UNIVERSITY OF KWAZULU-NATAL

The Economic Impact of Adult Mortality and Morbidity on Smallholder Farm Households in Malawi

By

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Abstract

This thesis comprises three essays on “The Economic impact of adult mortality and morbidity on smallholder farm households in Malawi.” The first essay estimates the levels of technical efficiency of AIDS-affected and non-affected smallholder farm households, and examines the technical efficiency differentials. The study uses time-varying and time-invariant inefficiency models of production. The results show that among both female and male headed households, for both affected and non-affected households, fertilizer and seeds are the only variables that contribute significantly towards technical efficiency. The mean efficiency levels of affected and non-affected households are statistically not different. The second essay examines the maize production differentials between AIDS-affected and non-affected farm households using the difference in difference estimation method. The results show that, for both affected and non-affected households, the mean maize production levels are higher during 2006/07 compared to 2004/05 However, the difference between the mean maize production levels of affected and non-affected households over the 2004/05 and 2006/07 period is not statistically significant. The third essay examines the coping strategies used by households facing food security problems. The results from the multinomial logistic model show that during 2004/05 and 2006/07, the most dominant coping strategy used by both AIDS-affected and non-affected households facing food security problems, is buying food from market. This is followed by casual labour, obtaining food from relatives and friends, eating unripe maize before harvest, and irrigation farming. The results from logistic discriminant analysis function indicate that, for all households, ordinary coping strategies are dominant among food-insecure households with a total score of close to 80 percent, much higher than survival strategies at around 20 percent during 2004/05.

Keywords: Morbidity, mortality, technical efficiency, maize production, coping strategies, small-scale farm households, Malawi

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Dedication

Dedicated to my late mother,

mama Loveness Nyafulirwa

She always wanted me to get educated and dedicated her life to this objective.

Her love, advice, encouragement, and hardworking spirit will always be my source of inspiration!

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List of abbreviations and acronyms

ADMARC	Agricultural Development and Marketing Corporation
AERC	African Economic Research Consortium
AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral therapy
ARV	Antiretroviral drugs
CEPA	Centre of Efficiency and Productive Analysis
CRS	Charnes, Cooper and Rhode
DEA	Data envelopment analysis
DID	difference in difference
DMU	Decision Making Unit
EAs	Enumeration Areas
FAO	Food and Agricultural Organization
FASAZ	Farming Systems Association of Zambia
GDP	Gross domestic product
HEARD	Health Economics and HIV/AIDS Research Division
HIV	Human immunodeficiency virus
IAEN	International AIDS Economic Network
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFRP	International Food Relief Partnership
IIA	Independent from Irrelevant Alternatives
IMF	International Monetary Fund
KHDS	Kagera Health and Development Survey
MDG	The millennium development goals
MNL	Multinomial logit model
MNP	Multinomial probit model
MoAFS	Ministry of Agriculture and Food Security
MPRSP	Malawi Poverty Reduction and Strategy Paper
NAADS	National Agricultural Advisory Services
NAC	The National AIDS commission
NPK	nitrogen, phosphorus and potassium
NSO	National Statistical Office
OLS	ordinary least squares

PLWHA	People Living With HIV/AIDS
PPS	Probability proportional to size
PSU	Primary Sampling Units
RENEWAL	Regional Network on AIDS Livelihoods and Food Security
RUM	Random Utility Maximization
SADC	Southern African Development Community
SADC FANR	One of the four directorates of SADC
SIDA	Swedish International Development Agency
TB	Tuberculosis
TE	Technical efficiency
TIP	Targeted Input Programme
UK	United Kingdom
UNAIDS	The Joint United Nations Programme on HIV/AIDS
UNDP	The United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNICEF	The United Nations Children’s Fund
USA	United States of America
VAC	Vulnerability and Assessment Committee
VRS	variable returns to scale
WB	World Bank
WFP	World Food Programme
WHO	World Health Organization

Chapter 1: Introduction

1.1 Background

HIV/AIDS is a key challenge to sustainable development in many developing countries. It is one of the biggest barriers to the success of the millennium development goals (MDGs). From theory, HIV/AIDS has great impacts on agriculture and people's wellbeing. The greatest impact of HIV/AIDS, as regards human and social costs, is typically borne at household level. The economic impacts of HIV/AIDS include reduction in income, as working members of the family get sick and eventually die, and additional health and funeral expenses. Other effects include selling assets, declining labour productivity and reduction in food supply.

As at end 2007, nearly 33.0 million people in the world had HIV/AIDS (UNAIDS 2010). Of this, 22.08 million people were in sub-Saharan Africa. In 2007 alone, about 2.0 million reportedly lost their lives to AIDS-related illnesses. Over 5 percent of the adult population are suffering from HIV/AIDS. In Malawi, UNAIDS estimates show that adult HIV prevalence rate at national level was 11.9 percent in 2007. The 2007 HIV survey on antenatal clinics puts the national prevalence rate at 12 percent, for approximately 900,000 Malawians with HIV/AIDS (UNAIDS, 2010).

In the late 1990s, the Malawi government started implementing a number of policy, institutional and operational strategies to prevent and moderate the spread of HIV/AIDS. About 43% of HIV-infected Malawians have been receiving anti-retroviral therapy (ARVs).

An important role for agricultural economists is to empirically investigate the micro and macro-level impact of HIV/AIDS and suggest policies for impact mitigation and rural development. Since the onset of the epidemic in the 1980s, researchers have taken keen interest in investigating the effects of HIV/AIDS, in order to develop measures to moderate the negative impacts. Initial studies during the first two decades mainly used country-wide models (e.g. Yamano and Jayne, 2004), and cross-sectional data. These studies showed that HIV/AIDS reduces labour supply and cultivated land. HIV/AIDS also results in farmers transferring from labour and capital intensive crops to low labour-demanding food crops, and reduction of assets, loss of knowledge and land rights (Barnet, 2002). Subsequent studies were more analytical and used statistical methods to compute the effects of AIDS from the time one is infected until death (Manther, 2004). For instance, Beagle's (2003) panel data study indicated that death of a working adult does not actually lead to reduction in labour, as additional members joined the family and assumed responsibilities (Ainsworth and Semali 1998; Beagle, 2003). Findings from studies such as Yamano and Jayne (2004) and Chapoto and Jayne (2005) show notable changes in types of crops grown, particularly among poor households. In these studies, the gender and status of the deceased were identified as important determining factors.

1.2 Problem statement and significance of the study

Policy responses to HIV/AIDS call for a multi-faceted approach to the HIV/AIDS impact studies. There is need for more research on the household and community level impact of HIV/AIDS. This research is essential for policy makers in designing policies in order to reduce the impact. Empirical knowledge on how affected rural households respond to HIV/AIDS remains weak.

A review of literature shows that more studies in Africa are beginning to offer insights on the effects of HIV/AIDS on farm households and how households respond. However, most of these studies have three common problems. First, most of the reviewed studies use cross-sectional data (except for Ulimwenngu, 2009, Fox, 2004 and Matthew, 2004). Additionally, the majority of the studies use data from specific geographical places deliberately chosen because they were linked with high prevalence rates (with the exception of Ulimwengu 2009, who uses countrywide data). Although they offer suggestions regarding how the affected households cope with the epidemic, results from such studies cannot be generalised in order to fully comprehend the impacts of HIV/AIDS at the national level (Chapoto and Jayne, 2005).

Second, little attention is paid to the vulnerable groups of the non-affected population. Moreover, there are a few available studies on this topic that are based on panel data. It is not possible to use cross-sectional surveys to evaluate the dynamic effects of mortality and morbidity, let alone control for unobserved heterogeneity. Furthermore, the majority of studies at household level assess the impact of mortality in AIDS-affected households in comparison with non-affected households. However, there are no studies that distinguishes morbidity and mortality that is AIDS-related[1] from that which is not. Among prominent studies have do not examine the distinction between AIDS-affected households and other households with health problems include Chapato and Jayne (2008), Chapato and Jayne (2005), and Yamano and Jayne (2004). This distinction is important as the effects of morbidity and mortality among AIDS-affected and non-affected households are likely to differ as mortality implies loss of an adult household member. In terms of morbidity, it is possible for the member of the household to contribute to farming activities depending on the nature of the illness. Finally, a few studies offer enough focus and empirical evidence on the gender dimension of the HIV/AIDS impact on households (Chapoto and Jayne, 2005).

In Malawi, research on the impact of HIV/AIDS remains at an early stage. The only comprehensive contribution on the impact of HIV/AIDS on agriculture in Malawi is Arrehag *et al.* (2006). This study offers a comprehensive literature review of the impact of HIV/AIDS on the economy, livelihoods and poverty in Malawi. Another study is Masanjala (2006)[2] on impact of HIV/AIDS on household income and consumption. However, there is absence of discussion regarding the impact of HIV/AIDS on technical efficiency[3] of farm households.

This gap in literature suggests three main questions. Firstly, what is the impact of prime-age adult mortality and morbidity on the technical efficiency of smallholder agricultural farmers? Secondly, what is the impact of prime-age adult mortality and morbidity on farm household's maize production? From these questions follows a third one, what are the coping strategies used by households facing food security problems? The study compares outcomes for the households with prime-age adult morbidity and mortality in order to investigate whether there are differentials in their impact on households. For instance, mortality entails complete loss of labour services (of the deceased working adult) while in the case of morbidity, labour services of the sick family member may still be available, depending on the nature of illness. This may have implications on the impact outcomes. The study also disaggregates the data by gender in order to test gender implications of the

[1] AIDS-related morbidity refers to illnesses medically linked to HIV/AIDS e.g. chronic tuberculosis (TB), chronic pneumonia and chronic diarrhoea. AIDS-related mortality refers to death resulting from illnesses medically associated with HIV/AIDS e.g. chronic TB, chronic pneumonia and chronic diarrhoea. For more information see Section 1.5

[2] Masanjala (2006) used panel data from 1998 integrated household survey and 2002 complementary panel survey

[3] Technical efficiency, in brief, means getting the most production from available resources

impact of prime-age adult mortality and morbidity. This is motivated by the fact that women in Malawi, particularly in patrilineal communities, have disproportionately lesser access to crucial farm inputs such as land compared to their male counterparts.

1.3 Objectives of the study

The main objective of this study is to examine the economic impact of prime-age adult mortality and morbidity on smallholder farm households in order to advise and offer policy recommendations to help mitigate the impact. This study has four objectives and related questions:

1. To estimate the levels of technical efficiency of AIDS-affected[4] and non-affected farm households and assess technical efficiency differentials. The related questions are:
    a) What are the social-economic determinants of technical efficiency of the farm households?
    b) What are the mean technical efficiency levels and differentials among AIDS-affected and non-affected farm households?
    c) What is the impact of prime-age adult morbidity and mortality on technical efficiency levels of AIDS-affected and non-affected farm households?
2. To investigate the effects of prime-age adult mortality and morbidity on maize production levels of AIDS-affected and non-affected farm households. The related questions are:
    a) What are the differentials in maize production levels of AIDS-affected and non-affected farm households?
    b) Does prime-age adult mortality and morbidity affect maize production levels?
3. To measure the response of households to food security problems. The related questions are:

[4] AIDS-Affected households are those with a family member who is either suffering from HIV/AIDS or died from HIV/AIDS. In this thesis, we use the terms "AIDS-affected" and "affected" interchangeably. Prime-age adult is the working adult age group. For an elaborate distinction between AIDS-affected and non-affected households, see section 1.5

a) What are the coping and survival strategies used by the households facing food security problems and how distinct are they?

b) Does the sex of the household head affect coping and survival strategies?

4. To identify policy recommendations that can be used in developing HIV/AIDS mitigation, and policies and programs in the agricultural sector:

a) Given the empirical evidence on the levels of technical efficiency and maize production of smallholder farmers in Malawi, what policy initiatives should be put in place to support maize production in the agricultural sector?

b) Given the empirical evidence of coping and survival strategies of food-insecure households, what policy initiatives should be put in place to mitigate the impact?

1.4 Structure of the thesis

This study is divided into seven chapters, including this chapter. The *second chapter* reviews the related empirical literature. *Chapter 3* reviews data sources, theory and study methodology. *Chapter 4* is an independent essay that deals with the first objective. It uses time varying and time-invariant inefficiency models to assess technical efficiency differentials between AIDS-affected and non-affected farm households. *Chapter 5* is an independent essay that deals with the second objective. It uses the difference-in-difference estimation technique to assess the impact of prime-age adult morbidity and mortality on maize production. *Chapter 6* is an independent essay that tackles the third objective. In particular, it is uses multinomial logit and multinomial probit regression models to model the probability that a given household, with given socio-economic characteristics, and facing food security problems, will choose a particular coping strategy. It also uses a discriminant analysis technique to distinguish ordinary coping strategies from survival strategies. *Chapter 7* gives a summary of the entire study.

1.5 Definitions of terminologies

- *AIDS-Affected households*

Refers to households in which one or more prime-age adults[5] are reported to have lost their lives due to HIV/AIDS or suffered from an AIDS-related illnesses such chronic TB,

[5] We concentrate on prime age because this is a working and productive age group. The assumption is that non-prime age groups cannot contribute significantly to economic activities.

chronic pneumonia and chronic diarrhoea over the last one to five years. Research shows that HIV/AIDS tops the rank among causes of death among adults with ages ranging from 15 to 50 years (UNAIDS, 1998). This study compares AIDS- affected households with non-affected households, which act as a control. It distinguishes differentials in the outcomes of households with AIDS-related morbidity from those with AIDS-related mortality. The study uses the terms “AIDS-affected” households and “affected” households interchangeably.

- *Non-affected households*

Refers to households in which one or more prime-age adult family member were reported to have died of or suffered from chronic non-AIDS related illnesses over at least one to five years. In this study, the treatment group will be the AIDS-affected households and our control group will be the non-affected households. The study distinguishes differentials in outcomes of non-affected households with prime-age adult morbidity from those with prime-age adult mortality. It also compares impact outcomes of AIDS-affected households with those of non-affected households.

1.6 Stylized facts about HIV/AIDS and smallholder agriculture in Malawi

1.6.1 The Status of HIV/AIDS in Malawi

Malawi is among countries with high HIV/AIDS incidence rates[6]. It is on position eight in terms of prevalence at global level. The national HIV/AIDS prevalence rate among adults in the productive age group of 15-49 years dropped to 11.9 percent in 2007, from 14.4 percent in 2003. Women are relatively more affected than men. About 490,000 women over the age of 14 were living with HIV/AIDS in 2007. Multi-partner heterosexual sex is regarded as the common means of spread. Prevalence rates are notably higher in the urban areas than in rural areas, with rates at 24 percent and 13.0 percent, respectively. The most recent data show that infection rates are growing in rural areas and going down in urban areas. At regional level, the Southern region of Malawi, with the highest population density, tops the rank. Incidence rates among pregnant women in Southern region are at 21.7 percent. On the other hand, prevalence rates for pregnant women in Northern and Central regions are at 14.0 percent and 14.3 percent, respectively (Arrehag et al. 2006).

[6] Arrehag, Durevall, Sjöblom, and De Vylder (2006) provide comprehensive literature review of studies on HIV/AIDS and its socio-economic impact in Malawi, which we utilize under this section.

Most people living with HIV are susceptible to tuberculosis (TB). An independent nationwide survey showed that 72 percent of all TB patients were HIV positive. Similarly, the 2009 World Health Organization (WHO) estimates show that 68 percent of new TB patients are carrying HIV. TB is among the major causes of death for people living with HIV. In general, Malawi's TB prevalence rates are high. The World Health Organization puts the incidence rate at 143 cases per 100,000 populations in 2006. The TB-HIV co-infection is also quite high, and more than half of new adult TB patients are positive (UNAIDS, 2008).

The high prevalence rates of HIV/AIDS in Malawi are attributable to a number of factors. The main factors include gender inequality as women are treated as subordinates in sexual relationships. There are also dangerous traditional practices such as initiation rituals which raise the risk of infection. Other factors include poverty, as girls and women involve themselves in commercial sex as a means of survival. By gender, prevalence rates are higher among women and the prevalence ratio of male to female among teenagers is about one to five. In most cases, women and girls take the up the responsibility of looking family members who fall ill (Arrehag et al. 2006).

The expenses of HIV/AIDS at the household level are high. They include medical costs, transport expenses in taking patients to hospitals, funeral costs and other related expenditures. There are also indirect costs which include loss of labour in the household. Because of the nature of the disease, most children in HIV/AIDS affected households have lost both parents and have become orphans. As the number of AIDS orphans rises, traditional safety nets such as extended families come under severe strain (Arrehag et al. 2006)

Over 80 percent of Malawians rely on agriculture for their income and livelihood needs. Most of the affected families face food security problems and therefore malnutrition. Due to reduced income and increased expenditures as a result of HIV/AIDS, farmers find it difficult to invest in seeds and fertilizers. As a coping strategy, most families turn to less labour intensive crops (Arrehag et al. 2006).

Apart from households, HIV/AIDS affects the non-agricultural economy as well. There are strong impacts on labour as HIV/AIDS mostly affects the population's working groups. Roughly 20 percent of the productive Malawian population have died from HIV/AIDS.

About 60,000 working adults are losing their lives to AIDS each year. This results in high cases of absenteeism at workplace, as people have to attend funerals. In general, HIV/AIDS negatively affects the productivity of labour (Arrehag et al. 2006).

The manufacturing sector has been declining over the past decades. One can hardly isolate the role of HIV/AIDS from other factors such trade liberalization and macroeconomic instability. Nevertheless, it is obvious that HIV/AIDS has raised production costs and lowered labour productivity (Arrehag et al. 2006).

Similarly, the effects of epidemic on the public sector are considerable as experienced workers die prematurely, and cases of absenteeism have gone up. Additionally, cost of replacing staff has increased and productivity and service delivery have declined. The impact on the private sector has been equally substantial. During the initial years of the epidemic, the highly affected groups included the well-educated in urban areas and government officials in health, the police, judiciary and agricultural extension services.

In education, cases of illness on account of HIV/AIDS and missing classes particularly among teachers have greatly affected delivery of services. The loss of skilled teachers creates a serious threat for future generations. Likewise, the health sector is greatly affected by the epidemic. About 70 percent of beds in hospitals are taken up by those suffering from HIV/AID. Additionally, most nurses have left the country for jobs in developed countries, particularly the United Kingdom and this has resulted in acute shortage of medical staff in Malawi (Arrehag et al. 2006).

Most Malawians are aware of the epidemic. They are informed about how HIV/AIDS is spread, and issues of protection. Thus it is not surprising that people's attitudes on issues such as multiple sexual partners, commercial sex, and extra-marital sex are changing. Malawians can now openly discuss issues of sexuality and reproductive health. This has resulted in noticeable change in sexual behaviour. Ironically, the challenge posed by HIV/AIDS is uniting people in dealing with the disease. Government and community-based organisations are cooperating well on the epidemic. Government has come up with good policies, but implementation problems remain due to human, financial and capacity constraints (Arrehag et al. 2006).

Since 1985, when the first case of AIDS was observed, the Malawi government has actively responded to the HIV/AIDS epidemic. In 1988, Government set up the National AIDS Control Program to manage educations and preventions of HIV/AIDS. In 2000, the government implemented a five-year national strategic framework to fight AIDS. However, it took time for the policy to be implemented due to financial and organisational problems within the NAC. The National AIDS commission (NAC) was formed in 2001. Since then, it has been supervising several initiatives on AIDS prevention and care. The initiatives include programs offering treatment, increasing testing, and preventing mother-to-child transmission of HIV. Government drafted the HIV/AIDS policy in 2003, putting in place the guiding principles for all HIV/AIDS programs and interventions at national level. The National Strategic Framework on HIV/AIDS for the period 2000–2004 include interventions on prevention, behaviour change and raising access to treatment, care, as well as antiretroviral drugs (ARVs). Recently, Government developed a national action framework for 2005–2009. Government has also developed and implemented policies and procedures for voluntary counselling and testing, HIV/Aids prevention, access to antiretroviral therapy, and treatment of sexually transmitted infections (UNAIDS 2008).

Malawi has made notable progress in scaling up ART. Since 2003, the ART has been offered for free in the public sector, and more than 130,000 people were initiated into treatment by mid-2008. Regulations have been put in place on issues of prescription and sale of ARV, in order to ensure quality control and reduce the risk of the drug resistance developing as a result of misuse of the drugs. In spite of the scale-up efforts of the program, there is still a lot more to be done to improve the quality of health care and to strengthen the health system so that it is able to support more patients who will require treatment in future (UNAIDS 2008).

In November 2007, Malawi was provided with a grant of about $36 million from the Global Fund to Fight AIDS, Tuberculosis and Malaria. Currently, Malawi is implementing a round-five grant approved in 2006 for orphan care and support. Other international donors to Malawi include the United Kingdom, the World Bank, UNICEF, the European Union, and several other United Nations agencies (UNAIDS, 2008).

International support is likely to continue. Research is expected to continue in the medical field. The availability of ARV treatment has raised chances of prolonging lives of HIV positive patients (Arrehag et al. 2006).

1.6.2 Incidence of chronic morbidity and mortality

According to the integrated household surveys, Malaria is the main type of illness in Malawi. It represents about 39 percent of the recorded cases during the two weeks before the integrated household survey carried out. Ranked second at 24 percent are respiratory problems. Prevalence rates of malaria are the same for male and females. Chronic illness has an overall occurrence rate of nine percent. Cases of chronic illnesses are higher in rural areas at nine percent compared to urban areas at six percent. Prevalence is higher in female headed households at 11 percent than in male headed households at nine percent. Arthritis/Rheumatism is the most regularly reported chronic illness, with reported cases at 33 percent. Asthma was ranked second with reported cases at 30 percent.

In terms of mortality, about 14 percent of the households reported at least one death in the two years preceding the survey. Differences are considerable regarding reported cases of deaths in male and female headed households. While 21 percent of female headed households recorded death of a member, only 12 percent of male-headed households reported such a case. The distribution of deaths by age reveals that about 38 percent of reported deaths occurring within the age group 25-49. This is followed by those 50 years and above. The age group 15-24 had the least number of reported cases of deaths at only 10 percent of all deaths reported.

1.6.3 Smallholder agriculture in Malawi

The Malawian smallholder agriculture is mostly dominated by poor farmers. These farmers are normally involved in low input maize production on small cultivated land. In most cases, maize production by these farmers is not adequate enough to meet consumption needs throughout the year. As a result, they rely on casual labour (off-farm employment) and other sources of income to meet their needs (MoAFS, 2008)[7].

[7] This section relies on a report by Ministry of Agriculture and Food Security, (MoAFS 2008)

The first universal starter packs fertilizer and seeds for 0.1 hectares of land were distributed to farmers in 1998. During 2003/04 season, Government implemented the targeted input programme (TIP). About 40 percent of smallholder households bought chemical fertilizer at market prices, with average purchases of about 65 kilograms per household.

However, national maize production during the 2004/05 season was low at 1.2 million tonnes. This was largely due to poor rains, delayed distribution and limited capacity of the targeted inputs programme for the 2004/5 season. Coupled with slow government food importation, the low maize production resulted in severe food shortages and high maize prices during 2005/06.

