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EXECUTIVE SUMMARY

1. As Singapore transits to a knowledge-based economy, the development of human capital as a key driver of economic growth has become even more important. The objective of this paper is to study the private rates of returns to investment in education for workers who are Singapore citizens, with particular focus on the returns to education for various fields of study at the polytechnic diploma and university first degree levels.

2. The paper adopts a Mincer-type earnings function to estimate the rate of return to education in terms of increase in wages for each additional year of study. The basic premise is that education enhances the productivity of a worker, which in turn is reflected in his earnings. The estimation controls for differences in other worker characteristics, i.e., gender and work experience, which may also affect earnings. Three sets of estimation have been undertaken: (i) the basic Mincer's equation, (ii) Mincer's equation accounting for various levels of schooling, and (iii) Mincer's equation accounting for various fields of study at the diploma and university level.

3. The key results of the study are as follows:

    a. The estimation of the basic Mincer's equation reveals that the rate of return for an extra year of schooling is positive and significant. In 2004, an extra year of schooling enhances a worker's earnings by 13.7%.

    b. The rate of return for schooling tends to be higher for tertiary education (i.e., diploma and above) as compared to non-tertiary education. In addition, the returns to university education have generally increased in 2004 compared to 2001. These findings are in line with the changing economic structure of the Singapore economy. As the economy shifts towards higher value-added and knowledge activities, there is a greater demand for more educated workers, which in turn enhances the returns to higher levels of education.

    c. The rates of return to secondary and primary education, on the other hand, were broadly unchanged in 2004 compared to 2001. Less educated workers are subjected to competition posed by low wage workers from China, India and other developing countries as a result of the effects of globalisation. This could have curbed their wage increases, and hence, partly account for the lack of improvement in returns to secondary and below education levels.

    d. In terms of the overall ranking of the fields of study at the diploma level, Engineering Sciences, Architecture & Building, and Business & Administration have the highest rates of return in 2004. The rates of return for all fields of study, except Health Sciences, are lower in 2004 compared to 2001. The higher rate of return for the study in Health Sciences reflects the increase in demand for allied health professionals. The higher demand for Health Sciences manpower is also observed with a higher rate of return for Health Sciences graduates at the first degree level in 2004.

e. In general, the professional and more technical fields of study (e.g., Law, Health Sciences, and Engineering Sciences) at the first degree level have higher rates of return than the less technical subjects (e.g., Humanities & Social Sciences). Furthermore, the rates of return for most fields of study have improved in 2004, except for Information Technology, Architecture & Building and Mass Communication & Information Science. The fall in the rates of return for these fields of study could be attributed to the negative shock from burst of the dot.com bubble and the slower growth in the construction industry.

4. In summary, the returns to investment in education in Singapore tend to increase with years of schooling, with the returns to tertiary education generally higher than those for non-tertiary education. This is similar to the findings for other Asian newly industrialised economies like South Korea and Hong Kong.

5. As the structure of Singapore's economy shifts towards higher value-added and knowledge activities, there will continue to be an increase in the demand for skilled and educated human capital. We can thus expect the demand for workers with tertiary education to increase, which implies that the rate of returns to tertiary education is likely to remain high and above those for secondary and below education. Education will hence continue to be an attractive investment for individuals.

… …

A. Introduction

1. The key for long-term sustainable growth in the New Economy for the East Asian region is in the contribution of knowledge to output growth. The development of human capital as the key source of knowledge that drives output growth takes centre stage as Singapore and the region struggles to attract more foreign direct investment (FDI) into the East Asian region, as rapidly emerging large countries like China and India tend to attract the attention of Multinational Corporations. As opposed to these large countries, the East Asian 'Tigers' of South Korea, Singapore and Taiwan tend to lack the lure of the large domestic market and rely heavily on the internal domestic capacity to maintain their competitiveness in the external markets for growth.

2. As their economy and industrial structures mature, these countries are moving into higher value-added production. Increasingly, the East Asian 'Tigers' are forced to compete in more high value-added exports with developed countries as labour and resource abundant countries tend to increase their presence in labour and capital-intensive production in the global market place. In the New Economy, the creation of indigenous knowledge is the key component for the East Asian 'Tigers' to maintain competitiveness in the export performance and to attract foreign Multinational Corporations. As the fundamentals in these countries are depreciating at a much faster rate in the global environment due to short technology cycles, there is a concerted effort by the East Asian 'Tigers' to increase their indigenous knowledge capital through human capital development and R&D expenditure.

3. The importance of human capital accumulation through education for technological change, innovation and long-term growth is clearly emphasised by theoretical and empirical studies by Becker (1964), Acemoglu and Angrist (2000), Griliches (1969), and Lucas (1988). In addition, there is a complementary relationship between higher education and technology development as the ability to implement and absorb new technologies increases with more educated workers (Bartel and Lichtenberg, 1987).

4. The objective of the paper is to study the private rates of returns to investment in education for the Singapore economy in terms of increase in wages for each additional year of study, using the datasets from the Labour Force Survey. The paper, in particular, examines the premium to fields of higher education at the polytechnic diploma and university first degree levels.[1] The paper examines 7 fields of studies at the polytechnic diploma level and 9 fields of studies at the university first degree level. Although the Singapore economy is moving to higher value-added activities, it is expected that premium in the education of technical and exact sciences such as engineering, life sciences etc. should be higher than studies in arts, social studies and humanities.

[1] The micro level data used for the study are accessed only by MRSD staff who collaborated in this study.

B. Literature Review on Returns to Education

5. Most papers on returns on investment in education adopt the Mincer wage equation to estimate the rate of return to schooling using data on earnings and schooling of different workers, and estimate the average rate of return for another year of schooling after adjusting for differences in worker characteristics such as age, education, sex, and race (see the survey by Psacharopoulos and Patrinos, 2004).

6. Recent evidence from Martins (2004) indicates that education has a significant external effect on productivity and wages within firms, implying social returns to education is greater than private returns. More specifically, the results suggest that there is a multiplier effect in the provision of education, as its benefits are not only circumscribed to those individuals who invest in their own human capital but also on the workers who have not made that investment at school but are able to interact with educated colleagues at their places of work.

7. The paper by Prieto, Roman and Domingues (2005), which examined the returns for schooling for Spain, suggests that worker's potential maximum wage increases with extra years of formal schooling. The increase is particularly noticeable for workers who have completed at least a five-year University education.

8. The evidence on the returns to education has implications for both economic policy and economic theory. A large literature reported estimates of private returns to education in the range of 6-10%. However, private returns may be only part of the story. If there are positive social returns to education, then private returns underestimate the economic value of schooling. The various private and social returns for different levels of schooling by various countries are given in Appendix 1. The results suggest that there is a large variation in the private and social rate of returns for schooling across countries that could be driven by industrial and institutional structures in the respective countries. However, the recent paper by Psacharopoulos and Patrinos (2004) suggests that on average, the private rate of return to higher education (higher than secondary) is twice that of the social rate of return (19% for private as against 11% for social rate of return for higher education).

9. Based on the World average, the study also indicates that women receive a higher rate of returns to their investments in schooling as compared to men (10% for women as against 8.7% for men). However, the men tend to have higher returns to primary education (20%) as compared to women (13%). The trend, however, indicates that women experienced higher returns to secondary and higher education as compared to men (15% for women as against 12% for men). The higher rates of return in schooling for women were also observed in a recent study on OECD countries (Medolicchio, 2005). These observations suggest that one extra year of schooling tends to increase the productive contribution of women as compared to men. In particular, we should expect higher social rates of return to the investment in schooling for women since women's education level not only increases the

productivity in the factory but also allows for greater labour force participation rate and improved child health and nutrition, thereby contributing positively to economic growth (World Development Report, 1999).

10. The paper by Jai-Kyung, Young-Sook and Carnoy (1993) examined the empirical observation that rates of returns to lower levels of schooling could be higher than that of University and tend to stay higher as the country develops. Their paper examined the changes in the rates of return in South Korea in the 1970s and 1980s. However, the results showed that during this period, the pay-off to lower levels of schooling fell substantially in absolute terms and relative to investment in 4-year full-term, leaving the return on college education considerably higher than primary and secondary education. The main restriction on students taking further education in such cases might not be due to self-selection due to declining returns but due to highly imperfect capital markets or the restriction on the number of places available in 4-year colleges. This paper further reinforces the evidence that the rate of returns could be driven by sustained periods of rapid industrialisation.

11. The Korean results are also supported by other studies in Colombia, the United States of America and Hong Kong which show the rate of returns to university education rising relative to rates of return to primary and secondary schooling, and are now considerably higher than the rates of investing in those lower levels. The Korean pattern seems to be associated with **rapid industrialisation** and simultaneous rapid expansion of schooling to universal completion at junior and senior high levels. In the Korean and other similar cases where the rates rise with education level, schooling may well act as a **screening mechanism**[2]. More importantly, the Korean results provide considerable support for the argument that in rapidly industrialising societies undergoing a sustained period of growth, university education may have a relatively high and rising pay-off both to individuals and to society.

