Diversification as a Risk Management Strategy in an Andean Agropastoral Community

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Peasant households in semi-arid Andean regions make their economic decisions in an environment characterized by high levels of uncertainty and risk. Low average income levels, recurrent droughts, destructive frosts, and price variability create the need for effective risk management strategies as a means of protecting the welfare of household members. Households in these agropastoral communities deal with periodic losses through complex social and economic mechanisms. Diversification of income sources is a prevalent risk management strategy.

Diversification is pervasive among Andean peasant households (Kervyn; Cotlear). Households mix market-oriented with subsistence-oriented production, crops with livestock, and entrepreneurial activity with wage labor. Improved varieties of crops and livestock are utilized alongside a large number of traditional varieties. Spatial diversification is extensive, in that a single household typically utilizes dozens of dispersed cropping fields and livestock pastures. As another form of spatial diversification, families send wage earners out of the community on a recurrent basis.

Diversification smooths the flow of income to the household by reducing both predictable and unpredictable fluctuations. Predictable, seasonal fluctuations in income can be smoothed by combining enterprises and activities that generate returns during different times of the year. Unpredictable fluctuations, those which create an unexpected loss in income, can be reduced by a diversified portfolio of economic activities with variances that

are not perfectly correlated (Robinson and Barry). In the absence of contingency markets, peasant households diversify by pursuing multiple economic activities in order to maintain a relatively smooth flow of income (Reardon, Delgado and Matlon; Bromley and Chavas; Fafchamps; Rosenzweig and Binswanger). There is limited evidence to suggest that households at higher income levels will be less likely to pursue *ex ante* risk-reducing strategies (Dercon; Rosenzweig and Binswanger).

The incentive for *ex ante* risk-reducing strategies, such as diversification, should be lowered when a household has effective mechanisms for dealing with losses *ex post* (Townsend; Morduch; Alderman and Paxson). In other words, there is less of a need to smooth income through diversification when there are alternative mechanisms for smoothing consumption after an income shock has occurred. Examples of *ex post* loss management mechanisms include liquidation of assets,[1] borrowing, labor sales, temporary migration, and nonmarket mechanisms (Dunn, Kalaitzandonakes and Valdivia). Nonmarket consumption smoothing mechanisms, such as interhousehold income transfers based on reciprocity relations, are often related to kinship ties and can play an important role in the success of Andean households (Caro).

In this paper, we test whether the existence of effective *ex post* loss management mechanisms reduces the incidence of diversification among a sample of semisubsistence households in the Bolivian altiplano.[2] In the following section, we introduce the production systems and income sources for households in the study community of San José Llanga. In the third section, we describe our model of risk management and the hypothesis to be tested.

Section four presents the empirical model and results, and section five the conclusions.

Production, Risk, and Income in San José Llanga

The rural community of San José Llanga consists of approximately 100 households and is located in the central altiplano of Bolivia, at an altitude of 3750 meters above sea level. The semiarid altiplano is characterized by periodic droughts, frequent frosts, occasional floods, and seasonal wind erosion (Washington-Allen). Data from the closest market town, located 16 kilometers away, indicate that the principle food crops of potato and quinoa have a fifty and sixty percent probability of weather-related failure, respectively (Le Tacon et al.).

In addition to potatoes and quinoa, the other main food crops are barley, wheat, and faba beans. The principal livestock are sheep and cows, which graze on natural rangelands, crop residue, and fallowed crop land. While unimproved (*criollo*) animals have been part of the production system for many years, improved breeds of sheep and dairy cattle were introduced more recently. In 1989, a national dairy initiative introduced small-scale, commercial dairy production based on improved animals. This led to the cultivation of alfalfa and barley hay as forages for the dairy cows. In 1993, the 7200 hectares of land in the community were utilized as follows: 5% in food crops, 31% in crop fallow, 48% in native grasses, 6% in cultivated forages, and 10% in other uses, such as buildings, rivers, roads, and uncultivated land (Massy and Valdivia).

Households in San José Llanga follow a complex and integrated production system of cropping, fallow, and grazing practices that provide for more efficient utilization of scarce moisture and nutrients. The average household utilizes 5 discontiguous plots of land

(Valdivia and Jetté), which permits the exploitation of diverse microclimates and the avoidance of large-scale losses from highly localized frost risk. Due to the large number of economic activities pursued by each household, the amount of available family labor represents an important constraint to the number and level of production activities.

Household Economic Portfolios and Family Life Cycle

Two distinct groups of households were identified through cluster analysis, with age of the head of household and available family labor as the defining criteria (Valdivia and Jetté).[3] The "elderly" are those households with an older head and fewer family workers, while the "productive" households have a younger head and a larger number of family workers. Selected characteristics of the two groups are presented in table 1. In addition to differing in age and labor availability, the two groups of households differ significantly in their holdings of different types of livestock, area of irrigated land, and total income. The elderly group has fewer animals, less irrigated acreage, and total incomes which are approximately one-fifth the average annual incomes of households in their productive years.

