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Gauging the Welfare Effects of Shocks in Rural Tanzania

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Abstract

Studies of risk and its consequences tend to focus on one risk factor, such as a drought or an economic crisis. Yet 2003 household surveys in rural Kilimanjaro and Ruvuma, two cash-crop-growing regions in Tanzania that experienced a precipitous coffee price decline around the turn of the millennium, identified health and drought shocks as well as commodity price declines as major risk factors, suggesting the need for a comprehensive approach to analyzing household vulnerability. In fact, most coffee growers, except the smaller ones in Kilimanjaro, weathered the coffee price declines rather well, at least to the point of not being worse off than non-coffee growers. Conversely, improving health conditions and reducing the effect of droughts emerge as critical to reduce vulnerability. One-third of the rural households in Kilimanjaro experienced a drought or health shocks, resulting in an estimated 8 percent welfare loss on average, after using savings and aid. Rainfall is more reliable in Ruvuma, and drought there did not affect welfare. Surprisingly, neither did health shocks, plausibly because of lower medical expenditures given limited health care provisions.

This paper—a product of the Africa Technical Families (AFTP2) Division in the Africa Region—is part of a larger effort in the department to document and analyze the determinants of household vulnerability in Tanzania. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at lchristiaensen@worldbank.org.

Gauging the Welfare Effects of Shocks in Rural Tanzania

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1 Introduction

The precipitous decline in coffee prices around the turn of the 20th century attracted a lot of attention among policy makers in Sub-Saharan Africa. Indeed, studies and policy debates of the effects of shocks on household welfare are very often instigated by a politically salient event—a drought or an economic crisis—and focus on a particular risk factor[2]. Yet, not only are the actual welfare effects for coffee growers in Sub-Saharan Africa of the coffee price decline poorly understood, the focus on coffee prices as a major risk factor also distracted attention away from the wide array of risks coffee-growing households faced, including health and drought shocks.

This paper takes a more holistic approach and jointly examines the immediate effects of different shocks on household welfare in the context of two coffee-growing regions in Tanzania, Kilimanjaro and Ruvuma. In a directly administered shock module as part of a comprehensive household survey, rural households identified health shocks, droughts, and commodity price declines as their major risk factors both in terms of the frequency of their occurrence as well as the severity of their effects. This underscores the need for a more comprehensive perspective on household vulnerability even when looking at the livelihoods of commodity producing households.

The paper addresses three broad questions. First, it explores the (immediate) welfare effects of idiosyncratic health, covariant drought and more systemic commodity price shocks. Second, it examines the occurrence and effectiveness of self- and mutual

[2] Dercon and Krishnan (2000), Dercon, Hoddinott and Woldehanna (2005), and Kenjiro (2005) are welcome exceptions.

insurance strategies as well as irrigation in mitigating the negative welfare effects of such shocks. Finally, the key correlates of people's coping strategies are identified.

The paper proceeds by outlining the empirical methodology in section 2. Data considerations are addressed in section 3. Empirical results regarding the welfare effects of the different shocks are presented in section 4, and the effectiveness of the different coping strategies is explored in section 5. Section 6 examines the correlates of households' coping capacity, followed by concluding remarks in section 7.

2 Empirical Methodology

Economic theory holds that households prefer smooth to volatile consumption. Given access to well functioning credit or insurance markets, these preferences generate stable consumption paths, even when shocks occur. If credit and insurance markets are imperfect, household consumption may be susceptible to shocks (Deaton, 1992; Besley, 1995; Dercon and Krishnan, 2000; Fafchamps and Lund, 2003; Kazianga and Udry, 2006). These theoretical insights provide a framework to empirically explore how shocks and households' coping capacity affect their consumption levels.

More formally, suppose households at time t maximize inter-temporal expected utility U_t. Let $u(c_t)$ be instantaneous utility derived from consumption c_t (≥ 0), $u'(.)>0$ and $u''(.)<0$ such that:

$$U_t = E_t \sum_{\tau=t}^{T} (1+\delta)^{t-\tau} u(c_\tau) \tag{1}$$

with δ the rate of time preference and T the end of the life-cycle. Households face risky income $y_t(S_t)$ with S_t representing idiosyncratic/covariate shocks (e.g. drought, illness) affecting income occurring in t. Income can be used to obtain consumption at prices p_t.

Define r as the rate of returns to savings between periods and A_{t+1} as the value of assets at the beginning of period $t+1$. Assets evolve from one period to the next according to:

$$A_{t+1} = (1+r)(A_t + y_t(S_t) - p_t c_t) \tag{2}$$

Solving (1) and (2) using the envelope condition and assuming that households have full access to credit and/or (formal or informal) insurance yields:

$$\frac{u'(c_t)}{p_t} = \frac{(1+r)}{(1+\delta)} E_t\left[\frac{u'(c_{t+1})}{p_{t+1}}\right] \tag{3}$$

Discounted marginal utilities suitably corrected for relative price changes will be equated. In the absence of uncertainty, with r equal to δ and prices constant over time, the optimal consumption path implies constant consumption over time.

In the tradition of Hall (1978) and Morduch (1991), assume constant relative risk aversion with instantaneous marginal utility defined at t as $c_t^{-\rho} e^{\theta_t}$ with ρ the coefficient of relative risk aversion and θ_t a general taste shifter to parametrize (3). Taking logs, and introducing subscripts i and j to denote household i in location j, (3) can be written as:

$$\ln\frac{c_{ijt+1}}{c_{ijt}} = \frac{1}{\rho}\left(\ln(1+r) - \ln(1+\delta) + \ln\frac{p_t}{p_{t+1}} + (\theta_{ijt+1} - \theta_{ijt})\right) + u_{ijt+1} \tag{4}$$

with u_{ijt+1} the expectation error which has mean zero and is orthogonal to all variables known at time t given rational expectations. According to equation (4) the path of consumption over time is only affected by taste shifters and price changes, as long as there are no binding liquidity constraints over time and provided the underlying factors determining wealth (or permanent income) are not changing. In other words, under the hypothesis of perfect consumption smoothing, the optimal consumption path is not affected by idiosyncratic and/or covariate (income) shocks S_{ijt+1} and introduction of these shocks overidentifies equation (4). This provides an empirical framework to explore the effects of shocks on welfare. Allowing further for a differential ability across households to cope with shocks ex post yields the following linear empirical specification:

$$\ln \frac{c_{ijt+1}}{c_{jit}} = \alpha_0 + \alpha_1 Z_{ijt} + \alpha_2 S_{ijt+1} \otimes M_{ijt} + u_{ijt+1} \qquad (5)$$

with Z_{ijt} comprising price changes and taste shifters (such as changes in household composition) and M_{ijt} a vector of variables such as initial wealth, social capital, access to credit, availability of safety net programs, capturing the household's capacity to mitigate the effect of income shocks ex post. Differential ability to cope with shocks ex post is likely to condition the effect of income shocks on consumption.

Alternatively, assume X_{ijt} is the comprehensive set of observable (and exogenous) household and location characteristics affecting preferences, permanent income and coping capacity (after shocks S_{ijt} have materialized)[3], such that $c_{ijt} = c(X_{ijt}, v_{ij}, \omega_j)$ with v_{ij} and ω_j reflecting unobserved (time invariant) household and location heterogeneity respectively. Equation (5) can then also be written and estimated as:

$$\ln c_{ijt+1} = \beta_0 + \beta_1 X_{ijt} + \beta_2 S_{ijt+1} \otimes X_{ijt} + v_{ij} + \omega_j + \varepsilon_{ijt+1} \qquad (6)$$

When panel data are available, equation (5) could be estimated (either as a difference or a fixed effects model) and unobserved household (and location) heterogeneity would be explicitly controlled for. Yet in practice, panel data are often not available, and when available, they tend to focus on a limited set of livelihoods/ populations and usually span relatively short time periods. This poses a particular challenge when studying the effect of slow onset, systemic shocks such as broad

[3] These include but are not limited to Z_{ijt} and M_{ijt}.

economic crises or a decline in commodity prices (which tend to have memory). The period covered by the panel may be too short to fully encompass the period of the shock (e.g. precipitous commodity price decline) and the shock may affect all households in the sample leaving the researcher in effect without a control group. Estimates of the welfare effect of an economy wide shock based on welfare before and after the shock will be biased, if there are secular trends.

Furthermore, the availability of repeated observations on a household's consumption and income does not eliminate the need for explicit information on shocks to estimate the welfare effects of shocks. While changes in consumption are sometimes regressed on changes in income (Harrower and Hoddinott, 2005), attenuation bias, due to oft observed measurement error in the latter, would lead us to underestimate the effect of an income shock. At the same time, imputation errors in valuing consumption from own food production in constructing the consumption and income variables may lead to a spurious positive correlation between total household consumption and income, biasing the income coefficient upwards (Deaton, 1997). Direct information on shocks usually provides the necessary instruments to address this problem. It also enables inference on the effect of shocks on income and consumption.

In the absence of panel data, but given cross sectional data on household consumption (C_{ijt+1}), explicit information on shocks experienced during t+1 (S_{ijt+1}) and comprehensive recall data on households' assets and their coping capacity (X_{ijt}) the differential effect of different shocks across households can be explored through estimation of equation (6), in effect using a retrospective panel approach and assuming $E(X_{ijt}v_{ij}) = E(S_{ijt+1}v_{ij})=0$.

