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**Spanish fluency and earnings:
Evidence from a primitive economy in the Bolivian Amazon**

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Abstract [words=91]

We contribute to studies on the returns to language skills by applying the human-capital approach to a highly autarkic society of hunters, gatherers, and farmers in the Bolivian Amazon. We use a five-quarter panel with objective measures of language, math, and writing skills. Bilingual speakers of Spanish and the local language earned 29-37% more than monolingual speakers of the local language. We also found positive returns to writing skills. Bilingualism correlated positively with earnings partly because it correlated with greater access to credit and modern production technologies, and improved labor productivity.

JEL classification: C23, J61, J24, J31, J15, F22

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Introduction. Among linguistic minorities and immigrants of industrial nations, proficiency speaking the national language increases earnings and wages, but do results also apply to highly autarkic linguistic minorities of developing nations? (Chiswick 1998; Dustmann & Fabbri 2003; McManus 1998). Drawing on information from a hunting, gathering, and farming society of the Bolivian Amazon in the early stages of continuous contact with the market economy, we contribute to studies of the returns to language skills in two ways. First, we estimate the private market returns to proficiency speaking the national language, Spanish, among adults. Most of the empirical literature on the returns to language skills comes from industrial nations. The material we present allows us to assess whether the human-capital approach and findings from industrial nations also hold in a very different socioeconomic setting. Second, we identify possible paths through which proficiency speaking the national language affects earnings. To do so we examine the correlation between proficiency speaking the national language and access to credit and modern production technologies, and labor productivity. Highly autarkic economies provide an ideal laboratory to estimate the private market returns to language skills because they lack the occupational division of labor, social stratification, and ethnic and racial heterogeneity of industrial nations, which have made it hard to obtain precise estimates of the returns to language proficiency in industrial nations.

To explore the topic, we use a panel of five consecutive quarters (May 2002-August 2003) with objective measures of language, math, and writing skills. We estimate the effect of proficiency speaking Spanish at baseline or during the first quarter (May 16-

August 15, 2002) on earnings at follow up or during the fifth quarter (May 16-August 15, 2003).

We find that bilingual speakers of Spanish and the local language, Tsimane', earned 29-37% more than monolingual speakers of the local language. Returns to fluency speaking the national language are higher than those found among immigrants in the United States (15-33%) or among Indians in Bolivian cities (25%). We also find positive returns to writing skills, consistent with findings from Morocco, Israel, Germany, and the United States. Results were robust to a wide range of tests and econometric specifications. Since attenuation bias is likely low, but we could not control for unobserved heterogeneity, results might overstate the true impact of language skills. Bilingualism correlated positively with earnings partly because it correlated with greater access to credit and modern production technologies, and improved labor productivity.

Previous research on the private markets returns to proficiency speaking the national language. Standard estimates of the market returns to proficiency speaking the national language by immigrants and by linguistic minorities contain biases from random measurement errors when using self-assessed ability to gauge language proficiency (Charette & Meng 1994; Dustmann & Van Soest 2001) and from the omission of third variables, such as drive or skills (Borjas 1994; Chiswick 1991; Dustmann 1994; Dustmann & Fabbri 2003), which correlate with both language skills and earnings. Valid instrumental variables produce asymptotically unbiased and larger estimates of the private market returns to language skills than estimates from ordinary least squares

regressions (Angrist & Lavy 1997; Angrist & Krueger 1991; Bleakley & Chin 2004; Chiswick 1998; Chiswick & Miller 1995; Dustmann & Fabbri 2003; Dustmann & Van Soest 2001; Robinson 1988).

Findings from industrial nations suggest that proficiency speaking the national language improves market outcomes because proficiency increases the probability of finding a job (Dustmann & Fabbri 2003), facilitates school attainment (Bleakley & Chin 2004), increases occupational success (Shields & Wheatley Price 2001; Shields & Wheatley Price 2002; Wheatley Price 2001), and conveys information about the human capital of the employee to employers screening applicants (Dustmann 1994). Paths that have received less attention include the effect of language skills in gaining access to credit, accumulating modern production technologies, and improving labor productivity. Skills speaking the national language should make it easier to widen one's network of social relations and access formal and informal institutions that provide credit. Proficiency speaking the national language should lower the costs of learning about and adopting new production technologies outside the community and, in so doing, enhance labor productivity.

Most studies on the returns to language skills come from urban populations of industrial nations, but the few studies from developing nations known to us suggest that results from industrial nations might also apply in developing nations (Angrist & Lavy 1997; Chiswick, Patrinos & Hurst 2000). In a study of indigenous peoples in Bolivian cities, Chiswick et al. found that self-reported monolingualism in Spanish correlated with about

23% ($t=8.31$) higher earnings among men and with about 28% ($t=6.26$) higher earnings among women compared with the earnings of bilingual speakers of Spanish and an Indian language. Bilingual male speakers of Spanish and an Indian language did not earn more than monolingual male speakers of an Indian language, but bilingual female speakers of Spanish and an Indian language earned 25% ($t=2.69$) more than women who spoke only an Indian language (Chiswick, Patrinos & Hurst 2000). Angrist and Lavy (Angrist & Lavy 1997) estimate the effects of math skills and of reading and writing skills in French and in Arabic on hourly wages in Morocco. They use objective tests to assess language and academic skills. In 1983, Morocco changed the language of instruction from French to Arabic in public schools for grades six and up. Angrist and Lavy use the exogenous policy change as an identifying instrument and find that “going from some ability to functional competence” writing French raised earnings by about 50% ($t=1.93$) (p. 72), three times higher than the estimate from the ordinary least squares regression (17%, $t=2.91$).