C. Studies on Returns on Investment in Schooling for Singapore

12. Using cross-sectional and time-series data from various published sources, the study by Toh and Wong (1999) computed the rate of returns to education in Singapore. Besides deriving estimates of the rate of returns to different levels of education, they also considered the rate of returns to various fields of study conducted at the university level. Their results indicated that the rate of return to schooling increases with the level of education and in particular, polytechnic education enjoys the highest social and private rate of return. Although polytechnic education still attains a higher rate of return than that of secondary education, the rates of return to tertiary education (polytechnic and university) computed using time-series information have declined during the past 15 years. They attributed this observation to the expanded enrolments in tertiary education as well as more liberal imports of workers who have tertiary

[2] In situations where employers could not differentiate the abilities of potential workers, educational attainment could provide signals to employers of their true potential thereby reducing any job mismatches.

qualifications. While the rate of return to primary education has increased, the rate of return to secondary education has remained rather stagnant over the years. Further, they also computed the private and social rate of return to tertiary education, which was above the market rate of interest. These suggest that the intention to encourage students to borrow to finance their tuition fees will not be a disincentive to pursue tertiary training; and that reduction in public subsidisation will not curtail enrollment, especially when the accessibility to study loans is facilitated.

13. With regards to the various fields of study for the local universities, their results showed that accountants and lawyers have the highest social return, followed by the different types of engineers, architects and general physicians. Among the different fields of engineering, chemical and civil engineers have higher social returns, with the lowest being the electronics engineers.

14. The recent paper by Low, Ouliaris, Robinson and Wong (2004) examined the education premium in Singapore by using a dataset drawn from the 2000 Survey on Educational Qualifications. The authors estimated the premium on various levels of education. The average number of years of schooling among the employed was estimated to be 10.1 years, which suggests a general increase in educational attainment when compared to earlier studies. The proportion of degree holders among the labour force has also risen from less than 5% in the early 1980s to more than 17% in 2002.

15. Based on their estimation using the standard Mincerian human capital earnings equation, they showed that higher education tends to have a relatively high premium in Singapore. On average, a worker who invests in an additional year of education is expected to increase his earnings by 13.2%. In addition, there is evidence of a positive "interaction" effect between education and work experience, implying that the wages of more educated workers increase at a faster rate than those of the less educated, as work experience increases. The results also indicate a strong premium on post-secondary education and beyond, implying that it is rational for individuals to invest in education.

16. In addition, the authors found that, in general, the premiums on education and work experience tend to be higher among industries with a higher proportion of higher skilled workers (such as the financial intermediation industry), as well as among white-collar jobs (such as professionals and managers).

D. Theoretical Framework: Mincer Estimation

17. There are two major approaches to the relationship between education and the economy in general; one is human capital theory (Schultz, 1961; Becker 1966). The theory relies on the statistical explanation of this relationship between earnings and individual labour characteristics, mainly the level of education. The basic premise is that education enhances the productivity of a worker which is reflected as a wage rate.

Competing theories include dynamic relationship (Bowles and Gintis, 1976; Carnoy and Levin, 1985) which is based on the view that socialisation is an important function provided by schooling for the economic system as a whole. A more elegant form of the relationship between earnings and schooling is expressed in the Mincer-type earnings function (1974), which the current study adopts in estimating the premium in the fields of education. The methodological framework and the derivation of the baseline equations for the study are given in Appendix 2. The full description of the dataset from the Labour Force Survey is also given in Appendix 2.

18. The study undertakes three sets of estimation of the Mincer's equation: the basic equation, the Mincer's equation accounting for various levels of schooling, and the Mincer's equation accounting for various fields of study at the polytechnic diploma and University level. The study covers the period of 2001 and 2004 and the empirical study is undertaken separately for each year. This allows the results to be compared between the two years. The sample for each year consists of around 30,000 citizens in full-time employment, excluding full-time National Servicemen and contributing family workers[3].

D1: Regression Results for Basic Mincer's Equation

19. The basic Mincer equation is given as:

$$\ln(income) = \beta_0 + \beta_1 sch + \beta_2 ex + \beta_3 ex^2 + \varepsilon$$

where *sch* is years of schooling, *ex* is years of experience $[\max(age - sch - 5, 0)]$, and ex^2 is the square of experience. The experience variable is proxied by age. All coefficient estimates for this equation are statistically significant at 5% level, using the heteroscedasticity-robust standard errors.

20. The results of the basic Mincer equation suggest that the citizens' rate of return to each additional year of schooling is 13.7% in 2004. We also observed that the rate of return for the citizens in 2004 has declined slightly for both male and female citizens as compared to 2001.

21. As highlighted above, the coefficient β_1 is the rate of return to education. It measures the rate of growth of income for each additional year of schooling. For instance, if the initial wage of an individual is \$800 per month, and the value of β_1 is 0.137 (i.e. 13.7%). Then holding other things constant, for an individual who has 5 years of schooling, the individual's monthly wage is expected to increase at a rate of 13.7% per annum for 5 years to reach (\$800) × $(1.137)^5$ = \$1,520.

[3] The study made use of 35,000 and 33,500 observations from the Jun 01 and 04 Labour Force Surveys which had consistently achieved a response rate of at least 80%.

Table 1: Premium to Years of Schooling for Singapore Citizens

	All		Male		Female	
	2001	**2004**	**2001**	**2004**	**2001**	**2004**
intercept	5.669	5.525	5.795	5.663	5.552	5.380
years of schooling	0.137	0.137	0.131	0.130	0.146	0.146
experience	0.041	0.045	0.043	0.045	0.034	0.043
experience^2	-0.0005	-0.0005	-0.0005	-0.0005	-0.0004	-0.0005

D2: Mincer Equation Accounting for Various Levels of Schooling

22. The Mincer equation accounting for various levels of schooling is given as:

$$\ln(income) = \beta_0 + \beta_1 pri + \beta_2 sec + \beta_3 usecgen + \beta_4 usecvoc + \beta_5 prodip + \beta_6 poly + \beta_7 firdeg + \beta_8 postgraddip + \beta_9 master + \beta_{10} phd + \alpha_1 ex + \alpha_2 ex^2 + \varepsilon$$

23. The coefficients $\beta_1, \beta_2, \cdots, \beta_{10}$ are the rates of return to each year corresponding to different educational qualifications. For instance, β_7 is the rate of return to each year expended in completing the first degree in the University.

24. The description of the variables in the above equation is given in Table 2. The coefficients which are underlined refer to estimates where the *p*-values are greater than 0.05 (i.e. statistically insignificant at 5% level of significance). The rest of the coefficient estimates are statistically significant at 5% level, based on the heteroscedasticity-robust standard errors. The full details of the model are given in Appendix 2.

Table 2: Premium to Various Levels of Education for Singapore Citizens

	All		Male		Female	
	2001	**2004**	**2001**	**2004**	**2001**	**2004**
intercept	6.089	6.020	6.246	6.175	6.037	5.952
primary	0.023	0.009	0.012	***-0.003***	***-0.004***	-0.012
secondary	0.149	0.144	0.135	0.132	0.207	0.191
upper secondary (general)	0.156	0.141	0.179	0.145	0.143	0.145
upper secondary (vocational)	0.101	0.101	0.077	0.089	0.106	0.089
professional qualifications & other diploma	0.177	0.184	0.188	0.174	0.176	0.193
polytechnic diploma	0.195	0.186	0.194	0.187	0.183	0.176
university first degree	0.182	0.187	0.169	0.183	0.183	0.182
postgraduate diploma	0.182	0.125	0.298	0.184	***-0.009***	***0.082***
master	0.195	0.231	0.191	0.228	0.177	0.213
doctorate	0.124	0.147	0.122	0.143	0.101	0.137
experience	0.055	0.061	0.057	0.061	0.051	0.059
experience^2	-0.0008	-0.0008	-0.0008	-0.0008	-0.0007	-0.0009

25. The results for the Mincer equation for various years of schooling are given in Table 2. The results suggest that for every year of completed primary school education, the wage rate can increase by 0.9% in 2004. In contrast, for every year of completed secondary school education, the wage rate of a worker will increase by a higher rate of 14.4%. In the case of tertiary education, every year of completed University first degree education will increase the wage rate by 18.7%. For example, suppose a worker with 'A' level qualification earns $1,200 per month. If the worker is able to enroll and graduate with a University degree, the monthly wage is expected to attain $2,382 in 2004 [($1,200) $\times$ $(1.187)^4 \approx$ $2,382] for his four years of University education, holding other things constant.