In practice, a comprehensive description of the household characteristics (X_{ijt}) helps reduce the likelihood of potential bias due to unobserved household heterogeneity. Furthermore, potential endogeneity issues related to the shock variables can be avoided through the use of external shock information as opposed to self-reported measures of shocks from the household questionnaire. The use of village fixed effects controls for bias due to correlation of X and S with unobserved village effects. Yet as this may cause an underestimate of the full effect of covariate shocks, it is useful to also explore models with an explicit comprehensive description of the location/village characteristics when available.

Given that slow onset commodity price shocks such as the systemic coffee price shocks only directly affect producers of these crops, the effect of these shocks could in principle be explored when the sample includes a sufficiently large control group of non-coffee or cashew crop growers with similar characteristics. The shock variable (S_{ijt+1}) in this case becomes being a coffee crop grower at t or not.

Yet, caution is warranted in interpreting the empirical results. First, it is implicitly assumed that cash and non-cash-crop growers are ceteris paribus equivalent ($E(S_{ijt+1} \cdot v_{ij})=0$) such that the effect of being a cash-crop grower only captures the effect of the systemic price shock. Second, if the overall economic activity in the region declines as a result of the price decline, the approach is likely to underestimate the direct negative effect as non-coffee growers are likely to have suffered as well, through general equilibrium effects. Given data limitations and bearing these caveats in mind, this study takes the retrospective panel approach.

3 Rural Households in Commodity-Growing Regions in Tanzania

To analyze the welfare effects of the different shocks, data from a household vulnerability survey conducted in rural Kilimanjaro (October-December 2003) and rural Ruvuma (February-March 2004) are used. In each region about 900 rural households were surveyed, of which two thirds were growing coffee in Kilimanjaro. In Ruvuma, about one third of the households grew coffee, one quarter cashew, and 4 percent tobacco. The remaining third did not cultivate cash crops. Features of the sampled households relevant to the empirical analysis are highlighted below (Table 1).

Welfare is measured through the (logarithm of) total household expenditures per adult equivalent.[4] To avoid a downward bias in the estimated effect of health shocks on welfare, all expenditures on health and functions (baptism, funerals) are excluded.[5] Age of the household head (and age squared) (life cycle proxies), the dependency ratio, gender of headship and the years of formal education achieved by the household head (allowing for differential effects across primary, secondary and post secondary education) are included as explanatory variables to capture differences in household preferences. They also affect households' permanent income and their coping capacity.

The ethnic origin of the household head is also controlled for. Cultivation of certain cash crops may traditionally be dominated by certain ethnic groups. This also helps control for people's social capital and thus their capacity to cope with shocks ex

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[4] For details on the construction of the expenditure variable, which does not include expenditures on education, see Christiaensen and Sarris (2007). They also provide a detailed description of the surveyed households and their communities.

[5] Comparison of health expenditures among households with and without an illness shock shows that households who experienced an illness shock spend on average 50 to 100 percent more on health. Similarly, expenditures on functions are also larger among households who experienced a death over the past two years. The data do not permit to distinguish between health expenditures for preventive reasons, plausibly an expression of larger household welfare, and health expenditures for curative reasons, or between expenditures on functions for funerals and baptisms.

post. For example, the Chagga, which make up 74 percent of the total rural population in Kilimanjaro, are known to be highly mobile and well connected in Tanzania.

The size of households' landholding possessions, the number of their large (cattle, oxen, horses) and small (goat, sheep, pigs) livestock, and the value of their agricultural equipment and vehicles (all normalized by the number of adult equivalents) are included to further proxy households' productive capacity (and permanent income potential). Squared terms of these variables help capture non-linearities in their effects on consumption. The substantial difference (factor of four) in average landholding size between Kilimanjaro, where the land frontier has been reached and agriculture is more intensive, and Ruvuma, where land is still relatively abundant and agricultural practice still rather extensive, is noteworthy. A self-reported measure of ease in obtaining seasonal credit for inputs is included to proxy access to production (as opposed to consumption) credit.

In addition to coffee and cashew price shocks, which affected every coffee and cashew producer, death or illness of a family member and drought emerged as the most important shocks[6] (Danford, Hoffmann and Christiaensen, 2007). Following a peak in the mid-1990s producer coffee prices stabilized at historically low levels from 2000 onwards (Figure 1). Similarly, by early 2000, cashew prices had dropped almost 50 percent from their mid-1990 peak. Asked at the village level and without explicitly stating that it concerned an unexpected deviation from last year's price (as in the

[6] During the 5 years preceding the survey, each of the other shocks (floods, harvest loss, livestock loss, cereal price shock, unemployment, property loss) were experienced by less than 7 percent of the households. Sickness and death/funeral were also the most frequently reported shocks in Nyakatoke, a typical Haya village in the Kagera region in northwestern Tanzania followed at a far distance by crime, functions (wedding and birth ceremonies), and shocks in income generating activities (De Weerdt and Dercon, 2006).

household shock module)[7], 82.8 percent of the households in Kilimanjaro and 35.6 percent of those in Ruvuma were found to reside in communities that reported having suffered from a coffee price shock over the past decade. About one quarter of Ruvuma's population resided in communities reporting a cashew price shock. In each case, 80 to 90 percent of the villagers in these communities were believed to have suffered.

From the directly administered household shock module, slightly more than one-fifth of all rural households experienced at least one death and one-fifth saw their welfare affected by at least one major illness during the five years preceding the survey. In Kilimanjaro, one third of the agricultural households were also affected by drought at least once during this period, compared with only 4.4 percent of the households in Ruvuma.[8]

The welfare effect of the coffee price decline is explored through inclusion of the number of coffee trees owned by the household in 2000, when the price decline set in. Being a coffee or cashew crop grower (in 2000 or 2002) is treated as exogenous to the household's current consumption expenditures. Yet, coffee-growing households are also more likely to be Chagga than Pare in Kilimanjaro and almost exclusively Matengo in Ruvuma (Table 1). Cashew production is largely confined to the Yao. Households benefiting from commodity booms in the past may also have accumulated wealth which they could draw down during times of shocks to smooth consumption. When exploring the effect of commodity price shocks through a retrospective panel approach it is thus critical to control for the ethnicity and assets of the household to avoid omitted variable

[7] Commodity price shocks differ from other shocks in that they are typically not totally unanticipated—prices have memory. However, swift adjustments are often difficult given sunk investment costs—coffee and cashew trees take at least 3 years before bearing fruit.
[8] Consistently, while both regions enjoy similar rainfall levels on average (1289.7 mm for Kilimanjaro and 1211.5 mm for Ruvuma), the rainfall distribution in Ruvuma is much less dispersed.

bias, i.e. capturing an ethnicity or wealth effect as opposed to the (relative) welfare loss associated with the commodity price decline. Data permitting, the asset variables are also lagged to 2000, to be consistent. This also mitigates potential simultaneity bias with health shocks.

There is a large difference in the number of coffee trees owned across coffee-growing households. To allow for differential effects among smaller and larger coffee farmers, coffee growers in the sample are divided in five quintiles based on their number of coffee trees in 2000.[9] The omitted category is the non-coffee growers. In Ruvuma, quintile categories for cashew growers, based on their number of cashew trees, and a category for tobacco growers are further included.[10]

To mitigate potential endogeneity problems arising from the self-reporting of drought shocks as registered in the directly administered shock module in the household questionnaire, an index of a household's qualitative assessment of the rainfall amount across its plots is used.[11] According to this measure, 21 percent of all households in Kilimanjaro experienced rainfall much below normal on their plots in 2003 and 42 percent rainfall somewhat below normal. Drought shocks are much less frequent in Ruvuma with 4 percent of all households experiencing rainfall much below normal in 2003 and 34 percent rainfall somewhat below normal. To better capture actual exposure

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[9] In Kilimanjaro, those in the lowest quintile have on average 40 trees, which more than doubles from quintile to quintile to reach 1326 trees among farmers in the highest quintile. In Ruvuma, coffee growing households have on average three times as many trees as in Kilimanjaro with those in the highest quintile owning on average 5 times as many trees as those in the lowest quintile.

[10] This categorization is based on tree ownership in early 2002, since recall data in Ruvuma extend only two years back. The tobacco group was not further disaggregated—only 4 percent of the households grew tobacco.

[11] In particular, households were asked in the production module for each plot whether the rainfall was much below normal, somewhat below normal, normal, somewhat above normal, much above normal. A plot size weighted average of these rainfall assessments was calculated and rounded off to the nearest integer to obtain a qualitative assessment for each household.

to the rainfall shock, the rainfall shock indicator is multiplied by the household's cultivated land area per adult equivalent.

The health shock variable includes both the occurrence of a death and/or an illness shock of an adult household member in the two years preceding the survey.[12] While death shocks are arguably not affected by self-reporting bias, illness shocks may be. The literature on the accuracy of self-reported health shocks (Foster, 1994; Groot, 2000; Gertler and Gruber, 2002; Baker, Stabile, and Deri, 2004) suggests that the likelihood of reporting a health shock is associated with a household's reference group (the poor tending to report fewer health problems), the intensity of the problem (the more severe the illness, the more likely it will be reported), and the need for justification (for example to rationalize absenteeism from work). While the two latter motivations are less of a concern in the current context, the former might bias the results. Inclusion of the comprehensive vector of household assets (as well as consumer durables) reflecting household wealth will however substantially mitigate the potential bias from self-reported illness shocks.