Estimation strategy. We adapt the standard human-capital earnings function (Mincer 1974) to estimate the parameters of the following linear approximation to earnings:

$$[1] E_{ihvt=5} = \alpha + \beta L_{ihvt=1} + \gamma S_{ihvt=1} + \delta P_{ihvt=1} + \zeta H_{ihvt=1} + \theta C_{vt} + \varepsilon_{ihvt}$$

In expression [1] $E_{ihvt=5}$ stands for the earnings of subject i , household h , village v at follow up or during the fifth quarter ($t=5$). $L_{ihvt=1}$ are two dummy variables for objective skills speaking the national language (Spanish) – either with difficulty or fluently – with

monolingual speakers of the local language as the excluded category. S stands for a vector of variables related to the modern human capital of the subject. S includes objective skills in math and writing, and the maximum school grade completed; the latter reflects other dimensions of schooling besides academic and language skills, such as increasing discipline and patience (Becker & Mulligan 1997; Bowles & Gintis 1975; Bowles, Gintis & Osborne 2001) (Godoy, Byron, Reyes-Garcia, Leonard, Patel, Apaza, Perez & Vadez 2004). P is a vector of observed variables for the subject (e.g., age, sex, days worked for wages, days with self-perceived illness, body-mass index) that directly affects earnings. H stands for household size. C includes dummy variables for villages to control for village characteristics that could directly affect both earnings and language fluency, such as proximity to market towns or the size of the language enclave in the village (Lazear 1999; McManus 1998). ε is a random error term that reflects stochastic shocks. All explanatory variables refer to the baseline or to the first quarter.

We use ordinary least squares with clustering of subjects by village because people are nested in villages. The use of weak instrumental variables in two-stage least square regressions produces large biases (Bound, Jaeger & Baker 1995; Staiger & Stock 1997; Wooldridge 2003). Since we did not have convincing instrumental variables to control for the endogeneity of language skills, our estimates of the returns to fluency in spoken Spanish may contain biases.

The people. The Tsimane' are a native Amazonian society of 8,000 people living in about 100 villages, department of Beni, in the Bolivian Amazon. They live along

riverbanks and logging roads in villages of about 24 households. Few Tsimane' move out of their territory. The latest Bolivian census (2001) suggests that only 7.15% of the Tsimane' population over 15 years of age lived outside the department of Beni (Instituto Nacional de Estadística 2003). Subsistence centers on hunting, gathering, fishing, and shifting slash-and-burn farming (Vadez, Reyes-Garcia, Godoy, Apaza, Byron, Huanca, Leonard, Wilkie & Perez 2004).

Tsimane' have been in contact with outsiders since the eighteenth century, but they started to come into more frequent and prolonged contact with outsiders at the turn of the twentieth century (Castillo 1988; Nordenskiöld 1924). During the eighteenth and nineteenth centuries, Tsimane' interacted with the outside world with the help of Mosekene, Mojeño, and Yuracaré Indians, who had greater command of spoken Spanish because of their more sustained contact with Catholic missionaries. Though highly endogamous, the Tsimane' married Mosekene, Mojeño, and Yuracaré and, through these exogamous unions, started to learn Spanish. The toffs of the group or many of today's Tsimane' most fluent speakers of Spanish had ancestor who came from a neighboring group.

By the early twentieth century Tsimane' started to pan gold, extract quinine, tap rubber, and work as unskilled laborers for cattle ranchers and loggers who moved into the Tsimane' territory (Chicchón 1992; Piland 1991). Contact with outsiders and encroachers remained sporadic until the 1950s, but rose during the 1970s when the government built roads across the Tsimane' territory to encourage migration from the

highlands to the lowlands.

Despite sporadic contact with Spanish speakers from the rest of Bolivia, the Tsimane' remain highly autarkic and have low-income. In an earlier panel study lasting six quarters (1999-2000) with 156 adults from 60 households in two villages, we measured the value of consumption and monetary earnings. We did so by asking adults every quarter to recall their monetary earnings for the previous 30 days. To measure consumption we identified and valued all goods they brought into their households from morning until dusk on a day chosen at random each quarter. During those days, we counted and valued all goods subjects brought into their households. We found that mean annual personal income from cash earnings and from the imputed value of farm and forest goods consumed from their own fields and forests was US\$332, a third of the average income in Bolivia (\$US 980/person). Put in dollars/day, the typical Tsimane' earned \$0.90, below the international poverty line of \$1/day/person. Goods bought in the market accounted for only 2.70% of the total value of household consumption.

Though highly autarkic, the Tsimane' need cash to buy food, tools, and clothing. Parents in villages with schools need cash to pay for school supplies. To earn cash, Tsimane' work as unskilled laborers in logging camps, cattle ranches, and in the homestead of colonist farmers. Tsimane' with more schooling work as village school teachers. The principal goods Tsimane' sell and barter include thatch palm, rice, and timber (Vadez, Reyes-Garcia, Godoy, Apaza, Byron, Huanca, Leonard, Wilkie & Perez 2004). Spanish-speaking traders travel into the Tsimane' territory along rivers or logging roads and

advance tittle, food, mosquito nets, metal fishhooks and tools, and clothing to villagers in exchange for future deliveries of thatch palm. To get out of hock, Tsimane' sell or barter thatch palm and rice to traders who come to villages, but they also take forest and farm goods to nearby towns to sell. Tsimane' also sell timber to loggers, and work as unskilled laborers for cattle ranchers, logging firms, and for highland colonist farmers who have moved into or next to the Tsimane' territory. Employers prefer to hire Tsimane' who speak Spanish.

The presence of schools dates back to the mid 1970s when Protestant missionaries started training Tsimane' to become bilingual school teachers so Tsimane' could teach and preach. Beginning in the 1990s the Ministry of Education started to pay Tsimane' teachers, but Protestant missionaries continue to train teachers. Missionaries have translated the Bible into Tsimane' and produced most of the textbooks used in primary schools. Missionaries have provided Tsimane' with an opportunity to learn Spanish and to study in schools run by missionaries.

