.719**	0.498	0.499**
N			1,112			
R^2/Pseudo R^2	0.613	0.261	0.327	0.411	0.436	0.433

** indicates significance at the 1% level; * indicates significance at the 5% level.