26. Overall, the rates of return to tertiary education (i.e., diploma and above) tend to be higher than those for lower levels of education. This is not surprising given that the Singapore economy is moving towards higher value-added and knowledge activities, which creates a greater demand for more educated workers. Such a trend is also in line with the findings for South Korea and other rapidly industrialising countries. We also observed that the rate of return to secondary and primary education were broadly unchanged in 2004 compared to 2001, which could also be partly attributed to the fact that less educated workers are subject to competition posed by low wage workers from China, India and other developing countries who have joined the global workforce. Faced with such competition, the wage increases of the less educated workers in Singapore could have been curbed, thus partly accounting for the lack of improvement in returns to secondary and below education levels.

27. In contrast, the rates of return to University education have risen in 2004 when compared to 2001, except for the postgraduate diploma level. In particular, the rate of return on postgraduate studies at the Master level has risen significantly from 19.5% in 2001 to 23.1% in 2004, thus making it much higher than those for other post secondary and University first degree education. Although the rate of return at the Doctorate level has also increased, it remains lower than the returns for a University first degree and a Master's degree. In contrast, postgraduate diploma experienced a significant decline in its rate of return from 18.2% in 2001 to 12.5% in 2004. The results for postgraduate diploma and Doctorate degree, however, have to be treated with caution given the relatively small sample captured for these two levels. Further, the years of schooling for a Doctorate degree tends to be more variable compared to other fields and the assumption of a certain number of years to complete a Doctorate tends to be less accurate.

28. Comparing the returns across gender, there is little differences in the rates of return at the higher education levels (post secondary and above) for males and females, except for the professional qualifications and other diploma level. In 2004, the rates of return for males in the Polytechnic diploma and University first degree levels are 18.7% and 18.3% respectively, whereas the rates of return for females in the same categories are 17.6% and 18.2% respectively. Similarly, the males have a rate of return at the

Masters and Doctorate levels of 22.8% and 14.3% respectively, compared to 21.3% and 13.7% respectively for the females.

D3: Mincer Equation Accounting for Fields of Education at Diploma and University level[4]

29. The estimation of the Mincer equation accounting for fields of education at polytechnic diploma and degree levels is given as:

$$\begin{aligned}\ln(income) = {} & \beta_0 + \beta_1 pri + \beta_2 sec + \beta_3 usecgen + \beta_4 usecvoc + \beta_5 prodip \\ & + \beta_{61} poly \cdot P_1 + \beta_{62} poly \cdot P_2 + \cdots + \beta_{68} poly \cdot P_8 \\ & + \beta_{71} dega \cdot F_1 + \beta_{72} dega \cdot F_2 + \cdots + \beta_{710} dega \cdot F_{10} \\ & + \beta_8 degb \\ & + \beta_{91} degc \cdot S_1 + \beta_{92} degc \cdot S_2 + \cdots + \beta_{97} degc \cdot S_7 \\ & + \beta_{10} degd \\ & + \alpha_1 ex + \alpha_2 ex^2 + \varepsilon\end{aligned}$$

30. The beta coefficients, other than β_0, are the rates of return corresponding to different educational qualifications and field of studies. For instance β_{62} provides an estimate of the rate of return for the years spend in obtaining a polytechnic diploma in Mass Communication & Information Science; while β_{74} provides an estimate of the rate of return to studying a Law degree at the first degree level in the University.[5]

31. The description of the variables and results of estimation are given in Table A2 in the Appendix 3. The coefficients that are underlined refer to estimates where the *p*-values are greater than 0.05 (i.e. statistically insignificant at 5% level of significance). The remaining coefficient estimates are statistically significant at 5% level, based on the heteroscedasticity-robust standard errors. The full details of the model are given in the estimation sections of the Appendix. The ranking of the rates of return by various fields of education at the diploma and first degree levels in 2001 and 2004 are given in Tables 3 and 4 below respectively.

[4] In this report, we will concentrate on the fields of study at polytechnic diploma and university first degree levels. Data limitations preclude analysis at the Masters level.

[5] It is important to highlight that the rates of return to Polytechnic diploma and University first degree is based on different relative educational levels. The rates of return to Polytechnic diploma is computed relative to the secondary level and the rates of return to University first degree is relative to upper secondary (general) level.

Table 3: Premium for Fields of Education at Diploma Level

(A) Overall (i.e., both Male and Female Citizens)

June 2001		June 2004	
Engineering Sciences	0.212	Engineering Sciences	0.202
Mass Communication & Information Science	0.195	Architecture & Building	0.191
Architecture & Building	0.194	Business & Administration	0.175
Information Technology	0.190	Health Sciences	0.169
Business & Administration	0.182	Information Technology	0.157
Fine & Applied Arts	0.134	Mass Communication & Information Science	0.146
Health Sciences	0.129	Fine & Applied Arts	0.126

(B) All Male Citizens

June 2001		June 2004	
Mass Communication & Information Science	0.217	Engineering Sciences	0.196
Engineering Sciences	0.205	Business & Administration	0.180
Architecture & Building	0.186	Architecture & Building	0.179
Information Technology	0.181	Health Sciences	0.179
Business & Administration	0.179	Mass Communication & Information Science	0.139
Fine & Applied Arts	0.111	Information Technology	0.139
Health Sciences	0.108	Fine & Applied Arts	0.118

(C) All Female Citizens

June 2001		June 2004	
Architecture & Building	0.196	Architecture & Building	0.197
Information Technology	0.190	Engineering Sciences	0.183
Engineering Sciences	0.188	Health Sciences	0.178
Business & Administration	0.186	Business & Administration	0.176
Mass Communication & Information Science	0.172	Information Technology	0.172
Fine & Applied Arts	0.149	Mass Communication & Information Science	0.147
Health Sciences	0.139	Fine & Applied Arts	0.130

32. The rates of return for various fields of education at the polytechnic diploma level are given in Tables 3(A)–(C) above. Given that the industrial structure of Singapore is moving into higher value-added sectors, the more technical subjects like Engineering Sciences, Health Sciences, and Architecture & Building have higher rates of return compared to less technical ones like Fine & Applied Arts. At the overall level, Engineering Sciences (20.2%), Architecture & Building (19.1%), and Business & Administration (17.5%) are the fields of study with the highest rates of return in 2004. Comparing the overall results for 2004 and 2001, the returns for all fields, except for Health Sciences, are lower in 2004. This trend is also observed for most fields of study for both male and female citizens. The male citizens experienced a fall in the rates of return for all fields of study except for Health Sciences, Business & Administration and Fine & Applied Arts. In the case of female citizens, they too experienced declines in the rates of return for all subjects, except for Health Sciences and Architecture & Building. It is noteworthy that the rate of return for Health Sciences enjoyed the highest increase for both males and females. The higher rate of return for the study in Health Sciences reflects the increase in demand for allied health professionals.

33. For example, suppose a worker with a secondary ('O' level) qualification earns $900 per month. If the worker is able to enroll and graduate with a polytechnic diploma in Engineering Sciences, the monthly wage is expected to attain $1,563 in 2004 [($900) $\times$ $(1.202)^3 \approx$ $1,563] for his three years of diploma education, holding other things constant. In contrast, if the worker completes and graduate with a polytechnic diploma in Business & Administration, the monthly wage is expected to attain $1,460 in 2004 [($900) $\times$ $(1.175)^3 \approx$ $1,460] for his three years of diploma education, holding other things constant.

34. Comparing across genders, female citizens have higher rates of return for Architecture & Building, Information Technology, Mass Communication & Information Science and Fine & Applied Arts as compared to the male citizens in 2004.

Table 4: Premium for Fields of Education at the University First Degree Level

(A) Overall (i.e., both Male and Female Citizens)

June 2001		June 2004	
Law	0.250	Law	0.252
Health Sciences	0.225	Health Sciences	0.240
Information Technology	0.202	Information Technology	0.194
Engineering Sciences	0.190	Engineering Sciences	0.193
Business & Administration	0.179	Business & Administration	0.190
Natural, Physical, Chemical & Mathematical Sciences	0.174	Natural, Physical, Chemical & Mathematical Sciences	0.181
Humanities & Social Sciences	0.160	Humanities & Social Sciences	0.166
Mass Communication & Information Science	0.159	Architecture & Building	0.158
Architecture & Building	0.159	Mass Communication & Information Science	0.152

(B) All Male Citizens

June 2001		June 2004	
Health Sciences	0.244	Health Sciences	0.298
Law	0.240	Law	0.239
Information Technology	0.179	Engineering Sciences	0.185
Engineering Sciences	0.167	Business & Administration	0.183
Business & Administration	0.165	Natural, Physical, Chemical & Mathematical Sciences	0.182
Natural, Physical, Chemical & Mathematical Sciences	0.163	Information Technology	0.176
Mass Communication & Information Science	0.163	Humanities & Social Sciences	0.164
Humanities & Social Sciences	0.150	Mass Communication & Information Science	0.148
Architecture & Building	0.146	Architecture & Building	0.132

(C) All Female Citizens

June 2001		June 2004	
Law	0.252	Law	0.258
Information Technology	0.214	Information Technology	0.208
Engineering Sciences	0.196	Health Sciences	0.196
Health Sciences	0.191	Business & Administration	0.191
Business & Administration	0.186	Architecture & Building	0.176
Natural, Physical, Chemical & Mathematical Sciences	0.179	Natural, Physical, Chemical & Mathematical Sciences	0.174
Humanities & Social Sciences	0.167	Engineering Sciences	0.168
Architecture & Building	0.156	Humanities & Social Sciences	0.165
Mass Communication & Information Science	0.152	Mass Communication & Information Science	0.150

35. The rates of return for University first degree are given in Tables 4(A)–(C) above. At the overall level, the ranking of the fields of education has not shifted much in 2004 as compared to 2001. The ranking in 2004 shows Law (25.2%), Health Sciences (24.0%), Information Technology (19.4%), and Engineering Sciences (19.3%) as the fields of study with the highest rates of return at the University first degree level. Law and Health Sciences also appear in the top three fields of study for both males and females in 2004. Hence, in general, it would appear that professional and technical fields of study (e.g., Law, Health Sciences, and Engineering Sciences) have higher rates of return when compared to less technical ones (e.g., Humanities & Social Sciences).