Information and methods. Research on the returns to language skills among Tsimane' forms part of a larger longitudinal study on the effects of markets on well-being as people in a highly autarkic society gain a stronger foothold in the market economy. The study started in 1999 and continues. We interviewed all subjects (304 women and 323 men; 257 households) over the age of 16 in 13 villages along the Maniqui river. Since permanent out-migration is rare and most people live in their villages, interviewing all adults captures a representative sample of the population. We selected villages at

different distances from the market town of San Borja (population 19,000) to capture cross-sectional variance in market exposure. We limit the analysis to subjects over the age of 16 because younger subjects are less likely to work for wages or sell goods since they still depend on their parents. Four female and four male researchers collected information. Researchers lived continuously in the villages while the study unfolded, but four had lived in the villages before as part of the longer study. Three of the researchers spoke Tsimane' moderately well, but all used translators for the interviews.

During the last or fifth quarter of the study, we could not find 89 subjects, or 14.19% of the sample from the baseline survey because they had temporarily left to hunt or work. In Table 1 we compare the mean of outcome and explanatory variables during the first quarter between subjects present during the fifth quarter and pre-attriters or subjects who left by follow up. The information in Table 1 suggests that subjects absent during follow up spoke more fluent Spanish and had more modern human capital than subjects who remained in the sample. Those who left during the fifth quarter were younger and more likely to come from smaller households. Those who left and those who remained had similar income at baseline. Later we test whether attrition bias affects the results of the analysis.

INSERT TABLE 1 ABOUT HERE

Dependent variable: Earnings at follow up. During quarterly interviews we asked subjects to list all sources of monetary income and all barter transactions for the past 14 days, and for each source of earnings we asked them to specify the monetary value or the value of goods received in barter. We added the value of all monetary

earnings to the value of goods received in barter to arrive at a total value of earnings for the subject for the two weeks before the day of the interview.

In Table 2 we present information on the sources of earnings for women, men, and for the pooled sample. Earnings came from wages, sale of forest and farm goods, and from the value of goods received in barter. 38.34% of women, 21.45% of men, and 29.98% of the total sample had no earnings, suggesting possible self-selection into the modern economy. The median earnings from wages, sales, and barter were zero for women and for men. We assessed whether standard instruments from industrial nations that predict selection into the labor market would work in our sample, but found nothing significant, even when we did the analysis only for women or only for men. The number of children, the dependency ratio (children/adults), and other demographic characteristics of the household did not correlate with positive earnings. The information in Table 2 suggests that women earned income chiefly from the sale of goods (67.11%) whereas men earned income chiefly from wage labor (54.65%) and from the sale of goods (37.66%).

INSERT TABLE 2 ABOUT HERE

Explanatory variable: Proficiency speaking Spanish. To reduce random measurement errors, we did not rely on subject's self-assessment of language proficiency. Instead, we judged the subject's ability to speak Spanish during the interviews, and coded answers as follow: 0=unable, 1=with difficulty, and 2=fluent. For the regressions we used the information to create two dummy variables: "Some Spanish" for people whom we classified as speaking Spanish with difficulty (1=with difficulty; 0=otherwise) and "Fluent Spanish" for people whom we classified as speaking fluent Spanish (1=fluent;

0=otherwise). Monolingual speakers of Tsimane' is the excluded category. 98% of subjects said Tsimane' was their mother tongue, so the variables "Some Spanish" and "Fluent Spanish" reflect degrees of bilingualism in Spanish and Tsimane'. We found no monolingual speakers of Spanish.

One advantage of a panel study worth stressing relates to the ability of researchers to correct mistakes in judging language fluency as the study unfolds. For example, a subject in the first survey may have displayed little competence speaking Spanish because of shyness, but as the study unfolded researchers would have had repeated opportunities to speak with the subject and gain more information about the subject's true proficiency speaking Spanish, allowing the researchers to correct initial coding mistakes. This said, we cannot rule out misclassification of language skills from researchers using different thresholds of language proficiency (Dustmann & Van Soest 2004).

We adapt the model of language fluency of Chiswick and Miller to identify the covariates of language fluency (Chiswick & Miller 1999). Chiswick and Miller view fluency in the national language as a function of economic incentives, exposure to the national language, and efficiency. In Table 3 we show the results of three probit regressions to identify the covariates of fluency speaking Spanish. To make the interpretation of coefficients easier, we do not use a multinomial logit regression, but use instead three separate probit regressions, each with one of the following three dummy variables as a dependent variable: (a) monolingualism in Tsimane' (1=monolingual; 0=bilingual), (b) "Fluent Spanish" (1=fluent; 0=not fluent), and (c) "Some Spanish" (1=some Spanish;

0=monolingual in Tsimane' or fluent in Spanish). Explanatory variables include age, sex (male=1; female=0), kilometers in a straight line from village of birth to the nearest market town, schooling, and the number of children under nine years of age. The distance variable picks up background characteristics of the household or the environment in which the subject grew up. Since parents might learn the national language from their children, and children learn languages faster than adults, the number of children under nine years of age should correlate with greater fluency speaking the national language by parents if parents do not use children as translators. If children have infrequent exposure to the national language, then the number of children should not correlate with the language skills of parents.

INSERT TABLE 3 ABOUT HERE

The results of Table 3 suggest that age, being male, and schooling lowered the probability of speaking only Tsimane'. For instance, an additional year of age over the mean age of the sample used in the regression (33 years) correlated with about a 0.83% greater probability of speaking only Tsimane' ($p < 0.002$). Males were 46.84% less likely to be monolingual in Tsimane' than females ($p < 0.001$). An additional year of schooling over the mean schooling of subjects in the regression (1.90) correlated with a 10.70% lower probability of speaking only Tsimane' ($p < 0.001$). The results of the probit regression with complete fluency in Spanish as a dependent variable suggest that men had a 36.34% greater probability of speaking fluent Spanish ($p < 0.001$) and that each additional year of schooling over the sample mean correlated with a 6.62% higher probability of speaking fluent Spanish ($p < 0.001$). Moderate or some fluency in Spanish did not correlate with any of the explanatory variables. The number of children in the household also did not

correlate with language fluency, possibly because children have sporadic exposure to Spanish.