During the 2005/06 agricultural season, the government implemented an expanded input subsidy programme. The purpose of the programme was to raise access to and use of fertilizers in maize production, in order to improve agricultural productivity and food security. Other objectives included supporting household food security, growth of the private sector input markets, and broader economic growth and development. About 2 million seeds and 3 million fertilizer coupons were distributed to targeted households within districts and areas. Later, two sets of NPK[8] and urea coupons were also distributed. Farmers were supposed to use fertilizer vouchers in buying fertilizer at MK950 per 50kg bag. This represents about 28 percent of the full cost, with government meeting the cost of the remaining 72 percent (MoAFS, 2008).

Altogether, the government distributed about 75,000 tonnes of fertilizer and 4,500 tonnes of improved maize seed. However, there were delays in the distribution of inputs in the southern region. This was due to delays in the purchase, issue and opening of markets. This, together with inadequate stocks in some markets, resulted in many farmers spending many hours on the lines waiting for their inputs. This resulted in delays in planting and fertilizer applications. In total, MK10.3 million (about US$91 million) was spent, of which 87 percent was contributed by Government (MoAFS, 2008).

In general, the evidence shows that the programme can contribute positively to government's objectives of increasing crop production, food security and pro-poor growth. For example, the 2005/06 and 2006/07 subsidy programmes contributed significantly to achieving the above-stated objectives. Nevertheless, there are still areas that require

[8] NPK fertilizer has three nutrients, namely nitrogen, phosphorus and potassium.

improvements in order to ensure efficiency and effectiveness of the programme. Total maize production for the 2005/06 and 2006/07 seasons amounted to 2.7 million and 3.4 million tonnes, respectively. The increase in maize production was due to the 2006/7 subsidy of approximately 670,000 tonnes (MoAFS, 2008).

The fertilizer subsidy programme has improved food security. A report on rural households' own subjective evaluation of their economic status show their status was eight percent higher in 2007 than in 2004. The percentage of households that experienced a major shock due to rising food prices in the previous three years dropped from 79 percent in 2004 to 20 percent in May/June 2007. This was attributed to an increase in household food production and lower food prices that benefited the poorer households. This is due to the effects of the fertilizer subsidy programmes coupled with the seed subsidy and adequate rains across the country (MoAFS, 2008).

References

Ainsworth, M. & Semali, I. (1998), "Who is most likely to die of AIDS? Socioeconomic correlates of adult deaths in Kagera, Tanzania," in M. Ainsworth, L. Farnese and M. Over (eds), *Confronting AIDS: Evidence for developing world*, European Commission, Brussels, Belgium

Arrehag, L., Durevall, D., Sjöblom, M. & De Vylder, S. (2006), "*The Impact of HIV/AIDS on Livelihoods, Poverty and the Economy of Malawi,"* SIDA, Studies no.8

Barnett, T. (2002), "HIV/AIDS impact studies – some progress evident," *Progress in development studies,* 2 (3): 219-225.

Beegle, K. (2003), "*Labour Effects of Adult Mortality in Tanzanian Households*," Washington D.C, World Bank, Unpublished working Paper

Blackie, M. & Conroy, A. (2007), "The collapse of agriculture," in: Conroy, A., Blackie, M., Whiteside, A., Malewezi, J. & Sachs, J. (eds.) *Poverty, AIDS and Hunger: Breaking the Poverty Trap in Malawi,* Palgrave Macmillan, Basingstoke, UK,

Casale, M. & Whiteside, A. (2006), "*The Impact of HIV/AIDS on Poverty, Inequality and Economic Growth,"* IDRC Working Paper on Globalization, Growth and Poverty Working Paper 3.

Chapoto, A. & Jayne, T.S. (2005), "*Socio-Economic Characteristics of Individuals Afflicted by AIDS-related Prime-age Mortality in Zambia,"* Presented at the conference "HIV/AIDS and Food and Nutrition Security: From Evidence to Action," Durban, South Africa.

Chirwa, E.W. (2003), "*Sources of technical efficiency among smallholder maize farmers in Southern Malawi,"* Department of Economics, Chancellor College, Zomba, Malawi, Unpublished working paper.

Devereux, S. & Tiba, Z. (2007), "Malawi's first famine, 2001-2002," in: Devereux, S. (ed.) *The 'New Famines': Why Famines Persist in an Era of Globalisation,"* Routledge, *London*, UK

Fox, T. (2004), “The Impact of HIV/AIDS on labour productivity in Kenya,” *Tropical Medicine and International Health,* 9 (3): 318-324

Malawi Demographic Health Survey (2004) National Statistical Office, Lilongwe, Malawi.

Malawi Growth and Development Strategy (MDGS), (2007) IMF Country Report, IMF website: http://www.imf.org/external/pubs/ft/scr/2007/cr0755.pdf

Malawi Poverty Reduction Strategy Paper (MPRSP), (2002) IMF Country Report, IMF website: http://www.imf.org/external/np/prsp/2002/mwi/01/043002.pdf

Masanjala, W. (2006), “HIV/AIDS, Household Income, and Consumption Dynamics,” in Gillespie, S, (ed.) *AIDS, Poverty and Hunger: Challenges and Response,* International Food Policy Research Institute, Washington D.C., USA

Masanjala, W. (2007), “The poverty-HIV/AIDS nexus in Africa: A livelihood approach,” Social *Science and Medicine,* 64(5): 1032-1041

Mather, D. (2004), “H*ousehold Responses to Prime Age Adult Mortality in Rural Mozambique: Implications for HIV/AIDS Mitigation Efforts and Rural Economic Development Policies,”* Centre for Study of African Economies Conference, Oxford University, UK

Matthew, P.F. (2004), “The impact of HIV/AIDS on labour productivity in Kenya,” *Tropical Medicine and International Health,* 9 (3): 318-324

Ministry of Agriculture and Food Security, (MoAFS) (2008), “*Evaluation of the 2006/07 Agricultural Input Subsidy Programme*,” Final Report, Lilongwe, Malawi

Mtika, M. (2001), “The AIDS epidemic in Malawi and its threat to household food security,” *Human Organisation*, 60 (2): 178-188

National Statistical Office (NSO) and World Bank (2005), “*Integrated Household Survey, 2004/05*,” Final Report, Lilongwe, Malawi

National Statistical Office (NSO) and World Bank (2008), "*Integrated Household Survey, 2004/05*," Final Report, Lilongwe, Malawi

Pinder, C. (2004), "*Economic Pathways for Malawi's Rural Households,*" Lilongwe, Malawi, CARE International, Lilongwe, Malawi

Ulimwengu, J.M. (2009), "*Farmer's health Status, Agricultural Efficiency, and Poverty in Rural Ethiopia: A Stochastic Production Frontier*," IFRP Discussion Paper 00868

United Nations Programme on HIV/AIDS (UNAIDS). (1998) Report, Geneva, Switzerland

United Nations Programme on HIV/AIDS (UNAIDS), (2004) Report, Geneva, Switzerland

United Nations Programme on HIV/AIDS (UNAIDS), (2008) Report, Geneva, Switzerland

United Nations Programme on HIV/AIDS (UNAIDS), (2010) Report, Geneva, Switzerland

Veenstra, N. & Whiteside, A. (2005), "Economic Impact of HIV/AIDS," *Best Practice & Research Obstetrics and Genecology*, 19(2): 192-210.

World Health Organization (1998), Annual report, Geneva, Switzerland

Yamano, T. & Jayne, T. S. (2004), "Measuring the Impacts of Working-Age adult Mortality on Small-Scale Farm Households in Kenya," *World Development,* 32(1): 91-119

Yamano, T. & Mghenyi, E. (2005), "A *Cross-Country Analysis of Household Responses to Adult Morality in Rural Sub-Saharan Africa: Implications for HIV/AIDS Mitigation and Rural Development Policies,*" Working Paper, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, USA

Chapter 2: Impact of HIV/AIDS on farm households: a review of empirical literature

2.1 Introduction

This chapter reviews relevant literature on the impact of HIV/AIDS and poor health on small-scale farm households. It re-examines studies on the impact of HIV/AIDS and poor health on technical efficiency of farm households, household size and assets, and farm production. It also looks at coping strategies used by affected households.

A number of studies have been carried out in recent years on the impact of HIV/AIDS on small-scale farm households. Theoretically[9], poor health in general, and HIV/AIDS in particular, reduce technical efficiency and crop production of farm households. The empirical literature on the impact of HIV/AIDS at household level is still at tender stage. This chapter reviews some of the recent studies.

2.2 Effects of HIV/AIDS on the technical efficiency of production

A few studies examine the impact of HIV/AIDS on technical efficiency of farmers in Africa (see table 2.1 for a summary of these studies). The studies include Ulimwengu (2009), Adeoti and Adeoti (2008), Ajani (2008), Yusuf et al. (2007), Fox (2004). The studies under review use cross-sectional data except for Ulimwenngu (2009), Fox (2004). The majority of the studies use data from specific geographical places, except for Ulimwengu (2009), who use countrywide data. Most of the studies use the stochastic production frontier as their analytical tool except for Fox (2004) who use descriptive statistics. Overall, there is consensus in the results from all the studies, confirming the negative impact of the epidemic on technical efficiency of farmers. This is due to loss of labour, either through death or reduction in available labour, as other members of households look after the sick. This implies that health contributes negatively to technical efficiency of the farmers and suggests that productivity can improve with improved health.

[9] Chapter 3 examines theories surrounding the link between health and production

Table 2.1: Summary table: impact of HIV/AIDS on technical efficiency in smallholder agriculture

Author, date	Focus of the study	Study design & analytical framework	Key findings
(Ulimwengu, 2009)	To evaluate the effect of HIV/AIDS on agricultural efficiency of farmers	2005 Ethiopian Demographic Health Survey Stochastic production function	HIV/AIDS negatively affects the efficiency of the farmers.
Adeoti & Adeoti. (2008)	To examine the impact of HIV/AIDS on cropping patterns, incomes and technical efficiency	Primary data from 155 farm households: 55 HIV/AIDS affected households, and 100 non-affected households. Stochastic production frontier	Technical efficiency differentials statistically significant at 1 percent level. In general, non-affected households are technically more efficient with a mean of 0.70 compared with non-affected households with mean 0.52.
Ajani & Ugwe (2008)	To examine the effect of poor health on farmers' productivity in North Central Nigeria	Cross sectional data of farmers Stochastic production frontier	The variance of output from the frontier-attributed efficiency is at 0.114. The poor health variable has the biggest coefficient in the inefficiency model and is statistically significant at 5 percent
Yusuf et al. (2007)	To assess the effects of HIV/AIDS on efficiency of farmers in Amambra state, Nigeria	Primary data from 102 respondents. 62 HIV positive and 40 HIV negative farmers selected randomly from the village within Nnewi. Stochastic production frontier	Efficiency of HIV negative farmers around 0.70. Efficiency levels of HIV positive farmers range between 0.60 and 0.69.
Fox (2004)	To evaluate the effects of HIV/AIDS on efficiency of labour as the disease progresses	Retrospective cohort examining the productivity of tea estate workers who lost life to or were retired	Workers with HIV pluck less tea during eighteen months before losing job, and utilize more leave days during the

		on medical reasons due to AIDS-related causes between 1997 and 2002 in western Kenya Descriptive analysis	three years prior to job loss.

2.3 Impact of HIV/AIDS on household size, cultivated land, assets, crop production and food security

The majority of the studies on the effects of HIV/AIDS on farm production, cultivated land, and fertilizer application used cross-sectional data. Among the studies that use panel data include Donovan and Manther (2008), Chapoto and Jayne (2005), Yamano and Jayne (2004), Mather (2004), Beagle (2003), Floyd (2003), Hosegood et al. (2004), and Urassa (2001). Of these studies, only Donovan (2008), Chapoto and Jayne (2005)), and Mather (2004) use nationally representative panel data.

Most studies use descriptive statistics or sustainable livelihood framework, as analytical tools. The only exceptions are Chapoto and Jayne (2005), Yamano and Jayne (2004), and Donovan and Mther (2008), who use difference in difference estimation technique to account for the issue of counterfactuals. Hosegood, Herbst, and Timaeus (2004) use multivariate hazard models.

a) Impact of HIV/AIDS on household size and composition

Table 2.2 summarizes studies of the impact of HIV/AIDS on household size and composition. The results show that relatively more AIDS-affected households are headed by females compared to non-affected households (Nguthi and Niohoff, 2008; Chamunika, 2006; FASAZ, 2003). Higher dependency ratios are reported among female headed households (Nguthi and Niohoff 2008; Chamunika, 2006; FASAZ, 2003). Regardless of the sex and position of the dead person, the household size for affected households declines (Chapoto and Jayne, 2005). There is larger drop in the size of household due to death of female than male (Yamano and Jayne, 2004; Manther, 2004). Results show that male headed and female headed households were looking after a similar number of orphans (FASAZ, 2003). Despite the significantly higher dependency ratio, and therefore higher household size, the female headed households face labour shortages (Nguthi and Niohoff, 2008). For every five marriages where a partner is found positive during the initial survey, only one family survives a break-up by the time of the second survey ten years later (Floyd, 2003). Cases of re-marriages for divorced spouses are lower for wives of men who are positive. Rates of re-marriage for males are not affected by the HIV status of their wives at the initial survey (Floyd, 2003).

Overall, previous studies validate the common opinion that death of working family members lead to labour shortfalls and the impact should be properly assessed (Chapoto and Jayne, 2005).

Table 2.2: Summary table: impact of HIV/AIDS on household size and composition

Author, date	**Focus of the study**	**Study design & analytical framework**	**Findings**
Nguthi & Niohoff (2008)	To investigate the impact of HIV/AIDS on the livelihoods of banana-farmers in Maragua district, Central Kenya.	Field studies during 2004-2005 using both quantitative and qualitative methods of data collection. Survey carried out among 254 farming households with 75 HIV/AIDS-affected households and 179 non-affected households. Sustainable livelihood approach	HIV/AIDS-affect households are mainly female-headed, with notably higher dependency ratios and face labour shortages despite their larger size
Chamunika (2006)	To explore the effects of HIV/AIDS on farm households in Limpopo province, South Africa.	Random selection of 218 households, with 100 households in the affected group and 118 in the non-affected group.	Relatively more affected households (53%) are female-headed compared to 46% for non-affected households. Evident differences in mean ages of the household. More affected households are headed by the elderly. Female headed households reported more dependents. Majority of affected households with household heads educated up to primary level, whilst the non-affected households have more heads educated

			up to matric and diploma levels
Chapoto & Jayne (2005)	To assess the impact of mortality and morbidity on size of households household size in Zambia.	Country-wide survey data on 5,420 households in collected in 2001 and 2004 Difference in difference estimation	Regardless of sex and position of the dead person, household size for affected households decreases. Poor households and households with death of male household head attract less new members than non-poor households.
Yamano & Jayne (2004)	To assess the impact of adult mortality on smallholder farmers in Kenya	Panel survey of 1,422 households between 1997 & 1998. Difference-in-difference estimation technique	Drop by 0.64 in household size for households with death of an adult compared to the comparison group. Female death result in larger household size reduction compared to male death.
Mather (2004)	To assess how households respond to adult mortality in Mozambique.	Panel survey for the period 1999 and 2002.	Households experiencing a female prime-age adult death have higher probability of having children moving out of the household and have a working age female join the family. For death of male adult, no child left the household and there was no increased arrival of adult males compared to non-affected.
Farming Systems Association of Zambia (FASAZ 2003)	To evaluate the impact of HIV/AIDS on household size	Survey of 770 households, (with the ratio of male headed to female headed households at 68:32)	Results indicate that female-headed and male headed households were taking care of the relatively similar numbers of orphans. Affected households with more members and less income than non-affected ones. Affected households with more children involved in agricultural activities, exchange of labour with neighbours and relatives, experienced shifts to less labour demanding mono-cropping, and had

			cases of hiring labour
Floyd (2003)	To find out the effects of HIV/AIDS on farm households in Malawi.	Retrospective cohort study using population-based surveys for 1980s; selected 197 HIV positive individuals aged 14 to 68 years; about 396 individuals were in control. Re-interviews conducted in 1998-2000	HIV positive mothers with mortality rates at 46% for their under-five children. HIV negative mothers with under-five mortality rates of 16% for their children. For marriage break-up, fewer marriages survive break-ups. There are lower cases of remarriages for women who lost their husbands than for males.
Hosegood et al. (2004)	To examine the effects of the death of younger adults on household stability.	Africa Centre data obtained between 2000 and 2001 for 10,490 households Hazard models	Younger and female heads with more cases of household break-ups. Households with mortality experience more break-up cases. Household size decline as a result of death of a household member and because the remaining members left the household.
Urassa (2001)	To evaluate the effects of HIV/AIDS on households in Mwanza region, Tanzania.	Surveys carried out between 1994 and 1998	About half of deaths of people between 15-44 years of age are associated with HIV/AIDS. Children born to HIV positive mothers with higher mortality rates.
Shah et al. (2001)	To assesses the impact of HIV/AIDS on farm production systems and rural livelihoods central region in Malawi.	Cross-sectional data from 15 areas in Malawi.	Loss of labour in more than 65 percent of the morbidity affected households.
Croppenstedt & Muller (2000)	To investigate whether there is relationship between health, nutritional status and agricultural productivity in Ethiopia.	Cross sectional data	Morbidity negatively affects agricultural productivity. The elasticities of labour productivity with respect to morbidity are very significant.

b) Effects of HIV/AIDS on cultivated land, fertilizer application and household assets

Table 2.3 summarizes studies of the impact of HIV/AIDS on fertilizer application and household assets. The households with death of a male experience significant reduction in land, livestock, and household properties (Donovan and Mather, 2008; Chamunika, 2006). This is attributable to health related expenses. However, there are no significant reductions in assets in households with a female death (Donovan and Mather, 2008; Chapoto and Jayne, 2005; Manther, 2004). Affected households record lower cultivated area, mostly those with cases of a male household head mortality (Donovan and Mather, 2008; Mather, 2004). The death of a prime-age adult male result in a higher reduction in cultivated area than death of a female adult (Chapoto and Jayne, 2005). A fascinating finding is that death of an adult male decrease the amount of land assigned for high-value crops, but increases the amount of land assigned for cereals (Yamano and Jayne, 2004). Despite the reported reduction in cultivated land, there are few cases of land grabbing from widows and orphans (Aliber and Walker, 2006). However, other studies report cases of women losing inheritance to household assets after the passing away of their husbands. On the other hand, the death of a wife does not result in any dispossession of assets (Engh et al. 2000; Chapoto and Jayne, 2005). Affected households tend to lease out their lands. In terms of gender, the issue of land leasing was widespread among female households (Mikael, 2004). Additionally, there are also cases of distress sales of household assets and livestock, and reduction in cultivated land area (FASAZ, 2003; NAADS, 2003).

The results suggest that responses to alleviating effects of HIV/AIDS will not be comprehensive unless one takes into account the gender imbalances that exist in such issues as access to land and other productive assets (Chapoto and Jayne, 2005).

Table 2.3: Summary table: impact of HIV/AIDS on cultivated land, fertilizer application and household assets

Author, date	**Focus of study**	**Study design & analytical framework**	**Findings**
Ajieh & Okoh (2009)	To assess the perception of the effects of HIV/AIDS pandemic on agricultural production by farmers. Conducted in the Central Agricultural Zone of Delta State, Nigeria.	Sample size of 100 respondents made up of 50 randomly selected farmers each from Udu and Ughelli South. Collected data using interview schedule.	HIV/AIDS leads to reduction in cultivated land, reduction in time allocated to farming and rise in food security problems.
Parker et al. (2009)	To explore the effects of HIV/AIDS on households in south east Uganda	Qualitative semi-structured research methods. Part of a multi-stage research process combining both qualitative and quantitative methods of investigation	HIV/AIDS results in increases in households headed by widows and orphans; reduction in labour as a result of illness and taking care of the sick; depletion of household assets to pay for health expenses; loss of assets and land tenure as a result of deaths, particularly among widows and orphans; and changes in agricultural practices and productivity.
Donovan & Mather (2008)	To analyze the effects of adult mortality on households in rural Mozambique	Panel assessment of 4,058 Mozambicans in interviewed in 2002 and re-interviewed in 2005. A difference in difference estimation	Households with a male death experience significant losses of land, livestock and all forms of income. No significant losses in assets for households with a female death.
Aliber & Walker (2006)	To examine the effects of HIV/AIDS on land tenure in rural Kenya	A combination of household surveys, in-depth interviews with informants in households, and participatory research techniques	Lesser cases of dispossession of land rights of widows and orphans.
Chamunika (2006)	To explore the effects of HIV/AIDS on agriculture in Limpopo, South Africa.	A random selection of 218 households, comprising 100 households in the affected group and 118 in	Few cases of households selling household property, farm assets or livestock. Slaughtering

		the non-affected group.	ox common among household that experience death (at 88%). Loss of assets due to death reported in only 1.45 of the households. For majority of households in the area that with loss of a household member, livestock is left for the deceased’s family, whereas relatives shared clothes and utensils
Chapoto & Jayne (2005)	To estimate the impact of adult chronic illness and death households in Zambia.	A country-wide representative panel survey on 5,420 households which was carried out in 2001 and 2004	Mortality cases of a prime age male results in a larger drop in cultivated land than death of a prime age female. Death of younger adults has a statistically insignificant impact on cultivated land. In about 33 percent of affected households with mortality of male head of household, the widow’s cultivation land dropped considerably in 2004 compared to previous years.
Mather (2004)	To assess how households respond to death of an adult member of household in rural Mozambique.	They use a country-wide sample, for the period 1999 & 2002.	Mortality leads to lower cash, cattle, assets, and income levels. Mortality of male household head resulted in less cultivated land
Mikael (2004)	To explore HIV/AIDS impact on food security in two states of Ambassel and Alaba in Ethiopia	Cross-sectional data in two states of Ambassel and Alaba Use sustainable livelihood framework	Affected households are involved in leasing out land. For example, out of 130 respondents in Ambassel, and 93 respondents in Alaba, about 63 percent and 11

			percent, respectively, lease out their lands. By gender, female headed households more involved in leasing out land.
Yamano & Jayne (2004)	To assess the effects of adult death on farm households in Kenya	Panel data survey of 1,422 households between 1997 & 1998. Difference-in-difference estimation technique	Prime age female mortality results in decline of cultivated land for cereals by 1.89 acres. Prime age-adult mortality reduces the size of cultivated land for high-value crops by 0.77 acres. Prime-age male mortality reduces the amount of land for high-value crops, but increases the amount of land for cereals. Death of a prime-age adult who is not a household head or spouse has smaller and less significant effects on cultivated area.
De Waal & Whiteside (2003)	To investigate why the 2002-03 food crisis differs from food security problems caused by drought	A conceptual design	Adult mortality leads to loss of assets and skills
Drimie (2003).	To examine the coping strategies for affected households	Reviewing literature, conducting interviews with relevant people, and participatory rural appraisal methods	For affected households, labour is withdrawn from farm production to look after the sick. This results in drop in cultivated land area. Most regular responses include selling assets and labour activities.
Farming Systems Association of Zambia (FASAZ 2003)	To examine the effects of HIV/AIDS on farmers.	Survey of 770 households, with 68 percent male headed and 32 percent female headed.	HIV/AIDS results in households the selling of household assets and livestock, and reduction in cropped areas.
The National Agricultural Advisory Services (NAADS	To explore the impact of HIV/AIDS on rural households	Survey of 631 households around lake Victoria	HIV/AIDS affected households sell assets, reduce food consumption, reduce size of herd, or cultivated

2003)			area; reduce crop varieties; abandon specific activities and crops. Cases property grabbing.
Mphale (2002)	To explore the impact of HIV/AIDS on farmers	Reviewing literature, surveys, interviews and other appraisal methods.	Affected households are involved in share-cropping. Reported cases of land grabbing from orphaned children. Affected households incur reduction in labour, sold household assets and reduction in savings.
Engh et al. (2000)	To examine the impact of HIV/AID on households	Interviews with 24 members of affected households	A 25 percent reduction in production time due to people attending funerals and observing mourning periods. Cases of women losing inheritance to assets after the death of husbands. Death of a wife does not result in any disruption. Widespread sale of assets to cover health and funeral expenses. This results in jeopardizing livestock and crop production.

c) Effects of HIV/AIDS on crop production and food security

Table 2.4 gives results on the impact of HIV/AIDS on crop production and food security. The findings show that affected households experience reduction in food production (Adoeti, 2008; Thangata, 2007; Chamunika, 2006; Chapoto and Jayne, 2005; Mikael, 2004; Asingwire and Kyomuhendo, 2003; Harvey, 2003; NAADS 2003; SADC FANR VAC, 2003). This could be due to loss or reduction in labour and consequently reduction in cultivated land. There is also a significant reduction in households growing labour-intensive cash crops, and a significant shift to food crop production (Nguthi and Niohoff, 2008, Chapoto and Jayne, 2005). Gender of the patient is an important factor in determining the impact of the epidemic on food production (Thangata, 2007). Illness and subsequent loss of a male household head results in reduction in available labour as family members are expected to care of the patient, leading to less food and cash crop production and creating food security problems (Thangata, 2007; Muwanga 2002; and Mutangadura, 2000).

