Sheepskin effects and screening in Colombia

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Summary

This article uses the Hungerford and Solon Test [1987] for calculating the sheepskin effect of returns from education in the Colombian labour market in 2000. It was found that secondary school graduates enjoyed 13% returns whilst a university degree led to 17% returns. The Hungerford and Solon Test [1987], applied to a quantile regression, found returns ranging from 7% to 17% for secondary school graduates (across the entire income range) whilst a university degree produced returns between 17% and 27%.

Keywords: screening, sheepskin effect, quantile regressions. **JEL Classification:** C29, J20.

This article was made possible by the dedication and effort of our academic team –Natalia González, Juan Carlos Gómez, Jhon James Mora and Blanca Zuluaga– as well as the financing provided by ICESI University for a project titled "The Effect of Schooling on Income in the City of Cali". The author wishes to acknowledge the comments of Empar Pons Blasco of the University of Valencia, and the final referee for useful comments. Any remaining errors are the author's sole responsibility. The author is Professor, Department of Economics. ICESI University. E-mail: jjmora@icesi.edu.co. This article was received on September 15th 2002 and approved on April 4th 2003.

Introduction

Sánchez and Núñez [2002: 15] found that the average returns of education in Colombia underwent important fluctuations between 1976 and 1998. The returns decreased from 12% in 1976 to 9% in 1981, they then remained constant until 1992 and rebounded to 11% between 1992 and 1998. At the same time, average returns for all levels of education have steadily decreased for the generations born between 1910 and 1914. Historically these returns had an average value of 12%. For the generation born between 1970 and 1974, they have averaged only 8%. Such a decrease in returns could conceivably lead to a drop in investment in education.

Could there not be alternative reasons for acquiring an education in Colombia? An answer to this question might be found in the job advertisments published in newspapers. For example, one now needs a secondary school diploma in order to be hired as an office helper, messenger or watchman. In some companies, one needs a secondary school diploma to qualify as a salesperson in any field.

With a view to determining the importance of a university degree in the Colombian labour market, we will apply the test proposed by Hungerford and Solon [1987], also known as the "sheepskin effect". This test indicates that by September 2000 employers were discriminating between applicants on the basis of their secondary school or university degrees.

However, this article not only seeks to determine the effect of schooling on workers' incomes. It also "extends" Hungerford and Solon Tests [1987] to a quantile regression, with a view to identifying educational returns in the 20^{th}, 40^{th}, 60^{th} and 80^{th} percentiles of the salary scale. This procedure is intended to uncover any exogenous variables that might be at work, such as differences in education quality and different returns across the salary scale. Such factors should come to light during a more thorough screening of each type of degree.

With a view to determining whether returns vary across the salary scale, we applied the quantile regression developed by Koenker and Bassett [1978]. Koenker

and Bassett showed that regressions under Ordinary Least Squares (OLS) implicitly assume that possible differences in the impact of exogenous variables along the conditional distribution are unimportant. However, if exogenous variables influence the conditional distribution parameters of a dependent variable other than the mean, then any analysis that disregards this possibility will be severely weakened [Koenker and Bassett 1978, Buchinsky 1994]. Unlike OLS, quantile regression models allow for a full characterisation of the conditional distribution of the dependent variable.

The technique of quantile regressions was initially applied to labour markets by Buchinsky [1994], using Mincer's equation of labour incomes in the United States, while Hartog, Pereira and Vieira [1999] applied the technique to the European Union. Both applications found that the returns resulting from an additional year of education vary across the income scale. The reasons for this variation in Mincer's model are several. While Buchinsky [1994] cites the possibility of technological and institutional changes, together with the diminished power of labour unions, Hartog *et al.* [1999] attribute the effect to variations in the marginal return of schooling for each educational level (due to differences in abilities), as well as to variations in the marginal cost of investing in education (due to differences in educational preferences and credit availability).

The results obtained in this article indicate that returns across the income scale vary from 7% to 17%, in the case of a secondary school diploma, and from 17% to 27%, in the case of a university degree.

In keeping with this approach, the present article is divided into four sections. In the second section we discuss screening and its effects on the selection of candidates by their schooling and possession of a diploma. In the third section we present the results of our research and calculate the returns of each type of degree across the income scale. In part four we present our conclusions.

Screening and sheepskin effects

According to Riley [2001] and Rasmusen [1989], a screening game is one in which an uninformed player (the employer) makes the first move. In screening models, the applicant's level of education helps the employer gauge his intelligence, motivation and discipline, but without directly affecting his productivity. Thus, employers are willing to pay higher salaries to more highly educated employees, even though their education does not have a direct bearing on their productivity.