Explanatory variables: Other dimensions of human capital. Besides fluency in the national language, modern human capital also included the maximum school grade attained by the subject and academic skills. Tsimane' have little schooling. The average subject had completed only 1.96 years of schooling (std dev= 2.34). The average adult men had 2.66 years of schooling (std dev=2.72; n=323) and the average adult women had 1.23 years of schooling (std dev=1.55; n=304). 30% of adult men and 50% of adult women had no schooling.

We gave tests to assess math skills. The tests had four questions that required subjects to add, subtract, multiply, and divide. We had several versions of equal difficulty of the math test and chose one at random for each subject. We assigned a one to each correct answer, so possible scores ranged from zero to four. The mean value in the math test was 1.05 (std dev=1.48) and the median score was zero. 56.46% of the sample scored a zero (men=39.94%; women=74.01%). Men scored an average of 1.64 points in the math test (std dev=1.69), four times higher than the mean score of women (mean=0.44; std dev=0.87).

We assessed writing skills by whether subjects could sign their name during the interview. Interviewers coded answers as follow: 0=unable, 1=with difficulty, 2=well. 56.55% of subjects could not write (women=64.69%; men=35.31%), 12.30% wrote with

difficulty (women=49.35%; men=50.65%), and 31.15% wrote well (women=18.97%; men=81.03%).

In Table 4 we show partial correlation coefficients between proficiency speaking Spanish, objective measures of writing and math skills, and schooling. Results suggest that proficiency speaking Spanish correlated positively with writing (0.56) and math (0.47) skills and with schooling (0.42). Schooling and writing and math skills had higher partial correlation coefficients (0.70-0.76) than language skills and other variables related to modern human capital (0.42-0.56), probably because subjects learned writing and math mainly in school, whereas they could have learned Spanish inside or outside school.

INSERT TABLE 4 ABOUT HERE

Control variables. Control variables included age, sex, household size, logarithm of body-mass index (BMI; kilograms/meters²), and days ill and days worked in wage labor during the 14 days before the day of the interview. The age variable contained measurement errors; 24.56% of subjects said they did not know their exact age, but the share could be higher because few adults had birth certificates. We opted to use age instead of experience because of the recall bias from trying to remember the age at which subjects first entered school. Also, the human-capital approach assumes a continuous commitment to the labor market (Chiswick & Miller 1999). Those conditions do not apply to this highly autarkic society where people slip in and out of the formal market. Later, we include a measure of experience as a check and find that age and experience produce similar results. We measured the size of the household by counting the number of people in the household each quarter. Households at baseline (n=257) had an average

of 6.35 people (std dev=2.95). We asked about the number of days worked in wage labor and about the number of days the subject reported feeling ill during the 14 days before the day of the interview. The variable for days worked underestimates the true number of days worked because it only includes days worked in jobs with wages; it does not include days worked producing goods in their own farms for sale or barter. We measured body-mass index because it proxies for short-run nutritional status and work capacity (Shetty & James 1994). Table 5 contains definition and summary statistics of the variables used in the regressions.

INSERT TABLE 5 ABOUT HERE

Regression results. Table 6 contains the main regression results. The first regression includes only language skills and no other variables for human capital. The result of the first regression suggests that fluency speaking Spanish correlates with 60 more bolivianos in earnings (1 US dollar = 7.45 bolivianos) ($p < 0.021$) for the two weeks before the day of the interview compared with the earnings of monolingual speakers of Tsimane'. 60 bolivianos amounts to \$0.57/day. Recall from the earlier panel study that mean annual individual income from sales, wage labor, barter, and the value of own consumption reached \$0.90/day, so a language premium of \$0.50/day represents a considerable improvement in earnings. Moderate fluency speaking Spanish did not correlate significantly with higher earnings.

INSERT TABLE 6 ABOUT HERE

In columns 2-4 we control for math (column 2) and writing (column 3) skills and for schooling (column 4) by adding each one of those variables, one at a time, to a separate regression. Adding other dimensions of human capital lowers the estimated impact of

fluency speaking Spanish on earnings from 60 (column 1) to between 46 and 54 bolivianos (columns 2-4) compared with the earnings of monolingual speakers of Tsimane', but results continue to be significant at the 95% confidence level or higher. In column 5 we interact fluency in spoken Spanish with writing, schooling, and math skills and include the three interaction terms in the same regression. Results buttress the analysis presented so far, but point to a new finding. Fluency speaking Spanish complements writing skills. The direct effect of Spanish fluency on earnings, 51 bolivianos, continues to be positive, roughly similar to the previous estimates, and statistically significant ($p < 0.071$), but, in addition, a one-point improvement in writing skills (e.g., from "unable to write" to "write with difficulty") among people fluent in Spanish correlates with an additional 51 bolivianos in earnings ($p < 0.037$) compared with the earnings of monolingual speakers of Tsimane'. The results of Table 6 suggest that none of the human-capital variables besides language skills mattered, and language skills mattered only when subject spoke fluent Spanish.

Table 7 contains the results of regressions to ensure robustness in results and to make results easier to compare with those from industrial nations. The regressions in Table 7 resemble regression 4 in Table 6, except for the changes described in the last column of Table 7. In row 1 we add a variable for distance from the village of birth to the nearest market town. The distance variable controls for unobserved characteristics of the family and for the place where subjects might have spent their formative years. We say might, because Tsimane' in the past were more mobile, so village of birth might not proxy accurately for the village in which subjects grew up. Conditioning for distance from

village of birth to town, the coefficient for the variable for Spanish fluency drops slightly from 0.054 to 0.051, but remains statistically significant ($p < 0.017$). In row 2 we add a quadratic term for age and find that the coefficient for the variable of Spanish fluency drops slightly from 0.054 to 0.049 ($p < 0.06$). In row 3 we add a variable for traditional human capital. We asked subjects to identify the uses of 19 wild and semi-domesticated plants for food, crafts, apparel, medicines, and construction. Controlling for traditional human capital raises slightly the coefficient for the variable of Spanish fluency to 0.051 ($p < 0.05$). In row 4 we take out age, and replace it with experience and with experience squared, where experience equals age minus maximum years of schooling minus age at which subjects started school. The coefficient for fluency in Spanish increases from 0.054 in the base regression to 0.072 ($p < 0.06$). Since the dependent variable was censored at zero, in rows 5-6 we use a median regression (row 5) and a lowered-censored tobit (row 6). The use of a median regression still produces positive and significant result for fluency in Spanish (coefficient 0.025; $p < 0.006$), but the use of a tobit regression produces a positive but statistically insignificant result at the 90% confidence level or higher (0.053; $p < 0.14$).

