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Thomas A. Rohling

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Article abstract

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Screening and Human Capital Theory
An Empirical Test

Thomas A. Rohling

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There is an ongoing debate in the literature about the role of higher education. Does education enhance an individual's productivity, or does education, through the granting of certificates, merely allow an individual to signal his productivity to employers? This debate about the role of education can be separated into two main camps, with Human Capital theory taking the former view and Screening theory the latter.

Human Capital theory contends that education is not a consumption good, but rather an investment leading to higher earnings in the future. As an investment, the demand for education then depends upon two important considerations not found in the traditional consumption view of education. First, the individual considers the opportunity cost of foregone earnings while in school, and second, he or she considers the expected earnings in the job market after graduation. Also, this theory predicts that the longer the period of investment, the greater the return. Thus, higher earnings should be correlated with higher levels of education.

Screening theory can also account for most of the above predictions, including a positive relationship between schooling and earnings. However, Screening theory attributes this correlation to the signalling effect of a degree or certificate. The Screening Hypothesis, first formalized by Michael Spence (1973), is based on the problem of hidden information. The prospective employees have private information about their productivity, and if

* ROHLING, Thomas A., Professor, Department of Economics, Simon Fraser University, British Columbia.

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they have higher than average productivity, they will attempt to relay this information to the firm. However, productivity is not easily measurable, and thus the employee must find indirect means of signalling his higher productivity to employers. One of these ways is for the highly productive individual to acquire a signal, such as a degree from a university. The highly productive individual will acquire this signal only if his costs of doing so are less than the costs incurred by low productivity individuals in obtaining the same signal. Thus, employers now have a means of distinguishing between high and low productivity employees at the point of hiring, and they will use the university degree as a proxy for productivity, and pay the employee accordingly. Also, employers will use the proxy as long as their prior beliefs about the correlation between productivity and degrees is confirmed. Spence's argument rests upon the assumption that individuals with higher than average productivity have lower costs of attaining education than other individuals.

Screening theory does not predict that education adds to a person's productivity. In fact, Spence notes, «if it (education) is too productive relative to the costs, everyone will invest heavily in education and education may cease to have a signalling function» (1973, p. 368). In contrast, Human Capital theory, as explained by Becker, states, «All (forms of investing) improve the physical and mental abilities of people and thereby raise real income prospects» (1962, p. S9). Employers are obviously willing to pay a higher wage to individuals with greater ability.

The two theories have different implications for the role and funding of universities. If the Screening hypothesis holds, the private costs to the individual should be raised in order to reduce the social costs of education but still retain the screening properties of the institution (Riley, p. s229). Signalling behavior utilizes scarce resources in activities that are individually profitable but are at best socially redistributive, unless, of course, universities screen more efficiently than alternative means. Human Capital theory, on the other hand, suggests that since higher education raises the individual's productivity and may impart a positive social externality, resources allocated to education should be increased until the social rate of return is equalized at the margin. Also, the yield on education should not fall below the yield on the next best alternative[1].

This paper analyses a way to empirically distinguish between the two competing theories on the role of higher education. The second part briefly discusses the test and the data. The following part uses regression analyses on Canadian survey data on university and college graduates, and the

1 For a more complete discussion of private vs. social rates of return to investment in education, see BLAUG, 1970, pp. 200-205.

results indicate that Human Capital theory appears to be very important in explaining the role of higher education. The final part summarizes and concludes the paper.

THE TEST

Wiles (1974) proposes that Human Capital theory predicts persons using their education in a specific manner on the job would command a premium over another graduate, but from another field of study. Screening theory, however, suggests there would be no premium. Since education does not add to an individual's productivity, the field of specialization of a persons degree would not matter to the employer's decision to hire or what to initially pay that individual. A degree holder should be rewarded with the same starting salary, no matter where he works. Thus if incomes of recent graduates working in fields associated with the content of their degree are higher than if they are working elsewhere, Human Capital theory would be confirmed, and Screening theory would be weakened.

This hypothesis is tested for four groups: bachelors and a combined group of masters and Phd graduates from the university data set, as well as one-two year programs, and three-four year programs from the college data set. The main emphasis of this paper will be on the bachelor category, since there are more subject areas for which data are available than there are for the other groups.

The Data

The data come from Statistics Canada, *Job Market Reality for Post Secondary Graduates; Employment Outcome by 1978, Two Years After Graduation*, by W. Clark and Z. Zigmond (1978). It is a survey of more than 43,698 people who graduated from community colleges and universities in 1976. There are 29,609 valid responses, broken down into bachelors, Masters-Phd students, and males and females, but the responses are recorded as percentages of each group. Thus, only 41 observations on different fields of study are available for the bachelor group, and only 35 observations are available for the Masters-Phd group.