Another impact of HIV/AIDS is reduction in food consumption and extra disease burden coming from social disruption (Harvey, 2003). In terms of gender, female- headed households experienced more serious food security problems compared to male headed households (Mikael, 2004). One reason could that women-headed households are associated with lower landholdings, due to lack of inheritance rights to family land. One implication that can be drawn from these studies is that HIV/AIDS mitigation strategies should take into account the issues of gender dimensions.

Table 2.4: Summary table: impact of HIV/AIDS on crop production and food security

Author, date	Focus of study	Study design & analytical framework	Findings
Gill (2010)	To examine HIV/AIDS impacts on food security of diverse rural households in Western Kenya	Ethnological linear programming model. Informal semi-structural interviews and various participatory methods in focus groups using a total of 10 households	Household food insecurity more serious in Amukura with an HIV infected female than an HIV infected male. Serious reduction in household food availability and utilization when an adult female contracted HIV. Reductions in available female labour resulted in lower food production compared to reductions in available male labour.
Masuku & Sithole (2009)	To explore the effects of HIV/AIDS on food security and household vulnerability in Swaziland	Personal interviews with 847 selected farming households	HIV/AIDS impacts include households selling crops and livestock to meet funerals and health expenses, reduction in expenditure on

			agricultural inputs, and rise in expenditure on medical bills and funerals. Most households faced food security problems.
Musita et al. (2009)	To investigate the effects of HIV/AIDS on food and nutritional security in Suba, Kenya	Survey and statistical data collection method. Collected data using questionnaires. Purposive sampling was used to select 566 control households	HIV/AIDS resulted in reduction in cultivated land, lower yields and food security problems.
Ugwu (2009)	To examine and determine the effects of HIV/AIDS on women famers in Nigeria with particular reference to Enugu State.	Multi-stage and purposive sampling methodologies in the selection of farm families/households including (women) persons living with HIV/AIDS (PLWHAs) and (women) persons affected with HIV/AIDS (PABA) for the study. About sixty (60) farm women/PLWHAs and sixty (60) uninfected farm women/households were purposively sampled for the study.	The impact of HIV/AIDS include loss of loss of feminine agricultural labour supply, reduction in household income, reduction in agricultural production, and loss of family assets and the women's right to land.
Adeoti & Adeoti (2008)	To evaluate the impact of health status of farm households with respect to HIV/AIDS, on cropping patterns, incomes and technical efficiency	Cross sectional data comparisons of 155 farm households, 55 households with HIV/AIDS and related illnesses and 100 non-affected Stochastic production frontier	HIV/AIDS results in reduction in cultivated land area and variety of cultivated crops, and reduction in gross revenue compared to non-affected households.
Chapoto & Jayne (2008)	To investigate the impact of adult mortality on livelihoods in Zambia	A country-wide survey, panel data, 5,420 households in rural areas, data collected between 2001 & 2004.	Death of male household head results in relatively serious effects on farm production and livestock assets compared to the death of other adults. The effect of adult death is more serious among households that were at first poor.

Nguthi & Niohoff (2008)	To explore the effects of HIV/AIDS on the livelihoods of banana-farming households in Maragua district, Central Kenya.	Field study during 2004-2005, quantitative and qualitative methods of data collection. Survey conducted among 254 farming households with 75 HIV/AIDS-affected households and 179 non-affected households. Sustainable livelihood approach	HIV/AIDS significantly reduces production of labour-intensive cash crops, and most households shift to food crop production.
Adenegan & Adewusi (2007)	To evaluate the determinants of the status on food security for households affected by HIV/AIDS in South-western Nigeria	Interviewed eighty-five persons with HIV/AIDS	Food security problems are severe among households affected with HIV/AIDS compared to non-affected households. By gender, there is higher food security among affected female headed households.
Thangata (2007)	To examine the impact of HIV/AIDS on improved fallow adoption, food production and food security in Malawi.	Cross sectional data in Central Malawi district of Kasungu. Ethnographic linear programming model for a representative household with three scenarios: no illness, adult female illness and adult male illness.	HIV/AIDS impact has gender dimensions. Sickness and death of a male head of the house results in serious reduction in field labour, less crop production and food security problems compared to death of other family members.
Chamunika (2006)	To evaluate the effects of HIV/AIDS on farm households in Limpopo province in South Africa.	Random selection a total of 218 households, with 100 affected households and 118 non-affected households	HIV/AIDS results in reduction in food and education expenditures. The effects are higher for mortality compared to morbidity.
Chapoto & Jayne (2005)	To examine the impact of working adult mortality and morbidity on households in Zambia.	Country-wide survey data on 5,420 households. Data collected 2001 & 2004	Adult woman mortality results in reduced cultivated land area for roots and tubers (by 5%). Affected households switch to cereals from

			crops of high-value
Mikael (2004)	To investigate the effects of HIV/AIDS on food security in two states of Ambassel and Araba in Ethiopia	Cross-sectional data in two states of Ambassel and Alaba Use sustainable livelihood framework	HIV/AIDS results in reduction in crop production. When compared with non-affected households, affected households rely more on food handouts. By gender, affected female headed households face more severe food security problems compared to male headed households.
Yamano & Jayne (2004)	To examine HV/AIDS impacts on farm households in Zambia	Panel survey of 1,422 households between 1997 and 1998. They employ the difference-in-difference estimation technique	Death of a working age woman results in increase in crop production per acre. The death of working age man results in reduction in crop production by 57 percent and shifting low value crops like cereals following the loss of a prime adult working man
Asingwire & Kyomuhendo (2003)	To assess the impact of HIV/AIDS on farm production in Uganda	Cross-sectional data from three districts. Used both statistical and qualitative methods. Survey 313 households.	Reports reduction in agricultural production among 77 percent of affected households. Loss of livestock due to lack of proper care reported
Beagle (2003)	To analyze the impact of adult death on allocation of time	The Kagera Health Development Survey (KHDS. Interviewed more than 800 households in between 1991 & 1994	Insignificant impact on labour supply and farm production.
Harvey (2003)	To assess the relationship between HIV/AIDS epidemic, food and famine in the 2002- 03 food crisis in southern Africa	Reviews and interviews conducted in Malawi, Zimbabwe, South Africa and Zambia	Affected households experience reduction in food intake and social disruptions.

SADC FANR Vulnerability Assessment Committee (2003)	To explore the impact of HIV/AIDS on 2002 food crisis.	Data from assessments carried out food security in Malawi, Zambia and Zimbabwe.	Affected households experience significant reduction in crop production resulting in decline in food security.
Muwanga (2002)	To analyze the effects of HIV/AIDS on agriculture and the private sector		HIV/AIDS results in food security problems.
Mutangadura (2000).	To assess the effects of the death of a female in Zimbabwe	Sample of 215 purposively chosen households	HIV/AIDS results in food security problems
Mather (2004)	To examine how rural ` rural Mozambique.	National survey rural panel data for the period 1999 & 2002.	About 44% of affected households experience reductions in reported reduction in weeding
National Agricultural Advisory Services (NAADS 2003)	To assess the effects of HIV/AIDS on households	A survey of 631 farm households around Lake Victoria.	Reduction in agricultural and fisheries production due to AIDS.

2.4 Survival responses of HIV/AIDS affected households

The empirical literature shows that affected households use various strategies to cope with HIV/AIDS consequences (see table 2.5). Of the studies under review on coping strategies, only four studies use panel data surveys and theses are, Naidu and Harris (2006), Chapoto and Jayne (2005), Yamano and Jayne (2004), Mather (2004) , and Lundberg, Over and Mujinja (2000).

The most common coping strategy is selling livestock and assets followed by borrowing funds. Findings such as reducing consumption, withdrawing children from school and reducing household size reflect failure to cope by some affected households. In other words, some affected households are using survival strategies.

i. *Selling livestock and assets* - Akinboade, (2008); Nguthi and Niohoff (2008); Bukusuba et al. (2007); Chapoto and Jayne, (2005); Boysen and Molelekoa, (2002);

Mikael, (2004); Yamano and Jayne, (2004); Mwakalobo, 2003; NAADS, (2003); FASAZ (2003); Oni et al. (2002); Drime (2003)

ii. *Borrowing funds* - Akinboade, (2008); Bukusuba et al. (2007); Naidu and Harris, (2006); Boysen and Arntz, 2004; Mikael, (2004); Yamano and Jayne, (2004); Lundberg et al. (2000)

iii. *Reducing consumption* - Akinboade (2008); Bukusuba et al. (2007); Mikael (2004); and SADC VAC, (2003); NAADS, (2003)

iv. *Utilizing savings* – Akinboade, (2008); Nguthi and Niohoff (2008); Naidu and Harris, (2006); Boysen and Arntz, (2004)

v. *Receiving social grants* - Akinboade (2008); Chamunika (2006); Naidu and Harris, (2006); Boysen and Arntz (2004)

vi. *Hiring labour*- Chamunika, (2006); Mather, (2004); Donovan et al. (2003); FASAZ, (2003)

vii. *Food handouts* – Akinboade, (2008); Chamunika, (2006); Mikael, (2004)

viii. *Replacing or hiring labour* – Chamunika, (2006); Donavan et al. (2003)

ix. *Community group networks* – Oni et al. (2002); FASAZ (2000)

x. *Withdrawal of children from school* - SADC FANR, (2003); Oni et al. (2002)

xi. *Reducing household size* – Bukusuba et al. (2007)

xii. *Remittances* – Chamunika, (2006)

xiii. *Leasing out land* – Nguthi and Niohoff, (2008)

xiv. *Shift from high-value crops to cereals* - Yamano and Jayne, (2004)

While the studies examine a broad range of coping strategies, what is lacking is an analysis of the gender dimension and the distinction between mortality and morbidity cases.

Table 2.5: Summary table: coping strategies for HIV/AIDS affected households

Author, date	**Focus of the study**	**Study design & analytical framework**	**Findings**
Masuku & Sithole (2009)	To study the impact of HIV/AIDS on food security and household vulnerability in Swaziland	Face to face interviews with 847 selected farming households	Households sell crops and livestock to pay for funeral and health care expenses. Reduction in expenditure on agricultural inputs, and an increase in expenditure on medical bills and funerals. Most affected households face food security problems.
Musita et al. (2009)	To examine the impact of HIV/AIDS on food and nutritional security in Suba district, Kenya	Cross-sectional survey. Statistical data collection methods. Data collection using questionnaires. Purposive sampling was used to choose study locations. There were about 566 control households	Coping strategies include increased planting of beans, millet and sorghum – crops requiring less input of labour. Other strategies include selling small stocks of heard such sheep, goats and poultry. Affected households' food security problems.
Akinboade (2008)	To examine gender dimensions of HIV/AIDS impact on land distribution in Limpopo province, in South Africa.	Questionnaires to deliberately selected affected households of about 36	Coping strategies include borrowing money or food; selling livestock due to failure to manage the herd; and selling crops to meet emergencies. Other coping strategies include receiving social grants, receiving food handouts and borrowing money or food
Nguthi & Niohoff (2008)	To examine the effects of HIV/AIDS on the livelihoods of banana farmers in Maragua	Field study conducted during 2004-2005. Both quantitative and qualitative	Identified coping strategies for affected households are using

	district, Central Kenya.	methods of data collection. Survey conducted among 254 farming households with 75 HIV/AIDS-affected households and 179 non-affected households. Sustainable livelihood approach	savings, selling livestock, leasing land and migration
Bukusuba et al. (2007)	To ascertain how affected households respond to the food shortages in Uganda.	Cross-sectional study using quantitative methods. 144 households of people living with HIV/AIDS randomly selected households with ages between 15 & 49, resident in Jinja district, to the East of Uganda.	Coping strategies include reducing household size to reduce food expenses, reducing food consumption (95 percent), borrowing money or food (77 percent), missing meals by all household members (62.3 percent), skipping eating for the whole day by all household members (21.5 percent), and selling non-productive household assets to buy food.
Chamunika (2006)	To explore the effects of HIV/AIDS on agriculture and food security in Limpopo, South Africa.	Random selection of a total of 218 households, with 100 affected households and 118 non-affected households.	Coping strategies include hiring extra labour to assist in agriculture, calling upon children to assist with household duties and agricultural activities in affected households. Other coping strategies include remittances from non-resident household members and relatives; food handouts distributed by the Social Welfare Department
Naidu &	To review survival strategies	Collected data on four	Sick members

Harris (2006).	used by HIV/AIDS affected households in Soweto	occasions between September 2002 and August 2003 from each household based on diary records and supplemented by interviews with the household head of the household.	continue working for as long as possible; borrowing money from friends and relatives; receiving funds from relatives, taking up social grants, and using savings
Chapoto & Jayne (2005)	To examine the impact of prime-age adult morbidity and mortality on crop production and livestock in Zambia.	Country-wide sample, representative, panel data on 5,420 households collected in 2001 & 2004	Selling cattle is cited as a coping strategy
Booysen et al. (2004)	To investigate the effects of HIV/AIDS on households in Free Town.	Cross-sectional data of affected households and non-affected households in two communities of Free State – Welcome (urban) and QwaQwa (rural) About 406 rural and urban households in mid-2001 and concluded with 351 households at the end of 2002. Further data collection conducted up to the end of 2004.	Coping strategies include individuals migrating into and out of households, borrowing, using savings, selling household assets, and accessing to social grants. Affected households borrow lesser than non-affected households. Accumulation of outstanding bills on water and electricity for affected households.
Mather (2004)	To analyze how rural households respond to adult mortality in Mozambique	National survey, panel data for the period 1999 & 2002.	Households resort to hired labour, joining of new members.
Mikael (2004)	To explore the impact of HIV/AIDS on food security in two states of Ambassel and Araba in rural Ethiopia	Cross-sectional data in two states of Ambassel and Alaba Sustainable livelihood framework	Coping strategies include selling of productive assets, obtaining loans to cover health expenses (happened in a third of affected households in both Ambassel and Araba). Other coping strategies include borrowing and getting assistance from relatives to cover such expenditures in both

			states; reducing consumption in Ambassel and relying on handouts
Yamano & Jayne (2004)	To examine the impact of death of adults on farm households in Kenya	Panel survey of 1,422 households between 1997 & 1998. They employ the difference-in-difference estimation technique	Coping strategies include selling off assets (e.g. small animals) over time; borrowing money; and switching from high-value crops to cereals
Donovan et al. (2003)	To appreciate specific effects felt by households in Rwanda.	A survey of 1520 households in 2002	Coping strategies include reduction in farm labour by 60% - 80 % of households of the affected households. Death of an adult male member of the household results in reduction in cultivated land. Mortality or morbidity of an adult female household member results in household adoption labour-based strategies such as sharing or hiring labour.
Mwakalobo (2003)	To find out whether the HIV/AIDS epidemic affects poverty in Rungwe district, Tanzania	Survey of 119 households carried out in 3 villages	Households cope by selling their assets. As a result, the households pushed into poverty.
The National Agricultural Advisory Services (NAADS 2003)	To obtain an evaluation of the effects of HIV/AIDS	Survey of 631 households around Lake Victoria Crescent agro-ecological zone	Coping strategies include selling assets, reducing food consumption; reducing the size of the herds or cultivated land; cases of confiscation of assets.
Zambia and SADC Vulnerability	To investigate livelihood strategies		Coping strategies include reduction in food consumption and

and Assessment Committee (VAC, 2003)			education expenditures.
Oni et al. (2002)	To assesses the impact of HIV/AIDS on rural households in Limpopo province, South Africa	Cross-sectional data from 680 rural households	Coping strategies include selling household assets, withdrawing children from education
Lundberg et al. (2000)	To examine how households respond to mortality	Panel data set from Kagera region in Tanzania.	Coping strategies include obtaining formal credit loans
Mutangadura (2000).	To examine the major household effects of death of a female member of household and identify coping strategies	Carried out a survey and interviewed 215 households	Major household coping strategies include decline in access to schools, children more burdened, and affected households lost assets. More cases of foster parents among the elderly women.
Rugalema (2000)	To examine whether affected household really cope	A conceptual study design	Study contends that coping strategies suggest that households were struggling to survive and failing to cope.
Farming Systems Association of Zambia (FASAZ 2003)	To examine the impact of HIV/AIDS on rural households in Zambia	Survey of 770 households, (ratio of male to female headed 68: 32)	Coping strategies include involving young ones in farm activities; labour exchanges with neighbours; shifting to less labour-demanding crops; reduction in cultivated land area.
Drimie (2003)	To assess the effects of HIV/AIDS on land in three countries (Kenya, Lesotho and South Africa)	Reviewing literature, Literature review, interviews, participatory rural appraisal methods	Strategies include selling livestock, and hiring labour, There are rare cases of renting

Mtika (2001)	To investigate the links between AIDS epidemic and its threat to food security in Malawi	Interviews with households guardians for ten consecutive weeks from December 1995 to February 1996 in three villages of Balaka, Malawi	Coping strategies include sharing resources by households belonging to the same extended family network share resources.
Bakusuba et al. (2007)	To explore the status of the food security among families affected with HIV/AIDS in urban Uganda	Affected households residents of Jinja Municipal Council or Mafubira sub-county in Jinja district, eastern Uganda. Cross sectional study with 160 randomly recruited, HIV-infected adults, of whom 144 participated.	Strategies: reduction in consumption of preferred foods (95 %), reduction of meals served to all household members (82·6%), borrowing money or food (77 %), skipping meals by all household members (62·3 %) and skipping eating for the whole day by all household members (21·5 %) have negative repercussions,

2.5 Conclusion

Overall, the empirical results show that poor health in general and HIV/AIDS in particular have negative impacts on technical efficiency and crop production. However, there are gaps in empirical literature which this research is filling. There are no studies that have distinguished morbidity and mortality that is AIDS-related[10] from morbidity and mortality that which is not. This distinction is important as the effects of morbidity and mortality among AIDS-affected and non-affected households are likely to be different. Secondly, no study has examined the impact of prime-adult morbidity and mortality within the context of successful government agricultural programmes. Since 2004, the Malawi Government has made several attempts to raise the productivity and production of food crops. These measures include encouraging and supporting farmers to adopt new technology, especially hybrid maize seeds, providing subsidized farm inputs, and implementing land reforms to

[10] AIDS related mortality refers to death resulting from illnesses medically associated with HIV/AIDS e.g. chronic TB, chronic pneumonia and chronic diarrhoea. AIDS-related morbidity refers to illnesses medically linked to HIV/AIDS e.g. chronic TB, chronic pneumonia and chronic diarrhoea. For more information see Section 1.5

address land shortages. As a result, Malawi has been hailed as a success story in terms of food crop production and food security. However, the impact of these policies within the context of HIV/AIDS epidemic has not been investigated. It would thus be interesting to investigate the impact of prime-adult morbidity and mortality among small-scale farm households within the context of this success story.

References

Adeoti, A.I. & Adeoti J.O. (2008), "HIV/AIDS and Farm Production Efficiency in Benue State, Nigeria," *African Journal of Biomedical Research,* 11 (3): 154-153

Adenegan, K.O. & Adewusi, O.A. (2007), "Determinants of Food Security Status of Rural Households Living With HIV/AIDS in South western Nigeria," *African Journal of Biomedical Research,* 10(1): 9-18

Ainsworth, M., Gosh, S. & Semali, I. (1995), "*The Impact of Adult Deaths on Household Composition in Kagera Region, Tanzania,"* Washington D.C.: Policy Research Department, World Bank, USA.

Ajani, O.I.Y. & Ugwe, P.C. (2008), "Impact of Adverse Health on Agricultural Productivity of Farmers in Kainji Basin North Central Nigeria Using a Stochastic production Frontier Approach," *Trends in Agricultural Economic*, 1(1): 1-7

Ajibefun, I.A. & Abdulkadri, O.A. (1999), "An investigation of technical efficiency of farmers under the National Directorate of Employment in Ondo State, Nigeria," *Applied Economics Letter,* 6: 111–114, Routledge, London

Ajibefun, I.A., Battese, G.E. & Daramola A.G. (1996), "*Investigation of factors influencing technical efficiency of smallholder croppers in Nigeria,*" CEPA Working Papers, Department of Econometrics, University of New England, Amidale, Australia.

Ajieh, P.C. & Okoh, R.N. (2009), "The effects of HIV/AIDS pandemic on agricultural production as perceived by farmers in the central agricultural zone of delta state, Nigeria," *ARPN Journal of Agricultural and Biological Science*, 4(4): 115-120

Akinboade, O.A. (2008), "Gender, HIV/AIDS, land, restitution and survival strategies in the Capricon district of South Africa," *International Journal of Social Economics*, 35 (11): 857-877

Alderman, H., Hoddinott J., Haddad, L. & Udry, C. (1995), "*Gender differentials in farm productivity: Implications for household efficiency and agricultural policy*," Food

Consumption and Nutrition Division, Discussion paper, no.6, International Food Policy Research Institute, Washington DC, USA

Aliber, M. & Walker, C. (2006), "The impact of HIV/AIDS on land rights: perspectives from Kenya," *World Development*, 34(4): 704-727

Alumira, J.D., Kambewa, P.S. & Binauli, L.D. (2005), "*Impact of HIV/AIDS on Inter- and Intra-Generational Information Flows among Smallholder Farmers in Malawi,"* ICRISAT, Malawi and RENEWAL, International Food Policy and Research Institute, Washington, DC.

Asingwire, N. & Kyomuhendo, S. (2003), "*Development of a national overarching HIV/AIDS policy for Uganda: A review of the HIV/AIDS policy environment in Uganda*," : Uganda AIDS Commission, Kampala, Uganda

Bachmann, M.O. & Booysen, F.L.R. (2002), "*HIV/AIDS and Poverty: Evidence from a Household Impact Study conducted in the Free State Province, South Africa*," Paper presented at DPRU Conference, Johannesburg, South Africa.

