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Do modern forms of human capital matter in primitive economies? Comparative evidence from Bolivia

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Abstract

We examine the correlation between modern human capital and income among adult men in four foraging-horticultural societies of Bolivia. Despite their remote location, we find results similar to those found in developed nations. We find that: (a) education correlates with 4.5% higher overall income and with 5.9% higher wages and math skills correlates with 13.5% higher cash income, and (b) the positive correlation between education or math skills and income is higher among households closer to market towns. The high returns to modern human capital even in highly autarkic economies might explain why people in those societies reduce investments in the accumulation of traditional folk knowledge.

JEL Classification: J150; J24; J610; R23; F22

Keywords: Economic development; Economic impact; Human capital; Rate of return

1. Introduction

Although we know much about the benefits of modern human capital in developed and most developing economies (Foster & Rosenzweig, 1996; Angrist & Lavy, 1997; Chiswick, Patrinos, & Hurst, 2000), we know little about their effects in simple, highly autarkic, rural economies of hunters, gatherers, and horticulturalists. Economists rarely study such primitive economies, and cultural anthropologists rarely provide empirical estimates of how modern forms of human capital affect the income, consumption, or wages of foragers and horticulturalists. This reflects the difficulty of measuring the outcomes and of doing formal surveys with such populations. As a result, we do not know whether findings from developed and formal economies about the benefits of modern human capital also hold up in these unique settings. We find that the relation does hold, that those with schooling and basic arithmetic skills earn more. Here, we contribute to the empirical study of how different forms of modern human capital correlate with cash income, wages, and farm production in four societies of foragers-horticulturalists in the Bolivian lowlands.

The information and approach we use is novel in three ways. First, we measure school attainment and skills associated with schooling, such as literacy, arithmetic skills, and Spanish-speaking proficiency. We measure

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skills because failure to control for skills when estimating returns to schooling can bias the estimate of schooling (Rivera-Batiz, 1990, 1996; Charette & Meng, 1994; Chiswick & Miller, 1992, 1999; Dustmann, 1994; Chiswick, 1991; Dustmann & van Soest, 2000; Dustmann & Fabbri, 2000; Angrist & Lavy, 1997; Chiswick & Repetto, 2000). Researchers who use public-use data sets to estimate the effect of schooling or language proficiency on economic outcomes generally cannot control for skills because most such data sets generally include only questions on formal schooling and on speaking proficiency in the dominant language or in the mother tongue of the immigrant (Chiswick & Miller, 1988; Lecker, 1997; Shapiro & Stelcner, 1997; McManus, 1985, 1998; Heum Park, 1999; Bloom & Grenier, 1996; Kossoudji, 1988). Second, we use observed rather than self-assessed measures of skills.[1] Since random errors from misclassification produce an attenuation bias, we believe this to be an important improvement. Last, we did the research among four ethnic groups to observe whether the findings hold across different cultures, albeit in similar economic settings.

2. The survey

During 1997–1998, two graduate students in anthropology carried out ethnographic fieldwork and a household survey among four ethnic groups of for agers-horticulturalists in the Bolivian lowlands: Tsimane', Yuracarè, and Mojeño of the river Sécure (department of Beni) and Chiquitano (department of Santa Cruz) (Huanca, 1999; MacDaniel, 2000). During June–July 1997, we tested the survey among the Tsimane' near the town of San Borja (population ~16,000) (department of Beni). Researchers carried out the survey at the end of fieldwork (in 1998) among 886 household heads evenly split between female and male heads, in 443 households of 42 villages. We surveyed between 2.79% and 11.80% of the households in each ethnic group, or 3.54% of all households in the total population of the four groups (Godoy & Contreras, 2001; Godoy, Wilkie, & Kirby, 2001). Only people from one village refused to take part in the survey.[2]

For each ethnic group we chose about 10 villages close and far from market towns, and villages between the extremes. Within a village, we surveyed as many households as we could. In the regressions discussed later, we include village-to-town distance as a control. We applied the survey to the female and to the male household head, but limit the analysis to men since women rarely enter the market for wage labor.

