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THE IMPACTS OF PRIME-AGE ADULT MORTALITY ON RURAL HOUSEHOLD INCOME, ASSETS, AND POVERTY IN MOZAMBIQUE

By

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The Impacts Of Prime-Age Adult Mortality On Rural Household Income, Assets, And Poverty In Mozambique

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EXECUTIVE SUMMARY

Using a three-year panel of 4,058 Mozambican households surveyed in 2002 and 2005, we measure how PA adult mortality due to illness affects rural household size and number of adult members, crop and non-farm income, total household income, and asset levels. First-difference estimations indicate that the effects of PA mortality vary considerably by the gender and household position of the deceased individual as well as by region. Results show that significant reductions in household size, income, and assets are more likely found in the event of a PA male death rather than a PA female death. In the North/Center of the country, a PA male head death can result in loss of 25% of crop income; in the South, such a death results in an average loss of 88% of non-farm income. In spite of these significant reductions in income, we do not find significant reductions in total income per AE among affected households, and they are not more likely to have ex post income/AE below the expenditure-based poverty line relative to non-affected households. However, due to significant asset losses and lower ex post landholding/AE relative to the non-affected population, affected households may be increasingly vulnerable to adverse income and assets shocks, especially those households that have suffered a PA male death.

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AE	Adult Equivalent
AIDS	Acquired Immune Deficiency Syndrome
ARVs	Anti-retroviral Treatment
BGLW	Becketti, Gould, Lillard, and Welch test
CDF	Cumulative distribution function
DID	Difference in Differences
FAO	Food and Agricultural Organization
FD	First Difference
FSRP	Food Security Research Project
GPS	Geographic Positioning System
HHs	Households
HIV	Human Immunodeficiency Virus.
IAF	Inquérito dos Agregados Familiares (Household Budget and Expenditure Surveys)
IIAM	Institute of Agricultural Research of Mozambique
INAM	National Institute of Meteorology
INE	National Statistics Institute
INGOs	International Non-governmental Organizations
IPW	Inverse Probability Weights
MINAG	Ministry of Agriculture
MSU	Michigan State University
NGOs	Non-governmental Organizations
PA	Prime age (15-59 years of age)
RIACSO	United Nations Regional Inter-Agency Coordination and Support Office
SIMA	Sistema de Informação de Mercados Agrícolas (Agricultural Market Information System)
TIA	Trabalho de Inquérito Agrícola (Agricultural Household Surveys)
TIA02	TIA conducted in 2002
TIA05	TIA conducted in 2005
TLUs	Tropical livestock units
UEM	Universidade Eduardo Mondlane
UNAIDS	Joint United Nations Programme on HIV/AIDS
UPA	Unidade Primaria de Administração (Standard Enumeration Unit)
USAID	United States Agency for International Development
WHO	World Health Organization

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1. INTRODUCTION

Estimates of adult mortality in Sub-Saharan Africa have risen considerably since the onset of the HIV/AIDS epidemic, most notably in countries with higher HIV prevalence rates (Ngom and Clark 2003). HIV/AIDS prevalence in Mozambique has increased dramatically since the mid-1990s and was estimated to be 16.2% in 2004 (Ministério de Saúde 2005). Although HIV prevalence in Mozambique varies considerably by region and rural/urban distinction, it is nevertheless continuing to rise in many regions of the country. While there is general agreement that the epidemic will have significant negative effects on agriculture and rural development in Mozambique, as throughout much of Sub-Saharan Africa, to date there has been little empirical information to identify which individuals and households living in rural areas of Mozambique are most likely to be suffer from HIV-related illness and death, and to quantify the impact of prime-age adult illness and death on rural household incomes and assets.

Theoretical and qualitative studies report a multifaceted loss to a rural household's livelihood due to HIV-related prime-age adult illness and death: the loss of on-farm labor, off-farm income from wage labor or own-business activities, technical knowledge of agricultural production and marketing, access to land, and liquidation of livestock, farm equipment or other assets to cover medical expenses during the illness period and funeral expenses after death. While some of these effects have been found by the few available empirical studies based on reasonably large and representative panel samples, these studies find that impacts vary considerably conditional on characteristics of the deceased individual (household position and gender) and the household (*ex ante* asset or poverty status) (Drimie 2002; Yamano and Jayne 2004; Chapoto 2006). More recent research has also indicated heterogeneous mortality effects across households (IFPRI 2006). In general, these studies found effects to be more severe in the case of the death of a male head of household and for households that were relatively poorer *ex ante*. Explanations for heterogeneous impacts include differences in household responses as well as differences in what assets the household lost when the individual died. An example of the first is that some affected households are better able to replace the lost farm labor either through attracting new members or through hiring part-time labor (i.e. given higher wealth). An example of the second is that male members, especially heads, tend to be the ones who cultivate the higher-value cash crops and have the educational background to access higher-wage non-farm employment.

Extant results also suggest that the magnitude and type of household effects may vary across countries (and regions within some countries). For example, Barnett et al. (1995) conclude from case study research in Uganda, Tanzania, and Zambia, that the effects of adult mortality on rural livelihoods may vary considerably across and within countries given numerous factors such as the extent of HIV infection, labor requirements of the predominant cropping system, population density, and the size of the local labor market. Given the large share of crop and livestock production in total incomes in Mozambique (Boughton et al. 2006), the limited use of animal traction and hired labor in Mozambique, and relatively high land/labor ratios, we might expect to find larger impacts on crop production and thus total household incomes relative to other countries. For example, while Beegle (2005) did not find evidence of shifts towards labor-saving subsistence crops such as roots/tubers by affected households (though she did find that some farm activities were temporarily scaled back after a male death and that wage income fell), she notes that the study area of Kagera is less vulnerable to labor shortages due to relatively high population density. As suggested in McEwan (2004), the increasing prevalence rates are just the leading indicator of potential major impacts of the disease on Mozambican households, so following households over time is critical, as infection leads to illness and death.

We would expect that mortality impacts on income and assets in Mozambique are also likely to be heterogeneous, given that earlier analysis of household demographic responses to adult mortality found that households which suffer a prime-age (PA) female death were considerably more likely to attract a new PA resident to the household ex post relative to household which suffer a PA male death. Effects on non-farm and cash cropping income may also be conditional on the gender of the deceased individual, given that men enjoy higher educational levels and participation in cash crops such as cotton and tobacco relative to women in Mozambique.

The article is organized as follows. We first describe the data sources used and outline the methods to be employed. We then perform tests to measure the degree to which sample attrition could be problematic for the measurement of the impact of adult mortality on household income and assets, then estimate a reinterview model to generate inverse probabilities of being reinterviewed for use as weights to control for attrition in the subsequent analyses. Then we estimate the impact of PA adult mortality first on the principal physical assets of rural households, the number of adults in the household and household landholding, using first-differenced regressions to control for time-variant unobservables, and stratifying the regressions by region so as to test for differences in mortality effects over space. We next estimate PA mortality impacts on the components of household income: total net crop income (which is then further stratified into grains, roots/tubers, and cash crops and analyzed separately), and non-farm income. We then estimate PA mortality impacts on total net household income and total net household income per adult equivalent. Finally, we present the evidence available from the data used concerning the *ex ante* and *ex post* income, asset, and poverty status of affected households, and discuss the implications of these findings for the welfare of rural households directly affected by prime-age adult mortality in Mozambique.

2. DATA

2.1. Sampling

This study uses a 3-year panel of rural household-level surveys known as the TIA (Trabalho do Inquérito Agrícola), implemented in 2002 and 2005 by Ministry of Agriculture (MINAG) staff from the Directorate of Economics in collaboration with colleagues from Michigan State University (Ministério da Agricultura 2005). Employing standards from the National Statistics Institute (INE) and based on the Agricultural Census sample, TIA in 2002 (TIA02) used a stratified, clustered sample design[1] that is representative of rural small- and medium-holders[2] at the provincial and national levels, and includes 4,908 households from 80 districts (out of 128) across the country. The TIA05 sample includes all TIA02 households which could be re-interviewed from the 80 TIA02 districts (i.e. the panel households), replacement households for attrited TIA02 households, as well as households from 16 additional districts which were not sampled in TIA02. The design thus works to be representative of the current conditions while also having the panel component. As shown in Table 1, not all TIA02 households were re-interviewed and attrition issues are discussed in detail below. Given the stratification and clustering of the sample, survey weights are used in estimations and the corrected standard errors calculated using STATA (2006) software.

The sampling for these studies is designed to meet the primary purpose of evaluating rural production and incomes. Some researchers have sought to increase the probability of having sufficient numbers of directly affected individuals by targeting areas known to have high HIV prevalence (Petty et al. 2005), or by over-sampling households likely to have experienced an adult illness or death (Beegle 2005). In the Mozambican case, there were no modifications to the sampling for the morbidity and mortality related research, and as Table 1 indicates, the cases of morbidity and mortality are sufficient for analysis, but will limit analysis based on regions and by gender and role of the person who is ill or has died. In the TIA panel dataset, there are 140 households nationwide that experienced a prime age adult male death between 2002 and 2005, and 149 households with a female adult death. However, these deaths were not distributed equally across the country, for 37% of male deaths and 49% of female deaths occurred in the South, where about 18% of Mozambican rural households are found. The North has proportionately fewer adult deaths and illnesses.

Both the TIA02 and TIA05 survey instruments covered a range of aspects: agricultural and livestock production, land use, and income sources and services. The survey instruments also included several demographic sections, to capture the characteristics of each current member of the household, and to document new arrivals, departures, deaths, and prolonged illness of household members. Land area, cassava production and income estimation present challenges to survey analysts, given the scope for errors in measurement and the need for comparability across time. Based on additional research and measurement, regression methods were developed to adjust farmer reported area and reported cassava production (see Walker et al. 2004). Crop income was net of reported inputs and based on adjusted local prices. Prices between the two panels were adjusted so as to remove the influence of inflation on the values, based on rural price deflators derived from the consumption baskets identified by the national

[1] The TIA02 sample was drawn from the sampling frame prepared for the year 2000 agricultural "census" (covering approximately 22,000 households) with the intention that TIA02 data can be analyzed at the provincial level and by agro-ecological zone.
[2] Medium scale farmers (based on criteria using land and livestock holdings and horticultural production) were expressly over-sampled, to ensure sufficient observations for analysis.

Table 1. TIA Sample Households and Prime-Age (15-59) Adult Mortality in Rural Mozambique, 2002-2005

	Households interviewed in 2002	Households reinterviewed in 2005		Households with Prime-age Illness Death 2002-2005						Urban/rural antenatal HIV prevalence, 2001[1]	Urban/rural antenatal HIV prevalence, 2004[1]
				Male	Female	All	Male	Female	All		
Province	Number	Number	% of 2002	Number	Number	Number	------- weighted % -------			%	%
Niassa	277	215	77.6	4	6	10	1.8	2.8	4.7	5.9	11.1
C.Delgado	500	406	81.2	5	12	17	1.1	2.9	4.0	5.0	8.6
Nampula	604	510	84.4	6	6	12	1.1	1.2	2.3	7.9	9.2
Zambezia	724	603	83.3	16	15	27	2.5	2.5	4.4	15.4	18.4
Tete	587	482	82.1	18	9	27	3.9	1.4	5.3	16.7	16.6
Manica	478	392	82.0	18	14	31	4.5	2.9	7.3	18.8	19.7
Sofala	416	307	73.8	21	18	35	7.3	5.7	11.4	18.7	26.5
Inhambane	426	372	87.3	12	17	27	2.5	5.9	7.7	7.9	11.7
Gaza	552	473	85.7	28	33	59	6.7	6.1	12.7	19.4	19.9
Maputo Province	344	298	86.6	12	19	28	4.2	5.8	9.2	14.9	20.7
Total	4908	4058	82.7	140	149	273	2.9	3.0	5.6	13.0	16.2

Source: TIA 2002, TIA 2005, Ministerio da Saude 2005

Notes: 1) No rural estimation of HIV prevalence rates at a provincial level. Maputo Province HIV prevalence exclude Maputo City.

expenditure survey (Inquérito dos Agregados Familiares (Household Budget and Expenditure Surveys - IAF), and prices from the national agricultural market information system (Sistema de Informação de Mercados Agrícolas, SIMA).

2.2. Sample Attrition

Given that over time, some individuals and households move away from a village and others dissolve as part of a typical household life-cycle, panel surveys typically have to contend with at least some sample attrition over time. In the three-year TIA panel, n=804 households (17.3% between the two surveys, or 5.8% per year) out of the n=4908 TIA02 households were unable to be re-interviewed (Table 1). Overall, the rate of attrition in this sample is relatively low, as compared to other African country surveys described in Alderman et al. (2001) and elsewhere (Chapoto 2006, for rural Zambia). However, household attrition remains a potential source of analytical problems for this research, in the event that characteristics of households affected with PA death due to illness are systematically different from those of 'non-affected' households and/or some household dissolution is a consequence of PA adult mortality due to illness. In the methods section below, we address the challenge of testing and correcting for possible sample selection bias due to attrition of these households.

Reasons for attrition in the TIA panel included dissolution of the household, migration of the household from the enumeration area, and integration of the household into other households through marriage (Table 2).[3] Although enumerators were unable to reach about 19% of the attrited households due to logistical difficulties such as transport or identification problems (reasons 3, 6, 7, 9 and 10), attrition of these cases is unlikely to be HIV/AIDS related.

Table 2. Declared Reasons for Household Attrition between TIA 2002 and TIA 2005

Declared reason for household attrition[1]	Attrited sample households (number)	Attrited sample households (%)
Moved away	411	48.4
Members not available at the time of the interview	137	16.1
Household was not ofund in the household listing of the enumeration area	84	9.9
Death of household head resulted in household dissolution	71	8.4
Reasons not identified	46	5.4
No one knows the household in enumeration area	36	4.2
New listing in enumeration area	21	2.5
Household dissolved	17	2.0
Lost information	12	1.4
UPA not included in 2005	8	0.9
Household refused reinterview	6	0.7
Household classifieed as large scale in 2005	1	0.1
Total	850	100

Source: TIA 2002, TIA 2005

Notes: [1] Neighbors and village leaders were asked for reasons as to why a households could not be located. In some cases, the difficulties were based on logistical constraints for enumerators to arrive.

[3] Information on reasons for attrition comes from the village head or neighbors and relatives who were asked about the reason for the absence or departure of a household.

However, in almost 9% of the attrited cases, the household dissolved due to the death of the head, one of the reasons for attrition most likely to be related to HIV/AIDS. In another 67% of attrited cases, the reasons given for absence were vague and do not enable us to accurately interpret whether HIV/AIDS and other illnesses played a role in why these households were not available for interview. Unlike a recent study in South Africa (Maluccio 2004), the TIA did not have funding to try to track down households that had moved, which could have reduced the attrition substantially. Thus, there remain a substantial number of cases that may be attrited due to reasons associated with HIV/AIDS or other illnesses.

2.3. Death/illness Proxy for HIV/AIDS

Following earlier studies (Donovan et al. 2003; Yamano and Jayne 2004; Mather et al. 2004a; Chapoto 2006), we use demographic information from the TIA panel on the 'illness-related' death of a PA household member as a rough proxy for an HIV/AIDS-related death. This section provides details on the information on PA illness-related deaths of household members available from the TIA panel and justification for its use as a proxy for HIV-AIDS-related death.

The demographic module of the TIA02 survey instrument was designed to elicit information from the respondent concerning all members who had left the household since 1999, including those who had died. For cases of adult mortality, the respondent was also asked for the basic cause of death of the deceased household member(s), given options including: accident, childbirth, non-prolonged illness, prolonged illness (at least three months), and an open category. Likewise, the demographic module of TIA05 inquired of the status of all the members which had been listed by TIA02 in panel households. It identified new members who had arrived since 2002, and identified the status of any members who had left the household since 2002 (deceased, moved away, etc. – including those individuals who entered the household after 2002 and left prior to 2005). In the event that a household member died between the 2002 and 2005 surveys (including new members who arrived since 2002), the respondent was then asked for a basic cause of death of the deceased household member(s), given options including: accident, childbirth, illness, and other. In the event of an illness-related death, the respondent was then asked about the duration of illness preceding death. Both TIA02 and TIA05 contained a morbidity module which asked if any adult members had been chronically ill (ill for at least 3 of the previous 12 months), thus information on adult morbidity is only available the previous twelve months, not the full intervening three years of the panel. In summary, the TIA panel data identify the mortality status of all adult members who resided in the household anytime during the panel period of 2002 to 2005, and the morbidity status of adult residents in 2002 and 2005.

Some researchers (e.g. Beegle 2005; Mather et al. 2005) have used the age range of 15-49 or 15-50 years to define the PA group for analysis of impacts of HIV/AIDS, while others have opted to define the PA group as 15-59 years of age (Chapoto 2006). For this research, we use the age range 15-59 to define the PA group.[4] While HIV/AIDS-related illness may often

[4] There are several reasons why we chose to include adults aged 50-59 in the prime age group for analysis of HIV/AIDS impacts on household income and assets. First, adults between 50-59 years of age often are still sexually active, thus may well still contract the disease after age 50. Second, adults between 50-59 years of age are often still making considerable contributions to household production and income activities. Third, age-specific HIV prevalence estimates (Barreto et al. 2000) suggest that HIV prevalence in Mozambique does not begin to fall off dramatically until well past age 60. Finally, the use of the 15-49 age range to define the PA group is perhaps itself a function of the availability of HIV/AIDS prevalence data – in most African countries,

involve a lengthy or intermittent process of decline, some opportunistic diseases can be fatal to an HIV positive adult within just a few months. For example, left untreated, 90% of those with HIV die within a few months of contracting tuberculosis, according to the World Health Organization (WHO 2007). For this reason, we use all TIA panel cases of 'illness-related PA deaths' in the following analysis, irregardless of the length of illness prior to death.

While an overriding objective of this study is to evaluate the effects of HIV/AIDS on rural incomes, the TIA 2002-2005 panel does not provide data which can tell us whether or not a 'PA death due to illness' was in fact HIV-related. Such a determination could only be made for certain by using invasive medical procedures[5], which were not within the scope, budget or intent of the TIA surveys. While some household surveys with mortality components have included 'verbal autopsy' questions (which elicit information regarding the symptoms which the ill adult suffered prior to his/her illness-related death), a review of literature on verbal autopsies suggests that their reliability has not yet been verified for use with a population-based sample (Chapoto 2006).

In this research, we recognize that not all the PA illness-related deaths are due to HIV/AIDS, yet it is generally accepted that the epidemic has played a large role in the rapid increase in PA mortality rates in countries with increasing HIV prevalence (Ngom and Clark 2003).[6] Opportunistic diseases such as tuberculosis and malaria are present in Mozambique and are more likely to occur or to be more severe when adults have a compromised immune system. Such diseases confound any simple diagnosis as to cause of illness or death and are also responsible for numerous deaths even in the absence of HIV/AIDS. However, chronic illness and/or death of PA adults, whether HIV-related or not, is clearly an increasingly important development problem. This paper therefore aims to quantify the effects of illness-related PA death on rural household income and assets in the interest of informing the design of policies and programs intended to mitigate the adverse effects of adult mortality on household welfare.

HIV/AIDS prevalence statistics are derived almost entirely from data obtained from surveillance sites at antenatal clinics, which only sample women who are in child-bearing years (i.e. 15 to 49).

[5] Because of limited health care facilities in rural Mozambique, official medical diagnosis of cause of death is most often lacking, and privacy considerations in an environment wherein HIV/AIDS is stigmatized limit what should be asked. In addition, no nationwide prevalence study based on a random sample of the population and medical testing has been conducted in Mozambique. The Nelson Mandela Study in South Africa (Shisana and Simbayi 2002) is an example of a nationally-representative, intensive HIV prevalence study, led by medical professionals.

[6] While anti-retroviral treatment (ARVs) may in time reduce HIV-related mortality, ARVs were not available in rural areas in Mozambique during the time period studied.

3. ESTIMATION STRATEGIES AND VARIABLES

3.1. Testing for Attrition Bias

The primary concern for survey analysis of panel data with sample attrition is that using the reinterviewed households to estimate the population distribution of household characteristics of interest, or relationships between such variables, may yield biased estimates if the observed and/or unobserved characteristics of the attrited households are systematically different (i.e. non-random) from those of the reinterviewed portion of the sample. However, recent research by Alderman et al. (2001) suggests that even high rates of attrition in panel samples may not always result in biased estimators, even when factors related to attrition are also highly correlated with the outcome variables of choice. Alderman et al. (2001) recommend that diagnostic tools be applied to all panel outcome and explanatory variables of interest, and then to correct for any existing selection bias only as necessary.