Spence [1973] and Arrow [1973] suggest that education is a type of credential that indicates a greater innate productivity. Berg [1970] and Dore [1976] indicate that a certain level of education is an entry requirement for many professions. Thus, companies offer higher salaries and more attractive jobs to applicants with a diploma. In other words, workers are not denied employment because of their inability to perform a given task, but simply because they lack the required degree. Might not the rush to acquire titles be due to the low esteem accorded to basic education, to the barriers to entry into the professions, or even to the snob appeal of having more highly educated employees?[1]

Psacharapoulos and Layard [1974] made empirical income comparisons between employees with degree and those without. They claimed that diplomas serve to explain much of what is observed in a world obsessed with screening[2]. Even though Psacharapoulos and Layard found no direct evidence of screening, Hungerford and Solon [1987] did find evidence of a sheepskin effect on salaries. That is to say, they found evidence of a correlation between returns and the year in which the diploma was obtained. Thus, it would seem that a diploma possesses a certain value apart from the number of years of education it represents. Similar results were found by Ziderman [1990], Corugedo *et al.* [1992], Card [1994], Jaeger and Page [1996], Belman and Heywood [1997], Park [1999], Arkes [1999] and Blanco and Pons [2000]. Following the work of Hungerford and Solon [1987], the sheepskin effect on salaries can be calculated in accordance with the following regression[3]:

$$LnWh_i = \alpha_0 + \alpha_1 s_i + \alpha_2 exp_i + \alpha_3 exp^2_i + \beta_0 s_i 11 + \beta_1 s_i 11(s-11) + \beta_2 s_i 16 + \beta_3 s_i 16(s-16) + \varepsilon_i \qquad [1]$$

In Regression [1][4] Wh_i, s_i and exp_i are hourly wages, education and potential experience (age - s - 6) respectively. The variable s_i11 is a dummy whose value is 1 if the individual has 11 or more years of education. The variable s_i16 is a dummy whose value is 1 if the individual has 16 or more years of education, and

[1] For an excellent summary see Pons [2001].

[2] Other screening tests were undertaken by Riley [1976, 1979] and Wolpin [1977].

[3] Unlike the original equation of Hungerford and Solon [1987], which assumes discontinuities in the salaries of individuals with 8, 12 and 16 years of education, this article assumes discontinuities only after 11 and 16 years of education, reflecting the required number of years of schooling for a secondary school and university diploma in Colombia.

[4] In Regression [1] there is no agreement as to how to account for spline (see Greene [1998: 336] for more details of the spline concept), Hungerford and Solon [1987] and SanMartin [2001] use both linear and cubic splines, Belman and Heywood [1991, 1997] and Jaeger and Page [1996] use linear splines, while Park [1999] uses a linear function for years of schooling.

ε_i is the random error. The return on the 11th year of education is then $\hat{\alpha}_1 + \hat{\beta}_0$ and the return on the 16th year is $\hat{\alpha}_1 + \hat{\beta}_1 + \hat{\beta}_2$. The sheepskin effect is accounted for by the parameters $\hat{\beta}_0$ and $\hat{\beta}_2$, which show how an individual's income is affected when he obtains a secondary school diploma, and when he obtains a professional or university degree. If the parameters and are positive, as well as significant, this indicates why highly educated individuals enjoy higher salaries simply because of their degrees, and independently of their total number of years in school.

Results

The data for calculating Regression [1] is taken from the September 2000 National Survey of Households in seven of Colombia's largest cities. A total of 36,982 observations were made, both among the employed and the population at large. Part-time workers, self-employed workers, unpaid family workers, employers and diverse others were then excluded[5], leaving a core of 11,686 traditional workers from which to draw information. A human capital regression, or Mincer equation of labour income, was then applied. The results indicated an average return of 13.5% for each additional year of schooling[6], and a return of 3.8% for each additional year of experience.

Table 1 also indicates that the average return from ten years of schooling is 7.2%. For 11 years of schooling it jumps to 20.75% and for 16 years it reaches 33.62%. The results also indicate that secondary school and university degrees are used by employers as a screening mechanism (and are thus statistically significant). More formal proof can be obtained by applying the Wald test on $\hat{\beta}_0$ and $\hat{\beta}$ [Gibson 2000], the only limitation being that they both be equal to zero. The results give us a value of 63.39 which, at $\chi^2_{95\%}(2) = 5.99$, enables us to reject the hypothesis that both variables are equal to zero. This in turn corroborates the hypothesis that a degree produces additional income gains for workers.

