Does market integration buffer risk, erode traditional sharing practices and increase inequality? A test among Bolivian forager-farmers

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Abstract

Sharing and exchange are common practices for minimizing food insecurity in rural populations. The advent of markets and monetization in egalitarian indigenous populations presents an alternative means of managing risk, with the potential impact of eroding traditional networks. We test whether market involvement buffers several types of risk and reduces traditional sharing behavior among Tsimane Amerindians of the Bolivian Amazon. Results vary based on type of market integration and scale of analysis (household vs. village), consistent with the notion that local culture and ecology shape risk management strategies. Greater wealth and income were unassociated with the reliance on others for food, or on reciprocity, but wealth was associated with a greater proportion of food given to others (i.e., giving intensity) and a greater number of sharing partners (i.e., sharing breadth). Across villages, greater mean income was negatively associated with reciprocity, but economic inequality was positively associated with giving intensity and sharing breadth. Incipient market integration does not necessarily replace traditional buffering strategies but instead can often enhance social capital.

Keywords

cooperation; sharing; risk management; food security; Tsimane; Bolivian Amazon; market integration

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Introduction

Food insecurity is an ancient problem with an ancient solution: sharing of food and labor among huntergatherers and other subsistence populations reduces the risk of variable returns and production failure (Jaeggi and Gurven 2013; Smith 1988; Winterhalder 1997). Human subsistence strategies often require substantial skill and depend on variable ecological conditions impacting prey abundance and soil fertility; kills or harvests that supply a steady stream of calories are difficult to obtain consistently even for skilled foragers and farmers. Hunting big game and other production activities often entail substantial risk of returning empty-handed, e.g., 96% for big game among Hadza of Tanzania (Hawkes *et al.* 1991), 40–65% in neotropics (Gurven *et al.* 2006; Hill and Hurtado 2009). Resources characterized by high variance in production are most likely to be shared, and to be shared widely (Gurven 2004b). However, even when resources are relatively predictable, sharing may be valued as a type of informal insurance. Sickness, injuries, drought, family death, divorce and other factors can disrupt productivity, providing additional need for resource sharing as an effective means of reducing risk (Gurven *et al.* 2012; Sugiyama 2004). In the absence of formal insurance arrangements, risk reduction through sharing is not limited to foragers but is a common strategy amongst the rural poor (Dercon and Krishnan 2000; Fafchamps and Gubert 2007; Ligon *et al.* 2001; Rosenzweig and Wolpin 1993). Where informal risk sharing networks abound, cultural values emphasizing generosity, egalitarianism, and demand-sharing may be common, minimizing wealth inequalities (Kent 1993; Peterson 1993).

Despite the apparent benefits of resource pooling, sharing carries the short-term cost of giving up resources or time, and involves risk if others do not reciprocate in a timely fashion, or during critical periods of need. The potential for cheating or defection acts as a constant threat to the stability of reciprocal sharing relationships without enforceable contracts. Reciprocity is also difficult to maintain in larger groups (Boyd and Richerson 1988), requiring transparency and monitoring, stable group membership, clustering among cooperators and effective punishment of defections (Axelrod and Dion 1988). The ability to store food and accrue savings and credit by alternative means may be a welcome option for smoothing variance in consumption, especially when disruptive, idiosyncratic shocks to production are frequent. Money obtained from wage labor or from selling meat, fish or agricultural crops to the market has the double advantage of being both storable and fungible; it can be saved and is easily exchanged for different resources of similar value. Market exchanges may also be more secure, especially when payment between parties occurs simultaneously without a fragile delay that might later lead to defection. Immediate payment removes the potential for free-riding. Thus, greater market integration and cash flow might erode traditional exchange networks. Individuals more involved in the market may rely on cash savings and market purchases rather than to debts owed by others to effectively buffer risk; these individuals may therefore favor material or market wealth over relational wealth (i.e., social capital). If greater market integration is associated with reduced resource pooling, then market integration may erode traditional egalitarian norms of redistribution, leading to increases in economic inequality.

Although not widely studied, there is precedent for expecting an influx of market interactions to disintegrate traditional social relations and erode egalitarian norms and values

(Haagsma and Mouche 2013). Among the Shipibo of Peru, a cash market for agricultural labor and meat led to a reduction in traditional food sharing behavior (Behrens 1992). Fish and game were increasingly sold within villages rather than shared informally with kin and other exchange partners. Traditional sharing networks based on kinship and reciprocity had been replaced by monetary payment for labor or food (Ensminger 1992; Putsche 2000). Similar claims have been made for the Dobe !Kung (Yellen 1990) of the Kalahari and the Igbo of Nigeria (Onyeiwu 1997). The notion that the markets bolster valuation of private property, personal profit and individualistic values while diminishing certain aspects of communal property, egalitarian values and associated production systems is explicit in Polanyi's "Great Transformation" (1944) and implicit in Marx (1998 [1848]) and many others. Indeed, the effects of markets extend beyond patterns of food sharing by altering other aspects of social life. For example, less bride service and greater nucleation of households was observed among more market-oriented Shipibo (Behrens 1992). Similarly, land privatization and greater market integration undermined traditional safety nets, increased community conflict and led to greater ethnic polarization among Samburu pastoralists in Kenya (Lesorogol 2003).

Conversely, cross-cultural experiments reveal that market integrated populations demonstrate more generous social behavior than isolated small-scale societies. Populations whose diet is derived more from the market tend to give a larger portion of monetary endowments away to others (Henrich *et al.* 2005). However, reliance on money as a medium of exchange may help build generalized trust in market transactions (Jevons 1885; Seabright 2010) but may also crowd out voluntary cooperation and gift giving (Camera *et al.* 2013; Onyeiwu 1997).

While sharing networks may reduce risk from daily food shortfalls and other activities, market exchanges may be used to reduce certain types of risk that sharing does not (De Weerdt and Dercon 2006). For example, informal sharing networks may be ineffective for dealing with health risks that require expensive treatments (Fafchamps and Lund 2003; Gertler and Gruber 2002). At the same time, sharing food may provide additional benefits that market exchanges do not, such as cementing in-group political alliances (Patton 2005; von Rueden *et al.* 2008) and aiding needy kin (Kaplan and Hill 1985). Low risk farm foods may be shared reciprocally to take advantage of fixed production and transport costs and economies of scale in production, processing and cooking (Hames and McCabe 2007). Reciprocal labor exchange can also occur during periods of peak labor loads (Erasmus 1956). Alternatively, cash obtained from wages or market sales might be used to boost one's reputation (Gurven and von Rueden 2006; Smith 2004), especially through luxury purchases, or to obtain mating benefits (Stieglitz *et al.* 2012), rather than helping to reduce risk (Godoy *et al.* 2007a). In all of these scenarios, traditional social exchange networks would still be needed, and so market integration may not disrupt or alter traditional sharing patterns. In the first study to examine the relationship between sharing behavior and selling of meat by the same individuals within a community, meat sharing intensity among Huaorani foragerhorticulturalists of Ecuador did not vary with greater market involvement (Franzen and Eaves 2007); market sales were instead used to purchase storable foods that were consumed primarily by household members, and so helped reduce risk, but did not erode sharing relationships. Thus, an alternative hypothesis is that greater market access may

be unrelated to reliance on others for social support and sharing when markets and sharing networks are at best imperfect substitutes.

Finally, we acknowledge the possibility that a *positive* relationship between market access and sharing could occur if specialization, divisions of labor and inter-household trade are common strategies for obtaining traditional and market goods. If entry into the marketplace requires specialized skills or substantial time investment (especially away from the village) that competes directly with the ability to employ traditional means of obtaining food, such divisions of labor among households with different specializations followed by resource pooling may be one possible efficient arrangement. While food could instead be purchased in the market, poor infrastructure in rural areas often limits the availability and/or increases the price of traditional meat and fish. Divisions of labor among households based on comparative advantage could therefore lead to a greater dependency on subsistence foods and trade among those engaged in market interactions. If divisions of labor instead occur within households, rather than between them, then we might expect more self-sufficiency at the household level and therefore less emphasis on traditional sharing with others. If transportation or other transaction costs for selling goods in the market are high, food production in excess of what is sold may be used to instead recruit and strengthen alliances and other forms of assistance. Income from wage labor or food production or gifts of food may be used to purchase others' labor to increase economies of scale in production. However, even if market-oriented families are not reliant on others for access to traditional foods and labor, their greater access to novel resources and market-related knowledge may make them attractive social partners (von Rueden *et al.* 2008).