Estimation of the impact of PA mortality on household income and assets could be especially prone to sample attrition bias. For example, the severe stress caused by adult illness and death, especially that of a household head or spouse, could result in household dissolution or absorption into another household. Thus, households directly affected by HIV/AIDS may have a higher probability of attrition relative to other households. If those 'affected' households which dissolve or move away happen to be those which suffered the largest reductions in household income or assets, then estimating the impact of adult mortality on income using reinterviewed households (and no attrition correction) would lead to underestimates of said impact. In developing a framework for understanding and dealing with potential attrition bias, Alderman et al. (2001), Wooldridge (2002), Maluccio (2004) and others focus on a key distinction: selection on observables versus selection on non-observables. If a household's reasons for attrition are associated with observable characteristics, then appropriate weighting procedures which use information on those characteristics can successfully reduce selection bias. On the other hand, selection based on unobservables is a more difficult issue, requiring the use of "highly parametric procedures" as Fitzgerald, Gottschalk, and Moffitt (1998, p. 252) suggest. In the sections below, we follow the diagnostics of Alderman et al. (2001) to test for the presence of attrition on observables, and apply a weighting procedure developed by Wooldridge (2002).

3.2. Reinterview Model

The first step in understanding the potential for bias is to test for differences in household and community characteristics from the initial period between the attrited and re-interviewed cases. Our choice of characteristics is based on variables which will be analyzed as outcomes in the ensuing analysis, used as regressors in models to explain those outcomes, or which previous research has shown to be useful in explaining household attrition. Finding significant differences in observed characteristics between the attrited and non-attrited cases suggests that the attrition may not be random and that an attrition bias correction is most likely necessary.

Wooldridge (2002) proposes Inverse Probability Weights (IPW) as a method to evaluate and address this possible source of selection bias. In short, IPW will effectively minimize attrition bias if the observed characteristics of the household are useful in predicting whether or not a household will be re-interviewed, and unobserved characteristics are not strong predictors.

We define z_t as a vector of observables for all observations, panel and attrited households, and x_t as a vector of observables when the household is observed for TIA05. X_t and z_t contain either time-invariant or lagged time-varying characteristics of the respondent or variables that do not require a completed interview. The variable s is the selection variable and $s_t = 1$ when the household is re-interviewed at time t, i.e. observed in both TIA02 and TIA05. For attrited households, $s_t = 0$. What we need to find is a set of z_t variables which affect attrition propensities yet are also related to the density of y_t (the outcome of interest for the analysis) conditional on x_t.

$\Pr(s_t{=}1 \mid x_t, z_t) = \Pr(s_t{=}1 \mid z_t) = \Pr(z_t)$.

If z_t is a good predictor of re-interview, then we will be able to use the inverse of the predicted probability as a weight in the outcome estimations. A key assumption is that the observable characteristics adequately explain re-interview status and that unobservables are not strong predictors of that status.

Alderman et al. (2001) note that while selective attrition on unobservables potentially remains a problem even after the analyses account for selection on observables, the possibilities for detecting selective attrition on unobservables using datasets from developing countries is very limited, given that such tests require comparisons with similar datasets which contain the same key variables yet no (or little) attrition. In addition, they argue that 'using as much information as possible about selection on observables in the panel helps to reduce the amount of residual, unexplained variation in the data due to attrition. Controlling for selection on observables thus will likely reduce any biases due to selection on unobservables (ibid 2001).' Following Alderman et al. (2001), we therefore rely upon observable characteristics to help explain attrition.

IPW methods have been applied in HIV/AIDS impact analysis by Yamano and Jayne (2005) and Chapoto (2006) and the research here will follow the same approach. First, key characteristics are selected that can help identify panel versus attrited households, using only those aspects observed in the initial survey (TIA02), and characteristics of the community or region. For example, we use a lagged district level HIV prevalence from an earlier year (2001). Since the HIV prevalence data do not distinguish between rural and urban at the provincial level, we have chosen to select the prevalence rate from the nearest sentinel site to proxy for a local HIV/AIDS prevalence rate, based on the reported rates (Ministério da Saúde 2005). Using these characteristics observed for all households in the original sample, we run a probit regression to determine the probability of being re-interviewed. The estimated probability is then retained for use with survey weights to create a weighting scheme that adjusts outcome estimates for the attrition, along with the customary adjustments for survey clustering and stratification with the complex survey.

3.3. First-Difference Model for Estimation of Mortality Impacts

To measure the impact of prime-age (15-59) death on household income and assets, we use the counterfactual framework of the program evaluation literature and a first-difference econometric model as employed in recent panel research on the impacts of adult mortality in Kenya (Yamano and Jayne 2004) and Zambia (Chapoto 2006). In the terminology of the program evaluation literature, each panel household has an outcome, either with or without 'treatment' (where treatment in this case is suffering a PA adult death during the panel period (between 2002 and 2005)[7]. The treatment group comprises households experiencing at least one PA adult death during the panel time period, and the comparison group contains households not experiencing PA adult deaths during the same time period.

To measure the impacts of PA mortality and morbidity on outcome Yi, we specify a first difference model as follows:

$$\Delta Y_i = \gamma + D_i^M \delta^M + D_i^F \delta^F + D_i^{2D} \delta^{2D} + ED_i^{EM} \delta^{EM} + ED_i^{EF} \delta^{EF} + \ldots$$
$$\ldots + I_i^{IM} \delta^{IM} + I_i^{IF} \delta^{IF} + V\beta + \Delta\varepsilon_i \quad (1)$$

Where:

- ΔY_i is the change in the outcome variable for household i
- γ is a constant
- D_i^M = 1 for households which experienced one PA male death from 2002-05 (and no other PA deaths), 0 otherwise
- D_i^F = 1 for households which experienced one PA female death from 2002-05 (and no other PA deaths), 0 otherwise
- D_i^{2D} = 1 for households which experienced two or more PA deaths from 2002-05, 0 otherwise
- ED_i^{EM} =1 for households which experienced one or more elderly male deaths from 2002-05, 0 otherwise
- ED_i^{EF} = 1 for households which experienced one or more elderly female deaths from 2002-05; 0 otherwise
- I_i^{IM} = 1 for households which had one or more chronically ill PA male adults in 2005; 0 otherwise
- I_i^{IF} = 1 for households which had one or more chronically ill PA female adults in 2005; 0 otherwise
- V is a vector of village × time dummies
- $\Delta\varepsilon_i$ is the error term

We consider mortality impacts on various household outcomes, including: total net household income, total net household income per adult equivalent (AE), total net crop income, non-farm income, and livestock and land assets. Anticipating gender-related mortality effects on crop income, we also disaggregate the analysis and test for mortality effects on crop income from grains (including cereals and legumes), roots/tubers, and cash crops (field cash crops, sales of cashews/copra, and sales of horticulture and fruit crops).

Because the impacts of adult mortality have been found to differ based on the gender and household position (status) of the deceased individual in the household (Yamano and Jayne 2004; Chapoto 2006), we disaggregate PA adult mortality by gender in (1). Although we do not present a second equation here, we also estimate a second model, which we refer to as (2), in which we further stratify the PA mortality dummies by both gender and household status. Thus, instead of having three PA mortality dummies (for PA male death, PA female death, and a dummy for two or more PA deaths) as in (1), we have five PA dummies: for PA male head/spouse, PA female head/spouse, PA male non-head/spouse, PA female non-head/spouse, and a dummy for two or more PA deaths. Note that any household which has more than one PA death is captured by the 'two or more PA death' dummy, and the other PA mortality variables represent households which experienced only one PA death. We

[7] To be more precise, 'panel deaths' are those which occurred after the first wave of the panel (TIA02 was in the field August-October 2002) and before the second wave (TIA05 was in the field September-November 2005).

distinguish between households with single and multiple PA deaths because we have n=22 households with multiple PA deaths (Appendix Table 1), and we expect the impact of PA mortality on income and assets of multiple-death households to be considerably worse than that suffered by households with only one PA death.

Although our principal interest is to measure the effects of PA mortality, we include dummies to indicate male and female elderly illness-related deaths in both (1) and (2) for several reasons. First, the definition of 'prime-age' is inherently arbitrary, and household members over 60 may well play important roles in the household economy. Second, estimates of HIV prevalence by age group in Mozambique suggest that HIV tapers off after age 60 in both men and women but is still present (Barreto et al. 2000)[8]. Third, if there is a correlation between PA death and elderly death, then omitting elderly deaths may bias estimates (upward) of the impact of PA death.

Given the likely correlation between PA illness and PA mortality in an HIV-affected household, we include dummies to indicate the presence of one or more chronically-ill PA males and females (I_i^{IM} and I_i^{IF}) in the household in 2005, and to control for and measure morbidity effects (which are discussed in more detail below). While the first-difference estimator controls for unobserved time-invariant household characteristics, there may be location-specific time-variant shocks (such as rainfall, crop or animal epidemics, etc.) which are correlated with both PA mortality and the household outcome. To control for such location-specific time-variant shocks, we include village × time interaction dummies.

Following the approach of Yamano and Jayne (2004), we do not include time-variant household-level independent variables in the models for two main reasons. First, construction of a theoretical model of household responses to PA mortality faces the challenge that little is known about the dynamics of household responses to adult mortality in Africa, and existing empirical descriptive work suggests great heterogeneity of household responses. Second, while household composition and asset levels are typically included as exogenous variables in modeling the determinants of total household expenditure or income, we believe that it is unlikely that the *post-death* levels of these household characteristics are exogenous to adult mortality.

We first estimate (1) and (2) for each outcome variable at the national level, and then we re-estimate each after stratifying the sample into the south and the center/north regions. We stratify in this manner because livelihood systems in the center and north are more similar to each other than either of them is in comparison with the south. Rural households in the south depend considerably less on crop agriculture (and more on non-farm income) than those in the center and north (Boughton et al. 2006). Thus, we would more likely expect to find significant mortality effects on crop income in the north/center and on non-farm income in the south. While there are reasons why further separation of the center from the north might provide additional analytical leverage (given the influence of the Beira corridor on non-farm incomes and that of Tete province on crop incomes), the TIA panel has few cases of PA mortality in the north (households with one or more PA deaths by region: North n=66; Center n=93; South=114), which could limit the effectiveness of stratification by gender and

[8] Since the only seroprevalence data for Mozambique are from sentinel sites at antenatal clinics (i.e. from pregnant women age 15-49 who visit said clinics), epidemiological/demographic models are used to extrapolate from the antenatal data to the rest of the population.

household position. We also ran regressions for the North and Center separately, and have included these results in Appendix Tables 2-12.[9]

Analysis of the effects of PA mortality on household income and assets using panel household survey data could be confounded by two principal econometric issues. The first is panel attrition, which was addressed in the previous section. The second is the potential endogeneity of PA death (omitted variable bias). There are at least two ways in which PA mortality could be endogenous. First, a PA death in the household could be a function of unobservable characteristics of the household and the deceased individual. If PA mortality in Africa were limited to accidents or diseases which are distributed randomly across the population, then we would not expect to find correlation between household unobservables and mortality. However, demographic evidence suggests that the recent increase in PA mortality rates in many parts of Africa is due primarily to HIV/AIDS (Ngom and Clark 2003). Evidence from the early years of the AIDS epidemic in Africa showed that men and women with higher education and income were more likely to contract HIV relative to others because they were more likely to have numerous sexual partners (Ainsworth and Semali, 1998). The most recent empirical evidence from Sub-Saharan Africa of household and individual correlates of HIV status (de Walque 2006) also shows some countries in which there are significant positive correlations between HIV/AIDS status and household wealth, though there are also countries with negative or no significant correlations.

Although available HIV prevalence data from Mozambique (as estimated from antenatal clinic sentinel site data) suggest a positive correlation between wealth and HIV status (provinces with lower poverty rates tend to have higher HIV prevalence), no large-sample, representative seroprevalence data exist for Mozambique which could test for correlations between individuals' HIV status and household and individual characteristics. HIV/AIDS is most commonly contracted due to distinct behavioral choices (reflecting unobservable characteristics), which may be influenced by observable factors such as wealth or education (though the correlation with HIV status could be positive, negative, or even non-linear, depending upon the country or region). Thus, it would be difficult to assume that HIV/AIDS in Mozambique is distributed randomly throughout the population. Failure to control for such unobserved heterogeneity across households may result in biased estimates of the impact of PA mortality on household outcomes. We address this potential econometric problem by using first-differenced regressions which remove unobservable time-invariant household and individual characteristics from the error term.

A second potential source of endogeneity of PA mortality is through the choice of residence made by ill or dying individuals. As many as one-third of deceased individuals in panel studies from Kagera, Tanzania (Beegle 2005) and rural Zambia (Chapoto 2006) were recent arrivals to the household (i.e. they were not resident members during the first wave of the panel). These individuals may have been living in urban areas prior to developing AIDS, and then returned home for terminal care. However, if household characteristics such as wealth affect the likelihood of receiving terminal care, and if a significant portion of PA deaths in rural respondent households are of members who joined the household sometime after the first wave of the panel, then PA deaths may not be distributed randomly. This is not likely to

[9] While Zambezia Province is administratively included in the Center Region, we follow various analysts who typically group Zambezia with the northern provinces, due to similarity in livelihoods, market relationships, agroecological potential, and the predominance of matrilineal land tenure systems.

be a significant concern for the TIA panel, as only n=14 out of n=250 PA deaths were of individuals who arrived after the first wave of the panel (Appendix Table 1)[10].

There is also another way in which newly-arrived members may confound estimates of the impact of PA mortality on income and assets, which to our knowledge has not been considered in the empirical impact literature. Unless the newly-arrived PA adult (new PA arrival) was sending remittance income (in cash or in kind) to the household in the first wave of the survey (which are captured by the survey instrument), then including a new PA arrival (who subsequently dies before the second wave of the panel) within the treatment group (the subgroup of households with a PA death during the panel period) would tend to underestimate mortality effects on household income because the new arrivals were technically not contributing to income in the first period. We do not separate out these members in the estimations presented here due in part to the small numbers of new arrival PA deaths (as noted above) and also because this further reduces subsample sizes of the treatment group when we stratify by gender, household status, region, etc.

Due to the lag between HIV/AIDS illness and death, another concern in measuring mortality effects is that some households may begin to adjust activities during the illness period, as Beegle (2005) and others have found. Assets may begin to be liquidated during the illness period, as the PA adult's illness may increase the household's demand for cash (for medicine) and/or reduce its normal cash supply, given the incapacity of the ill individual to work. Thus, the pre-death observation of household income or assets in the first wave of the panel may not represent the household's 'pre-HIV/AIDS' income level. It would tend to be lower than the income we would expect that household to generate with healthy PA adults. Unfortunately, truly separating impacts on household income and assets due to PA illness from those due to PA death is not possible, without the availability of multiple-period panels of high frequency (such as the four survey waves in Kagera which were undertaken every six months (Beegle 2005)). TIA02 and TIA05 do provide information on PA illness during 2002 and 2005, though the overlap between illness and panel deaths is not large (n=23 households have a panel death and 2002 PA illness; n=13 households have a panel death and TIA05 illness). In our estimations, we control for PA illness in TIA05 but do not interact this variable with the mortality dummies out of concern for mortality group subsample sizes, especially given the interest in stratifying the mortality cases by gender, region, and asset level.

The ideal measurement of the effect of adult mortality (one adult) on income would use a 'treatment' group with the following characteristics: households (HHs) which suffered one panel death of a HH member who resided in the HH in TIA02; no PA illness in TIA02, and no PA illness in TIA05. Thus, we would interact dummies for 2002 and 2005 PA illness with each of the mortality variables, to ensure that we isolate a subsample of PA death households which did not have PA illness in either of the survey years (we are doing this to test the robustness of our findings, but a full investigation of illness and death effects is beyond the scope of this paper). Not controlling for TIA05 illness in a panel death household would tend to overestimate the mortality effect. However, while this may improve confidence in our income estimates to some extent, this still does not isolate 'mortality' effects from those due to illness, because some households may experience both the illness and death effects between 2002 and 2005. This also would not guarantee that we have a 'healthy' 2002 income observation for panel death households, because some illness effects could actually precede 2002, with the death effects following in 2003 or 2004.

[10] In addition, the n=14 new arrival PA deaths were spread relatively evenly across the quintiles of 2002 income/AE.

3.4. Outcome Variables

We estimate the effects of PA mortality on household income and various income components: impacts on various household outcomes: total net household income, total net household income per AE, total net crop income, and non-farm income. Given gender-differentiation of mortality effects by crop type, we also disaggregate crop income into the net value of grain production (including cereals and legumes), roots/tuber production, and sale of cash crops (field cash crops, sales of cashew/copra, and sales of horticulture and fruit crops). Due to the variability of household income over time, we also estimate the impact of PA mortality on household levels of production assets, including the number of adults (as a proxy of labor availability), total land area[11] (which includes area cultivated to annual crops, permanent crops, in fallow, and in pasture) and livestock.[12]

We define total net household income as net returns to family resources (land, labor, and other assets) from crop and livestock production, small business activities, wage labor of resident members, remittance income received from non-residents, and income from pensions and land rental. Crop income includes the retained and sold value of food crops (grains, beans, oilseeds, roots/tubers), retained and sold value of cashew and copra, sales of field cash crops (such as tobacco and cotton), and sales of horticultural and fruit crops. Costs of seed and chemical fertilizers and herbicides are netted out from gross crop income.

We depart from the traditional method of food crop valuation wherein retained food production is valued at the farmgate sale price (typically at harvest), and instead value retained food production at the annual average retail price of the nearest SIMA rural retail market. Since non-farm income is typically reported in cash terms, sold crops represent cash income, and cash income is an indicator of household consumption potential, then valuing retained food production at retail (rather than farmgate) prices better approximates the 'consumption' value to the household of food production which is retained. In sum, we feel that this valuation method improves the ability of household income to serve as a welfare indicator. Livestock income consists of the value of live animals sold as the sale of meat and dairy products, as reported by the households.

Small business activities include those involving natural resource extraction (hunting, fishing, production of coal and firewood, making straw mats, etc.) and activities such as sales and trading of commodities and agricultural inputs (petty trading, crafts, construction, repair, etc.). TIA includes information on expenses undertaken on these latter small business activities, which we net out from gross returns. Wage labor includes income from any farm or non-farm employment, involving various skill levels and duration.

[11] TIA enumerators used Geographic Positioning System (GPS) units to measure one *machamba* (parcel) per household for 25% of TIA households. Coefficients from a regression of TIA05 measured *machamba* area on the TIA05 area declared by the household for that *machamba*, the household head's education, and district dummies were used to adjust declared machamba area for household which did not have a *machamba* measured by TIA enumerators.

[12] TIA collects information on housing quality (type of walls and type of roof) and ownership of the more common household goods such as radios, bicycles, and lanterns, as well as ownership of some types of farm equipment (ploughs, carts, etc.), however, farm equipment ownership is quite low, and TIA does not provide information for valuing household goods or farm equipment.

Prices between the two panels were adjusted so as to inflate 2002 values to 2005 values, based on rural price deflators constructed from available secondary data.[13] Further details on the income components and valuation procedures are presented elsewhere (Mather and Cunguara forthcoming). To control for differences in household composition over time and space, we also present results for mortality effects on total household income per AE. AE's were computed using the following scale which is based upon general findings regarding the typical 'share of total expenditure' of children and adults: adults of either sex = 1.0 AE, children age 0 to 4 years = 0.4 AE; and children 5 to 14 = 0.5 AE (Deaton 1997, p. 259).

[13] Price inflators were created for the provincial level using the food consumption baskets identified by the national expenditure survey, IAF 2002/03, (INE databse) for various rural poverty zones (which correspond to the rural area within 1-2 provinces each), and price data from the national agricultural market information system (SIMA). Fixed price inflators were created using SIMA data to update the cost of the IAF 2002/03 food consumption basket for each (rural) province to 2005 values (Mather and Cunguara forthcoming).