Anecdotal evidence supports the intuition that skills in writing and in arithmetic (aside from education) could affect economic outcomes. Villagers view literate people with esteem because those who can read and write can decode official documents and the records kept by employers. They can also write messages for fellow villagers who cannot write. The ability to do simple arithmetic also confers advantages, not only when people go to market towns, but also when traders come to villages to barter, buy, and sell. The ability to speak Spanish allows villagers to better understand market transactions and economic news about the region transmitted through the radio, and deal with government officials and teachers. Some villagers acquire the skills on their own outside of school.

3. Variables and data

We estimate four earnings functions using different definitions of earnings. We use right-side variables that have become standard in studies of earnings functions with human-capital variables.

3.1. Dependent variables

We use four different dependent variables—total household cash income, total household imputed farm income, sum of total household imputed farm income and non-farm cash income, and daily wages. The different measures allow us to calculate the correlation of human capital with particular economic activities, not just with overall income. Note, however, that some dependent variables are measured with more accuracy than others. For example, subjects found it easier to remember their daily wage than to estimate the total imputed farm income of their household or the total cash earned by the household from the sale of goods and from wage labor.

To estimate the total cash income of the household, we asked about all the cash income earned from wage labor and from the sale of animals and farm, forest, and animal products during 1997—the year before the interview. About 10% of households reported receiving no cash income during 1997. The consumption of those households came from their own foraging and farm production; they got goods from the outside world through barter.

To estimate the total imputed farm income for the household, we asked about the annual production of the three principal annual crops—maize, rice, and peanuts—the year before the interview. These crops are the

[1] For example, we found only three studies that contained objective measures of skills when assessing the effects of language proficiency on earnings (Charette & Meng, 1994; Rivera-Batiz, 1990; Angrist & Lavy, 1997).

[2] The village that declined to be interviewed consisted of people undergoing a messianic movement. They did not want outsiders to question them about any aspect of their social life.

most important in the region in labor requirements and area planted. Because the three crops are economically important, are harvested only once a year, and are used mostly for a household's own consumption, villagers remember well the quantity harvested. To arrive at an estimate of the gross imputed farm income for the entire household we multiplied the reported quantity of the crop harvested by the household by the village price of the crop. To estimate the village price of the crop we asked village leaders and schoolteachers in the village to estimate the average selling price of the crop during 1997. About 6% of the households reported producing no maize, rice, or peanuts and so had no imputed farm income. We did not attempt to impute a value to the consumption from foraging or from perennial tree crops. Much of the consumption in the area comes from hunting, fishing, harvesting tubers, plantains, and tree crops, and from collecting wild products from the forest. A one-time survey is unsuitable for accurately measuring the imputed value of consumption from foraging and from perennials that trickle into the household throughout the year. Asking subjects to recall the flow of goods that trickle into the household throughout the year taxes their memory and produces measurement error from faulty recall. For this reason, we only include the three principal annual crops when imputing farm income.

To assess the effect of modern forms of human capital on total income we created a third dependent variable which is the sum of the prior two, but excludes the portion of cash earnings from the sale of farm crops to avoid double counting that portion of farm production that villagers later sold.

The last dependent variable was the average daily wage earned in logging camps, ranches, and in towns during 1997. About half the sample (45%) said they had not worked for wages during the year before the interview.

Since the first three measures of income were collected at the level of the household, we divided the resulting estimate by the number of adult men in the household to arrive at a proxy of individual earnings for an adult man. We took logarithms of dependent variables and added a one to observations with the value of zero to avoid reductions in the sample size.

We cannot estimate the contribution of women to the total cash or imputed income of the household because we did not collect separate information on income from women and from men. We suspect that the contribution of women to total household cash income is low. In a panel study carried out over five consecutive quarters among 52 households in two villages of Tsimane' Indians in a neighboring region we found that women accounted for 17% of total household cash income. On days chosen at random, we identified, weighed, and valued all goods brought from the farm and forest to the household for consumption. We found that the value of the goods brought by the female head of the household was 34.62% lower than the value of the goods brought by the male head.

3.2. Explanatory variables

Variables related to human capital included formal educational attainment of the subject and of the subject's parents, fluency in spoken Spanish determined by the interviewer, literacy in Spanish determined through a reading test, and competence in arithmetic determined through an oral test in Spanish. We used parental education to control for unobserved heterogeneity or for background attributes of the subject.

