The Effect of Market Economies on the Well-Being of Indigenous Peoples and on Their Use of Renewable Natural Resources

Ricardo Godoy,[1] Victoria Reyes-García,[1] Elizabeth Byron,[2] William R. Leonard,[3] and Vincent Vadez[1]

[1]Heller School for Social Policy and Management, Brandeis University, Waltham, Massachusetts 02454-9110; email: rgodoy@brandeis.edu, vreyes@brandeis.edu, v.vadez@cgiar.org

[2]International Food Policy Research Institute, Washington, DC 20006-1002; email: e.byron@cgiar.org

[3]Department of Anthropology, Northwestern University, Evanston, Illinois 60208; email: w-leonard1@northwestern.edu

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Key Words

acculturation, traditional ecological knowledge, health, nutrition

Abstract

Assessing the effects of markets on the well-being of indigenous peoples and their conservation of natural resources matters to identify public policies to improve well-being and enhance conservation and to test hypotheses about sociocultural change. We review studies about how market economies affect the subsistence, health, nutritional status, social capital, and traditional ecological knowledge of indigenous peoples and their use of renewable natural resources. Market exposure produces mixed effects on well-being and conservation. Unclear effects arise from the small sample size of observations; reliance on cross-sectional data or short panels; lack of agreement on the measure of key variables, such as integration to the market or folk knowledge, or whether to rely on perceived or objective indicators of health; and endogeneity biases. Rigorous empirical studies linking market economies with the well-being of indigenous peoples or their use of renewable natural resources have yet to take off.

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INTRODUCTION

Analysis of six databases of journal articles in the social sciences covering 1985–2003 show an annual growth rate of 9.46% in the number of articles about indigenous peoples. The growth of interest stems from two reasons. On the applied side, indigenous peoples are among the world's poorest populations (Patrinos 1994), account for most of the population in some nations, hold most of the world's traditional knowledge, and enjoy usufruct and ownership rights to some of the world's hot spots of biological diversity (Laird 2002). Governments and international organizations have started to collect data on the well-being of indigenous peoples owing to the social and numerical importance of indigenous peoples; indigenous peoples have organized to enter the radar screen of policy makers (Kuper 2003). On the academic side, indigenous peoples provide us with an opportunity to test hypotheses about what happens to people and societies as they modernize, hypotheses that are harder to test in industrial nations with greater socioeconomic heterogeneity.

We review the literature on the effects of market economies on the well-being of indigenous peoples and on their use of renewable natural resources. The outcomes covered include (*a*) health, (*b*) human growth and nutritional status, (*c*) social capital, (*d*) renewable natural resources, and (*e*) traditional ecological knowledge. The outcomes explain how markets affect a wide range of quality-of-life indicators. For brevity we limit the review to the above outcomes, developing nations, and quantitative studies. For each topic, we discuss methods of data collection and analysis. We do not discuss the effects of markets on economic inequality and vulnerability because we cover the topics elsewhere (Godoy et al. 2004a, Wong & Godoy 2003).

DEFINITION AND METHODS

Indigenous peoples are the original inhabitants of a region. We equate well-being with quality of life. Renewable natural resources include wildlife, forests, and farmlands. Autarky refers to economic self-sufficiency and is an ideal construct because even precontact foragers traded with other bands (Cashdan 1989). In rural settings of developing nations where many of today's indigenous peoples live, income refers to the sum of the following: cash received from the sale of goods and

services and rental, value of goods and services from barter and gifts received, and value of consumption from one's own fields. Market participation refers to the share of monetary earnings and value of barter with outsiders in total income. Less precise measures of market participation include the value of commercial physical assets, money borrowed from outsiders, or distance from village to market town. Physical assets or wealth, a stock variable, reflect past market participation. Monetary credit from outsiders used for consumption proxies for market participation but is best used to assess the easing of constraints on consumption (Morduch 1995). Distance between community and market town is a poor, indirect proxy for market participation because people may choose how far from market towns to live.

We distinguish between market participation, as defined above, and acculturation. People who participate in markets must acquire new language skills, attitudes, and values (Lane 1991, Bowles 1998, Lazear 1999). Standard proxies for acculturation include language skills, years of schooling, and direct measures of values (Godoy et al. 2004b). Researchers should control for the independent direct effect of acculturation; otherwise the estimated effect of market participation will contain a bias from omitting acculturation.

In studies of how markets affect indigenous peoples, anthropologists have relied on cross-sectional data or observations at one time. With such data, researchers draw inferences about the effects of markets by comparing outcomes in units that differ in market participation. Cross-sectional studies rely on contemporaneous observations to infer a process that took place over time. Panel data are more unusual and consist of repeated formal measures from the same units. Panels allow one to assess change from the same unit of observation. Panel data is better than cross-sectional data to study some types of changes (Ashenfelter et al. 1986) but has unique problems, such as biases from attrition and conditioning. Studies of how markets affect indigenous peoples have relied on cross-sectional or on short panels, making it hard to detect trends over time.

DETERMINANTS OF PARTICIPATION IN THE MARKET

Researchers have advanced five complementary hypotheses to explain what pulls or pushes indigenous peoples toward or away from markets: (*a*) the allure of foreign goods (Orlove 1997, Bauer 2001), (*b*) encroachment by outsiders (Gross et al. 1979), (*c*) resource scarcity from internal population pressure (Diamond 1995), (*d*) taxation (Cooper 2000), (*e*) the desire to improve individual well-being by capitalizing on one's comparative advantage and gains from trade (Henrich 1997, Godoy 2001), and (*f*) distaste for markets (Hirschman 1984).