The younger, more productive households can be subdivided into those who have adopted the new dairy technology, involving improved dairy cows and the cultivation of alfalfa, and those who have not. The commercial dairy households have higher average incomes (11,457 bolivianos) than the nonadopters (4,696 bolivianos). In addition, the commercial dairy households have higher incomes in each of the following categories: food crops, sheep, milk, cattle sales, wages, and remittances. Analysis of the data clearly indicates that the intensification of forage cultivation and the production of improved animal stocks

have not been accompanied by a reduction in food crops or traditional sheep production (Dunn, Céspedes and Valdivia).

Sheep, Food Security, and Gender

Sheep represent an important asset and are owned by 84 percent of households (Valdivia, Dunn and Sherbourne). Sheep contribute to food security in two ways. First, subsistence consumption of sheep products provides the main source of protein (Murillo and Markowitz). Second, the income generated from sheep sales is used primarily for purchases of food and school supplies. Case studies and survey data indicate that sheep are the domain of women; women purchase the sheep, manage their herding, select them for sale and slaughter, and transact the sales of sheep (Valdivia, Dunn and Sherbourne). These findings are consistent with patterns found in agropastoral systems throughout the Andes (Martínez and Barrera; Caro). In San José Llanga, sheep represent a valuable asset which can be utilized by women to smooth consumption within their households.

Diversification and Assets

Risk, defined as the chance of loss or the loss itself, may threaten the economic security of low income households. These households, who are vulnerable to the negative consequences of a loss, employ two types of risk management strategies. The first type are the risk reducing strategies, which are designed to smooth income by reducing the *ex ante* possibility of a loss. Diversification of income sources is an important example of a risk reducing strategy. The second type are the loss management strategies, which are designed to mitigate the *ex post* consequences of a loss by smoothing consumption in the event of an income

shock. Liquidation of assets is a key loss management strategy. In the community of San José Llanga, sheep are an important asset which can be liquidated when there is a need to smooth consumption.

Risk reducing strategies and loss management strategies are related: the greater the availability of *ex post* loss management mechanisms, the lower will be the household's need to engage in *ex ante* risk reduction. In other words, if the household has effective mechanisms for mitigating the negative consequences after a loss has occurred, it will be less concerned with protecting itself from a loss in the first place. This leads to our conceptual model, which relates the availability of sheep, as a loss management mechanism, to the incidence of diversification, as a risk reducing mechanism:

diversification = fn (number of sheep; family life cycle).

The family life cycle is included in our model of diversification, since differences in the availability of labor can affect the ability of the household to diversify its income generating activities. Our principle hypothesis is that households with more sheep are better able to deal with *ex post* losses in income, therefore they are less likely to diversify in an attempt to reduce the possibility of an income shock. However, elderly households are less likely to diversify irregardless of the number of sheep they have, due to the fact that they have a reduced family labor source.

Empirical Model and Results

For empirical estimation of the model, three variables were constructed from the data. The SHEEP variable represents the number of animals owned by the household, with improved

animals being weighted by a factor of 1.38 to reflect their higher market value relative to unimproved animals. The mean value for the sheep variable is 22. The LIFE CYCLE variable is a categorical variable with a value of 1 for productive households and 0 for elderly households. The classification of the households into the "productive" and "elderly" groups was accomplished through the cluster analysis cited previously and summarized in table 1.

The DIVERSITY variable was constructed from data on the amount of cash and in-kind income received from each income source. An inverse Simpson index of diversity was used (Hill), with the index given by the following:

$$1/\sum_{i=1}^{n} p_i^2$$

where n represents the number of different income sources, and p_i is the proportion of household income generated by activity i. The inverse Simpson index is affected both by the number of income sources as well as by the distribution of income between the different sources (balance). The more uniformly distributed is the income from each source, the more closely the index comes to measuring the number of income sources. In our data, the index ranged from a low of 1.26 to a high of 4.67, with a mean value of approximately 3.

The results of the OLS regression were as follows (t-values in parentheses):

$$\begin{array}{lcccc} \text{DIVERSIFICATION} = & 2.213 & + & 0.009\ \text{SHEEP} & + 0.909\ \text{LIFE CYCLE} \\ & (10.485) & & (1.275) & (2.795) \end{array}$$

with model statistics given by $F = 10.59$, adjusted $R^2 = 0.31$, and $n = 44$. The results indicate that there is a strong statistical relationship between family life cycle and diversification. As

hypothesized, households in their productive years are able to diversify more as a result of their access to labor and other productive resources. The older households have bequeathed their land and animals to their adult children and maintain few economic activities, with food crop production being the one economic activity reported by all households.

The hypothesized inverse relationship between number of sheep and level of diversification was not supported by the statistical results.[4] Thus, the statistical evidence indicates that the availability of assets in the form of sheep is not associated with a reduction in the incidence of income diversification among households in San José Llanga. There are several possible explanations for this result. Extremely high levels of risk in the economic and natural environment and the low absolute levels of household income may combine to create a situation in which all households are motivated to seek diversification as a risk reducing strategy. Under this interpretation, the primary explanation for different levels of diversification is variation in access to productive resources. This would be consistent with the result for family life cycle.