INSERT TABLE 7 ABOUT HERE

Clustering by households rather than by villages did not change results (row 7). In row 8a we use a regression with fixed effects for households and restrict the analysis only to the first quarter. We find that the coefficient for Spanish fluency reaches 0.062, almost statistically significant at the 90% confidence level ($p < 0.11$). A fixed-effect model for households with contemporaneous information for all variables estimated over the five quarters with quarter dummies added (row 8b) suggests that complete fluency in spoken

Spanish correlates with higher earnings (coefficient 0.042, $p < 0.003$) and so did some fluency in spoken Spanish (coefficient 0.024; $p < 0.019$).

In rows 9-10 we take logarithms of dependent variables to facilitate comparison with results from industrial nations. In row 9 we show the results of the main regression with the logarithm of earnings during the fifth quarter as the dependent variable. The result suggests that fluency speaking Spanish correlates with 36% ($p < 0.08$) higher earnings. We re-estimate row 9 (results not shown) by taking out the age variable and including instead experience and experience squared and found a higher coefficient for the variable for fluency speaking Spanish (coefficient=0.520, $p < 0.10$). In another regression (not shown) we added earnings over the five quarters instead of using earnings only from the fifth quarter, and found that fluency in Spanish correlated with 36.7% ($p < 0.081$) higher earnings. In row 10 we re-define earnings by excluding the value of goods received in barter and taking the logarithm only of cash received by subjects. Results are nearly identical to those shown in row 9; fluency speaking Spanish correlates with about 37% ($p < 0.066$) more earnings.

In row 11 we control for attrition bias. We do so by creating a dummy variable for subjects we could not find during the fifth quarter; the variable took the value of one if we could not find the subject during the fifth quarter, and zero otherwise. We ran the regression with contemporaneous information for all five quarters plus the dummy variable for attriters and dummy variables for quarters. We used the Breusch and Pagan Lagrangian multiplier test for random effects, and rejected the null hypothesis

($\chi^2=7.45$; $p<0.006$), so we use a random-effect regression. We find that the dummy variable for attriters was insignificant (coefficient 0.020; $p<0.483$), but the two language variables were significant. Some and complete fluency in Spanish correlated with 23 more bolivianos ($p<0.03$)(some fluency) and with 40 more bolivianos ($p<0.007$)(complete fluency) in earnings for the two weeks before the day of the interview compared with the earnings of monolingual speakers of Tsimane'. In row 12 we re-estimate the expression of row 11, but use the logarithm of earnings as a dependent variable instead of using earnings in bolivianos. The results shown in row 12 suggest that some and complete fluency speaking Spanish correlated with about 23.49% ($p<0.003$)(some fluency) and with 29.11% ($p<0.004$)(complete fluency) higher earnings compared with the earnings of monolingual speakers of Tsimane'. The dummy variable for attrition (coefficient=0.097; $p<0.439$) did not correlate significantly with earnings.

We did two final regressions (not shown) to control for religious affiliation and for occupation. Protestant subjects might have been more likely to attend school and accumulate modern skills because they might have sided to teachers of the same religion. If Protestantism correlates with hard work and with greater accumulation of modern human capital, then the omission of the variable for religious affiliation might cause an upward bias in the returns to language skills. The inclusion of a dummy variable for self-assessed religious affiliation (Protestant=1; other religions = 0) in the main model did not change results; the coefficients for some and complete fluency in spoken Spanish were 0.012 ($p<0.386$) and 0.054 ($p<0.037$). In a small sample such as ours the inclusion of Tsimane' teacher might skew results since they earn a regular salary and are more likely

to speak Spanish well. We re-estimated the main regression excluding teachers ($n=30$) and found essentially the same results (some fluency= 0.013 , $p<0.371$; complete fluency= 0.056 , $p<0.045$).

We tested for interaction effects between language skills and subject's sex and between language skills and distance from village of residence to town, and found no significant results for interaction terms, so we conclude that the pooled results tell most of the story, with one exception. Recall from column 5 of Table 6 that although fluency in spoken Spanish correlated with higher earnings compared with the earnings of monolingual speakers of Tsimane', the effect was stronger when fluency in spoken Spanish interacted with writing ability.

Taken together, the results of Table 7 suggest that fluency speaking Spanish correlates with higher earnings. As in the main regression, in other regressions testing for robustness we find that slight competence speaking Spanish did not generally correlate with higher earnings, suggesting a threshold of fluency beyond which fluency speaking Spanish pays off.

Paths. To explore the paths by which fluency in spoken Spanish might affect earnings, we regressed moderate and complete fluency in spoken Spanish on the following dependent variables: (a) access to credit, (b) value of modern physical assets, (c) foraging productivity, and (d) self-perceived health (Table 8). The notes to Table 8 contain a list of the explanatory variables used in each regression and details of the regressions used.

INSERT TABLE 8 ABOUT HERE

The results shown in the first column of Table 8 suggest that subjects who spoke some Spanish (or who spoke it with difficulty) had 38.25 more bolivianos in credit ($p < 0.074$) than monolingual speakers of Tsimane'; subjects who spoke fluent Spanish had 143.58 more bolivianos ($p < 0.001$) in credit than monolingual speakers of Tsimane'. Results held up even after using a median regression (not shown) to control for the lower censoring of the credit variable (57.43% of subjects did not take out credit). To explore the topic further, we asked subjects whether they could borrow 100 bolivianos in an emergency. Subjects who spoke Spanish with difficulty and those who spoke Spanish fluently were 8.74% ($p < 0.009$) and 7.35% ($p < 0.098$) more likely to have access to 100 bolivianos in credit in an emergency than monolingual speakers of Tsimane'.