This paper tests hypotheses about trade-offs between maintaining traditional sharing relationships and obtaining novel types of wealth through market involvement among Tsimane foragerhorticulturalists of lowland Bolivia. The Tsimane are an excellent test case for examining potential changes in traditional risk management strategies. First, like many Amazonian and other indigenous populations, the Tsimane are currently experiencing rapid socioeconomic change due to the growth of lowland towns, creation of new roads, improved motorized river transport, greater availability of schools, and increased acculturation. According to 2002–2005 data (Martin *et al.* 2012) in many villages 96% of the Tsimane diet consisted of horticultural field products, fish and wild game, although cooking oils, sugar, beef jerky and other food items are becoming more common, especially in villages located near the local market town. Second, villages vary in access to roads and markets, and within villages, households vary in the degree of their market participation, making the Tsimane region appropriate for evaluating patterned variation in risk-management strategies. Lastly, the Tsimane Health and Life History Project (THLHP) has been collecting ongoing economic, demographic, and biomedical data since 2002, providing a unique dataset for examining tradeoffs in risk management strategies at both the household and village level.

Hypotheses and Predictions

Markets and buffering

We hypothesize that material wealth obtained through greater market access should help Tsimane adults recover from common risks that disrupt production, such as sickness and

crop failure (H1). Cash income from wages and sales is a more liquid form of self-insurance than owning market assets, which require trade or selling in order to generate cash. The possession of either, however, is consistent with a greater ability to obtain market-related resources. Additionally, it is possible that having greater market access may be associated with a lower likelihood of experiencing shocks in the first place, in which case the opportunity costs of compromised social networks may be lower (H1b). However, we acknowledge that greater consumption smoothing from having larger, reliable social networks, or from being a high producer, may make investments in market wealth cheaper to afford.

Markets and social capital

Individuals wealthier in market goods and wages are expected to rely less on others to meet their daily subsistence needs (H2). To the extent that markets and savings may restrict sharing behavior, we offer a typology that helps characterize the social ecology of food sharing in four ways (Gurven 2004b; Gurven *et al.* 2002). These include sharing depth (proportion of food consumed that comes from others), breadth (number of sharing partners), giving intensity (proportion of food production given to others), and contingency (statistical relationship between giving and receiving among dyads). Depth reflects the degree of self-reliance for food security, breadth refers to the size of pooling units, giving intensity reflects contributions to others, and contingency reflects the reliability of reciprocity. For cooperative field labor, we use the breadth measure to refer to the number of individuals who participated in field clearing, weeding, planting, burning or harvesting.

Market wealth should be inversely related to the number of food sharing and field labor sharing partners (breadth) and the percentage of food consumption derived from others (depth). It should also associate inversely with contingency; that is, market-oriented families should rely less on reciprocal food sharing to smooth consumption. We expect the trade-off between market-derived wealth and sharing to be steeper among educated Tsimane fluent in Spanish because these more acculturated individuals may be more immune to social consequences of violating traditional egalitarian norms of redistribution within and among extended families (H2b).

An alternative hypothesis to the trade-offs described above is that greater material wealth and market access may help to further cultivate traditional sharing networks (H3). Market wealth in this case should associate with more food given away to others (giving intensity). Additionally, with increasing (intergenerational) specialization, trading of traditional resources for market-derived goods may reflect an efficient division of labor among households. Greater market access may also help secure additional social support and build alliances. Reverse causality is also possible, where more labor sharing partners serve to help increase agricultural surplus to sell in the market. H3 is based on social capital serving functions additional to risk management, such as information gathering, conflict support and mediation.

Trade-offs between material wealth and sharing at the village level

As an attempt to understand how regional differences in market integration may affect sharing relationships across villages we expand predictions to the village level of organization, after adjusting for household level effects in multilevel analyses. Village-level analysis captures localized effects and possible externalities associated with market integration, inequality and local culture (Gurven *et al.* 2008) (H4). For example, more market-oriented families living in a village dominated by more traditional sharing may be more likely to participate in sharing networks than if they lived in a village where market interactions were commonplace if there is social pressure to conform to local culture. Following H2, we expect more market-oriented villages to rely less on reciprocal sharing as a means of risk management. All else equal, living in a village with greater material wealth should associate with reduced contingency between giving and receiving food, and lower sharing breadth and depth. If these local effects are strong, less reliance on traditional sharing in wealthier villages could be expected to reduce leveling across households, and thereby increase wealth inequality (H5). Greater wealth inequality may also foster the erosion of an egalitarian ethos, leading to more restricted sharing relationships. Regardless of the causal direction between sharing and inequality, we expect villages with greater wealth inequality to show evidence of more restricted sharing practices, including lower contingency, breadth and depth.

Methods

Study Population

Tsimane are forager-horticulturalists living in over 100 small villages in the neotropics of central Bolivia (Ballivian province of the Beni Department, estimated census population in 2013, ~15,000). Their economy is based on swidden horticulture (plantains, manioc, rice and corn), hunting, fishing and fruit gathering. Closely related families co-reside in residential clusters of several households, which act as units of cooperative production and consumption. Tsimane have relatively short life expectancy, high work load, and minimal access to modern amenities such as healthcare, sanitation and electricity (Gurven *et al.* 2007).

Tsimane lives are rife with risk at all ages due to food shortage, illness, injury, kin and partner death, conflict and theft. For example, 45% of hunting events end in failure, and the coefficient of variation (CV) in hunting returns is 2.22 (mean±SD=9,119±20,199 cals); 21% of fishing events result in failure, with a CV of 2.75 (2,218±6,105 cals). Horticultural returns are often affected by floods, aridity and pests (Gurven *et al.* 2012). Seventy-five percent of adults report being sick enough that they could not get out of bed at least once in the past three months, with a mean duration of incapacitating illness of 8.7±20.9 days; 91% of these cases lasted longer than three days, and included fevers, influenza, gastrointestinal infection, physical pains and swellings, accidents and injury. These results suggest that Tsimane are incapacitated by illness or injury on about 10% of all days (Gurven *et al.* 2012). Breakage and theft of the limited toolkit used for resource production is not infrequent: 79% experienced loss, and 33% theft, of at least one household item, including machetes, shotguns and rifles, and canoes (ibid).

Tsimane reduce these risks and smooth consumption through self-insurance, e.g., overplanting, crop diversification and through high levels of sociality. But sharing is not indiscriminate; spouses and close kin such as parents, offspring and siblings are consistently the main sources of support (Gurven *et al.* 2012; Hooper *et al.* 2015). Living near kin, maintaining access to kin, and investing in reputation are important components of social capital among Tsimane. Reciprocity also traditionally structures social relations of sharing and field labor among both kin and non-kin (Ellis 1996; Hooper 2011). Over the course of a 15 month study in two Tsimane villages, food consumption (proxied by anthropometric measures of short-term nutritional status) in children was completely protected despite idiosyncratic adverse cash income shocks, whereas adult consumption was not (Godoy *et al.* 2007d).

The Tsimane were relatively unaffected by Jesuit missions in the eighteenth century and rubber and quinine booms in the late nineteenth and early twentieth century, and remained largely unconnected to Bolivian society until the mid-twentieth century with the arrival of Protestant and Catholic missionaries (Chicchón 1992). Market integration has increased since the 1970s with the advent of new roads connecting the local market town of San Borja to the highlands, makeshift roads opened by logging companies, an influx of colonists with cattle ranches and homesteads, and the growth of the *jatata* thatch palm leaf market (woven for roof panel manufacture throughout the Bolivian lowlands) (Añez 1992). Wages are obtained sporadically by working as ranch hands and assisting in local farms, selling crops and jatata panels, working for logging companies, NGOs, or as teachers. Fewer than a third of Tsimane adults are fluent in Spanish, yet fluency substantially improves wages (Godoy *et al.* 2007c), which average about US$1.30/day (Godoy *et al.* 2007b). In addition to wages, Tsimane have informal savings through surplus production of rice, plantains and maize that is later sold or bartered, and maintenance of edible domesticated animals such as chickens, ducks, and occasional pigs and cattle (Undurraga *et al.* 2013).