To estimate the effects of markets on outcomes one must identify an exogenous source of variation in market participation; otherwise estimated effects will contain biases from endogeneity. Endogeneity biases arise from omitted variables, measurement errors, and two-way causality. For example, in testing hypothesis *b*, one must control for land quality because encroachers likely move into better lands. Because land quality correlates positively with cash earnings and with encroachment, failure to control for land quality would overstate the significance of encroachers in pushing indigenous peoples to the market. A test of hypothesis *e* must control for self-selection because only people who have the personality (Fromm & Maccoby 1970), language skills, social rank (Langer & Hames 1994), or health and nutritional status (Strauss & Thomas 1998) might self-select to participate in the market.

In a recent study (Godoy et al. 2005c) we draw on data from Tsimane' Amerindians of the Bolivian Amazon to test all but hypothesis *d* (because Tsimane' do not pay

taxes). Drawing on two annual waves of panel data from 2001 and 2002 with 378 households from 36 villages, we test hypotheses *b* and *c* by regressing household monetary income against village dummy variables. Village dummies pick up village-level traits (e.g., land quality, encroachers). Village dummies explained <5% of variation in household monetary income so we reject the idea that village or regional dynamics drive indigenous peoples to the market. To test hypothesis *a* we used two five-quarter-panel data sets (1999–2000 and 2002–2003) and estimate the share of luxury goods in cash expenditures and in the total value of goods obtained in barter. Luxury goods accounted for 2.67% of all goods obtained in barter and for 0.89% of all cash expenditures, so we reject the hypothesis that people sidle to the market to get the baubles of the modern world.

To test hypothesis *e* we used outside encroachers as an instrumental variable for monetary income in the first stage, and in the second stage we used predicted income to estimate production functions of nutritional status and health. Encroachers are a reasonable instrument for monetary income because they correlate with monetary income, but not with nutritional status or with self-perceived health. We hypothesized that own income would protect own well-being in a low-income population, but we found that instrumented monetary income bore no correlation with self-perceived health or nutritional status. Perhaps in highly autarkic societies, indigenous people self-select to take part in the market to increase group rather than individual well-being. Norms of reciprocity and gift giving common in preindustrial societies may cause own monetary income to leak out, attenuating the protective role that own income would have had on own well-being. Results raise the possibility that indigenous peoples in highly autarkic settings self-select to enter the market to improve group rather than individual well-being.

HEALTH

As indigenous peoples gain greater exposure to market economies, their health may improve or worsen. Researchers have come to different conclusions about how market exposure influences health partly because of differences in the definition of health used.

Methods

Researchers have assessed health using objective and perceived measures. Objective measures include clinical examinations, functional tests, analysis of blood, urine, or fecal samples, and assessment of anthropometric indicators of nutritional status (Hern 1994). The measures reflect Western concepts of the function and structure of the body. Objective measures require investments in training observers and in equipment but have the advantage of being replicable (Murray & Chen 1992).

Perceived health reflects subjective measures of one's or another's health and cultural concepts of illness and well-being. Anthropologists have recorded perceived illness or symptoms by having a subject recall events over a well-defined reference period (Young & Garro 1982, Scrimshaw & Hurtado 1987, Reeve 2000, Byron 2003). Reference periods range from seven days to three months; longer periods work better for major illnesses (Weller et al. 1997). Repeated recalls over short periods improve accuracy. The use of health services, a measure of the severity of perceived illness, introduces additional data about perception of efficacy, access, and price (Murray & Chen 1992).

Objective and subjective measures incur trade-offs in time, resources, acceptability ethics, and privacy. Some societies may reject invasive methods (e.g., collecting blood specimens), so their use would hinder data collection (Ulijaszek & Strickland 1993). Remote areas pose greater challenges to the preservation of samples that require special temperature or sterile conditions (Ulijaszek & Strickland 1993). Laboratory analyses of this

type of data enable diagnosis of illnesses (e.g., iron-deficiency anemia) impossible to obtain from perceived measures of health. Although requiring no advanced technology, the recall method requires knowledge of cultural concepts of illness to improve external validity (Kroeger 1983). Factors that influence the quality of data collected from recall include the wording and sequencing of questions and the use of proxy respondents (Murray & Chen 1992). Further, the use of perceived measures of health trammels comparisons across populations and subjects.

Beneficial Effects

Expanded opportunities to earn income, better nutrition, modern knowledge about illnesses, and access to modern health care bode well for indigenous peoples if they can access these resources and services (Steckel 1995). Market economies can satisfy needs for schooling, modern medicines, and new health technologies (Berry et al. 1986, Santos & Coimbra 1991). Integration into the market could increase monetary income and consumption of goods and services, including health care (Akin et al. 1985) and food.

Adverse Effects

Archaeological and ethnographic data suggest that the shift to a sedentary lifestyle harms health because infections can persist and hygiene is harder to maintain with greater population densities (Armelagos 1990). Disrupting traditional subsistence can limit indigenous peoples's capacity to protect their health (Lawrence et al. 1980, Wirsing 1985, Coimbra et al. 2002). Positive income effects on health from market exposure may not occur without parallel improvements in physical infrastructure of living conditions (Kennedy 1994) or knowledge about disease transmission and prevention (Tomes 1999). Further, people can use income to buy luxury items, including tobacco and alcohol, which do not directly improve (and may even harm) health (Steckel 1995). Last, if market participation erodes social capital, market exposure may harm health (Godoy et al. 2005a).