Beagle, K. (2003), "*Labour Effects of Adult Mortality in Tanzanian Household*s," Washington D.C, World Bank, Unpublished Working Paper

Ben-Belhassen, B. (2000), "*Measures and explanation of technical efficiency in Missouri farm production,"* Selected Paper, American Agricultural Economics Association. Annual Meeting, Tampa Florida

Booysen, F. (2001), "HIV/AIDS, Poverty, and Risky Sexual Behaviour: evidence from South Africa," *Journal of Health Population Nutrition*, 20(4): 285-288

Booysen, F. R. & Molelekoa, J. (2002), "Benefits of HIV/AIDS Intervention in the Workplace: A Case Study," *South African Journal of Economic and Management Sciences*, 5(1): 180-202

Booysen F.R. & Arntz, T. (2004), "The methodology of HIV/AIDS impact studies: A review of current practices," *Social Science and Medicine,* 56: 2391–2405.

Booysen, F., Bachmann, M., van Rensburg, H., Engelbrecht, M., Steyn, F. & Meyer, K. (2004), "*The Socio- Economic Impact of HIV/Aids on Households in South Africa: Pilot Study in Welkom and Qwaqwa, Free State Province*," Consultants Report to the Joint Centre, Pretoria

Bukusuba, J., Kikafunda J.K. & Whitehead, R.G. (2007), "Food security status in households of people living with HIV & AIDS (PLWHA) in a Ugandan urban setting," *Br Journal of Nutrition*, 98: 211-7.

Chamunika, M. (2006), "*Impact of HIV/AIDS on Agriculture and Food Security: The case of Limpopo Province in South Africa*," FANRAPAN Working Document, Series Ref. no: NAT SA005

Chapoto, T.S. & Jayne, T. (2005), "Measuring Impact of Working-Age Adult Mortality on Small-scale Farm Households in Kenya," *World Development*, 32 (1): 91-111

Chapoto, A. & Jayne, T. (2008), "Impact of AIDS-related mortality on farm households welfare in Zambia," *Economic Development and Cultural Chang*, 56 (2): 327-374

Croppenstedt, A. & Muller, C. (2000), "The Impact of Farmers' Health and Nutritional Status on their Productivity and Efficiency: Evidence from Ethiopia," *Economic Development and Cultural Change,* 48 (3): 475-502

de Janvry, A., Fafchamps, M. & Sadoulet, E. (1991), "Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained," *Economic Journal*, 101 (409): 1400–17

De Waal, A. & Whiteside, A. (2003), "New Variant famine. AIDS and Food Crisis in Southern Africa," The *Lancet,* 362: 1234-1237.

Donovan, C., Bailey, L., Mpsyisi, E. & Weber, M. (2003), "*Prime-Age Adult Mortality and Morbidity in Rural Rwanda: Which households are affected and what are their strategies for adjustment?"* Contributed paper selected for presentation at the 25th International Conference of Agricultural Economists, Durban, South Africa.

Donovan, C. & Mather, D. (2008), "*Impacts of Prime Age Adult Mortality on Rural Household Income, Assets, and Poverty in Mozambique: Analysis with Panel Data Set*," International Development Collaborative Policy Briefs MZ-MINAG-FL-49e, Department of Agricultural Economics, Michigan State University

Dorward, A., Mwale, I. & Tuseo, R. (2006), "Labor market and wage impacts of HIV/AIDS in rural Malawi," *Review of Agricultural Economics,* 28(3), pp. 429-439.

Drimie, S. (2003), "HIV/Aids and land: case studies from Kenya, Lesotho and South Africa," Development *Southern Africa,* 20 (5): 647-658.

Engh, I. E., Stloukal, L. & du Guerny, J. (2000), "*HIV/AIDS in Namibia: The impact on the livestock sector*," FAO, Rome
http://www.fao.org/sd/wpdirect/wpan0046.htm.

FASAZ. (2000), "*Interlinkages between HIV/AIDS, agriculture production and food security, Southern Province, Zambia*. Baseline Survey Report," Farming Systems Association of Zambia (FASAZ), Lusaka, Zambia.

FASAZ. (2003), "*Interlinkages between HIV/AIDS, agriculture production and food security, Southern Province, Zambia,"* Baseline Survey Report. Farming Systems Association of Zambia (FASAZ).
www.fao.org/hivaids

Floyd, S. (2003), "The long-term impact of HIV and orphanhood on the mortality and physical well-being of children in rural Malawi," *AIDS,"* 17(3): 389-397

Fox, T. (2004), "The Impact of HIV/AIDS on labour productivity in Kenya," *Tropical Medicine and International Health,* 9 (3): 318-324

Gill, T.B. (2010), "Modelling the impact of HIV/AIDS upon food security of diverse rural households in Western Kenya," *Agricultural systems,* 103 (5): 210-225

Harvey, P. (2003), "*HIV/AIDS: The Implications for Humanitarian Action: A Literature Review*," Overseas Development Institute, London

Hosegood V., McGrath, N., Herbst K. & Timæus, I.M. (2004), "The impact of adult mortality on household dissolution and migration in rural South Africa," *AIDS*, 18(11): 1585–1590.

Lundberg, M., Over, M. & Mujinja, P. *(*2000), "Sources of financial assistance for households suffering an adult death in Kagera, Tanzania," *South African Journal of Economics*, 68: 947-984

Lipton, M. (1968), "The Theory of the Optimizing Peasant," *Journal of Development Studies*, 4(3): 327–51.

Masuku, M. & Sithole, M. (2009), "The impact of HIV/AIDS on food security and household vulnerability in Swaziland," *Agrekon*, 48(2): 115-125

Mather, D. (2004), "*Household Responses to Prime Age Adult Mortality in Rural Mozambique: Implications for HIV/AIDS Mitigation Efforts and Rural Economic Development Policies*," Centre for Study of African Economies Conference, Oxford University, UK

Matthew, P.F. (2004), "The impact of HIV/AIDS on labour productivity in Kenya," *Tropical Medicine and International Health*, 9 (3): 318-324

Mikael, L. (2004), "*Exploring the impact of HIV/AIDS on household food security in rural Ethiopia: two case studies,"* A joint UNECA/UNDP/WFP study
http://uneca.org/eca_programmes/policy_analysis/publications/AIDS_food_security-report.pdf

Mtika, M. (2001), "The AIDS epidemic in Malawi and its threat to household food security," *Human Organisation*, 60 (2): 178-188

Mphale, M. (2002), "*HIV/AIDS and its impacts on land tenure and livelihoods in Les*otho," Unpublished draft report for FAO, United Nations, Rome, Italy

Musita, C.P., Ariga, E.S., Kaseje, D.K. & Otieno, A. (2009), "Impact of HIV and AIDS on household food and nutrition security in suba district, Kenya," *AIDS,* 9 (7): 1452-1467

Mutangadura, G.B. (2000), "*Household Welfare impacts of mortality of adult females in Zimbabwe: Implications for policy and program development*," Paper presented at the AIDS and Economics Symposium organized by IAEN Network, Durban

Muwanga, F.T. (2002), "*Impact of HIV/AIDS on Agriculture and the Private Sector in Swaziland,*" State of the World's Forests/FAO, Eldis Reporter on HIV/AIDS, University of Sussex Institute of Development Studies, UK.

Mwakalobo, A. (2003), "*Implications of HIV/AIDS on rural livelihoods in Tanzania: The case of Rungwe district,*" Unpublished report, Development Studies Institute, Sokoine University of Agriculture, Morogoro, P. O. Box 3024, Tanzania.

NAADS, (2003), "*The Impacts of HIV/AIDS on the Agricultural Sector in Uganda*," Baseline survey report, FAO's Integrated Programme, Rome, Italy.

Naidu, V. & Harris, G. (2006), "Survival Strategies of HIV/AIDS affected households in Soweto," *Development Southern Africa*, 23(3): 1470-3637

Nguthi, F.N. & Niohoff, A. (2008), "Effects of HIV/AIDS on the livelihood of banana farming households in Central Kenya," *International Journal of Life Sciences*, 50 (3): 179-190

Obwona, M. (2000), "*Determinants of technical efficiency among small and medium scale farmers in Uganda: A case of tobacco growers*," Final report presented at AERC Biannual Research Workshop, Nairobi, Kenya.

Oni, S. A., Obi, C. L., Okone, D, Thabede, D. & Jordan, A. (2002), "The economic impact of HIV/AIDS on rural households in Limpopo Province," *South African Journal of Economics*, 70 (7): 1173-1192.

Parker, D.C., Jaconsen, K.H. & Komwa, M.K. (2009), "A Qualitative Study of the Impact of HIV/AIDS on Agricultural Households in South-Eastern Uganda," *International Journal of Environmental Research and Public Health*, 6(8): 2113-2138

Rugalema, G. (2000), "Coping or struggling? A Journey into the Impact of HIV/AIDS in Southern Africa," *Review of African Political Economy*, 86: 537-544.

SADC FANR Vulnerability Assessment Committee (VAC) (2003), "*Towards identifying impacts of HIV/AIDS on food security in southern Africa and implications for response: Findings from Malawi, Zambia and Zimbabwe,"* Report, *Harare*, Zimbabwe

Shah, M., Osborne, N., Mbilizi, T. & Villi, G. (2001), "*Impact of HIV/ AIDS on Agricultural Productivity and Rural Livelihoods in the Central Region of Malawi*," Lilongwe, Malawi, CARE International Malawi

Thangata, P.H. (2007), "Predicted Impact of HIV/AIDS on Improved Fallow Adoption and Rural Household Security in Malawi," *Sustainable Development*, 15(4): 205-215

Ugwu, D.S. (2009), "Socio-Economic Impact of HIV/AIDS on Farm Women in Nigeria: Evidence from Enugu State," *World Applied Sciences Journal*, 6 (12): 1617-1624

Ulimwengu, J.M. (2009), "*Farmer's health Status, Agricultural Efficiency, and Poverty in Rural Ethiopia: A Stochastic Production Frontier*," IFRP Discussion Paper 00868

Urassa, M. (2001), "The Impact of HIV/AIDS on mortality and household mobility in rural Tanzania," *AIDS*, 15: 2017-2023

Yamano, T. & Jayne, T.S. (2004), "Measuring the Impacts of Prime-Age Adult Death on Rural Households in Kenya," *World Development*, 32 (1): 91-119

Yamano, T. & Mghenyi, E. (2004), "*A Cross country Analysis of Household Responses to Adult Mortality in Rural Sub-Saharan Africa: Implications for HIV/AIDS Mitigation and Rural Development Policies*," International Development Working Paper 82. Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

Yusuf, S.A., Ukpebor, E.I. & Salimonu, K.K. (2007), "Impact of HIV/AIDS on Farmers' Efficiency in Anambra State, Nigeria," *Research Journal of Applied Sciences*, 2(3): 221-224

Zambia Vulnerability Assessment Committee (2006), "*Rapid Assessment on the effects of rainfall on livelihoods*," Lusaka, Zambia

Chapter 3: Review of data sources, theory and study methodology

3.1 Introduction

This chapter reviews the data sources, theory and study methodology. It discusses the farm production theory (in order to understand the theoretical foundation of technical efficiency of production). It also examines the relationship between health and production. Furthermore, it examines related analytical models that have been used in literature. The models include the stochastic production frontier model, data envelopment analysis, and discrete choice models.

3.2 Household data

This study is based on the two-year panel data[11] from the Integrated Household Surveys that were conducted by the National Statistical Office (Malawi) and the World Bank during the 2004/05 and 2006/07 seasons.

The 2004/05 Integrated Household Survey[12] gathered information from a representative sample of 11,280 households across the nation. It was aimed at examining several issues, with the main objective of providing a comprehensive collection of data in order to understand the socio-economic status of the population in Malawi (National Statistical Office (NSO) 2005)). The questionnaire was mainly on the following modules: household identification (enumeration area, village, town ,district, household identity, and name of household head), household roster (a comprehensive list of individuals connected to the household, their gender, relationship with the head and ages), education (of all household members aged five years and above), health (of all persons in the households, including chronic illness –including who diagnosed the illness - and death), time use and labour (of all household members aged five years and older), security and safety (of all household members aged ten years and older), housing, consumption of selected foods, non-food expenditures, durable goods, agriculture (size of cultivated land, crops grown, fertilizer application, type and amount of seeds, family and hired labour, crop harvest, food security, coping strategies etc), subjective assessment of wellbeing, social anthropometric information, among other modules (NSO, 2005).

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[11] We use panel data because cross sectional studies have distinct limitations. Such studies cannot capture the impacts other than those immediately preceding the interview with the respondent.
[12] This section relies on report on Integrated households surveys 2004/05 and 2006/07

The survey treated each of the twenty-seven districts in Malawi as a separate sub-section of the main rural stratum. It used a two-stage stratified sample selection process. Enumeration Areas (EAs) were used as primary sampling units (PSU). They were selected for each stratum based on probability proportional to size (PPS). In the second stage, about 20 households were randomly selected in each EA. The chances of being chosen to be enumerated were the same for every listed household (NSO, 2005).

The survey successfully interviewed 10,777 households out of a total 11,280 households selected, achieving a response rate of 98 percent. Of the chosen households, 507 replacements were made. This was done due to the fact that a dwelling could be identified but no household member was available after repeated attempts or the dwelling was not occupied at all. There were only 41 refused questionnaires from respondents (NSO, 2005).

A follow-up national survey was carried out during 2006/07. About 3,298 households were interviewed for the second time in 175 enumeration areas in 28 districts. Of these, 3,100 were formerly sampled and interviewed in the 2004/05 Integrated Household Survey (NSO 2008). Random sampling procedure was used in selecting households and enumeration areas in each district. After removing households with unavailable information, clear data errors, those who stated that they cultivated greater than 20 hectares of land, and those that could not be accurately matched, the sample was cut to 2,431 households (NSO, 2008). Thus, the final analysis is on a panel data set of 2,431 households in the smallholder sector that were interviewed both in 2006/07 and 2004/05 (NSO, 2008).

Data used in the study include inputs and output of maize production, and social economic variables. Input variables include cultivated land area (in hectares, ha) or farm size. The sizes of farms in Malawi have been described as small. Chirwa (2007) found that the average farm size was 0.35 hectares. Labour (person-hours) represents the most important input in small-scale agriculture. Thus any constraint on labour supply is can negatively affect farm productivity. Labour input can be obtained from within the family (family labour) or from the commercial market (hired labour). The amounts of person-days of family labour that a household can use is dependent on the size of the household, age range of household members, and the main occupation of members of the household. If family labour is inadequate, farmers go for hired labour. The amounts of persons-days of hired labour that a household can use for production depend on several factors including availability of hired labour and farm wage rate. Finally, the amount and type of seed used depend on size of the farm, availability of seed, seed variety, and price per kg. Fertilizer is measured in kilograms per hectare.

Social-economic variables include age, gender and education. Education plays an important role in acquiring skill and transferring technology. More educated farmers are expected to be more efficient in using inputs compared to those with lower education levels.

The study faced some methodological challenges. First, household break-up as a result of AIDS-related mortality and morbidity can bias the results. Second, the results are short-term, as households were asked about prime-age mortality and morbidity occurring one to five years earlier. Longer-term effects are most likely to be worse, especially for widows/widowers. Finally, the study does not take into account intra-household effects. To-date, almost all studies have evaluated the impact of morbidity and mortality at the household level, although it is likely that mortality and morbidity effects are passed across households. In this case, a few households may incur a shock whose effects will eventually be felt by other households in an area. This provides a challenge at methodological level.

3.2.1 Demographic characteristics of the households

Table 3.1 summarizes household characteristics for our sample. About 11.8 percent of the sampled households are affected by HIV/AIDS. This compares with the official national rates of 12 percent (2007) and 14.0 percent (2004).

Table 3.1: Descriptive statistics for sampled households (balanced panel[13] 2004/05 and 2006/07)

Households characteristics	Demographics
All households[14]	2,431
Female headed (%)	21.4
AIDS-Affected households (%)	11.8
Female headed	19.2
Prime age mortality	10.7
Female headed	56.5
Prime age morbidity	89.3
Female headed	14.6
Non-affected households [15](%)	88.2
Prime age mortality	4.4
Female headed	20.8
Prime age morbidity (chronic)	95.6
Female headed	23.5

Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

In terms of labour size, the mean sizes of the sampled households are 3.57 and 3.62 for 2004/05 and 2006/07, respectively (see Table 3.2). Affected households have a higher mean size (3.65) during 2006/07 compared to non-affected households[16] (3.60).

[13] This is a balanced panel as only households which were earlier interviewed in 2004/05 and re-interviewed in 2006/07 reported information.
[14] This represents all AIDS-affected households, non-affected households with prime-age adult mortality and morbidity, and non-affected households *without* prime-age adult morbidity and mortality.
[15] This includes non-affected households with prime-age adult mortality and morbidity and non-affected households *without* prime-age adult morbidity and mortality.
[16] The non-affected households in this table refer to both healthy households and those with non-AIDS related mortality and morbidity.

Table 3.2: Descriptive statistics for affected and non-affected households (2004/05 and 2006/07)

Households characteristics	Labour size	
	2004/05	2006/07
All households	3.57 (1.87)	3.62 (1.88)
AIDS-Affected households	3.54 (1.81)	3.65 (1.78)
Female headed	3.07 (1.69)	3.33 (1.76)
Prime age mortality	3.89 (1.95)	3.94 (2.05)
Female headed	2.69 (1.18)	3.00 (1.35)
Prime age morbidity	3.51 (1.79)	3.62 (1.75)
Female headed	3.04 (1.73)	3.33 (1.83)
Non-affected households	3.58 (1.91)	3.60 (1.94)
Female headed	2.86 (1.64)	2.97 (1.80)
Prime age mortality	3.86 (1.93)	3.37 (1.94)
Female headed	3.06 (1.36)	3.13 (1.50)
Prime age morbidity (chronic)	3.49 (1.90)	3.68 (1.94)
Female headed	2.78 (1.91)	2.91 (1.91)

Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)
Figures in parenthesis are standard errors

3.3 Farm household production theories

This section[17] reviews theoretical as well as methodological literature on technical efficiency of production. Production refers to the economic method of using inputs to produce outputs. The inputs used in the production process are known as factors of production (Mendola, 2007). The fundamental assumption in production is that maximum output can be obtained from a given combination of inputs. An understanding of theories of

[17] This section relies on Mendola (2007)

farm household production will help to understand the theoretical basis of technical efficiency of production (Mendola 2007).

Presented below are three different economic theories on the behaviour of peasant households. These theories are relevant as they form the foundation for estimating technical efficiency of production, a subject that is examined in chapter 4. The main assumption in each approach is that peasant households have an objective function to maximize production and this is subject to a number of constraints. The theories depend on several other assumptions concerning the operations of the bigger economy in which peasant[18] production is carried out. Not all assumptions can apply to all theories. However, all assumptions use the same methods in describing the behaviour of farm households. The first theory is the model of profit maximizing peasant. The main problem with these theories is that they do not account for the role of consumption in decisions on production. As a result, researchers turned their attention to the neoclassical agricultural household models. These models take into account both production and consumption objectives of farm households (Mendola, 2007).

3.3.1 Profit-maximizing Peasant Theories

Schultz's (1964) hypothesis states that most farm households in less developed countries are poor but efficient. This sparked a vigorous debate among economists and led to an increase in empirical research to test the hypothesis.

Ideally, Schultz (1964) stated when peasant households make decisions on production, their objective is to maximise profit. He assumed that there is perfect competition, where all producers charge the same prices and workers are paid the value of their marginal product, firms that are not efficient are forced out of the business and entrepreneurs do not display diminishing marginal utility of their income. His hypothesis has elements of both allocative and technical efficiency[19] (Schultz, 1964).

Several studies have tried to test whether peasant households are allocatively efficient or not. In other words, they have tried to find out whether peasants maximising profit or not. The results from these studies have been mixed (see Bliss and Stern, 1982). The main issue in this approach is that profit maximization has two components. The first is the

[18] A peasant is an agricultural worker who subsists (survives or lives) by working on a small plot of land.
[19] Allocative efficiency refers to the optimal distribution of resources by the market. On the other hand, technical efficiency is the effectiveness with which a given set of inputs is used to produce an output

behavioural component, which is about household motivation. The second is the technical-economic component, which is about the farm performance as a business entity. A high proportion of research work on farm or firm efficiency deal more with technical efficiency outcomes and less with the decision making process. However, research work on household behaviour has been growing over time. Researchers have criticized the profit maximisation theory, pointing to trade-offs between profit maximization and other household goals, and also the role of uncertainty and risk in decisions on the farm household production (Mendola, 2007).

3.3.2 Utility Maximization Theories

Mendola (2007) states that various utility maximization theories have been used to study peasant production behaviour. The main difference between these theories and peasant theories of profit maximising is that these theories take into account the complex nature of peasant households – that they can both be families and enterprises. Thus they are able to take into consideration peasants decisions on consumption (Mendola, 2007). The most prominent work on this issue is Chayanov's work in the 1920s. The Chayanova model highlighted the role of family size and composition in the economic behaviour of peasants. He conducted his analysis using by assessing household labour in the absence of the labour market (Chayanov, 1966).

The Chayanov model assumes that labour market exists and the household is able to hire or hire out labour. This model allows peasants to make best possible production decisions on use of labour. It also assumes that peasants make best possible decisions on consumption. However, these sets of decisions are distinct and are made against the other uses of time. The neoclassical model raised the scope of the Chayanovian model and by assuming perfect market. It became popular in the 1960s in explaining the behaviour of farm households when they simultaneous make decisions about consumption and production. This model takes into account household income (Becker 1965) and treats the households as a production unit that transforms purchased goods and services as well as its own resources into consumable utilities (Mendola, 2007).

It assumes that a household maximises utility in consumption of all commodities subject to constraints in available income. The model makes the following other assumptions: all markets are operational, all goods can be traded, all prices are exogenously determined, and production decisions are independent of consumption decisions. In such a scenario, any decision making process is treated separately. For instance, time spent on leisure and time used in production becomes independent. The use of family labour depends on market determined wages and income is the only factor that links production and consumption (Mendola, 2007).

Without the labour market, just as in the Chayanovian model, decisions cannot be separate, as the family has to make a decision on how much of its total time should be allocated to production. Thus the "separability condition" between decisions on consumption and production is not applicable. The process of decision making becomes 'circular", as consumption influences income and income in turn influences consumption (Mendola, 2007).

Thus the strength of "recursive modelling" of household resource allocation rests on the fact that the household is price-taker and markets are perfect for both output and inputs, including labour and capital (Mendola, 2007). In real life, however, household in developing countries often face various market imperfections which makes it difficult for first-best transactions and investments to take place. In instances where researchers have tested for recursivity in farm household decision-making, evidence show negative results (Bardhan and Udry, 1999). Thus, theoretical progress on farm household models with missing markets resulted in neoclassical economists conducting new research. They assumed that the objective of the household is still to maximise utility from a list of consumption, but subject to numerous constraints. One of the constraints on households is missing market. Empirical research also concentrated on finding evidence of market inefficiencies and the impact of these on household production choices (Mendola, 2007)

However, these theories have serious shortfalls in their ability to describe peasant economies. Just as in the profit maximising theory, they don't take into account the risk and uncertainty in peasant production and the social context in which peasant production is carried out, which has no influence on farm household behaviour (Mendola, 2007). Additionally, most of the models are not dynamic and assume that there is no uncertainty about the future i.e. households are 'risk neutral'. When carrying out empirical tests on farm household models, important issues include research focus, analysis and available data result, simplified in terms of both the objective function and the constraints (Taylor et al 2003). However, this attracted criticisms especially when taking into account uncertainty, and thus risk aversion starts playing essential roles in understanding farm household production decisions (Mendola, 2007).