[5] Part-time workers were omitted so as to exclude temporary variations in the labour market; self-employed individuals were omitted because they do not require degrees in order to enter the labour market; employers were omitted because it is they who do the screening.

[6] Sánchez and Núñez [2002] found that in 1998 the average return on education was 14.5%.

Table 1
Human capital and sheepskin regression
LnWh dependent variable (t-values in parenthesis)

Variables	Human capital equation	Degree equations
Constant	5.67556	6.15960
	(241.913) *	(193.755) *
Education	0.13551	0.07232
	(86.854) *	(18.875) *
Exp	0.03841	0.03743
	(26.60) *	(25.579) *
Exp ^{2}	-0.00038	-0.00045
	(-12.321) *	(-14.149) *
S11		0.13518
		(6.432) *
S16		0.17895
		(5.062) *
S11(s-11)		0.08498
		(10.93) *
S16(s-16)		-0.01733
		(-1.060)
Wald Test on (**)		63.39
N	11,686	11,686
R^2 (adjusted)	0.459393	0.487933
F	3,310.86	1,591.61

Note: Standard errors were corrected through heteroscedasticity using White's robust standard error.
(*) Significant at the 5% level. (**) Wald test over S11 and S16.
Source: DANE, Household Survey. Author's Estimates.

Do diploma returns vary across income scale?

The results of Table 1 show a sheepskin effect on salaries. More specifically, they expose a sheepskin effect in the Colombian labour market, indicating that diplomas are indeed a means used by employers to gage the abilities of job applicants.

Nonetheless, proof of such an effect implicitly assumes that degree returns do not vary across the income scale. But what do unvarying degree returns across the income scale in turn imply? The implication is that for employers the number of years of schooling makes no difference. They are willing to pay identical salaries to applicants with identical secondary school or university diplomas, regardless of the number of years of schooling involved.

How might we explain variations in diploma returns across the salary scale? Perhaps differences in the quality of educational institutions granting identical diplomas lead to distinctions being made with regard to those diplomas, thus indicating the relative abilities of graduates from different institutions despite their having had the same number of years of schooling. This would lead to a certain heterogeneity among ostensibly similar diplomas[7]. The employer would then be compelled to screen candidates with similar diplomas in order to minimize his uncertainty regarding each applicant's abilities. This in turn would lead to variations in returns within each of the income scale percentiles.

This is of particular relevance in countries like Colombia, that have a high level of heterogeneity among degree-granting institutions, which in turn leads to heterogeneity among diplomas of a certain type[8]. Such heterogeneity makes it unlikely that their merit will be considered equal[9]. Nor is it likely that they ever be used homogeneously by employers to screen candidates. If an employer screens candidates possessing the same sort of diploma the heterogeneity of degree-granting institutions may be considered an exogenous variable affecting the conditional distribution of salaries, which in turn will affect the returns from each type of diploma. Such an exogenous variable would not imply a permanent, immutable situation, and would also depend on the educational policies pursued by each government with regard to the quality of degree-granting institutions.

We may therefore conclude that in the absence of exogenous variables that influence the conditional distribution of salaries and affect the returns of identical

[7] Even though two candidates may both have a secondary school degree, the heterogeneity of degree-granting institutions would lead employers to value the degree conferred by Institution A above the degree conferred by Institution B.

[8] Gaviria and Barrientos found that in 2000, among secondary school graduates "differences between educational institutions explain to a substantial degree differences in individual achievement" [Gaviria and Barrientos 2001: 4]. In fact, if state examinations reflect the relative quality of secondary schools, then the classification of schools according to the results obtained by their students in those examinations indicates that only 18% of such institutions ranked High or Very High in 2000. As regards higher education, recent measures by the Ministry of Education show that only 10.6% of institutions (30 of the 281) received accreditation in at least one of their undergraduate programmes in 2001. This is a strong signal that the quality of the higher education is far from homogeneous (See Vallejo Mejia [2001] for more complex considerations).

[9] A standard for diplomas would be possible only if there were homogeneity in the quality of the diplomas, and hence agreement as to the abilities that such diplomas reflect, both the principal's and the agent's [Mora 1998].

types of diplomas –be they secondary school or university degrees– due perhaps to heterogeneity among degree-granting institutions, a quantile regression of incomes should only show differences between the regression intercepts in each quantile. However, if exogenous factors do exist then one would expect variations in the coefficients associated with degree variables, indicating different returns for the same type of diploma[10].