We developed eight tests of equal difficulty to measure competence in reading and three tests of equal difficulty to measure competence in arithmetic. For each subject, interviewers selected one test of literacy and one of arithmetic at random. Randomizing the type of test given reduced the likely bias from cheating. Subjects who overheard an answer could not use it as their own when we interviewed them later. The tests of arithmetic consisted of four questions that required subjects to add, subtract, multiply, and divide. Subjects could score a maximum of four points in the arithmetic test. The test of reading consisted of having subjects read a sentence in Spanish during broad daylight. The sentence was written in large, dark block letters on a piece of paper. Subjects could get a score of one if they could read or zero if they could not read the sentence.

Researchers judged proficiency in spoken Spanish on the spot: if subjects required a translator to answer the survey questions they were considered non-fluent even if they understood the meaning of questions. Since more than 90% of the subjects spoke Spanish, we decided to drop the Spanish variable from the analysis.

Control variables included: (1) age and age squared, (2) parental education, (3) number of adults and (4) number of children in the household, (5) distance in a straight line from the village to the nearest market town measured with a Global Positioning System (GPS) receiver, (6) dummy variables for different ethnic groups, (7) two dummy variables, one each for the type of mathematics or reading test taken, (8) a dummy variable for whether the household had earned any cash, and (9) a full set of dummy variables for villages. The regressions with total cash income as a dependent variable also includes the logarithm of the number of days worked in wage labor. We did not use travel time to the nearest road to proxy for distance because travel time varies depending on the season of the year and on the form of transport (e.g. canoe, walking).

We tested to see whether the effect of human capital varied by ethnic groups and by distance to the nearest market town. To do this we ran two separate sets of

Table 1
Definition and summary statistics of variables used in regression analysis (only male household heads)

Variables	Definition	Obs	Mean	Std dev	Min	Max
Dependent						
Overall income	Imputed farm income + total cash income (excluding cash income from farm) divided by number of adult men	478	2169	2112	0	12403
Total cash income	Farm + forest + animal + wage income (*in Bolivianos*) in household divided by number of adult men	478	1323	1906	0	11325
Imputed farm income, 1997	Gross value of maize, rice, and peanut harvest, *in Bolivianos* in the household divided by number of adult men	478	910	893	0	5750
Daily wage	*Bolivianos* received for day of work, 1997	481	7.18	8.38	0	52
Explanatory						
Age	Age of household head in years	477	40.81	13.01	18	79
Education	Years of schooling completed	478	3.29	3.02	0	16
Numerate	Arithmetic skills from test; possible score 0–4	477	1.522	1.67	0	4
Read	Reading proficiency from test; possible score 0 (could not read) or 1 (could read)	477	0.66	0.47	0	1
Parented	Education of either parent; 1 = some education; 0 = no education	436	0.29	0.45		
Adults	Number of adults (16+ years) in household	481	2.67	1.09	0	9
Children	Number of boys and girls under 16 years of age	481	3.52	2.13	0	12
Work days	Number of work days in work labor, 1997; in regression entered in logarithmic form only for regression with total cash income as dependent	481	49.7	80.0	0	288
Days ill	Number of days ill during last forest-cutting season	433	2.60	7.96	0	90
Mojeño	Dummy: 1 = Mojeño; 0 = non-Mojeño	481	0.27	0.44	0	1
Chiquitano	Dummy; 1 = Chiquitano; 0 = non Chiquitano; excluded category	481	0.49	0.50	0	1
Yuracaré	Dummy; 1 = Yuracaré; 0 = non Yuracaré	481	0.12	0.33	0	1
Tsimane'	Dummy; 1 = Tsimane'; 0 = non Tsimane'	481	0.10	0.30	0	1
Distance	Km from village to nearest town; measured in straight line with GPS	481	98.7	43.2	48.4	186
No casha	Dummy: 1 = household earned cash in 1997; 0 = household earned cash in 1997	481	0.10	0.30	0	1

regressions that included (a) an additional interaction term between skills and a dummy variable for the ethnic group and (b) an additional interaction term between skills and village-to-town distance. The coefficients of the interaction terms with the dummy variables for ethnic groups were statistically insignificant at the 90% confidence level or above, and the coefficients of the variables capturing the interaction of distance with different forms of human-capital were generally significant. We therefore analyze the information for the pooled sample, but also analyze information separately for villages far and close from market towns, where far and close refers to villages above and below the median distance.