Subjects who spoke Spanish with difficulty and those who spoke it fluently had 64.73 % ($p < 0.001$) and 63.68% ($p < 0.001$) more wealth in modern physical assets than monolingual speakers of Tsimane. Modern assets included items that protect health (e.g., mosquito nets) and that increase labor productivity (e.g., metal fishhooks, fishing nets, hunting rifles).

To measure foraging productivity, we carried out scans or spot observations. During scans, we visited each household in the village once/week on a day chosen at random. Visits took place during different blocks of time of the day (7-10am, 10am-1pm, 1-4pm, or 4-7pm), also selected at random. After arriving at the household, we recorded the number of adults present in the house and the activity of each subject at the moment

interviewers first saw the subject. We asked each subject about their activities during the previous 24 hours, and about the type and amount of forest plants, game, fish, and crops brought into the household during the previous 24 hours. We scanned subjects an average of six times/quarter (std dev=3.59). The results of Table 8 suggest that subjects who spoke Spanish with difficulty brought 1.47 more kilograms of fish each day than monolingual speakers of Tsimane' ($p < 0.022$).

Last, bilingual speakers of Spanish and Tsimane' reported more self-perceived illness. Subjects who spoke fluent Spanish reported feeling ill 1.52 more days during the 14 days before the day of the interview than monolingual speakers of Tsimane' ($p < 0.062$). The positive correlation between fluency in Spanish and perceived illness may stem from the cultural inflation of morbidity that arises with economic prosperity (Murray & Chen 1992). As incomes rise, the standard of what people consider healthy rises, so an ailment that people viewed as normal might get reported as an illness when living standards improve.

We did other analysis (not shown) to assess whether competence speaking Spanish affected anthropometric indicators of short-run nutritional status, hunting (rather than fishing) productivity, frequency of contact with outsiders or travel to market towns, social capital or pro-social behavior, and self-perceived emotions (e.g., happiness), and found no significant results. We also tested whether fluency speaking Spanish by parents affected anthropometric indicators of nutritional status of their children, and found no significant results.

In sum, the evidence suggests that increased skills speaking Spanish correlates with greater access to credit, accumulation of modern physical assets, improvements in some types of foraging productivity, and greater self-perceived illness. Some of the paths might help to explain why proficiency speaking the national language correlates with higher earnings.

Conclusions. We end by comparing our results with those from industrial nations. Immigrants in the United States proficient speaking English earn 15-20% more than immigrants who cannot speak English well (Chiswick & Miller 1999). The premium for fluency speaking English among immigrants in the United States may reach 33% (Bleakley & Chin 2004). The results in rows 9-10 and 12 of Table 7 with the logarithm of earnings as a dependent variable suggest that fluency in spoken Spanish correlates with 29-37% higher earnings compared with the earnings of monolingual speakers of Tsimane'. Our estimates fall toward the upper range of estimates from industrial nations. The 29-37% premium is also higher than the 25% premium for bilingualism in Spanish and an Indian language that Chiswick et al. found among indigenous women in the labor market of Bolivian cities (Chiswick, Patrinos & Hurst 2000). Our estimates should not contain marked attenuation bias from language misclassification for reasons discussed earlier, but the 29-37% return might contain an upward bias if it picks up various forms of unobserved heterogeneity (e.g., self-selection into the modern economy). If ordinary least squares produce conservative estimates of the returns to language skills, as the evidence from industrial nations reviewed earlier suggests, then one might read the 29-

37% return as a lower bound of the true magnitude. We found that fluency speaking Spanish complemented writing skills. Dustmann in Germany, Chiswick and Repetto in Israel, Angrist and Lavy in Morocco, and Gonzalez in the United States also found positive returns to writing skills (Angrist & Lavy 1997; Chiswick & Repetto 2001; Dustmann 1994; Gonzalez 2000).

In sum, our results suggest that the human-capital approach applies to a very different social and economic setting. Even in a highly autarkic economy of hunters, gatherers, and farmers, with inchoate formal markets for labor, crops, and credit, we find that proficiency speaking the national language correlates with higher earnings owing to the likely effect of proficiency in the dominant language on variables such as access to credit, accumulation of modern production technologies, and enhanced labor productivity. The next item in the empirical agenda needs to center in finding suitable instrumental variables for language proficiency or another convincing identification strategy.

Table 1

Comparison of socioeconomic and demographic attributes between Tsimane' subjects over 16 years of age who remained in the sample and who left by follow up (fifth quarter)

<i>Variables:</i>	<i>Subjects:</i>					
	<i>Left by follow up:</i>			<i>Present at follow up:</i>		
	<i>Number</i>	<i>Mean</i>	<i>Std Dev</i>	<i>Number</i>	<i>Mean</i>	<i>Std Dev</i>
Spanish						
Unable	89	.359	.482	538	.386	.487
Some	89	.224	.419	538	.297	.457
Fluent	89	.415*	.495	538	.315	.465
Math	89	1.348**	1.624	538	1.011	1.456
Writing	89	.977***	.941	537	.707	.890
Schooling	89	2.483**	2.482	538	1.882	2.315
Earnings	83	.074	.178	517	.098	.162
Age	89	28.760**	13.738	538	35.603	15.592
Male	89	.584	.495	538	.503	.500
Health	62	3.548	4.713	458	4.623	6.861
Work days	83	1.331	3.443	517	1.329	3.132
BMI	69	22.897	1.886	495	23.134	2.568
Household size	89	6.370**	3.672	538	7.237	3.145

Note: *, **, and *** significant at 10%, 5%, and 1% level in t or chi-square test

comparing difference in mean between the two groups at baseline. For definition of variables see Table 5.