4. RESULTS

4.1. Tests of Attrition Bias

Table 3 presents the results of simple comparisons of characteristics between households with a prime age death and those without. The testing indicates that there are significant differences in characteristics between households that are re-interviewed and those that fall out of the sample. The existence of significant differences means that there is a possibility that attrition will result in biased estimations of panel sample means and/or relationships between variables.

We also conduct the Becketti, Gould, Lillard, and Welch (BGLW) (1988) test as recommended by Alderman et al. (2001). In the BGLW test, the value of y at the initial wave of the survey is regressed on respondent's characteristics in the same time period and on A (which =1 if household attrited, =0 otherwise). A is also interacted with the household characteristics. The test is whether the coefficients of the predetermined household characteristics and the constant differ for attrited relative to re-interviewed respondents (i.e. test for equality of all the slope coefficients and the constant). We find that they are in fact significantly different, signifying the presence of attrition on observables.

4.2. Determinants of Reinterview

The results for the probit regression to predict the probability of re-interview are shown in Table 4. Logic would suggest that households with more of an investment in their community and home would be more likely to be re-interviewed. Households in which either the household head or spouse have been born in the village, for example, are more likely to be re-interviewed as are households with a good quality roof. Surprisingly, land area and tropical livestock units were not significant in predicting re-interview. While the number of prime age adult males in the household was not a significant predictor, all of the other household composition variables were significant and positive, particularly the number of elderly adults.

The probit included factors related to HIV/AIDS, as measured in TIA02. At the district level, the 2001 estimated HIV prevalence of the nearest sentinel site[14] was a significant predictor of re-interview. While the sentinel site data may not be a very accurate measure of local prevalence, the lack of detailed HIV prevalence data prevents a more detailed approach. In spite of these difficulties in measurement of prevalence, households in districts with higher HIV prevalence were significantly less likely to be re-interviewed for TIA05. Looking at possible household indicators for illness and death, only the earlier death of a prime age female significantly reduced the probability of re-interview, although the signs for the coefficients for PA male death, multiple deaths, and PA illness in 2002 were all negative, as would be expected.

Overall, the predictive ability of the probit suggests that using IPW will be helpful in addressing the potential for attrition bias. For all estimations that follow, the TIA population weights are combined with the IPW and knowledge of the clustering and stratification of the sample to create IPW-adjusted survey weights (using STATA svy commands).

[14] In 2001, the sentinel sites were expanded to include more relatively rural sites. Earlier sentinel site data includes few rural sites and so was not used here.

Table 3. Means of Household Outcome and Predetermined Variables by Household Attrition Status

Variables	Unit	Not re-interviewed		Re-interviewed		Sig. of Difference Between means [1]
		Mean	Std. Error	Mean	Std. Error	
Lagged Outcome variables (2002)						
Total income (ln)	ln(contos) [2]	8.53	0.061	8.64	0.051	+
Total income (ln) per adult equivalent	ln(contos)	7.41	0.053	7.41	0.048	
Net crop income (ln)	ln(contos)	7.83	0.085	8.05	0.085	**
Net grain crop income (ln)	ln(contos)	3.15	0.212	3.43	0.159	+
Net roots/tubers income (ln)	ln(contos)	5.13	0.162	5.38	0.156	+
Net cash crop income	ln(contos)	2.94	0.141	3.35	0.122	**
Net non-farm income	ln(contos)	4.58	0.191	4.54	0.125	
Total land area (ln)[3]	ln(hectares)	0.12	0.069	0.27	0.047	**
Number of Tropical Livestock Units (TLU)[3]	number	0.50	0.056	0.99	0.062	**
Household Characteristics in 2002						
Head native of village	0=no;1=yes	0.55	0.024	0.66	0.017	**
Spouse native of village	0=no;1=yes	0.42	0.019	0.50	0.012	**
Female-headed HH	0=no;1=yes	0.27	0.019	0.24	0.010	*
Age of household head	Years	40.13	0.571	42.45	0.338	**
Age of household head squared	Years squared	1850.0	54.5	2018.2	32.8	*
Education level of household head	Years	2.35	0.128	2.21	0.058	
Number of TLU squared	Number squared	4.49	1.307	9.99	2.195	**
Good quality roof	0=no;1=yes	0.08	0.125	0.13	0.009	**
Males members: 15-59 years old	Number	1.09	0.035	1.13	0.016	
Female members: 15-59 years old	Number	1.18	0.028	1.31	0.020	**
Infants/Children less than 5 years old	Number	0.75	0.037	0.85	0.022	**
Children from 5-14 years old	Number	1.24	0.058	1.53	0.029	**
Elderly adult members: above age 59	Number	0.19	0.018	0.24	0.012	*
2001)	0=no;1=yes	0.02	0.006	0.02	0.002	
Death due to illness of PA woman (1999-2001)	0=no;1=yes	0.03	0.006	0.02	0.002	
Death due to illness of at least two PA members (1999-2001)	0=no;1=yes	0.00	0.002	0.00	0.001	
Illness of a prime age adult male in 2002	0=no;1=yes	0.01	0.005	0.01	0.002	
Illness of a prime age adult female in 2002	0=no;1=yes	0.02	0.007	0.02	0.002	
Village and District Level Characteristics						
HIV prevalence at nearest sentinel site in 2000 [4]	proportion of adults age 15-49	0.10	0.541	0.10	0.536	
Regular public transport available in village	0=no;1=yes	0.27	0.032	0.27	0.020	
Number of Households		850		4058		

Source: TIA 2002, 2005. HIV sentinel site prevalence from 2004 CNCS report.

Notes: [1] Significance of t-stats with unequal variance (Wald statistics): ** 0.01 level; * 0.05 level; + 0.10 level; 2 Values are in adjusted 2005 contos ('000 Meticais). 3 Variables are used as predetermined variables in the re-interview probit and as outcomes in the first-difference analysis. 4 We assume the HIV prevalence for each TIA district to the 2000 prevalence reported for the nearest rural sentinel site (antental clinic data from the 2004 CNCS report).

Table 4. Probit Regression of Household Reinterview Model

Variables[1]	Dependent variable = 1 if household was reinterviewed in 2005; =0 otherwise
Household Characteristics	
1=Head native of village	0.224**
	(4.56)
1=Spouse native of village	0.116*
	(2.40)
1=Female-headed HH	-0.105
	(1.63)
Age of household head (years)	0.037**
	(3.21)
Age of household head squared (years)	-0.000**
	(2.96)
Education level of household head (years of schooling)	-0.025
	(1.61)
ln(Total land area) (hectares)	0.010
	(0.34)
Number of Tropical Livestock Units (TLU)	0.013
	(1.10)
Number of TLU squared	0.000
	(1.59)
1=Good quality roof	0.350**
	(3.35)
Males members: 15-59 years old	-0.001
	(0.04)
Female members: 15-59 years old	0.076*
	(2.06)
Infants/Children less than 5 years old	0.051*
	(2.03)
Children from 5-14 years old	0.053*
	(2.56)
Elderly adult members: above age 59	0.196*
	(2.60)
1=PA death due to illness (1999-2001)	-0.005
	(0.02)
1=PA death due to illness (1999-2001)	-0.273+
	(1.86)
1=More than one PA death due to illness (1999-2001)	-0.132
	(0.24)
1=Chronically ill PA male in 2002	-0.289
	(1.22)
1=Chronically ill PA female in 2002	-0.148
	(0.67)
Village and District Level Characteristics	
HIV prevalence at nearest sentinel site in 2000 3	-0.420**
	(16.63)
Regular public transport available in village	-0.041
	(0.57)
Constant	7.655**
	(14.25)
District dummies included	yes
P-value of test for joint significance test of HH characteristics	0.000
Number of households	4908

Source: TIA 2002, 2005. HIV sentinel site prevalence from 2004 CNCS report.

[1] Significance of t-stats with unequal variance (Wald statistics): *** 0.01 level; ** 0.05 level; + 0.10 level. Coefficients are unadjusted; numbers in parentheses are absolute t-stats, calculated using linearized standard errors which account for complex sampling).

4.3. Mortality Impacts on Household Labor Availability

Some of the theoretical literature on the effects of adult mortality assumes that households which suffer a PA death will see significant reductions in agricultural production and non-farm income due to the loss of labor and/or wages formerly provided by the deceased PA adult (Gillespie 1989; Topouzis and du Guerny 1999). However, this literature does not consider the possibility that surviving members may adjust household composition in order to replace lost labor (by attracting new PA adults to the household) or reducing household consumption demands by sending children to other households. Results from the empirical studies of the effects of adult mortality on household composition suggest varied responses. For example, Ainsworth and Semali (1995) found that rural households in Kagera, Tanzania were able to maintain their household sizes and dependency ratios even after suffering a PA death. By contrast, studies in Chiang Mai in Thailand and Rakai in Uganda found that household size declined by one person following a PA death, suggesting that, on average, affected households in these areas were unable to attract new members (Janjaroen 1998; Menon et al. 1998). Recent studies in rural Kenya (Yamano and Jayne 2004) and rural Zambia (Chapoto and Jayne forthcoming) also found that most affected households were not able to attract new adult members, on average. However, these latter two studies went further than earlier studies and found that effects of adult mortality on household composition (as well as on income and assets) tended to vary significantly by characteristics of the deceased individual (such as household position and/or gender) and of the household (such as the household's *ex ante* (pre-death) asset level). For example, households in Kenya which suffered a the death of a household head or spouse were not able to replace the deceased adult, on average, yet approximately one-half of the households with a non-head/spouse death were able to attract a new adult to the household.

The existing literature also suggests that population density likely affects the probability of replacement, as this tended to be more likely in areas with high population density (such as Kagera, Tanania) relative to areas of lower population density (such as rural Zambia).

The qualitative and case study 'household coping' literature also finds that some affected households respond to the loss of family labor by attempting to replace the lost labor through such means as increasing the labor hours of remaining family members, increasing available family labor by pulling children out of school, hiring additional labor, and mutual labor-sharing arrangements with other households. Qualitative recall data on household responses to adult mortality in TIA02 showed that some households which suffered a PA death from 1999-2002 employed many of the "labor replacement" strategies cited above (Mather et al. 2004a). While testing for such a wide range of potential responses is beyond both the scope of this paper and the data available from the TIA panel survey, we proceed to examine changes in the number of adult members and total household size in adult equivalents (AEs) in response to adult death, as this may facilitate the interpretation of effects on farm production, nonfarm income, and total income analyzed later in this paper. In this section, we use both a non-regression difference-in-difference framework and the first-difference regression approach which was described in detail in Section 3.3.

Given the importance of family labor to rural household agricultural production, we use adults as a proxy for household labor availability for on-farm activities and look first at the change in the number of adults (age 15 and older) in the household due to adult mortality. We begin with a simple non-regression difference-in-difference framework (Table 5), in which first compute the change in the mean number of adults of non-affected households from 2002 to 2005 (the control group). We find that households with a PA male death have an average change of -0.93 PA adults from 2002-05 (column C), while households with a PA female death have an average change of -0.16 PA adults from 2002-05 (Column F). Because these estimates might pick up time trends within the general population which are unrelated to the PA adult death, we control for such trends by subtracting the mean change in PA adults of the control group – households without a PA death (Column I) – from the change in PA adults of each of the affected households (Column C or Column F). The result is termed a difference-in-difference (DID) estimate (Column J & K) of the effect of PA mortality on the number of PA adults from 2002-05.[15]

The DID results show an astonishing difference in household responses to PA male and PA female death; on average, a PA male death results in a reduction of -1.07 PA adults in the household, whereas a PA female death results in reduction of -0.30 PA adults (Table 5). If households which suffer a PA death are unable to adjust their numbers of male and female adults after the death, we should find an average decline of one PA adult among affected households. Information on the gender and age of new arrivals to the household (individuals who are new to the household since the 2002 – the year of the initial survey) supports this interpretation, as 52% of households with a PA female death attracted a new PA adult to the household since 2002 (Table 6). By contrast, households with a PA male death are about as likely to have attracted a new PA adult (27%) as a non-affected household (24%).

While the DID estimates control for unobserved household characteristics, there may also be area-specific time-variant effects (i.e. village-level shocks) which might be correlated with both the PA death and the outcome variable of interest. To control for both unobserved household characteristics and area-specific time-variant effects, we estimate a first difference (FD) model with 'change in adults' as the dependent variable, regressed on mortality dummies and village*time dummies. Using the FD regression approach, we find that, on average, a PA male death results in a significant reduction of -1.05 adults in the household, whereas a PA female death results in a significant reduction of only -0.25 adults (Table 7). These results suggest that, on average, three out of four households with a PA female death are able to attract a new adult to the household, whereas, on average, no households with a PA male death are able to attract new adults. Results from both approaches (DID and FD regression) imply that households with a PA male death are unlikely to replace the deceased adult, while a majority of households with a PA female death attract a new adult to the household. If the number of adults is a reasonable proxy of labor available to the household, then these results suggest that households with a PA male death are more likely than those with a PA female death to experience reductions in crop production, and perhaps also in non-farm and total household income.

[15] Note that for this analysis, we drop the n=14 cases of PA deaths which were new members to the household since 2002 ('new arrivals'), since this would tend to underestimate the effects on household composition due to PA mortality. We also drop the n=23 cases of households which suffered more than one PA death.

Table 5. Difference-in-Differences Analysis of Rural Household Composition by Gender of Deceased Prime-age Adults, Mozambique, 2002-2005

Household Characteristic	Households with Male Prime-age Death, 2002-05			Households with Female Prime-age Death, 2002-05			Households without Prime-age Death, 2002-05			Difference-in-Differences	
										Male PA death	Female PA death
	X_{2002} (A)	X_{2005} (B)	ΔX^M (C)	X_{2002} (D)	X_{2005} (E)	ΔX^F (F)	X_{2002} (G)	X_{2005} (H)	ΔX_O (I)	$\Delta X^M - \Delta X_O$ (J)	$\Delta X^F - \Delta X_O$ (K)
Household Size	6.48	5.24	**-1.23**	5.69	5.52	**-0.17**	4.91	5.29	**0.37**	**-1.61**	**-0.54**
										0.275	*0.209*
Male adults	1.89	1.12	**-0.78**	1.32	1.54	**0.22**	1.23	1.31	**0.09**	**-0.86**	**0.13**
										0.119	*0.091*
Female adults	1.90	1.77	**-0.13**	1.93	1.57	**-0.36**	1.38	1.47	**0.09**	**-0.21**	**-0.45**
										0.099	*0.111*
Boys 5-14	0.93	0.83	**-0.10**	0.85	0.77	**-0.08**	0.76	0.87	**0.11**	**-0.21**	**-0.19**
										0.095	*0.103*
Girls 5-14	0.80	0.81	**0.01**	0.85	0.82	**-0.03**	0.71	0.83	**0.12**	**-0.11**	**-0.15**
										0.075	*0.094*
Young Children 0-4	0.96	0.68	**-0.28**	0.74	0.83	**0.09**	0.83	0.80	**-0.03**	**-0.25**	**0.12**
										0.111	*0.134*
Household Size (AE)	5.04	4.01	**-1.02**	4.40	4.23	**-0.17**	3.68	3.95	**0.28**	**-1.30**	**-0.44**
										0.220	*0.166*
Prime-age adults	3.52	2.59	**-0.93**	2.93	2.77	**-0.16**	2.38	2.51	**0.14**	**-1.07**	**-0.30**
										0.173	*0.172*
Elderly adults	0.27	0.29	**0.03**	0.32	0.33	**0.01**	0.23	0.27	**0.04**	**-0.01**	**-0.02**
										0.035	*0.035*
Dependency ratio[a]	0.90	1.25	**0.35**	1.10	1.11	**0.01**	1.19	1.29	**0.09**	**0.26**	**-0.08**
										0.087	*0.110*
Cases	115	115		121	121		3,806	3,806			

Source: TIA 2002-05 panel

Notes: Linearized standard errors are in italics; households with more than one prime-age death are excluded (n=23), as well as households with prime-age individuals who arrived after 2002 but subsequently died (n=14). A) Dependency ratio is the Effective Dependency Ratio: (children + adults over 60 + prime-age adults with chronic illness) / prime-age adults without chronic illness

Table 6. Arrivals and Departures of Individuals from Rural Households with and without Prime-age Death, 2002-2005

Household Characteristic	Non-Affected HH	HH with PA Male Death [a]	HH with PA Female Death	Non-Affected HH	HH with PA Male Death	HH with PA Female Death
	-------- Mean number of individuals ---------			% of HHs with one or more individual of the given age and gender who has arrived or left since 2002		
New arrivals: Individuals new to household since 2002						
Children age 0-4	0.55	0.44	0.59	41.2	36.0	35.4
Children age 5-14	0.25	0.15	0.29	17.0	11.8	21.4
Children age 5-14, male	0.12	0.06	0.17	9.7	5.7	13.7
Children age 5-14, female	0.13	0.09	0.13	10.2	9.0	9.0
PA adults age 15-59	0.34	0.43	0.68	24.4	27.8	52.3
PA adults 15-59, male	0.14	0.21	0.14	11.2	17.8	12.3
PA adults 15-59, female	0.20	0.22	0.55	17.0	19.0	49.2
Adults age 60+	0.02	0.01	0.03	2.1	1.1	3.1
Departures: Individuals who have left the household since 2002 (not including deaths of PA adults)						
Children age 0-4	0.02	0.05	0.00	1.6	4.9	0.4
Children age 5-14	0.11	0.20	0.13	7.7	13.5	9.2
Children age 5-14, male	0.05	0.10	0.08	4.2	8.5	6.3
Children age 5-14, female	0.06	0.10	0.05	5.0	8.0	4.5
PA adults age 15-59	0.30	0.52	0.21	21.0	32.7	14.4
PA adults 15-59, male	0.14	0.19	0.13	11.2	16.2	8.7
PA adults 15-59, female	0.17	0.33	0.08	13.5	25.0	7.5
Adults age 60+	0.01	0.01	0.00	0.8	1.4	0.4

Source: TIA02-05 panel

Notes: a) Male and female prime-age (PA) deaths only includes deaths which were due to illness

Table 7. The Impacts of Prime-age Adult Mortality on Rural Household Number of Adults (age 15 and over)

Covariates	Change in Household Number of Adults [b]					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [a]						
Male adult	-1.049**		-1.038**		-1.073*	
	(5.50)		(5.09)		(2.36)	
Female adult	-0.254+		-0.318+		-0.135	
	(1.81)		(1.84)		(0.53)	
Male heads/spouse		-0.935**		-1.070**		-0.68
		(3.72)		(4.59)		(1.20)
Female heads/spouse		-0.361*		-0.430*		-0.14
		(1.99)		(2.15)		(0.34)
Other adult male		-1.273**		-0.980*		-2.233**
		(3.80)		(2.46)		(5.35)
Other adult female		-0.109		-0.108		-0.136
		(0.40)		(0.25)		(0.48)
2 or more PA deaths	-0.753**	-0.755**	-0.701*	-0.703*	-0.869**	-0.869**
	(2.85)	(2.87)	(2.12)	(2.13)	(3.68)	(3.69)
Elderly mortality						
Elderly male	-0.858**	-0.868**	-1.064**	-1.069**	-0.42	-0.446
	(3.57)	(3.70)	(4.13)	(4.17)	(0.83)	(0.92)
Elderly female	-1.085**	-1.081**	-1.082**	-1.087**	-1.088**	-1.108**
	(4.31)	(4.29)	(3.28)	(3.28)	(3.80)	(3.67)
Chronically ill PA male adults (=1)	0.482**	0.480**	0.483*	0.483*	0.456	0.473
	(2.74)	(2.72)	(2.26)	(2.26)	(1.48)	(1.56)
Chronically ill PA female adults (=1)	0.104	0.098	-0.013	-0.018	0.625	0.599
	(0.69)	(0.64)	(0.10)	(0.13)	(1.12)	(1.04)
Constant	-0.059**	-0.059**	-0.059**	-0.059**	-1.965**	-1.965**
	(1.53e+12)	(1.23e+12)	(3.51e+12)	(4.31e+12)	(7.37e+12)	(7.11e+12)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.000	0.000	0.000	0.000	0.013	0.001
R-squared	0.21	0.21	0.22	0.22	0.19	0.2
Number of observations	4,042	4,042	2,904	2,904	1,138	1,138

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. a) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise. b) n=14 households are dropped which had a PA death of a member new to the household since 2002

Household responses to PA death may involve not only changes in the numbers of surviving PA adults, but also the arrival and/or departure of children or elderly adults. Because changes in household size are highly relevant to the interpretation of changes in household welfare over time, we also estimate the effect of PA death on household size, as measured in 'cost' adult equivalents (AEs) (Deaton 1997). We find that households with a PA male death lose -1.27 adult equivalents (AEs) on average, while households with a PA female death lose an average of -0.34 AEs (Table 8). Since each adult equals one AE in the 'cost AE' scale which we are using, the fact that the change in AE (-1.27 for PA male death) is larger than the change in adults (-1.05 for PA male death) for both PA male and female deaths suggests that, on average, PA death results in a net loss in the number of children and/or elderly adults for at least some affected households. The DID results (Table 5) show that the mean change in elderly members for PA death households is negligible (column C for PA male death, and column F for PA female death), and that the mean change in boys and girls is quite small, on average.