To cope with a shock, almost three quarters of the households used own savings (mostly cash and less revenues from asset sales). In addition, 50 to 60 percent of households received aid (the overwhelming majority from extended family) (Table 1).[13] Between 25 and 30 percent generated additional income generation, reduced their non-

[12] In a study focused on the economic consequences of health shocks in Vietnam Wagstaff (2007) used death of working age household members in the 2 years preceding the survey, and hospitalization for 7 days or more of a working and non-working age household member (entered separately) in the year preceding the survey as health shock measures.

[13] Similarly, drawing down *cash* reserves and risk-sharing (especially through private gifts, followed at some distance by (zero interest) loans and self help groups) were also the key coping strategies in Nyakatoke, in Kagera (De Weerdt and Dercon, 2006). Saving happened largely in the form of cash due to the limited availability of banking services.

food consumption or a changed their dietary pattern. Less than 7 percent of households migrated or borrowed money (Danford, Hoffmann and Christiaensen, 2007).

Households' coping capacity is approximated directly through the inclusion of reported coping through saving or receipt of aid in case of health and drought shocks and indirectly through the value of household consumer durables (per adult equivalent) in the year preceding the survey. The proportion of time in non-farming activities and the amount of remittances (per adult equivalent) received are further included as indirect determinants of households' coping capacity. The amount of acres irrigated (per adult equivalent) indicates exposure to drought shocks. Similarly, the proportion of time spent on non-farming activities may also reflect exposure to drought shocks.

To control for unobserved heterogeneity across locations, village dummies are used in the base models. By unbundling the village effects using a series of village characteristics, it is subsequently examined whether the shock variables underestimate the welfare effects of (covariant) shocks when they cannot fully capture their covariant nature, albeit at the expense of potentially introducing endogeneity related to unobserved village effects.

To capture the connectivity of the village, information on the presence of a tarmac road in the village, the availability of a public phone and a cell phone signal, the regular organization of a market, and the availability of a bus service to the village are used. Quality of the village's infrastructure is captured through the availability of electricity at the village level. The altitude at which the village is located is included to help define its agricultural potential—coffee typically grows at higher altitudes while cashew production is confined to lower altitudes.

4 Estimating the Welfare Effects of Shocks

Given the divergent nature of the economies in Kilimanjaro and Ruvuma, separate regressions are run for each region (Tables 2 and 3). The baseline model in column (1) includes the shock variables and controls for location effects through village dummies. Models incorporating interaction terms of coping strategies (aid, use of own savings, and remittances) with the different shocks are in column (2). The differential effects of death and illness of an adult member are explored in column (3). In column (4) the location effects are identified through inclusion of village proxies of connectivity, access to electricity and agro-ecological conditions. The specifications fit the data very well, explaining almost half the variation in the observed (log) expenditures.

The coefficients on the household demographics and productive assets are highly significant and largely consistent with predictions from theory. Households with higher dependency ratios tend to be poorer and households with better educated heads enjoy higher consumption. However, the latter effect only holds when the heads have secondary education in Kilimanjaro and only when heads have primary education in Ruvuma, possibly reflecting the fact that Kilimanjaro finds itself further on the path of structural transformation than Ruvuma. Surprisingly, household heads with post secondary education appear disadvantaged in Kilimanjaro though not in Ruvuma, maybe due to lack of remunerative employment opportunities for the well educated in Kilimanjaro. Once a household's possession of assets and education are controlled for, female-headed households appear better off, though the results are only weakly significant.

Households with more asset variables (landholdings, livestock ownership, total value of productive assets) are richer, with the marginal returns declining as asset possessions increase. Households with easy access to credit for modern inputs are estimated to be about ten percent better off in Kilimanjaro (though not in Ruvuma) underscoring the importance of access to capital and the use of modern inputs, especially when land is scarce.

Access to irrigation is estimated to increase consumption in Kilimanjaro on average by 19 percent per acre per adult equivalent irrigated, but has no statistically significant effect in Ruvuma. While 21 percent of the households in Kilimanjaro irrigate (some of) their fields, only 2.1 do so in Ruvuma, consistent with the less variable rainfall patterns in the latter region, but also causing limited variability in the sample. Income from remittances positively contributes to consumption, though the effect is less precisely estimated in Ruvuma. Households with a larger proportion of productive time spent in non-agricultural activities tend to be richer. Consumption is also positively associated with the possession of consumer durables (at a declining marginal rate).

Farmers in Kilimanjaro who reported receiving much below normal rainfall on their plots experienced a reduction of consumption of 10 percent per acre cultivated per adult equivalent. Clearly, households in Kilimanjaro cannot fully protect their consumption from drought shocks. Household consumption in Ruvuma is not negatively affected by drought shocks. As less than 4 percent of the sample experienced a drought shock in 2003, there may not be enough variation in the sample to precisely estimate the effect.

The availability of (cash) savings may help offset the effect of the drought shocks (in Kilimanjaro), though its effect is imprecisely estimated (Table 2, column 2). Access to irrigation does not mitigate the effect of severe rainfall shocks. This does not come as a surprise. Most irrigation in Kilimanjaro is gravitation irrigation and rainfall failure was relatively widespread in 2003. The result serves as a reminder that irrigation does not automatically reduce ex ante exposure to droughts. The findings also suggest that the receipt of aid may exacerbate the effect of a drought shock. This is counterintuitive, but may reflect the fact that those receiving aid from neighbors and relatives in times of a covariate shock are the very poorest.

In contrast, households in Kilimanjaro are able to cope with milder rainfall shocks. In Ruvuma, they appear even slightly better off, though this result was only statistically significant at the 10 percent level. Experiences of somewhat below average rainfall were explicitly included to render households with normal (or above) rainfall the control group.

The results in column (1) of Tables 2 and 3 suggest that household welfare is unaffected by health shocks (death or illness of an adult household member) experienced over the past two years. Yet, when household's coping behavior is controlled for through interactions with the self-reported use of savings and the receipt of aid (column (2) and (4)), households in Kilimanjaro were estimated to lose 16 percent of their consumption when faced with a health shock. However, households who used savings (often cash) to cope with health shocks managed to almost completely offset the negative effects. Receipt of aid from others appeared less effective. Surprisingly, health shocks appear not to affect household welfare in Ruvuma, even after controlling for households' use of coping strategies.

Welfare loss from illness or death shocks comes about through 1) increased (medical and funeral) expenditures and 2) foregone opportunities through a loss in labor supply (and thus earnings) and/or a decrease in the return to labor (Gertler and Gruber, 2002). While there is no information on the (opportunity) cost related to changes in labor supply and returns to labor, expenditures related to illness and death shocks are substantially larger in Kilimanjaro than in Ruvuma, suggesting a larger shift of resources from other household consumption to medical and/or funeral expenditures in Kilimanjaro than in Ruvuma (Table 4, panel 1). These results are consistent with the much lower reported use of health services in case of illness/injury in Ruvuma.[14] The larger average distance to a dispensary or health center in rural Ruvuma (4.5 km) compared with rural Kilimanjaro (2 km) suggests that lower accessibility of health care underpins this difference in health spending.[15]

Moreover, the directly *reported* health expenditures in case of an illness or death[16] in Kilimanjaro appear at least as large as the *estimated* average welfare loss[17] suggesting that the welfare loss is largely due to medical and other related expenses and less due to

[14] While about the same proportion of households reported an illness/injury over the past 4 weeks in Kilimanjaro and Ruvuma (23 and 24 percent respectively) during the 2000/01 Household Budget Survey, 74 percent of all households (rural and urban) in Kilimanjaro consulted a health provider, compared with 47 percent of all households in Ruvuma (National Bureau of Statistics, 2002, Table C16).
[15] National Bureau of Statistics, 2002, Table C17.
[16] These have been calculated from the survey in two ways. First, the average difference (=6,900 TSH) in per adult equivalent health expenditures over the past 30 days between those with a health (illness or death) shock during the past year and those without (panel 2, table 4) was multiplied by 12, yielding 82,800 TSH as the average annual health expenditures in case of a health shock. Alternatively, the average expenses incurred per household as a result of an illness or death shock (140,000 TSH from Table 4) divided by the average adult equivalent per household (4.4) yields 31,818 TSH.
[17] The estimated 16 percent welfare loss associated with a health shock in Kilimanjaro yields an average reduction of consumption per adult equivalent of 30,688 TSH given 191,800 TSH average per adult equivalent consumption in Kilimanjaro 2003.

labor supply effects and income loss. This is also consistent with the low marginal productivity of labor reported by Sarris, Savastano and Christiaensen (2006) in Kilimanjaro. Labor is even more abundant in Ruvuma, and when combined with the limited medical expenditures, the *estimated* absence of a welfare loss associated with a health shock in Ruvuma no longer comes as a surprise. However, given the lack of health care services in Ruvuma and lower overall living standards, this result should not necessarily be taken to mean that there *is* no welfare loss associated with illness and/or death shocks in Ruvuma, either in the longer run or in terms of non-monetary welfare.

Further decomposition of the health shock into illness and death (Table 2, column 3) suggests that households suffer especially from illness shocks, and less so from the death of an adult member. The overall absence of welfare loss in case of the death of an adult member, despite expenditures at least as large as in case of an illness shock (Table 4, panel 1) suggests that 1) households don't suffer major income losses from lost labor supply as mentioned above and especially that 2) households manage to insure themselves from such shocks through reliance on savings and likely also through aid (discussed further below in Tables 7 and 8) and traditional/informal insurance schemes (such as group based funeral insurance as illustrated in Dercon, et al. (2006))[18].