Data on market wealth, economic shocks and social capital were compiled from several sources from the THLHP (www.unm.edu/~tsimane) (see Table S1). All methods were approved by Institutional Review Boards at UCSB and UNM, and by the Tsimane government, village leaders and study participants.

Food production, food sharing and field labor

From January 2005 to December 2009, adults from 11 villages were interviewed once or twice per week about all production activity for each co-resident household member over age six during the previous two days (n=1,245 individuals). Each family was interviewed an average of 45.5 times (SD = 20.4), yielding a mean of 92.8 sample days per individual. Quantities produced and shared were estimated through the use of locally understood standard measures and project data on mean weights for common resources, and converted into calories using standard nutritional tables (see Hooper *et al.* 2015).

Sharing was operationalized as the number of individuals giving or receiving 1 calorie of food per day (*sharing breadth*), the percentage of calories consumed that came from other households (*sharing depth*), the percentage of household production given to other households (*giving intensity*), and the association between giving and receiving food among

household dyads over the sample period (*sharing contingency*). Household- and village-specific contingency was estimated with a multilevel Poisson model predicting food given from household A to household B (in absolute calories), by food received and several control variables (difference in need, distance between houses, average kinship between all members of family A with family B, age difference between household heads). We allowed the effect of food received on food given to vary among households and villages by including random intercepts and slopes for household and village ID. The contingency measures presented are the random slopes for households and villages respectively (Table S6).

Field labor sharing was investigated through annual field interviews conducted from 2005–2009 (the period overlapping with the other interviews). Household heads were asked from whom they had received any help in field clearance, burning and harvesting this year, and for how many days. Help given to others in field labor was also recorded. Payment for labor was recorded as money, food, harvest share, or unpaid. We use the number of households to which ego gave unpaid labor and the number of households from which ego received unpaid labor per year as measures of relational capital. There were 119 households from nine communities for which detailed food production and sharing, labor sharing, and material wealth data were available.

Market wealth

We operationalize market wealth through separate measures of material household assets and cash income. Household possessions were inventoried through interviews asking heads of households whether any member of the household owned any of a set inventory of 30 items. Items included domestic animals such as chickens, pigs or cows, industrial assets such as cooking pots, knives, shotguns, radios, bicycles and motorbikes, and traditional assets that can be produced with local materials and knowledge, such as bows and arrows or canoes. We include traditional assets because these are often used to produce and sell crops, and because they can be sold to merchants, loggers, other Tsimane, or the occasional tourist.Only 18.5% of household wealth is categorized as traditional assets; exclusion of traditional assets does not qualitatively affect the results of any analyses where market wealth was used as a predictor. The monetary value of these items was estimated by market prices in the town of San Borja in 2012 (in local currency Bolivianos, Bs, 6.8 Bs=$1US). The value of all items were then summed for each household.

Information on cash income came from interviews asking about wage labor and produce sales in the past month and year, respectively (Table S1). We categorize income from selling agricultural produce (rice, plantains, corn) and manufactured goods (lumber, jatata roof panels) as *produce income*, separately from *wage income* (e.g., as ranch hands, logging, teachers). Monthly income was calculated by dividing annual produce sales by 12 and summing with wage income. Income was pooled for spouses living in the same household. All measures of income and wealth were converted into 2010 Bolivianos using annual consumer price indices published by the Bolivian Institute for Statistics (http://www.ine.gob.bo/indice/visualizador.aspx?ah=PC02020104.HTM).

Village inequalities for income and wealth were calculated as Gini coefficients using the R package *reldist* version 1.6–2 (Handcock 2013) after adjusting for age (see Borgerhoff Mulder *et al.* 2009 SOM) and controlling for the average date of income/wealth interviews in each village. The same controls were included to calculate average wealth and income by village. Data for calculating average income and wealth and Ginis by village came from a total sample of 248 households in the nine communities for which food production and sharing data were available.

Shocks and buffers

Retrospective interviews (n=671 adults, age 16+, March 2005 to July 2006) recorded information on frequency, impact, types and amount of assistance given and received for several kinds of common shocks experienced over the past month, or past year, including illness, crop failure, theft, residence changes, debt, divorce and conflict (see Gurven *et al.* 2012). Data on shocks and material wealth (see below) were available for 238 households from 27 communities.

Data Analysis

The unit of most analyses was the household, with measures of production, income, or wealth pooled among household members. In order to obtain measures of variation in sharing at the village level, we used multilevel models, with village-specific random intercepts and random slopes for all wealth measures; these random effects then become the dependent variables for analyses predicting variation at the village level using village-level predictors[1]. When analyzing variation in random effects, no intercepts were estimated as random effects have a mean of 0. We used R 3.0.2. (Team 2013) for all analyses and graphs. Multilevel (or mixed-effects) models were fit using the MCMCglmm package (Hadfield 2010) with flat priors and default settings as model convergence, assessed visually by plotting time series and histograms of posterior samples, was always good. Linear regressions and generalized linear models were used for analyses without random effects. Poisson error distributions were used to model count data and binomial error distributions for binary data.

All analyses controlled for the date at which wealth interviews were conducted to adjust for seasonal and annual variation, and all analyses involving food production and sharing control for the average date of the production interviews as well as the number of production and sharing risk days. For each analysis, we first constructed a full model including all variables of interest and controls and then conducted stepwise deletion based on the deviance information criterion (DIC) for multilevel models and Aikaike's information criterion (AIC) for linear regression and generalized linear models, resulting in a best-fit model. In the case of multilevel models, we first performed selection on the random effects holding fixed effects constant and once the optimal random effects formula was found proceeded to select among the fixed effects (Zuur *et al.* 2009). We provide standardized

Results do not vary when including village-level variables and their interaction with other relevant variables in the same multilevel model.

coefficients (β) for all models to facilitate comparisons, following Menard's (2004) method for generalized linear models.

In order to reduce collinearity among potential predictors, we calculated variance inflation factors (VIF), conservatively taking VIF>3 to indicate high collinearity (Zuur *et al.* 2010). For individuallevel predictors, high collinearity was found only for age and age[2]; when one of them was removed all VIFs were <3, which was the case in all our best-fit models. For village-level analyses, collinearity was more problematic (Supplementary Table S5); only average income and village size could be included as predictors of village-level variation in sharing. The correlation matrix in Supplementary Table S5 shows that village size was positively correlated with income inequality (r=0.62), wealth inequality (r=0.39), average wealth (r=0.51), and distance to the market town (r=0.40). The effects of village size may therefore partially represent the effects of these other variables.

Results

Among the 119 households in our sample, average total monthly household income was 233 Bolivianos (Bs) ($33 US in 2010 equivalent), with 40% of income from selling agricultural produce and 60% from earned wages. Total income for Tsimane was about a third of the average 2010 inflation-adjusted income for non-indigenous households nationwide (766 Bs) (Bolivian Census 2001). Average income Gini in the nine sample communities was 0.42, lower than the 0.59 reported for Bolivia (in 2001) (Table S2). Households in our sample shared food with an average of 2.5 other households (range 0–11) and received food from 2.3 (0–7) households. They gave labor to 2.2 (0–8) and received labor from 2.2 (0–11) other households. (Table S2).

Does material wealth reduce food insecurity and shocks, and help smooth consumption?

Average household food production was 5,700 calories per day, with a coefficient of variation of 1.6. Greater income and to a lesser extent greater wealth were associated with greater food security, in terms of higher daily caloric returns (Table 1, Fig. 1a); the income effect was due to produce sales (Fig. S1). When limiting food production to meat and fish, there was no effect of income but a significant positive effect of wealth. While these results suggest that wealthier Tsimane have better average food security, people with higher income from wage labor and more wealth experienced *higher* daily variability in food production returns (Fig.1b, Fig.S2; Table S3).

Among the 238 households for which data on shocks and buffers and material wealth were available, most (97%) experienced some crop loss in the past year, most (87%) claimed that the level of loss affected them, and 74% reported receiving some aid. People with higher produce income were 63% less likely to have experienced crop loss in the past year, which is likely the reason they garnered more money selling crops. However, they were more likely to report having been affected by the crop loss they did experience, possibly because of heavier investment in cash cropping (Table 2). Neither wage income nor household wealth affected the likelihood of crop loss and no material wealth variable was associated with help received during crop loss.