Table 8. The Impacts of Prime-age Adult Mortality on Rural Total Household Size (Adult Equivalents)

	Change in Household size (Adult Equivalents) [b]					
Covariates	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [a]						
Male adult	-1.273**		-1.254**		-1.295*	
	(5.50)		(5.00)		(2.36)	
Female adult	-0.344*		-0.527**		-0.03	
	(2.47)		(3.08)		(0.11)	
Male heads/spouse		-1.062**		-1.229**		-0.73
		(3.42)		(4.09)		(1.07)
Female heads/spouse		-0.463**		-0.619**		-0.012
		(2.61)		(3.27)		(0.03)
Other adult male		-1.690**		-1.296**		-2.963**
		(4.24)		(2.73)		(8.56)
Other adult female		-0.182		-0.354		-0.053
		(0.63)		(0.86)		(0.14)
2 or more PA deaths	-1.041*	-1.043*	-0.825	-0.827	-1.595**	-1.595**
	(2.34)	(2.35)	(1.56)	(1.57)	(4.84)	(4.86)
Elderly mortality						
Elderly male	-0.826*	-0.838**	-1.137**	-1.141**	-0.186	-0.22
	(2.57)	(2.67)	(3.11)	(3.14)	(0.31)	(0.40)
Elderly female	-1.097**	-1.089**	-1.183**	-1.184**	-0.875*	-0.905*
	(4.17)	(4.15)	(3.59)	(3.60)	(2.51)	(2.50)
Chronically ill PA male adults (=1)	0.467*	0.468*	0.331	0.331	0.769+	0.795+
	(2.37)	(2.36)	(1.38)	(1.38)	(1.87)	(1.96)
Chronically ill PA female adults (=1)	-0.001	-0.01	-0.117	-0.121	0.512	0.476
	(0.01)	(0.05)	(0.64)	(0.66)	(0.76)	(0.68)
Constant	0.239**	0.239**	0.239**	0.239**	-1.855**	-1.855**
	(3.93e+12)	(4.84e+12)	(2.87e+12)	(2.70e+12)	(1.00e+13)	(9.24e+12)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.000	0.000	0.000	0.000	0.002	0.000
R-squared	0.22	0.22	0.24	0.24	0.19	0.2
Number of observations	4,042	4,042	2,904	2,904	1,138	1,138

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. a) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise. b) n=14 households are dropped which had a PA death of a member new to the household since 2002

While it does appear that children are somewhat more likely to leave the household in the event of a PA male death, relative to a PA female death (Table 6), it is nevertheless important to note that most PA death households are not sending dependents away from the household. Changes in household composition may also affect the household dependency ratio, which could potentially become manifested in changes in household welfare over time. We compute the simple DID for the 'change in effective dependency ratio' from 2002-05 (Table 5).[16] The change in effective dependency ratio of households with a PA male death is 0.26 on average, while that for households with a PA female death is -0.08. While the dependency burden on surviving PA adults increases following a PA male death, it is important to note that the *ex post* (i.e. 2005) effective dependency ratio of both PA male death and PA female death households is the same or less than that of non-affected households, on average.

While this result may seem surprising, it is perhaps explained by the fact that households with either a PA male or PA female death still have as many or more PA adults *ex post* (post-death) in the household relative to non-affected households, on average (Table 5). This implies that households with a death were larger *ex ante* than households without a death, and thus may be further along the household lifecycle than non-affected households. Considering that both the number of surviving PA adults and the dependency burden of affected households is similar to that of the non-affected population, this suggests that while affected households may experience reductions in absolute levels of crop production and non-farm wage income – especially if the PA adult is not replaced –, it is hard to predict *a priori* whether or not their household welfare level (as measured by income/AE) will fall in the short term. However, as we discuss later in the paper, using income/AE alone as a welfare indicator is probably not sufficient, as the key to maintaining the affected household's long-term welfare may well depend upon whether or not they suffered significant asset depletion (considering human as well as physical capital).

4.4. Mortality Impacts on Household Landholding

Apart from labor, land is the primary physical asset used by rural Mozambican households for food and income generation. The availability of land for cultivation is one of the key assets thought to change with an adult death. Studies in rural Kenya and Zambia (Yamano and Jayne 2004; Chapoto 2006) found some significant reductions in cultivated area due to the loss of a male head (typically among poorer households which could not hire labor or attract new members), yet these studies did not measure changes in total landholding (and thus a complete measure of land access), as we do here.

There are several reasons why we might expect to find significant reductions in landholding following a PA death in Mozambique, each related to the fact that rural households in Mozambique gain access to land not through title but through 'use rights' to parcels in and around the village.[17] While there may be more than one source to which a household in a given village might appeal for use rights to a specific parcel, such use rights are typically given to small holders by the local village leader(s) and/or the head of the household's lineage (extended family) in the area (Marrule 1998). Within the framework of the

[16] A household's effective dependency ratio (de Waal 2003) is defined as: (children + elderly adults + chronically ill prime-age adults) / healthy prime-age adults.

[17] Technically, all land in Mozambique is owned by the State. In addition, the TIA surveys of 2002 and 2005 include information on the source of each parcel which a given household uses, and this information shows that less than 15% of parcels are obtained through government programs and through purchases, usually without a title (Walker et al. 2004).

predominant lineage system in the area (matrilineal or patrilineal), parcel allocation is usually based upon household size (consumption requirements), social connections to village leadership, and the political strength of the household's lineage (Marrule 1998).

The principal determinant used by such village authorities for land allocation is typically the household's size (food consumption requirements) and ability to cultivate (adult labor and/or access to animal traction). Thus, the first reason to expect reductions in landholding following a PA death is due to the significant reductions in the numbers of adults (available labor) and household size in adult equivalents following a PA death, as seen in section 4.3. Because land preparation in Mozambique is performed almost entirely by hand-hoe[18] (especially in Zambezia and the North), the principal constraint to land preparation for most households is labor availability. Therefore, the amount of land which a household can cultivate may well decline after the death of a PA adult, unless the deceased member's labor input can somehow be replaced (through a new arrival, community labor sharing, hiring labor, increased child labor, etc.). In the event that a household is not able to maintain cultivation rates, we speculate that they might face reduced land access over time.

A second reason to expect some affected households to lose land access is related to the various lineage systems in Mozambique, and the typical lack of inheritance rights of the surviving spouse. Thus, in the patrilineal tenure system which predominates in the South and Center regions, the death of a male head of household might result in the surviving widow and children losing rights to some or all of the parcels which they previously cultivated. By contrast, the death of a female spouse in these regions would not be expected to result in lower landholdings, unless the surviving widower is unable to maintain the household's previous cultivation rates (recall that a majority of widowers are able to attract a new PA female to the household).

By contrast, conventional wisdom holds that the matrilineal lineage system, which predominates north of the Zambezi river,[19] should offer more protection to widows given that household land access is typically gained via her family and tied to her and her children.[20] Under this system, surviving widowers are likely to lose land access given that husbands are not typically viewed as part of the deceased wife's family. In neighboring southern Malawi (where matrilineal systems predominate), anecdotal evidence exists that a PA female death sometimes results in the deceased female's brother taking land away from the widower and other surviving members (Mazhangara 2003). However, there is recent evidence that the assumption that widows under the matrilineal system maintain their land following the death of their male spouse is not always accurate in practice. In recent interviews by CARE/IRIS of female members of Village Savings and Loan Associations groups in several districts of Nampula, property rights violations following the death of a male spouse were common and a real fear among the women (Hendricks and Meagher 2007). Likewise, a study in neighboring Zambia, based upon a large, nationally-representative panel survey, found that widows from

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[18] Only 11% of TIA panel households used animal traction in 2002 (owned or rented), and only 1.9% indicate ownership of a cow or burro for animal traction use,

[19] Our delineation of patrilineal and matrilineal systems across Mozambique is based upon Marrule (1998). However, it should be noted that his fieldwork was based on rapid appraisal and selected interviews with village leaders, and that a representative (population-based) survey of lineage systems across Mozambique has not been implemented, to the best of our knowledge.

[20] This conventional wisdom is not just common among development practitioners, but also is found in Mozambique. During recent interviews with various INGOs (International non-governmental organizations) and local NGOs in Maputo, researchers from CARE/IRIS were repeatedly told that they would find that property rights violations were not an issue in Nampula, as the north was predominantly a matrilineal area (Hendricks and Meagher 2007).

matrilineal areas were just as likely to lose land access as widows from patrilineal areas (Chapoto et al. 2006). Thus, the death of the male spouse in a matrilineal area might still result in reduced land access for the surviving female spouse and her children, as the widow's male relatives (typically her brother or her uncle) technically control her household's access to land. Anecdotal evidence suggests that these male relatives have in some cases taken control of the widow's land, farm assets, and even custody of her children. One explanation for this might be that the negative stigma of HIV/AIDS-related mortality could lead the head of a local lineage group (the widow's brother or uncle) to disown his sister/niece in the event that he and/or the community suspect that she is somehow 'to blame' for her husband's illness and death (as is reportedly the case in other parts of Sub-Saharan Africa). Based on the available evidence, it appears that household land access in matrilineal areas of Mozambique may well decline following a PA head/spouse death, regardless of which spouse died.

Third, there is essentially no land rental market in Mozambique, as fewer than 5% of parcels in the TIA 2002 sample were rented. Thus, nearly all households which lose access to land due to lower household size and/or loss of familial or political ties to parcels do not have the option to rent land, even if they could afford to do so. Fourth, household survey evidence from Nampula demonstrates that household land access is not only a function of household size, but also of the household's social connections to village leaders and the political strength of their family's lineage (Marrule 1998)[21]. Thus, the ability of affected households to maintain land access might also vary by the social capital of surviving members. Unfortunately, neither TIA02 nor TIA05 collected information on household ties to local village leaders.

In the regressions reported below, we control for lineage systems to some extent by disaggregating the analysis by region, as the South is predominantly patrilineal and the North (which we define as including Zambezia) is predominantly matrilineal. However, there are some Center provinces included in the North/Center grouping. Further refinement of this analysis is warranted but beyond the scope of this paper.

We find that a PA male death results in a 20% reduction in total landholding, while a PA female death results in a 19% reduction (Table 9).[22] Reductions in total landholding for a female death are significant and of larger magnitude in the North/Center than in the South, where they are not significant. This regional difference in landholding effects due to PA female death may be due to the predominance of matrilineal systems north of the Zambezi River; When we stratify mortality by household position, the reductions are somewhat larger among households with a male head death (32% reduction in landholding) and that of a female non-head/spouse (38%), while the magnitude of coefficients for PA female head/spouse and PA male non-head deaths are much smaller and not close to significant.

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[21] Marrule's (1998) results were derived from a regression using random-sample survey data from Nampula. While his sample was not representative of the whole country, it is likely that such results might be found elsewhere in Mozambique, given that similar results are found across Zambia in a nationally-representative sample (Chapoto et al. 2006).

[22] Results in all tables using logarithmic variables report the actual change in the natural log of the dependent variable, not the percentage change; note that the actual percentage change in the dependent variable needs to be adjusted since the logarithmic transformation approximates small changes (those under 20%) well but larger changes less well (Wooldridge 2002). The necessary adjustment is as follows: % change in y = [exp(B) – 1].

Table 9. The Impacts of Prime-age Adult Mortality on Total Household Land Area

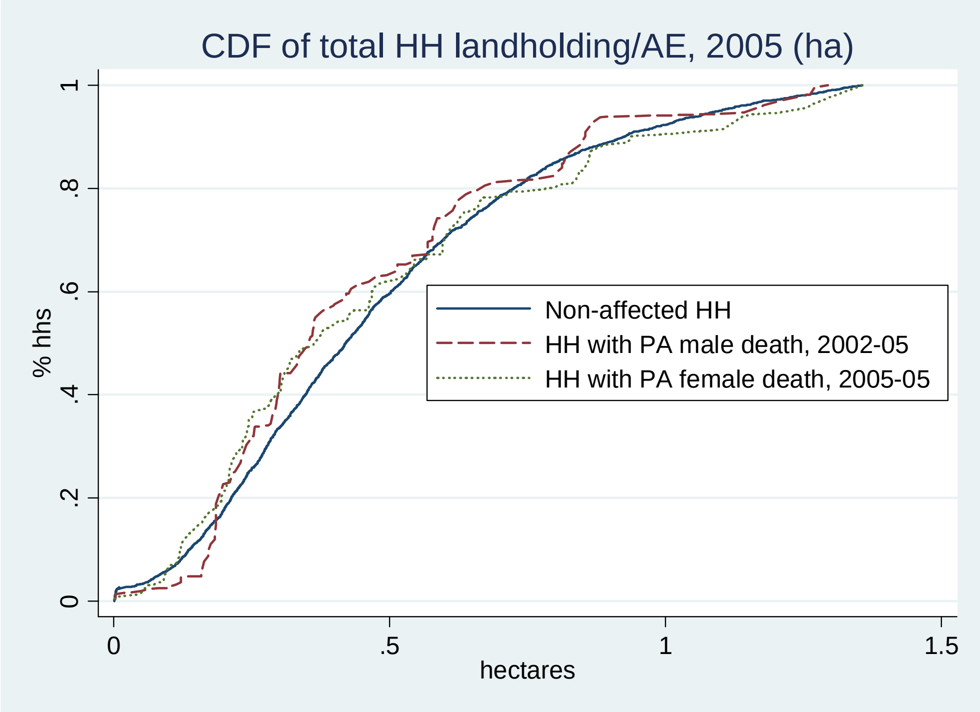
Covariates	Change in ln(Total household land area)					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	-0.230*		-0.226+		-0.223	
	(2.28)		(1.79)		(1.54)	
Female adult	-0.202+		-0.248+		-0.114	
	(1.83)		(1.92)		(0.53)	
Male heads/spouse		-0.356*		-0.398*		-0.27
		(2.51)		(2.12)		(1.48)
Female heads/spouse		-0.085		-0.106		-0.033
		(0.51)		(0.55)		(0.10)
Other adult male		-0.005		0.037		-0.083
		(0.04)		(0.32)		(0.29)
Other adult female		-0.343*		-0.480**		-0.169
		(2.51)		(3.74)		(0.61)
2 or more PA deaths	-0.132	-0.128	-0.043	-0.035	-0.289	-0.289
	(0.77)	(0.74)	(0.22)	(0.18)	(0.68)	(0.68)
Elderly mortality						
Elderly male	-0.01	-0.003	-0.054	-0.054	0.082	0.093
	(0.06)	(0.02)	(0.26)	(0.26)	(0.30)	(0.32)
Elderly female	-0.785**	-0.788**	-1.004**	-1.011**	-0.252	-0.25
	(3.10)	(3.13)	(3.20)	(3.25)	(1.06)	(1.05)
Chronically ill PA male adults (=1)	-0.255*	-0.251*	-0.171	-0.17	-0.442*	-0.438+
	(2.05)	(2.00)	(1.04)	(1.03)	(2.21)	(2.08)
Chronically ill PA female adults (=1)	-0.163	-0.157	-0.175	-0.168	-0.095	-0.09
	(0.88)	(0.85)	(0.78)	(0.75)	(0.50)	(0.46)
Constant	0.427**	0.427**	0.427**	0.427**	0.767**	0.765**
	(3.19e+12)	(3.27e+12)	(2.16e+13)	(2.24e+13)	(18.01)	(17.54)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.014	0.016	0.029	0.001	0.057	0.250
R-squared	0.30	0.30	0.29	0.29	0.30	0.30
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

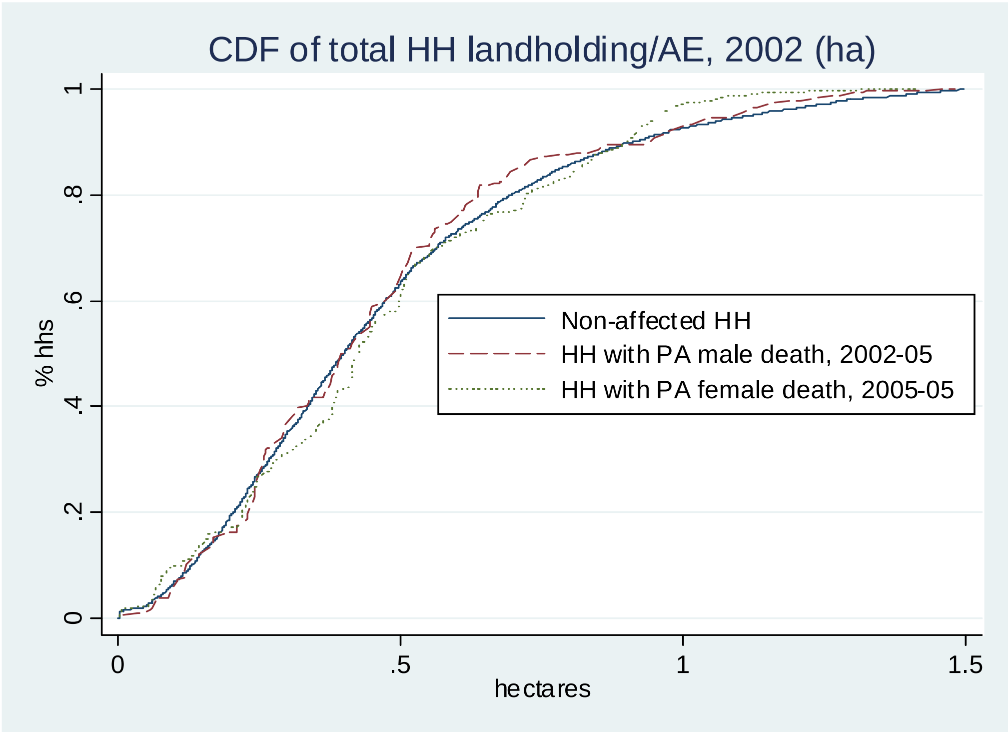
While TIA02 found that some 85% of households declared that it was 'easy to obtain additional land' in their village, an important empirical question for future research would be whether or not households which lose land access following a PA death are later able to reclaim additional land as their children grow older, in the event of arrival of new members, etc. Thus, regardless of whether household consumption requirements are lower following the PA death, suffering significant losses in landholding levels is unlikely to result in benign changes in the household's long-term welfare potential. In fact, the magnitude of the landholding reduction among affected households is reflected in the cumulative distribution function (CDF) of e*x post* (2005) landholding/AE (Figure 1), which shows that the distribution appears lower among most affected households relative to non-affected households. Given that *ex ante* (2002) landholding/AE was similar between the two groups (Figure 2), this confirms the magnitude of land loss among affected households, and the negative welfare consequences likely to follow from this.

Figure 1. Cumulative Distribution Function of 2005 Total Household Land-holding/AE for Households with and without Prime-age Mortality, 2002-05.



Source: TIA02, TIA05. The top 5% of the landholding/AE distribution is excluded.

Figure 2. Cumulative Distribution Function of 2002 Total Household Land-holding/AE for Households with and without Prime-age Mortality, 2002-05.



Source: TIA02, TIA05. The top 5% of the landholding/AE distribution is excluded.

4.5. Mortality Impacts on Household Livestock

Households can mitigate the short-run effects of adult mortality and other shocks by selling assets such as farm equipment and small and large livestock. Asset depletion is cited as a common response to adult morbidity and mortality in the household coping literature, and other studies have found large reductions in asset holdings due to adult mortality (Barnett and Blaikie 1992). However, asset depletion can also increase households' vulnerability to future income shocks, and may decrease household use of cash inputs and animal traction in crop cultivation, which will tend to result in lower productivity and overall crop production. In addition, PA mortality may also reduce both the stock and the inter-generational transfer of human capital with respect to location-specific farm management practices.