Information was collected on the average annual salary of each type of graduate, two years after graduation. Unfortunately, data on starting salaries are unavailable, and thus our salary data reflect a two year lag between graduation and employment. The theoretical implications of this are discussed below. Also, questions were asked as to whether they felt their job

was directly, indirectly, or not related to their field of study, and the responses are recorded in percentages of the relevant subgroup. This question is taken to represent the extent to which Human Capital accounts for starting salaries. For example, an economics graduate working as an economist would answer that his work is directly related to his field of study. Human Capital theory predicts that firms would be willing to pay a premium for this specific skill, and hence salaries of economic graduates working in economics should be greater than salaries of economists working in different fields. Of course, this assumes that other conditions which may influence salaries are the same across different fields of employment.

Another exogenous factor that may influence starting salaries of graduates is if the graduate's job is permanent or temporary. Theoretically, a permanent job may offer a higher salary than a temporary job. Data for the permanent job variable also comes from this survey. The labour market tightness variable, explained below, is from *Education in Canada*; a Statistics Canada publication. The data are incomplete in the respect that observations are not available for every graduate type. The effective number of observations of the bachelor regression is reduced to 27 when this variable is included.

THE EMPIRICAL RESULTS

University Education

This study follows closely the procedure used by Miller and Volker (1984) in their application of the Wiles test on Australian micro data. They regressed the log of income on a vector of explanatory variables such as subject background of the degree, age, place of study, private or government jobs and if study was on a full time or part time basis. These variables were shown to influence starting salaries to some extent.

Our study also regresses the log of income on some explanatory variables. Unfortunately, our data does not have information on many of factors available to Miller and Volker, but the specification bias may not be too severe. For example, the graduates tend to be roughly the same age with respect to degree type, and thus, there is no need to include an age variable. Moreover, The Miller — Volker results show that the dummy variables on the location of the degree provided, as a group, the least evidence of explanatory power in their regression. No data are available for the other variables used in the Miller — Volker regressions.

The graduates indicated whether their jobs were directly, indirectly or not at all related to their field of specialization. The RELATED variable in all regressions is a summation of the first two responses, and this gives a measure of graduates using their specific skills on the job. Regressions run with only the 'directly' response yield results very similar to those using the RELATED variable. As mentioned, our regression also includes a variable (PERM) for the nature of the job; *i.e.*, if the job is permanent or temporary. One would expect a permanent job to offer a higher salary than a temporary job, unless the temporary job's salary compensates for the increased variance to a persons income stream.

Another variable included in our regression is the relative demand for particular fields of specialization. Suppose excess demand exists for a particular job type, such as economist. One would expect the income offered for economists to be higher than other types of graduates, and therefore the variable PERCGRAD, measuring excess demand, is included in the regression explaining the salaries of graduates from universities. Our measure for excess demand uses the rate of change of graduates from 1972 to 1976 for each different field of specialization. We suggest that if the rate of change of graduates from a particular field is low, salaries should be rising in occupations of the same nature as the degree field. A situation of excess demand exists, and the sign on the coefficient of this variable should be negative. Unfortunately, using rates of change of graduates as a proxy for excess demand leaves the above conclusion open to interpretation. For example, salaries may not have risen sufficiently from the time students enter a program, and when they finish, yielding a positive sign on the excess demand variable. That is, if students enter a program with a high relative salary, then there may already exist excess demand. When they graduate, the excess demand may still be present. The salary will be high when the rate of change of graduates is high. Despite the differences of interpretation, a measure of labour market tightness is used as an explanatory variable in the regression of salaries of bachelor graduates. This is because we are less concerned about the sign of this variable as we are with the robustness of the RELATED variable to the inclusion of other exogenous variables. Two regressions on the bachelor salary data are shown in Table 1. The excess demand variable is included in the second regression but is absent from the first.

The coefficient on the PERCGRAD variable in the second regression is statistically insignificant at the 5% level of significance. The negative sign would indicate, at least superficially, that there may have been a situation of excess demand characterizing many fields of study.