36. For example, suppose a worker with 'A' level qualification earns $1,200 per month. If the worker is able to enroll and graduate with a first degree in Engineering Sciences, the monthly wage is expected to attain $2,431 in 2004 [($1,200) × $(1.193)^4 \approx$ $2,431] for his four years of University education, holding other things constant. In contrast, if the worker completes and graduate with an University degree in Business & Administration, the monthly wage is expected to attain $2,406 in 2004 [($1,200) × $(1.190)^4 \approx$ $2,406] for his four years of University education, holding other things constant.

37. The rates of return for most fields of study have improved in 2004 when compared to 2001, except for Information Technology, Architecture & Building and Mass Communication & Information Science. We also observe a similar trend in the rates of return for male citizens, with Health Sciences showing the largest increase. In contrast, for female citizens, the rates of return for five of the nine fields of study are slightly lower in 2004 compared to 2001. Law, Health Sciences, Business & Administration and Architecture & Building are the only subjects to register a higher rate of return for female citizens in 2004.

38. In a recent study on OECD countries, it was observed that females tend to have experienced higher rates of return in education as compared to males (Medolicchio, 2005). In particular, we should expect higher rates of return to the investment in schooling for women since women's education level not only increases the productivity in the factory but also allows for greater labour force participation rate. The comparison by gender at the first degree level indicates that female citizens tend to experience higher rates of return in most fields of education. In 2004, the rates of return for females in most fields of study, except for Health Sciences, Engineering Sciences, and Natural, Physical, Chemical & Mathematical Sciences, are higher than those experienced by the males.

E. Policy Discussions and Conclusions

39. The paper estimated the rate of return for investment in various levels of education, and also the rate of return for various fields of education at the polytechnic diploma and first degree levels. The key summary of the results are:

    a. The rate of return for an extra year of schooling is positive and significant. The rate tends to be higher for tertiary (i.e., diploma and above) education as compared to lower levels of education. In addition, the returns to university education have generally increased in 2004 compared to 2001. This finding is in line with the economic structure of the Singapore economy. As the economy transits towards higher value-added and knowledge activities, there is a greater demand for more educated workers, thus increasing the returns to higher levels of education.

    b. In general, the professional and more technical fields of study (e.g., Law, Health Sciences, and Engineering Sciences) at the first degree level have higher rates of return than the less technical subjects (e.g., Humanities & Social Sciences). Furthermore, the rates of return for most fields of study have improved in 2004, except for Information Technology, Architecture & Building and Mass Communication & Information Science. The fall in the rates of return for these fields of study could be attributed to the negative shock from burst of the dot.com bubble and the slower growth in the construction industry.

    c. In terms of the overall ranking of the various fields of study at the diploma level, Engineering Sciences, Architecture & Building, and Business & Administration are the fields of study with the highest rates of return in 2004. The rates of return for all fields of study, except Health Sciences, are lower in 2004 compared to 2001. The higher rate of return for the study in Health Sciences reflects the increase in demand for allied health professionals. The higher demand for Health Sciences manpower is also observed with a higher rate of return for Health Sciences graduates at the first degree level in 2004.

40. Among the Asian newly industrialised economies, Singapore's rate of return to education resembles those of South Korea, whereby the rate of returns tend to vary with the different stages of growth and changing industrial structures. Similar to the findings of Ryoo et al. (1993) for South Korea, the pay-off to investing in schooling in Singapore does not decline as individuals take more schooling.

41. In a rapidly changing small-open economy like Singapore, the growth of potential human capital is very crucial to attaining sustainable growth in the long-run. As the structure of Singapore's economy shifts towards higher value-added and knowledge activities, there will continue to be an increase in the demand for skilled and educated human capital. We can thus expect the demand for workers with tertiary education to increase, which implies that the rate of returns to tertiary education is likely to remain

high and above those for secondary and below education. Education will hence continue to be an attractive investment for individuals.

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Appendix 1

Table A1: Rates of Returns for Schooling Across Countries

Country	Year	Social			Private			Source
		Prim.	Sec.	Higher	Prim.	Sec.	Higher	
Argentina	1989	8.4	7.1	7.6	10.1	14.2	14.9	Psacharopoulos (1994)
Australia	1976	..	..	16.3	..	8.1	21.1	Psacharopoulos (1994)
Austria	1981	..	..	..	..	11.3	4.2	Psacharopoulos (1994)
Bahamas	1970	..	20.6	..	..	26.1	..	Psacharopoulos (1994)
Belgium	1960	..	17.1	6.7	..	21.2	8.7	Psacharopoulos (1994)
Bolivia	1990	13.0	6.0	13.0	20.0	6.0	19.0	Psacharopoulos *et al*. (1997)
Botswana	1983	42.0	41.0	15.0	99.0	76.0	38.0	Psacharopoulos (1994)
Brazil	1989	35.6	5.1	21.4	36.6	5.1	28.2	Psacharopoulos (1994)
Burkina Faso	1982	20.1	14.9	21.3	..	..	..	Psacharopoulos (1994)
Canada	1994	..	..	..	..	7.8	13.0	Cohn (1997)
Chile	1989	8.1	11.1	14.0	9.7	12.9	20.7	Psacharopoulos (1994)
China	1993	14.4	12.9	11.3	18.0	13.4	15.1	Hossain (1997)
Colombia	1989	20.0	11.4	14.0	27.7	14.7	21.7	Psacharopoulos (1994)
Costa Rica	1989	11.2	14.4	9.0	12.2	17.6	12.9	Psacharopoulos (1994)
Cyprus	1979	7.7	6.8	7.6	15.4	7.0	5.6	Psacharopoulos (1994)
Denmark	1964	..	..	7.8	..	..	10.0	Psacharopoulos (1994)
Dominican Republic	1989	..	..	..	85.1	15.1	19.4	Psacharopoulos (1994)
Ecuador	1987	14.7	12.7	9.9	17.1	17.2	12.7	Psacharopoulos (1994)
El Salvador	1990	16.4	13.3	8.0	18.9	14.5	9.5	Psacharopoulos (1994)
Estonia	1995	14.0	2.2	10.3	..	..	..	Noorkoiv *et al*. (1998)
Ethiopia	1996	14.9	14.4	11.9	24.7	24.2	26.6	World Bank (1998)
France	1976	..	..	..	..	14.8	20.0	Psacharopoulos (1994)
Germany (West)	1978	..	..	..	..	6.5	10.5	Psacharopoulos (1994)
Ghana	1967	18.0	13.0	16.5	24.5	17.0	37.0	Psacharopoulos (1994)
Greece	1993	..	6.5	5.7	..	8.3	8.1	Magoula and Psacharopoulos (1999)
Guatemala	1989	..	..	..	33.8	17.9	22.2	Psacharopoulos (1994)
Honduras	1989	18.2	19.7	18.9	20.8	23.3	25.9	Psacharopoulos (1994)
Hong Kong	1976	..	15.0	12.4	..	18.5	25.2	Psacharopoulos (1994)