These results support earlier findings by Beegle (2005) for Kagera, northwestern Tanzania, where wage employment of adult men declined substantially in response to a future female or male adult death, while past deaths were not associated with changes in either wage employment or non-farm self-employment. Similarly, she reports that coffee

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[18] The reported amount of contributions to (other) funerals also suggests substantial solidarity in bearing the funeral costs. Rutherford (2001) has documented the existence of insurance mechanisms for funerals across the developing world and highlights funeral insurance as one of the most popular products offered by more formalized micro-finance institutions.

farming is reduced in households with a death within 6 months, but not for deaths after 6 months. In Nyakatoke, a typical Haya village in Kagera, De Weerdt and Dercon (2006) also find a decline in consumption (by 7.3 percent) following an unexpected illness shock, with risk sharing through networks important in mitigating non-food consumption. Similarly, in rural Vietnam, the death of an adult working age member is not found to affect income (neither earned or unearned) or medical expenditures, while hospitalization of a worker reduces earned income (by 9 percent) (though not total income) and increases medical spending (more so for the uninsured) (Wagstaff, 2007). No change was observed in consumption in case of a death of a working age member, and non-food consumption increased when a worker was hospitalized (likely substituting spending on food for electricity and upgrading of the house to care for the ill).

Kilimanjaro coffee growers in the lowest quintile category of tree ownership are ceteris paribus about 20 percent poorer than rural households not growing coffee, while those in the richest quintile tend to enjoy higher consumption levels. When interactions with the amount of remittances received (one of the coping strategies)[19] are included, coffee growers in the richest quintile are no longer statistically significantly richer.

Given the comprehensive controls for differences in wealth among households at the time of the onset of the coffee price shocks, these result suggest that while most coffee growers have managed to cope with the coffee price decline, i.e. their consumption levels did at least not fall below those of the non-coffee growers, the smallest among them experienced a substantial decline in their consumption. Given several years of high prices preceding the collapse in coffee prices starting in 2000, it is plausible that coffee

[19] Unlike for the health and rainfall shocks, no data has been collected on the particular strategy coffee growers used to cope with the systemic coffee price shock (e.g. use of savings and/or aid).

growers largely managed to smooth their consumption, using cash savings and/or remittances and cash savings. Many also switched to bananas which are intercropped with coffee for sale in Dar es Salaam.[20] In sum, while it cannot be excluded that coffee growers' welfare declined, most appear not worse off nowadays compared with non-coffee growers. The smallest coffee growers, however, clearly suffered.

Similarly, coffee growers in Ruvuma are not worse off than non-cash-crop growers, with the larger ones actually enjoying substantially higher consumption levels despite the decline in coffee prices since 2000.[21] As asset holdings are well controlled for, though not cash savings, this may again reflect the availability of cash savings held by the larger coffee growers following windfall earnings from coffee production during the late 1990s. This hypothesis is consistent with the fact that the likelihood of using (cash) savings in case of a drought or health shock is largely unassociated with a household's asset holdings (section 6).

While cashew growers also appear better off than non-cash-crop growers, this picture reverses when we replace the village dummies (column 2) by village characteristics (column 4). Cashew growers live concentrated in one district in Ruvuma and virtually all sampled households in this district have at least some cashew trees. The overall lower consumption levels among cashew crop growers are thus captured through the village dummies. As there are no reasons to believe that the cashew-crop-growing villages systematically differ from the non-cash-crop-growing villages beyond the village characteristics included in the analysis, the smaller cashew growers are likely

[20] The number of banana trees per household among coffee growers increased by 37 from 405 to 442 while the number of coffee trees declined by 50 from 492 to 442.
[21] Given the limited number of observations receiving remittances in each of the coffee and cashew quintile categories, we did not interact these with the receipt of remittances.

substantially worse off than the non-cash-crop growers (column 4). Cashew prices collapsed since the late 1990s and smaller cashew growers are likely to hold less cash savings compared with the larger cashew farmers.

Village dummies may capture some of the covariant effect of shocks. The results presented in column 4 of Table 2 seem to bear this out, though for all practical purposes the observed changes are negligible, with the exception of the results for cashew farmers. Finally, it is noteworthy that households in villages with a tarmac road are on average about 16 percent richer in Kilimanjaro and about 33 percent richer in Ruvuma, indicating the importance of being connected through all weather roads, though placement effects cannot be excluded.

5 Poverty Effects of Shocks and the Effectiveness of Coping Strategies

For illustrative purposes, we simulate by how much average consumption and poverty incidence would have improved in the absence of shocks compared with the currently observed situation and by how much coping mitigated the effect of the shocks (Table 5). To do so, the relevant terms $\hat{\beta}_{21} S_{ijt+1}$ and $\hat{\beta}_{22} S_{ijt+1} X_{ijt}$ in the village fixed effect model from Kilimanjaro, including interaction terms with households' coping strategies (column 2, Table 2), are added or subtracted. When coping more than offsets the effect of the shock, the effects are set equal to cancel each other.

The gross total loss among households in rural Kilimanjaro in 2003 due to health and drought shocks is estimated at about 11,100 TSH per adult equivalent or about 6 percent of annual consumption on average. Put differently, households who experienced either one or both shocks lost on average 33,369 TSH per adult equivalent gross or about

18 percent of their annual consumption. This amounts to a total gross loss of about 9.27 billion TSH or 9.27 million US$ in 2003 among rural households in Kilimanjaro alone.[22] Clearly the gross costs of shocks to the economy can be substantial.

As about 12 percent of all rural households in Kilimanjaro experienced an illness or death of an adult member in the two years preceding the survey and almost twice as many households experienced a drought shock in 2003 (Table 6), drought shocks contributed more to the loss (7,000 TSH per adult equivalent) than health shocks (4,100 TSH per adult equivalent), even though the welfare loss associated with a health shock was estimated to be slightly larger than the estimated gross loss from a drought shock.[23] Put differently, the immediate total gross loss in personal consumption among rural households in Kilimanjaro attributed to drought is estimated at 5.32 billion TSH, while the loss associated with illness and death of adult household members is estimated at 3.11 billion TSH.

Yet, some households managed to (partly) smooth their consumption in the face of these shocks. The difference between the observed average consumption in our sample and the average consumption in the absence of any (or the use of other) coping strategies[24] provides an estimate of the effectiveness of households' coping strategies. On average about 53 percent (=5,900 TSH/11,100TSH) of the loss due to health and rainfall shocks was compensated for either through use of one's own savings or reliance

[22] From Table 6, it can be seen that 63,134 households experienced either a health or a drought shock in 2003, corresponding to 277,790 adult equivalents at an average of 4.4 adult equivalents per household. Given an average loss of 33,369 TSH, this results in a total estimated gross loss of 9,269,574,510 TSH or about 9.27 million US$ at the 2003 exchange rate of about 1,000 TSH per US$.

[23] The gross negative effects of the health and drought shock are estimated at 16 and 11 percent respectively (see column 2, Table 2).

[24] In the simulations we focus on the use of savings and aid from others as coping strategies. When coping more than offset the effect of the shock, only the effect of the shock is subtracted from the actual consumption.

on aid from family and neighbors or traditional funeral insurance schemes. This presents an upper bound estimate of the potential crowding out effect from introducing public insurance. Furthermore, households were better able to cope with health shocks than with rainfall shocks. In case of idiosyncratic health shocks, households could rely on both their own savings as well as aid from others. In case of covariant droughts, they were large confined to their savings.

Finally, assuming the decline in welfare among the small coffee growers could be completely ascribed to the coffee price decline, we estimated that the coffee price decline resulted in a net average loss of about 3,900 TSH per adult equivalent. Given that larger farmers may have used their (unobserved cash) savings to cope with the coffee price decline, this is likely to be an underestimate.

Looking at the distributional consequences of the different shocks, health and drought shocks increased poverty incidence by 3.8 percentage points from 38.2 to 42 percent (in the absence of coping), with both shocks equally attributing to the increase. Yet, private coping strategies (either through self- or informal mutual insurance) substantially mitigated the poverty increasing effects of the shocks (by 2.1 percentage points). It is simulated that the coffee price increased poverty by at least 1.9 percentage points, though as argued before this may well be an underestimate.

6 Correlates of Households' Ex Post Coping Strategies

Savings and aid emerge as important coping strategies for rural households in Kilimanjaro and Ruvuma. Understanding when savings, aid or both are more likely to be used in case of different shocks and by whom is important to inform better targeting of social protection interventions. Tables 7 and 8 present probit models of having received aid or having used savings (or both) in case of a shock for Kilimanjaro and Ruvuma respectively.

Consistent with the covariate nature of rainfall shocks, households are more likely to use their own savings to cope with droughts, though savings are also used to cope with illness and death shocks. External formal assistance (e.g. food aid or formal social protection interventions) has been rare in the study areas. When faced with a health shock (especially when it concerns the death of an adult member) which is idiosyncratic in nature, a household is more likely to receive aid. Aid appears not responsive to drought shocks.

No clear pattern of association emerges between the amount of assets possessed by the household and its use of coping strategies. The Ruvuma results suggest that the more coffee trees a household had two years ago, the higher the likelihood was that it coped either through use of savings and the reception of aid. This is consistent with the earlier finding that coffee-growing households in Ruvuma are not worse off than non-cash-crop growers despite the decline in coffee price during the early 2000s. There is no association between the number of coffee trees owned in 2000 and the use of self- or mutual insurance in Kilimanjaro. Yet, when quintile categories of coffee trees owned are included (as opposed to the number of coffee trees and its squared term) (results not presented), those in the highest quintile are more likely to use savings (though not aid), consistent with the results in table 2 that this group is still better able to cope and that it might still be better off than the non-coffee growers. Cashew tree growers were not found to be different in their coping capacity than the other non-cash-crop growers.