Table 1

Regression Results of Salary on Selected Variables

	University Salaries			*College Salaries*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Explanatory Variables	*Bachelor*	*Bachelor*	*Master-PhD*	*One-Two year programs*	*Three-Four year programs*
RELATED	0.0039 (3.415)[1]	0.00518 (4.316)	0.00497 (2.761)	0.00390 (1.3875)	0.00780 (3.9807)
PERM	0.00274 (2.800)	0.00125 (1.301)	0.00415 (2.564)	--	--
PERCGRAD	--	-0.05167 (-1.887)	--	--	--
INTERCEPT	9.12405 (112.51)	9.12476 (108.96)	9.1550 (63.60)	9.06584 (38.848)	8.76939 (52.839)
R^2	0.55	0.59	0.43	0.11	0.50
No of observations	41	27	35	18	18

1. The bracketed values are t statistics.

As mentioned, the explanatory variable PERM represents the proportion of persons in permanent jobs, and it is statistically significant in the first regression, but insignificant in the second. The positive sign on the PERM coefficient indicates that the higher the percent of graduates having permanent (rather than temporary) jobs, the higher the salary. This seems intuitively correct, but the insignificant coefficient in the second regression weakens this hypothesis. More importantly, the coefficient on the 'related to field of study' variable is significant in both regressions. This suggests Human Capital theory is correct: employers place a premium on skills learned in university if the skills are related to the job.

The interpretation of the coefficient on the RELATED variable requires some discussion. Usually, the coefficient is interpreted as the percentage effect of the independent variable of the dependent variable, but according to Kennedy (1981, p. 801), the correct interpretation is as follows:

$$\%\Delta\text{income} = \exp(c - 1/2*\text{var}(c)) - 1$$

where c is the coefficient on RELATED. The percentage change of income is 67.86% when using the coefficient and variance of the coefficient of

regression 2 from Table 1, and 47.1% from regression 1. If all of graduates from a given field of study are working in their field of study, their starting salary will be roughly 50% higher than if none of the graduates from a given field of study are so employed. It works out to a difference of income of over 7 000 $ between the two extremes, which provides very strong support for Human Capital theory.

However, the data may be heteroscedastic which could have implications for the above findings, as heteroscedasticity is known to bias the estimate of the variance of the coefficients, and thus provide misleading t and F statistics. The White test[2] shows heteroscedasticity of bachelor's income against the RELATED variable, but the corrections did not affect the size and significance of the coefficient on the RELATED variable noticeably.

The third regression in Table 1 uses the masters-Phd data. The coefficient on the RELATED variable is statistically significant, and positive. The coefficient is roughly of the same magnitude as obtained for the bachelor study, indicating a difference of income of 64.36% between the extremes of all Masters and Phds using their university training on the job and no Masters and Phds so employed.

College Education

If Human Capital holds in the case of university education, it should hold even more so in the case of a college education, because a college provides courses that are more directly job oriented than most university courses. Thus, a person with a college diploma in communication working in a field like communications should be paid more initially than they would receive in any other field. The empirical data comes from the same source as the university data but there are less groups than there are for the university study. The college data are broken down into one to two year programs and three to four year programs. Unfortunately, problems of interpretation may arise, because the sample size is so small: each group has only 18 observations. The small sample size could cause the results to be unstable, or subject to major revisions if new data were added. The data were pooled to increase the degrees of freedom, but the regression results were not greatly different than the results obtained from running separate regressions, so for convenience, the separate regressions are shown in columns 4 and 5 of Table 1. The one to two year programs show an insignificant coefficient on the related variable. The three to four year programs, however, does provide a

2 An explanation of the White test and the construction of the heteroscedasticity consistent covariance variance matrix can be found in WHITE (1980) and MESSER and WHITE (1984).

significant coefficient and the same interpretation of this coefficient applies here as it does with the university data. The coefficient indicates that the difference of income between the two extremes of a field where everyone uses their education on the job and a field where no one uses their education on the job is roughly 100 per cent.

This result indicates that whether a graduate from college is working in his or her field of study is important to that person's salary. Human Capital theory appears substantiated, and the results from the college data (at least for the three to four year program) coincide with the results of the university data.

Unfortunately, the robustness of the coefficients on the RELATED variable in the college regressions could not be investigated, as data on variables such as part time employment or labour market tightness are unavailable for sufficient fields to be useful. Testing for heteroscedasticity reveals the data are not heteroscedastic.