Ninety-seven percent of households experienced at least one serious illness or accident in the three months prior to interview, and most of them received some help, with 74% reporting they received help from people other than their immediate kin. Household heads with higher wage income were less likely to experience illness or accidents but those with greater wealth were twice as likely to have had a sick spouse (Table 2). Families with higher produce income were 63% less likely to receive aid during sickness.

For a subset of 56 households where information on money lending was available, 32% of households had borrowed or lent money in the past six months, with average loan size of 24 Bs given (range 0–200) and 56 Bs (0–430) received. Adults with greater wealth and income borrowed *more* money from others, suggesting that they remain susceptible to idiosyncratic shocks; 90% of the reported uses for borrowed money include food and medicines, with the remainder for school supplies or luxury goods. Those with greater income lent less money to others, whereas those with greater wealth lent more (Table 2).

Does market wealth reduce reliance on traditional resource pooling?

Contra H2, sharing depth, i.e., the proportion of consumption derived from others, was not significantly associated with any wealth or income measures, although all variables were retained in the best-fit model (Table 3). Partially consistent with H3, household wealth, but not income, significantly predicted higher giving intensity; wealthier households gave a greater percentage of food produced to others (Table 3, Fig. 2a). When considering absolute number of calories received and given, households with greater produce income gave significantly more net calories, but this effect did not hold for meat sharing; there was no effect of wage income or household wealth on net meat sharing (Supplementary Material, Table S4).

Contra H2, none of the indicators of market-oriented wealth were significantly associated with the extent to which household shares to others were contingent upon receiving from the same families. The best-fit model predicting contingency did not contain any of these predictor variables nor any random effects. The only village-level variation in contingency therefore comes from the original model estimating contingency (Table S6).

Lastly, we examine whether sharing breadth was associated with market-oriented wealth. For simplicity, we use a single measure of sharing breadth because the numbers of other households with whom ego gave and received food or labor were inter-correlated (Pearson r's between 0.23 and 0.44); a principal components analysis showed positive loadings with similar weights for all four variables in the first component. We therefore summed the four variables to yield an overall measure of relational capital, or sharing breadth, but results remain unchanged if using the separate measures. Contrary to H2 and consistent with H3, greater household wealth (but not income) was *positively* associated with sharing breadth (Table 4a, Fig. 3).

Despite the correlation between Spanish fluency and schooling (r=0.67, p<0.001), educated Tsimane had fewer sharing partners, while fluent Spanish speakers had more (Table 4b). Contra H2b, we did not find that those with more schooling or greater Spanish fluency were more likely to invest in material wealth at the expense of food and labor sharing

relationships. Instead, Tsimane with higher education showed *greater* relational capital per unit of material wealth and those with greater Spanish fluency had lower relational capital, as indicated by the significant positive interaction term of education with wealth and produce income and the negative interactions of Spanish fluency with the same measures (Table 4b). Considering main and interaction effects jointly, those most fluent in Spanish witnessed a decrease in sharing breadth with greater income while the most educated witnessed an increase (Fig. S3).

Do wealthier villages show more restricted sharing and increased inequality?

A substantial amount of variance in sharing patterns was explained by village-level differences, as indicated by comparing marginal R^2 (R^2_m, proportion of variance explained by fixed effects alone) and conditional R^2 (R^2_c, amount of variance explained by fixed and random effects (Nakagawa and Schielzeth 2013)) from the models in Tables 3, 4 and Table S6: Giving intensity R^2_m=0.16, R^2_c=0.35, Sharing depth R^2_m=0.24, R^2_c=0.47, Sharing breadth R^2_m=0.07, R^2_c=0.10, Contingency: R^2_m=0.72, R^2_c=0.84).

Variation in village-specific intercepts and slopes obtained from multilevel models was analyzed using village-level predictors including average income and village size (Table 5); other potential villagewide predictors, such as income inequality, mean wealth, and distance to town, were excluded due to high collinearity with village size and mean income (Table S5). If a variable such as village size significantly predicts variation in the village intercept for giving intensity, this would suggest that village size is associated with average village differences in giving intensity; if it predicted variation in the slope of giving intensity with income, this would mean that village size moderates the relationship between income and giving intensity across villages.

Across nine Tsimane villages, mean income was negatively associated with sharing contingency (Fig. 4, Table 5). Mean income also was associated with a reduced effect of wage income on sharing depth and giving intensity, but with a significantly higher effect of wealth on giving intensity (Fig. 2b, Table 5). Larger village size was associated with greater giving intensity and contingency across villages. Village size was also associated with wealth having a lower impact on giving intensity (Table 5).

The best-fit model shows that income inequality is greater in villages with higher sharing breadth, larger number of households, and those located further from market (Table 6). Wealth inequality was greater in villages with higher giving intensity and in larger villages (Table 6).

Discussion

Increasing market integration among Tsimane over the past half century has not substantially displaced more traditional social networks that help buffer against a variety of risks that can affect food security. Wealth and income were not significantly associated with the extent of reliance on others (sharing depth), nor with use of reciprocal food sharing (contingency). Wealthier Tsimane, however, share food and pool horticultural labor with more partners (sharing breadth), and give more away to other households (giving intensity).

This effect was moderated by the extent of modernization, as measured by Spanish fluency and schooling. As wealth increases, those with more schooling shared food and labor with even more households, while those more fluent in Spanish shared with fewer. In the Tsimane context, Spanish fluency may be more tightly related to novel economic opportunities. Fluency in Spanish has been shown to be an important prerequisite for obtaining wage labor opportunities and earning higher wages, more so than schooling (Godoy *et al.* 2007c), although schooling is presently becoming more relevant and is likely to continue in the future as employment opportunities for Tsimane expand. Indeed, both Spanish fluency and schooling were roughly equally correlated with wage income in our sample ($r=0.33$, $p=0.01$; $r=0.34$, $p<0.001$, respectively); neither was associated with produce income or household wealth.

One reason that greater market integration may not erode traditional Tsimane insurance strategies is that market involvement does not appear to buffer households against experiencing idiosyncratic shocks nor facilitate recovery (but see Godoy *et al.* 2005). Tsimane families with greater income and household assets produce more food, but with greater daily variability (Fig. 1). While higher income from harvest sales was related to lower crop loss in the preceding year, households with more harvest income reported being more affected by their crop loss. Furthermore, households with high harvest income tended to experience more frequent losses in the past, perhaps due to greater longterm investment in cash cropping. Possession of more household assets was associated with greater meat and fish production, likely due to access to more effective extractive technology, including firearms, ammunition and fishing gear. However, the variability in meat and fishing returns was no different among more or less wealthy households.

In fact, market integration introduces new risks that may offset any potential risk buffering advantages. Wage labor away from the village was associated with a greater likelihood of spousal sickness (Table 2), although it is possible that spousal sickness may also increase motivation to obtain wages to help pay for medical expenses. While money may be used to purchase medicines, food and other necessities in San Borja, cash is often used to purchase alcohol, cigarettes and luxury goods. In a sample of expenditures by 63 men, a maximum of only 58% of recent wages (mean 1,192 Bs) was reported to have been used for self-insurance (food, medicine, transport, paying off debts, fixing or replacing tools) (unpublished data). We also suspect that cash and material goods are subject to theft, and some investment in social capital may be necessary to dissuade theft in the first place, particularly with rising inequality.

The evidence supports instead a diverse portfolio of risk buffering strategies that varies, in part, by the particular type of market activity used to supplement more traditional household production. Those who supplemented their earnings by cash cropping invested more in agricultural production, and were more affected by crop loss. Greater cash cropping may lead to (and also may be due to) greater self-sufficiency, and is therefore associated with less reliance on sharing to smooth consumption. Cash cropping, however, is not necessarily an effective means for consumption smoothing; produce income was unrelated to the variability in food production (Table S3). Wage earnings do not appear to smooth consumption either;

working for wages removes adult men from their home villages for periods of time, and is associated with *higher* variability in food production (Table S3).