Country	Year	Social			Private			Source
		Prim.	Sec.	Higher	Prim.	Sec.	Higher	
Hungary	1993	..	6.0	2.6	..	8.2	13.4	Varga (1995)
India	1995	..	..	..	2.6	17.6	18.2	Kingdon (1998)
Indonesia	1989	..	11.0	5.0	..	..	..	Psacharopoulos (1994)
Iran	1976	15.2	17.6	13.6	..	21.2	18.5	Psacharopoulos (1994)
Israel	1958	16.5	6.9	6.6	27.0	6.9	8.0	Psacharopoulos (1994)
Italy	1969	..	..	..	..	17.3	18.3	Psacharopoulos (1994)
Ivory Coast	1984	..	..	..	25.7	30.7	25.1	Psacharopoulos (1994)
Jamaica	1989	17.7	7.9	..	20.4	15.7	..	Psacharopoulos (1994)
Japan	1976	9.6	8.6	6.9	13.4	10.4	8.8	Psacharopoulos (1994)
Kenya	1980	..	10.0	..	..	16.0	..	Psacharopoulos (1994)
Korea	1986	..	8.8	15.5	..	10.1	17.9	Psacharopoulos (1994)
Lesotho	1980	10.7	18.6	10.2	15.5	26.7	36.5	Psacharopoulos (1994)
Liberia	1983	41.0	17.0	8.0	99.0	30.5	17.0	Psacharopoulos (1994)
Malawi	1982	14.7	15.2	11.5	15.7	16.8	46.6	Psacharopoulos (1994)
Malaysia	1978	..	..	..	..	32.6	34.5	Psacharopoulos (1994)
Mexico	1992	11.8	14.6	11.1	18.9	20.1	15.7	Cohn and Addison (1998)
Morocco	1970	50.5	10.0	13.0	..	..	..	Psacharopoulos (1994)
Nepal	1999	15.7	8.1	9.1	16.6	8.5	12.0	Parajuli (1999)
Netherlands	1965	..	5.2	5.5	..	8.5	10.4	Psacharopoulos (1994)
New Zealand	1991	..	12.4	9.5	..	13.8	11.9	Maani (1996)
Nicaragua	1996	13.6	10.4	14.7	..	..	..	Belli and Ayadi (1998)
Nigeria	1966	23.0	12.8	17.0	30.0	14.0	34.0	Psacharopoulos (1994)
Norway	1966	..	7.2	7.5	..	7.4	7.7	Psacharopoulos (1994)
Pakistan	1991	..	..	..	8.4	13.7	31.2	Katsis *et al.* (1999)
Panama	1989	..	..	..	5.7	21.0	21.0	Psacharopoulos (1994)
Papua New Guinea	1986	12.8	19.4	8.4	37.2	41.6	23.0	Psacharopoulos (1994)
Paraguay	1990	20.3	12.7	10.8	23.7	14.6	13.7	Psacharopoulos (1994)
Peru	1990	..	..	..	13.2	6.6	40.0	Psacharopoulos (1994)
Philippines	1988	13.3	8.9	10.5	18.3	10.5	11.6	Psacharopoulos (1994)
Puerto Rico	1959	24.0	34.1	15.5	68.2	52.1	29.0	Psacharopoulos (1994)
Senegal	1985	23.0	8.9	..	33.7	21.3	..	Psacharopoulos (1994)
Sierra Leone	1971	20.0	22.0	9.5	..	..	..	Psacharopoulos (1994)

Country	Year	Social			Private			Source
		Prim.	Sec.	Higher	Prim.	Sec.	Higher	
Singapore	1998	16.7	10.1	13.9	22.2	12.9	18.7	Sakellariou (2001)
Somalia	1983	20.6	10.4	19.9	59.9	13.0	33.2	Psacharopoulos (1994)
South Africa	1980	22.1	17.7	11.8	..	..	..	Psacharopoulos (1994)
Spain	1991	7.4	8.5	13.5	..	..	..	Lassibille and Navarro (1998)
Sri Lanka	1981	..	..	..	..	12.6	16.1	Psacharopoulos (1994)
Sudan	1974	..	8.0	4.0	..	13.0	15.0	Psacharopoulos (1994)
Sweden	1967	..	10.5	9.2	..	..	10.3	Psacharopoulos (1994)
Taiwan	1972	27.0	12.3	17.7	50.0	12.7	15.8	Psacharopoulos (1994)
Tanzania	1991	..	..	..	7.9	8.8		Mason and Khandker (1997)
Thailand	1989	..	..	..	16.0	12.9	11.8	Schultz (1994)
The Gambia	1997	33.5	12.1	..	37.1	12.7	..	EdInvest (1999)
Tunisia	1980	..	..	..	..	13.0	27.0	Psacharopoulos (1994)
Turkey	1987	..	..	8.5	1.9	8.6	16.2	Tansel (1994)
Uganda	1965	66.0	28.6	12.0	..	..	..	Psacharopoulos (1994)
United Kingdom	1986	8.6	7.5	6.5	..	..	..	Cohn and Addison (1998)
United States	1987	..	10.0	12.0	..	..	..	Psacharopoulos (1994)
Uruguay	1989	21.6	8.1	10.3	27.8	10.3	12.8	Psacharopoulos (1994)
Venezuela	1989	23.4	10.2	6.2	36.3	14.6	11.0	Psacharopoulos (1994)
Vietnam	1992	13.5	4.5	6.2	10.8	3.8	3.0	Moock *et al*. (1998)
Yemen	1985	2.0	26.0	24.0	10.0	41.0	56.0	Psacharopoulos (1994)
Yugoslavia	1986	3.3	2.3	3.1	14.6	3.1	5.3	Psacharopoulos (1994)
Zambia	1983	..	..	5.7	..	..	19.2	Psacharopoulos (1994)
Zimbabwe	1987	11.2	47.6	-4.3	16.6	48.5	5.1	Psacharopoulos (1994)

Appendix 2

Rates of Return to Education: Mincer's Equation

The wage (W) of the individual will depend on his own productive characteristics (q) and the non-monetary attributes of his job (x):

$$W = \mathrm{f}(q, x)$$

In a perfect capital market, where relative wages are determined entirely on the supply side, for someone with s years of schooling,

$$W_s = W_0 (1 + r)^s \approx W_0 \, \mathrm{e}^{rs}$$

Thus $\log W = \log W_0 + rs$

where r is the interest rate or rate of return.

Formulation 1

Consider an education system with 3 levels: Primary, Secondary and University.

Then

$$W_U = W_0 \, \mathrm{e}^{rP \cdot tP} \mathrm{e}^{rS \cdot tS} \mathrm{e}^{rU \cdot tU}$$

University: $\log W_U = \log W_0 + r_p t_p + r_s t_s + r_u t_u$

Secondary: $\log W_S = \log W_0 + r_p t_p + r_s t_s$

Primary: $\log W_P = \log W_0 + r_p t_p$

The estimating equation is:

$$\begin{aligned} \log W = \{a(D_P + D_S + D_U) + r_P[t_P(D_P + D_S + D_U)]\} + r_S[t_S(D_S + D_U)] \\ + r_U[t_U D_U] + b_1 x + b_2 x^2 \end{aligned} \qquad \textbf{(EQ A1)}$$

where D_P, D_S and D_U are the dummy variables corresponding to Primary, Secondary and University educated workers. The variable x stands for years of work experience. The term in braces {…} is the constant term.

Formulation 2

Suppose an individual has completed primary education, which involves t_{np} years of schooling, then

$$\log W_P = \log W_0 + r_{np} t_{np}$$

where r_{np} is rate of return to an individual with primary education starting from a status of no educational qualification, and t_{np} is the associated time duration from the initiating status.

As an illustration, consider an education system with 3 levels: Primary, Secondary and University. If we take Primary as the starting point, the earning equations are written as:

Starting with Primary:

For Secondary Educated Workers: $\log W_S = \log W_P + r_{ps} t_{ps}$

For University Educated Workers: $\log W_U = \log W_P + r_{pu} t_{pu}$

Where t_{ps} is the additional number of time period (e.g. in years) to complete secondary education after completing primary education; and t_{pu} is the additional number of time period to complete university education after completing primary education.

Typically, t_{ps} will be 6 years; and t_{pu} will be 10 years.

The estimating equation can be written as:

$$\log W = a_P (D_P + D_S + D_U) + r_{ps} (D_S t_{ps}) + r_{pu} (D_U t_{pu}) + b_1 x + b_2 x^2 \qquad \textbf{(EQ A2)}$$

Where D_P, D_S and D_U are the dummy variables corresponding to Primary, Secondary and University educated workers. The variable *x* stands for years of work experience.

Starting with Secondary

For Primary Educated Workers: $\log W_P = \log W_S + r_{sp} t_{sp}$

For University Educated Workers: $\log W_U = \log W_S + r_{su} t_{su}$

Typically, t_{sp} will be **–6** years; and t_{su} will be 4 years.

The estimating equation will be:

$$\log W = a_S\left(D_P + D_S + D_U\right) + r_{sp}\left(D_P t_{sp}\right) + r_{su}\left(D_U t_{su}\right) + b_1 x + b_2 x^2 \qquad \textbf{(EQ A3)}$$

Remarks

- In the estimation of EQ A2 and EQ A3, note that $t_{ps} = -t_{sp}$. Also $r_{ps} = r_{sp}$.

- EQ A3 can be 'derived' from EQ A2, by putting $D_S = 1 - D_P - D_U$;
  and $r_{pu} t_{pu} = r_{ps} t_{ps} + r_{su} t_{su}$. That is r_{pu} is a weighted average of r_{ps} and r_{su}.