Table 1 contains definitions and descriptive statistics of the variables used in the analysis. Elsewhere we review ethnographic studies for the groups and discuss the educational context and constraints of the four groups (Godoy, 2001; Godoy & Contreras, 2001).

4. Empirical results

4.1. Education

In the pooled sample, an additional year of education correlated with 4.5% ($t = 2.18$; $p = 0.03$) higher overall income (monetary income plus imputed farm income) and with 5.90% higher wages (t—1.61; p—0.10) (Table 2). Among households close to market towns, an additional year of education correlated with 9.90% ($t = 2.52$; $p = 0.012$) higher overall income (Table 3).

Table 2
Effects of human capital on economic outcomes among lowland Indian male head of households in Bolivia: Pooled results without interaction terms between human capital and village-to-town distance[a]

Explanatory variables:	Dependent variables:			
	1. Overall	2. Imputed	3. Cash	4. Wages
Human capital				
Education	.045(2.18)	−.015 (0.25)	−.016(0.51)	.059(1.61)
Numerate	.037 (0.95)	.062 (0.56)	.135(2.13)	−.013 (0.21)
Read	−.152(1.17)	−.461 (1.51)	−.146 (.76)	−.143(0.70)
Controls				
Age	.023 (0.71)	−.008(0.17)	.002 (.09)	.027 (0.78)
Age squared	−.0002(0.61)	.00002 (0.04)	.00008 (0.23)	−.0006(1.51)
Parented	.077 (0.72)	−.214 (0.95)	−.061 (0.46)	.293(1.82)
Adults	−.211 (4.71)	−.069 (0.73)	−.314(5.02)	−.045 (0.64)
Children	−.009 (0.39)	−.015 (0.30)	.026 (0.84)	.009 (0.26)
Days ill	.0009(0.19)	.011 (1.34)	.006 (0.57)	−.007 (0.90)
Work days			.587 (8.87)	
Mojeño	.101 (0.31)	−1.480(1.16)	.757 (2.08)	−.426(0.60)
Yuracaré	.182(0.56)	−.721 (0.74)	.967(2.10)	−.080(0.12)
Distance	.0003(0.10)	−.001 (0.36)	−.008 (2.29)	−.009 (2.27)
No cash	−.776(3.84)		−4.63 (−12.24)	−.931 (4.20)
Observations	416	416	244	416
$R2$	0.40	0.18	.78	.466
Mean VIF	3.72	3.74	9.83	3.72

[a] *Note:* Regressions are OLS with robust standard errors. Dependent variables are logarithms of following values for 1997: [1] sum of imputed farm income and total household cash from wage labor and sale of animals and forest goods/man, [2] total household imputed farm output/man, [3] total cash earnings from sale of crops, forest goods, and animals, plus wage labor/man, and [4] average daily wage earned by male household heads. +1 added to dependent variables if they contained zero. The variable "no cash" is a dummy variable for those who earned no cash (1 = no cash; 0 = cash). Number in parenthesis is t value. Controls not shown include: dummy variables for different math and reading tests and for villages. VIF = mean variance inflation factor without age^2.

Even after controlling for the interaction of education and distance, education correlated with 10.20% ($t = 1.66$; $p = 0.09$) higher wages (Table 3).

4.2. Arithmetic

In the pooled sample, mastery of each of the four basic arithmetic operations, or a one-point improvement in the arithmetic score, correlated with an increase in cash earnings of 13.54% ($t = 2.13$; $p = 0.03$) (Table 2). Among households close to market towns, a one-point improvement in arithmetic skills correlated with 12.78% ($t = 1.68$; $p = 0.094$) higher overall income and with 71.40% higher value of imputed farm output ($t = 3.48$; $p = 0.001$) (Table 3).

4.3. Reading

After conditioning for schooling and for skills in arithmetic, literacy in Spanish had no statistically significant correlation with economic outcomes.