While the reliance on social networks to smooth consumption varied by the type of market activities, and whereas market activities did not associate with sharing depth and reciprocity at the household level, we found that giving intensity and sharing breadth were consistently higher among more market integrated households. The cost of giving may be cheaper among wealthier households; these households become higher, rather than lower, net contributors in their villages. These findings are supported by another study that showed that household cash earnings among Tsimane were positively associated with household gifts of food, medicine and labor to other households (Reyes-Garcia *et al.* 2006). Another study by the same research team found evidence of display signaling through greater consumption of visible luxury goods, but no evidence that such signaling was higher in more market integrated villages closer to town (Godoy *et al.* 2007a). Godoy and colleagues conclude that "people with a weak toehold in the market economy enjoy relative affluence, invest in social capital for social more than for economic reasons, but cope with adversity largely on their own" (Godoy *et al.* 2007b; see also Nolin 2012).

While greater giving intensity and breadth of food and labor sharing partners are consistent with signaling generosity or display sharing rather than consumption smoothing, it is possible that greater giving intensity and sharing breadth act as a loose safety net for other types of risks. Reinforcing social ties with a larger audience is important for maintaining status and securing allies who can be called upon for support during conflicts, or for obtaining useful information. Allies are also important for defending and expanding wealth, including obtaining access to prime locations for cash cropping, and favorable negotiations with loggers and merchants (von Rueden *et al.* 2008). Allies and greater social capital may also help facilitate the hiring of other Tsimane to assist with cash cropping, a phenomenon that has occurred more frequently in villages near town over the past decade as rice prices have risen. Lastly, it is also possible that wealthier individuals who remain in the village are compelled to pay higher "taxes" through greater demand sharing from nearby kin. To date, very few Tsimane households have opted to leave Tsimane villages altogether and live in San Borja or other towns. As suggested by the quote above, it might be the case that several decades of increasing modernization still largely leaves the Tsimane with only a "weak toehold in the market economy" so market access may be used more to supplement traditional income rather than manage or cope with risks.

Despite the possibility that certain households might be taxed at higher rates, Tsimane households maintain a large degree of autonomy in economic decision-making. Villages themselves, with organized leadership roles, are relatively recent legally-recognized entities. More traditionally, a "village" consisted of relatively dispersed clusters of extended families (von Rueden *et al.* 2014). Nevertheless, we find strong evidence that village residence affects sharing behavior above and beyond household-level factors. The amount of additional variance in sharing behavior explained by village residence was fairly substantial. Some of the village-level variability in sharing outcomes was explained by village-level characteristics (e.g., mean income, village size and its correlates, wealth and income inequality), but much of the village-level variation was unexplained in our statistical models.

We suggest that village social norms or local "culture" might shape the content and form of buffering strategies in a frequency-dependent manner. For example, contingent reciprocity might be difficult to maintain among households when embedded in a local culture of private self-insurance. Similarly, private insurance strategies might be difficult to maintain in a local culture characterized by reciprocity and demand sharing. Such frequency-dependence in exchange strategies is consistent with expectations from a formal model by Kranton (1996).

Consistent with these notions that local culture might affect buffering strategies, we found several village-level patterns. Larger villages show evidence of higher giving intensity, suggesting that the benefits of display sharing may be higher in larger villages. Household differences in wealth also impact giving intensity less in larger villages, perhaps indicative of less demand sharing. Larger villages also show higher contingency, suggesting that perhaps tighter contingency among household dyads may be required to maintain reciprocity in large villages. A network analysis would be needed to confirm whether the clustering of household sharing partners varies as a function of village size. In richer villages, contingency is lower, and higher household wages have a smaller impact on both sharing depth and giving intensity. The latter suggests that where earned income is more normative, having higher household wages is associated with relying less on others for smoothing daily food consumption. Household wealth, however, is associated with greater giving intensity in richer villages.

Village-level findings were sometimes at odds with findings at the household level. While reciprocity in food sharing was unrelated to wealth or income at the household level, it was lower in villages with higher average income earnings (Fig. 4). Villages where mean incomes are higher might therefore witness less overall reciprocity, even among villagers with minimal income. While sharing breadth was higher among households with higher wealth, it did not differ among villages by wealth or income in controlled models. Other aspects of sharing behavior were similar at both scales of analysis. For example, giving intensity was greater with higher income at both household and village levels of analysis.

Income and wealth inequality were associated with village-wide sharing patterns. In villages with greater sharing breadth, we found evidence of greater income inequality, and those with greater giving intensity had more wealth inequality. These findings run counter to expectations that higher levels of sharing might be associated with lower economic inequality (H5). Reciprocity and sharing depth were unrelated to income and wealth inequality. We also found that larger villages had greater income and wealth inequality, and villages closer to town had lower income inequality. Thus, lower levels of sharing behavior across areas of Tsimane territory do not currently associate with greater incipient economic inequality.

Our multilevel modeling framework therefore shows evidence that local variation, whether due to social norms, or unmeasured demographic or socio-ecological factors, can impact sharing behavior, and the ways that market integration shapes resource buffering strategies. The salience of intra-cultural variation in social behavior has now been observed in several independent studies among Tsimane. In a series of economics experiments designed to

measure "altruistic" giving and punishment behavior, the village residence of participants was one of the most significant predictors (Gurven 2004a; Gurven *et al.* 2008). A study of gift-giving and labor sharing in 37 Tsimane villages similarly found that village fixed effects accounted for almost three times as much variation as did individual-level variables (Reyes-Garcia *et al.* 2006). While village characteristics such as population size, distance to market, and mean income may explain some of the variance in sharing behavior among villages, other local dynamics can affect social interactions, including past internal conflicts affecting trust, conflicts with interlopers or loggers, personality differences (Gurven *et al.* 2014), and local norms and institutions.

This study benefited from the use of multiple measures to characterize the social ecology underlying traditional risk management, and from several ways of quantifying market integration. While our analysis spanned nine Tsimane villages, the extent of economic development and available insurance options among Tsimane remains limited despite a half century of greater exposure and at least three decades of growing markets, public infrastructure and urbanization in San Borja. Very few Tsimane in our sample lived and worked permanently in town, had even a high school education, or had migrated to cities. All Tsimane who engage in cash cropping, logging or other non-traditional activities also engage in subsistence horticulture, fishing and hunting activities. State-subsidized health insurance has improved over the past decade, but using it requires legal identification (which many still do not have), and is often unreliable or limited to certain medical conditions. Very few Tsimane have bank accounts, or have ever received microcredit loans. The range in employment opportunities also remains limited, especially among women, whose main source of income is from selling crops and jatata thatch. Due to their relatively low level of market integration, small differences in wealth holdings can lead to a large range in Ginis for income and material wealth among villages (Table S2, Fig. S3, Fig. 5). Indeed, Ginis for income inequality in our nine village sample span the range of most countries measured by the World Bank, from Denmark (0.26) to Namibia (0.65) (http://data.worldbank.org/indicator/SI.POV.GINI/). The Ginis we report for non-traditional types of wealth are higher than those for traditional forms of wealth (Gurven *et al.* 2010). It remains to be seen whether further market integration in the coming decades will reduce levels of inequality among villages (Godoy *et al.* 2004).

Conclusion

How people make decisions about food production and risk management amid socioeconomic change is fundamental for rural development, especially among indigenous populations who often rely on informal insurance to maintain their livelihood. Why populations differ in the extent to which market integration replaces or augments traditional buffering strategies will require comparative analysis, currently underway as a follow-up to the Intergenerational Inheritance of Inequality Project (Borgerhoff Mulder *et al.* 2009). Past studies suggest a variety of experiences in different societies. Yellen (1990) reported that over the period of a decade or two, the social ecology of Dobe !Kung society was radically transformed: "Once the !Kung had ready access to wealth, they chose to acquire objects that had never before been available to them. Soon they started hoarding instead of depending on others to give them gifts, and they retreated from their former interdependence" (p. 105).

Greater cash income and wage labor opportunities were associated with a greater dependence on purchased foods and less reliance on reciprocity among Shipibo horticulturalists of the Peruvian Amazon (Putsche 2000), whereas greater town access and selling meat reduced the risk of food shortfalls among Huaraoni foragerhorticulturalists but did not disrupt traditional sharing behavior (Franzen and Eaves 2007). Among Machiguenga forager-horticulturalists of lowland Peru, market integration was highly stratified within and among villages, leading to incipient class division and greater social distance among households (Henrich 1997). Among highland Peruvian intensive farmers, wealthier households have more diverse diets, purchase more commercial foods, and experience lower frequency of seasonal food shortages (Leonard and Thomas 1989). Food sharing is attenuated among Basarwa farmers of northern Botswana with larger fields and more grain storage (Cashdan 1985). Wealthier, high status Lamalera households in Indonesia are more likely to give food away to others, consistent with display signaling, but embedded within a larger system of exchange (Nolin 2012). In rural Tanzania, there is evidence that wealthier households in villages with greater income inequality are less likely to join social groups, and villagelevel social conflict is more common (La Ferrara 2002).