The second household model is the Barnum-Squire farm household model. This model has three objectives in household utility function namely home time, own food consumption, and market purchases. This result in three sets of trade-offs between the goals. One example of prediction is that an increase in the market wage results in a reduction total farm output, an increase in farm work time, and a drop in hired labour and a rise in the amount of consumption at home. The role of profit is more important in determining how households respond to changes in input and output prices. The profit effect is as a result of increasing or reducing farm profit as a result of household consumption choices. For example, an increase in output price would normally lead to a reduction in own consumption of food staple. However, the profit effect causes own consumption to increase and thus reduces market supply response. The strength of the Barnum-Squire model is its ability to conduct general equilibrium analysis of the whole peasant economy using outcome of peasant decisions in output and input markets. One weakness of the model is that it depends on competitive markets to apply its results. However, this model may not be appropriate for Malawians farmers as the majority of the smallholder farmers produce for their own household consumption.

The third model is the Low (1986) farm household model. This model explains the stagnation of farm output in southern Africa. It assumes that there are different wage rates exists for different household members depending on their levels of productivity. Wage rates are calculated in real terms i.e. in terms of their purchasing power. Thus the percentage of household labour involved in non-farm activities depends on both money and the consumer price of food.

Both the Barnum Squire and Low models highlight the importance of labour market in the operations of the peasant economy. One important issue is that one can only evaluate the impact of an increase in output on market on market supply using product and labour markets. Low's model explains the division of labour between women and men by referring to 'comparative advantage' in wage earnings versus farm productivity.

3.3.3 The Risk-averse Peasant

Peasant farm production faces high levels of uncertainty. The uncertainties are due to natural shocks such as natural shocks, market instability and social uncertainty. These conditions create risks to peasant production and make farmers to be very careful in making decisions (see Ellis, 2000). Thus, it is not unexpected that farmers are usually assumed to be 'risk averse' when making decisions. Lipton and De Kadt 1988 criticise the profit approach by showing how the assumption of risk and uncertainty raises questions about the theoretical foundation of the profit maximising model. He claimed that small-farmers are generally risk averse, as they have to make sure that they are able to meet their household needs from the current production or face starvation (Mendola, 2007). As a result, they cannot aim for higher income levels by taking risky decisions (Lipton and De Kadt 1988).

There are two approaches to the issue of farm household's risk aversion, namely, the standard expected utility theory and the disaster avoidance approach. According to the standard expected utility theory, farm households make choices, from existing risky choices, based on appeal. This normative approach is has a number of assumptions based on the Von Neumann-Morgenstern expected utility model (see Mas-Colell, Whinston) and on a hypothesis that the objective of peasants is to maximize utility. The utility function reflects the household behaviour and its revealed attitude towards risk. Assuming other things constant, a risk-averse household would prefer to have a stable consumption over time compared to unstable one. This entails that households are risk-averse in making choices on productive activities (see Morduch, 1994).

Some analysts have devised allocative choice models that do not depend on calculating expected returns to several alternative prospects and the knowing the probability distributions of the outcomes. This was after noting that peasant farmers usually face difficult risks. Roumasset's (1976) criticizes the expected utility theory, stating that the theory has such weaknesses as measurement of risk aversion and the lack of decision costs. He further stated that expected utility maximisation can be expressed as a full optimality model because they specify the best a person can do subject to the certain constraints. But, it does not specify how peasants make the choices, and thus it ignores roles of costs in decision making behaviour under uncertain conditions (Mendola, 2007). As underlined by Roumasset (1976), when costs of getting information are high, it is not rational for an individual to choose the best option. When one orders the choices beforehand, then one is likely to make comparisons. But after comparing the alternatives, choosing the best alternative is not that easy (Roumasset, 1976).

Thus, the ‘full optimality approach’ appears a weak factor that one can use to describe to describe how small peasant farmers make their decisions in developing countries. On the other hand, most analysts found it logical to assume that individuals act according to experience (see Dasgupta, 1993).

Those opposing the full optimality approach in peasant production modelling have come up with a different idea of explaining household production behaviour at low level of income in unpredictable environment. One assumption is that when faced with risky income flows, households at first use safety as a deciding factor, and from among safe options they choose one with the highest expected and income (Mendola, 2007). These models are called ‘safety first’ choice models under uncertainty. In this case, it is assume that the decision-maker makes sure there is survival for himself and hence desires to evade danger of his income dropping below minimum levels. Therefore, risk is treated as the probability that the variable of interest (income) will take a value less than minimum level (Mendola, 2007). This safety-first principle results in a household preferring either risky income levels or less-risk choices. In other words, there is no basis why individuals should behave in line with the expected-utility theory when faced with very low levels of income. In such circumstances, an individual has no other option but to avoid disaster (Dasgupta 1993).

Hence, the ‘safety-first’ approach is appealing because it is a positive way of identifying some specific behaviour from the expected utility theory near threshold income levels. Indeed, the safety-first model takes into account the strong points from both the behavioural and full optimality approaches to model risky choices in low income farmers. At a practical level, these two views do not represent different courses of actions. However, they may depend on the choices and initial conditions. From a broader view, though, although utility maximisation theory cannot underscore issues like acute poverty and insecurity, which form part and parcel of peasant life, the safety first theory takes into account these aspects in describing peasant behaviour in rural areas (Mendola, 2007).

3.4 Economic theory of consumer choice

Classical economic theory assumes that consumers try to maximise their self interest. It assumes that self interest is consistent across different decisions. Tausing (1912) states that an object can only have value if it has utility. John Hicks and Paul Samuelson worked on the concept of rational consumer behaviour in their analysis of classical theory. According to Herb Simon, the rational man of economics is a maximizer, who will settle for nothing less than the best. Theorists agreed on the issue of diverse preferences; however this issue was never addressed in empirical studies of market demand that used the representative consumer tool (McFadden, 2000)

As microeconomic data became available in the 1960s, econometricians started getting interested in findings ways of specifying individual agent behaviour. In a prominent paper on psycho-physical discrimination, Thurstone (1927) suggested the law of comparative judgement for alternatives choices. This resulted in a binary probit model looking at how respondents distinguish among alternative choices. Marschak (1960) introduced Thurstone work into economics. He investigated the theoretical implications for choice probabilities of maximising utilities. Marschak named this the Random Utility Maximization (RUM) Model (McFadden, 2000).

Through his study of choice behaviour, Luce (1959) brought up the concept of an 'Independent from Irrelevant Alternatives' (IIA) axiom. The IIA axiom made it easier to collect choice data by enabling people to make inferences of multinomial choice probabilities from binomial choice experiments. McFadden (1968, 1976) formulated the multinomial logit model for discrete responses. He estimated it using the maximum likelihood. Multinomial logit model is an extension of binomial logit model, which is usually for two alternative choices. The development of the multinomial logit model for discrete responses sparked widespread attention because of its direct link to consumer theory connecting unobserved preference heterogeneity to demand (McFadden, 2000).

3.5 Models for technical efficiency

This section examines models that are used for measuring technical efficiency. Models of technical efficiency fall under two main groups: parametric frontier approach and non-parametric frontier approach. The main models under parametric approach include Battesse and Coelli (1992; 1995), and Huang and Liu (1994) and the normal-gamma stochastic frontier model. On the other hand, the most common estimation technique under the non-parametric approach is the Data Envelopement Analysis (DEA).

Production frontiers were proposed by Farrell (1957) and they attempt to measure technical efficiency. The frontier identifies the boundary to a series of possible observed production (cost) levels and identifies the extent to which the firm lies below (above) the frontier.

3.5.1 Technical efficiency of production

Substantial empirical work has been conducted on efficiency since the ground-breaking work of Farrell (1957). Several approaches have been proposed to measure productive efficiency. These have been grouped into non-parametric frontiers (Meller, 1976) and parametric frontiers (Aigner, 1977).

a) Non-parametric frontier/full frontier/linear programming approach

The main assumption of the non-parametric approach is that all observations are positioned on or below the frontier, with all variations from the frontier being due to inefficiency[20] (Battese and Coelli 1995). They make use of linear programming techniques. Battese and Coelli (1995) state that the most common non-parametric approach is the Data envelopment analysis (DEA). The DEA assumes whole distance to the frontier as inefficiency. This results in including exogenous events in the inefficiency term. Battese and Coelli (1995) mentions two main advantages of the DEA approach in estimating efficiency scores. Firstly, it does not one to specify beforehand a functional form of the link between output and input. Instead, the DEA assumes that the frontier envelops the data tightly. Secondly, there are no assumptions about the error term. Furthermore, the DEA allows for several inputs and outputs. The main drawback is that it is not stochastic and, and thus it is not possible to separate technical efficiency from random noise (Lovell 1993). Furthermore, estimates of technical efficiency are subject to errors (Forsund et al. 1980).

b) Parametric stochastic frontier / econometric approach[21]

The parametric approach is mainly used when dealing with single output production technology. The approach makes assumptions about the mathematical form of the model and data. It uses econometric methods to measure technical efficiency. The most common

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[20] The non-parametric approach requires no functional form for the production function and one is not required to make assumptions about the error term.

[21] The parametric/econometric/stochastic frontiers production method was suggested first by Aigner et al.(1977) and Meeusen and Van den Broeck (1977)

functional form of the parametric approach is the stochastic production function. Unlike the DEA, the stochastic frontier divides the distance to the frontier into random error and inefficiency. The random error takes into account exogenous shocks. The main advantage of the approach is that it accounts for the traditional random error[22] of regression. Battese and Coelli (1995) recommend the stochastic production frontier framework for application in agricultural studies because measurement errors, missing variables and weather are likely to play a significant role in agriculture. Criticisms of this method include the need to specify in advance the mathematical form of the production function and the distributional form of the inefficiency term.

3.5.2 The Stochastic Frontier Production Function

Technical efficiency of production is denoted $TE(y,x)$. The most commonly used production function is the single output production frontier. Battese and Coelli (1995) specified output function as follows:

Let $y \leq f(x)$ (3.2)

where equation 3.2 represents the production function for the single output, y, using input vector, x. They then specified an output-based measure of technical efficiency as follows:

$$TE(y,x) = \frac{y}{f(x)} \leq 1 \quad (3.3)$$

Equation 3.3 represents the standard method of measuring of total factor productivity. As advised by Battese and Coelli (1995), the econometric framework represents the Debreu-Farrell interpretation of a production function. They started with a model of the following type:

$$y_i = f(x_i, \beta)TE \quad (3.4)$$

where $0 < TE(y_i, x_i) \leq 1$, β is a set of parameters of the production function to be estimated, and i are the indices of the *i*-th of the N farm households.

The production function is usually translog and takes the following form:

$$\ell n y_i = \ell n f(x_i, \beta) + \ell n TE_i = \ell n f(x_i, \beta) - u_i \quad (3.5)$$

where $u_i \geq 0$ is a measure of technical inefficiency since $u_i = -\ell n TE_i \approx 1 - TE_i$

[22] This takes into account measurement errors and external shocks e.g. weather.

Note that

$$TE_i = \exp(-u_i) \qquad (3.6)$$

3.5.3 Stochastic frontier models

The stochastic frontier production function, was suggested by Aigner et al. (1977) and Meeusen and van den Broeck (1977). It has been applied and modified or extended in various empirical works. The motivation of the model is that divergences from the production frontier that may not necessarily be under control of farm households.

The model had a disturbance term with two components, representing random effects and another representing technical inefficiency.

Battese and Coelli (1995) expressed the model in the following form[23]:

$$y_i = x_i\beta + (v_i - u_i) \qquad i=1,\ldots,N, \qquad (3.7)$$

where y_i represents production of the farm household *i* in logarithm; x_i is the k *1 set of input units of the firm *i*;

β represents a set of unknown coefficients; the v_i is the symmetric error term assumed to be *iid* as $N(o,\sigma_v^2)$;

u_i is the second error term assumed to be *iid* (independently and identically distributed) and represents technical efficiency in production and are assumed to N(o,σ_u^2) distribution.

Empirical literature is replete with different models of technical inefficiency. Researchers have developed technical inefficiency models to handle panel data. This section will review three parametric models for technical inefficiency effects. These models are those suggested by Battese and Coelli (1992, 1995) and Huang and Liu (1994). While the first and second models were suggested for panel data, the third was initially suggested for cross-sectional data, but later extended to use panel data. Common to all the models is the assumption that data is available for a sample of *N* farm households over *T* time periods. The first two models can handle both balanced and unbalanced panel data.

a) Battese and Coelli (1992) Time varying model for panel data

This stochastic frontier production function is a simple exponential form of time varying farm household effects. In the time-invariant model, the inefficiency term is assumed to

[23] The equations under this sub-section rely on Coelli (1996) ; Battesse and Coelli (1995)

have a truncated normal distribution. In the time varying model, the inefficiency term is modeled as a truncated normal random variable multiplied by a specific function of times. The model takes into account unbalanced panel related to observations on a sample of N farm households over T time periods. They specified the model as follows:

$$y_{it} = f(x_{it};\beta)\exp(v_{it} - u_{it})$$

and

$$u_{it} = \eta_{it} u_i = \{\exp[-\eta(t-T)]\} u_i \qquad t \in \mathcal{J}(i);\ i = 1, 2, \ldots, N; \qquad [3.8]$$

where y_{it} represents the production for the household *i* at the period *t* of the observation; $f(x_{it};\beta)$ is a function of vector, x_{it}, which represents factor inputs and household-specific variables related with the production of the household *i* in the period *t* of observation and a set, β, of unknown coefficients;

the $v_{it}'s$ are assumed to be *iid* $N(0,\sigma_v^2)$; $u_i's$, i = 1, …, N, are non-negative variables, representing technical efficiency and assumed to be *iid* with truncations at zero following $N(\mu,\sigma^2)$ distribution;

η is unknown scalar parameter;

and t represents time periods (Battese and Coelli 1992).

This model relates the technical inefficiency effects follow an exponential function. By imposing one or more restrictions on this model, one can come up with a number of special cases which have been documented in empirical studies.

Utilizing the parameterization of Battese and Corra (1977), Battese and Coelli (1992) replace σ_v^2 with $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$. They obtained maximum likelihood estimates for coefficients of the model using the γ-parameter. The model assumes that the parameter, γ, carries values between 0 and 1. Thus the model searches for values within this range.

With the specification in model (3.8), Battese and Coelli (1992) obtained the minimum-mean-squared error estimation of the efficiency levels of household *i* at period *t*, $TE_{it} = \exp(-U_{it})$ defined as follows:

$$E[\exp(-U_{it}) \mid E_i] = \left\{ \frac{1-\Phi[\eta_{it}\sigma_i^* - (\mu_i^* / \sigma_i^*)]}{1-\Phi(-\mu_i^* / \sigma_i^*)} \right\} \exp\left[-\eta_{it}\mu_{it}^* + \frac{1}{2}\eta_{it}^2\sigma_i^{*2} \right] \quad (3.9)$$

where E_i stands for the $(T_i * 1)$ vector of E_{it}'s observed for household *i*, where $E_i = V_{it} - U_{it}$

$$\mu_{it} = \frac{\mu\sigma_v^2 - \eta_i' E_i \sigma^2}{\sigma_v^2 + \eta_i'\eta_i\sigma^2} \quad (3.10)$$

$$\sigma_i^{*2} = \frac{\sigma_v^2\sigma^2}{\sigma_v^2 + \eta_i'\eta_i\sigma^2} \quad (3.11)$$

where η_i represents $T_i * 1$ set of η_{it}'s related to the time period for household *i*.

The mean technical efficiency of households at the *t*-th time period,

$$TE_t \equiv E[\exp(-\eta_t U_i)], \qquad \text{where } \eta_t = \exp[-\eta(t-T)], \quad (3.12)$$

This can be obtained by integration with the density function of U_i, is

$$TE = \left\{ \frac{1-\Phi[\eta_t\sigma - (\mu/\sigma)]}{[1-\Phi(-\mu/\sigma)]} \right\} \exp\left[-\eta_t\mu + \frac{1}{2}\eta_t^2\sigma^2 \right] \quad (3.13)$$

Assuming firm effects are time invariant, and then the mean technical efficiency of the firms can be obtained from the above equation by substituting $\eta_t = 1$.

Using parameterization of the model suggested by Battese and Corra (1977), Battese and Coelli (1992) expresses the log likelihood function expressed by:

$$L^*(\theta; y) = -\frac{1}{2}\left(\sum_{i=1}^{N} T_i\right)\left\{\ell n(2\pi) + \ell n(\sigma_s^2)\right\} - \frac{1}{2}\sum_{i=1}^{N}(T_i - 1)\ell n(1-\gamma)$$

$$-\frac{1}{2}\sum_{i=1}^{N}\ell n[1 + (\eta_i'\eta_i - 1)\gamma] - N(\ell n(1-\phi(-z) - \frac{1}{2}Nz^2 \text{ls}$$

$$+\sum_{i=1}^{N}\ell n[1-\phi(-z_i^*)] + \frac{1}{2}\sum_{i=1}^{N} z_i^{*2}$$

$$-\frac{1}{2}\sum_{i=1}^{N}(y_i - x_i\beta)'(y_i - x_i\beta)/(1-\gamma)\sigma_s^2 \qquad (3.14)$$

where $\theta \equiv (\beta', \sigma_s^2, \gamma, \mu, \eta)'$, $z \equiv (\frac{\mu}{\gamma}\sigma_s^2)^{1/2}$ and

$$z_i^* = \frac{\mu(1-\gamma) - \gamma\eta_i^*(y_i - x_i\beta)}{\{\gamma(1-\gamma)\sigma_s^2[1+(\eta_i^{'}\eta_i - 1)\gamma]\}^{1/2}}$$

Literature offers a number of models that one can consider for applications. According to Battese and Coelli (1992), one can assume that inefficiency effects either follow a truncated normal distribution or follow a half normal distribution. When using panel data, one assumes whether the inefficiencies are time varying or they are time-invariant (Battese and Coelli, 1992). Battese and Coelli (1995) recommends that when making such decisions, one must first estimate the various alternative models and then select a preferred model using likelihood ratio tests.

For instance, by assuming a half normal distribution of u_i, they suggested that efficiency levels can be obtained as follows:

$$E[\exp(-u_{it})] = 2[1 - \Phi(\sigma\sqrt{\gamma})]*[-\gamma\sigma^2/2)] \qquad (3.15)$$

b) The Huang and Liu (1994) specification

This is a non-neutral stochastic frontier function which relates household-specific variables with input variables. Huang and Liu (1994) specified the model as follows:

$$u_{it} = z_{it}\delta + z_{it}^*\delta^* + w_{it} \qquad (3.16)$$

where z_{it}^* represents values of relationships involving the variables in z_{it} and x_{it}, and δ^* is represents coefficients.

Since the inefficiency effects model in equation (3.16) has an intercept parameter, household-specific variables and time observation, then the vector, z_{it}^*, can only contain the different products of the input variables in x_{it} and the variables in z_{it} (Battese and Coelli, 1995).

Equation 3.16 is termed a *non-neutral* stochastic frontier because the inefficiency effects depend on values of the input variables, and this makes the stochastic frontier not to be a neutral shift of the intercept for different firms and time periods. The technical inefficiency effects suggest that any shifts in the frontier for different households are dependent on input variables levels. Furthermore, the marginal products and elasticities of the mean production for different households dependent on household-specific variables, specified in the vector of independent variables, z_{it}. Huang and Liu (1994) specify the null hypothesis that the stochastic frontier model is a neutral shift of the average response function is specified, in terms of equation 3.3 as $H_0 : \delta^* = 0$ (Battesse and Coelli, 1995).

Household *i*'s technical efficiency in time *t* is specified as

$$TE_{it} = \exp(-u_{it}) \qquad (3.17)$$

where u_{it} is defined by the specification of the different inefficiency models (Battese and Coelli, 1988).

c) The Battese and Coelli (1995) inefficiency frontier model

The authors proposed a stochastic production frontier for panel data with firm, household or individual effects assumed to follow a truncated normal distribution, and which are also allowed to vary with time. They expressed the time varying inefficiency models as follows:

$$y_{it} = x_{it}\beta + (v_{it} - u_{it}) \qquad i=1,\dots,N,\ t=1,\dots T, \qquad (3.18)$$

where y_{it} is the logarithm of production of household *i* in time period *t*; x_{it} are input quantities of household *i* time period *t*

β represents unknown coefficients;

$v_{it}s$ are the statistical disturbance term assumed to be *iid* $N(o, \sigma_v^2)$.

$u_{it}s$ the second component of disturbance term, non-negative and representing technical inefficiency. $u_{it}s$ are assumed to be *iid* and are obtained by truncations (at zero) with mean $z_{it}\delta$ and variance, σ^2. $u_{it}s$ are assumed to be a function of a set of independent variables, the $z_{it}s$ and unknown set of coefficients, δ.

Battese and Coelli (1995) specify the technical inefficiency effects as follows:

$$u_{it} = z_{it}\delta + w_{it} \qquad (3.19)$$

where z_{it} represent independent variables that determine technical inefficiency, δ is an (*M * 1)* represents coefficients, and w_{it} s represent technical efficiency.

One might get different means for different households and time periods. However, the variances are assumed to be constant.

Given the specification of equation 3.18, the authors specify that null hypothesis that the technical efficiency effects are not random as $H_0 : \gamma = 0$, where $\gamma = \sigma^2 /(\sigma_v^2 + \sigma^2)$. They make this specification with the estimation of the likelihood ratio in mind. The parameter γ is supposed to lie between 0 and 1. This specification has been put to use in various empirical applications over the past two decades (Battese and Coelli 1995).

Furthermore, Battese and Coelli (1995) specify the null hypothesis that the technical inefficiency is not influenced by the independent factors in equation 3.19 as $H_0 : \delta' = 0$, where δ' denotes the vector, δ.

One may look at Battese and Coelli (1995) model as a special case of the Huang and Liu (1994) specification in which the parameters in the vector, δ, are assumed to be zero. Various extensions have been suggested in literature.

d) The normal-gamma stochastic frontier model

This model extends the normal-exponential model. It was proposed by Greene (1980) who specified the model as follows:

$$f(u) = \theta^p / \Gamma(P) \exp(-\theta u) u^{p-1} \qquad (3.20)$$

This specification offers a more flexible parameterization of the distribution. Assumptions one makes about the value of *P* will lead to assumptions how the inefficiencies are distributed (Green, 1990).