While educational attainments do not affect households' coping capacity in Kilimanjaro, in Ruvuma secondary education of the head is associated with a lower probability of receiving assistance, and primary schooling negatively correlated with the use of either coping strategy. Female-headed households in Kilimanjaro are much more likely to receive aid, and much less likely to use savings to cope with shocks. A similar pattern was observed in Ruvuma, though the coefficients were imprecisely estimated. In Kilimanjaro, the probability of receiving aid decreases with the age of the household head up to 36 years, and becomes positively associated with age at 72 years. In Ruvuma, a corresponding increase in the likelihood of using savings is observed up to the age of 43.

The availability of a bus service in a village positively affects households' likelihood of using savings in Ruvuma, while electrification and cell phone reception in the village, both indicators of general wealth levels, are positively associated with the use of savings in Kilimanjaro.[25]

7 Conclusions

This study has explored the immediate effects of drought and health shocks on welfare and poverty in the Kilimanjaro and Ruvuma regions of Tanzania and reflected on the effect of the coffee and cashew price declines since 2000. About one-third of the rural population in Kilimanjaro suffered either from drought or health shocks in the survey year, resulting in an 18 percent gross loss in their 2003 consumption. Through reliance on savings and aid, losses were reduced to 8 percent on average. The joint effect on poverty incidence was 2.3 percentage points, and the net effect 0.6 percentage point,

[25] None of the villages in Ruvuma has electricity, and only one village has cell phone reception.

compared with an estimated poverty incidence in Kilimanjaro of only 15 percentage points.

No immediate (negative) welfare effects were found from the drought and health shocks in Ruvuma. At 1289 mm, rainfall in Kilimanjaro is on average not low, but much more variable than in Ruvuma, where drought shocks are rare. Lower medical expenditures in case of illness, associated with less access to health facilities and lower incomes, appear to underpin the estimated absence of an immediate welfare loss following a health (death and/or illness) shock in Ruvuma.

Even though the directly reported expenses related to death shocks are similar to those related to illness shocks, death shocks have much smaller immediate welfare effects. This likely relates to the existence of effective group based funeral insurance schemes (Dercon et al., 2006), though higher HIV/AIDs incidence may put these schemes under increasing pressure. Second, the estimated welfare losses from illness shocks were largely associated with the medical expenses and not due to substantive income losses. However, this does not necessarily imply that households in Ruvuma suffer less from health shocks. Rather, they spend less to deal with them.

Overall, households rely heavily on self-insurance through a depletion of their cash savings (and less their assets) as well as informal mutual insurance schemes, including group-based funeral societies to smooth their consumption. Formal assistance schemes are rare. Aid from others is frequently received in case of death shocks, less so when there is an illness and rarely in case of a drought shock, when households fall back on their own savings. Own savings are also relied upon to deal with health shocks, especially illness shocks. Female-headed households tend to rely more on aid and less on their own savings.

Coffee growers (apart from the smallest) have managed to weather the effects of the coffee price decline in the early 2000s, at least to the point of not falling below the welfare levels of the non-cash-crop growers, and most likely at the expense of a depletion of their (cash) savings, with indications that the larger ones (especially in Ruvuma) are still better off. Many coffee growers in Kilimanjaro also switched to bananas, which is intercropped with coffee, for the market in Dar es Salaam. The smaller cashew crop growers, conversely, appear substantially worse off than non-cash-crop growers. Several years of low cashew prices are beginning to take their toll.

Overall, while significant, especially in Kilimanjaro, the welfare losses associated with droughts, health shocks and commodity price declines estimated in this study likely only provide a lower bound. The study does not account for the long-run welfare losses through the depletion of productive capital (Dercon, 2004) and disinvestment in human capital development (Ainsworth, Beegle, and Koda, 2005) and the income forgone through ex ante portfolio diversification (Rosenzweig and Binswanger, 1993) and adoption of low-risk/low-return technologies (Dercon and Christiaensen, 2007) to reduce exposure to risk. A quantification of these costs is necessary to obtain more comprehensive estimates of the total benefits from vulnerability-reducing interventions, which in rural Tanzania should especially focus on improving health conditions and mitigating the effect of droughts.

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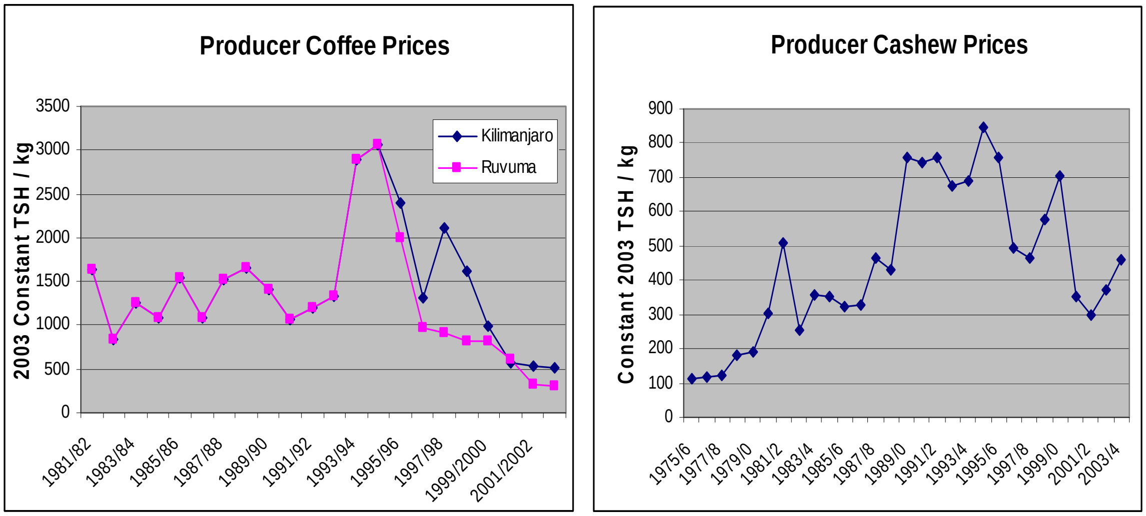
Figure 1: Real producer prices for mild coffees and cashew nuts



Source: Danford, Hoffmann and Christiaensen (2007).

Table 1: Socioeconomic characteristics, shocks and coping behavior among cash crop and non-cash-crop-growing households and communities in Kilimanjaro and Ruvuma.

		Kilimanjaro			Ruvuma				
		Coffee	Non coffee[1)]	All	Coffee	Cashew	Tobacco	Non-cash	All
Number of households	Units	117,266	74,256	191,522	57,195	44,060	7,091	66,849	173,921
Proportion of total	%	61.2	38.8	100	32.9	25.3	4.0	38.4	100
Total consumption per adult equivalent (2003)	000TSh	187.6	198.1	191.8	179.5	127.2	126.6	164.6	159.0
Age of head	Years	55.7	50.1	53.5	42.2	43.2	45.7	44.5	43.4
Dependency ratio	%	50.6	51.4	50.9	48.0	45.0	46.9	49.4	47.7
Female-headed	%	9.4	17.4	12.5	4.8	4.3	0.0	13.2	7.7
Education of head	Years	5.9	6.1	6.0	6.3	5.6	5.8	6.0	6.0
Household size	Units	5.4	5.2	5.3	5.3	5.1	5.5	5.2	5.2
Adult equivalents	Units	4.5	4.3	4.4	4.3	4.1	4.4	4.2	4.2
Ethnicity of household head									
Pare	%	6.1	35.3	17.8	-	-	-	-	-
Chagga	%	93.4	46.3	74.5	-	-	-	-	-
Matengo	%	-	-	-	95.7	3.9	3.8	24.0	41.6
Ndendeule	%	-	-	-	1.1	3.0	23.0	11.6	6.4
Ngoni	%	-	-	-	1.8	6.5	50.9	27.1	14.5
Yao	%	-	-	-	0.0	60.9	10.4	16.8	22.3
Nyasa	%	-	-	-	0.0	0.9	0.0	0.9	0.6
Land owned last year	Acres	2.51	3.02	2.71	9.5	11.7	9.0	10.4	9.3
Head of cattle, oxen, horses	Units	1.57	2.24	1.84	0.8	0.2	0.0	0.2	0.4
Head of goats, sheep, pigs	Units	3.08	3.82	3.38	4.2	1.9	3.6	2.8	3.1
Value of agricultural tools and non-farm enterprise assets)	000Tsh	445.8	99.5	238.5	229.6	26.0	37.7	35.8	97.2
Easy to get access to obtain credit for seasonal inputs	%	14.8	15.3	15.0	21.1	13	50.6	21.3	20.2
Households affected by at least one death between 1999 and 2003	%	23.1	29.9	26.0	13.1	17.6	16.5	18.2	16.2
Households with at least one member seriously ill between 1999 and 2003	%	23.7	22.8	23.3	20.6	15.0	17.9	19.1	18.3
Households affected by at least one self-reported drought between 1999 and 2003	%	27.8	39.9	33.0	1.5	4.1	4.2	7.1	4.4
Coffee trees 3 (Kilimanjaro) or 2 (Ruvuma) years ago	Units	492.3	2.7	301.0	1197.3	6.3	0	0.4	393.9
Cashew trees 2 years ago	Units	-	-	-	0.1	292.9	3.5	0	72.7
Used savings/sold assets to cope with shock	%	76.3	68	72.6	74.0	76.5	61.0	66.1	71.1
Received aid to cope with shocks	%	59.5	60	59.7	51.3	53.1	42.3	41.3	47.0
Remittances per capita	000Tsh	6.6	5.1	6.0	2.5	1.2	1.8	3.3	2.1
Proportion of household time spent on nonagricultural activities	%	15.9	25.6	19.7	11.3	11.4	6.5	19.9	14.5
Irrigated land	%	17.3	26.2	20.7	1.7	0.9	0.9	3.4	2.1
Tarmac road reaches village	%	10.3	19.2	14	0	0	3.9	10.3	4.1
Village has public phone	%	31.7	29.1	30.7	0	0	0	0	0
Village has cell phone signal	%	96.4	86.4	92.7	6.8	0	0	0.8	2.5
Bus service to village	%	50.1	58.0	53.3	5.8	13.5	55.3	38.1	22.3
Village has a market	%	32.6	35.5	33.8	25.5	30.2	61.9	39.3	33.3
Village has electricity	%	87.6	56.5	75.2	0	0	0	0	0

