What is it About Schooling that the Labor Market Rewards? The Components of the Return to Schooling

Cyril D. Pasche

University of Geneva, Switzerland

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Research Question

- What is it about schooling that the labor market rewards?
  - Is it intelligence?
  - Is it personality and behavior?

- Question matters both economically and politically:
  - Private and public education expenses are 7% U.S. GDP.
  - Wages are 75% of U.S. domestic income.
  - Education is a vector of economic growth.
  - Defines what schools should teach.
  - Determines the form of schooling quality tests.

Literature and Definitions

- "Some schools like those for barbers, specialize in [the production] of one skill, while others, like universities, offer a large and diverse set" Becker (J. Polit. Economy 1962).

- "It [schooling] is productive for the individual but, it does not increase his real marginal product at all" Spence (Quart. J. Econ. 1971).

- The question of knowing on what type of skills are acquired or signaled in schooling is left unanswered.

Literature and Definitions (2)

- Little research focussed on this research question.
- Bowles et al. (J. Econ. Lit. 2001) survey 25 American studies and find 18% of the return to schooling is affected by the influence of a cognitive measure. This leaves up to 82% of the return to be noncognitive or cognitive skill mis-measurement...
    - "The most obvious problem – that the cognitive score might be measured with considerably more error than the schooling variable and hence α [the noncognitive component of the return to schooling] is upwards biased- almost certainly not the case" Bowles et al. (2001).
    - "... these studies provide strong support for the Affective model [noncognitive skill hypothesis], and indicate that cognitive development is not the central means by which education enhances worker success" Gintis (Amer. Econ. Rev. 1971).

- The Scholastic Assessment Test, the American College Test and the Graduate Record Examination are used for virtually every college and graduate school admission.

- Seven out of eight Ivy League schools require cognitive tests in their admission process.

- 85% of the research in J. Lab. Econ., J. Human Res., Lab. Econ. and Econ. Educ. Rev. focusses on cognitive skills. 15% on noncognitive skills.

Theoretical Model

- Bowles et al. (2001) determine schooling's components using the omitted variable bias:

$$w = \alpha_0 + \alpha_1 S + \alpha_2 X + \varepsilon$$
$$w = \beta_0 + \beta_1 S + \beta_2 TC + \beta_3 X + \varepsilon$$

- The "noncognitive" and cognitive components are as follows:

$$\tau = \frac{\beta_1}{\alpha_1} \text{ and } \upsilon = 1 - \tau$$

Theoretical Model (2)

- If schooling influences wages solely by increasing ones cognitive skills, τ would be zero. In this case the years of schooling coefficient, β_1, drops to zero when one controls for cognitive skills, because the effect of schooling is entirely captured by the cognitive skill variable (*i.e.* schooling noncognitive skills are not rewarded).

- Conversely, if the effect of schooling on cognitive skills explains none of schooling's contribution to wages τ is equal to one, because the inclusion of the cognitive skill measure does not affect the return to schooling (*i.e.* $\alpha_1 = \beta_1$).

Theoretical Model (3)

- "Across almost all the specifications considered, we found that mother's accumulated ability, as measured by the AFQT, and home inputs (contemporaneous and lagged) are substantive determinants of children's test scores in math and reading" Todd and Wolpin (J. Human Cap. 2007).

- "The picture that emerges suggests a powerful role for environment in shaping individual IQ" Dickens and Flynn (Psychol. Rev. 2001).

Theoretical Model (4)

- The return to skills may differ depending on their origin:

$$w = \gamma_0 + \gamma_1 S + \gamma_2 SC + \gamma_3 NSC + \gamma_4 X + \varepsilon$$

- Cognitive ability observed by the researcher is only partially related to schooling:

$$TC = SC + NSC$$

- The return to total cognitive skills is the weighted return to schooling and non-schooling cognitive skills:

$$\beta_2 = \gamma_2 \frac{SC}{TC} + \gamma_3 \frac{NSC}{TC}$$

Omitted Variable Bias

$$
\begin{aligned}
E\left[\alpha_1 | \Omega\right] &= \beta_1 + \beta_2 \frac{\text{Cov}(S, TC)}{\text{Var}(S)} + \beta_2 \frac{\text{Cov}(S, X)}{\text{Var}(S)} \\
&= \beta_1 + \beta_2 \left(\frac{\text{Cov}(S, SC)}{\text{Var}(S)} + \frac{\text{Cov}(S, NSC)}{\text{Var}(S)} \right) + \phi \\
&= \beta_1 + \beta_2 \left[\xi + \mu \right] + \phi
\end{aligned}
$$

$$
\begin{aligned}
E\left[\alpha_1 | \Omega\right] &= \gamma_1 + \gamma_2 \frac{\text{Cov}(S, SC)}{\text{Var}(S)} + \gamma_3 \frac{\text{Cov}(S, NSC)}{\text{Var}(S)} + \gamma_4 \frac{\text{Cov}(S, X)}{\text{Var}(S)} \\
&= \gamma_1 + \gamma_2 \xi + \gamma_3 \mu + \psi
\end{aligned}
$$