Greene (1990) derives the log likelihood function and specified the log likelihood of the normal-exponential (*NE*) model as follows:

$$\log L_{NE} = N\left(\log\theta + \frac{1}{2}\theta^2\right) + \sum_{i=1}^{N}\{\theta\varepsilon_i + \log\Phi[-(\varepsilon_i / \sigma_v + \theta\sigma_v)]\} \qquad (3.21)$$

Where $\varepsilon_i = y_i - \beta' X_i$

Green (1990) further specified the log likelihood for the normal-gamma (*NG*) model as follows:

$$\log L_{NG} = \log_{NE} + N[(P-1)\log\theta - \log\Gamma(P)] + \sum_{i=1}^{N} \log h(P-1, \varepsilon_i) \qquad (3.22)$$

$$h(r, \varepsilon_i) = \frac{\int_0^\infty z^r (\frac{1}{\sigma_v})\phi(\frac{z-\mu_i}{\sigma_v})dz}{\int_0^\infty (\frac{1}{\sigma_v})\phi(\frac{z-\mu_i}{\sigma_v})dz}, \qquad \mu_i = -\varepsilon_i - \theta\sigma_v^2 \qquad (3.23)$$

3.5.4 Data Envelope Analysis (DEA)

Data envelopment analysis is used in estimating relative efficiency of economic decision units similar to one another in terms of goods and services they produce. DEA was originally suggested by Farrell (1957) and uses linear programming as an efficiency measurement technique based on combinations of inputs and outputs. Efficiency measures are then computed relative to this surface (Coelli, 1996). Charnes et al. (1978) suggested a DEA model with constant returns to scale as its assumption (CRS). Other later papers considered other sets of assumptions such as Banker et al. (1984) who proposed a variable returns to scale (VRS)[24].

a) The Constant Returns to Scale Model

This model is calculated the DEA in form of a ratio. For each Decision Making Unit (DMU)[25], they get ratio of all outputs given all inputs, as $u' y_i / v' x_i$, where u represents weights of output and v represents weights of input. In order to obtain optimal weights, they denote the mathematical programming function as follows:

$$\max_{uv} (u' y_i / v' x_i),$$

$$\text{s.t.} \quad u' y_j / v' x_j \le 1 \qquad j=1,2,\ldots,N \qquad (3.24)$$

$$u, v \ge 0$$

[24] This chapter draws from Battesse and Coelli 1995

[25] The term Decision Making Unit is used to refer to any entity that is to be evaluated in terms of its ability to convert inputs into outputs

This entails obtaining values for u and v in order to maximise the estimate of efficiency for DMU *i*. One problem that arises with this ratio form is it that number of solutions obtained is infinite[26].

b) The Variable Returns to Scale Model

To avoid the problem of an infinite number of solutions in 3.24, Banker, Charnes and Cooper (1984) suggested extensions to the model by assuming a constraint $v'x_i = 1$, which results in the Variable Returns to Scale (VRS) model specified as:

$$\max_{\mu,v}(\mu' y_i),$$

$$\text{s.t.} \quad v'x_i = 1$$

$$\mu' y_j - v'x_j \leq 0, \qquad j=1, 2,\ldots,N \qquad (3.25)$$

$$\mu, v \geq 0$$

Where the change in notations from u and v to μ and v is a result of the transformation developed by the authors. They called this the multiplier form of the linear programming problem. The authors then derived an equivalent form and specify it as follows:

$$\min_{\theta\lambda} \theta$$

$$\text{s.t.} \quad -y_i + y\lambda \geq 0 \qquad (3.26)$$

$$\theta x_i - x\lambda \geq 0$$

$$N1'\lambda = 1$$

$$\lambda \geq 0$$

where θ is a scalar, λ represents a set of constants, $N1'\lambda$ is an N x 1 set of ones. This form, known as envelopment form, entails having fewer constraints compared to the multiplier form (K+M<N+1) and as a result, researchers prefer it in estimations. The value θ is the estimated efficiency for the firm *i*. It is satisfied when θ<1, where a value of one implies that a point is on the frontier, and hence the firm is technically efficient (Coelli, 1996).

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[26]That is if (u^*, v^*) is optimal, then (αu^*, αv^*) is another solution, also optimal for $\alpha > 0$

3.6 Review of discrete choice models

Discrete choice models can be classified in two ways. The first classification is based on the number of available alternatives. There are binomial choice models, which deal with two available alternatives, and there are multinomial choice models, which deal with three or more available alternatives. The second classification is based on whether the choices are ordered or unordered. In ordered choice models, the dependent variable follow a normal order of alternatives e.g. larger values are associated with higher outcomes. In unordered choice model, the dependent variables take values that can be counted (Cameron and Trivedi, 2005 and Wooldridge, 2002).

Discrete choice models that deal with multiple choices include multinomial and conditional logit, multinomial probit, nested logit, generalized extreme value models, mixed logit, exploded logit, multivariate probit, and random parameters logit. Multivariate probit and random parameters logit are estimated using simulation methods such as Bayesian methods. The commonly used multinomial models for ordered data are ordered logit and probit. Since this study is dealing with unordered multinomial choices, we will only review models under this category.

3.6.1 The multinomial logit and conditional logit model

The standard model for unordered multinomial choices is the multinomial (polytomous) logit model. The model assumes that explanatory variables (regressors) contain only individual characteristics e.g gender. Following Cameron and Triveldi (2005) and Wooldridge (2002), and specify multinomial logit model is specified as follows:

$$p(y_i = j = p_{ij} = \frac{e^{X_i^{'}\beta_j}}{\sum_{k=0}^{J} e^{X_i^{'}\beta_k}} \quad \text{for } j=0, \ldots, J \qquad (3.27)$$

Where y_i is a random variable that represents the choice made, x_i represents characteristics for individual *i*, and β_j is a set of coefficients for the *j*-th alternative. Thus the model involves choice specific coefficients and only individual specific regressors. For the identification of the model, it is usually assumed that $\beta_0 = 0$. The multinomial logit model reduces to the binary model if $J = 1$.

Where regressors differ according to alternatives (for example, prices), the appropriate model to use is the conditional logit model, specified as

$$p_{ij} = \frac{e^{X'_{ij}\beta}}{\sum_{j=1}^{J} e^{X'_{ik}\beta}} \tag{3.28}$$

Both multinomial and conditional logit models assume that the error term, ε_{ij}, is independent. This implies that there are no similarities among the alternatives. In other words, the odds-ratio between the two alternatives does not change when one includes or leaves out any other alternative (Cameron and Trivedi, 2005; and Wooldridge, 2002). This is property is commonly known as the independence from irrelevant alternatives (the IIA-property).

3.6.2 Mixed logit model

One way of avoiding the IIA property (i.e. allow correlations across alternatives) is using the mixed logit model. The mixed logit model can estimate any random utility model. Mixed logit deal with the three limitations of a standard logit: it assumes that random tastes can vary, it also allows substitutions patterns to differ, and it can also be used to capture correlations over time. This model is not restricted to normal distributions. It is called mixed because it combines aspects of the multinomial logit model and conditional logit model. It includes the characteristics of both the alternatives and the individual in examining consumer choice. Following Cameron and Trivedi (2005) and Wooldridge (2002), we specify the mixed logit model is specified as follows.

$$p_{ij} = \frac{e^{x'_{ij}\beta_i}}{\sum_j e^{x'_{ij}\beta_i})} \tag{3.29}$$

where x_{ij} vary over alternatives and w does not vary over alternatives

Mixed logit allows the unobserved factors to follow any distribution. The unobserved component in a mixed logit model is divided into two components. The first component has all the correlation and heteroskedasticity, while the second component is *iid* extreme value.

3.6.3 Nested logit model

Another alternative model is the *nested logit model*. In this model, the researcher has sets of choices. This allows for correlation between unobserved components of choices in a nest. However, it assumes no correlation among nests. Assuming the sets of choices {0, 1, …,*J*} and of coefficients B_1, …, B_s. Then set the conditional probability of choice *j* given that your choice is in the set *Bs,* be equal to

$$p(y_i = j \mid x_i, y_i \in Bs) = \frac{\exp(p_s^{-1} x_{ij} \beta}{\sum_{l \in Bs} \exp(p_s^{-1} x_{il}^{'} \beta)} \quad (3.30)$$

for $j \in Bs$, and zero otherwise (see Cameron and Trivedi 2005; Wooldridge 2002).

3.6.4 Multinomial probit model (MNP)

The multinomial probit model is the most general framework used for studying discrete choice models. It allows correlation between all alternatives. The model assumes that the unobserved part of the utility function follows a multivariate normal distribution. It relaxes the covariance matrix by assuming that there are correlations between the residuals. However, this approach has not been regularly used in empirical literature because it involves evaluation of multiple integrals. New developments in computer speed and use of simulation techniques in estimation have made other approaches to be good alternative options. The multinomial probit model is theoretically attractive. However, it has some practical drawbacks. Its response probabilities are very complex as they involve a *J+1* dimensional integral. This complexity renders estimating partial effects and response probabilities for more alternatives practically impossible. The appealing aspect about this model is that is that there are no limitations on choices that are close substitutes. The difficult part of the unrestricted multinomial probit approach is that when one is faced with a reasonable number of choices, one has to estimate a large number of parameters: all elements in the $(J + 1) \times (J + 1)$ dimensional Ω minus some normalizations and symmetry restrictions (Cameron and Trivedi, 2005; Wooldridge, 2002).

Cameron and Trivedi, 2005 and Wooldridge, 2002 specify a three choice multinomial probit model as follows:

$$p_1 = \Pr[y = 1] = \int_{-\infty}^{\tilde{v}_{31}} \int_{-\infty}^{\tilde{v}_{21}} f(\tilde{\varepsilon}_{21}, \tilde{\varepsilon}_{31}) d\,\tilde{\varepsilon}_{21}\, d\,\tilde{\varepsilon}_{31} \quad (3.31)$$

where $f\,(\varepsilon_{21},\ \varepsilon_{31})$ is a bivariate normal with two free covariance parameters and v_{21} and v_{31} depend on explanatory variables and parameters $\boldsymbol{\beta}$. This bivariate normal integral can be examined empirically. A trivariate normal integral is the limit for numerical methods, as it limits the standard numerical integration methods to a MNP model with four choices.

When dealing with a larger model, one can use simulation methods. For simplicity's sake, model 3.31 assumes an MNP model with three choices. One can use the frequency simulator to get an approximated estimate of p_1 by the fraction of draws of $(\varepsilon_{21}, \varepsilon_{31})$ that are less than $(v_{21},\ v_{31})$. It is difficult to get an accurate estimate of all these covariance parameters, just by using first choice data (as opposed to scenario with first and second choices). For one to make a prediction about a new good, one would need to specify correlations with all other goods.

3.6.5 Multivariate probit model

A multivariate probit model is comparable to seemingly unrelated models (SUR) for M binary variables. According to the multivariate probit model, the probability that $Y_i = y_i$, based on parameters β, $\sum$ and a set of regressors x_{ij}, is give by

$$pr(Y_i = y_i \mid \beta, \sum) \equiv pr(y_i \mid \beta, \sum) = \int_{AiJ} \ldots \int_{Ai1} \phi_J\,(t \mid 0, \sum)dt \qquad (3.32)$$

Where, $pr(Y_i = y_i \mid \beta,\ \sum)$, is the density of a J-variate normal distribution with mean vector zero and correlation matrix, $\sum$. , is the interval.

It is $A_{ij} = \begin{cases} (-\infty, x_{ij}^{'}\beta_j) \\ (x_{ij}\beta_j, \infty) \end{cases}$ infeasible to conduct a direct maximization with more than 3-5 choices.

$$y_1^* = \beta_1^{'} x_1 + \varepsilon_1,\ y_1 = 1(y_1^* > 0)$$

$$y_2^* = \beta_2^{'} x_2 + \varepsilon_2,\ y_2 = 1(y_2^* > 0)$$

$$\ldots$$

$$y_m^* = \beta_m^{'} x_m + \varepsilon_m,\ y_m = 1(y_m^* > 0)$$

The multinomial probit model has m equations. Estimation requires evaluating the m-order integrals (Cameron and Trivedi, 2005; Wooldridge, 2002).

3.6.6 Random coefficients model

A fourth possibility of handling the IIA property is the random effects model. The model assumes unobserved heterogeneity in the slope coefficients. One way of estimating a random effects model is to assume a finite number of types of individuals as follows:

$$\beta_{ik} \in \{b_0, b_1, ..., b_k\},$$

with $$prob(\beta_i = b_k \mid Z_i) = p_k, \text{ or } \quad prob(\beta_i = b_k \mid Z_i) = \frac{\exp(Z_i^{'}\gamma_k)}{1 + \sum_{l=1}^{k} \exp(Z_i^{'}\gamma_l)} \quad (3.33)$$

3.6.7 *Discriminant analysis*

Another analytical tool used in empirical literature is discriminant analysis.. Discriminant analysis is a statistical technique that is used in predicting group membership. Discriminant analysis attempts to use the independent variables to distinguish among groups or categories of the dependent variable.

The usefulness of a discriminant model is based upon its accuracy rate, or ability to predict the known group memberships in the categories of the dependent variable. Discriminant analysis works by creating a new variable called the discriminant function score which is used to predict which group a case belongs. The score is used in making predictions about the group where a particular case belongs. Discriminant function scores are estimated in the same way as factor scores, i.e. using eigen values. The discriminant analysis is similar to a regression equation in which the independent variables are multiplied by coefficients and summed to produce a score. A discriminant function score is calculated by multiplying coefficients and explanatory variables and adding the results.

3.7 Conclusion

In Summary, this study is based on a two year panel data from the Integrated Household Surveys carried out by the National Statistical Office (Malawi) and the World Bank during the 2004/05 and 2006/07. The analysis is based on a panel data set of 2,431 households in that were interviewed both in 2006/07 and 2004/05. Technical efficiency of farm households, one of the main issues of inquiry in this study, is based on the production theory. The main assumption in production theory is that households have an objective function of maximising production, subject to constraints. The production theory forms the basis for understanding technical efficiency and maize production of farm households.

Regarding the consumer theory, which guides consumer choices, classical theory assumes that consumers try to maximise their self interest. Coping strategies are based on economic theory of consumer choice.

Turning to the analytical models, various models have been developed to model technical efficiency. They are largely grouped into parametric and non-parametric models. Parametric models are also referred to stochastic production frontier models. The most common form of non-parametric model is data envelopment analysis (DEA). The most common stochastic production frontier model is the Battese and Coelli (1995) for panel data. Since agricultural production is associated with exogenous shocks such as droughts, Coelli (1996) recommends the stochastic production frontier models. Finally, there are various models for discrete choice in literature. The most common discrete models for multinomial choices are multinomial logit and probit models.

References

Aigner, D.K, Lovell C.K. & Schimidt, P. (1977), "Formulation and Estimation of Stochatsic: Frontier Production function Models," *Journal of Econometrics*, 6: 21-37

Ali, A.I. & Seiford, L.M. (1993), "The mathematical programming approach to efficiency analysis," In *The Measurement of Productive Efficiency: Techniques and Applications*, H. O. Fried, C. A. K. Lovell, and S. S. Schmidt, eds., Oxford University Press, New York

Anselin, L. (1989), "*Some Robust Approaches to Testing and Estimation in Spatial Econometrics*," Regional Science and Urban Economics, 20(2): 141-163.

Antle, JM & Pingali, PL, 1994, "Pesticides, productivity, and farmer health: A Philippine case study," *American Journal of Agricultural Economics*, 76 (3): 418–30.

Bardhan, P.K. & Udry, C. (1999), *Development microeconomics*, Pranab K. Bardhan and C. Udry, Clarendon Press, Oxford

Banker, R.D., Charnes, A. & Cooper, W.W. (1984), "Some models for estimating technical and scale inefficiencies in Data Development Analysis," *Management Science*, 30: 1078-1092.

Bardhan, P. & Udry C. (1999), *Development Microeconomics*, Oxford University Press, Oxford

Battese, G.E. & Corra, G.S. (1977), "Estimation of production frontier model: application to pastoral zone of Eastern Australia," *Australian Journal of Agricultural Economics*, 21: 169–79.

Battese, G.E. & Coelli T.J. (1988), "Prediction of farm level technical efficiencies with a generalized frontier production function and panel data," *Journal of Econometrics*, 38: 338-387

Battese, G.E., Coelli, T.J. & Colby T.C. (1989), "Estimation of frontier production functions and the efficiencies of Indian farms using panel data from ICRISAT's village level studies". *Journal of Quantitative Economics*, 5: 327–48.

Battese, G.E. & Coelli, T.J (1992), "Frontier production functions and technical efficiency: A survey of empirical applications in agricultural economics," *Agricultural Economics*, 7:185–208

Battese, G.E. & Coelli, T.J. (1995), "A model for technical inefficiency effects in a stochastic frontier production function for panel data," *Empirical economics*, 20: 325-332.

Battese, G.E., Malik, Malik, S.J. & Gill, M.A. (1996), "An investigation of technical inefficiencies of production of wheat farmers in four districts of Pakistan," *Journal of Agricultural Economics*, 47(1): 37-49

Becker, G. S. (1965), "A Theory of the Allocation of Time," *Economic Journal*, 75 (299): 493-517

Bliss, C. J. & Stern, N. H. (1982), *Palanpur: The Economy of an Indian Village*, Clarendon Press, Oxford

Cameron, A. C. & Trivedi, P.K. (2005), *Microeconometrics: Methods and Applications*, Cambridge University Press, New York

Charnes, A., Cooper, W.W. & Rhodes, E. (1978), "Measuring the inefficiency of decision making unit," *European Journal of Operational Research*, 2: 429–44.

Chayanov, A.V. (1966), *The Theory of Peasant Economy*, Daniel Thorner, Basile Kerblay, and R. E. F. Smith. Homewood, IL, Irwin

Chirwa, E. (2007), "*Sources of Technical Efficiency among Smallholder Maize Farmers in Malawi*," Research Paper 172, African Economic Research Consortium

Coelli, T.J. (1996), "*A Guide to Frontier 4.1: A computer Program for Stochastic Frontier Production and Cost Function Estimation*," CEPA Working Paper, Department of Econometrics, University of New England, Armidale, Australia.

Coelli, T.J. & Perelman, S. (1999), "A Comparison of Parametric and Non-parametric Distance Functions: With Application to European Railways," *European Journal of Operations Research*, 117: 326-339.

Coelli, T., Rao, D.S.P. & Battese, G.E. (1998), *An Introduction to Efficiency Analysis*, Kluwer Academic Publishers, USA

Dasgupta, P. (1993), *An Inquiry into Well-Being and Destitution*, Clarendon Press, Oxford.

de Janvry, A. & Fafchamps, M. & Sadoulet, E. (1991), "Peasant Household Behaviour with Missing markets: Some paradoxes Explained," *Economic Journal*, *Royal Economic Society*, 101(409): 1400-417

Ellis, F. (2000), *Peasant Economics*, Cambridge University Press, Cambridge

Fare, R., Grosskopf, S. and Lovell, C.K.A (1985), "The Structure of Technical Efficiency," *Scandinavian Journal of Economics*, 2: 181-190

Farrel, M.J. (1957), "The Measurement of Productive Efficiency,". *Journal of Royal Statistical Society*, 120 (3): 253-281.

Forsund, E. R., Lovell C.A.K. & Schmidt, P. (1980), "A Survey of Frontier Production Functions and Their Relationship to Efficiency Measurement," *Journal of Econometrics*, 13 (5): 225-235

Gill, J. (2001), *Generalized Linear Models: A Unified Approach*, Thousand Oaks, Sage, California

Greene, W. (1980), "Maximum likelihood estimation of econometric frontier functions," *Journal of Econometrics*, 13: 27-56.

Greene, W.H. (1990), "A gamma distributed stochastic frontier model," *Journal of Econometrics*, 46: 141-163

Greene, W. H. (1997), *Econometric Analysis,* (3rd ed.), Upper Saddle River, NJ: Prentice-Hall.

Grossman, M, (1972), "On the concept of health capital and the demand for health," *Journal of Political Economy,* 80(2): 223–55.

Grossman, M, (1999), "*The human capital model of the demand for health,*", NBER Working Paper 7078, NEBER, USA

Helfand S.M. & Levin E.S. (2003), "Farm size and determinants of productive efficiency in the Brazilian Centre-West," *Agricultural Economics,* 31: 241-249.

Huang, C.J. & Liu, J.T. (1994), "Estimation of a non-neutral stochastic frontier production function," *Journal of Productivity Analysis*, 4: 171–80.

Jondrow, J., Lovel, C.A.K. Materov, I.S. & Schmidt, P. (1982), "On the estimation of technical inefficiency in the stochastic frontier production function," *Journal of Econometrics*, 19: 233 -238

Kinsey, B., Burger, K. & Gunning, J. W. (1998), "Coping with drought in Zimbabwe: Survey evidence on responses of rural households to risks," *World Development*, 26 (1):89-110

Kumbhakar, S.C., Gosh, S. & McGuckin, T.J. (1991), "A generalized production frontier approachfor estimating determinants of inefficiency in US daily farms," *Journal of Business and Economic Statistics*, 9: 279-286

Lipton, A. (1986), "US Rule on Investment Bank Performance Fees," *International Financial Law Review,* 5: 26-27.

Lipton, M & De Kadt, E, (1988), "*Agriculture: Health linkages*," World Health Organization, Geneva.

Lipton, M., & Longhurst, R. (1989), *New Seeds and Poor People,* Unwin Hyman, London

Lovel, C. A. K. (1993), "Production frontier and productive efficiency," In Fried, H.O., Lovel, C.A.K., and Schmidt, S.S. (Eds). *Measurement of productive efficiency*. Oxford University Press, New York

Low, A. (1986), *Agricultural Development in Southern Africa. Farm household economics and food crisis*, James Currey, London

Luce, D. (1959), *Individual Choice Behavior*, Wiley, New York

Marschak, J., (1960), Binary Choice Constraints on Random Utility Indicators, In: *Stanford Symposium on Mathematical Methods in the Social Sciences*, Arrow, K. (ed.). Stanford University Press, Stanford.

Mas-Colell, A., Whinston, M. D. & Green. J. R. (1995), *Microeconomic Theory*, Oxford University Press, Oxford

McFadden, D. (1968), "*The Revealed Preferences of a Public Bureaucracy*," Department of Economics, University of California, Berkeley

McFadden, D. (1976), "The Revealed Preferences of a Bureaucratic Government: Empirical Evidence," *The Bell Journal of Economics and Management Science*, 7: 55-72

McFadden, D.L. (2000), "*Economic choices*," Nobel Prize lecture. http://nobelprize.org/nobel_prizes/economics/laureates/2000/mcfadden-lecture.pdf

Meeusen, W. & van den Broeck, J. (1977), "Efficiency Estimation from Cobb-Douglas Functions with Composed Error," *International Economics Review*, 81: 435-444

Meller, J.P. (1976), "*Efficiency Frontier for Industrial Establishments of Different Sizes. Explorations in Economic Research*," NEBER Occasional paper, USA

Mendola, M. (2007), "Farm Household Production Theories: A Review of Institutional and Behavioural Responses," *Asian Development Review*, 24 (1): 49-68

Morduch, J. (1993), “Risk, Production, and Saving: Theory and Evidence from Indian Households,” Harvard University, Cambridge

Morduch, J. (1994), “Poverty and Vulnerability,” American *Economic Review*, 84: 221–225.

National Statistical Office (NSO). (2005), “*Integrated Household Survey, 2004/05*,” Final Report, Lilongwe, Malawi

National Statistical Office (NSO). (2008), “*Integrated Household Survey, 2006/07*,” Final Report, Lilongwe, Malawi

Pitt, MM & Rosenzweig, MR, (1986), Agricultural prices, food consumption, and the health and productivity of Indonesian farmers, In Singh, I, Squire, L & Strauss, J (Eds), *Agricultural Household Models*, Johns Hopkins University Press, Baltimore

Reifschneider, D. &. Stevenson. R. (1991), “Systematic departures from the frontier: A framework for the analysis of firm inefficiency,” *International Economic Review*, 32: 715–23.