With a view to analysing the sheepskin effect on a particular percentile of the salary scale, we performed the following regression[11]:

$$LnWh_i = X'_i\beta_\theta + \varepsilon_{\theta i};\ \hat{Q}_\theta\ (LnWh_i \mid X_i) = X'_i\beta_\theta + \varepsilon_i;\ P[\varepsilon_i > 0 \mid X_i] = P[\varepsilon_i < 0 \mid X_i] \qquad [2]$$

Where X_i is a vector of variables determining the sheepskin effect on the θ percentile (20^{th}, 40^{th}, 60^{th} and 80^{th}) of the salary scales. That is, X_i is composed of s, exp, exp^2 and the variables explaining the sheepskin effect[12]. The error is distributed with zero mean; it is independent of X and $E(X'_iX_i) < \infty$. The parameter vector β_θ can be consistently estimated by means of the Least Absolute Deviation regression (LAD):

$$\tilde{\theta}_{LAD} = \arg\min_\theta \sum_{i=1}^{N} \left| LnWh_i - X'_i \right|$$

[10] As Buchinsky [1995] states, if the distribution of the dependent variable (or of the error term) is the same throughout x, then the coefficient vectors in the various percentiles should differ only in the intercept, and the slope of the coefficients should be identical. Nonetheless, if the distribution of the error term depends on x, then the coefficients of the slope in the various percentiles will not be identical.

[11] The work of Buchinsky [1994], Martins and Pereira [2001, 2000], Hartog *et al.* [1999] on the Human Capital Model (Mincer's income equation) raise an interesting point: the income increment due to an additional year of schooling is not constant across the salary scale. This implies that the workforce cannot be adequately described by a constant educational return for all workers. The above studies, employing quantile regression models in order to estimate educational returns, found that the return of an additional year of schooling increases across the salary scale. That is, the return of an additional year of schooling varies from one percentile to the next in the salary scale. Martins and Pereira [2000] point to the example of Switzerland. Although in that country the average return of an additional year of schooling is 4%, the return within the first decile is not above 2%, while the return within the last decile reaches 6%. The authors provide several explanations. First, there is the overeducated population (given an equal level of education among workers, variations in educational returns from one percentile to the next could indicate an overly educated workforce). Then there are possible variations in abilities, as well as differences in the quality of education.

[12] In the quantile regression, the estimate is performed over the entire conditional distribution of y , given x. That is, the entire sample is taken into account. Thus, it is possible to analyse the sheepskin effect within each percentile of the salary scale.

and

$$\sqrt{\tilde{\theta}_{LAD} - \theta_0} \xrightarrow{d} N_k\left(0, \left(1/[2f(0)]^2 Q^{-1}\right)\right)$$

where f is the density of ε_j and $Q = \text{Plim}_{N\to\infty}(1/N)\sum_{i=1}^{N} X_i X_i'$ [Koenker and Basset 1978].

Variations in the sheepskin effect can then be compared by means of a Wald test on β_θ. Algorithms based on the LAD enabled us to estimate not only parameters but also variance and covariance. Nonetheless, if the error term happens to be correlated with one of the variables explaining the phenomenon, then the LAD will be skewed. Amemiya [1982] proposed an extension to the method of instrumental variables for estimating functions of conditioned quartiles in a system of simultaneous equations. Bierens and Guenther [2001] proposed a test for erroneous specifications in quantile regressions. The Bierens and Guenther test [2001], Bierens [2002], also known as ICM, examines the functional form of the regression model. More specifically, Bierens and Guenther [2001] propose the following:

- Choose $\hat{F} = \dfrac{N\hat{Q}(\hat{\theta})}{\left(\frac{1}{N}\right)\sum_{i=1}^{N}\int W_i(\xi))^2 d\mu(\xi)}$ as the statistical test or ICM,

  such that $\hat{\theta} = \arg\min_{\theta\in\Theta} \hat{Q}(\theta)$

- If $\hat{F} = F_N(\hat{\theta}) \le F_N(\theta_0)$ under Ho: $\limsup_{N\to\infty} P(\hat{F}>F) \le P(\bar{F}>F)\ \forall F>0$ not random.

- $P(\bar{F} > 3.23) = 0.10$, $P(\bar{F} > 4.26) = 0.05$ according to Bierens and Ploberger [1997].

- Rejects Ho at 10% if $F > 3.23$ and at 5% if $F > 4.26$.

In Table 2, we can observe the way in which returns from the first ten years of schooling vary between 5.5% and 7.8%, while the return of an additional year of experience is about 3%. The results also show that the sheepskin effect is statistically significant in all estimates: $\chi^2_{95\%}(2)$ is 5.99 and the value obtained in the 20th, 40th, 60th and 80th percentiles of the salary scale is higher than this value, hence negating the hypothesis that all titles are equivalent to zero. The results of the ICM test indicate that the functional form of the model is the correct one.