On the other hand, it may be that there are alternative motivations behind diversification for households in the study area. Due to the high degree of seasonality in agriculture, the primary reason for diversification could be to provide for more productive year-round employment of household resources. This would result in an increase in total annual income by reducing predictable periods of low income due to seasonality. Instead of being a strategy for reducing covariant risk, diversification may actually be a mechanism for increasing overall expected returns to the household.

Other possible explanations for the empirical result between diversification and sheep relate to alternative motivations for the holding of sheep. The households in San José Llanga are prime examples of peasant producers, with partial engagement in markets being one of the defining characteristics (Ellis). In addition to representing a store of value, sheep are a critical source of protein for household members. Within an environment of imperfect rural factor and product markets, households may be unwilling to relinquish this self-provisioning mechanism (Fafchamps).

Finally, the empirical results may be inconsistent with the hypothesized relationship because of problems with the unit of analysis. Diversification was measured based on the household as the unit of analysis. However, the production and marketing of sheep are almost exclusively the domain of women in the community. There may be a complex relationship between individual risk management strategies, bargaining and allocation within the household, the selection of enterprises by individual household members, and the level of diversification as measured at the household level. As models for intrahousehold analysis continue to be developed and refined, it may be possible to analyze these issues empirically.

Conclusion

There is a need for better empirical information on risk management strategies among low-income households in developing countries. In particular, there is very little empirical evidence on the relationships between risk reducing strategies and loss management strategies. While diversification has been widely cited as a risk reducing strategy, additional information is needed in order to better understand the actual motivations behind

diversification in different settings. In some cases, this may require the development of appropriate models of intrahousehold decision making. A better understanding of risk management could provide valuable information about household welfare and improve our ability to anticipate how households will respond to policy efforts.

Footnotes

The authors are Research Assistant Professor and Assistant Professor, Department of Agricultural Economics, University of Missouri-Columbia, and Collaborating Scientist for the Small Ruminant Collaborative Research Support Program (SR-CRSP) in Bolivia, respectively. Funding for this study was provided by the SR-CRSP USAID Grant DAN 138-G-00-0046-00. We thank the Community of San José Llanga for their support.

[1] Evidence from household responses to drought indicates that loss management strategies occur in stages. Households first dispose of assets held primarily as stores of value (self-insurance assets). Only in later stages of loss management do they begin to dispose of productive assets (Corbett; Webb).

[2] The household level data utilized in this and the related studies described in this paper were collected from a random sample of 45 households in the community of San José Llanga, Aroma Province, Bolivia. The data refer to the 1992-1993 production year and measure income from all sources, as well as expenditure patterns and gender domains related to livestock. The data are described fully in Valdivia, Dunn and Sherbourne. Unless otherwise noted, all empirical results cited in the paper are based on this data set.

[3] SYSTAT for Windows Statistics 5.0 sotfware was used for the cluster analysis. The dendogram identified two clusters with two subgroups each (Valdivia and Jetté).

[4] In fact, the positive estimated coefficient on the sheep variable, along with the associated t-statistic of 1.275, provide some statistical evidence of a positive relationship between numbers of sheep and level of diversification. A null hypothesis that the coefficient

on sheep is zero could be rejected in favor of the alternative hypothesis that the coefficient is positive, with a probability of .13 of making a Type I error.

Table 1. Characteristics of "Elderly" and "Productive" Households, San José Llanga, 1993 (standard deviation in parentheses)

Variable	Elderly Households (n = 16)	Productive Households (n = 29)
Age (years)	65.4 (6.7)	43.7 (11.9)
Labor	1.5 (0.6)	3.4 (1.3)
Criollo Sheep (numbers)	3 (3.9)	11.9 (13.5)
Improved Sheep (number)	1.1 (4.3)	17.4 (24.7)
Improved Cattle (number)	0.2 (0.5)	3.0 (2.4)
Criollo Cattle (numbers)	0.7 (1.0)	1.3 (1.9)
Irrigated Land (hectares)	0.6 (0.6)	3.3 (2.9)
Total Income (Bolivianos)	1,720 (1,553)	8,193 (5,612)

Notes: Differences between means are statistically significant at a 0.05 level of significance for all variables except criollo cattle. Conversion rate is US$1 = 4.05 Bolivianos (1993).

Source: C. Valdivia and C. Jetté "Peasant Households in Semi Arid San José: Confronting Risk Through Diversification Strategies." Technical Report IBTA181/49/SRCRSP47/1996.

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June 26, 1996

Dear Dr. Wohlgenant,

Enclosed please find the manuscript entitled "Diversification as a Risk Management Strategy in an Andean Agropastoral Community". My co-authors, Elizabeth G. Dunn and Christian Jetté, and I are presenting it as a principal paper in the session *Modeling Household Behavior in Developing Countries,* at the AAEA meetings in San Antonio, 28-31 July 1996. We are submitting one month prior to the annual meetings as requested.

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