Subjective good health may decrease with integration into the market economy (Godoy & Cardenas 2000) if people cannot meet rising expectations for better health (Goodland 1988). As people become acculturated to a different understanding of what it means to be healthy, their standards of hygiene and perceptions of good health change. International studies suggest that perceptions of health correlate positively with income (Akin et al. 1985); people of higher income report more illness (Murray et al. 1992).

Recent Evidence

Byron (2003) found no association between measures of market participation or acculturation and perceived illness among Tsimane'. Parental acculturation correlated positively with perceived poor health of children; parents of children living closer to the market town reported more illness, longer duration, and greater severity of illness for their children. Among adults, only women's schooling correlated with fewer reports of own illness and with shorter duration and less severity. McDade et al. (2005) found a positive association between maternal schooling and C-reactive protein among Tsimane' children, possibly indicating high burden of infectious disease. Fitton (2000) studied two Cofan communities in Ecuador and found that market participation correlated negatively with children's health and nutritional status. Children from the more urbanized community showed higher levels of parasitic infections, lower hemoglobin levels, and poorer growth measures.

HUMAN GROWTH AND NUTRITIONAL STATUS

Here we examine the influence of markets on the physical growth and nutritional status of lowland South American indigenous peoples.

MAC: mid-arm circumference

HAZ: height-for-age Z-scores

We focus on children's growth and nutritional status because they respond to environmental quality and therefore provide a robust index of general population health (World Health Organ. 1995).

Common measures to assess growth status include height (stature), weight, mid-arm circumference (MAC), and selected skinfolds. Height for age proxies for long-term, chronic nutritional problems, whereas weight measures (weight for age and weight for height) reflect short-term, acute nutritional problems. Arm circumference reflects a child's muscular development and thus provides an index of protein reserves. Skinfolds reflect body fatness and provide a measure of energy store.

Children's growth status is evaluated with reference norms from well-nourished populations. Height for age, weight for age, and weight for height are typically evaluated relative to standards from the U.S. National Center for Health Statistics (Hamill et al. 1979). Skinfold and arm circumference measures are generally compared with Frisancho's (1990) standards on the basis of data from the United States. Measures are typically compared with reference data using Z-scores. Children with Z-scores ≤ -2.0 are nutritionally at risk. Children with low (≤ -2) height-for-age Z-scores (HAZ) are called stunted, and those with low weight for height are called wasted.

Previous research suggests that stunting is common among lowland South American indigenous peoples (Hodge & Dufour 1991, Orr et al. 2001, Foster et al. 2005). In contrast, growth in weight, muscularity, and body fatness resembles U.S. norms. **Table 1** compares the prevalence of stunting and wasting in several lowland South American indigenous populations. The average prevalence of stunting is 46%. The exceptions are the Achuar, with levels of stunting ranging from 0% to 32%. In contrast, low weight-for-height levels are rare, averaging only 3%. Young Shipibo boys from Peru are the exceptions for this measure, having low weight-for-height levels of 13%.

These patterns are seen in **Figures 1–4**, which show the growth of 859 Tsimane' children fewer than 18 years of age. Tsimane' children are short relative to their U.S. peers: Males and females both track near the U.S. fifth centile throughout their growth (**Figure 1**). Body weight tracks between the tenth and twenty-fifth centiles for males and between the twenty-fifth and thirtieth centiles for females (**Figure 2**). Despite their diminutive size, arm muscle development is good. Male MAC tracks at fifteenth centile, whereas females fluctuate between the twenty-fifth and fiftieth centiles

Table 1 Prevalence of stunting and wasting among children from lowland South American populations

Population	Sex	Stunted	Wasted	Reference
Tsimane' (Bolivia)				
(<5 years)	M	55%	2%	
	F	52%	1%	
(5–9.9 years)	M	43%	2%	
	F	49%	2%	
(10–17.9 years)	M	31%	0%	
	F	32%	0%	
Chachi (Ecuador)				
(4–9.9 years)	M/F	75%	1%	Stinson (1989)
Shipibo (Peru)				
(<3 years)	M	53%	13%	Hodge & Dufour
	F	31%	6%	(1991)
Tukanoan (Colombia)				
(1–4.9 years)	M	82%	0%	
	F	60%	6%	Orr et al. (2001)
(5–9.9 years)	M	70%	0%	
	F	70%	3%	
(10–17.9 years)	M	80%	5%	
	F	77%	2%	
Achuar (Ecuador)				
(1–4.9 years)	M	32%	0%	Orr et al. (2001)
	F	0%	0%	
(5–9.9 years)	M	12%	0%	
	F	0%	0%	
(10–17.9 years)	M	42%	0%	
	F	45%	0%	
Peru: rural Amazonia (<6 years)	M	52%	2%	Instituto Nacional
	F	53%	1%	de Estadística del Peru (1986)

(**Figure 3**). Tsimane' also have adequate body fat as measured by the sum of triceps and subscapular skinfolds (**Figure 4**). Tsimane' males are consistently between the twenty-fifth and fiftieth centiles. Tsimane' females fall between the twenty-fifth and fiftieth centiles through age 13 and exceed the U.S. median after that.

Influence of Diet and Disease on Growth

Measures of physical growth of lowland Amerindian children suggest that they generally are not experiencing severe protein energy malnutrition. Growth in body mass, muscle development, and fatness compare favorably with U.S. norms. Rather, the high levels of stunting suggest chronic, mild-to-moderate undernutrition that may reflect low dietary quality and high rates of infection.