Table 10. The Impacts of Prime-age Adult Mortality on Household Tropical Livestock Units

Covariates	Change in Household Tropical Livestock Units					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	-0.420*		-0.477*		-0.243	
	(2.31)		(2.32)		(0.67)	
Female adult	0.093		0.042		0.16	
	(0.47)		(0.30)		(0.33)	
Male heads/spouse		-0.458*		-0.677**		0.026
		(2.06)		(3.12)		(0.06)
Female heads/spouse		0.144		0.113		0.242
		(0.69)		(0.60)		(0.42)
Other adult male		-0.353		-0.169		-1.034*
		(1.58)		(0.66)		(2.66)
Other adult female		0.031		-0.073		0.1
		(0.11)		(0.33)		(0.19)
2 or more PA deaths	-0.666*	-0.664*	-0.414	-0.406	-1.308**	-1.304**
	(2.12)	(2.11)	(1.18)	(1.16)	(5.54)	(5.54)
Elderly mortality						
Elderly male	-0.091	-0.088	-0.179	-0.182	0.08	0.071
	(0.26)	(0.25)	(0.55)	(0.55)	(0.09)	(0.08)
Elderly female	-0.191	-0.192	-0.167	-0.179	-0.25	-0.264
	(0.72)	(0.72)	(0.63)	(0.67)	(0.41)	(0.43)
Chronically ill PA male adults (=1)	-0.021	-0.019	-0.19	-0.188	0.389	0.407
	(0.08)	(0.08)	(0.67)	(0.66)	(0.75)	(0.79)
Chronically ill PA female adults (=1)	-0.156	-0.154	-0.139	-0.133	-0.208	-0.222
	(1.54)	(1.53)	(1.24)	(1.19)	(0.80)	(0.87)
Constant	-0.091**	-0.091**	-0.091**	-0.091**	0.894**	0.897**
	(3.74e+12)	(3.78e+12)	(1.08e+12)	(1.02e+12)	(15.34)	(15.75)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.004	0.010	0.009	0.000	0.008	0.042
R-squared	0.13	0.13	0.11	0.11	0.19	0.19
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS.
1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Due to data limitations and the general paucity of farm equipment ownership in Mozambique,[23] we only consider changes in livestock, which we aggregate together using tropical livestock units (FAO 2007).[24] We find sizeable reductions (-34%) in tropical livestock units (TLUs) due to a PA male death, but no significant change in response to PA female death (the coefficients for which are small and positive) (Table 10). Stratification by household position shows that significant reductions are found only in the event of a PA male head death in the North/Center, and from a PA non-head male death in the South. We do not find evidence of livestock loss during the illness period. Like the landholding results reported above, the finding of significant reductions in livestock assets following a male PA death bodes ill for these households' longer-term potential welfare, given that they will have to count on lower livestock income and may become more vulnerable to future income shocks.

4.6. Household Net Crop Income

As indicated in the MINAG HIV/AIDS strategy document (2006), PA mortality could result in reductions in crop income for various reasons, primarily including the loss of labor for timely land preparation, weeding, or harvest, and the loss of cash cropping income in the event of a PA male death (given gender bias in cash crop extension and household cropping responsibilities in general). Another concern is that PA mortality could lead to shifts away from cereals and towards less nutritious root/tuber crops due to the more flexible labor requirements of the latter.

We estimate the effect of adult mortality on changes in total net crop income (Table 11), net income from grains, beans, and oilseeds (Table 12), net income from roots and tubers (Table 13), and net income cash crops (Table 14). We find a large and significant reduction in total net crop income in the event of a PA male death (-41%) but no reduction due to a PA female death (Table 11). This effect is not significant in the South, though it is significant and a bit larger in the North/Center (-49%). Stratification of mortality by household position shows that the PA male effect (in the North/Center) is only significant in the event of PA male head death. Although the magnitude of the coefficient for PA male non-head is actually a bit larger, it is insignificant. There is also evidence of large reductions in crop income during a PA female illness in the South, due to losses in grains (Table 12) and cash crops (Table 14).

The total crop income results appear to be driven by large reductions in grain income following a PA male head death (-61%) in both the North/Center and South, and reductions in cash crop income in the North/Center (also due to a PA male head death). The significant reduction in grain income in both the North/Center and South is likely the result of reduced labor availability and/or consumption requirements, recalling that households which lose a PA male do not replace that adult, on average. The large and significant reduction in cash crop income (-74%) following a PA male head death in the North/Center (where most field cash crop production is located) is likely due to the fact that males tend to manage cash crops in Mozambique (Table 14). Curiously, we also find a large increase in cash crop production

[23] TIA collects information on housing quality (type of walls and type of roof) and ownership of the more common household goods such as radios, bicycles, and lanterns, as well as ownership of some types of farm equipment (ploughs, carts, etc.), however, farm equipment ownership is quite low, and TIA does not provide information for valuing household goods or farm equipment.

[24] One cow = 1 TLU; pigs = 0.4 TLU; sheep/goats = 0.2 TLU; chickens = 0.02 TLU as per FAO (2007).

in the South following a PA male head death. This result requires further investigation in order to understand which crops are involved, as increased cash crop cultivation in response to a PA death is the opposite of findings from other countries. Such a response begs the question of why the household did not pursue this high-value crop cultivation prior to the death of the male head. Perhaps these are tree crops to which the household previously had access, but which heretofore may not have been harvested if the household had been earning more income in other activities.

Because roots/tubers require less labor at specified times, some have predicted that affected households will increase root/tuber production. We find a large and significant increase in root/tuber production following the death of a PA male head in the South (Table 13), and the death of a non-head PA female in the North/Center.[25]

Table 11. The Impacts of Prime-age Adult Mortality on Household Total Net Crop Income

	Change in ln(Household total net crop income)					
Covariates	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	-0.536*		-0.682*		-0.115	
	(1.99)		(2.60)		(0.16)	
Female adult	-0.083		-0.145		0.04	
	(0.38)		(0.67)		(0.08)	
Male heads/spouse		-0.336		-0.589*		0.243
		(1.24)		(2.06)		(0.41)
Female heads/spouse		-0.236		-0.386		0.169
		(0.91)		(1.28)		(0.35)
Other adult male		-0.894+		-0.823		-1.169
		(1.90)		(1.64)		(0.94)
Other adult female		0.102		0.258		-0.054
		(0.24)		(1.12)		(0.06)
2 or more PA deaths	-1.400*	-1.406*	-1.732*	-1.739*	-0.422	-0.418
	(2.12)	(2.14)	(2.17)	(2.19)	(0.57)	(0.56)
Elderly mortality						
Elderly male	0.461	0.452	0.543	0.535	0.29	0.28
	(1.41)	(1.36)	(1.18)	(1.15)	(1.07)	(1.01)
Elderly female	-0.545	-0.539	-0.5	-0.5	-0.626+	-0.645+
	(1.35)	(1.33)	(0.89)	(0.89)	(1.94)	(2.04)
Chronically ill PA male adults (=1)	-0.101	-0.106	-0.037	-0.038	-0.25	-0.225
	(0.42)	(0.43)	(0.12)	(0.13)	(0.67)	(0.58)
Chronically ill PA female adults (=1)	-0.249	-0.258	-0.129	-0.14	-0.793+	-0.811+
	(0.97)	(1.00)	(0.43)	(0.45)	(1.91)	(1.94)
Constant	-0.344**	-0.344**	-0.344**	-0.344**	1.996**	2.000**
	(1.97e+12)	(1.98e+12)	(7.61e+12)	(8.89e+12)	(21.51)	(21.44)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.048	0.087	0.022	0.052	0.921	0.322
R-squared	0.31	0.31	0.26	0.27	0.4	0.4
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS.
1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

[25] We plan to investigate mortality effects on area cultivated to each crop group in future research, as well as to test for productivity effects (crop income/ha).

Table 12. The Impacts of Prime-age Adult Mortality on Household Total Net Crop Income from Grains, Beans, and Oilseeds

Covariates	Change in ln(Household net grain/beans/oilseed crop income)					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	-0.883**		-0.827*		-1.054+	
	(3.15)		(2.58)		(2.11)	
Female adult	-0.36		-0.08		-0.964+	
	(1.28)		(0.25)		(1.91)	
Male heads/spouse		-0.936**		-0.821*		-1.152
		(3.03)		(2.57)		(1.71)
Female heads/spouse		-0.418		-0.223		-1.064
		(1.01)		(0.48)		(1.19)
Other adult male		-0.787		-0.836		-0.767
		(1.31)		(1.16)		(0.91)
Other adult female		-0.288		0.16		-0.893
		(0.68)		(0.65)		(1.06)
2 or more PA deaths	-1.034	-1.033	-1.804	-1.807	1.464+	1.463+
	(0.93)	(0.93)	(1.28)	(1.29)	(2.08)	(2.07)
Elderly mortality						
Elderly male	0.409	0.404	0.807	0.802	-0.385	-0.389
	(0.73)	(0.71)	(1.29)	(1.27)	(0.34)	(0.33)
Elderly female	-0.594	-0.598	-0.722	-0.726	-0.14	-0.135
	(1.19)	(1.20)	(1.07)	(1.06)	(0.28)	(0.27)
Chronically ill PA male adults (=1)	0.003	0	-0.424	-0.424	1.18	1.168
	(0.00)	(0.00)	(1.21)	(1.21)	(0.81)	(0.77)
Chronically ill PA female adults (=1)	-0.723**	-0.723**	-0.313	-0.318	-2.604**	-2.602**
	(2.80)	(2.78)	(1.08)	(1.10)	(5.10)	(4.92)
Constant	-0.836**	-0.836**	-0.836**	-0.836**	4.447**	4.447**
	(7.63e+12)	(8.19e+12)	(3.97e+13)	(5.68e+13)	(38.94)	(37.65)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.012	0.020	0.085	0.081	0.025	0.134
R-squared	0.3	0.3	0.23	0.23	0.39	0.39
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Table 13. The Impacts of Prime-age Adult Mortality on Household Total Net Crop Income from Root and Tuber Crop Income

Covariates	Change in ln(Household net root/tuber crop income)					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	0.286		0.114		0.765	
	(0.70)		(0.23)		(1.08)	
Female adult	0.38		0.275		0.639	
	(0.90)		(0.44)		(1.54)	
Male heads/spouse		0.574		0.227		1.317+
		(1.03)		(0.30)		(1.89)
Female heads/spouse		-0.347		-0.352		-0.28
		(0.53)		(0.41)		(0.44)
Other adult male		-0.223		-0.053		-0.882
		(0.55)		(0.12)		(0.94)
Other adult female		1.262**		1.326*		1.269
		(2.87)		(2.45)		(1.74)
2 or more PA deaths	-0.879	-0.893	-1.421	-1.435	0.303	0.311
	(0.95)	(0.97)	(1.26)	(1.28)	(0.32)	(0.33)
Elderly mortality						
Elderly male	0.346	0.296	0.446	0.424	0.156	0.032
	(0.57)	(0.48)	(0.51)	(0.48)	(0.44)	(0.08)
Elderly female	-0.940*	-0.941*	-0.769	-0.78	-1.308	-1.338
	(2.12)	(2.13)	(1.44)	(1.48)	(1.62)	(1.68)
Chronically ill PA male adults (=1)	-1.134+	-1.161+	-1.021	-1.022	-1.463	-1.509
	(1.88)	(1.94)	(1.35)	(1.35)	(1.63)	(1.73)
Chronically ill PA female adults (=1)	-0.076	-0.106	-0.22	-0.246	0.485	0.418
	(0.22)	(0.30)	(0.53)	(0.59)	(0.90)	(0.78)
Constant	0.156**	0.156**	0.156**	0.156**	4.217**	4.232**
	(1.57e+12)	(1.45e+12)	(9.42e+11)	(9.71e+11)	(35.10)	(35.32)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.531	0.058	0.586	0.174	0.467	0.187
R-squared	0.26	0.26	0.26	0.26	0.26	0.26
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Table 14. The Impacts of Prime-age Adult Mortality on Household Total Net Income[2] from Cash Crops

Covariates	Change in ln(Household net cash crop income)					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	-0.135		-0.505		0.898*	
	(0.28)		(0.80)		(2.52)	
Female adult	-0.423		-0.68		0.086	
	(0.92)		(1.10)		(0.13)	
Male heads/spouse		-0.505		-1.354+		1.407**
		(0.85)		(1.74)		(3.34)
Female heads/spouse		-0.612		-1.075		0.716
		(1.11)		(1.55)		(1.13)
Other adult male		0.535		0.812		-0.592
		(0.91)		(1.17)		(1.46)
Other adult female		-0.187		0.009		-0.359
		(0.30)		(0.01)		(0.40)
2 or more PA deaths	0.042	0.049	-1.503	-1.48	4.033*	4.039*
	(0.03)	(0.03)	(1.40)	(1.37)	(2.54)	(2.54)
Elderly mortality						
Elderly male	0.341	0.323	0.352	0.312	0.363	0.392
	(0.68)	(0.64)	(0.63)	(0.55)	(0.36)	(0.39)
Elderly female	-0.047	-0.068	0.612	0.542	-1.532*	-1.557*
	(0.08)	(0.11)	(0.83)	(0.76)	(2.78)	(2.86)
Chronically ill PA male adults (=1)	-0.468	-0.477	-0.299	-0.291	-0.979	-0.909
	(0.65)	(0.66)	(0.41)	(0.40)	(0.57)	(0.53)
Chronically ill PA female adults (=1)	-0.482+	-0.481+	-0.375	-0.38	-1.097*	-1.107*
	(1.93)	(1.92)	(1.28)	(1.29)	(2.64)	(2.66)
Constant	0.094**	0.094**	0.094**	0.094**	0.381**	0.383**
	(1.58e+12)	(1.34e+12)	(1.62e+12)	(1.58e+12)	(4.10)	(4.11)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.815	0.757	0.356	0.101	0.141	0.048
R-squared	0.23	0.23	0.23	0.23	0.23	0.23
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

4.7. Household Non-farm Income

Previous research on the effects of PA mortality on household income suggests that households which suffer PA mortality might face reductions in non-farm income or, in some cases, lose access to it entirely. This hypothesis implicitly assumes that households engage in non-farm income to increase their household income, thus expects to find empirically that PA mortality results in a reduction in non-farm income. However, this line of reasoning focuses on the factors that 'pull' households into non-farm activities – which for some households provide higher returns to their existing labor and other assets – while ignoring that some households are 'pushed' into non-farm activities in the pursuit of reduced income risk, in response to diminishing factor returns (such as family labor in the presence of land constraints), or to alleviate cash constraints in the presence of imperfect or weak credit markets (Barrett et al. 2001). Therefore, while we may expect that some households with a PA adult will face reductions in non-farm income, especially if the skills and experience necessary for a non-farm activity formerly pursued by the deceased PA adult are not held by surviving members, there could also be cases in which a household increases its non-farm income in response to PA mortality (Mazhangara 2007). Thus, it is difficult to hypothesize *a priori* the effect of PA adult mortality on household non-farm income, without some type of disaggregation of non-farm income by skill or asset level. Such disaggregated analysis is beyond the scope of this paper, though will be pursued in future work.

We find a large and significant reduction (-88%) in non-farm income following the death of a PA male head in the South, and a large but insignificant loss following a PA male head death in the North/Center (Table 15). We find a large and significant increase in non-farm income in the South among households with two or more PA deaths, which may well be the type of 'push' response noted above. In the North/Center, we find a large significant increase in non-farm income following a PA female head/spouse death, which is cause for further investigation. There are also some large and significant reductions due to current PA illness, which suggests that the affected households are not able to substitute for the ill individual's labor in that job or MSE activity.

Table 15. The Impacts of Prime-age Adult Mortality on Household Total Net Nonfarm Income

Covariates	Change in ln(Household total net non-farm income)					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	-1.307*		-1.004		-2.195*	
	(2.35)		(1.59)		(2.30)	
Female adult	0.229		0.664		-0.779	
	(0.40)		(0.85)		(1.04)	
Male heads/spouse		-1.418*		-1.101		-2.154+
		(2.28)		(1.53)		(2.10)
Female heads/spouse		1.262		1.844+		-0.444
		(1.64)		(1.87)		(0.44)
Other adult male		-1.123		-0.869		-2.308
		(1.38)		(0.93)		(1.52)
Other adult female		-1.027		-1.319		-1.013
		(1.49)		(1.52)		(1.11)
2 or more PA deaths	0.506	0.518	0.269	0.292	1.749+	1.749+
	(0.83)	(0.85)	(0.36)	(0.39)	(2.12)	(2.12)
Elderly mortality						
Elderly male	-0.166	-0.092	-0.603	-0.557	0.832	0.863
	(0.21)	(0.11)	(0.78)	(0.72)	(0.44)	(0.45)
Elderly female	2.436**	2.450**	2.752**	2.781**	1.703+	1.701+
	(3.58)	(3.65)	(2.98)	(3.07)	(1.87)	(1.86)
Chronically ill PA male adults (=1)	-1.321+	-1.280+	-1.732+	-1.731+	-0.204	-0.177
	(1.78)	(1.73)	(1.77)	(1.77)	(0.29)	(0.25)
Chronically ill PA female adults (=1)	-0.326	-0.29	0.164	0.212	-2.489+	-2.480+
	(0.66)	(0.58)	(0.31)	(0.41)	(2.00)	(1.98)
Constant	0.313**	0.313**	0.313**	0.313**	4.347**	4.345**
	(5.89e+11)	(5.90e+11)	(8.60e+11)	(8.50e+11)	(15.64)	(15.54)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.125	0.013	0.344	0.019	0.143	0.369
R-squared	0.23	0.23	0.24	0.24	0.21	0.21
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005
Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

4.8. Household Total Net Income and Total Net Income/AE

When we look at the effect of PA mortality on total net income (Table 16), we find that a PA male death results in a significant reduction in total net household income of -25%, while the coefficient on PA female death is positive (though insignificant). At a regional level, this negative effect of PA male death is only found in the Center/North, and only for the death of a PA male head/spouse; no significant mortality effects are found in the South (though the magnitude for death of PA non-head male is quite large).

Table 16. The Impacts of Prime-age Adult Mortality on Rural Total Net Household Income

Covariates	Change in ln(Total net household income)					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	-0.290*		-0.307*		-0.24	
	(2.02)		(1.98)		(0.71)	
Female adult	0.169		0.112		0.232	
	(0.82)		(0.42)		(0.88)	
Male heads/spouse		-0.236		-0.339+		-0.012
		(1.33)		(1.78)		(0.03)
Female heads/spouse		0.321		0.34		0.253
		(1.11)		(0.94)		(0.61)
Other adult male		-0.390+		-0.26		-0.911
		(1.72)		(1.11)		(1.47)
Other adult female		-0.018		-0.27		0.214
		(0.07)		(0.94)		(0.59)
2 or more PA deaths	-0.614*	-0.614*	-0.639*	-0.634*	-0.332	-0.329
	(2.50)	(2.50)	(2.22)	(2.19)	(0.68)	(0.68)
Elderly mortality						
Elderly male	-0.066	-0.054	-0.29	-0.281	0.395	0.382
	(0.27)	(0.22)	(1.10)	(1.07)	(0.78)	(0.79)
Elderly female	0.59	0.595	0.771	0.776	0.111	0.099
	(1.47)	(1.48)	(1.37)	(1.39)	(0.41)	(0.36)
Chronically ill PA male adults (=1)	-0.273	-0.266	-0.154	-0.153	-0.572*	-0.561*
	(1.24)	(1.21)	(0.53)	(0.53)	(2.44)	(2.33)
Chronically ill PA female adults (=1)	-0.235	-0.231	-0.039	-0.03	-1.062*	-1.075*
	(1.24)	(1.22)	(0.19)	(0.14)	(2.72)	(2.76)
Constant	0.037**	0.037**	0.037**	0.037**	2.896**	2.899**
	(8.42e+11)	(8.11e+11)	(1.01e+12)	(1.08e+12)	(33.19)	(33.29)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.032	0.032	0.053	0.012	0.778	0.785
R-squared	0.23	0.23	0.23	0.23	0.23	0.23
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005
Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Given the subsistence orientation of most rural Mozambican households, it perhaps should not be surprising that PA male death households – which lose -1.27 AEs on average – would suffer reduced income given not only the loss of family on-farm labor and potential non-farm wage income, but also the lower expenditure burden (i.e. food and other requirements) for that household. For example, one PA adult represents 23.5% of the *ex ante* household AEs of PA male death households, on average. If children are assumed to not play a large role in household income generation (and adult members serve as a reasonable proxy of available labor), then it seems straightforward to link the share of the deceased PA male in *ex ante* HH AEs (24%) to the average loss in income resulting from the death of that PA male (-25%), keeping in mind that PA male death households do not attract new PA adults, on average.