At the 5% level the functional form is not rejected in the percentiles that were examined.

Table 2
Quantile regression on the sheepskin model
LnWh Dependent Variable[13] (t-values in parenthesis)

Variable	$Q_{20\%}$	$Q_{40\%}$	$Q_{60\%}$	$Q_{80\%}$
Constant	5.972398	6.310335	6.416574	6.402252
	(167.885) *	(222.832) *	(217.060) *	(161.177) *
Education	0.065869	0.055293	0.058196	0.078248
	(14.896) *	(15.709) *	(15.838) *	(15.848) *
Exp	0.034491	0.030240	0.032636	0.038625
	(22.341) *	(24.606) *	(25.439) *	(22.407) *
Exp^2	-0.000486	-0.000364	-0.000387	-0.000405
	(-15.349) *	(-14.442) *	(-14.701) *	(-11.457) *
S11	0.076393	0.109344	0.144431	0.171807
	(3.067) *	(5.515) *	(6.978) *	(6.177) *
S16	0.230243	0.278264	0.183719	0.172327
	(6.152) *	(9.340) *	(5.907) *	(4.124) *
S11(s-11)	0.058006	0.084706	0.118083	0.102499
	(6.759) *	(12.399) *	(16.558) *	(10.696) *
S16(s-16)	0.038026	0.012279	-0.028147	-0.033515
	(2.493) *	(1.011)	(-2.220) *	(-1.968) *
Wald (**)	44.82	110.95	78.18	51.84
ICM or	1.112938523	.4769264161	1.8933281898	2.6633451
	N.R.	N.R.	N.R.	N.R.
N	11,686	11,686	11,686	11,686

Note: (*) Significant at the 5% level, (**) Wald test over S11 and S16 ; N.R.: No rejection of ICM at 5%

Source: DANE, Household Survey. Author's estimates.

The results of the September 2000 ENH survey lend credence due to the way of determining workers income.

In Table 3, the average returns from ten years of education do not vary significantly whether the estimate is made by means of Ordinary Least Squares or by means of quantile regressions. Both cases yield results between 5% and 7%. Similarly, one may observe that the average return of an additional year of experience hovers around 3%.

[13] Since there could be heteroscedasticity in the residues [Koenker and Basset 1982], which would overestimate the real standard errors and hence the t-values, we use bootstrapping to calculate standard errors.

Table 3
Sheepskin effects and Screening

Return ¢B Type of estimate	OLS	$Q_{20\%}$	$Q_{40\%}$	$Q_{60\%}$	$Q_{80\%}$
Average: 10 years of education	7.2%	6.5%	5.5%	5.8%	7.8%
One additional year of experience	3.7%	3.4%	3.0%	3.2%	3.8%
11th year of education	20.7%	14.2%	16.4%	20.2%	25.0%
16th year of education	33.6%	18.0%	17.6%	17.4%	21.6%
Secondary school diploma	13.5%	7.6%	10.9%	14.4%	17.1%
University diploma	17.8%	23.0%	27.8%	18.3%	17.2%

As for a secondary school diploma, the results indicate that returns across the income scale vary substantially; from 7.6% to 17.1%. As for the returns of a university degree, one observes that in the lower levels of the income scale, in the 20th to 40th percentiles, the sheepskin effect is much stronger than in the higher levels (the 60th to 80th percentiles). This means that the sheepskin effect diminishes as one climbs the salary scale, which in turn implies that some sort of correction is being performed by the employer. This correction may well be attributed to the screening process which employers perform when it comes to choosing candidates whose degrees are apparently identical.

Conclusions

The results obtained here corroborate the observation that the Colombian labour market awards the worker not only for his schooling, but also for his possession of a secondary school or university diploma. Thus, the possession of a diploma is used by employers to gage the intelligence, motivation or discipline of workers, even though productivity remains unaffected.

Upon applying a quantile regression, the results also show the effects of screening with regard to each type of degree. We observe that a secondary school diploma has a return of 14.2% in the 20th percentile of the salary scale, but that it jumps to 25% in the 80th percentile. With regard to university degrees, one observes that at higher income levels the sheepskin effect is reduced. Thus, the higher one's income the lower the contribution of one's university degree.

Finally, future investigations should analyse if the screening effect is different between professions and/or sectors, with the purpose of better understanding the evolution of the labour market.

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