Table 2

Sources of earnings during fifth quarter for Tsimane' women, men, and for the pooled sample (16+ years of age)

Women (n=266)					
	<i>% with 0</i>	<i>Mean</i>	<i>% of total</i>	<i>Std Dev</i>	<i>Median</i>
Wages	95.11	4.18	13.43	28.24	0
Sales	58.27	20.89	67.11	46.97	0
Barter	66.54	6.05	19.43	11.72	0
Total	38.34	31.13	100.00	60.07	10
Men (n=261)					
Wages	55.93	78.52***	54.65	128.27	0
Sales	57.85	54.11***	37.66	182.97	0
Barter	60.91	11.03***	7.68	25.01	0
Total	21.45	143.67***	100.00	213.63	75
Women and men (n=527)					
Wages	75.71	41.00	47.20	99.59	0
Sales	58.06	37.34	42.99	133.92	0
Barter	63.75	8.52	9.81	19.61	0
Total	29.98	86.86	100.00	165.98	25

Notes: 1 US dollar = 7.45 bolivianos. *, **, and *** indicate significance at 10%, 5%, and 1% level in t-test comparing mean values between women and men. Std Dev = standard deviation. Earnings refers to the monetary income from wage labor and from the sale of goods, plus the value of goods received in barter for the past 14 days.

Table 3

Estimated probabilities of fluency speaking Spanish among Tsimane' over 16 years of age during the first quarter (n=237)

<i>Explanatory variables:</i>		<i>Dependent variable: Fluency in Spanish</i>		
<i>Name</i>	<i>Sample mean</i>	<i>None (monolingual)</i>	<i>Some</i>	<i>Fluent</i>
Distance	22.16	.002 (.001)	-.0003 (.002)	-.002 (.002)
Age	32.97	-.008 (.003)***	.001 (.002)	.004 (.002)
Male	0.46	-.468 (.112)***	.136 (.142)	.363 (.091)***
Children<9	3.63	-.011 (.025)	-.028 (.026)	.041 (.030)
Schooling	1.90	-.107 (.023)***	-.010 (.016)	.066 (.023)***
Pseudo R2		0.335	0.018	0.289

Note: Regressions are probit with probabilities estimated for marginal changes at the mean value of explanatory variables. Robust standard errors shown in parenthesis. *, **, and *** significant at the 10%, 5%, and 1% level. Distance = kilometers from village of birth to nearest market town, age in years, and male=1 if subject was a men, and zero otherwise. Monolingual = subjects who spoke only Tsimane'.

Table 4

Correlation between fluency speaking Spanish, schooling, and academic skills among Tsimane' over 16 years of age during first quarter (n= 626)

	Spanish	Writing	Math
Writing	0.562 (0.001)		
Math	0.473 (0.001)	0.765 (0.001)	
Schooling	0.428 (0.001)	0.703 (0.001)	0.725 (0.001)

Note: Significance level in parenthesis. Significance level adjusted for multiple comparisons using Šidák method. Table 5 contains definition of variables.

Table 5

Definition and summary statistic of variables used in regression analysis for Tsimane’

subjects over 16 years of age

<i>Name</i>	<i>Definition</i>	<i>N</i>	<i>Mean</i>	<i>Std Dev</i>
<i>Dependent variable (fifth quarter):</i>				
Earnings	Earnings from wage labor and sale of goods plus value of goods received in barter for 14 days before the day of the interview. In 1000s of bolivianos. 1 US dollar = 7.45 bolivianos	509	.088	.168
<i>Explanatory variables (first quarter): Human capital</i>				
Spanish	Ability to speak Spanish; in regression, “with difficulty” or “Some” and “Fluent” included			
	Unable (1=unable; 0=able)	627	.382	.486
	With difficulty or “Some” (1= with difficulty; 0=without difficulty)	627	.287	.452
	Well or “Fluent” (1=well; 0= unable or with difficulty)	627	.330	.470
	Overall (0=unable; 1=with difficulty; 2=well)	627	.947	.843
Schooling	Maximum school grade achieved by subject	627	1.968	2.347
Math	Score in math test; 4 questions. Total score range 0 to 4	627	1.059	1.485
Writing	Ability to sign name; in regression, only one variable, “Overall”, included			
	Unable (1=unable; 0=able)	626	.565	.496
	With difficulty (1= with difficulty; 0=without difficulty)	626	.123	.328
	Well (1=well; 0= unable or with difficulty)	626	.311	.463
	Overall (0=unable; 1=with difficulty; 2=well)	626	.746	.902
<i>Explanatory variables (first quarter): Controls</i>				
Male	Sex of subject (1=male; 0=female)	627	0.515	.500
Age	Age of subject in years	627	34.631	15.518
Health	Self-reported person-days ill from three main ailments during 14 days before interview	520	4.495	6.647
Days worked	Number of days worked in wage labor during 14 days before the interview	600	1.330	3.174
Household Size	Household size measured with number of people in the household	257	6.350	2.951
BMI	Body-mass index (kilograms/meters ²); in regression entered in logarithms	564	23.105	2.495

Table 6

Main regression results: Effect of proficiency speaking Spanish on earnings among Tsimane' adults (16+ years of age)

