Sheepskin Effects in the Returns to Education

Thomas Hungerford, Gary Solon

The Review of Economics and Statistics, Volume 69, Issue 1 (Feb., 1987), 175-177.

Meltzer, Alfred, Kathryn Langwell, Michael Keane, and Shelly Nelson, *Report on the Geographic Distribution of Vision Care Providers* (Silver Spring, Maryland: Applied Management Sciences, Inc., 1983).
Nelson, Phillip, "Advertising as Information," *Journal of Political Economy* 81 (July/Aug. 1974), 729–754.
Newhouse, Joseph, Albert Williams, William Schwartz, and Bruce Bennett, "The Geographic Distribution of Physicians: Is the Conventional Wisdom Correct?" Rand (Oct. 1982).
Office of Technology Assessment, *The Contact Lens Industry: Structure, Competition, and Public Policy*, Health Technology Case Study 31, Dec. 1984.
Pauly, Mark, and Mark Satterthwaite, "The Pricing of Primary Care Physicians' Services: A Test of the Role of Consumer Information," *Bell Journal of Economics* 12 (Autumn 1981), 488–506.
Posner, Richard, *Antitrust Law–An Economic Perspective* (Chicago: University of Chicago Press, 1976).
Schmalensee, Richard, "Commodity Bundling by Single-Product Monopolies," *Journal of Law and Economics* 25 (Apr. 1982), 67–71.
Stigler, George, "A Note on Block Booking," in *The Organization of Industry* (Homewood: R. D. Irwin, 1968).
Waterson, Michael, *Economic Theory of the Industry* (Cambridge: Cambridge University Press, 1984).

SHEEPSKIN EFFECTS IN THE RETURNS TO EDUCATION

Thomas Hungerford and Gary Solon*

Abstract—Some previous discussions have dismissed screening theories of education partly on the ground that diploma years of education do not confer especially large earnings gains. Similarly, most empirical research on earnings functions has assumed an absence of "sheepskin" effects. We report evidence, however, of substantial and statistically significant sheepskin effects. Although this suggests that the previous dismissals of the screening hypothesis were premature, our evidence of sheepskin effects is amenable to nonscreening interpretations also.

According to screening theories of education, individuals with more schooling tend to earn more not because (or, at least, not solely because) schooling *makes* them more productive, but rather because it *credentiates* them as more productive. A frequently cited article by Layard and Psacharopoulos (1974), however, dismissed the importance of the screening hypothesis on the grounds that several of its refutable predictions were not supported by available evidence. One of these was the "sheepskin" prediction that "wages will rise faster with extra years of education when the extra year also conveys a certificate." After surveying a number of studies, Layard and Psacharopoulous (henceforth LP) concluded that "rates of return to dropouts are as high as to those who complete a course, which refutes the sheepskin version of the screening hypothesis."

Since publication of the LP paper, an undergraduate labor economics textbook[1] has cited LP's analysis of sheepskin effects as "telling criticism" of the screening hypothesis. A prominent proponent of the screening hypothesis, Riley (1979), has accepted LP's summary of the empirical evidence, but responded that some versions of the screening hypothesis do not imply sheepskin effects. In the meantime, the ongoing flood of empirical research on earnings functions typically has continued to treat the natural logarithm of the wage rate as a linear (or occasionally quadratic) function of years of education, with no allowance for discontinuities in diploma years.[2]

The estimated rates of return used by LP were based on data that did not disaggregate dropouts' earnings by how many years of school they had completed. LP acknowledged, "We would have preferred to show the earnings gain associated with each year of the course, including the year when it was successfully completed." This note presents a reanalysis of sheepskin effects based on the type of data LP wished they had. The results contain very strong evidence of sheepskin effects after all. The next section describes our analysis, and the following section summarizes and discusses our results.

Empirical Analysis

Our analysis is based on May 1978 Current Population Survey data on white male nonagricultural wage and salary workers between the ages of 25 and 64. The uncommonly large sample size in this data set (16,498 observations) enables relatively precise estimation of nonlinear returns to education.

Received for publication March 6, 1986. Revision accepted for publication July 8, 1986.
* The University of Michigan.
The authors thank Charles Brown and the referees for their comments.
[1] Addison and Siebert (1979, p. 139).

[2] There have been occasional exceptions, however, such as Goodman (1979), Mohan (1981), Olneck (1979), and Weiss (1984).

The dependent variable in all our specifications is the natural logarithm of the ratio of usual weekly earnings to usual weekly hours.[3] First, for comparison purposes, we report least-squares estimates of the prototypical earnings function popularized by Mincer (1974). This specification treats the log wage as a linear function of education, work experience, and work experience squared. Our education variable (S) is the highest grade completed by the worker (except that, because of the design of the survey instrument, 18 denotes 18 *or more* years of school), and experience is measured as age $- S - 6$. The results, reported in the first column of table 1, are similar to those in previous studies.