- Formulation 1 and Formulation 2 are equivalent.
  If $r_{pu} D_U t_{pu}$ is replaced by $r_{ps} D_U t_{ps} + r_{su} D_U t_{su}$, then

$$\log W = a_P\left(D_P + D_S + D_U\right) + r_{ps}\left(D_S t_{ps}\right) + r_{ps} D_U t_{ps} + r_{su} D_U t_{su} + b_1 x + b_2 x^2$$

$$\rightarrow \qquad \log W = a_P\left(D_P + D_S + D_U\right) + r_{ps}\left[\left(D_S + D_U\right) t_{ps}\right] + r_{su} D_U t_{su} + b_1 x + b_2 x^2 \qquad \textbf{(EQ A4)}$$

Note that $a_P = \log W_0 + r_{np} t_{np}$; hence EQ A4 can be written as

$$\rightarrow \qquad \log W = \left\{\log W_0 + r_{np}\left[\left(D_P + D_S + D_U\right) t_{np}\right]\right\} + r_{ps}\left[\left(D_S + D_U\right) t_{ps}\right] + r_{su} D_U t_{su} + b_1 x + b_2 x^2$$

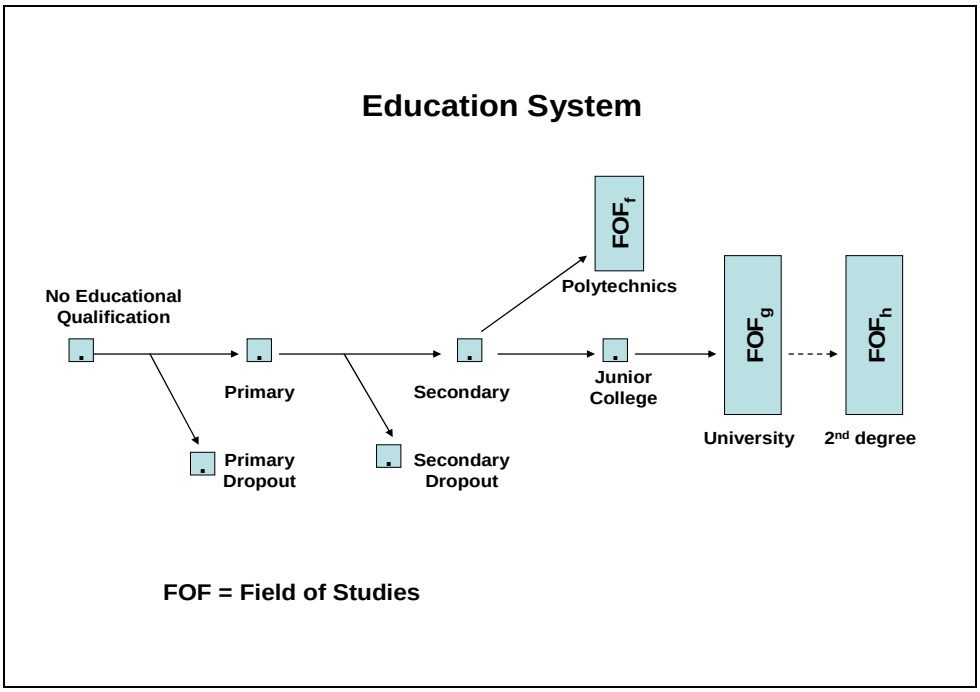
which is the same specification as EQ A1.

Returns to Field of Study

Suppose there are 3 fields of studies with identification dummy variables F_1, F_2, and F_3. The estimation equation is the same as EQ A1 except that the term $\left\{r_{su} D_U t_{su}\right\}$ has to be expanded into 3 separate terms with r_{F1}, r_{F2}, and r_{F3}, being the parameters to be estimated.

$$\log W = \left\{\log W_0 + r_{np}\left[\left(D_P + D_S + D_U\right) t_{np}\right]\right\} + r_{ps}\left[\left(D_S + D_U\right) t_{ps}\right]$$
$$+ r_{F1}\left[D_U F_1 \cdot t_{su}\right] + r_{F2}\left[D_U F_2 \cdot t_{su}\right] + r_{F3}\left[D_U F_3 \cdot t_{su}\right] + b_1 x + b_2 x^2 \qquad \textbf{(EQ A5)}$$

Education System



Notation:

		Dummy Variable	Time Duration of Schooling	Rates of Return
1	No Qualification	D_N		
2	Not Completed Primary	D_{P1}	T_{P1}	R_{P1}
3	Primary	D_{P2}	T_{P2}	R_{P2}
4	Not Completed Secondary	D_{S1}	T_{S1}	R_{S1}
5	Secondary	D_{S2}	T_{S2}	R_{S2}
6	Polytechnic	D_Z	T_{SZ}	R_{SZ}
7	Junior College	D_J	T_{SJ}	R_{SJ}
8	University: First Degree	D_U	T_{JU}	R_{JU}
9	Second & Higher Degree	D_M	T_{UM}	R_{UM}

Overall Specification

$$
\begin{aligned}
\log W = \; & a\left(D_N + D_{P1} + D_{P2} + D_{S1} + D_{S2} + D_J + D_Z + D_U + D_M\right) && \cdots \text{ All} \\
& + R_{P1}\left[T_{P1} D_{P1}\right] && \cdots \text{ Not Completed Primary} \\
& + R_{P2}\left[T_{P2}\left(D_{P2} + D_{S1} + D_{S2} + D_J + D_Z + D_U + D_M\right)\right] && \cdots \text{ Primary \& Above} \\
& + R_{S1}\left[T_{S1} D_{S1}\right] && \cdots \text{ Not Completed Secondary} \\
& + R_S\left[T_{P2}\left(D_{S2} + D_J + D_Z + D_U + D_M\right)\right] && \cdots \text{ Secondary \& Above} \\
& + R_{SZ}\left[T_{SZ} D_Z\right] && \cdots \text{ Poly Only} \\
& + R_{SJ}\left[T_{SJ}\left(D_J + D_U + D_M\right)\right] && \cdots \text{ JC \& Above} \\
& + R_{JU}\left[T_{JU}\left(D_U + D_M\right)\right] && \cdots \text{ University} \\
& + R_{UM}\left[T_{UM} D_M\right] && \cdots \text{ Master} \\
& + b_1 x + b_2 x^2 && \cdots \text{ All}
\end{aligned}
$$

(EQ A6)

The variable *x* stands for years of work experience.

Include FOF for Polytechnics:

Suppose there are 3 FOFs with identification dummy variables F_1, F_2, and F_3. The term $R_{SZ}\left[T_{SZ} D_Z\right]$ will be replaced by 3 terms: $R_{SZ1}\left[T_{SZ} D_Z \cdot F_1\right]$, $R_{SZ2}\left[T_{SZ} D_Z \cdot F_2\right]$, and $R_{SZ3}\left[T_{SZ} D_Z \cdot F_3\right]$. Note that $D_Z = F_1 + F_2 + F_3$

Include FOF for University:

Suppose there are 3 FOFs with identification dummy variables G_1, G_2, and G_3. The term $R_{JU}\left[T_{JU}\left(D_U + D_M\right)\right]$ will be replaced by 3 terms: $R_{JU1}\left[T_{JU}\left(D_U + D_M\right) \cdot G_1\right]$, $R_{JU2}\left[T_{JU}\left(D_U + D_M\right) \cdot G_2\right]$ and $R_{JU3}\left[T_{JU}\left(D_U + D_M\right) \cdot G_3\right]$. Note that $D_U = G_1 + G_2 + G_3$.

Include FOF for Master (2nd Degree):

Suppose there are 3 FOFs with identification dummy variables H_1, H_2, and H_3.
Note that $D_M = H_1 + H_2 + H_3$

We do not have data on what is the first degree attained by those respondents who reported they have a second degree. The 2nd degree is partitioned into fields of studies.
The term $R_{UM}[T_{UM}D_M]$ will be replaced by 3 terms: $R_{JM1}[T_{JM}D_M \cdot H_1]$, $R_{JM2}[T_{JM}D_M \cdot H_2]$, and $R_{JM3}[T_{JM}D_M \cdot H_3]$. Note that T_{JM} is the years of schooling starting from after completing JC to graduating with a 2nd degree. So technically, $T_{JM} = T_{JU} + T_{UM}$.
Similarly, note that R_{JM} is the average rate of return to schooling starting from completion of JC; it is a weighted average of the return for University (1st degree) education and the Master (2nd degree) education.
Thus, $R_{JM} = (T_{JU}/T_{JM})R_{JU} + (T_{UM}/T_{JM})R_{UM}$.