<i>Variables:</i>	[1]	[2]	[3]	[4]	[5]
<i>Human capital:</i>					
Some Spanish	.014 (0.12)	.009 (.010)	.012 (.013)	.012 (.013)	.015 (.014)
Fluent Spanish	.060** (0.02)	.046** (.018)	.052** (.023)	.054** (.023)	.051* (.025)
Math	^	.015 (.011)	.019 (.016)	.024 (.018)	.027 (.017)
Writing	^	^	-.006 (.016)	-.001 (.016)	-.029 (.022)
Schooling	^	^	^	-.009 (.007)	.003 (.003)
Fluent* <i>math</i>	^	^	^	^	-.005 (.027)
Fluent* <i>writing</i>	^	^	^	^	.051** (.021)
Fluent* <i>schooling</i>	^	^	^	^	-.017 (.010)
<i>Other:</i>					
Age	.0003 (.0002)	.0008* (.0004)	.0007** (.001)	.0005* (.0002)	.0007** (.0003)
Male	.062*** (.014)	.056*** (.016)	.056*** (.016)	.052*** (.016)	.050*** (.016)
Days ill	-.0006 (.0008)	-.0006 (.0009)	-.0003 (.0008)	-.0005 (.0009)	-.0004 (.001)
Days worked	.009* (.003)	.008** (.002)	.007** (.002)	.009** (.003)	.010** (.003)
Log BMI	.115* (.054)	.134** (.058)	.131** (.058)	.137** (.061)	.138** (.062)
Household size	.003 (.002)	.003 (.002)	.003 (.002)	.003 (.002)	.003 (.002)
Constant	-.372* (.183)	-.463** (.199)	-.454** (.196)	-.445** (.203)	-.462** (.210)
R-square	0.21	0.22	0.22	0.22	0.23
<i>Sample size</i>	411	411	410	410	410

Note: ^ variables not entered. Regressions=OLS with village dummies (not shown) and clustering by village. Standard errors in parenthesis. *, **, and *** significant at 10%, 5%, and 1% level. Dependent variable= earnings in 1000's bolivianos for the two weeks before interview. Explanatory variables = first quarter; earnings = fifth quarter.

Table 7

Robustness analysis: Effect of speaking fluency in Spanish on earnings among Tsimane' adults (16+ years of age)

#	<i>Coefficient of Spanish proficiency:</i>		<i>Changes introduced to main model (column 4, Table 6):</i>
	<i>Some</i>	<i>Fluent</i>	
	.012 (.013)	.054 (.023)**	Baseline case from column 4, Table 6
1	.014 (.013)	.051 (.018)**	+ Distance from village of birth to town
2	.010 (.013)	.049 (.023)*	+ age squared
3	.010 (.013)	.051 (.024)*	+ Control for traditional human capital with measure of ethno-botanical knowledge
4	.011 (.021)	.072 (.036)*	+ Experience and experience ² instead of age. Experience=age-schooling-entry age in school.
5	-.002 (.007)	.025 (.009)**	Median regression
6	-.001 (.030)	.053 (.036)	Lowered-censored tobit regression
7	.012 (.015)	.054 (.024)**	Clustering by households instead of villages
8a	.025 (.028)	.062 (.039)	Household fixed effects; only baseline
8b	.024 (.010)**	.042 (.014)***	Household fixed effects; five quarters (n=2255)
9	.089 (.189)	.369 (.197)*	Log of earnings during fifth quarter as dependent variable (n=289)
10	.079 (.180)	.370 (.183)*	Log of earnings without barter as dependent variable (n=234)
11	.023 (.010)**	.040 (.015)***	Random-effect regression with quarter and attrition dummies; five quarters (n=2196)
12	.234 (.079)***	.291 (.102)***	Like 11, except with logarithm of earnings as a dependent variable (n=1542)

Note: Similar to regression [4] in Table 6, except for changes described in the last column. Standard errors in parenthesis. *, **, and *** significant at 10%, 5%, and 1% level

Table 8

Paths: Effects of fluency in spoken Spanish on credit, modern assets, foraging productivity, and self-perceived health among Tsimane' adults (16+ years of age) over five quarters

<i>Explanatory variables, Spanish fluency</i>	<i>Dependent variables:</i>				
	<i>Access to credit:</i>		<i>Log of value of modern assets</i>	<i>Foraging productivity</i>	<i>Self-perceived health</i>
	<i>Level</i>	<i>Emergency</i>			
	<i>[1]</i>	<i>[2]</i>	<i>[3]</i>	<i>[4]</i>	<i>[5]</i>
Some	38.25* (21.41)	.087*** (.035)	.647*** (.146)	1.475** (.645)	.016 (.610)
Fluent	143.58*** (27.79)	.073* (.047)	.636*** (.183)	.825 (.839)	1.524* (.816)
<i>Sample size</i>	2116	1916	1739	1303	1703

Notes: Standard errors in parenthesis. *, **, and *** significant at 10%, 5%, and 1% level. Explanatory variables common to all regressions: two dummies for different levels of proficiency speaking Spanish, sex, age, math, writing, schooling, distance from village of birth to nearest market town, household size/quarter, and dummies for quarters and villages. Below we list explanatory variables unique to each regression besides the ones just listed.

Table 8

Paths: Effects of fluency in spoken Spanish on credit, modern assets, foraging productivity, and self-perceived health among Tsimane' adults (16+ years of age) over five quarters

[1]. Dependent variable = total credit of subject. Explanatory variables: logarithm of total wealth (modern and traditional assets). Regression is lowered-censored tobit.

[2]. Dependent variable=1 if subject reported being able to access 100 bolivianos in an emergency, 0 otherwise. Explanatory variables same as [1]. Regression is probit with probability estimated at mean values of explanatory variables and clustering by subjects.

[3]. Dependent variable=logarithm of value of 13 modern physical assets owned by subject (e.g., metal fishhooks, mosquito nets). Explanatory variables: age and sex-standardized height for age and logarithm of body-mass index. Regression is OLS with household-fixed effect (but no village dummies) and clustering by subjects.

[4]. Dependent variable=kilograms of fish brought by subject during 24 hours before scans or spot observations (see text). Explanatory variables: total number of days with self-reported illness for two weeks before interview, and logarithms of BMI and total wealth (modern and traditional assets). Regression is lowered-censored tobit.

[5]. Dependent variable= total number of days with self-reported illness for two weeks before interview. Explanatory variables: total number of days worked during the two weeks before the day of the interview, logarithms of BMI and total wealth (modern and traditional assets), and age and sex-standardized z scores of height for age and mid-arm muscle area. Regression is lowered-censored tobit.

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