The question we wish to address is whether, contrary to the prototypical specification, the returns to education increase discontinuously in diploma years. To allow for such a pattern, we generalize the specification by treating the relationship between the log wage and S as a discontinuous spline function with discontinuities at $S = 8$, 12, and 16. Operationally, this involves regressing the log wage on S, a dummy variable equal to 1 if $S \geq 8$, an interaction of this dummy with $S - 8$, another dummy equal to 1 if $S \geq 12$, an interaction of this dummy with $S - 12$, a dummy equal to 1 if $S \geq 16$, and two more dummies for $S = 17$ and $S = 18$. These last dummies and the interaction terms allow for slope changes in the returns to education. The dummies for $S \geq 8$, $S \geq 12$, and $S \geq 16$ allow for sheepskin effects, which would be indicated by positive coefficients for these variables.

The results for this specification are reported in column 2 of table 1. An F-test of the prototypical specification relative to this alternative rejects the prototypical specification at the 0.01 level. Most interestingly for present purposes, the estimated coefficients of the dummy variables for $S \geq 8$, $S \geq 12$, and $S \geq 16$ suggest positive sheepskin effects. For example, the estimated effect on the log wage of an additional year of school is 0.058 for the 7th year, jumps to 0.082 (the sum of 0.058 and 0.024) for the 8th year, and recedes to 0.042 (0.058 minus 0.016) for the 9th year. Similarly, the estimated return is 0.042 for the 11th year, 0.077 for the 12th, and 0.045 for the 13th. Finally, the estimated return is 0.045 for the 15th year, 0.134 for the 16th, and 0.007 for the 17th. Substantial estimated diploma effects thus appear at every level. The F-statistic for testing the null hypothesis of no sheepskin effects (i.e., the hypothesis that the dummy variables for $S \geq 8$, $S \geq 12$, and $S \geq 16$ all have zero coefficients) easily rejects the null hypothesis at the 0.01 level. This is primarily due to the highly significant estimated coefficient of the dummy variable for $S \geq 16$. By a one-sided test, the estimated coefficient for $S \geq 12$ is significantly different from zero at the 0.10 level, but not quite at the 0.05 level. The estimated coefficient for $S \geq 8$ is not significantly different from zero at any conventional level.

[3] Note that measurement error in *either* component of the ratio contributes to measurement error in our dependent variable. This cumulation of measurement error is probably an important factor behind the low R^2's reported in tables 1 and 2.

TABLE 1.—ESTIMATED COEFFICIENTS (AND STANDARD ERRORS) IN LOG WAGE REGRESSIONS

	1	2	3
Constant	.7499	.7654	.7031
	(.0234)	(.0497)	(.0578)
Experience	.0356	.0361	.0359
	(.0012)	(.0013)	(.0013)
Experience^2	−.00060	−.00061	−.00061
	(.00003)	(.00003)	(.00003)
S	.0590	.0576	.0906
	(.0013)	(.0086)	(.0184)
Dummy for $S \geq 8$		.0242	.0324
($D8$)		(.0318)	(.0286)
$D8 \times (S - 8)$		−.0159	
		(.0114)	
Dummy for $S \geq 12$		.0350	.0375
($D12$)		(.0224)	(.0180)
$D12 \times (S - 12)$		.0032	
		(.0092)	
Dummy for $S \geq 16$		.0895	.0899
		(.0204)	(.0197)
Dummy for $S = 17$		−.0383	
		(.0227)	
Dummy for $S = 18$		.0090	
		(.0188)	
S^2			−.0042
			(.0019)
S^3			.00012
			(.00006)
R^2	.1404	.1420	.1420

The results from a different specification are shown in the third column of table 1. This specification allows for slope changes in the returns to education by including a cubic in S rather than a spline function. Discontinuities in diploma years are still allowed for by including the dummies for $S \geq 8$, $S \geq 12$, and $S \geq 16$. The estimated coefficients of these variables become slightly larger in this specification. The estimated coefficient of the dummy $S \geq 16$ remains highly significant, and the one for $S \geq 12$ becomes significant at the 0.05 level. Again, the null hypothesis of no sheepskin effects is easily rejected at the 0.01 level.