Overall Specification

$$
\begin{aligned}
\log W = \; & a(D_N + D_{P1} + D_{P2} + D_{S1} + D_{S2} + D_J + D_Z + D_U + D_M) && \cdots \text{ All} \\
& + R_{P1}[T_{P1}D_{P1}] && \cdots \text{ Not Completed Primary} \\
& + R_{P2}[T_{P2}(D_{P2} + D_{S1} + D_{S2} + D_J + D_Z + D_U + D_M)] && \cdots \text{ Primary \& Above} \\
& + R_{S1}[T_{S1}D_{S1}] && \cdots \text{ Not Completed Secondary} \\
& + R_S[T_{P2}(D_{S2} + D_J + D_Z + D_U + D_M)] && \cdots \text{ Secondary \& Above} \\
& + R_{SZ1}[T_{SZ}D_Z \cdot F_1] && \cdots \text{ Poly with FOF1} \\
& + R_{SZ2}[T_{SZ}D_Z \cdot F_2] && \cdots \text{ Poly with FOF2} \\
& + R_{SZ3}[T_{SZ}D_Z \cdot F_3] && \cdots \text{ Poly with FOF3} \\
& + R_{SJ}[T_{SJ}(D_J + D_U + D_M)] && \cdots \text{ JC \& Above} \\
& + R_{JU1}[T_{JU}D_U \cdot G_1] && \cdots \text{ University w FOF1} \\
& + R_{JU2}[T_{JU}D_U \cdot G_2] && \cdots \text{ University w FOF2} \\
& + R_{JU3}[T_{JU}D_U \cdot G_3] && \cdots \text{ University w FOF3} \\
& + R_{JM1}[T_{JM}D_M \cdot H_1] && \cdots \text{ Master w FOF1} \\
& + R_{JM2}[T_{JM}D_M \cdot H_2] && \cdots \text{ Master w FOF2} \\
& + R_{JM3}[T_{JM}D_M \cdot H_3] && \cdots \text{ Master w FOF3} \\
& + b_1 x + b_2 x^2 && \cdots \text{ All}
\end{aligned}
$$

(EQ A7)

Estimate (EQ A6) and (EQ A7) using data set:

(a) All Citizens (b) All Male Citizens (c) All Female Citizens

Empirical Specification

I. The basic Mincer's equation is given below:

$$\ln(income) = \beta_0 + \beta_1 sch + \beta_2 ex + \beta_3 ex^2 + \varepsilon$$

where *sch* is years of schooling, *ex* is years of experience $[\max(age - sch - 5, 0)]$, and ex^2 is the square of experience.

Coding of the Variable *sch*

Highest Qualification Attained (SSEC2000)	**sch**
01 Never attended school	0
02 Primary education without PSLE/PSPE 03 Certificate in BEST4	3
1 Primary	6
2 Lower Secondary	8
3 Secondary	10
4 Upper Secondary (General)	12
5 Upper Secondary (Vocational)	12
7 Professional Qualification & Other Diploma	13
6 Polytechnic Diploma	13
8 University First Degree	16
91 Postgraduate Diploma (including NIE postgraduate diploma)	17
92 Master	17.5
93 Doctorate	20

Source: Modified from *Education for Growth: The Premium on Education and Work Experience in Singapore*, MAS Staff Paper No. 26, January 2004

$ex = \max(age - sch - 5, 0)$, where *sch* = number of years of schooling.

II. Model Specification for Eq A6: The Mincer equation accounting for various levels of Schooling

$$\ln(income) = \beta_0 + \beta_1 pri + \beta_2 sec + \beta_3 usecgen + \beta_4 usecvoc + \beta_5 prodip + \beta_6 poly + \beta_7 firdeg + \beta_8 postgraddip + \beta_9 master + \beta_{10} phd + \alpha_1 ex + \alpha_2 ex^2 + \varepsilon$$

Description of variable names in Equation A6

Variable	Code in Equation A6
Intercept	intercept
number of years in primary school	pri
number of years in secondary school	sec
number of years in upper secondary (general) (e.g. JC)	usecgen
number of years in upper secondary (vocational) (e.g. ITE)	usecvoc
number of years in professional qualification and other diploma	prodip
number of years in polytechnic	poly
number of years in taking first degree	firdeg
number of years in taking postgraduate diploma (e.g. NIE diploma)	postgraddip
number of years in taking masters degree	master
number of years in taking PhD degree	phd
experience [= max(age – sch – 5, 0)]	ex
square of experience	ex^2

Coding of Schooling Dummy Variables

Highest Qualification Attained (SSEC2000)	pri	sec	usecgen	usecvoc	prodip	poly	firdeg	postgraddip	master	phd	sch
01 Never attended school	0	0	0	0	0	0	0	0	0	0	0
02 Primary education without PSLE/PSPE 03 Certificate in BEST4	**3**	0	0	0	0	0	0	0	0	0	3
1 Primary	**6**	0	0	0	0	0	0	0	0	0	6
2 Lower Secondary	**6**	**2**	0	0	0	0	0	0	0	0	8
3 Secondary	**6**	**4**	0	0	0	0	0	0	0	0	10
4 Upper Secondary (General)	**6**	**4**	**2**	0	0	0	0	0	0	0	12
5 Upper Secondary (Vocational)	**6**	**4**	0	**2**	0	0	0	0	0	0	12
7 Professional Qualification & Other Diploma	**6**	**4**	0	0	**3**	0	0	0	0	0	13
6 Polytechnic Diploma	**6**	**4**	0	0	0	**3**	0	0	0	0	13
8 University First Degree	**6**	**4**	**2**	0	0	0	**4**	0	0	0	16
91 Postgraduate Diploma (including NIE postgraduate diploma)	**6**	**4**	**2**	0	0	0	**4**	**1**	0	0	17
92 Master	**6**	**4**	**2**	0	0	0	**4**	0	**1.5**	0	17.5
93 Doctorate	**6**	**4**	**2**	0	0	0	**4**	0	0	**4**	20

Source: Modified from *Education for Growth: The Premium on Education and Work Experience in Singapore*, MAS Staff Paper No. 26, January 2004

$ex = \max(age - sch - 5, 0)$, where sch = number of years of schooling.

III. Model Specification for Eq A7: The Mincer equation accounting for various fields of education at Diploma and University level.

$$\begin{aligned}\ln(income) = {} & \beta_0 + \beta_1 pri + \beta_2 sec + \beta_3 usecgen + \beta_4 usecvoc + \beta_5 prodip \\ & + \beta_{61} poly \cdot P_1 + \beta_{62} poly \cdot P_2 + \cdots + \beta_{68} poly \cdot P_8 \\ & + \beta_{71} dega \cdot F_1 + \beta_{72} dega \cdot F_2 + \cdots + \beta_{710} dega \cdot F_{10} \\ & + \beta_8 degb \\ & + \beta_{91} degc \cdot S_1 + \beta_{92} degc \cdot S_2 + \cdots + \beta_{97} degc \cdot S_7 \\ & + \beta_{10} degd \\ & + \alpha_1 ex + \alpha_2 ex^2 + \varepsilon\end{aligned}$$

Description of variables in Equation A7

Variable	**Code in Equation A7**
Intercept	intercept
number of years in primary school	pri
number of years in secondary school	sec
number of years in upper secondary (general) (e.g. JC)	usecgen
number of years in upper secondary (vocational) (e.g. ITE)	usecvoc
number of years in professional qualification and other diploma	prodip
number of years in polytechnic	poly
number of years in taking first degree (for those whose highest qualification attained is first degree)	dega
number of years in taking ***all*** degree courses (for those whose highest qualification attained is postgraduate diploma)	degb
number of years in taking ***all*** degree courses (for those whose highest qualification attained is masters)	degc
number of years in taking ***all*** degree courses (for those whose highest qualification attained is PhD)	degd
experience [= max(age – sch – 5, 0)]	ex
square of experience	ex^2

Coding of Schooling Dummy Variables

Highest Qualification Attained (SSEC2000)	pri	sec	usecgen	usecvoc	prodip	poly	dega	degb	degc	degd	sch
01 Never attended school	0	0	0	0	0	0	0	0	0	0	0
02 Primary education without PSLE/PSPE 03 Certificate in BEST4	**3**	0	0	0	0	0	0	0	0	0	3
1 Primary	**6**	0	0	0	0	0	0	0	0	0	6
2 Lower Secondary	**6**	**2**	0	0	0	0	0	0	0	0	8
3 Secondary	**6**	**4**	0	0	0	0	0	0	0	0	10
4 Upper Secondary (General)	**6**	**4**	**2**	0	0	0	0	0	0	0	12
5 Upper Secondary (Vocational)	**6**	**4**	0	**2**	0	0	0	0	0	0	12
7 Professional Qualification & Other Diploma	**6**	**4**	0	0	**3**	0	0	0	0	0	13
6 Polytechnic Diploma	**6**	**4**	0	0	0	**3**	0	0	0	0	13
8 University First Degree	**6**	**4**	**2**	0	0	0	**4**	0	0	0	16
91 Postgraduate Diploma (including NIE postgraduate diploma)	**6**	**4**	**2**	0	0	0	0	**5**	0	0	17
92 Master	**6**	**4**	**2**	0	0	0	0	0	**5.5**	0	17.5
93 Doctorate	**6**	**4**	**2**	0	0	0	0	0	0	**8**	20

Source: Modified from *Education for Growth: The Premium on Education and Work Experience in Singapore*, MAS Staff Paper No. 26, January 2004