It appears that PA female death households don't suffer a significant loss in total income because although the deceased PA female adult represents 27% of *ex ante* household AEs on average, these households are able to attract new PA adults such that their net loss in available adult labor (and cost burden) is -0.25 adults and -0.33 AEs. Therefore, because available PA labor and consumption requirements do not fall nearly as much for households with a PA female death, this may help explain why we do not find evidence of significant reductions in their total household income. Another explanation for the gender disparity in income effects may be related to the low level of labor substitutability in certain activities, such as cash crop marketing or high-wage non-farm labor opportunities. These activities are more likely to be managed exclusively by males in the household either due to tradition/experience (in the case of cash cropping) or due to educational requirements (in the case of high-wage non-farm labor), either of which may act as a barrier against female participation. Therefore, in the event that the deceased PA adult had managed a high-return activity such as cash-cropping or a salaried non-farm job, it is unlikely that a surviving female would be able to continue such an activity.

However, when we look at the effect of PA mortality on total net income per AE, we do not find evidence of significant negative mortality effects, with the exception of cases where the household suffered 2 or more PA deaths during the period 2002-2005 (Table 17). In fact, the coefficient on PA male death is quite small, and that on PA female death shows an increase in income/AE of 37.4%, but not significant. We do find significant reductions in income due to current PA male or female illness (the female effect is considerably larger), though this perhaps should not be surprising given that the ill PA adult becomes a dependent in the household and thus must be supported by the other adults. In other words, consumption requirements remain constant but sources of labor and wage income fall by at least one person, possibly more if care-taking demands time of other members.

The results here show that, on average, some affected households experience reductions in absolute income yet are still managing to maintain their pre-death income/AE level. To explain this apparent divergence, recall from the earlier demographic results that affected households can still count on PA labor availability and a dependency ratio which is similar, on average, to that of non-affected households. Therefore, this may explain why a household which suffers PA mortality can suffer significant losses in total income yet maintain the same general welfare level (i.e. income per AE), on average. However, it should be noted that the logic for this explanation is based on the assumption that family labor in agriculture generally has a high degree of substitutability, such that a new PA adult may to a large extent substitute for a deceased adult. Yet, we might expect to find reductions in both income levels and income/AE in a scenario where the household loses a PA adult who had a salaried non-farm job, which could not be filled by a surviving member.

Although total household income and income/AE are valuable for use as welfare indicators, we offer several reasons for caution against interpreting the lack of significant mortality effects on income/AE as evidence that affected households are therefore 'no worse-off' than the non-affected population. First, the TIA panel only provides us with a snapshot of the income and asset levels of households during the 1-3 years following a PA death, thus the data only permit estimation of the short-term impact of adult mortality. Second, adult mortality may result in important differences between affected and non-affected households in terms of asset levels and accumulation paths over time. We have already noted that landholding was significantly reduced due to PA death (both male and female), that landholding/AE of affected households (for both male and female PA death) is somewhat lower relative to the non-affected population, and that livestock assets were significantly

Table 17. The Impacts of Prime-age Adult Mortality on Rural Total Net Household Income Per Adult Equivalent

Covariates	Change in ln(Total net household income/AE)					
	National		North/Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)
Prime-age Adult Mortality [1]						
Male adult	0.037		0.016		0.09	
	(0.24)		(0.10)		(0.22)	
Female adult	0.318		0.342		0.241	
	(1.62)		(1.33)		(0.86)	
Male heads/spouse		0.054		-0.013		0.205
		(0.28)		(0.07)		(0.39)
Female heads/spouse		0.516+		0.601+		0.263
		(1.79)		(1.69)		(0.55)
Other adult male		0.002		0.057		-0.25
		(0.01)		(0.22)		(0.42)
Other adult female		0.076		-0.095		0.225
		(0.33)		(0.34)		(0.65)
2 or more PA deaths	-0.454+	-0.453+	-0.502	-0.497	-0.117	-0.115
	(1.80)	(1.79)	(1.65)	(1.62)	(0.25)	(0.25)
Elderly mortality						
Elderly male	0.205	0.22	0.054	0.064	0.519	0.514
	(0.90)	(0.97)	(0.20)	(0.23)	(1.25)	(1.31)
Elderly female	0.889*	0.893*	1.103*	1.109*	0.327	0.321
	(2.25)	(2.27)	(1.99)	(2.02)	(1.32)	(1.31)
Chronically ill PA male adults (=1)	-0.35	-0.342	-0.22	-0.22	-0.664*	-0.657*
	(1.65)	(1.61)	(0.77)	(0.77)	(2.87)	(2.77)
Chronically ill PA female adults (=1)	-0.208	-0.202	0.009	0.02	-1.130**	-1.137**
	(1.10)	(1.07)	(0.04)	(0.09)	(3.05)	(3.09)
Constant	-0.014**	-0.014**	-0.014**	-0.014**	2.344**	2.346**
	(9.04e+10)	(8.84e+10)	(1.52e+12)	(1.59e+12)	(28.30)	(28.57)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.134	0.296	0.252	0.284	0.707	0.917
R-squared	0.23	0.23	0.24	0.24	0.24	0.24
Number of observations	4,058	4,058	2,915	2,915	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

reduced in the event of PA male death. Thus, while affected households have maintained their pre-death income/AE levels in the 1-3 years following the PA death (on average), the diminished asset base of these households may nevertheless make them less resilient to future adverse shocks to income such as those from drought or epidemics. Finally, given the importance of human capital accumulation for household welfare over time, another concern, which will be addressed by future research, is that adult mortality could have negative effects on child schooling.

5. POVERTY AND PRIME-AGE ADULT MORTALITY

5.1. *Ex Ante* Income and Poverty Status

While studies in the early 1990s showed that HIV positive individuals in Africa tended to have higher education levels and come from wealthier households (Ainsworth and Semali 1995), some argue that this phase of the epidemic is past and that poverty is now likely a driving factor behind current HIV prevalence. However, de Walque (2006) finds no consistent pattern of a link between asset wealth and HIV-positive individuals across five countries in which recent Demographic and Health Surveys have included seroprevalence testing, though he finds a positive association between wealth and HIV for infected women in three of the five countries.

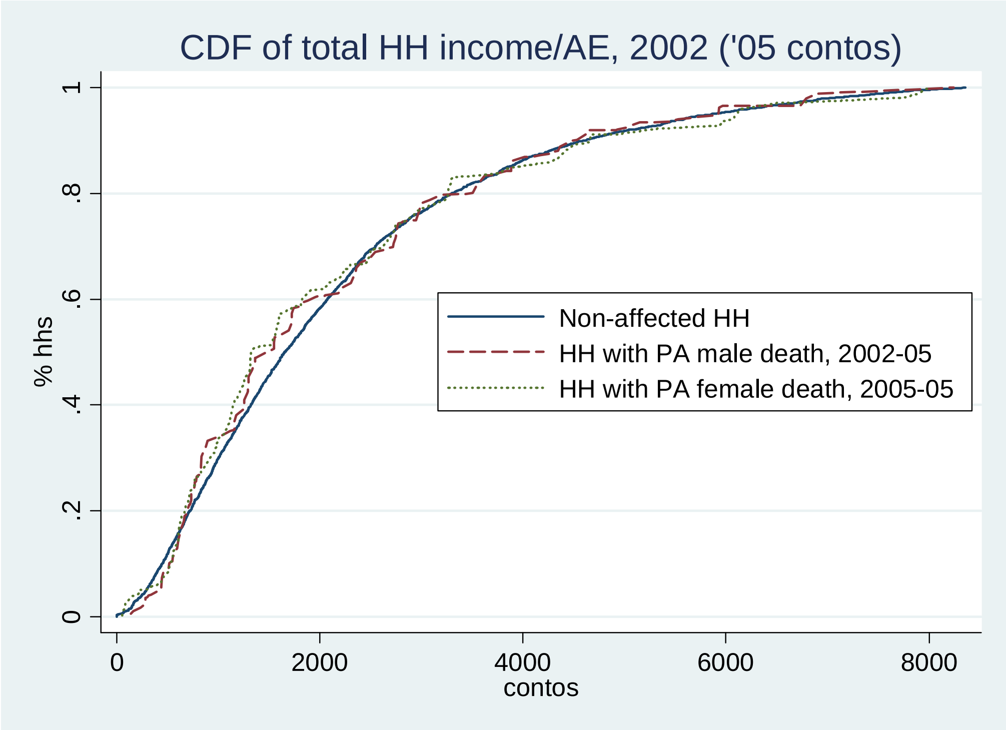
At the national level of rural Mozambique, we find that the distribution of households with a PA death during 2002-2005 across quintiles of 2002 (*ex ante*) total net household income/AE (computed at the national level) is similar to that of the non-affected population in the top two quintiles, though affected households are somewhat more prevalent in the lowest two quintiles of (Table 18), and less prevalent in the middle quintile.

Table 18. Proportion of TIA Panel Households With and Without Prime-age Mortality 2002-05, by Quintiles of *Ex Ante* Total Net Household Income/AE, 2002

Quintiles of total net HH income/AE, 2002	Panel HHs without a PA death 2002-05	Panel HHs with any PA death 2002-05	Panel HHs with any PA male death 2002-05	Panel HHs with any PA female death 2002-05
National		------------ % -------------		
1-low	19.9	22.0	22.5	22.1
2	19.7	25.3	24.4	25.0
3	20.5	12.7	11.6	12.4
4	20.1	18.5	21.5	18.0
5-high	19.9	21.5	20.0	22.6
North/Center				
1-low	21.2	21.5	22.4	21.7
2	19.7	29.6	25.2	31.7
3	21.3	10.1	8.4	10.8
4	20.5	21.5	27.9	18.2
5-high	17.3	17.3	16.1	17.8
South				
1-low	13.7	23.1	22.9	22.8
2	19.5	15.9	22.3	12.6
3	16.2	18.3	20.5	15.3
4	17.9	11.8	3.8	17.8
5-high	32.7	30.9	30.5	31.5
	----------- total number of cases by region -------------			
National	3785	273	140	149
North/Center	2756	159	88	80
South	1029	114	52	69

Source: TIA02, TIA05

Figure 3. Cumulative Distribution Function of 2002 Total Net Household Income/AE for Households with and without Prime-age Mortality, 2002-05.



Source: TIA02, TIA05. The top 5% of the income/AE distribution is excluded.

This result is nearly the same when considering the gender of the deceased PA adult. Yet, when we stratify the sample by regions, there appears to be a 'U-shaped' association between *ex ante* household income/AE and PA death when using either the distribution of households across *ex ante* income/AE quintiles (Table 18) or cumulative distribution functions (CDFs) (Figure 3). This suggests that households most likely to suffer a PA death tended to be either poorer or wealthier than non-affected households, prior to the death. However, when we consider the CDF (Figure 2, page 29) of a more stable welfare indicator – household landholding/AE, which along with labor is the principal asset in rural Mozambique – we find that affected households tended to have the same or greater levels of *ex ante* landholding/AE throughout most of the distribution (especially the lower 80%). In summary, while *ex ante* household income/AE appears to have a U-shaped relationship with PA death, we find that affected households tended to have the same or greater levels of *ex ante* landholding/AE, thus there does not appear to be a clear link at present between *ex ante* welfare and PA death in the case of rural Mozambique.

Keeping in mind the caveats related to using income as a poverty indicator, we consider the distribution of affected and non-affected households in relation to the IAF 2002/03 food poverty line, which we have inflated to 2005 values using the rural expenditure inflator described earlier. Using the IAF food poverty line, we categorize households into groups of extremely poor (TIA income/capita below 0.33*poverty line), poor (above extremely poor and below the poverty line), non-poor (above the poverty line but below 1.5*poverty line) and wealthy (above 1.5*poverty line). The results in this table suggest that the only difference between the affected and non-affected households is that affected households are a few percentage points more likely to fall within the wealthy category (Table 19). These results demonstrate how sensitive the apparent 'U-shaped' association is to the arbitrary

Table 19. Proportion of TIA Panel Households With and Without Prime-age Mortality 2002-05, by *Ex Ante* Poverty Category, 2002

Poverty category, 2002	Panel HHs without a PA death 2002-05	Panel HHs with any PA death 2002-05	Panel HHs with any PA male death 2002-05	Panel HHs with any PA female death 2002-05
National		------------ % -------------		
Extremely poor	28.3	29.1	31.2	28.2
Poor	41.4	39.8	34.7	41.1
Non-poor	13.1	11.3	13.7	8.9
Wealthy	17.3	19.7	20.4	21.8
North/Center				
Extremely poor	26.8	25.2	27.6	23.2
Poor	42.2	42.1	35.3	45.3
Non-poor	13.7	12.7	14.4	10.9
Wealthy	17.4	20.0	22.7	20.6
South				
Extremely poor	35.5	37.9	41.4	37.4
Poor	37.4	34.7	33.0	33.4
Non-poor	10.3	8.3	11.7	5.1
Wealthy	16.8	19.1	13.9	24.0
	------------ total number of cases by region -------------			
National	3785	273	140	149
North/Center	2756	159	88	80
South	1029	114	52	69

Source: TIA02, TIA05
Notes: * Poor = TIA02 total household income/capita below the IAF 2002/03 food poverty line and above extreme poverty; extremely poor = income <0.33*poverty line; non-poor = income > povertyline and < 1.5*poverty line; wealthy = income >1.5*poverty line.

cut-off points of various subgroups of the distribution. Because it is likely that HIV vectors in Mozambique vary both by region and perhaps gender, investigation of *ex ante* household and individual characteristics of deceased individuals would ideally require multivariate analysis similar to that undertaken by Chapoto (2006) for Zambia, which is beyond the scope of this paper.

5.2. *Ex Post* Income and Poverty Status

While it is often assumed by the theoretical or qualitative literature on mortality impacts that the negative effects of adult mortality on agricultural production and non-farm income will force many affected households into poverty, panel data (preferably on household expenditure) are required to determine whether or not households which were non-poor *ex ante* fall below the poverty line following a PA death. The few extant studies using panel data have not focused specifically upon whether or not PA mortality forces affected households below the national poverty line, but rather on how an affected household's *ex ante* asset position conditions the mortality impacts on household income and asset levels, and use of land or labor. This focus is likely taken by these studies because they tend to come from data sets which record income and not expenditure, which is the preferred indicator of poverty status. A multi-country study of various African cross-sectional datasets found that *ex post* household income per adult equivalent of affected households – as a homogenous group – did not tend to be systematically different from those of non-affected households, though they were lower for some types of affected households, such as those headed by widows (Mather et al. 2004b).

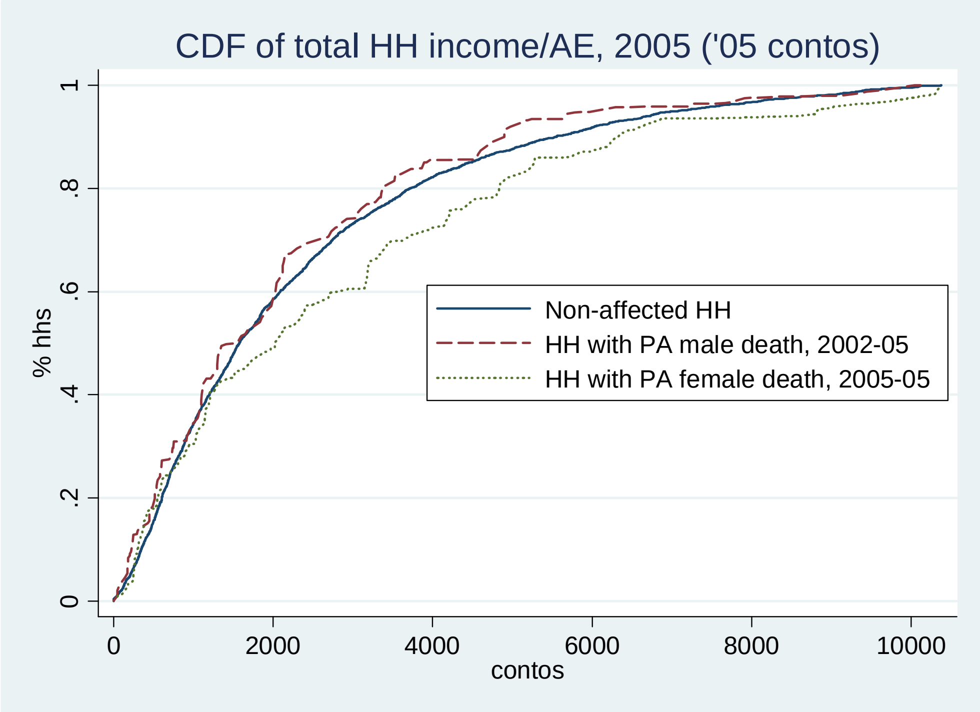
The distribution of affected TIA panel households across quintiles of *ex post* (2005) total net household income/AE is quite similar to that of the non-affected population, with the exception that PA male death households are somewhat more prevalent in the lowest quintile, and PA female death households are more prevalent in the highest quintile (Table 20). A CDF of *ex post* (2005) total net household income/AE shows the same result, that PA male death households have similar ex post income/AE relative to the non-affected population, though PA female death households are somewhat better off (Figure 4). However, the CDF of 2005 total net household landholding/AE suggests that affected households have somewhat lower landholding/AE.

Table 20. Proportion of TIA Panel Households With and Without Prime-age Mortality 2002-05, by Quintiles of *Ex Post* Total Net Household Income/AE, 2005

Quintiles of total net HH income/AE, 2005	Panel HHs without a PA death 2002-05	Panel HHs with any PA death 2002-05	Panel HHs with any PA male death 2002-05	Panel HHs with any PA female death 2002-05
National		------------ % -------------		
1-low	19.8	23.1	26.4	20.7
2	20.2	16.7	15.5	16.4
3	20.2	17.5	24.6	11.7
4	20.1	18.0	16.5	20.5
5-high	19.7	24.7	17.0	30.7
North/Center				
1-low	21.4	24.5	26.3	24.3
2	21.2	20.0	17.8	20.4
3	20.8	19.3	25.6	12.5
4	20.1	17.1	18.0	17.2
5-high	16.6	19.2	12.3	25.6
South				
1-low	12.4	20.0	26.6	14.0
2	15.1	9.5	9.4	8.9
3	17.0	13.7	21.8	10.2
4	20.5	20.0	12.4	26.7
5-high	35.1	36.9	29.8	40.2
	------------ total number of cases by region -------------			
National	3785	273	140	149
North/Center	2756	159	88	80
South	1029	114	52	69

Source: TIA02, TIA05

Figure 4. Cumulative Distribution Function of 2005 Total Net Household Income/AE for Households with and without Prime-age Mortality, 2002-05.



Source: TIA02, TIA05. The top 5% of the income/AE distribution is excluded.

Using the three-subgroup poverty categorization, we next consider household income poverty dynamics (Table 21). The results show that while there is considerable income volatility across the two years for both affected and non-affected households, affected households do not appear on average to be falling (moving) into poverty or extreme poverty at a faster rate than households from the non-affected rural population. These results also demonstrate the high volatility of household income and thus the inherent limitations of its use to determine poverty status.

However, although affected households appear to be indistinguishable from non-affected households in terms of income/AE, there are several reasons why their long-term welfare situation may well be worsened by the PA mortality shock. First, the finding of significant losses of both land and livestock suggests that vulnerability to further shocks (exogenous shocks such as drought or animal/plant disease, or endogenous shocks such as further HIV-related illness or death) is likely diminished in affected households. We did not analyze these assets in AE terms because there is no reason *a priori* why a household would lose such assets even if AEs fell due to the PA death. Second, although income/AE does not fall, the longer-term welfare potential of the surviving members may well be compromised if the income level maintenance which we observe is achieved by trading off investment in child education (i.e. increasing children's contribution to farm and non-farm labor) for current income, or by sending children to live with other households, where their probability of schooling may fall relative to their situation prior to the adult death.[26]

[26] While some studies have found that orphans have a lower probability of schooling relative to non-orphans (such as that by Ainsworth, Beegle, and Koda (2002) in Northwestern Tanzania), a review of nationally-representative surveys from the 1990s from 28 countries (Ainsworth and Filmer 2002), mostly in Sub-Saharan Africa, found that differences in enrollment rates between orphans and non-orphans varies greatly across countries, as well as by wealth levels within countries.