Dietary data for lowland South American Indians suggest that energy availability is generally good. Among 229 Tsimane' households, energy and protein intakes averaged 2912 kcal/person/day and 86.3 g/person/day. The intake levels resemble those of other South American Indians (Berlin & Markell 1977, Orr et al. 2001). Although household energy availability may be adequate, the quality of the diet may not be nutritionally appropriate for young children. Garden products such as manioc and plantains typically contribute upwards of 65%–70% of dietary energy in lowland Amerindian groups. The staples are sufficiently dense in nutrients to meet adult requirements but are inadequate to meet the high nutritional needs of young children.

Besides diet, disease also hampers the growth of lowland Amerindian children. Intestinal parasites such as hookworm (*Necator americanus/Ancylostoma duodenale*) and roundworm (*Ascaris lumbricoides*) are common throughout Amazonia. Berlin & Markell (1977) found high rates of parasitic infections among the Aguaruna: 93% of subjects were infected with hookworm, 92% with Whipworm (*Trichuris trichiura*), and 62% with roundworm. Fitton (2000) found roundworm and hookworm infection rates of 44% and 17% in two Cofan villages of Ecuador. Tanner et al. (2004) found that 85% of Tsimane' had parasitic worm or protozoa infection. Hookworm was the most common parasitic infection, affecting 73% of subjects, 15% of whom were infected with roundworm.

Parasitic infections compromise growth and nutritional status by limiting intestinal absorption of key nutrients (e.g., iron). Consequently, high rates of anemia are another common nutritional problem for Amazonian Amerindian children. Among the Bari of Venezuela, Diez-Ewald et al. (1997) found that 54% of children 1–18 years of age were anemic. Lindsay et al. (2003) report similar results among Tsimane' children 1–10 years old. They found that 61% of boys and 57% of girls were anemic and showed significantly poorer measures of growth in height, weight, and muscularity.

WHZ: weight-for-height Z-scores

WAZ: weight-for-age Z-scores

Influence of Markets

Markets do not have a uniform influence on children's growth status among lowland South American Indians. Stinson (1996) studied Chachi Amerindian children under five years of age in Ecuador. Measures of socioeconomic status, including material possessions and type of employment, correlated positively with HAZ, weight-for-height Z-scores (WHZ), skinfolds, and MAC. Leonard et al. (1994) found similar results in coastal Ecuador. Schooling of mothers and fathers, livestock ownership, and cash expenditures for food all correlated positively with HAZ and weight-for-age Z-scores (WAZ) in children under six years of age.

Research among Tsimane' underscores the variable influences that market exposure has on growth. Byron's (2003) analyses of panel data from two Tsimane' villages showed divergent effects of maternal and paternal schooling. Mother's schooling showed a modest positive influence on WHZ and MAC, but father's schooling correlated negatively with

BMI: body mass index

HAZ and WAZ. Lindsay Analyses by Lindsay et al. (2003) of children from 12 Tsimane' villages suggest that children from households with intermediate levels of market participation were at greatest risk. Children of mothers with intermediate levels of Spanish proficiency had the poorest HAZ, WAZ, and hemoglobin measures. Foster et al. (2005) analyzed village correlates of children's nutritional status in 58 Tsimane' villages. Distance to the nearest town did not correlate with children's growth, but the number of teachers per village correlated with improved WHZ, WAZ, and sum of skinfolds. Using panel and cross-sectional data, Godoy et al. (2005a, 2005b) showed that household income had ambiguous effects on adult body mass index (BMI) and skinfolds, but schooling and wealth correlated with improved anthropometric indices of short-run nutritional status.

The comparative analyses suggest that integration to the market does not have a uniform positive or negative influence on children's growth status. Simple measures of isolation are generally not strong predictors of children's growth. Of the integration measures noted above, mothers' schooling appears to correlate with improvements in growth. Stature, a long-term measure of nutritional status, is the least affected by integration to the market. In contrast, measures of short-term nutritional well-being—weight, muscularity, and fatness—are more sensitive to differences in exposure to the market and acculturation.

SOCIAL CAPITAL

Social capital refers to trusts, safety nets, and institutions that enable people to act collectively. In preindustrial societies, social capital consists of informal institutions (e.g., gift-giving) (Kaplan & Hill 1985, Gintis et al. 2003), whereas in industrial societies social capital consists of participation in formal civic institutions (Portes 1998).

In preindustrial societies, social capital helps to smooth consumption against idiosyncratic income shocks, such as illness (Carter & Maluccio 2003) or poor luck foraging (Winterhalden 1997). Researchers have debated whether markets worsen the well-being of indigenous peoples by eroding their traditional social capital. The debate matters because if social capital weakens with the expansion of markets, then one might expect greater economic vulnerability among indigenous peoples as they enter the market economy. Some researchers argue that modernization weakens social capital. Putsche (2000) found that Peruvian Amerindians shared purchased goods less than goods produced at home. Bury (2004) found that gold mining eroded access to interhousehold social capital and created distrust, social differentiation, and conflict between households.

Researchers also find, however, that integration into the market does not always erode social capital because traditional forms of social capital permeate new institutions (La Ferrara 2003), nor does it harm well-being because the prevalence of reciprocity in preindustrial societies reduces the adverse effects of income inequality. With reciprocity, the effect of own income spills over to the rest of the community, attenuating the protective role of own income on own health that one finds in industrial nations (Kawachi 2002). Other investigators have found that informal safety nets fail to protect rural households fully against unexpected income shocks (Wong & Godoy 2003, Heemskerk et al. 2004). Formal systems of self-insurance (e.g., credit) can improve well-being by allowing households to smooth consumption (Gertler & Gruber 2002).

In sum, we find contradictory evidence on whether integration into the market economy erodes traditional forms of social capital, or whether traditional forms of social capital permeate the new market-based forms of self-insurance. We know of no quantitative study that compares the private benefits of traditional social capital with its private costs.