CONCLUSIONS

This paper uses the Wiles test in an attempt to distinguish between Human Capital theory and Screening theory. Wiles noted that if the Human Capital theory holds, the starting salaries of graduates using their education in their job should be higher than those graduates not so employed. There is no expectation, under the Screening hypothesis, that incomes of graduates from a given field of study would vary across work types. The coefficient on the RELATED variable in the bachelor regression of the university study supports Human Capital theory, as the difference of incomes between fields where no graduates have jobs related to their field of study, and fields where all graduates are working in jobs related to their field of study is large, with a value of 7 820 $. The tests on the other data sets, including the college data, confirm the findings of the university study. These findings suggest, by implication, that screening is not as important in the role of education as Spence suggests. The results presented here contradict the empirical results of Miller and Volker. Their results generally show an insignificant coefficient on the related to field of study variable, implying that Human Capital is unimportant, and thus Screening accounts for the role of universities.

There are a few problems with this paper's analysis that may affect the results. First, the income variable may not reflect starting salaries if the graduate found a job immediately after graduation. The two year interim could give the employer enough time to change the salary to reflect the observed productivity and Screening theory could still hold. In other words, Screening may still be important, as the theory only accounts for starting

salaries. It does not say that the salary cannot be changed at a later date to reflect the true observed productivity. However, this criticism is weakened somewhat by noting that the salary cannot change too much, as the employer's *a priori* beliefs about the correlation between productivity and credentials must be confirmed *ex post*. Otherwise, education would cease to be a signal.

Also, it would be much better to work with micro data as was used in the Miller-Volker study, since this would allow a more complete analysis which would include many of the other relevant variables that were unavailable; such as age, place of study, and whether the job was government or private. Despite the aforementioned shortcomings, the results obtained are robust to the inclusion of other relevant variables, and the equation explains roughly 50% of the variation of income. This would lead one to conclude that Human Capital improvement is a major factor in the role of higher education.

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La théorie du tamisage et des ressources humaines. Une analyse empirique

Il y a débat en cours dans la littérature au sujet du rôle de la formation supérieure. La formation supérieure augmente-t-elle la productivité de l'individu ou, par l'octroi d'un diplôme, permet-elle simplement à une personne de mettre en évidence sa valeur auprès des employeurs? Ce débat à propos du rôle de la formation supérieure a donné naissance à deux camps qui s'opposent: les théoriciens des ressources humaines et les tenants du tamisage (screening).

La théorie des ressources humaines soutient que les placements dans la formation supérieure accroissent la valeur productive de la personne et, par conséquent, elle doit commander des traitements plus élevés. La théorie du tamisage soutient aussi que des gains plus forts sont associés à la formation supérieure, mais en attribue la conséquence au grade ou au diplôme. Les mesures du rendement sont difficiles et les employeurs recourront donc à un parchemin pour vérifier le rendement, soit un brevet ou un certificat d'études. La formation supérieure agit donc ainsi à la manière d'un dispositif de tamisage pour permettre à des personnes très performantes de manifester leur valeur aux employeurs. Cependant, la théorie du tamisage refuse d'accepter que la formation supérieure comporte de soi une grande valeur de rendement de sorte qu'il serait avantageux pour tout le monde d'acquérir ce parchemin et que, en conséquence, le brevet ou le certificat cesserait d'avoir une fonction discriminatoire.

Wiles (1974) a mis au point un test qui permet de faire la démarcation entre ces deux théories concurrentes. Brièvement, il estime que la théorie des ressources humaines signifie que les revenus d'un gradué travaillant dans un champ d'activité correspondant au contenu de son diplôme seraient plus élevés que si celui-ci travaillait ailleurs. La théorie du tamisage, toutefois, ne voit aucune différence dans les revenus. La vérification de Wiles s'applique aux données d'une enquête des universités et des collèges canadiens. L'échantillon des universités est formé de deux groupes: les bacheliers et les docteurs en philosophie. L'échantillon des collèges est composé d'un groupe de diplômés des programmes d'un à deux ans et d'un groupe de diplômés des programmes de trois à quatre ans.

Les gradués ont indiqué si leur emploi actuel se rattache à leur champ de spécialisation à l'université ou au collège. S'il existe un rapport positif entre les revenus et un pourcentage élevé de gradués qui travaillent dans leur champ de spécialisation, la théorie des ressources humaines se trouve confirmée et la théorie du tamisage, affaiblie.

Les résultats de la régression révèlent que le coefficient de la variable réflé-chissant l'utilisation des connaissances post-secondaires est significatif tant pour les données de groupes universitaires que pour celles du groupe des programmes de trois et quatre ans des collèges. Ceci démontre avec évidence que l'amélioration des ressources humaines est un facteur majeur du rôle de la formation supérieure.