Roisenzweig, M.R. (1986), “*Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs and Their Effects on Birth weight*,” Discussion Paper no. 437, Economic Growth Centre, Yale University, USA

Roumasset, J. (1976), “*Rice and Risk: Decision Making among Low-income Farmers,”* North-Holland Publishing, Amsterdam

Rugalema, G. (2000), “Coping or struggling: A journey into the impact of HIV/AIDS in southern Africa,” *Review of African Political Economy*, 86: 537-545

Sarma, S. & Simpson, W. A. (2007), “Panel multinomial logit analysis of elderly living arrangements: Evidence from aging in Manitoba longitudinal data, Canada,” *Social Science & Medicine*, 65 (12): 2539-52

Seyoum, E.T., Battese, G.E. & Fleming, E.M. (1998), "Technical efficiency and productivity of maize producers in eastern Ethiopia: A study of farmers within and outside the Sasakawa-Global 2000 project," *Agricultural Economics,* 19: 341-348.

Schultz, T. W. (1964), *Transforming Traditional Agriculture*, University of Chicago Press, Chicago, USA

Schultz, P. (1999), "*Productive benefit of improving health: Evidence from low-income countries*," Mimeo, Yale University, USA

Seyoum, E.T., Battese G.E. & Fleming E.M. (1998), "Technical efficiency and productivity of maize producers in Eastern Ethiopia: A study of farmers within and outside the Sasakawa-Global 2000 Project," *Agricultural Economics*, 19: 341-348

Singh I., Squire, L. & Strauss, J. eds. (1986), *Agricultural Household Models: Extensions and Applications,* Johns Hopkins University Press, Baltimore, USA

Strauss, J. & Thomas, D. (1998), "Health, Nutrition and Economic Development," *Journal of Economic Literature*, 36 (4): 766-817

Tausing, F. (1912), *Principles of Economics*, Macmillan, New York

Taylor, J. Adelman, A. & Adelman.I. (2003), "Agricultural Household Models: Genesis, Evolution and Extensions," *Review of Economics of the Household*, 1(1): 33–58.

Thurstone, L.L. (1927), "A Law of Comparative Judgement," *Psychological Review*, 34: 273-286

Train K., (2003), *Discrete Choice Methods with Simulation*, First Edition, Cambridge University Press, United Kingdom

Weir, S. & Knight. J. (2000), "*Education Externalities in Rural Ethiopia: Evidence from average and stochastic frontier production functions,*" Working Paper 4. Centre for Study of African Economies, University of Oxford, UK.

Wooldridge, J.M. (2002), *Econometric Analysis of Cross Section and Panel data*, Massachusetts Institute of Technology, USA

World Bank, 2007, "*World Development Report*," World Bank, Washington, DC.

Chapter 4: Technical efficiency levels among maize farmers in Malawi: Evidence from time varying and time-invariant inefficiency models

4.1 Introduction

The Malawi economy is agricultural-based, with about 85 percent of the population either employed or self-employed in the agricultural sector. The sector is quite fundamental to the economy as it accounts for about 40 percent of gross domestic product (GDP). It is the key income earner for over 70 percent of Malawians (MGDS[27] 2006). Additionally, it is the key to the food security of the country, as most food crops are produced for subsistence needs.

Inequalities in land ownership among Malawian households constitute a major constraint on agricultural productivity. The majority of smallholder farm households possess land under customary tenure and own less than one hectare. Land holdings per household have declined over the years from 1.53 hectares in 1968 to around 0.5 hectares. The reduction is largely due to the increase in population. Since 2005, the Malawi government has been implementing a World Bank funded land reform programme. The programme offers opportunities for the landless or near landless to access land by purchasing unused land mainly from estate farmers. A total of 14,000 hectares of land has been earmarked for redistribution to 3, 500 farm households (Malawi Government, 2002).

Apart from implementing land reforms to address land shortages, Government has made various attempts to raise the productivity and production of food production. These measures include encouraging and supporting farmers to adopt technology, especially hybrid maize seeds; providing extension services to farmers, and providing subsidized farm inputs. However, the impact of these policies within the context of HIV/AIDS epidemic has not been investigated. The ability of smallholder farmers in Malawi to produce sustainably largely depends on how technically efficient they are (MGDS, 2006).

Nevertheless, there is still scope for improvement as extension services are still on a low scale compared to the 1980s and 1990s. Additionally, the input and output agricultural markets remain underdeveloped. As a matter of fact, ADMARC, a parastatal input and

[27] MGDS is the Malawi Growth and Development Strategy

output marketing body, has closed most of its offices in the rural areas because of deregulation of the agricultural sector and the entry of new players in the market. During the 1970s and 1980s, ADMARC had the network of markets in every area. Similarly, farmer clubs, which were available in all districts during the 1970s and 1980s are now non-existent. Farmer clubs enabled farmers to share ideas, skills and resource about crop production. They were also channels through which credit facilities were provided to the famers.

The majority of studies at household level have assessed the impact of mortality in AIDS-affected households in comparison with non-affected households. However, there are no studies that have distinguished morbidity and mortality that is AIDS-related[28] from that which is not. Among prominent studies have do not examine the distcintion between AIDS-affected households and other households with helath problems include Chapato and Jayne (2008), Chapato and Jayne (2005), and Yamano and Jayne (2004). This distinction is important as the effects of morbidity and mortality among AIDS-affected and non-affected households are likely to differ as mortality implies loss of an adult household member. In terms of morbidity, it is possible for the member of the household to contribute to farming activities depending on the nature of the illness.

This chapter reviews the relationship between health and technical efficiency. It also analyzes, cultivated land and fertilizer application for both AIDS-affected and non-affected households. Furthermore, it examines the social-economic determinants of technical efficiency of AIDS-affected and non-affected farm households, and also assesses technical efficiency differentials between AIDS-affected and non-affected households.

4.2 Health and technical efficiency

The relationship between health and productivity of labour[29] is based on the theory of household production which was proposed by Becker (1965). In his framework, Becker (1965) treats households as both producers and consumers of goods and services. Pitt and Rosenzweig (1986) extend the traditional agricultural household models in order to estimate the impact of changes in health on supply and productivity of labour and overall

[28] AIDS-related morbidity refers to illnesses medically linked to HIV/AIDS e.g. chronic tuberculosis (TB), chronic pneumonia and chronic diarrhoea. AIDS-related mortality refers to death resulting from illnesses medically associated with HIV/AIDS e.g. chronic TB, chronic pneumonia and chronic diarrhoea. For more information see Section 1.5

[29] For a comprehensive review of technical efficiency of production and health, see Chapter 3

farm production. The extension entails including a variable on health in the utility function and specifying a production function for health. Health is treated as a capital good, and it can either raise or reduce the productivity of a farm household. Schultz (1999) and Strauss and Thomas (1998) postulate that there is a positive relationship between health and productivity (efficiency) of labour. Good health improves household farm production while poor health will lead to reduction in the number of days worked, and this, if a household is facing financial constraints, will ultimately result in reduction in farm output (Antle & Pingali, 1994). Illness and death from such diseases as HIV/AIDS, malaria and tuberculosis lead to reduction in labour productivity. This is due to reduction or loss of labour and household assets to cope with illness.

Several studies have assessed the impact of HIV/AIDS and poor health on technical efficiency of farmers[30]. The studies include Ulimwengu (2009), Adoeti and Adeoti (2008), Ajani (2008), Yusuf et al. (2007), Fox (2004), Matthew (2004) and Croppenstedt and Muller (2000). Overall, there is consensus on the negative impact of the epidemic on technical efficiency of farmers. This is due to loss of labour, either through death or reduction in available labour, as other members of households look after the sick.

The objectives of this essay are to (i) examine the social-economic determinants of technical efficiency of AIDS-affected and non-affected farm households;[31] (ii) assess technical efficiency differentials between AIDS-affected and non-affected households; and (iii) investigate the impact of prime-age adult mortality and morbidity on technical efficiency levels of AIDS-affected and non-affected farm households. The study uses two technical efficiency models, time varying and time-invariant models, to test how sensitive and robust the results are to different model specifications. The study disaggregates the analysis by gender mindful of the fact that there are gender disparities in access to crucial inputs of production such as land in most African countries.

[30] For a comprehensive literature review on HIV/AIDS impact on on technical efficiency of farmers, see Chapter 2.

[31] AIDS-Affected households are those in which one or more prime-age adult was reported to have lost life due to or suffered from AIDS-related illnesses such chronic TB, chronic pneumonia and chronic diarrhoea over the last one to five years. Non-affected households are those in which at least one prime-age adult family member was reported to have died of or suffered from other chronic illnesses over at least one to five years. We use the words ‘AIDS-affected’ and ‘non-affected” interchangeably.

4.3 Descriptive statistics on farm inputs, 2004/05 and 2006/07

This section conducts descriptive statistics on farm inputs such as cultivated land, fertilizer application and proportion of households using hybrid maize among AIDS-affected and non-affected households.

Table 4.1 shows cultivated area per household for non-affected households. The cultivated area for non-affected households declined from 0.72 hectares per household to 0.40 hectares (ha) per household. During the 2006/07 agricultural season, female headed households had lower cultivated land (0.34 hectares) compared to male headed (0.41 hectares). This could be due to the fact that among patrilineal families, only male family members have the rights to inheritance land[32]. The average cultivated land per households for households with morbidity was just marginally higher (0.40 hectare per household) than that for households with mortality (0.39 hectare per household). Among both households with mortality and morbidity, female headed households had slightly lower average cultivated land per household compared to their male headed counterparts. Adult child morbidity resulted in lower cultivated land during 2006/07 (0.32 hectares per household) compared to household head morbidity (0.41 hectares per household). Similarly, adult child mortality resulted in lower cultivated land (0.37 hectares per household) than household head mortality (0.40 hectares per household).

Table 4.1: Cultivated area for non-affected households

Inputs of production	2004/05	2006/07	Two sample t-tests Ho: diff=0; Ha=diff>0
Cultivated area (hectares per household)			Ho: diff=0; prob (|T|>t)
Non-affected households	0.72	0.40	-8.86
	(0.03)	(0.02)	(0.00)**
Female headed	0.58	0.34	-4.82
	(0.04)	(0.03)	(0.00)**
Male headed	0.76	0.41	-7.77
	(0.04)	(0.02)	(0.00)**
Morbidity (chronic)	0.68	0.40	-7.35
	(0.03)	(0.02)	

32 However, some parts of Malawi are matrilineal, and this tradition is not practised.

Female headed	0.55	0.34	(0.00)**
	(0.05)	(0.04)	-3.65
Male headed	0.72	0.42	(0.00)**
	(0.04)	(0.03)	-6.54
Head of households/spouse morbidity	0.70	0.41	(0.00)**
	(0.03)	(0.03)	-6.50
Female headed	0.57	0.35	(0.00)**
	(0.05)	(0.04)	-3.59
Male headed	0.74	0.43	(0.00)**
	(0.04)	(0.03)	-5.65
Adult child morbidity	0.59	0.32	(0.00)**
	(0.04)	(0.02)	-5.49
Female headed	0.31	0.22	(0.00)**
	(0.05)	(0.07)	-1.07
Male headed	0.62	0.33	(0.32)
	(0.05)	(0.03)	-5.64
Mortality	0.81	0.39	(0.00)**
	(0.08)	(0.03)	-5.01
Female headed	0.66	0.34	(0.00)**
	(0.09)	(0.04)	-3.19
Male headed	0.86	0.41	(0.002)**
	(0.09)	(0.04)	-4.29
Head of household/spouse mortality	0.87	0.40	(0.00)**
	(0.11)	(0.04)	-4.17
Female headed	0.61	0.31	(0.00)**
	(0.13)	(0.05)	-2.25
Male headed	0.93	0.42	(0.03)**
	(0.13)	(0.05)	-3.76
Adult child mortality	0.66	0.37	(0.00)**
	(0.06)	(0.06)	-3.53
Female headed	0.71	0.38	(0.00)*
	(0.13)	(0.07)	-2.26
Male headed	0.64	0.37	(0.03)**

	(0.07	(0.08)	-2.65 (0.01)**

*Source: Integrated household survey data, 2004/05 and 2006/07 (National Statistical Office, NSO, 2005, 2008); **means significant at 5% level. Figures in parenthesis are standard errors*

Table 4.2 shows the cultivated land area per household for AIDS-affected households. Average cultivated land per household for the affected households during the 2006/07 season was comparably similar to that of non-affected households (0.40 hectares per household). This was a drop from 0.70 hectares per household during 2004/05 season for the affected households. This result is in line with empirical findings for AIDS-affected households in Ajieh and Okoh (2009), Chapoto and Jayne (2005), and Drime (2003). In terms of gender, female-headed households had lower cultivated land (0.34 hectares per household) compared to male-headed households (0.41 ha per household). This result is consistent with findings in Manther (2004) and Yamano and Jayne (2004). The gender differentials in cultivated land are observed in households with mortality and morbidity. Just like among non-affected households, affected households with mortality had slightly lower cultivated land (0.37 hectares per household) compared to affected households with morbidity (0.40 hectares per household). Similarly, adult child morbidity resulted in slightly lower cultivated land during 2006/07 (0.39 hectares per household) compared to household head morbidity (0.41 hectares per household). However, household head mortality resulted in lower cultivated land (0.33 hectares per household) than adult child mortality (0.38 hectares per household). This could reflect issues of property grabbing and dispossession upon death of household head, especially male household head (see Parker 2009 and Donovan & Mather 2008, Chapoto and Jayne 2005).

Table 4.2: Cultivated area per household for AIDS-affected households

Inputs of production	2004/05	2006/07	Two sample t-test Ho: diff=0; Ha=diff>0
Cultivated area (hectares per household)			Ho: diff=0; prob (|T|>t)
Affected households	0.70	0.40	-7.89
	(0.03)	(002)	(0.00)**
Female headed	0.58	0.34	-3.89
	(0.05)	(0.03)	(0.00)**
Male headed	0.74	0.41	-7.03
	(0.04)	(0.043)	(0.00)**
Morbidity (chronic)	0.71	0.40	-7.47
	(0.04)	(0.02)	(0.00)**
Female headed	0.57	0.36	-3.15
	(0.06)	(0.03)	(0.002)**
Male headed	0.75	0.41	-6.86
	(0.04)	(0.03)	(0.00)**
Head of households/spouse morbidity	0.71	0.41	-5.36
	(0.04)	(0.02)	(0.00)**
Female headed	0.55	0.34	-2.25
	(0.09)	(0.04)	(0.03)**
Male headed	0.74	0.42	4.94
	(0.06)	(0.02)	(0.00)**
Adult child morbidity	0.72	0.39	-4.68
	(0.04)	(0.04)	(0.00)**
Female headed	0.60	0.39	-2.26
	(0.07)	(0.06)	(0.03)**
Male headed	0.76	0.39	-5.56
	(0.05)	(0.04)	(0.00)**
Mortality	0.63	0.37	-2.72
	(0.08)	(0.06)	(0.01)**
Female headed	0.61	0.29	-2.39
	(0.13)	(0.03)	(0.03)**

Male headed	0.64	0.43	-1.52
	(0.08)	(0.11)	(0.13)
Head of household/spouse mortality	0.58	0.33	-1.59
	(0.12)	(0.09)	(0.13)
Female headed	0.59	0.27	-1.69
	(0.18)	(0.04)	(0.12)
Male headed	0.56	0.45	-0.33
	(0.13)	(0.29)	(0.75)
Adult child mortality	0.65	0.38	-2.18
	(0.90)	(0.08)	(0.04)**
Female headed	0.63	0.31	-1.58
	(0.20)	(0.04)	(0.14)
Male headed	0.67	0.43	-1.49
	(0.11)	(0.12)	(0.15)

Source: author's calculations; Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)
** *means significant at 5% level; Figures in parenthesis are standard errors*

The differences between the mean cultivated lands of AIDS-affected and non-affected households during 2004/05 and 2006/07 seasons were not statistically significant, except for households with adult morbidity during 2004/05 (see Table 4.3). This finding differs with the findings in empirical literature, where affected households had lower cultivated land compared to non-affected households. However, our finding is not surprising as unlike previous studies, we are comparing cases of prime-age morbidity and mortality, for both AIDS-affected and non-affected households. During 2004/05 season, cultivated land for affected households with adult child morbidity was statistically higher than that for the non-affected households.

Table 4.3: Differences in mean cultivated area for AIDS-affected and non-affected households

Inputs of production	Two sample t-test 2004/05 Ho: diff=0; Ha=diff>0	Two sample t-test 2006/07 Ho: diff=0; Ha=diff>0
Cultivated area (hectares per household)	Ho: diff=0; prob (|T|>t)	Ho: diff=0; prob (|T|>t)
Non-affected households and affected households	0.29	
	(0.77)	-0.02
Female headed	0.07	(0.99)
	(0.95)	-0.03
Male headed	0.32	(0.97)
	(0.75)	0.01
Morbidity (chronic)	-0.59	(0.99)
	(0.56)	-0.03
Female headed	-0.22	(0.98)
	(0.83)	-0.231
Male headed	-0.44	(0.82)
	(0.66)	0.11
Head of households/spouse morbidity	-0.14	(0.92)
	(0.87)	0.17
Female headed	0.23	(0.86)
	(0.81)	0.29
Male headed	0.02	(0.77)
	(0.98)	0.22
Adult child morbidity	-1.87	(0.82)
	(0.06)*	-1.46
Female headed	-1.93	(0.15)
	(0.07)*	-1.21
Male headed	-1.71	(0.24)
	(0.09)*	-1.14
Mortality	1.05	(0.26)
		0.32

	(0.29)	(0.75)
Female headed	0.27	0.69
	(0.79)	(0.49)
Male headed	0.83	-0.22
	(0.41)	(0.82)
Head of household/spouse mortality	0.85	051
	(0.39)	(0.61)
Female headed	0.10	0.38
	(0.92)	(0.71)
Male headed	0.59	-0.14
	(0.55)	(0.89)
Adult child mortality	0.13	-0.08
	(0.89)	(0.93)
Female headed	0.36	0.72
	(0.73)	(0.48)
Male headed	-0.20	-0.38
	(0.84)	(0.71)

*Source: author's calculations; Integrated household survey data, 2004/05 and 2006/07 (National Statistical Office, NSO, 2005, 2008); ** means significant at 5% level; Figures in parenthesis are standard errors*

In general, the mean cultivated land for the AIDS-affected and non-affected households with prime-age adult mortality and morbidity are lower than the cultivated land for non-affected households *without* prime-age adult morbidity and mortality[33]. The cultivated land per household for non-affected households *without* prime-age adult mortality and morbidity declined from 0.75 hectares per household to 0.45 hectares (ha) per household (see Table 4.4). This is attributed to the fact that over years, there is division and sub-division of household land among family members, as the number of adult members of the family increases. During the 2006/07 agricultural season, female headed households had lower

[33] While our primary concern in this study is to compare the outcomes of AIDS-affected households with prime-age adult mortality and morbidity, with the outcomes of non-affected households with prime-age adult mortality and morbidity, we also examine, in passing, the outcomes of a third category of households, non-affected households *without* prime-age adult mortality and morbidity

cultivated land (0.42 hectares per household) compared to male headed (0.48 hectares per household).

Table 4.4: Cultivated area per household for non-affected households without mortality and morbidity

Inputs of production	2004/05	2006/07	Two sample t-tests Ho: diff=0; Ha=diff>0
Cultivated area (hectares per household)			Ho: diff=0; prob (|T|>t)
All households	0.75	0.45	-10.62
	(0.02)	(0.01)	(0.00)**
Female headed	0.62	0.42	6.32
	(0.03)	(0.02)	(0.00)**
Male headed	0.78	0.48	11.44
	(0.03)	(0.02)	(0.00)**

*Source: author's calculations; Integrated household survey data, 2004/05 and 2006/07 (National Statistical Office, NSO, 2005, 2008); ** means significant at 5% level; Figures in parenthesis are standard errors*

Non-affected households with prime-age adult mortality and morbidity recorded an increase in fertilizer application per hectare from 2.14 bags per hectare during the 2004/05 season to 4.07 bags (see Table 4.6). During the 2006/07 season, female headed households had lower applications (3.41 bags per hectare) compared to male headed households (4.27 bags). Similarly, both non-affected households with mortality and morbidity recorded increases in fertilizer application. In general, non-affected households with morbidity had higher fertilizer application levels than non-affected households with mortality. The non-affected households with prime-age adult mortality and adult morbidity recorded higher fertilizer application levels than households with household head mortality and household morbidity.

Table 4.6: Fertilizer applications for non-affected households (no. of 50 kg bags)

	2004/05	2006/07	Two sample t-tests Ho: diff=0; Ha=diff>0
Fertilizer application per hectare (no. of bags)			Ho: diff=0; prob (|T|>t)
Non-affected households	2.14 (1.83	4.07 (0.18)	4.23 (0.00)**
Female headed	1.24 (0.22)	3.41 (0.39)	4.75 (0.00)**
Male headed	2.38 0.53)	4.27 (0.21)	3.32 (0.001)**
Mortality	1.17 (0.12)	3.71 (0.36)	6.67 (0.00)**
Female headed households	0.97 (0.24)	2.23 (0.58)	1.93 (0.06)
Male headed households	1.23 (0.14)	4.18 (0.42)	6.62 (0.00)**
Head of household/spouse mortality	0.98 (0.14)	3.52 (0.40)	5.92 (0.00)**
Female headed	0.74 (0.30)	1.96 (0.75)	1.44 (0.16)
Male headed	1.04 (0.15)	3.91 (0.46)	5.97 (0.00)**
Adult child mortality	1.63 (0.25)	4.18 (0.73)	3.23 (0.002)**
Female headed	1.27 (0.39)	2.61 (0.94)	1.28 (0.22)
Male headed households	1.81 (0.32)	4.99 (0.97)	3.07 (0.004)**
Morbidity	2.49 (0.57)	4.20 (0.21)	2.82 (0005)**
Female headed households	1.35 (0.29)	3.88 (0.47)	4.39 (0.00)**
		4.30	

Male headed households	2.78	0.24)	2.01
	(0.71)	4.15	(0.04)**
Head of households/spouse morbidity	2.70	(0.23)	2.09
	(0.66)	3.82	(0.04)**
Female headed	1.42	(0.49)	3.99
	(0.31)	4.26	(0.00)**
Male headed	3.05	(0.26)	1.37
	(0.84)	4.53	(0.17)
Adult child morbidity	1.11	(0.62)	5.02
	(0.24)	4.74	(0.00)**
Female headed	0.34	(2.22)	1.98
	(0.21)	4.50	(0.08)*
Male headed	1.21	(0.66)	4.56
	(0.27)		(0.00)**

*** Significant at 5% level; source; author's calculations using data from Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008). Figures in parenthesis are standard errors*

AIDS-Affected households also experienced increases in fertilizer application per hectare from 1.39 bags during the 2004/05 agricultural season to 4.07 bags during the 2006/07 season (see Table 4.7). Again, this could be attributable to the scaled-up fertilizer subsidy programme. In terms of gender, male headed households had more bags of fertilizer (4.16 bags) compared to female headed households (3.80 bags). In general, affected households with mortality recorded higher fertilizer application during the 2006/07 agricultural season (4.93 bags) compared to affected households with morbidity (3.99 bags). This is in contrast to non-affected where households with morbidity recorded higher fertilizer application levels. While AIDS-affected households with death of household head recorded higher fertilizer application per hectare than those with adult child mortality, the opposite was true for non-affected households with morbidity.