NATURAL RESOURCES AND SUBSISTENCE PRACTICES

Here we discuss how integration into the market influences the way indigenous peoples use renewable natural resources. The depletion of renewable natural resources undermines biological and cultural diversity and climate stability (Costanza et al. 1997).

Traditional Use of Renewable Natural Resources

Researchers have debated whether indigenous peoples use renewable natural resources in a sustainable way and have found that, irrespective of traditional practices, increasing integration into the market and population pressure induce indigenous peoples to degrade renewable natural resources (Godoy 2001). With simple technology, low rate of population growth, and weak links to the market economy, traditional land uses have been able to feed local populations (Posey & Balee 1989). At present, few indigenous peoples rely exclusively on natural resources, and most depend on agriculture and commerce with outsiders. Market penetration changes the way indigenous peoples use natural resources. A study using cross-sectional and panel data among the Tsimane' suggests that as households integrate into the market economy, they deforest about twice as much to cultivate rice (the main cash crop) compared with more autarkic households; they also intensify farm production by replanting a higher proportion of their fields after the rice harvest (Vadez et al. 2004). Land shortage induces pastoral nomads to intensify production by shifting to farming (Coast 2002, Mccabe 2003). These studies rely on a small sample size of observation and contain little variance in exposure to the market, making it difficult to obtain reliable estimates of how integration into the market affects traditional uses of renewable natural resources.

Integration to the Market and Crop Diversification

Indigenous peoples diversify production to protect subsistence (Bentley 1987) and to improve nutrition (Tontisirin et al. 2002). Trade theory predicts that integration into the market should correlate with greater specialization in production because people specialize in the crops in which they enjoy a comparative advantage, but empirical studies suggest that indigenous peoples preserve agricultural diversity (Brush et al. 1992). Vadez et al. (2004) show that Tsimane' households more integrated into the market intercropped more, used more varieties of manioc, and put more crops in new fields than did more autarkic households. A possible explanation for why integration into the market does not erase crop diversification relates to the role of genetic diversity as a safety net against unexpected mishaps. Because the market does not yet provide well-functioning forms of self-insurance (e.g., credit), people opt to maintain crop diversity to protect income and consumption.

Tropical Forests and Cash Cropping

Few studies focus on the relation between cash cropping and deforestation among indigenous peoples. Lowland Amerindians join the market to raise their income and consumption (Simmons 1997), often by increasing the surface under cash crops. In Thailand, Dearden (1995) suggests that the intensification of cabbage cultivation as a cash crop may have increased deforestation because cabbage has low value/land unit compared with opium, which it replaces. Mertens et al. (2000) found that deforestation in Cameroon rose with increased marketing of food crops. Vadez et al. (2004) found that cash cropping rice among Tsimane' correlated with more deforestation and that people expanded cash cropping to remote areas of tropical forests. We used a simulation model and found that reaching the international poverty line of 1 US$/person/day by cash cropping rice would require doubling

NTFP: non-timber forest products

the area of forest cleared/household, and it would require tripling the area of forest cleared/household if one added demographic increases. In sum, cash cropping will likely increase deforestation, except if farm productivity increases or if new crops with higher value/land unit are introduced.

Non-Timber Forest Products and Conservation

Indigenous peoples now choose non-timber forest products (NTFP), once used chiefly for consumption, to diversify the household economy, even among households well integrated into the market. Some researchers say that expanding the use of NTFP could increase the value of forests, thereby helping conservation (Panayotou & Ashton 1992). Although NTFP produce less income than do other land uses, the extraction of NTFP could be a lasting option because it does not require deforestation (Prance 1997). Other scholars say that the intensification of NTFP could hurt the poorest users (Arnold & Perez 2001) and degrade the forest. For example, in tropical Africa, where people widely trade bushmeat (Wilkie et al. 2000), the intensification of hunting could lead to species extinction. In sum, NTFP could be an option to enhance conservation if one has management plans to prevent people from overexploiting NTFP.

Other Options to Conserve Renewable Natural Resources

One option to conserve renewable natural resources might be to intensify production in a sustainable way. The depletion of renewable natural resources by indigenous peoples may reflect access to new farm technologies, but the lack of empirical data to test the hypothesis makes it unclear whether technological improvements reduce or increase pressure on natural resources (Angelsen & Kaimowitz 2001). Some researchers say that increases in agricultural productivity increase deforestation (Godoy 2001), but others say that technological improvements decrease deforestation (Jones et al. 1995) or produce ambiguous results, depending on the type of technology and crops used (Angelsen & Kaimowitz 2001).

Some researchers have proposed agroforestry as a way for slash-and-burn farmers to increase land productivity (van Noordwijk et al. 2002). Various technologies (e.g., legume plants) are available to maintain or restore soil fertility. A study in Ecuador suggests that the use and sparing of *Iriartea deltoidea* palms would allow sustainable harvesting of the palm and improve the well-being of the local user (Anderson & Putz 2002). A study on natural rubber in Brazil suggests that 80% of farmers believe that associated vegetation did not depress rubber yields, and 90% of them extracted other products from the agro-forests (Schroth et al. 2003). Those results suggest that low-intensity agroforestry can improve well-being without the need for plantations. We know little about the determinants of adoption of new farm technologies benign to the environment, except that their rate of adoption is low (Dagang & Nair 2003) overall but higher among households with more land and capital (Perz 2003).