Table 21. Rural Household Income Poverty Dynamics 2002-2005 and Prime-Age Adult Mortality, by Region

HH Income Poverty Dynamic Category, 2002-2005	Panel HHs without a PA death 2002-05	Panel HHs with a PA death 2002-05	Panel HHs without a PA death 2002-05	Panel HHs with a PA death 2002-05	Panel HHs without a PA death 2002-05	Panel HHs with a PA death 2002-05
	National		Center/North		South	
Stayed in Extreme Poverty	22.2%	24.4%	24.0%	22.0%	26.8%	22.6%
ExPoor to Poor	9.2%	13.4%	8.7%	11.1%	11.7%	18.6%
ExPoor to Non-Poor	8.7%	13.3%	8.0%	10.7%	12.0%	19.1%
Poor to ExPoor	11.3%	8.6%	11.8%	9.0%	8.8%	7.6%
Stayed Poor	7.7%	3.3%	8.0%	4.5%	6.3%	0.9%
Poor to Non-Poor	8.4%	8.2%	8.5%	10.0%	7.8%	4.1%
Non-Poor to ExPoor	9.1%	12.1%	9.2%	12.4%	8.2%	11.4%
Non-Poor to Poor	6.2%	6.1%	6.6%	5.8%	4.2%	6.8%
Stayed Non-Poor	14.9%	12.8%	15.1%	14.5%	14.3%	9.1%
% HHs with no movement	44.8%	40.5%	47.1%	40.9%	47.4%	32.5%
% HHs which moved down	26.6%	26.8%	27.7%	27.3%	21.1%	25.8%
% HHs which moved up	26.3%	34.9%	25.3%	31.8%	31.5%	41.7%

Source: TIA 2002, IAF 2002/03

Notes: * Poor = TIA02 total household income/capita below the IAF 2002/03 food poverty line and above extreme poverty; extremely poor = TIA02 income below one-half the IAF food poverty line

6. CONCLUSIONS

The design of effective programs to mitigate the impacts of HIV/AIDS-related adult mortality requires accurate information on how households are affected by, and respond to, the death of PA adult members. In this paper, we use the three-year, nationally-representative TIA panel survey of 2002-2005, consisting of 4,058 rural Mozambican households, to measure the impact of PA adult mortality on household demographics, crop and non-farm income, total household income, and levels of assets such as landholding and livestock. We also investigate whether or not there is an association between PA mortality and *ex ante* and *ex post* rural household income poverty.

This paper has four principal findings: First, while *ex ante* household income/AE appears to have a U-shaped relationship with PA mortality, we find that affected households tended to have the same or greater levels of *ex ante* landholding/AE. Thus, there does not appear to be a clear link at present between *ex ante* household welfare and PA mortality in the case of rural Mozambique.

Second, the effects of PA mortality in rural Mozambique tend to be conditional on the gender and household position of the deceased individual. Results show that significant reductions in household size, income, and assets are more likely found in the event of a PA male death rather than a PA female death, and effects tend to be larger with the death of a male household head. One explanation for the gender differential in mortality impacts appears to be found in gender-differentiated demographic responses to PA mortality. We find that a PA male death results in a significant reduction of -1.05 adults in the household, whereas a PA female death results in a significant reduction of only -0.25 adults. These results suggest that, on average, three out of four households with a PA female death are able to attract a new PA adult to the household, whereas, on average, no households with a PA male death are able to attract new adults. If the number of adults is a reasonable proxy of labor available to the household, then this gender disparity in demographic adjustment to PA mortality helps to explain why households with a PA male death are more likely than those with a PA female death to experience reductions in crop and non-farm income. A complementary explanation for the gender disparity in mortality impacts is that PA males (especially male household heads) in rural Mozambique are more likely than women to manage high-return crops such as cotton or tobacco, and are more likely to have the required education or social connections for higher-return non-farm wage or self-employment. Thus, a household which loses a PA male is more likely to lose human capital, specific work experience, and/or social contacts which enable access to higher-return activities, yet which are not easily substitutable by surviving adult members.

Third, the effects of PA mortality tend to vary significantly by region, as we find significant negative effects of PA mortality on crop income predominantly in the Center/North regions, and significant effects on non-farm income in the South. This is likely due to regional differences in the structure of total household income, which is primarily derived from crop production in the Center/North and by non-farm activities in the South, as well as by the spatial differences in the concentration of high-return activities – most cash crop production is in the North/Center, while most high-wage non-farm employment is found in the South.

Fourth, we find that PA male death results in a significant reduction in total net household income of -25%, and that PA female death does not have a significant impact on total net household income. When we disaggregate the analysis by region, the PA male effect is only significant in the Center/North. However, in spite of these significant reductions in total household income, we do not find significant reductions in total household income per adult equivalent (income/AE) among households suffering either a PA male or female death, and we also find that affected households are not more likely to have *ex post* income/AE below the (expenditure-based) poverty line relative to non-affected households. Thus, even though households with a PA male death suffer significant losses in total household income, they are able to maintain the same *ex ante* welfare level, on average, as measured by income/AE.

While these two results appear to be contradictory, several other findings in the paper help to explain this apparent divergence. Given the subsistence orientation of most rural Mozambican households, it perhaps should not be surprising that a household which loses -1.27 AEs on average (as do households with PA male death) between 2002 and 2005 would experience reduced income over that time period given not only the loss of family labor and wage labor income but also the lower consumption burden requirements for that household. By contrast, households with a PA female death lose only -0.33 AEs on average, thus their available PA labor and their consumption requirements do not fall nearly as much, and subsequently we don't find significant reductions in total household income. In addition, even among households which are not able to attract a new PA adult, their *ex post* dependency burden does not appear to have declined to the point to which they are unable to maintain their previous level of income/AE.

There are several reasons for caution against interpreting the lack of significant mortality effects on total household income/AE as evidence that affected households are somehow 'no worse-off' than the non-affected population. First, the TIA panel only provides evidence of short-term impacts, thus while affected households have maintained their pre-death income/AE levels in the 1-3 years following the PA death (on average), the diminished asset base of these households (as seen in losses of landholding and livestock) may nevertheless make them less resilient to future adverse shocks to income such as those from drought or epidemics. In the longer-run, unless affected households are able to maintain their asset levels, adult mortality may result in important differences between affected and non-affected households in terms of asset levels and accumulation paths over time. Third, in this paper, we have focused on the change in adult labor as a proxy of changes in available adult labor, implicitly assuming that children are not playing a role in household income generation and household economy. As this assumption is not valid for many poor households, it is therefore possible that while affected households are able to maintain income/AE over time, the burden of this adjustment may be borne by children whose families pull them out of school due either to inability to pay school fees or to demands for family labor, either of which may reduce child schooling levels and thus jeopardize the longer-term welfare potential of those children and their families. Fourth, it is possible that affected households in the TIA panel sample have benefited from labor or food donated by their neighbors and/or extended family, and that it is less likely that such assistance will be available to households which suffer a PA death 5-10 years from now, as HIV-related mortality rates continue to increase across the country. Thus, mortality rates in rural Mozambique may be sufficiently low enough at present for communities to provide informal safety nets for many affected households.

These findings suggest three implications for programs aimed at mitigating the impacts of adult mortality on rural household income and assets. First, our finding that mortality effects vary significantly by region suggests that mitigation strategies should be tailored not only to specific countries, but also to regions within those countries. Second, our findings that mortality impacts vary significantly by the gender and household position of the deceased, and that the distribution of affected household *ex post* income/AE levels are similar to those of non-affected households, suggest that a homogenous conceptualization of 'affected households' is inappropriate for the design of mitigation strategies. Indicators beyond 'adult mortality' are required to help identify affected households most in need of immediate assistance, such as households with a male head death and/or those with low asset and nutritional indicators. Third, considering the acute scarcity of resources for both HIV/AIDS mitigation and rural development, within the context of a rural poverty rates around 64% in Mozambique (as of 2002/03), there are potential mitigation responses which appear to be appropriate to the needs of households hardest-hit by adult mortality which would also benefit other poor but non-affected households at the same time: improved land tenure security (especially for women); labor-saving technologies for water, fuel, and food processing; and redressing gender bias in extension, production credit, and education, thus improving access to cash crop and non-farm income opportunities for women. While it is important to provide a safety net for the hardest-hit households to protect their assets, investing in pro-poor agricultural productivity growth is likely to be an effective means by which to respond to the HIV/AIDS epidemic in rural Mozambique.

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APPENDIX TABLES

Appendix Table 1. Case Numbers of TIA Households with Prime-age Adult Mortality during the Panel Period 2002-2005, and Chronic Prime-age Illness in 2005.

Household Categories	National	Center/ North	South
	Number of Cases (Households)		
Non-Afflicted[1]	3584	2618	966
Households (HHs) with one PA illness death[2]	250	145	105
PA Male death	121	76	45
PA Female Death	129	69	60
PA Head /spouse death	135	81	54
PA Male head/spouse death	72	43	29
PA Female head/spouse death	63	38	25
Other PA adult death (Non-Heads/spouses)	115	64	51
Other PA male death	49	33	16
Other PA female death	66	31	35
HHs with 2 or more PA deaths	23	14	9
HHs with PA death of new member	14	10	4
HHs with PA death and 2005 PA chronic illness	13	6	7
HHs with PA death and 1999-02 PA death[3]	23	14	9
HHs with PA death and 2002 PA chronic illness	23	13	10
Households with any Elderly illness death	148	80	68
Elderly Male Death	84	45	39
Elderly Female death	67	37	30
Households with any PA chronic illness in 2005	214	144	70
PA Male chronic illness	63	42	21
PA Female chronic illness	152	102	50
HHs with 2 or more PA chronic illness 2005	3	1	2

Source: TIA 2002, TIA 2005

Notes: 1) Non-afflicted = no prime-age death due to illness during the panel period 2002-05 or prime-age chronic illness in 2005; 2) Hereafter, 'PA death' refers to prime-age (15-59) deaths due to illness during the panel period 2002-05; 3) 1999-02 period refers to death reported in TIA02, which is separate from those reported in TIA 2005 (which refer to deaths between 2002-2005)

Appendix Table 2. The Impacts of Prime-age Adult Mortality on Rural Household Number of Adults (age 15 and over) (Extension of Table 7)

Covariates	Change in Household Number of Adults[b]							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality[a]								
Male adult	-1.049**		-1.140**		-0.899**		-1.073*	
	(5.50)		(3.67)		(3.35)		(2.36)	
Female adult	-0.254+		-0.322+		-0.314		-0.135	
	(1.81)		(1.74)		(0.86)		(0.53)	
Male heads/spouse		-0.935**		-0.013		-1.389**		-0.68
		(3.72)		(0.05)		(2.81)		(1.20)
Female heads/spouse		-0.361*		-0.911*		-1.178**		-0.14
		(1.99)		(2.25)		(5.02)		(0.34)
Other adult male		-1.273**		-0.379+		-0.675		-2.233**
		(3.80)		(1.68)		(1.55)		(5.35)
Other adult female		-0.109		-1.457**		-0.248		-0.136
		(0.40)		(3.49)		(0.41)		(0.48)
2 or more PA deaths	-0.753**	-0.755**	-0.003	-0.158	-1.389**	-0.034	-0.869**	-0.869**
	(2.85)	(2.87)	(0.01)	(0.45)	(2.80)	(0.04)	(3.68)	(3.69)
Elderly mortality								
Elderly male	-0.858**	-0.868**	-0.919*	-0.921*	-1.261**	-1.278**	-0.42	-0.446
	(3.57)	(3.70)	(2.50)	(2.51)	(3.79)	(3.87)	(0.83)	(0.92)
Elderly female	-1.085**	-1.081**	-1.203*	-1.183*	-0.992**	-1.017*	-1.088**	-1.108**
	(4.31)	(4.29)	(2.21)	(2.16)	(2.68)	(2.59)	(3.80)	(3.67)
Chronically ill PA male adults (=1)	0.482**	0.480**	0.552*	0.551*	0.284	0.25	0.456	0.473
	(2.74)	(2.72)	(2.15)	(2.14)	(0.67)	(0.58)	(1.48)	(1.56)
Chronically ill PA female adults (=1)	0.104	0.098	0.07	0.069	-0.416+	-0.415+	0.625	0.599
	(0.69)	(0.64)	(0.43)	(0.43)	(2.00)	(1.80)	(1.12)	(1.04)
Constant	-0.059**	-0.059**	-0.059**	-0.059**	-1.741**	-1.825**	-1.965**	-1.965**
	(1.53e+12)	(1.23e+12)	(1.07e+12)	(1.09e+12)	(16.03)	(7.73)	(7.37e+12)	(7.11e+12)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.000	0.000	0.002	0.003	0.000	0.000	0.013	0.001
R-squared	0.21	0.21	0.21	0.21	0.25	0.25	0.19	0.2
Number of observations	4,042	4,042	1,732	1,732	1,172	1,172	1,138	1,138

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. a) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise. b) n=14 households are dropped which had a PA death of a member new to the household since 2002

Appendix Table 3. The Impacts of Prime-age Adult Mortality on Rural Total Household Size (Adult Equivalents) (Extension of Table 8)

Covariates	Change in Household size (Adult Equivalents)[b]							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality[a]								
Male adult	-1.273**		-1.375**		-1.107**		-1.295*	
	(5.50)		(3.40)		(3.67)		(2.36)	
Female adult	-0.344*		-0.514**		-0.538		-0.03	
	(2.47)		(3.12)		(1.33)		(0.11)	
Male heads/spouse		-1.062**		0.174		-1.765+		-0.73
		(3.42)		(0.40)		(1.98)		(1.07)
Female heads/spouse		-0.463**		-1.136+		-1.294**		-0.012
		(2.61)		(1.94)		(6.10)		(0.03)
Other adult male		-1.690**		-0.600**		-0.698		-2.963**
		(4.24)		(2.97)		(1.40)		(8.56)
Other adult female		-0.182		-1.705**		-0.674		-0.053
		(0.63)		(3.52)		(0.81)		(0.14)
2 or more PA deaths	-1.041*	-1.043*	0.186	-0.27	-1.765+	-0.41	-1.595**	-1.595**
	(2.34)	(2.35)	(0.43)	(0.93)	(1.98)	(0.53)	(4.84)	(4.86)
Elderly mortality								
Elderly male	-0.826*	-0.838**	-0.76	-0.762	-1.689**	-1.696**	-0.186	-0.22
	(2.57)	(2.67)	(1.46)	(1.47)	(3.89)	(3.94)	(0.31)	(0.40)
Elderly female	-1.097**	-1.089**	-1.381*	-1.360*	-1.032**	-1.045**	-0.875*	-0.905*
	(4.17)	(4.15)	(2.28)	(2.24)	(4.54)	(4.44)	(2.51)	(2.50)
Chronically ill PA male adults (=1)	0.467*	0.468*	0.333	0.332	0.315	0.294	0.769+	0.795+
	(2.37)	(2.36)	(1.23)	(1.22)	(0.64)	(0.59)	(1.87)	(1.96)
Chronically ill PA female adults (=1)	-0.001	-0.01	-0.054	-0.055	-0.433+	-0.427	0.512	0.476
	(0.01)	(0.05)	(0.25)	(0.26)	(1.69)	(1.59)	(0.76)	(0.68)
Constant	0.239**	0.239**	0.239**	0.239**	-2.017**	-2.055**	-1.855**	-1.855**
	(3.93e+12)	(4.84e+12)	(1.35e+13)	(1.50e+13)	(16.68)	(8.85)	(1.00e+13)	(9.24e+12)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.000	0.000	0.001	0.000	0.000	0.000	0.002	0.000
R-squared	0.22	0.22	0.23	0.24	0.25	0.25	0.19	0.2
Number of observations	4,042	4,042	1,732	1,732	1,172	1,172	1,138	1,138

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. a) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise. b) n=14 households are dropped which had a PA death of a member new to the household since 2002

Appendix Table 4. The Impacts of Prime-age Adult Mortality on Total Household Land Area (Extension of Table 9)

Covariates	Change in ln(Total household land area)							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality [1]								
Male adult	-0.230*		-0.351+		-0.083		-0.223	
	(2.28)		(1.75)		(0.52)		(1.54)	
Female adult	-0.202+		-0.255		-0.206		-0.114	
	(1.83)		(1.59)		(1.05)		(0.53)	
Male heads/spouse		-0.356*		0.405		-0.463*		-0.27
		(2.51)		(1.41)		(2.52)		(1.48)
Female heads/spouse		-0.085		-0.528+		-0.282		-0.033
		(0.51)		(1.82)		(1.16)		(0.10)
Other adult male		-0.005		-0.18		0.242		-0.083
		(0.04)		(0.82)		(0.82)		(0.29)
Other adult female		-0.343*		-0.107		0.252		-0.169
		(2.51)		(0.72)		(1.42)		(0.61)
2 or more PA deaths	-0.132	-0.128	0.391	-0.446**	-0.461*	-0.494*	-0.289	-0.289
	(0.77)	(0.74)	(1.36)	(2.85)	(2.46)	(2.41)	(0.68)	(0.68)
Elderly mortality								
Elderly male	-0.01	-0.003	0.234	0.236	-0.473**	-0.471**	0.082	0.093
	(0.06)	(0.02)	(0.75)	(0.76)	(3.90)	(3.44)	(0.30)	(0.32)
Elderly female	-0.785**	-0.788**	-1.310*	-1.326*	-0.670**	-0.658**	-0.252	-0.25
	(3.10)	(3.13)	(2.29)	(2.33)	(3.94)	(4.08)	(1.06)	(1.05)
Chronically ill PA male adults (=1)	-0.255*	-0.251*	-0.279	-0.278	0.114	0.125	-0.442*	-0.438+
	(2.05)	(2.00)	(1.32)	(1.31)	(0.97)	(1.06)	(2.21)	(2.08)
Chronically ill PA female adults (=1)	-0.163	-0.157	-0.184	-0.183	-0.176	-0.126	-0.095	-0.09
	(0.88)	(0.85)	(0.68)	(0.68)	(1.33)	(0.87)	(0.50)	(0.46)
Constant	0.427**	0.427**	0.427**	0.427**	0.442**	0.421**	0.767**	0.765**
	(3.19e+12)	(3.27e+12)	(3.33e+13)	(3.89e+13)	(8.06)	(7.01)	(18.01)	(17.54)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.014	0.016	0.015	0.003	0.047	0.003	0.057	0.250
R-squared	0.30	0.30	0.26	0.26	0.39	0.39	0.30	0.30
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Appendix Table 5. The Impacts of Prime-age Adult Mortality on Household Tropical Livestock Units (Extension of Table 10)