		Kilimanjaro			Ruvuma				
		Coffee	Non coffee[1)]	All	Coffee	Cashe w	Tobacco	Non-cash	All
Village has health center, dispensary, or hospital	%	56.2	61.9	58.4	56.5	37.3	80.5	67.5	56.5
Altitude of village, 100m	%	45.7	36.0	41.7	45.9	19.8	30.6	30.1	32.8

[1)] Defined as having coffee trees at survey time.

Table 2: Shocks, coping and consumption in Kilimanjaro

Log consumption per adult equivalent (exclusive of expenditures on health, education and functions)	*Baseline* (1)	*Shocks interacted with coping strategies* (2)	*Health shocks unbundled* (3)	*Village dummies unbundled* (4)
Shocks, exposure and coping				
major illness or death of adult member	-0.020	-0.161		-0.205
	(0.47)	(1.82)*		(2.29)**
received aid to cope with major illness or death of adult member		0.070		0.074
		(0.87)		(0.93)
used savings to cope with major illness or death of adult member		0.148		0.202
		(1.55)		(2.19)**
death of adult member last 2 yrs			-0.150	
			(0.78)	
death of adult member last 2 yrs * received aid			0.025	
			(0.13)	
death of adult member last 2 yrs * used savings			0.271	
			(1.99)**	
major illness of adult member last 2 yrs			-0.170	
			(1.63)	
ill adult member last 2 yrs * received aid			0.068	
			(0.70)	
ill adult member last 2 yrs * used savings			0.101	
			(0.90)	
acres/ae * very low rainfall	-0.104	-0.112	-0.108	-0.116
	(2.82)***	(3.04)***	(2.94)***	(3.24)***
acres/ae * very low rainfall * got aid for drought		-0.243	-0.245	-0.253
		(2.02)**	(2.05)**	(2.07)**
acres/ae * very low rainfall * used savings for drought		0.131	0.131	0.137
		(1.21)	(1.20)	(1.25)
acres/ae * somewhat low rainfall	0.044	0.025	0.027	0.029
	(1.19)	(0.72)	(0.76)	(0.87)
acres/ae * somewhat low rainfall * got aid for drought		-0.214	-0.195	-0.136
		(1.35)	(1.18)	(0.87)
acres/ae * somewhat low rainfall * used savings for drought		0.166	0.165	0.158
		(2.93)***	(2.97)***	(2.70)***
lowest quintile coffee trees 2000	-0.205	-0.217	-0.210	-0.233
	(3.45)***	(3.59)***	(3.47)***	(3.85)***
lowest quintile coffee trees 2000 * remittance income 100,000 TSH/ae		-0.119	-0.124	-0.051
		(1.18)	(1.23)	(0.53)
second quintile coffee trees 2000	-0.065	-0.092	-0.093	-0.085
	(1.14)	(1.60)	(1.61)	(1.58)
second quintile coffee trees 2000 * remittance income 100,000 TSH/ae		0.150	0.148	0.163
		(1.08)	(1.07)	(1.22)
third quintile coffee trees 2000	-0.043	-0.065	-0.062	-0.071
	(0.72)	(1.03)	(1.00)	(1.27)
third quintile coffee trees 2000 * remittance income 100,000 TSH/ae		0.150	0.147	0.207
		(1.18)	(1.15)	(1.75)*
fourth quintile coffee trees 2000	-0.022	-0.051	-0.051	-0.044
	(0.38)	(0.86)	(0.86)	(0.85)
fourth quintile coffee trees 2000 * remittance income 100,000 TSH/ae		0.179	0.172	0.227
		(1.97)**	(1.89)*	(2.68)***
highest quintile coffee trees 2000	0.145	0.114	0.118	0.156
	(2.10)**	(1.56)	(1.63)	(2.48)**
highest quintile coffee trees 2000 * remittance income 100,000 TSH/ae		0.155	0.155	0.111
		(1.15)	(1.15)	(0.92)
irrigated acres/ae * very low rainfall	0.039	0.060	0.053	0.099
	(0.42)	(0.66)	(0.58)	(1.10)
irrigated acres/ae * somewhat low rainfall	-0.265	-0.241	-0.245	-0.234
	(3.10)***	(2.92)***	(2.99)***	(2.90)***
irrigated acres cultivated 2003 per ae	0.188	0.188	0.188	0.195
	(2.89)***	(2.96)***	(3.07)***	(3.36)***
remittance income, 100,000 TSH/ae	0.149	0.060	0.065	0.030
	(2.81)***	(0.68)	(0.74)	(0.37)
proportion of time in non-agricultural activities in 2002	0.185	0.203	0.205	0.212
	(2.80)***	(3.05)***	(3.09)***	(3.12)***
value of consumer durables in 2002, 100,000 TSH per ae	0.304	0.297	0.297	0.311
	(8.49)***	(8.53)***	(8.57)***	(9.35)***

Log consumption per adult equivalent (exclusive of expenditures on health, education and functions)	*Baseline*	*Shocks interacted with coping strategies*	*Health shocks unbundled*	*Village dummies unbundled*
	(1)	(2)	(3)	(4)
value of consumer durables in 2002 squared, 100,000 TSH	-0.027	-0.024	-0.024	-0.025
	(4.96)***	(4.72)***	(4.72)***	(5.01)***
Demographic characteristics				
dependency ratio	-0.186	-0.181	-0.180	-0.178
	(3.00)***	(2.89)***	(2.88)***	(2.89)***
age of head	-0.028	-0.027	-0.027	-0.027
	(4.07)***	(4.00)***	(4.02)***	(4.14)***
age of head squared	0.000	0.000	0.000	0.000
	(3.83)***	(3.74)***	(3.77)***	(3.98)***
female-headed household	0.068	0.063	0.068	0.089
	(1.51)	(1.40)	(1.53)	(1.97)**
years primary education of head	0.006	0.005	0.006	0.008
	(0.89)	(0.74)	(0.83)	(1.21)
years secondary education of head	0.034	0.033	0.033	0.034
	(1.68)*	(1.65)*	(1.63)	(1.66)*
whether head has post-sec education	-0.206	-0.222	-0.219	-0.238
	(1.80)*	(1.95)*	(1.93)*	(2.09)**
head is Chagga	0.149	0.158	0.152	0.132
	(2.41)**	(2.52)**	(2.43)**	(2.40)**
head is Pare	0.125	0.125	0.112	0.036
	(1.82)*	(1.81)*	(1.64)	(0.59)
Productive assets				
land owned 3 years ago/ae	0.094	0.095	0.094	0.072
	(2.62)***	(2.64)***	(2.62)***	(2.21)**
(land owned 3 years ago/ae) squared	-0.000	0.000	0.000	0.002
	(0.04)	(0.06)	(0.03)	(0.94)
value of productive assets in 2002, 100,000 TSH per ae	0.043	0.042	0.042	0.040
	(3.17)***	(3.04)***	(3.03)***	(2.35)**
value of productive assets in 2002 squared, 100,000 TSH	-0.000	-0.000	-0.000	-0.000
	(3.37)***	(3.24)***	(3.23)***	(2.53)**
relatively easy to obtain seasonal credit for inputs	0.114	0.119	0.119	0.128
	(2.50)**	(2.54)**	(2.53)**	(2.71)***
head of cattle, oxen, horses 3 years ago / ae	0.088	0.091	0.091	0.105
	(4.54)***	(4.70)***	(4.79)***	(5.49)***
(head of cattle, oxen, horses 3 years ago / ae) squared	-0.001	-0.001	-0.001	-0.001
	(2.58)**	(2.80)***	(2.85)***	(3.59)***
head of goat, sheep, pigs 3 years ago / ae	0.031	0.032	0.032	0.024
	(2.39)**	(2.48)**	(2.58)***	(1.93)*
(head of goat, sheep, pigs 3 years ago / ae) squared	-0.001	-0.001	-0.001	-0.001
	(2.21)**	(2.34)**	(2.41)**	(1.97)**
Village connectivity, infrastructure and agro-ecological potential				
tarmac road reaches village				0.161
				(2.36)**
village has public phone				0.036
				(0.97)
village has cell phone signal				0.024
				(0.35)
bus service to village				0.010
				(0.25)
village has a market				0.040
				(1.13)
village has electricity				0.102
				(2.14)**
village has health center, dispensary, or hospital				-0.084
				(0.89)
Altitude of village, 1000 m				0.200
				(0.09)
Constant	5.268	5.268	5.260	5.136
	(22.61)***	(22.45)***	(22.53)***	(24.12)***
Observations	914	914	914	914
R-squared	0.49	0.50	0.50	0.47