The current study in the Bolivian Amazon builds on this literature and can contribute to building theory that should help parse the variation among societies. Differences in the variance structure of food production strategies, frequency and types of risks (e.g., aggregate affecting villages vs. idiosyncratic affecting households *sensu* Morduch (1999)), proximity to markets, the extent to which the market provides suitable substitutes for goods and services obtained from traditional exchange networks, and available options for storage and self-insurance all should impact costs and benefits of alternative buffering strategies. Trade-offs affecting the cost and benefit structure of different buffering strategies should determine whether market integration leads to greater or lesser inequality in indigenous populations. As we found among Tsimane, where material capital is most easily acquired by those with higher traditional wealth (e.g., networks, farming productivity) we should expect little evidence of trade-offs and more evidence of a "head start" leading to increasing inequality. If investments in different types of wealth are instead mutually exclusive and relatively substitutable, we should expect to find more evidence of trade-offs, economic specialization, and possibly increasing cultural emphasis on individualistic rather than egalitarian values.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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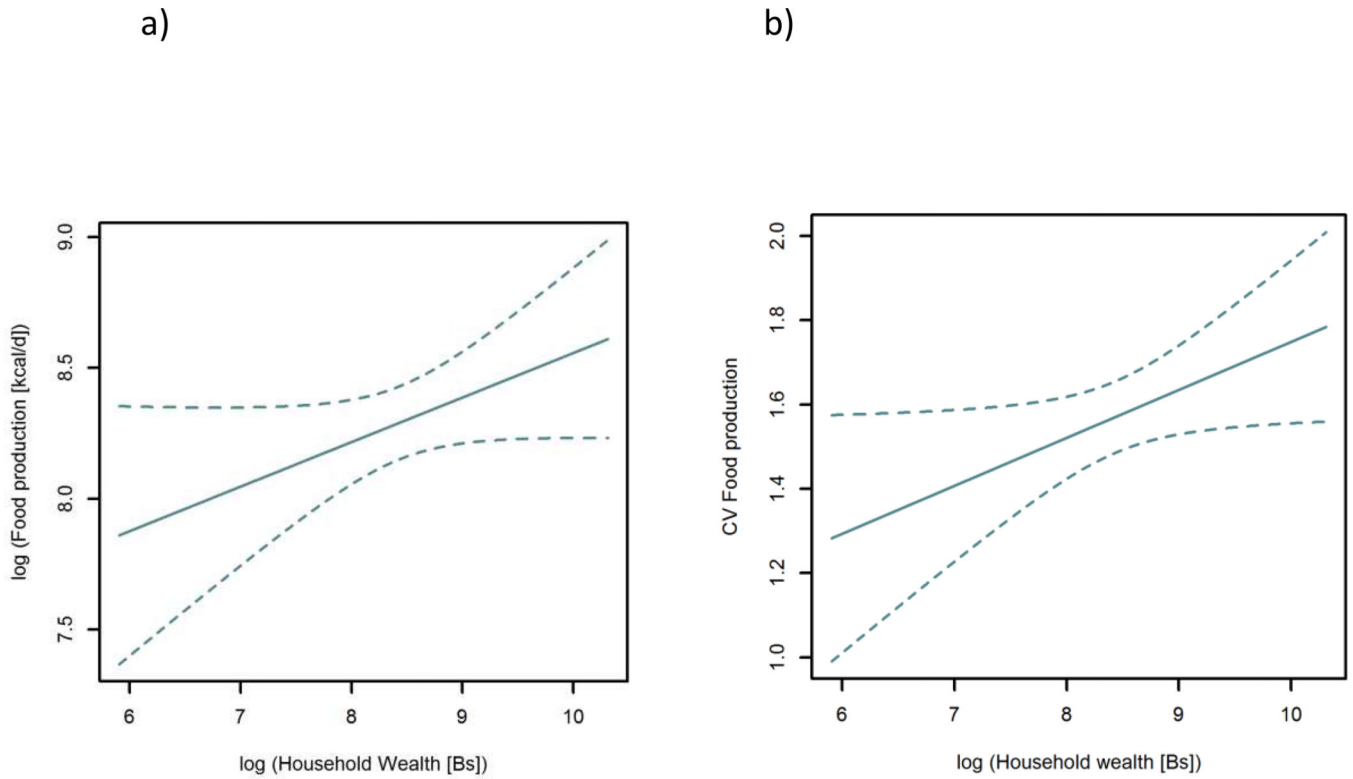a)   b)

Figure 1.
Food security and household material wealth: (a) Mean daily food production and (b) coefficient of variation (CV) as a function of household wealth. Solid line is predicted fit and dashed lines are 95%CI controlling for income and average date of production interview. For detailed results see Table 1.