Coding of Field of Study Dummy Variables

(a) For those whose highest qualification attained is *polytechnic diploma*

SSEC2000 Field Code	Field of Study Description	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
02	Fine & Applied Arts	**1**	0	0	0	0	0	0	0
04	Mass Communication & Information Science	0	**1**	0	0	0	0	0	0
05	Business & Administration	0	0	**1**	0	0	0	0	0
08	Health Sciences	0	0	0	**1**	0	0	0	0
09	Information Technology	0	0	0	0	**1**	0	0	0
10	Architecture & Building	0	0	0	0	0	**1**	0	0
11	Engineering Sciences	0	0	0	0	0	0	**1**	0
01, 03, 06, 07, 12, 13, 99	Others	0	0	0	0	0	0	0	**1**

(b) For those whose highest qualification attained is *university first degree*

SSEC2000 Field Code	Field of Study Description	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
03	Humanities & Social Sciences	**1**	0	0	0	0	0	0	0	0	0
04	Mass Communication & Information Science	0	**1**	0	0	0	0	0	0	0	0
05	Business & Administration	0	0	**1**	0	0	0	0	0	0	0
06	Law	0	0	0	**1**	0	0	0	0	0	0
07	Natural, Physical, Chemical & Mathematical Sciences	0	0	0	0	**1**	0	0	0	0	0
08	Health Sciences	0	0	0	0	0	**1**	0	0	0	0
09	Information Technology	0	0	0	0	0	0	**1**	0	0	0
10	Architecture & Building	0	0	0	0	0	0	0	**1**	0	0
11	Engineering Sciences	0	0	0	0	0	0	0	0	**1**	0
01, 02, 12, 13, 99	Others	0	0	0	0	0	0	0	0	0	**1**

(c) For those whose highest qualification attained is *master*

SSEC2000 Field Code	Field of Study Description	S_1	S_2	S_3	S_4	S_5	S_6	S_7
03	Humanities & Social Sciences	**1**	0	0	0	0	0	0
05	Business & Administration	0	**1**	0	0	0	0	0
07	Natural, Physical, Chemical & Mathematical Sciences	0	0	**1**	0	0	0	0
08	Health Sciences	0	0	0	**1**	0	0	0
09	Information Technology	0	0	0	0	**1**	0	0
11	Engineering Sciences	0	0	0	0	0	**1**	0
01, 02, 04, 06, 10, 12, 13, 99	Others	0	0	0	0	0	0	**1**

$ex = \max(age - sch - 5, 0)$, where *sch* = number of years of schooling.

Correspondence between Codes in Equation A7 and codes in STATA Output

Code in Equation A7	**Code in STATA Output**
intercept	_cons
pri	pri
sec	sec
usecgen	usecgen
usecvoc	usecvoc
prodip	prodip
poly • P_1	p02
poly • P_2	p04
poly • P_3	p05
poly • P_4	p08
poly • P_5	p09
poly • P_6	p10
poly • P_7	p11
poly • P_8	p00
dega • F_1	f03
dega • F_2	f04
dega • F_3	f05
dega • F_4	f06
dega • F_5	f07
dega • F_6	f08
dega • F_7	f09
dega • F_8	f10
dega • F_9	f11
dega • F_{10}	f00
degb	degb
degc • S_1	s03
degc • S_2	s05
degc • S_3	s07
degc • S_4	s08
degc • S_5	s09
degc • S_6	s11
degc • S_7	s00
degd	degd
ex	ex
ex^2	exsq

DESCRIPTION OF DATA SOURCE USED FOR FIELD OF STUDY PREMIUM PROJECT

a. The datasets used for this study are sourced from the Mid-Year Labour Force Survey of Singapore conducted by the Manpower Research and Statistics Department, Ministry of Manpower. For the study, we made use of the dataset for June 2001 and June 2004, given that the information on field of study was collected in the mid-year Labour Force Survey from 2001 onwards and the latest available dataset is for 2004.

b. A subset of the full datasets for June 2001 and 2004 were used for the study. The actual datasets used for the Field of Study Premium project includes all full-time employed citizens aged 15 & over, **excluding** those who are contributing family workers[6] and full-time national servicemen.

c. Concepts and Definitions

   i. **Employed Persons** – This refers to persons aged 15 years and over who, during the reference period:
      1. worked for one hour or more either for pay, profit or family gains; or
      2. had a job or business to return to but were temporarily absent because of illness, injury, breakdown of machinery at workplace, labour management dispute or other reasons.

   ii. **Full-Time Employment** – This refers to employment where the normal hours of work is 30 hours or more in a week.

   iii. **Educational Attainment** – This refers to the highest level or standard which a person has passed or attained either through attendance at an institution of learning or through correspondence or self-study. The classification of educational attainment is based on the Singapore Standard Educational Classification (SSEC), 2000.

   iv. **Field of Study** – This refers to the principal discipline, branch or subject matter of study that leads to the award of the **highest** qualification attained at polytechnic and university levels.

   v. **Employment Status** – This refers to the position or status of an employed person in relation to other persons within the organisation for which he worked. Employed persons are divided into the following four categories:
      1. *Employers* – These are persons who employ at least one paid worker in their business or trade.
      2. *Employees* – These are persons who work for employers in return for regular wages or salaries.
      3. *Own Account Workers* – These are persons who operate their own business without employing any paid workers in the conduct of their business or trade.

[6] These are persons who assist in the operation of family business without receiving regular wages or salaries.

4. *Contributing Family Workers* (excluded from this project) – These are persons who assist in the operation of family business without receiving regular wages or salaries.

vi. **Gross Monthly Income** – This refers to the total amount of income earned from employment during the full calendar month preceding the date of the interview. For employees, this would include wages or salaries, allowances, overtime, commission, tips and bonuses. It would also include the employee's Central Provident Fund contribution **but not the employer's contribution for the employee**. For employers and own account workers, it refers to the total receipt from sales and services performed less the business expenses incurred.

Note: The above write-up was mainly extracted from the *Report on Labour Force in Singapore* 2004.

Appendix 3

Table A2: Estimation Results for Mincer Equation Accounting for Fields of Education at Polytechnic Diploma and Degree Level (Citizens)

	Code in Stata Output	All		Male		Female	
		2001	2004	2001	2004	2001	2004
intercept	_cons	6.092	6.025	6.244	6.179	6.038	5.952
primary	Pri	0.024	0.009	0.012	***-0.003***	***-0.004***	-0.011
secondary	Sec	0.149	0.144	0.135	0.132	0.207	0.190
upper secondary (general)	usecgen	0.156	0.141	0.179	0.145	0.143	0.145
upper secondary (vocational)	usecvoc	0.100	0.101	0.078	0.089	0.105	0.089
professional qualifications & other diploma	Prodip	0.177	0.184	0.188	0.174	0.176	0.193
polytechnic diploma (fine & applied arts)	p02	0.134	0.126	0.111	0.118	0.149	0.130
polytechnic diploma (mass communication & information science)	p04	0.195	0.146	0.217	0.139	0.172	0.147
polytechnic diploma (business & administration)	p05	0.182	0.175	0.179	0.180	0.186	0.176
polytechnic diploma (health sciences)	p08	0.129	0.169	0.108	0.179	0.139	0.178
polytechnic diploma (information technology)	p09	0.190	0.157	0.181	0.139	0.190	0.172
polytechnic diploma (architecture & building)	p10	0.194	0.191	0.186	0.179	0.196	0.197
polytechnic diploma (engineering sciences)	p11	0.212	0.202	0.205	0.196	0.188	0.183
polytechnic diploma (other fields)	p00	0.165	0.163	0.166	0.169	0.160	0.157
first degree (humanities & social sciences)	f03	0.160	0.166	0.150	0.164	0.167	0.165
first degree (mass communication & information science)	f04	0.159	0.152	0.163	0.148	0.152	0.150
first degree (business & administration)	f05	0.179	0.190	0.165	0.183	0.186	0.191
first degree (law)	f06	0.250	0.252	0.240	0.239	0.252	0.258
first degree (natural, physical, chemical & mathematical sciences)	f07	0.174	0.181	0.163	0.182	0.179	0.174
first degree (health sciences)	f08	0.225	0.240	0.244	0.298	0.191	0.196
first degree (information technology)	f09	0.202	0.194	0.179	0.176	0.214	0.208
first degree (architecture & building)	f10	0.159	0.158	0.146	0.132	0.156	0.176
first degree (engineering sciences)	f11	0.190	0.193	0.167	0.185	0.196	0.168
first degree (other fields)	f00	0.114	0.120	0.096	0.146	0.127	0.108
experience	Ex	0.055	0.060	0.057	0.061	0.050	0.059
experience^2	Exsq	-0.0008	-0.0008	-0.0008	-0.0008	-0.0007	-0.0009

Notes:

(1) Figures in bold and italic are not significant at the 5% level. All other figures are significant at 5% level.

(2) Dummy variables for Postgraduate Diploma, Doctorate and fields of study at the Masters level has also been included as control variables.