Because NTFP, agro-forestry, and new farm technologies contribute only indirectly to the conservation of natural resources, and because they have had a modest impact on conservation, development organizations have started to assess the merits of paying direct users to protect forests. One initiative consists of buying forests to create parks. Another initiative, conservation payments, directly rewards forest owners for not using forests (Ferraro 2001). Although transparent and simple, the proposals have drawbacks. First, parks without people might undermine biological diversity because humans have increased biological diversity; the proposal may also contribute to landlessness (Romero & d'Andrade 2004). Second, direct conservation payments may displace deforestation to new areas where no payment is made. Last, payments may undermine the pride that stems

from exspending effort to produce goods and services one needs.

In the debate over indigenous peoples' use of natural resources, monetary income will likely continue to play a prominent role. Effective options for conservation should increase income and have a high ratio of income/land unit, taking into account the possible positive environmental externality of land. Conservation options could include agro-forestry, extraction of NTFP, or cash cropping. Conservation payments could take the form of promoting or subsidizing products (e.g., organic rice) with a high value and a high ratio of income to land, thereby enhancing conservation.

TRADITIONAL ECOLOGICAL KNOWLEDGE

Researchers often use as synonyms the terms folk, local, indigenous, and traditional ecological knowledge to refer to the culturally shared body of knowledge of the environment held by people that interact with the environment. Since the 1970s, researchers have used quantitative methods to study patterns of intracultural distribution of knowledge and have found that the distribution of folk knowledge is not random but patterned. Demographic variables such as age, sex, and kinship (Boster 1986, Caniago & Siebert 1998) correlate with intracultural variation in traditional ecological knowledge. Most of the studies linking traditional ecological knowledge to demographic variables have relied on bivariate analysis and used a small sample size of observations.

More recently, researchers have advanced hypotheses to explain patterns of intracultural distribution of traditional ecological knowledge and used multivariate regressions and larger samples to test the hypotheses. Sternberg (1997) predicts that the loss of traditional ecological knowledge results from acculturation. Time and resources invested in school deflect from investments in folk knowledge because people cannot learn two things concurrently. Researchers have found empirical support for the hypothesis that acculturation correlates with less traditional ecological knowledge (Benz et al. 2000, Zent 2001).

Researchers studying the relation between patterns of intracultural variability of traditional ecological knowledge and integration into the market economy have hypothesized that integration into the market would correlate with less traditional ecological knowledge because markets enable people to access substitutes for natural products and because markets correlate with greater socioeconomic heterogeneity, undermining the pooling of traditional ecological knowledge. This debate matters because if economic development consistently erodes traditional ecological knowledge, then it will be difficult to simultaneously preserve traditional ecological knowledge and achieve economic development for people holding the knowledge. There is scarce empirical evidence to support the hypothesis that markets consistently erode traditional ecological knowledge. For example, Zarger & Stepp (2004) found no change in ethnobotanical knowledge among children despite significant socioeconomic changes in Chiapas. Godoy et al. (1998) found that integration into the market through the sale of crops or through wage labor correlated with less knowledge of wildlife, but integration into the market through the sale of forest goods correlated with more knowledge of wildlife. Reyes-García et al. (2005) found that, although the link between traditional ecological knowledge and proximity to towns resembled an inverted U, other canonical indicators of market economies (e.g., cash) bore no significant correlation with traditional ecological knowledge. Guest (2002) found that integration into a market economy through an activity based in the natural environment could accelerate the acquisition of local ecological knowledge.

A likely explanation for the inconsistency across findings stems from differences in methods used. First, researches have used

different proxies to measure traditional ecological knowledge. Some authors have proxied traditional ecological knowledge by studying the uses of wild plants (Caniago & Siebert 1998, Zent 2001, Reyes-García et al. 2004), others have studied crops (Boster 1986), and others have studied wild plants and animals and their interactions (Godoy et al. 1998, Atran et al. 2002). Second, researchers have used many methods to measure traditional ecological knowledge. Some have measured knowledge by using transect's surveys (Zarger & Stepp 2004), free-listing (Atran et al. 2002), and multiple-choice (Zent 2001, Guest 2002, Reyes-García et al. 2004) and objective tests (Godoy et al. 1998). Data collected with different methods do not correlate highly (Reyes-García et al. 2004). Differences in methods of data collection curb our ability to compare results of studies and draw generalizations about what drives intragroup variation of traditional ecological knowledge. Third, lack of reliable baseline measures makes it difficult to estimate changes in traditional ecological knowledge.

Most definitions and methods do not capture well the concept of traditional ecological knowledge. Traditional ecological knowledge includes different dimensions. Theoretical knowledge refers to the ability to name species or uses of species. Practical knowledge refers to the ability to associate names with organisms or the ability to use that knowledge. Most studies have measured theoretical knowledge; for several reasons, practical knowledge may be more useful when examining how markets affect knowledge. First, the literature suggests that people acquire most of their theoretical ecological knowledge by adolescence (Zarger 2002), but they acquire practical skills during adulthood (Ohmagari & Berkes 1997). One ought to find more variation in the practical knowledge of adults than in their theoretical knowledge. Second, if markets erode traditional ecological knowledge by enabling people to access substitutes for natural products, then we would expect markets to affect practical knowledge before affecting theoretical knowledge. Third, the ability to transform plants and animals implies not only the ability to recognize and use them, but also knowledge of their ecology and the techniques to transform them in a culturally appropriate way.