4.4. Multicollinearity, endogeneity, and selection bias

In this section, we discuss the robustness of results to multicollinearity, endogeneity, and selection bias. Owing to the small sample size, we estimated the severity of multicollinearity. We regressed each explanatory variable on all other explanatory variables to estimate a variance inflation factor (VIF). In the last rows of Tables 2 and 3, we report the results of those estimations. Scores for variance inflation factors were 3.72–3.74 except for the regression with only cash as a dependent variable (VIF = 9.83). The results suggest that multicollinearity, though present, was not severe in most cases.

We did not have instrumental variables to control for potential endogeneity between human capital and various forms of earnings. Several studies from industrial societies suggest that controlling for language endogeneity with instrumental variables produces estimates 2–3 times larger than estimates from ordinary least squares (Chiswick & Miller, 1995, pp. 276–277; Chiswick, 1998; Robinson, 1988; Dustmann & Fabbri,

Table 3
Effects of human capital on economic outcomes among lowland Indian male head of households in Bolivia: Results by proximity to market town[a]

Explanatory variables:	Dependent variables:			
	1. Overall	2. Imputed	3. Cash	4. Wages
Human capital				
Education	−.029 (1.01)	−.094(0.81)	−.092(1.09)	.102(1.66)
Numerate	−.021 (0.43)	−.246(1.58)	.139(1.54)	−.017 (0.20)
Read	.033 (0.22)	−.041 (0.11)	.027 (0.09)	−.355 (1.35)
Interaction: human capital close*				
Education	.099 (2.52)	.062 (0.45)	.093 (0.97)	−.066 (0.86)
Numerate	.012(1.68)	.714(3.48)	.007 (0.07)	−.010 (0.08)
Read	−.295 (1.05)	−1.053(1.62)	−.290 (0.76)	.528(1.20)
Distance	.001 (0.39)	.0007(0.14)	−.007 (2.07)	−.007 (1.78)
Observations	416	416	244	416
*R*2	0.42	0.22	0.79	.469
Mean VIF	3.72	3.72	9.83	3.72

(a) Effects of human capital on economic outcomes among lowland Indian male head of households in Bolivia: Results by proximity to market town[a]

Explanatory variables:	Dependent variable: OVERALL			
	All interactions	Ed*close	Math*close	Read*close
Human capital				
Education	−.029 (1.01)	−.032(1.23)		
Numerate	−.021 (0.43)		−.042 (0.86)	
Read	.033 (0.22)			−.106(0.78)
Interaction: human capital close*				
Education	.099 (2.52)	.115(3.36)		
Numerate	.012(1.68)		.199(2.77)	
Read	−.295 (1.05)			.280(1.07)
Distance	.001 (0.39)	.003 (0.99)	.002 (0.63)	
Observations	416	416	416	416
*R*2	0.42	0.41	0.41	0.39
Mean VIF	3.72			

(b) Effects of human capital on economic outcomes among lowland Indian male head of households in Bolivia: Results by proximity to market town[a]

Explanatory variables:	Dependent variables: IMPUTED INCOME			
	All interactions	Ed*close	Math*close	Read*close
Human capital				
Education	−.094(0.81)	−.161 (1.77)		
Numerate	−.246(1.58)		−.295(1.97)	
Read	−.041 (0.11)			−.507 (1.72)
Interaction: human capital* close				
Education	.062 (0.45)	.197(1.87)		
Numerate	.714(3.48)		.609 (3.35)	
Read	−1.053(1.62)			.173(0.35)
Distance	.0007(0.14)	.016(1.30)	.006(1.31)	.007(1.28)
Observations	416	416	416	416
*R*2	0.22	0.19	0.21	0.18
Mean VIF	3.72			

Table 3 (*continued*)

(c) Effects of human capital on economic outcomes among lowland Indian male head of households in Bolivia: Results by proximity to market town[a]