Covariates	Change in Household Tropical Livestock Units							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality [1]								
Male adult	-0.420*		-0.022		-0.899*		-0.243	
	(2.31)		(0.20)		(2.44)		(0.67)	
Female adult	0.093		-0.138		0.487		0.16	
	(0.47)		(1.13)		(1.35)		(0.33)	
Male heads/spouse		-0.458*		-0.493+		-0.212		0.026
		(2.06)		(1.67)		(0.30)		(0.06)
Female heads/spouse		0.144		0		-1.267**		0.242
		(0.69)		(0.00)		(4.06)		(0.42)
Other adult male		-0.353		-0.157		1.276*		-1.034*
		(1.58)		(1.03)		(2.48)		(2.66)
Other adult female		0.031		-0.054		-0.281		0.1
		(0.11)		(0.67)		(0.51)		(0.19)
2 or more PA deaths	-0.666*	-0.664*	-0.491+	-0.088	-0.209	-0.019	-1.308**	-1.304**
	(2.12)	(2.11)	(1.66)	(0.33)	(0.29)	(0.05)	(5.54)	(5.54)
Elderly mortality								
Elderly male	-0.091	-0.088	0.054	0.054	-0.558	-0.557	0.08	0.071
	(0.26)	(0.25)	(0.33)	(0.32)	(0.76)	(0.74)	(0.09)	(0.08)
Elderly female	-0.191	-0.192	-0.225	-0.223	-0.108	-0.087	-0.25	-0.264
	(0.72)	(0.72)	(1.19)	(1.17)	(0.21)	(0.17)	(0.41)	(0.43)
Chronically ill PA male adults (=1)	-0.021	-0.019	-0.183	-0.183	-0.191	-0.171	0.389	0.407
	(0.08)	(0.08)	(1.49)	(1.50)	(0.20)	(0.18)	(0.75)	(0.79)
Chronically ill PA female adults (=1)	-0.156	-0.154	-0.057	-0.058	-0.428	-0.338	-0.208	-0.222
	(1.54)	(1.53)	(0.54)	(0.54)	(0.92)	(0.74)	(0.80)	(0.87)
Constant	-0.091**	-0.091**	-0.091**	-0.091**	0.045	0.007	0.894**	0.897**
	(3.74e+12)	(3.78e+12)	(3.38e+12)	(3.40e+12)	(0.23)	(0.04)	(15.34)	(15.75)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.004	0.010	0.264	0.478	0.117	0.001	0.008	0.042
R-squared	0.13	0.13	0.16	0.16	0.1	0.1	0.19	0.19
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Appendix Table 6. The Impacts of Prime-age Adult Mortality on Household Total Net Crop Income (Extension of Table 11)

Covariates	Change in ln(Household total net crop income)							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality [1]								
Male adult	-0.536*		-0.45		-0.881+		-0.115	
	(1.99)		(1.64)		(1.96)		(0.16)	
Female adult	-0.083		-0.305		0.261		0.04	
	(0.38)		(1.18)		(0.93)		(0.08)	
Male heads/spouse		-0.336		-0.739		-2.937*		0.243
		(1.24)		(1.00)		(2.54)		(0.41)
Female heads/spouse		-0.236		-0.559*		-0.604		0.169
		(0.91)		(2.20)		(1.21)		(0.35)
Other adult male		-0.894+		-0.411		-0.26		-1.169
		(1.90)		(1.28)		(0.33)		(0.94)
Other adult female		0.102		-0.298		-1.348		-0.054
		(0.24)		(0.82)		(1.47)		(0.06)
2 or more PA deaths	-1.400*	-1.406*	-0.741	-0.028	-2.938*	0.594*	-0.422	-0.418
	(2.12)	(2.14)	(1.01)	(0.08)	(2.53)	(2.27)	(0.57)	(0.56)
Elderly mortality								
Elderly male	0.461	0.452	0.867	0.865	0.094	0.096	0.29	0.28
	(1.41)	(1.36)	(1.35)	(1.34)	(0.19)	(0.18)	(1.07)	(1.01)
Elderly female	-0.545	-0.539	-0.773	-0.783	-0.303	-0.316	-0.626+	-0.645+
	(1.35)	(1.33)	(0.89)	(0.90)	(0.45)	(0.45)	(1.94)	(2.04)
Chronically ill PA male adults (=1)	-0.101	-0.106	0.068	0.068	-0.305	-0.319	-0.25	-0.225
	(0.42)	(0.43)	(0.21)	(0.21)	(0.39)	(0.40)	(0.67)	(0.58)
Chronically ill PA female adults (=1)	-0.249	-0.258	-0.08	-0.085	-0.314	-0.376	-0.793+	-0.811+
	(0.97)	(1.00)	(0.22)	(0.23)	(0.94)	(1.06)	(1.91)	(1.94)
Constant	-0.344**	-0.344**	-0.344**	-0.344**	1.506**	1.532**	1.996**	2.000**
	(1.97e+12)	(1.98e+12)	(5.31e+12)	(5.19e+12)	(10.86)	(10.37)	(21.51)	(21.44)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.048	0.087	0.361	0.408	0.004	0.006	0.921	0.322
R-squared	0.31	0.31	0.26	0.26	0.28	0.28	0.4	0.4
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Appendix Table 7. The Impacts of Prime-age Adult Mortality on Household Total Net Crop Income from Grains, Beans, and Oilseeds (Extension of Table 12)

Covariates	Change in ln(Household net grain/beans/oilseed crop income)							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality[1]								
Male adult	-0.883**		-0.627		-0.972+		-1.054+	
	(3.15)		(1.64)		(1.91)		(2.11)	
Female adult	-0.36		-0.17		0.144		-0.964+	
	(1.28)		(0.38)		(0.64)		(1.91)	
Male heads/spouse		-0.936**		-0.681		-2.987**		-1.152
		(3.03)		(0.30)		(2.67)		(1.71)
Female heads/spouse		-0.418		-0.277		-1.287**		-1.064
		(1.01)		(0.59)		(2.74)		(1.19)
Other adult male		-0.787		-0.165		-0.436		-0.767
		(1.31)		(0.29)		(0.90)		(0.91)
Other adult female		-0.288		-1.113		-0.42		-0.893
		(0.68)		(1.25)		(0.38)		(1.06)
2 or more PA deaths	-1.034	-1.033	-0.659	-0.192	-2.992**	0.546	1.464+	1.463+
	(0.93)	(0.93)	(0.29)	(0.51)	(2.66)	(1.64)	(2.08)	(2.07)
Elderly mortality								
Elderly male	0.409	0.404	1.054	1.054	0.45	0.405	-0.385	-0.389
	(0.73)	(0.71)	(1.25)	(1.25)	(0.55)	(0.51)	(0.34)	(0.33)
Elderly female	-0.594	-0.598	-1.62	-1.588	0.164	0.129	-0.14	-0.135
	(1.19)	(1.20)	(1.50)	(1.45)	(0.30)	(0.23)	(0.28)	(0.27)
Chronically ill PA male adults (=1)	0.003	0	-0.09	-0.092	-1.305**	-1.307**	1.18	1.168
	(0.00)	(0.00)	(0.20)	(0.21)	(2.85)	(3.05)	(0.81)	(0.77)
Chronically ill PA female adults (=1)	-0.723**	-0.723**	-0.319	-0.316	-0.304	-0.316	-2.604**	-2.602**
	(2.80)	(2.78)	(0.94)	(0.93)	(0.75)	(0.79)	(5.10)	(4.92)
Constant	-0.836**	-0.836**	-0.836**	-0.836**	1.336**	1.341**	4.447**	4.447**
	(7.63e+12)	(8.19e+12)	(1.31e+13)	(1.27e+13)	(7.92)	(8.02)	(38.94)	(37.65)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.012	0.020	0.382	0.676	0.000	0.030	0.025	0.134
R-squared	0.3	0.3	0.2	0.2	0.32	0.32	0.39	0.39
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Appendix Table 8. The Impacts of Prime-age Adult Mortality on Household Total Net Crop Income from Root and Tuber Crop Income (Extension of Table 13)

Covariates	Change in ln(Household net root/tuber crop income)							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality[1]								
Male adult	0.286		-0.294		0.481		0.765	
	(0.70)		(0.46)		(0.66)		(1.08)	
Female adult	0.38		-0.595		2.373**		0.639	
	(0.90)		(0.78)		(3.50)		(1.54)	
Male heads/spouse		0.574		-1.258		-1.688		1.317+
		(1.03)		(0.84)		(0.99)		(1.89)
Female heads/spouse		-0.347		-0.777		1.059		-0.28
		(0.53)		(0.88)		(0.98)		(0.44)
Other adult male		-0.223		-1.188		3.236*		-0.882
		(0.55)		(1.34)		(2.45)		(0.94)
Other adult female		1.262**		0.378		-0.528		1.269
		(2.87)		(0.73)		(0.70)		(1.74)
2 or more PA deaths	-0.879	-0.893	-1.264	0.944	-1.68	1.768**	0.303	0.311
	(0.95)	(0.97)	(0.84)	(1.03)	(0.99)	(2.97)	(0.32)	(0.33)
Elderly mortality								
Elderly male	0.346	0.296	0.236	0.222	0.703	0.78	0.156	0.032
	(0.57)	(0.48)	(0.21)	(0.19)	(0.50)	(0.55)	(0.44)	(0.08)
Elderly female	-0.940*	-0.941*	-0.946	-0.994	-0.531	-0.476	-1.308	-1.338
	(2.12)	(2.13)	(1.39)	(1.51)	(0.63)	(0.57)	(1.62)	(1.68)
Chronically ill PA male adults (=1)	-1.134+	-1.161+	-0.62	-0.618	-2.004	-2.003	-1.463	-1.509
	(1.88)	(1.94)	(0.82)	(0.82)	(0.99)	(0.99)	(1.63)	(1.73)
Chronically ill PA female adults (=1)	-0.076	-0.106	-0.374	-0.398	0.457	0.465	0.485	0.418
	(0.22)	(0.30)	(0.80)	(0.85)	(0.53)	(0.59)	(0.90)	(0.78)
Constant	0.156**	0.156**	0.156**	0.156**	2.793**	2.790**	4.217**	4.232**
	(1.57e+12)	(1.45e+12)	(7.67e+12)	(8.77e+12)	(7.81)	(8.58)	(35.10)	(35.32)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.531	0.058	0.758	0.302	0.008	0.009	0.467	0.187
R-squared	0.26	0.26	0.27	0.27	0.24	0.24	0.26	0.26
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Appendix Table 9. The Impacts of Prime-age Adult Mortality on Household Total Net Income from Cash Crops[2] (extension of Table 14)

	Change in ln(Household net cash crop income)							
Covariates	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality [1]								
Male adult	-0.135		-0.705		-0.254		0.898*	
	(0.28)		(0.59)		(0.53)		(2.52)	
Female adult	-0.423		-1.007		0.086		0.086	
	(0.92)		(1.32)		(0.10)		(0.13)	
Male heads/spouse		-0.505		-2.333+		-0.07		1.407**
		(0.85)		(1.74)		(0.04)		(3.34)
Female heads/spouse		-0.612		-2.872*		0.068		0.716
		(1.11)		(2.40)		(0.10)		(1.13)
Other adult male		0.535		-1.456+		0.409		-0.592
		(0.91)		(1.88)		(0.36)		(1.46)
Other adult female		-0.187		2.297*		-0.813		-0.359
		(0.30)		(2.43)		(1.22)		(0.40)
2 or more PA deaths	0.042	0.049	-2.454+	0.185	-0.066	-0.146	4.033*	4.039*
	(0.03)	(0.03)	(1.89)	(0.13)	(0.04)	(0.16)	(2.54)	(2.54)
Elderly mortality								
Elderly male	0.341	0.323	0.588	0.577	-0.127	-0.091	0.363	0.392
	(0.68)	(0.64)	(0.68)	(0.66)	(0.27)	(0.19)	(0.36)	(0.39)
Elderly female	-0.047	-0.068	0.537	0.336	0.911	0.935	-1.532*	-1.557*
	(0.08)	(0.11)	(0.41)	(0.27)	(1.51)	(1.53)	(2.78)	(2.86)
Chronically ill PA male adults (=1)	-0.468	-0.477	-0.253	-0.243	-0.406	-0.407	-0.979	-0.909
	(0.65)	(0.66)	(0.29)	(0.28)	(0.28)	(0.28)	(0.57)	(0.53)
Chronically ill PA female adults (=1)	-0.482+	-0.481+	-0.195	-0.224	-1.232*	-1.239*	-1.097*	-1.107*
	(1.93)	(1.92)	(0.59)	(0.67)	(2.12)	(2.11)	(2.64)	(2.66)
Constant	0.094**	0.094**	0.094**	0.094**	0.511*	0.514*	0.381**	0.383**
	(1.58e+12)	(1.34e+12)	(4.91e+12)	(3.29e+12)	(2.12)	(2.11)	(4.10)	(4.11)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.815	0.757	0.134	0.002	0.959	0.808	0.141	0.048
R-squared	0.23	0.23	0.21	0.22	0.28	0.28	0.23	0.23
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Appendix Table 10. The Impacts of Prime-age Adult Mortality on Household Total Net Nonfarm Income (Extension of Table 15)

Covariates	Change in ln(Household total net non-farm income)							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality [1]								
Male adult	-1.307*		-1.287		-0.668		-2.195*	
	(2.35)		(1.25)		(0.86)		(2.30)	
Female adult	0.229		0.938		0.083		-0.779	
	(0.40)		(1.01)		(0.07)		(1.04)	
Male heads/spouse		-1.418*		0.73		0.024		-2.154+
		(2.28)		(0.69)		(0.02)		(2.10)
Female heads/spouse		1.262		-1.433		-0.783		-0.444
		(1.64)		(1.08)		(1.11)		(0.44)
Other adult male		-1.123		1.741		2.383		-2.308
		(1.38)		(1.52)		(1.55)		(1.52)
Other adult female		-1.027		-1.088		-0.51		-1.013
		(1.49)		(1.02)		(0.31)		(1.11)
2 or more PA deaths	0.506	0.518	0.688	-1.132	0.036	-1.442*	1.749+	1.749+
	(0.83)	(0.85)	(0.65)	(0.74)	(0.03)	(2.53)	(2.12)	(2.12)
Elderly mortality								
Elderly male	-0.166	-0.092	0.026	0.046	-1.499	-1.422	0.832	0.863
	(0.21)	(0.11)	(0.03)	(0.04)	(1.43)	(1.30)	(0.44)	(0.45)
Elderly female	2.436**	2.450**	2.282	2.274	3.329**	3.421**	1.703+	1.701+
	(3.58)	(3.65)	(1.36)	(1.38)	(5.54)	(5.80)	(1.87)	(1.86)
Chronically ill PA male adults (=1)	-1.321+	-1.280+	-2.720*	-2.719*	0.879	0.917	-0.204	-0.177
	(1.78)	(1.73)	(2.47)	(2.47)	(0.72)	(0.75)	(0.29)	(0.25)
Chronically ill PA female adults (=1)	-0.326	-0.29	0.19	0.217	-0.058	0.116	-2.489+	-2.480+
	(0.66)	(0.58)	(0.32)	(0.37)	(0.06)	(0.12)	(2.00)	(1.98)
Constant	0.313**	0.313**	0.313**	0.313**	4.220**	4.148**	4.347**	4.345**
	(5.89e+11)	(5.90e+11)	(5.31e+12)	(4.74e+12)	(9.95)	(9.99)	(15.64)	(15.54)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.125	0.013	0.141	0.096	0.575	0.000	0.143	0.369
R-squared	0.23	0.23	0.21	0.21	0.31	0.32	0.21	0.21
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Appendix Table 11. The Impacts Of Prime-age Adult Mortality on Rural Total Net Household Income (Extension of Table 16)

Covariates	Change in ln(Total net household income)							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality [1]								
Male adult	-0.290*		-0.539*		-0.085		-0.24	
	(2.02)		(2.06)		(0.48)		(0.71)	
Female adult	0.169		0.004		0.38		0.232	
	(0.82)		(0.01)		(0.75)		(0.88)	
Male heads/spouse		-0.236		-0.585		-0.795		-0.012
		(1.33)		(1.42)		(1.50)		(0.03)
Female heads/spouse		0.321		-0.600*		-0.108		0.253
		(1.11)		(2.02)		(0.51)		(0.61)
Other adult male		-0.390+		0.142		1.173*		-0.911
		(1.72)		(0.35)		(2.11)		(1.47)
Other adult female		-0.018		-0.454		-0.058		0.214
		(0.07)		(1.26)		(0.17)		(0.59)
2 or more PA deaths	-0.614*	-0.614*	-0.595	-0.351	-0.79	-0.147	-0.332	-0.329
	(2.50)	(2.50)	(1.45)	(0.83)	(1.48)	(0.38)	(0.68)	(0.68)
Elderly mortality								
Elderly male	-0.066	-0.054	-0.165	-0.161	-0.467	-0.439	0.395	0.382
	(0.27)	(0.22)	(0.45)	(0.44)	(1.27)	(1.21)	(0.78)	(0.79)
Elderly female	0.59	0.595	1.041	1.036	0.501	0.533	0.111	0.099
	(1.47)	(1.48)	(1.11)	(1.11)	(0.93)	(1.00)	(0.41)	(0.36)
Chronically ill PA male adults (=1)	-0.273	-0.266	-0.24	-0.239	0.076	0.089	-0.572*	-0.561*
	(1.24)	(1.21)	(0.75)	(0.75)	(0.13)	(0.15)	(2.44)	(2.33)
Chronically ill PA female adults (=1)	-0.235	-0.231	-0.007	-0.003	-0.198	-0.139	-1.062*	-1.075*
	(1.24)	(1.22)	(0.03)	(0.01)	(0.55)	(0.38)	(2.72)	(2.76)
Constant	0.037**	0.037**	0.037**	0.037**	1.496**	1.472**	2.896**	2.899**
	(8.42e+11)	(8.11e+11)	(2.85e+12)	(2.26e+12)	(10.04)	(9.58)	(33.19)	(33.29)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.032	0.032	0.117	0.129	0.539	0.000	0.778	0.785
R-squared	0.23	0.23	0.23	0.23	0.24	0.24	0.23	0.23
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

Appendix Table 12. The Impacts of Prime-age Adult Mortality on Rural Total Net Household Income Per Adult Equivalent (Extension of Table 17)

Covariates	Change in ln(Total net household income/AE)							
	National		North		Center		South	
	(A)	(B)	(C)	(D)	(E)	(F)	(E)	(F)
Prime-age Adult Mortality [1]								
Male adult	0.037		-0.102		0.118		0.09	
	(0.24)		(0.42)		(0.57)		(0.22)	
Female adult	0.318		0.245		0.585		0.241	
	(1.62)		(0.76)		(1.31)		(0.86)	
Male heads/spouse		0.054		-0.585		-0.47		0.205
		(0.28)		(1.36)		(0.88)		(0.39)
Female heads/spouse		0.516+		-0.229		0.168		0.263
		(1.79)		(0.88)		(0.74)		(0.55)
Other adult male		0.002		0.431		1.327**		-0.25
		(0.01)		(1.04)		(2.93)		(0.42)
Other adult female		0.076		0.074		0.018		0.225
		(0.33)		(0.22)		(0.05)		(0.65)
2 or more PA deaths	-0.454+	-0.453+	-0.601	-0.234	-0.465	0.088	-0.117	-0.115
	(1.80)	(1.79)	(1.40)	(0.51)	(0.86)	(0.26)	(0.25)	(0.25)
Elderly mortality								
Elderly male	0.205	0.22	0.154	0.158	-0.092	-0.061	0.519	0.514
	(0.90)	(0.97)	(0.38)	(0.39)	(0.29)	(0.19)	(1.25)	(1.31)
Elderly female	0.889*	0.893*	1.401	1.39	0.8	0.833	0.327	0.321
	(2.25)	(2.27)	(1.51)	(1.51)	(1.53)	(1.61)	(1.32)	(1.31)
Chronically ill PA male adults (=1)	-0.35	-0.342	-0.308	-0.307	0.018	0.028	-0.664*	-0.657*
	(1.65)	(1.61)	(0.94)	(0.94)	(0.03)	(0.06)	(2.87)	(2.77)
Chronically ill PA female adults (=1)	-0.208	-0.202	0.024	0.03	-0.051	-0.003	-1.130**	-1.137**
	(1.10)	(1.07)	(0.10)	(0.13)	(0.14)	(0.01)	(3.05)	(3.09)
Constant	-0.014**	-0.014**	-0.014**	-0.014**	1.597**	1.577**	2.344**	2.346**
	(9.04e+10)	(8.84e+10)	(1.20e+12)	(1.11e+12)	(10.35)	(9.92)	(28.30)	(28.57)
Village X time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test on PA mortality	0.134	0.296	0.481	0.430	0.400	0.012	0.707	0.917
R-squared	0.23	0.23	0.23	0.23	0.24	0.25	0.24	0.24
Number of observations	4,058	4,058	1,734	1,734	1,181	1,181	1,143	1,143

Source: TIA 2002, TIA 2005

Notes: ** Significant at the 1% level; * Significant at the 5% level; + Significant at the 10% level. Numbers in parentheses are absolute t-ratios computed with linearized standard errors which account for complex sampling. Estimation by Inverse Probability Weighted OLS. 1) The first 6 prime-age mortality dummies =1 for a household which has one PA death of the given type and no other PA deaths, =0 otherwise.

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