Models (1)-(3) include village dummies (not presented to save space). All models use population-weighted least squares with standard errors corrected for heteroskedasticity and intra-cluster correlation. Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Shocks, coping and consumption in Ruvuma

Log consumption per adult equivalent (exclusive of expenditures on health, education and functions)	*Baseline*	*Shocks interacted with coping strategies*	*Health shocks unbundled*	*Village dummies unbundled*
	(1)	(2)	(3)	(4)
Shocks, exposure and coping				
major illness or death of adult member	-0.005	0.030		0.067
	(0.11)	(0.42)		(0.99)
received aid to cope with major illness or death of adult member		-0.004		-0.024
		(0.05)		(0.29)
used savings to cope with major illness or death of adult member		-0.083		-0.074
		(1.06)		(0.94)
death of adult member last 2 years			0.075	
			(0.93)	
death of adult member last 2 years * received aid			-0.414	
			(2.72)***	
death of adult member last 2 years * used savings			0.164	
			(1.15)	
major illness of adult member last 2 years			0.003	
			(0.04)	
ill adult member last 2 years * received aid			0.057	
			(0.62)	
ill adult member last 2 years * used savings			-0.021	
			(0.20)	
acres/ae * very low rainfall	-0.018	-0.020	-0.019	-0.017
	(0.34)	(0.36)	(0.36)	(0.28)
acres/ae * very low rainfall * got aid for drought		-0.078	-0.078	0.014
		(0.69)	(0.69)	(0.19)
acres/ae * somewhat low rainfall	0.031	0.030	0.030	0.036
	(1.83)*	(1.73)*	(1.74)*	(2.11)**
acres/ae * somewhat low rainfall * got aid for drought		-0.326	-0.325	-0.328
		(1.52)	(1.51)	(1.61)
acres/ae * somewhat low rainfall * used savings for drought		0.004	0.006	-0.010
		(0.09)	(0.11)	(0.17)
lowest quintile coffee trees 2002	0.134	0.138	0.131	0.071
	(1.49)	(1.54)	(1.46)	(0.83)
second quintile coffee trees 2002	0.156	0.156	0.158	0.066
	(1.81)*	(1.81)*	(1.86)*	(0.80)
third quintile coffee trees 2002	0.079	0.083	0.075	0.003
	(0.94)	(0.97)	(0.89)	(0.04)
fourth quintile coffee trees 2002	0.336	0.338	0.345	0.243
	(3.87)***	(3.86)***	(3.94)***	(2.85)***
highest quintile coffee trees 2002	0.290	0.289	0.291	0.199
	(3.21)***	(3.17)***	(3.22)***	(2.16)**
lowest quintile cashew trees 2002	0.066	0.068	0.065	-0.148
	(0.79)	(0.81)	(0.77)	(2.01)**
second quintile cashew trees 2002	0.103	0.107	0.110	-0.234
	(0.99)	(1.02)	(1.05)	(3.12)***
third quintile cashew trees 2002	0.312	0.312	0.304	-0.034
	(2.67)***	(2.67)***	(2.60)***	(0.39)
fourth quintile cashew trees 2002	0.312	0.326	0.316	-0.042
	(2.76)***	(2.87)***	(2.79)***	(0.52)
highest quintile cashew trees 2002	0.394	0.401	0.393	0.025
	(3.27)***	(3.32)***	(3.24)***	(0.29)
irrigated acres/ae * somewhat low rainfall	0.039	0.036	0.052	0.037
	(0.16)	(0.15)	(0.22)	(0.16)
irrigated acres cultivated 2003 per ae	0.142	0.141	0.137	0.147
	(1.03)	(1.03)	(1.00)	(1.15)
cultivated tobacco in 2004	-0.160	-0.156	-0.150	-0.091
	(1.46)	(1.42)	(1.37)	(0.84)
remittance income, 100,000 TSH/ae	0.184	0.183	0.186	0.184
	(1.45)	(1.44)	(1.49)	(1.35)
proportion of time in non-agricultural activities in 2003	0.218	0.212	0.217	0.286
	(2.39)**	(2.33)**	(2.39)**	(3.05)***
value of consumer durables in 2003, 100,000 TSH per ae	0.470	0.470	0.465	0.466
	(5.91)***	(5.92)***	(5.89)***	(5.66)***
value of consumer durables in 2003, 100,000 TSH per ae, squared	-0.004	-0.004	-0.004	-0.004
	(4.76)***	(4.72)***	(4.65)***	(4.70)***

Log consumption per adult equivalent (exclusive of expenditures on health, education and functions)	*Baseline* (1)	*Shocks interacted with coping strategies* (2)	*Health shocks unbundled* (3)	*Village dummies unbundled* (4)
Demographic characteristics				
dependency ratio	-0.196	-0.195	-0.189	-0.162
	(2.44)**	(2.41)**	(2.34)**	(1.94)*
age of head	-0.046	-0.046	-0.046	-0.043
	(5.66)***	(5.67)***	(5.64)***	(5.15)***
age of head squared	0.000	0.000	0.000	0.000
	(4.88)***	(4.89)***	(4.83)***	(4.45)***
female-headed household	0.105	0.107	0.110	0.101
	(1.75)*	(1.77)*	(1.83)*	(1.64)
years primary completed by head	0.024	0.024	0.024	0.024
	(2.70)***	(2.68)***	(2.72)***	(2.61)***
years secondary completed by head	0.015	0.013	0.015	0.007
	(0.61)	(0.55)	(0.60)	(0.29)
head has post-secondary education	0.209	0.207	0.182	0.261
	(1.17)	(1.17)	(1.06)	(1.56)
head is Matengo	-0.063	-0.061	-0.057	-0.004
	(0.71)	(0.68)	(0.64)	(0.06)
head is Ndendeule	-0.009	-0.011	-0.009	0.116
	(0.09)	(0.10)	(0.09)	(1.27)
head is ngoni	-0.132	-0.134	-0.137	-0.025
	(1.64)	(1.65)*	(1.70)*	(0.32)
head is yao	-0.062	-0.065	-0.065	-0.056
	(0.78)	(0.80)	(0.79)	(0.85)
head is nyasa	0.010	0.007	0.019	0.024
	(0.07)	(0.05)	(0.13)	(0.17)
Productive assets				
land owned 1 year ago/ae	0.035	0.035	0.035	0.042
	(3.24)***	(3.19)***	(3.27)***	(3.87)***
land owned 1 year ago/ae, squared	-0.001	-0.001	-0.001	-0.001
	(2.56)**	(2.52)**	(2.57)**	(2.85)***
value of productive assets in 2003, 100,000 TSH per ae	0.047	0.046	0.046	0.039
	(1.76)*	(1.73)*	(1.76)*	(1.47)
value of productive assets in 2003 squared, 100,000 TSH	-0.001	-0.001	-0.001	-0.001
	(2.12)**	(2.10)**	(2.10)**	(1.72)*
relatively easy to obtain seasonal credit for inputs	-0.070	-0.068	-0.072	-0.072
	(1.76)*	(1.72)*	(1.79)*	(1.84)*
head of cattle, oxen, horses one year ago per ae	0.389	0.385	0.401	0.353
	(4.43)***	(4.36)***	(4.55)***	(3.98)***
head of cattle, oxen, horses, one year ago per ae, squared	-0.146	-0.143	-0.150	-0.146
	(3.68)***	(3.54)***	(3.88)***	(3.98)***
head of goat, sheep, one year ago per ae	0.080	0.082	0.081	0.101
	(2.88)***	(2.91)***	(2.91)***	(3.58)***
head of goat, sheep, one year ago per ae, squared	-0.007	-0.007	-0.007	-0.009
	(1.53)	(1.61)	(1.57)	(1.94)*
Village connectivity, infrastructure and agro-ecological potential				
tarmac road reaches village				0.331
				(3.02)***
village has cell phone signal				-0.059
				(0.75)
village has a market				-0.073
				(1.95)*
bus service to village				0.035
				(0.72)
health facility in village				0.046
				(1.28)
altitude				0.154
				(0.06)
constant	5.235	5.491	5.477	5.446
	(21.79)***	(23.75)***	(23.61)***	(24.61)***
Observations	878	878	878	878
R-squared	0.47	0.47	0.47	0.42

Models (1)-(3) include village dummies (not presented to save space). All models use population-weighted least squares with standard errors corrected for heteroskedasticity and intra-cluster correlation. Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; rainfall very low * acres cultivated/ae * used savings to cope with drought, rainfall very low * irrigated acres/ae, village electricity, village public phone, are all dropped due to collinearity.

Table 4: Expenses incurred as result of an illness or death shock

	Illness of adult member (15-64 yrs old)		*Death of adult member (15-64 yrs old)*	
Average expenses ('000 TSH) incurred per household in case of an illness or death shock over the past 5 years				
Kilimanjaro	137		143	
Ruvuma	38		94	
	Illness shock		Death shock	
	No	Yes	No	Yes
Health expenditures ('000 TSH) per adult equivalent during 30 days preceding the survey				
Kilimanjaro	9.6	13.8	9.7	12.4
Ruvuma	5.4	11.2	5.6	8.4

Source: Authors' calculations.