Omitted Variable Bias (2)

- Using the previous equations:

$$
\begin{aligned}
E\left[\alpha_1 | \Omega\right] &= \beta_1 + \beta_2 \left[\xi + \mu\right] + \phi = \gamma_1 + \gamma_2 \xi + \gamma_3 \mu + \psi \\
&\Rightarrow \beta_1 + \beta_2 \xi = \gamma_1 + \gamma_2 \xi \\
&\Rightarrow \beta_1 - \gamma_1 = \xi \frac{NSC}{TC} \left(\gamma_2 - \gamma_3\right)
\end{aligned}
$$

- Bowles et al. (2001) measure is accurate in only three cases:
  - Schooling yields no cognitive skills whatsoever.
  - Cognitive skills are exclusively related to schools and people have no non-schooling cognitive skills.
 - Employers have perfect and immediate information of employees' skills.

Differences in the returns to cognitive skills and schooling

Situation	Return to cog.			SC	NSC
A	$\gamma_2 > 0$ and $\gamma_3 = 0$	$\gamma_2 = \beta_2$	$\gamma_1 = \beta_1$	>0	$=0$
B	$\gamma_2 > \gamma_3 \geqslant 0$	$\gamma_2 > \beta_2$	$\gamma_1 < \beta_1$	>0	>0
C	$\gamma_2 = \gamma_3$	$\gamma_2 = \beta_2$	$\gamma_1 = \beta_1$	>0	>0
D	$\gamma_3 > \gamma_2 \geqslant 0$	$\gamma_2 < \beta_2$	$\gamma_1 > \beta_1$	>0	>0
E	$\gamma_3 > 0$ and $\gamma_2 = 0$	$\gamma_2 < \beta_2$	$\gamma_1 = \beta_1$	$=0$	>0

- Because employers learn (Farber and Gibbons, Quart. J. Econ. 1996, Altonji and Pierret, Quart. J. Econ. 2001, and Lange, J. Lab. Econ. 2007) and non-schooling cognitive skills exist (Dickens and Flynn 2001, and Todd and Wolpin 2007) situation B is likely to prevail.
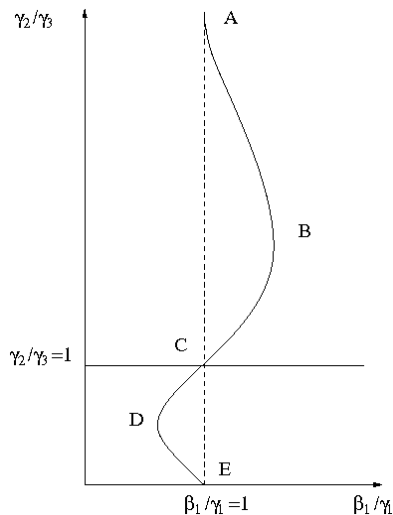
Returns to Skills and Mismeaurements in Schooling's Components

Data

- Adult Literacy and Lifeskill Survey (ALL) 2003.
- Cross-section survey conducted in Bermudas, Canada, Italy, Norway, Switzerland and the United States.
- Swiss sample of 1'146 males and 984 females.
- Cognitive proficiency measured in prose, document reading, numeracy and problem solving.

- Self reported years of schooling and schooling degree.
- Mincerian years of labor market experience.
- Cognitive ability is average of prose, document reading and numeracy score.
- Controls include place of birth, location of residence, parent's place of birth, parents' education and ability at age 15.
- Findings are robust to collar color, activity and industry controls.