a)   b)
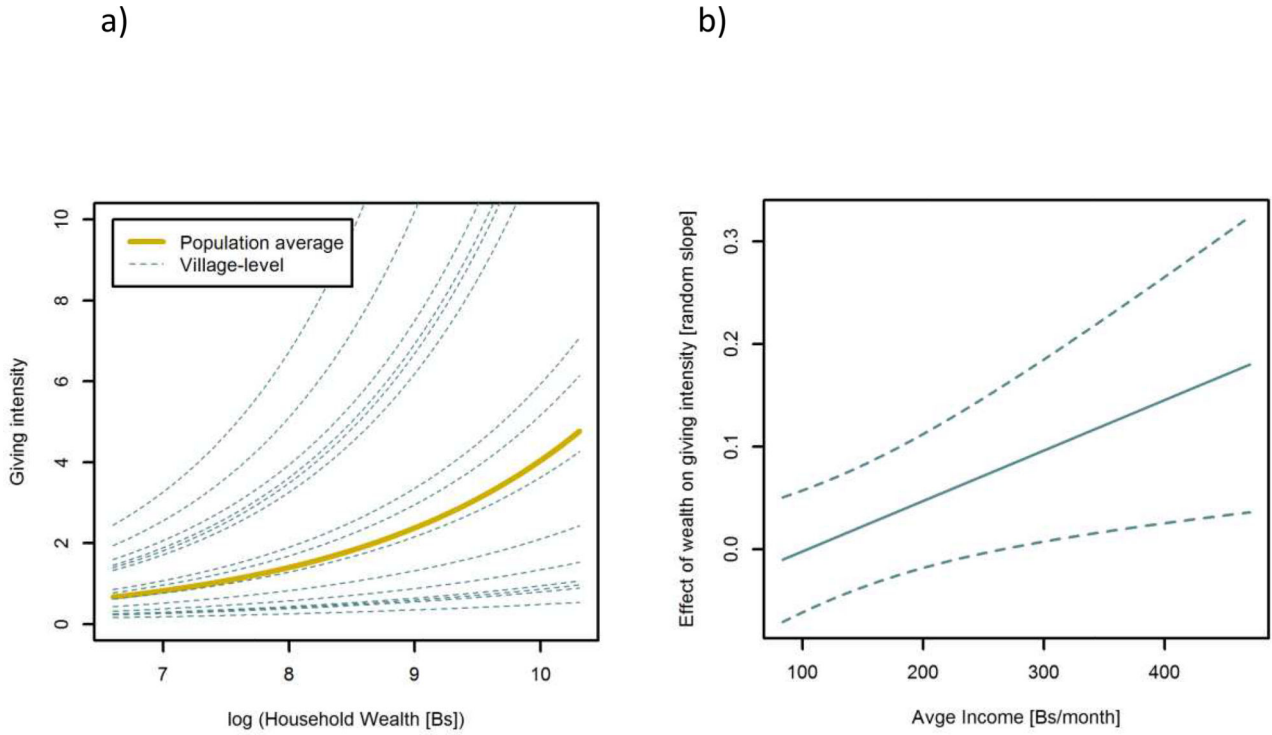
Figure 2.
Effect of material wealth on giving intensity at (a) household level, showing the population average curve (red) and village-specific curves (dashed grey), and (b) the village level, showing that average village-level income moderates the effect of household wealth on giving intensity (cf. slope of the grey lines in a). In other words, in villages with higher average incomes, richer households give more than the population average. All curves are based on models in Tables 3 and 5, holding all other factors constant. Size of data points in (b) reflects number of households (range 21–225), dashed lines are 95% confidence intervals
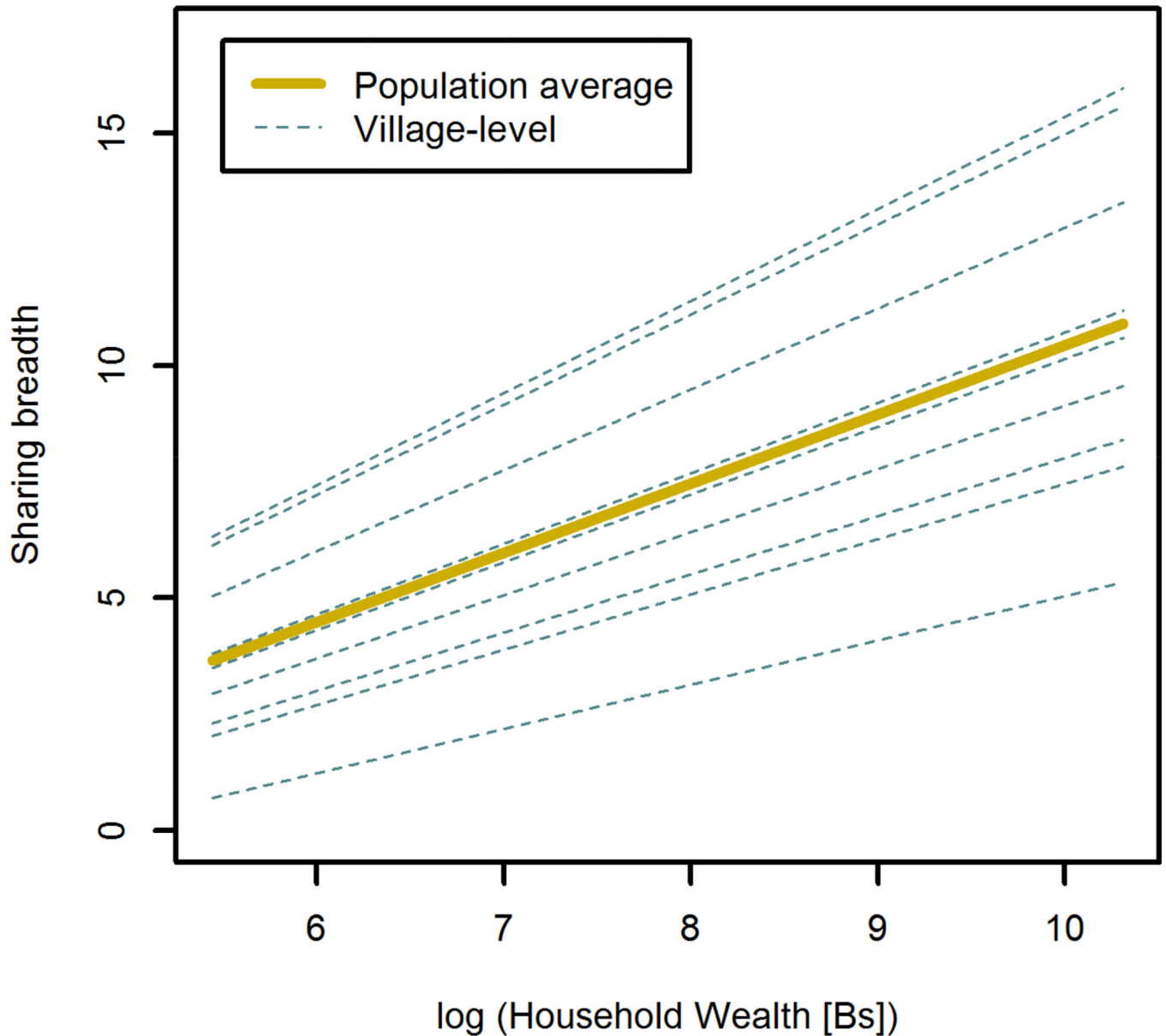
Figure 3.
Association between sharing breadth, i.e., the number of food and labor sharing partners and
household wealth: Lines are predicted fit at the population level (solid red) and for
individual villages (dashed grey) (Table 3). The association between household wealth and
number of sharing partners is positive across all nine villages, with little variation in the
strength of the association, i.e., village-level slopes. Villages do vary in the intercepts, i.e., in
some villages people have more sharing partners than in others, yet this variation was not
explained by any village-level predictors (Table 5)
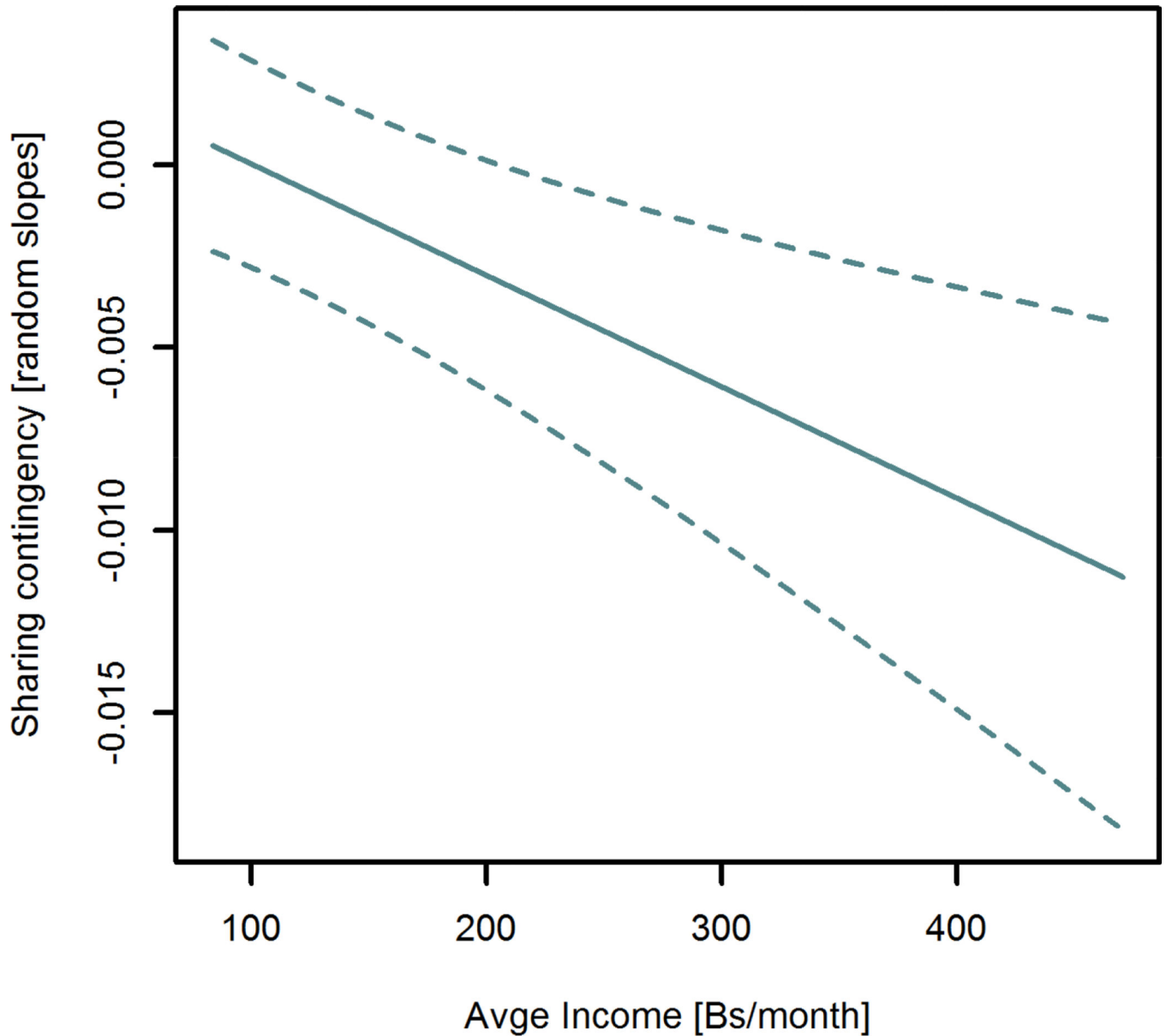
Figure 4.
Association between sharing contingency, i.e., village-level slopes for the association between giving and receiving food, and village-level average income and village size (indicated by the point size reflecting number of households, range 21–225). Lines are predicted fit (solid) and 95% confidence intervals (dashed) based on the model in Table 5. People in larger villages share food relatively more contingently, while people in villages with greater average income share less contingently