Table 5: Welfare and Poverty effect of Shocks and Coping in Kilimanjaro[1)]

	health & rainfall	health only	rainfall only	coffee shock only
Consumption per adult equivalent (‘000TSH)				
no shock, no coping	197.0	192.9	195.8	195.7
shock and coping (=actual)	191.8	191.8	191.8	191.8
shock, no coping	185.9	189.0	188.6	191.8
Poverty incidence (%)				
no shock, no coping	38.2	39.7	38.6	38.0
shock and coping (=actual)	39.9	39.9	39.9	39.9
shock, no coping	42.0	41.1	41.0	39.9

1) The simulations were performed using the village fixed effect model including interaction terms with households’ coping strategies (column 2, Table 2).

Source: Authors’ calculations.

Table 6: Incidence of rainfall and health shocks in Kilimanjaro and Ruvuma in 2002-2004

	Kilimanjaro		Ruvuma	
	percent of households	number of households	percent of households	number of households
Adult health shock last 2 years	12.2	23,336	11.9	20,706
Adult illness shock last 2 years	6.9	13,172	8.1	14,105
Adult death shock last 2 years	5.8	11,194	4.0	7,035
Very low rainfall this year	20.8	39,798	3.8	6,547
Somewhat low rainfall this year	41.9	80,234	33.8	58,822
Either very low rainfall or adult health shock	33.0	63,134	15.7	27.253

Source: Authors' calculations.

Table 7: Correlates of use of savings and aid in case of a shock in Kilimanjaro

	(1) received aid	(2) used savings	(3) received aid or used savings
Shocks			
shock was any death	1.896	0.559	1.891
	(8.89)***	(3.05)***	(6.01)***
shock was any illness	0.894	0.758	1.057
	(4.47)***	(3.77)***	(4.85)***
shock was drought	-0.053	0.852	0.741
	(0.29)	(4.98)***	(4.33)***
Productive assets			
head of cattle, oxen, horses one year ago per ae	0.365	-0.196	0.185
	(1.89)*	(1.35)	(0.99)
head of cattle, oxen, horses one year ago per ae, squared	-0.057	-0.000	-0.047
	(1.63)	(0.01)	(1.53)
head of goat, sheep, one year ago per ae	-0.134	0.022	-0.033
	(2.24)**	(0.41)	(0.55)
head of goat, sheep, one year ago per ae, squared	0.005	0.001	0.002
	(2.27)**	(0.80)	(1.00)
land owned 3 years ago/ae	0.037	-0.119	0.024
	(0.26)	(0.91)	(0.17)
land owned 3 years ago/ae, squared	0.001	0.009	0.000
	(0.14)	(1.01)	(0.03)
coffee trees owned in 2000, per ae (hundreds)	0.013	0.115	0.054
	(0.16)	(1.05)	(0.52)
coffee trees owned in 2000 per ae, squared (hundreds)	-0.003	0.002	0.002
	(0.70)	(0.24)	(0.45)
Demographics			
dependency ratio	-0.205	-0.020	0.071
	(0.68)	(0.07)	(0.21)
female-headed household	0.611	-0.432	0.120
	(3.00)***	(2.22)**	(0.54)
age of head	-0.072	0.028	-0.016
	(2.45)**	(1.19)	(0.63)
age of head squared	0.001	-0.000	0.000
	(2.89)***	(1.35)	(0.56)
yrs primary education of head	0.021	-0.006	-0.026
	(0.60)	(0.20)	(0.72)
yrs secondary education of head	0.058	0.021	0.022
	(0.56)	(0.23)	(0.22)
whether head has post-sec education	-0.424	0.170	-0.089
	(0.94)	(0.37)	(0.19)
head is Chagga	-0.505	-0.385	-0.279
	(1.90)*	(1.36)	(0.91)
head is Pare	-0.195	-0.355	-0.167
	(0.67)	(1.17)	(0.52)
Village connectivity, infrastructure and agro-ecological potential			
tarmac road reaches village	0.045	0.070	0.183
	(0.17)	(0.25)	(0.59)
village has public phone	-0.201	-0.248	-0.197
	(0.97)	(1.29)	(0.92)
village has cell phone signal	0.251	0.728	0.910
	(0.68)	(2.09)**	(2.67)***
village has a market	-0.113	-0.158	-0.150
	(0.60)	(0.87)	(0.73)
village has electricity	0.294	0.520	0.631
	(1.21)	(2.11)**	(2.30)**

	(1) received aid	(2) used savings	(3) received aid or used savings
bus service to village	0.076	0.192	0.046
	(0.38)	(1.02)	(0.22)
village has bank or other formal credit inst.	-0.336	-0.075	-0.181
	(1.52)	(0.31)	(0.70)
Altitude	0.003	-0.002	-0.002
	(0.27)	(0.24)	(0.16)
Constant	0.500	-1.273	-0.318
	(0.49)	(1.44)	(0.34)
Observations	484	484	484
F stat	5.41	2.43	3.12
Prob > F	0.000	0.000	0.000
Pseudo R-squared [1)]	0.2873	. 1230	0.2249

Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; ae=adult equivalent; all models use population-weighted probits with standard errors corrected for intra-cluster correlation; post-secondary education of head predicts use of savings and no receipt of aid perfectly; differing number of observations between regressions is due to the fact that observations are dropped when a variable is perfectly collinear with the dependent variable.

Source: Authors' calculations.

Table 8: Correlates of use of savings and aid in case of a shock in Ruvuma

	(1) received aid	(2) used savings	(3) received aid or used savings
Shocks			
shock was any death	1.769	0.553	1.321
	(5.37)***	(1.88)*	(3.30)***
shock was any illness	0.129	0.773	1.424
	(0.50)	(2.58)**	(3.23)***
shock was drought	-0.377	0.902	0.657
	(0.88)	(1.82)*	(1.31)
Productive assets			
head of cattle, oxen, horses one year ago per ae	-0.676	-0.560	-3.012
	(0.94)	(0.80)	(2.30)**
head of cattle, oxen, horses, one year ago squared per ae	0.485	0.036	1.333
	(1.67)*	(0.13)	(1.77)*
head of goat, sheep, one year ago per ae	0.374	-0.535	-0.322
	(1.53)	(2.16)**	(1.10)
head of goat, sheep, one year ago squared per ae	-0.095	0.075	0.014
	(1.78)*	(1.48)	(0.26)
land owned 1 year ago/ae	0.041	0.141	0.196
	(0.36)	(1.27)	(1.44)
land owned 1 year ago/ae sqr	-0.000	-0.006	-0.008
	(0.04)	(0.82)	(0.99)
coffee trees owned in 2002, hundreds per ae	0.331	0.339	0.902
	(1.29)	(1.29)	(2.81)***
coffee trees owned in 2002 per ae squared, hundreds	-0.056	-0.034	-0.146
	(1.08)	(0.73)	(2.63)***
hundreds of cashew trees owned in 2002 per ae	0.169	-0.770	-1.007
	(0.55)	(0.78)	(0.93)
hundreds of cashew trees owned in 2002 per ae, squared	-0.027	0.663	0.573
	(0.72)	(1.31)	(1.20)
whether produced tobacco this year	0.577	-0.168	-0.272
	(0.77)	(0.24)	(0.35)
Demographics			
dependency ratio	-0.279	0.442	-0.217
	(0.59)	(0.87)	(0.39)
head is female	0.466	-0.578	0.050
	(1.13)	(1.37)	(0.11)
age of head	-0.038	0.086	0.108
	(0.68)	(1.71)*	(1.82)*
age of head squared	0.000	-0.001	-0.001
	(0.53)	(1.99)**	(2.13)**
yrs primary completed by head	0.038	-0.031	-0.145
	(0.72)	(0.54)	(2.10)**
yrs secondary completed by head[2)]	-0.411	0.113	0.235
	(2.30)**	(0.82)	(1.63)
head is Matengo	-0.178	0.144	-0.285
	(0.45)	(0.37)	(0.64)
head is Ndendeule	-0.772	-0.379	-0.311
	(1.47)	(0.76)	(0.60)
head is Ngoni	0.265	-0.110	-0.088
	(0.59)	(0.26)	(0.19)
head is Yao	0.429	0.297	0.648
	(1.16)	(0.76)	(1.38)
head is Nyasa	-0.394		
	(0.57)		

	(1) received aid	(2) used savings	(3) received aid or used savings
Village connectivity, infrastructure and agro-ecological potential			
tarmac road reaches village	-0.134	0.647	0.286
	(0.17)	(0.87)	(0.39)
village has cell phone signal	-0.470		
	(0.89)		
village has a market	0.302	-0.107	-0.099
	(1.14)	(0.39)	(0.30)
bus service to village	-0.007	0.709	0.689
	(0.03)	(2.16)**	(1.96)*
village has bank or other formal credit inst.	-0.020	-0.187	-0.577
	(0.05)	(0.44)	(1.12)
Constant	-1.087	-1.366	-0.373
	(0.53)	(0.69)	(0.16)
Observations	202	195	195
F stat	1.63	1.43	1.53
Prob > F	0.0289	0.0865	0.0550
Pseudo R-squared	0.2025	0.1686	0.2847

Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; ae=adult equivalent; population-weighted probits with standard errors corrected for intra-cluster correlation; post-secondary education of head predicts use of savings and no receipt of aid perfectly; differing number of observations between regressions is due to the fact that observations are dropped when a variable is perfectly collinear with the dependent variable.

Source: Authors' calculations.