The growing concern that traditional ecological knowledge may disappear forever, and the increasing interest in the potential uses of traditional ecological knowledge to help identify biological and genetic resources, has inspired a global movement to protect the rights of indigenous peoples to their knowledge. The policy debate centers on compensating indigenous peoples for the commercial uses of their knowledge (Laird 2002, Brown 2003) while acknowledging that traditional ecological knowledge is a common-pool resource (Reyes-García et al. 2003). Practitioners and researchers have proposed two overlapping ways to preserve traditional ecological knowledge. Ex situ preservation methods consist of documenting the knowledge and storing it in databases and registers (UNU-IAS 2004). In situ methods try to reverse the causes that generate the erosion of traditional ecological knowledge and attempt to preserve and strengthen local knowledge by promoting activities that draw on its use.

CONCLUSIONS

Rigorous quantitative studies linking market economies with the well-being of indigenous peoples or with their use of renewable natural resources have yet to take off. Such studies face four hurdles: (*a*) lack of agreement on how to measure variables, which occludes comparisons and generalizations; (*b*) lack of a convincing strategy to identify causality, which impugns the accuracy of previous findings; (*c*) weak collaboration among researchers of different disciplines, which produces a partial view; and (*d*) absence of long panels, which hinders understanding development over time. Anthropology, with its unique biocultural perspective and its penchant for long-term research, has the potential to overcome these hurdles.

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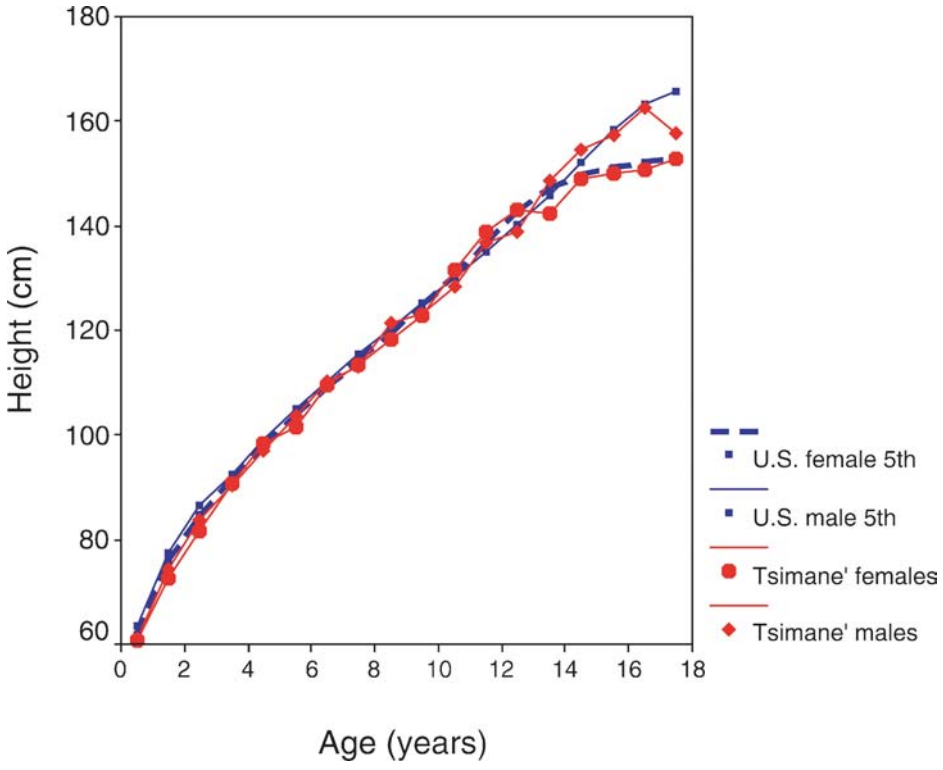

Figure 1

Stature (cm) of Tsimane' males and females fewer than 18 years relative to the U.S. fifth centiles from Hamill et al. (1979).

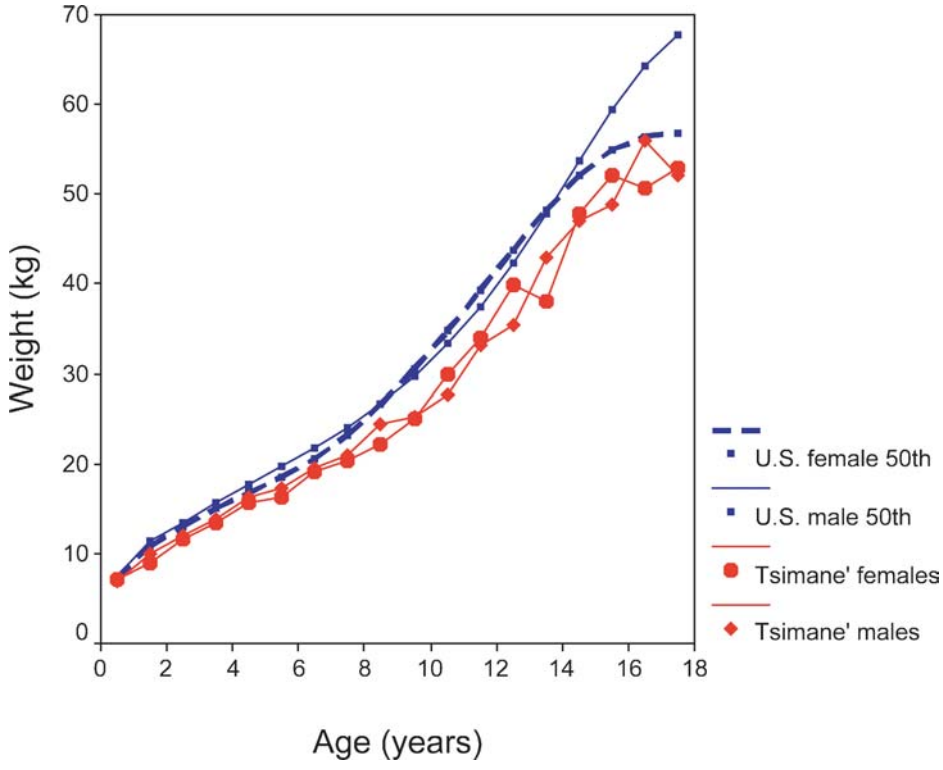

Figure 2

Body weight (kg) of Tsimane' males and females fewer than 18 years relative to the U.S. fiftieth centiles from Hamill et al. (1979).