Finally, table 2 provides a more direct look at the data by reporting the results of a regression of the log wage on experience, experience squared, and a set of dummy variables for $S = 1, 2, \ldots, 18$. This specification imposes no restrictions on the shape of the wage/schooling profile. It treats the log wage as a step function of years of education with a separate step for each year. Even given the large overall sample size, the precision of estimation here is limited by the fact that most of the S categories contain very small fractions of the sample. It is quite noticeable, though, that particu-

TABLE 2.—ESTIMATED COEFFICIENTS (AND STANDARD ERRORS) IN REGRESSION OF LOG WAGE AS STEP FUNCTION OF S

	Estimated Coefficients	Implied Step Sizes
Constant	.5645	
	(.0738)	
Experience	.0362	
	(.0013)	
Experience^2	−.00061	
	(.00003)	
$S = 1$	.3022	.3022
	(.1672)	(.1672)
2	.4351	.1329
	(.1109)	(.1726)
3	.4498	.0146
	(.0940)	(.1032)
4	.3833	−.0665
	(.0893)	(.0795)
5	.5903	.2070
	(.0839)	(.0672)
6	.5618	−.0285
	(.0796)	(.0536)
7	.5518	−.0100
	(.0781)	(.0437)
8	.6830	.1311
	(.0741)	(.0328)
9	.7150	.0320
	(.0750)	(.0242)
10	.7880	.0730
	(.0745)	(.0248)
11	.7953	.0073
	(.0751)	(.0249)
12	.8810	.0858
	(.0731)	(.0197)
13	.9713	.0902
	(.0743)	(.0153)
14	.9852	.0139
	(.0740)	(.0187)
15	.9803	−.0049
	(.0756)	(.0233)
16	1.1561	.1758
	(.0736)	(.0220)
17	1.1628	.0067
	(.0757)	(.0221)
18	1.2550	.0922
	(.0740)	(.0234)
R^2	.1440	

larly large upward steps in the predicted log wage appear for diploma years. It is also interesting that a large step appears for the *first* year of college. This accords with Arrow's (1973) suggestion that *admission* to college may serve a screening function.

Summary

All of our results point to the existence of sheepskin effects in the returns to education. This finding suggests, first, that treating the log wage as a smooth function of years of education, as is conventionally done in the earnings function literature, gives an inferior fit to the data. It implies, second, that previous authors' dismissal of the screening hypothesis on the ground that sheepskin effects do not exist was premature.

On the other hand, it should be noted that evidence of sheepskin effects need not be interpreted as corroboration of the screening hypothesis. For example, an alternative interpretation due to Chiswick (1973) is that dropouts are disproportionately comprised of inefficient learners who leave school when they realize how little their productivity is augmented by education. Graduates are disproportionately comprised of efficient learners who complete their diploma programs because their productivity is much enhanced by education. Statistical comparions of wages of graduates and dropouts then appear to show large diploma effects because the graduates are much more productive. Under this interpretation, education's effect on wages arises solely from its effect on productivity and not from any screening function.

A related point is that our regression analyses may be biased by omission of ability variables or other factors correlated with degree completion. Indeed, some of the studies highlighted by Layard and Psacharopoulos controlled for IQ or other ability measures, which are not available in our data set. We doubt, however, that this accounts for the discrepancy in results on sheepskin effects. Analyses of other data sets reported in table 6.3 of Olneck (1979) estimated positive sheepskin effects from college graduation and found that these estimated effects were not generally reduced by controlling for such ability measures or for family background variables.

REFERENCES

Addison, John T., and W. Stanley Siebert, *The Market for Labor: An Analytical Treatment* (Santa Monica, Calif.: Goodyear Publishing Company, 1979).

Arrow, Kenneth J., "Higher Education as a Filter," *Journal of Public Economics* 2 (July 1973), 193–216.

Chiswick, Barry R., "Schooling, Screening, and Income," in Lewis C. Solmon and Paul J. Taubman (eds.), *Does College Matter?* (New York: Academic Press, 1973).

Goodman, Jerry D., "The Economic Returns of Education: An Assessment of Alternative Models," *Social Science Quarterly* 60 (Sept. 1979), 269–283.

Layard, Richard, and George Psacharopoulos, "The Screening Hypothesis and the Returns to Education," *Journal of Political Economy* 82 (Sept./Oct. 1974), 985–998.

Mincer, Jacob, *Schooling, Experience, and Earnings* (New York: National Bureau of Economic Research, 1974).

Mohan, Rakesh, "The Determinants of Labor Earnings in Developing Metropoli: Estimates from Bogota and Cali, Colombia," Staff Working Paper No. 498 (Washington, D.C.: World Bank, Oct. 1981).

Olneck, Michael, "The Effects of Education," in Christopher Jencks et al. (ed.), *Who Gets Ahead?* (New York: Basic Books, 1979).

Riley, John G., "Testing the Educational Screening Hypothesis," *Journal of Political Economy* 87 (Oct. 1979), S227–S252.

Weiss, Andrew, "Testing the Sorting Model of Education," Working Paper No. 1420 (Cambridge, Mass.: National Bureau of Economic Research, Aug. 1984).