TABLE 1

Linear regression models predicting average daily food production [kilocalories] by household as a function of material wealth and controls (age, age^2, average date of income interviews, average month of production interviews, number of risk days for production; details for controls not shown). Reported are the best-fit models based on stepwise AIC selection

All Production	Estimate	SE	t value	p-value	β
(Intercept)	8.25	0.90	9.15	0.00	
Log produce income	0.11	0.04	2.56	0.01	0.20
Log wealth	0.16	0.10	1.64	0.10	0.13

Hunting and Fishing Only	Estimate	SE	t value	p-value	β
(Intercept)	2.22	1.88	1.18	0.24	
Log wage income	0.05	0.03	1.54	0.13	0.13
Log wealth	0.28	0.13	2.18	0.03	0.21

t
p<0.1,

*
p<0.05,

**
p<0.01,

***
p<0.001

TABLE 2

Wealth, shocks and resilience: Results of generalized linear models on likelihood of experiencing shocks and receiving aid when a shock occurs, as a function of income and wealth, controlling for age and interview date. Odds ratios are given for binary outcomes, and standardized regression coefficients (β) for count variables

Shock	Produce Income	Wage income	Wealth
Lost any crop in past year (y/n)	**0.37**[t]	1.19	1.32
Lost rice (binary: yes/no)	1.11	**0.76**[**]	0.58
Lost corn (y/n)	0.93	1.05	0.82
Lost yucca (y/n)	0.87	1.00	1.18
Lost plantain (y/n)	1.14	0.90	1.07
Affected by any of these crop losses (y/n)	**1.26**[t]	0.90	0.78
# of these crop losses that affected (count)	**0.16**[*]	0.004	−0.06
Received help crop loss (y/n)	0.88	1.06	1.07
Received help nonkin crop loss (y/n)	1.08	1.08	0.97
Self or spouse sickness or accident (y/n)	1.02	**0.70**[*]	1.28
Self sickness or accident (y/n)	0.97	0.97	1.46
Spouse sickness or accident (y/n)	1.25	0.96	**2.04**[*]
Received help when sick (y/n)	**0.37**[t]	1.19	1.32
Received help from nonkin when sick (y/n)	0.93	0.96	0.89
Received food when sick (y/n)	0.69	1.10	1.89
Received food from nonkin when sick (y/n)	0.98	0.98	0.66
Total money borrowed from others (Count: Bs)	**0.07**[***]	**0.11**[***]	**0.20**[***]
Total money lent to others (Bs)	**−0.10**[***]	**−0.14**[***]	**0.20**[***]

[t] $p < 0.1$,

[*] $p < 0.05$,

[**] $p < 0.01$,

[***] $p < 0.001$

TABLE 3

Multi-level poisson models of sharing depth and giving intensity: (a) the proportion of all calories kept in the household that was received by other households (depth), (b) the proportion of food production given to other households (giving intensity) as a function of material wealth and controls (age, age², average date of income interviews, n production events). Reported are the best-fit models based on the deviation information criterion (DIC), details on control variables are not shown. Both models included village-specific intercepts, as well as village-specific slopes for produce income, wage income, and wealth.

a) Sharing Depth	Estimate	lower 95% CI	upper 95% CI	P value	β
(Intercept)	5.94	0.99	10.95	0.03	
Log produce income	−0.08	−0.39	0.25	0.62	−0.21
Log wage income	0.08	−0.16	0.32	0.51	0.31
Log wealth	−0.04	−0.40	0.41	0.84	−0.04

b) Giving Intensity					
(Intercept)	−0.45	−6.28	5.91	0.89	
Log produce income	−0.09	−0.48	0.22	0.63	−0.08
Log wage income	0.05	−0.30	0.34	0.66	0.08
Log wealth	0.49	−0.02	0.98	0.06	0.18

t
$p<0.1$,

*
$p<0.05$,

**
$p<0.01$,

***
$p<0.001$

TABLE 4

Multilevel models predicting food and labor sharing breadth, i.e. the total number of other households to which ego gave food or labor or from which ego received food or labor, as a function of material wealth and controls (age, age², average date of income interviews, risk days for food sharing, number of field interviews) [baseline model]. The second model extends the baseline to include education (highest grade level achieved) and Spanish competency (none, some, good). Reported are the best-fit models based on stepwise DIC selection, details for control variables are not shown. The baseline model included village-specific intercepts, as well as village-specific slopes for wealth the baseline + education/Spanish model additionally included a village-specific slope for wage income.

A. Baseline Model

	Estimate	lower 95% CI	upper 95% CI	p-value	β
(Intercept)	−3.27	−14.90	9.70	0.616	
Log wealth	1.50	0.12	3.13	0.056	0.21
age²	−0.0006	−0.0012	0.0001	0.092	−0.16

B. Baseline + Education and Spanish with interactions

	Estimate	Lower 95% CI	Upper 95% CI	p-value	β
(Intercept)	−14.64	−41.75	16.80	0.28	
Log wealth	2.62	−0.87	6.14	0.13	0.35
Education	−2.62	−7.84	2.62	0.33	−2.03
Spanish	18.07	−13.58	50.43	0.27	2.00
Log produce income *Education	0.19	0.03	0.36	0.02	0.59
Log produce income *Spanish	−0.71	−1.58	−0.03	0.07	−0.42
Education *log wealth	0.26	−0.35	0.94	0.42	1.74
Spanish *log wealth	−1.81	−5.88	1.73	0.36	−1.75

t
 p<0.1,

*
 p<0.05,

**
 p<0.01,

***
$p < 0.001$

TABLE 5

Predictors of village-level sharing: Random effects terms from multilevel models capture village-level variation in giving intensity, sharing depth, breadth and contingency. Predictors include average income and village size on village-level variation. Village size may also proxy effects of inequality, average wealth, and distance to the market town (see Supplementary Table S5 for correlations among potential predictors). For contingency, the analysis was performed with and without the outlier in Figure 4. Reported are standardized coefficients from the best-fit linear regression models based on stepwise AIC selection, blank cells indicate that the predictor was not retained in the best-fit model. No intercepts were estimated because random effects have a mean of 0.

	Variance	Mean income	Village size
Giving intensity:			
Random Intercept	0.29		0.43^t
Produce income Slope	0.15		
Wage income Slope	0.14	−0.23	
Wealth Slope	0.10	0.53^*	−0.36
Sharing depth:			
Random Intercept	0.24		
Produce income Slope	0.11		
Wage income Slope	0.09	-0.30^t	
Wealth Slope	0.07		
Sharing breadth:			
Intercept	0.43		
Wealth Slope	0.19		
Contingency:			
With outlier	0.008		
Without outlier		-0.60^{**}	0.40^t

$^t p{<}0.1$,

$^* p{<}0.05$,

$^{**} p{<}0.01$,

$^{***} p{<}0.001$

TABLE 6

Linear regression models predicting income and wealth inequality (Ginis) across villages. Predictors included average income, average wealth, sharing breadth, depth given and contingency, village size and distance to the market town of San Borja. Shown here are the best-fit models.

A. Predicting income inequality

	Estimate	SE	t value	P value	β
(Intercept)	0.14	0.04	3.36	0.02	
Sharing breadth	0.01	0.004	1.78	0.14	0.24
Village size	0.000	0.000	1.86	0.12	0.26
Distance to SB	0.01	0.001	5.07	<0.01	0.71

B. Predicting wealth inequality

	Estimate	SE	t value	P value	β
(Intercept)	0.08	0.06	1.32	0.23	
Giving intensity	2.36	1.05	2.26	0.06	0.67
Village size	0.001	0.000	2.14	0.08	0.64