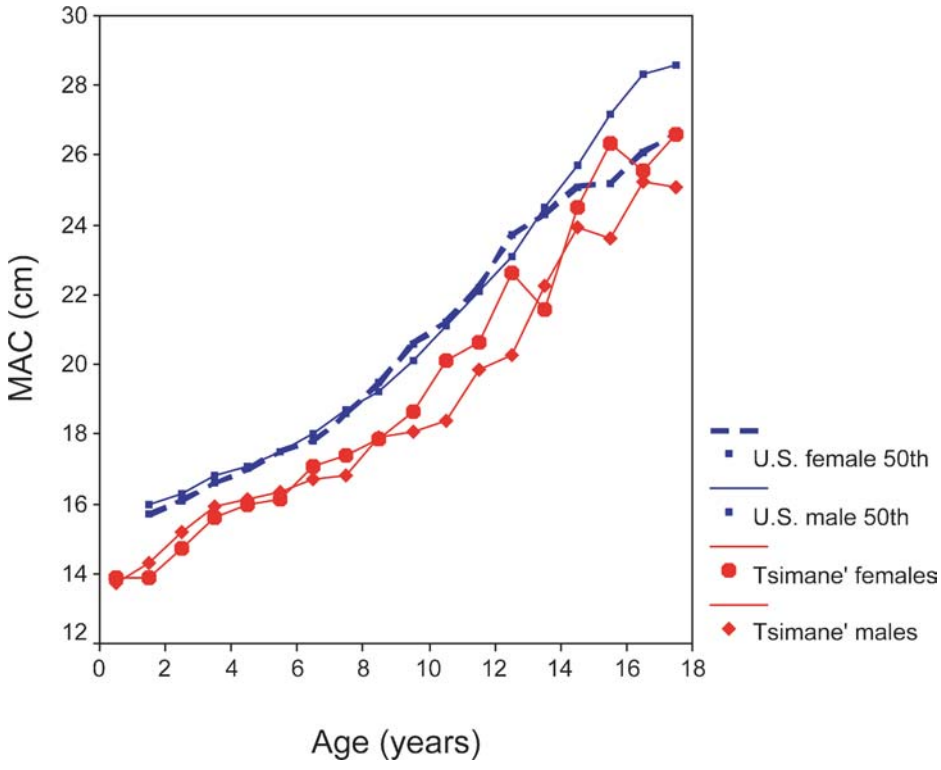

Figure 3

Mid arm circumference (MAC; cm) of Tsimane' males and females fewer than 18 years relative to the U.S. fiftieth centiles from Frisancho (1990).

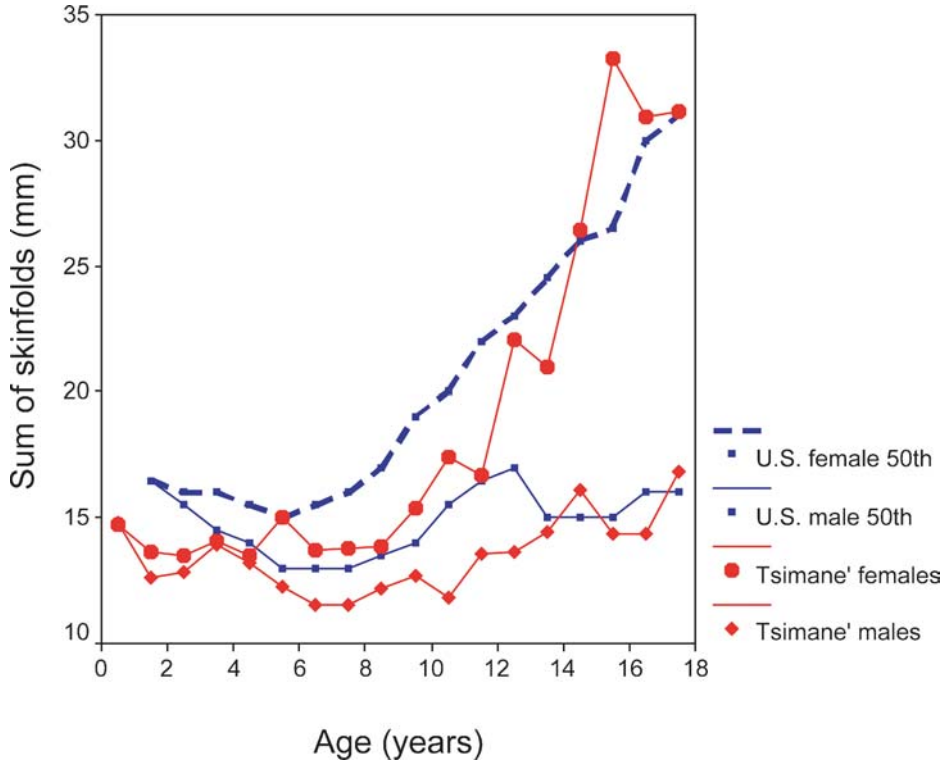

Figure 4

Sum of skinfolds (mm) for Tsimane' males and females fewer than 18 years relative to the U.S. fiftieth centiles from Frisancho (1990).

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