Empirical Application

- The total cognitive skill measure is to be separated into a schooling and a non-schooling measure (Farber and Gibbons 1996, and Ishikawa and Ryan, Econ. Educ. Rev. 2002):

$$
\begin{aligned}
TC &= \theta_0 + \theta_1 ST + \nu \\
SC &= E(TC|ST) \\
NSC &= TC - E(TC|ST) = \nu
\end{aligned}
$$

Empirical Application (2)

Total cognitive skills, OLS regression

	Male	Female
General culture school[+]	30.99	15.63
	(10.52)	(6.01)
Basic vocational training[+]	22.41	21.98
	(4.94)	(3.82)
High school[+]	40.40	36.04
	(7.29)	(5.22)
Teaching program[+]	47.85	44.60
	(8.26)	(5.16)
Advanced vocational training[+]	45.60	40.18
	(5.11)	(4.61)
Applied science school[+]	56.24	33.17
	(6.13)	(8.17)
Bachelor[+]	51.69	36.58
	(7.70)	(7.43)
Master[+]	57.61	52.97
	(5.38)	(4.35)
Ph.D.[+]	65.12	55.12
	(5.78)	(7.90)
Other[+]	19.16	36.21
	(12.11)	(9.32)
Constant	253.73	252.47
	(4.68)	(3.52)
Adjusted R^2	0.2078	0.1817

Base category is junior high school.
Robust standard errors in parentheses. [+]dummy variables.
Number of observations is 1'146 males and 984 females.

Log annual earnings, OLS regressions, male

Model:	I	II	III	IV
Years of schooling	0.077	0.067	0.039	0.038
	(0.01)	(0.01)	(0.01)	(0.01)
$TC^{\#}$		0.105		
		(0.01)		
$SC^{\#}$			0.174	0.181
			(0.03)	(0.02)
$NSC^{\#}$				0.063
				(0.01)
Experience/10	0.677	0.671	0.607	0.614
	(0.06)	(0.06)	(0.06)	(0.06)
$(\text{Experience}/10)^2$	-0.106	-0.102	-0.095	-0.093
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	9.303	9.483	9.942	9.960
	(0.13)	(0.13)	(0.14)	(0.14)
Adjusted R^2	0.3836	0.4075	0.4223	0.4327

Robust standard errors in parentheses. $^{\#}$ standardized variables. Additional
control dummy variables are place of birth, location of residence, father born in
Switzerland, mother born in Switzerland, father university degree and mother
university degree. TC=Total cog. skills, SC=Schooling cog. skills and
NSC=Non-schooling cog. skills. Sample size is 1'146.

Components of the return to schooling, male

Components	τ	υ	$\tau^{'}$	$\upsilon^{'}$
	87.0%	13.0%	50.9%	49.1%

τ and υ are the noncognitive and cognitive components
of the return to schooling. τ=II/I, $\upsilon = 1 - \tau$, $\tau^{'}$=III/I
and $\upsilon^{'} = 1 - \tau^{'}$.

- Considerable change in the components of the return to schooling.
- Cognitive component increases from 13% to 49% when using a measure of schooling cognitive skills.

Log annual earnings, OLS regressions, female

	I	II	III	IV
Years of schooling	0.071	0.064	0.031	0.030
	(0.01)	(0.01)	(0.01)	(0.01)
TC#		0.074		
		(0.02)		
SC#			0.177	0.184
			(0.02)	(0.02)
NSC#				0.044
				(0.02)
Experience/10	0.473	0.475	0.420	0.424
	(0.07)	(0.06)	(0.06)	(0.06)
$(\text{Experience}/10)^2$	-0.078	-0.075	-0.070	-0.066
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	9.429	9.535	10.083	10.109
	(0.12)	(0.12)	(0.12)	(0.12)
Adjusted R^2	0.2517	0.2652	0.3017	0.3063

Robust standard errors in parentheses. # standardized variables. Additional control dummy variables are place of birth, location of residence, father born in Switzerland, mother born in Switzerland, father university degree and mother university degree. TC=Total cog. skills, SC=Schooling cog. skills and NSC=Non-schooling cog. skills. Sample size is 984.

Empirical Application (6)

Components of the return to schooling, female

Components	τ	υ	$\tau^{'}$	$\upsilon^{'}$
	90.1%	9.9%	43.7%	56.3%

τ and υ are the noncognitive and cognitive components
of the return to schooling. τ=II/I, $\upsilon = 1 - \tau$, $\tau^{'}$=III/I
and $\upsilon^{'} = 1 - \tau^{'}$.

- Results for women are similar to those found for men

Conclusions

- The cognitive component of the return to schooling has been previously underestimated because of asymmetric information.
- Results suggest half the return to schooling is made of cognitive skills. The other half may be unaccounted cognitive skills or noncognitive skills.
- Measuring schooling quality with cognitive tests is appropriate, yet partial.
- Cognitive skills issued from a schooling environment are more likely to be rewarded than non-schooling cognitive skills.