Explanatory variables:	Dependent variables: CASH			
	All interactions	Ed*close	Math	Read*close
Human capital				
Education	−.092(1.09)	−.039 (0.71)		
Numerate	.139(1.54)		.088 (1.12)	
Read	.027 (0.09)			−.068 (0.29)
Interaction: human capital close*				
Education	.093 (0.97)	.063(1.01)		
Numerate	.007 (0.07)		.038 (0.40)	
Read	−.290(0.76)			.067 (0.21)
Distance	−.007 (2.07)	−007(2.15)	−.010 (2.97)	−.007 (2.23)
Observations	244	244	244	244
*R*2	0.79	0.78	0.78	0.78
Mean VIF	9.83			

(d) Effects of human capital on economic outcomes among lowland Indian male head of households in Bolivia: Results by proximity to market town[a]

Explanatory variables:	Dependent variables: WAGES			
	All interactions	Ed*close	Math*close	Read*close
Human capital				
Education	.102(1.66)	.055(1.11)		
Numerate	−.017 (0.20)		.004 (0.05)	
Read	−.355(1.35)			−.137(0.62)
Interaction: human capital close*				
Education	−.066(0.86)	−.013 (0.23)		
Numerate	−.010(0.08)		.027 (0.25)	
Read	.528(1.20)			.366(1.00)
Distance	−.007(1.78)	−.010(1.73)	−.008 (2.20)	−.007 (1.35)
Observations	416	416	416	416
*R*2	.469	.466	.463	0.464
Mean VIF	3.72			

[a]*Note:* Same notes and variables as Table 2, except regressions here include interaction terms between dummy variable "close" and schooling, literacy, and arithmetic. VIF excludes interaction terms.

2000; Bleakley & Chin, 2002). If this is also true in relatively autarkic economies, one could interpret the results presented earlier as lower bounds of true magnitudes. Aside from parental education, we did not have convincing variables to control for unobserved skills.

Since ~50% of the sample reported receiving no wages or working for a wage, the estimates could contain bias from sample selectivity. We did not have a convincing identifying instrument to determine whether we could observe the dependent variable, so we could not use the Heckman selection model. Instead, to find out whether there was something special about the households earnings no cash or wages, we created a dummy variable, which equaled one if the household earned no cash and zero otherwise. Most of the regressions summarized in Tables 2 and 3 contained the dummy variable. The dummy variable was significant, suggesting that selection bias might be coloring the results.

Lastly, in developed countries it has been argued that OLS regressions of earnings on education are biased downward by attenuation bias and upward by omitted variable bias, and that these biases are typically of a similar proportion (Card, 1999). If the omitted variable bias is more important in less remote areas, then the interaction of education and living close to town should be positive. Or, if the attenuation bias is more significant in remote areas (because the necessary skills for success are more cultural and socially driven, not so much about education, numeracy, and literacy), then the interaction

effects also will be positive. Our data do not allow us to distinguish between these explanations, but the prevalence of significant interaction effects suggests that the returns to education or basic skills do differ significantly depending on how remote the area is.

5. Conclusion

The results of this study suggest that even in highly autarkic foraging and horticultural economies that have yet to undergo structural transformations, education and skills in arithmetic correlate in positive ways with economic outcomes. For instance, men living close to market towns who knew arithmetic obtained 71.40% higher value from their farm output and 12.78% higher overall income than their nearly identical counterparts living farther away. After controlling for skills in arithmetic and reading and for a broad range of other cov-ariates, each additional year of education correlated with 4.50% higher overall income and with 5.90% higher wages.

We conclude with a reflection on the possible implications of the study for our understanding of the worldwide waning of folk knowledge. For many years, cultural anthropologists have documented the passing of folk knowledge among traditional peoples. Rich corpus of folk knowledge about the local environment disappear fast as highly autarkic people gain a stronger foothold in market economies. Bodies of knowledge that drew on personal experiences and that grew slowly over millennium disappear overnight and forever. The public and academics have lamented the erosion because it represents the irreversible loss of humanity's heritage and diversity, particularly for poor nations.

The results of this study might help to explain why. Even among people in highly autarkic economies, schooling produces many desirable outcomes. By themselves and without prodding from outsiders, parents in highly autarkic settings probably realize that modern human capital yields larger dividends than folk knowledge. Given the tradeoffs parents and students face, people in relatively autarky—facing different returns to investments in different forms of human capital—will start to forget and devalue one form of knowledge to make room for the other, and invest in the acquisition and accumulation of one at the expense of the other.

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