Table 4.7: Fertilizer application for AIDS-affected households (non of 50 kg bags)

	2004/05	2006/07	Two sample t-tests Ho: diff=0; Ha=diff>0
Fertilizer application per hectare (no. of bags)			Ho: diff=0; prob (|T|>t)
Affected households	1.39 (0.11)	4.07 (0.23)	10.36 (0.26)
Female headed	1.28 (0.22)	3.80 (0.51)	4.49 (0.00)**
Male headed	1.42 (0.13)	4.16 (0.26)	9.34 (0.00)**
Mortality	1.63 (0.35)	4.93 (0.82)	3.65 (0.00)**
Female headed households	1.74 (0.57)	4.51 (1.09)	2.25 (0.03)**
Male headed households	1.52 (0.44)	5.29 (1.24)	2.79 (0.01)**
Head of household/spouse mortality	1.64 (0.73)	6.10 (1.26)	3.06 (0.008)**
Female headed	1.97 (1.05)	5.53 (1.41)	2.02 (0.07)*
Male headed	0.96 (0.73)	7.24 (2.87)	2.12 (0.10)
Adult child mortality	1.62 (0.39	4.38 (1.05)	2.40 (0.02)**
Female headed	1.53 (0.64)	3.64 (1.65)	1.19 (0.26)
Male headed households	1.67 (0.52)	4.81 (1.40)	2.03 (0.06)*
Morbidity	1.37 (0.12)	3.99 (0.24)	9.69 (0.00)**
Female headed households	1.17 (0.24)	3.62 (0.58)	3.89 (0.00)**
Male headed households	1.42	4.08	

	(0.14)	(0.26)	8.89
Head of households/spouse morbidity	1.21	3.96	(0.00)**
	(0.14)	(0.29)	8.33
Female headed	1.11	4.01	(0.00)**
	(0.29)	(0.79)	3.43
Male headed	1.23	3.91	(0.001)**
	(0.16)	(1.23)	7.58
Adult child morbidity	1.69	4.10	(0.00)**
	(0.22)	(0.42)	5.04
Female headed	1.25	3.07	(0.00)
	(0.42)	(0.86)	1.89
Male headed	1.82	4.42	(0.07)*
	(0.26)	(0.49)	4.73
			(0.00)**

*Source: Authors calculations using data from Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008); **(*) means significant at 5% (10%) level. Figures in parenthesis are standard errors.*

When comparing fertilizer application levels for AIDS-affected and non-affected households, in general, the levels of fertilizer application per hectare are comparable, and statistically not different (see Table 4.8). However, non-affected households with morbidity recorded higher fertilizer application levels during 2004/05 season than the levels for the affected households. On the other hand, affected households with mortality reported higher levels of applications than affected households during 2006/07. This was particularly true for households which suffered the death of their household head.

Table 4.8: Fertilizer application per hectare (comparing AIDS-affected and non-affected households)

Inputs of production	Two sample t-test 2004/05 Ho: diff=0; Ha: diff>0	Two sample t-test 2006/07 Ho: diff=0; Ha: diff>0
Fertilizer application per hectare (no. of 50kg bags) Affected households and non-affected households	Ho: diff=0; prob (|T|>|t|	Ho: diff=0; prob (|T|>|t|
	1.3979	-0.0078
Female headed	(0.1628)	(0.9938)
	-0.1215	-0.6001
Male headed	(0.9034)	(0.5492)
	1.4104	0.3386
Morbidity (chronic)	(0.1589)	(0.7350)
	1.7233	0.6665
Female headed	(0.0853)*	(0.5053)
	0.4621	0.3383
Male headed	(0.6448)	(0.7356)
	1.6901	0.6138
Head of households/spouse morbidity	(0.0916)*	(0.5396)
	1.7537	0.5979
Female headed	(0.0801)*	(0.5502)
	0.6194	-0.2040
Male headed	(05179)	(0.8388)
	1.7357	0.8463
Adult child morbidity	(0.0834)*	(0.3979)
	-1.6072	0.5749
Female headed	(0.1103)	(0.5663)
	-1.0147	0.8029
Male headed	(0.3200)	(0.4296)
	-1.5544	0.1012
Mortality	(0.1230)	(0.9196)
	-1.4664	-1.4296

Female headed	(0.1447)	(0.1549)
	-1.4688	-2.0013
Male headed	(0.1499)	(0.0518)*
	-0.7105	-0.9438
Head of household/spouse mortality	(0.4789)	(0.3473)
	-1.3592	-1.9371
Female headed	(0.1773)	(0.0556)*
	-1.5657	-2.3234
Male headed	(0.1331)	(0.0297)*
	0.0987	-1.4489
Adult child mortality	(0.9217)	(1.1517
	0.0199	-0.1580
Female headed	(0.9842)	(0.8751)
	-03667	-0.5886
Male headed	(0.7174)	(0.5635)
	0.2246	0.1074
	(0.8237)	(0.9151)

*Source: Authors calculations using data from Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008); **(*) means significant at 5% (10%) level. Figures in parenthesis are standard errors.*

Non-affected households *without* prime-age adult mortality and morbidity recorded higher fertilizer application per hectare compared to AIDS-affected and non-affected households with prime-age adult mortality and morbidity. Fertilizer application per hectare increased from 1.90 bags per hectare in 2004/05 to 4.25 bags per hectare in 2006/07 (see Table 4.9). In general, despite the recorded increase during 2006/07 season, the use of fertilizer by both AIDS-affected and non-affected farm households still remain below the internationally recommended quantity of 5 bags per hectare (2 bags per acre).

Table 4.9: Fertilizer application for non-affected households without mortality and morbidity

Inputs of production	2004/05	2006/07	Two sample t-tests Ho: diff=0; Ha=diff>0
Fertilizer application per hectare (no. of 50 kg bags)			Ho: diff=0; prob (|T|>t)
All households	1.90	4.25	-8.23
	(0.20)	(0.11)	(0.00)**
Female headed	1.36	3.80	-7.42
	(0.14)	(0.31)	(0.00)**
Male headed	2.10	4.50	-5.08
	(0.27)	(0.15)	(0.00)**

*Source: author's calculations; Integrated household survey data, 2004/05 and 2006/07 (National Statistical Office, NSO, 2005, 2008); ** means significant at 5% level; Figures in parenthesis are standard errors*

Still on fertilizer application, the proportion of non-affected households (with prime-age adult mortality and morbidity) applying fertilizer increased slightly from 68.26 percent during the 2004/05 season to 70.12 percent during 2006/07 season (see Table 4.10). By gender, the proportion of male headed households applying fertilizer among non-affected households rose from 69.09 percent to 74.19 percent. On the other hand, female headed households experienced a decline from 65.45 percent to 56.36 percent. The decline was experienced in all categories of female headed households. Overall, non-affected households (with mortality) applying fertilizer declined from 69.53 percent during 2004/05 season to 67.18 percent during 2004/05. On the other hand, for morbidity cases, households applying fertilizer increased from 67.80 percent to 71.18 percent.

Table 4.9: Proportion of households applying fertilizer for non-affected households

Agricultural activities	2004/05	2006/07
Households applied fertilizer (%)		
Non-affected households	68.26	70.12
Female headed households (%)	65.45	56.36
Male headed households (%)	69.09	74.19
Mortality (%)	69.53	67.18
Female headed households (%)	64.52	51.61
Male headed households (%)	71.13	72.16
Household head/spouse mortality	66.67	65.55
Female headed	61.11	44.44
Male headed	68.06	70.83
Adult child mortality	76.32	71.05
Female headed	69.23	61.54
Male headed	80.00	76.00
Morbidity (%)	67.80	71.18
Female headed households (%)	65.82	58.22
Male headed households (%)	68.36	74.90
Household head/spouse morbidity	69.81	70.92
Female headed	70.27	58.11
Male headed	69.66	75.00
Adult child morbidity	58.70	72.99
Female headed	40.00	60.00
Male headed	60.98	74.42

Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

AIDS-Affected households applying fertilizer were slightly higher (73.59 percent) than non-affected households (70.12 percent) during 2006/07 (see Table 4.10). Among affected households, all categories experienced increases in terms of the proportion of households that apply fertilizer during 2006/07 season compared to 2004/05 season. In terms of gender, male households recorded more increases in fertilizer application compared to female headed households. A high proportion of mortality affected households applied fertilizer than morbidity affected households.

Table 4.10: Proportion of households applying fertilizer for AIDS-affected households

Agricultural activities	2004/05	2006/07
Households applied fertilizer (%)		
Affected households	65.68	73.59
Female headed households (%)	64.18	67.16
Male headed households (%)	66.10	75.42
Mortality (%)	78.57	82.14
Female headed households (%)	84.62	76.92
Male headed households (%)	73.33	86.67
Household head/spouse mortality	77.78	100.00
Female headed	83.33	100.00
Male headed	66.67	100.00
Adult child mortality	78.95	73.68
Female headed	85.71	57.14
Male headed	75.00	83.33
Morbidity (%)	64.36	72.72
Female headed households (%)	59.25	64.81
Male headed households (%)	65.61	74.66
Household head/spouse morbidity	62.64	71.98
Female headed	62.50	65.63
Male headed	62.67	73.33
Adult child morbidity	67.74	74.19
Female headed	54.55	63.64
Male headed	71.83	77.46

Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

Regarding use of hybrid maize seeds, non-affected households that grew hybrid maize rose slightly from 46.47 percent during 2004/05 to 47.10 percent in 2006/07 (see Table 4.11). In terms of gender, while the proportion of female headed households using hybrid maize seeds rose during 2006/07, the proportion was constant for male headed households. The only exceptions are female headed households with household head/spouse mortality and adult child morbidity. Nevertheless, more male headed households used hybrid maize seeds during 2006/07 compared to female headed households. In general, relatively more households with morbidity used hybrid maize seeds than households with mortality. More male headed households used maize seeds than female headed households.

Table 4.11: Non-affected affected households growing maize hybrid

Agricultural activities	2004/05	2006/07
Households grows hybrid maize (%)		
Non-affected households	46.47	47.10
Female headed households (%)	32.73	35.54
Male headed households (%)	50.54	50.53
Mortality (%)	39.84	39.84
Female headed households (%)	25.81	25.80
Male headed households (%)	44.33	44.32
Household head/spouse mortality	42.22	40.00
Female headed	38.89	27.78
Male headed	43.06	43.06
Adult child mortality	34.21	39.47
Female headed	7.61	23.08
Male headed	48.00	48.00
Morbidity (%)	48.87	49.72
Female headed households (%)	35.44	39.24
Male headed households (%)	52.73	52.73
Household head/spouse morbidity	47.73	49.02
Female headed	35.14	40.54
Male headed	51.71	51.72
Adult child morbidity	56.52	54.17
Female headed	40.00	20.00
Male headed	58.54	58.14

Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

Regarding AIDS-affected households, in general, the proportion of households using hybrid seeds using rose from 47.9 percent to 49.50 percent (see Table 4.12). The proportion of affected households using hybrid maize was slightly higher (49.50 percent) during 2006/07 compared to non-affected households (47.10) (see table 4.12). However, the proportion of affected female headed households using hybrid seeds declined during 2006/07. Similarly, affected households with mortality households dropped from 60.71 percent to 50.00 percent. This is in contrast to non-affected households which were constant at 39.84 percent. The drop mainly came from affected households with adult child mortality. Similarly, the proportion of households with adult child morbidity using hybrid maize seeds declined during 2006/07.

Table 4.12: AIDS-affected households growing hybrid maize

Agricultural activities	2004/05	2006/07
Households grows hybrid maize (%)		
Affected households	47.91	49.50
Female headed households (%)	37.68	31.34
Male headed households (%)	50.83	54.66
Mortality (%)	60.71	50.00
Female headed households (%)	38.46	30.77
Male headed households (%)	80.00	66.67
Household head/spouse mortality	33.33	55.56
Female headed	33.33	50.00
Male headed	33.33	66.67
Adult child mortality	73.68	47.37
Female headed	42.86	14.29
Male headed	91.67	66.67
Morbidity (%)	46.64	49.45
Female headed households (%)	37.50	31.48
Male headed households (%)	48.90	53.85
Household head/spouse morbidity	45.50	50.55
Female headed	36.36	34.48
Male headed	47.44	54.00

Adult child morbidity	48.94	47.31
Female headed	39.13	27.27
Male headed	52.11	53.52

Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

In summary, both AIDS-affected and non-affected households experienced reduction in per household cultivated area. In both cases, affected households with morbidity had slightly higher average cultivated area during 2006/07 compared to affected households with mortality. In terms of gender, female headed households had lower cultivated area per household compared to male headed households.

In terms of fertilizer application, both AIDS-affected and non-affected households experienced increases in fertilizer application per hectare during 2006/07. In general, both affected and non-affected households had similar levels of fertilizer application per hectare. In terms of gender, male headed households had more bags of fertilizer compared to female headed households. While affected households with mortality recorded higher fertilizer application during 2006/07 season (4.93 bags) compared to affected households with morbidity, the outcome was different for non-affected households.

4.4 Functional forms of stochastic production frontier and variables

This study follows Battese and Coelli (1995) stochastic production function. It consider data on small holder maize farmers in Malawi for the two agricultural seasons from which production data was obtained in the Integrated Household panel survey

Following Battese and Coelli (1995), the study specifies the general functional form for the stochastic frontier for maize farmers in Malawi is the translogarithmic function:

$$\ell n y_{it} = \beta_0 + \beta_0^* D_{it} + \beta_1 \sum_{j=1}^{5} \beta_j x_{jit} + \sum_{j\leq}^{5} \sum_{k=1}^{5} \beta_{jk} x_{jit} x_{kit} + (v_{it} - u_{it}) \qquad [4.1]$$

where *i* and *t* represents farm household *i* and time period *t*.

$\ell n y_{it}$ stands for the logarithm of amount of maize harvested (in kilograms) (*ly*),

D is the dummy variable for use of hybrid maize, which takes value 1 if hybrid maize was used, zero otherwise;

x_1 stands for the logarithm of land where maize was grown (in hectares) (*lh*);

x_2 is the logarithm of the total amount of labour in man days from both family and hired labour (*lb*);

x_3 is the logarithm of fertilizer applied to the maize field (in kilograms (*lf*);

x_4 is the logarithm of the amount of maize seed sown (in kgs) (*ls*);

x_5 is the year of observation, accounts for Hicksian neutral technological change; where x_5 =1, 2 for years, 2004/05 and 2006/07, respectively.

v_{it} and u_{it} are the random variables defined above.

Battesse and Coelli (1995) assume that the disturbance term in a stochastic frontier model has two error components. The first has a non-negative distribution. On the other hand, the second has a symmetric distribution. In empirical literature, the nonnegative part is known as the inefficiency term while the other part is known as the disturbance term. When estimating the panel stochastic production function in Stata, one makes a choice whether to use a time-invariant inefficiency model or the time varying inefficiency model.

This stochastic frontier model (4.1) includes year of observation in such a way that non-neutral technical change is specified. There would be no technical change among the maize farmers if the parameters of all variables related to year of observation were zero, i.e., $\beta_2 = \beta_{i2} = 0$, $i = 1,\ 2$.

Following Battesse and Coelli (1995), the inefficiency model is specified as follows:

$$u_{it} = \delta_0 + \delta_1(age_{it}) + \delta_2(edu_{it}) + \delta_3(t_i) + w_{it} \quad (4.2)$$

where age_{it} and edu_{it} represents the age and years of formal education of the household head at the *t-th* year of observation.

4.5 Estimation results: Determinants of technical efficiency

Tables 4.13 to 4.16 show estimation results for determinants of technical efficiency of AIDS-affected and non-affected households using time varying and time-invariant inefficiency models[34]. The results show that land, fertilizer and seeds contributed significantly to technical efficiency of AIDS-affected households under both time varying and time-invariant models (see tables 4.13 and 4.14). By gender, land, fertilizer, seeds, education and age contributed significantly to technical efficiency of affected female headed households. On the other hand, land, fertilizer and education contributed significantly to the technical efficiency levels of affected male headed households (see appendix I, tables A-4.1 to A-4.4). Fertilizer is a crucial input of production and is well known for its role in enhancing productivity of farmers. Education plays an important role in enabling farmers to acquire skills about farming activities, including appropriate use of farm inputs. The estimated coefficient for age has a positive sign, suggesting that old farmers are more efficient than young ones. This could be due to knowledge, skills and experience on crop husbandry acquired by the farmers over the years. For affected households with mortality and morbidity, fertilizer and seeds were the common variables that were statistically significant.

For non-affected households, only fertilizer and land contributed significantly to productivity of the farm households (tables 4.15 and 4.16). By gender, fertilizer and land were the only statistically significant variable for female headed households, while labour, fertilizer and age were the statistically significant determinants of technical efficiency of male headed households (see appendix I, tables B-4.1 to B-4.3). For non-affected households with mortality and morbidity, fertilizer, land and labour are the major statistically significant determinants of technical efficiency (see appendix I, A-4.7 to A-4.14).

[34] This helps in testing how sensitive the empirical results are to the use of alternative models.

Table 4.13: AIDS-affected households – time varying inefficiency model results

```
Time-varying decay inefficiency model           Number of obs      =       410
Group variable: id                              Number of groups   =       263

Time variable: t                                Obs per group: min =         1
                                                               avg =       1.6
                                                               max =         2

                                                Wald chi2(8)       =    196.51
Log likelihood  = -515.64965                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1023402	.0431257	8.63**	0.004	-.0961825	.3080629
lb	.2973416	.0896894	1.31	0.191	-.0584464	.2931296
lf	.4318217	.0441411	9.78**	0.000	.3453068	.5183367
ls	.2530484	.0914311	1.67*	0.094	-.0261534	.3322501
t	.2125243	.1411019	1.79	0.074	-.0240303	.5290789
sex	.0596876	.114341	0.52	0.602	-.1644166	.2837919
age	.0012207	.0027493	0.44	0.657	-.0041679	.0066093
edu	-.0653894	.0735749	-0.89	0.374	-.2095936	.0788147
_cons	4.229109	.4277983	9.89	0.000	3.390639	5.067578
/mu	-2.513486	8.383145	-0.30	0.764	-18.94415	13.91718
/eta	-.4898009	.3190093	-1.54	0.125	-1.115048	.1354459
/lnsigma2	.8361765	1.670105	0.50	0.617	-2.43717	4.109523
/ilgtgamma	1.100469	2.203094	0.50	0.617	-3.217515	5.418454
sigma2	2.307527	3.853814			.0874079	60.91765
gamma	.750348	.4126965			.0385119	.9955856
sigma_u2	1.731449	3.84247			-5.799655	9.262552
sigma_v2	.5760787	.0635129			.4515958	.7005617

*significant at 10% level; sex (female=1, male=2); education (no education=0)

Table 4.14: AIDS-affected households - time invariant inefficiency model results

```
Time-invariant inefficiency model               Number of obs      =       410
Group variable: id                              Number of groups   =       263

                                                Obs per group: min =         1
                                                              avg =        1.6
                                                               max =         2

                                                Wald chi2(8)       =    186.90
Log likelihood = -516.93128                     Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1007392	.0354618	9.26**	0.025	-.1003765	.301855
lb	.2525327	.0901766	1.20	0.229	-.0682102	.2852757
lf	.4336891	.04524	9.59**	0.000	.3450203	.5223579
ls	.2577066	.0912915	1.73*	0.084	-.0212215	.3366346
t	.0893292	.0980233	0.91	0.362	-.102793	.2814514
sex	.0694879	.1141588	0.61	0.543	-.1542593	.2932351
age	.0013903	.0027628	0.50	0.615	-.0040248	.0068053
edu	-.0549349	.0735401	-0.75	0.455	-.1990709	.0892011
_cons	4.349331	.4160277	10.45	0.000	3.533932	5.16473
/mu	-15.52872	103.0175	-0.15	0.880	-217.4393	186.3818

/lnsigma2	1.854568	5.608098	0.33	0.741	-9.137102	12.84624
/ilgtgamma	2.231164	6.199783	0.36	0.719	-9.920186	14.38251
sigma2	6.388936	35.82978			.0001076	379358.7
gamma	.9030134	.5429784			.0000492	.9999994
sigma_u2	5.769295	35.82332			-64.44312	75.98171
sigma_v2	.6196414	.0624205			.4972995	.7419834

***(**)** significant at 10% level and 5% level of significance; significant at 10% level; sex (female=1, male=2); education (no education=0)

The findings for both affected and non-affected households differ with other studies on Malawi. They differ with Tchale (2009), whose study show that only education level of household head was significant. They also differ with Chirwa (2007) whose small sample of small-scale farmers in one of the districts in Southern Malawi find only labour as the statistically significant variable. They further differ with findings in studies from other African countries. For instance, Obwona (2006) indicates that education has a significant impact on technical efficiency. It is noteworthy that while labour, a critical input in maize production, is significant for non-affected households, it is not significant for AIDS-affected households.. The estimated return to the scale for of -0.04615 and 0.71238 for affected households and non-affected households, respectively, imply that maize is produced at a decreasing and close to constant returns to scale, respectively on the same plots. This is lower compared to estimate of returns to scale obtained in Chirwa (2007) who found estimated returns to scale at 0.97. Affected female and male headed households have estimated returns to scale at -0.9875 and 0.895277, respectively. Non-affected female and male headed households record estimated returns to scale at 0.655533 and 0.769227 (see appendix 1, tables A-4.1 to A-4.4, and tables B-4.1 to B-4.3).

Table 4.15: Non-affected households – time varying inefficiency model results

```
Time-varying decay inefficiency model          Number of obs      =        120
Group variable: id                               Number of groups   =         86

Time variable: t                                 Obs per group: min =          1
                                                                avg =        1.3
                                                                max =          2

                                                 Wald chi2(7)       =      12.13
Log likelihood  = -109.91634                     Prob > chi2        =     0.0963
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
age	.0053903	.0017628	0.60	0.515	-.0030346	.0078549
edu	-.0277003	.2596591	-0.11	0.915	-.5366228	.4812221
lh	.0213395	.2104826	5.40**	0.005	-.3911989	.4338779
lb	.3961175	.2981535	1.33	0.184	-.1882526	.9804875
lf	.7920051	.0226711	8.57**	0.000	-.048426	.4324361
ls	.1387257	.1391391	1.00	0.319	-.133982	.4114334
t	-.0122531	.3185195	-0.04	0.969	-.6365399	.6120338
sex	.1434649	.2675285	0.54	0.592	-.3808814	.6678111
_cons	4.933464	.8611172	5.73	0.000	3.245705	6.621223

/mu	-5.591935	119.6798	-0.05	0.963	-240.16	228.9762
/eta	.5060411	1.112504	0.45	0.649	-1.674427	2.686509
/lnsigma2	1.088286	12.71114	0.09	0.932	-23.82509	26.00166
/ilgtgamma	.9810913	17.25328	0.06	0.955	-32.83472	34.79691
sigma2	2.969179	37.74165			4.50e-11	1.96e+11
gamma	.7273247	3.421731			5.50e-15	1
sigma_u2	2.159557	37.60863			-71.55201	75.87112
sigma_v2	.8096218	.2462347			.3270107	1.292233

***(**)** significant at 10% level and 5% level of significance; significant at 10% level; sex (female=1, male=2); education (no education=0)

Table 4.16: Non-affected households –time invariant inefficiency model results

```
Time-invariant inefficiency model                  Number of obs      =       120
Group variable: id                                 Number of groups   =        86

                                                   Obs per group: min =         1
                                                                  avg =       1.4
                                                                  max =         2

                                                   Wald chi2(6)       =     36.98
Log likelihood  = -179.30621                       Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1529719	.174869	3.02	0.006	-.1897649	.4957088
lb	.2215137	.1875177	1.18	0.237	-.1460143	.5890417
lf	.4705726	.0387773	3.13**	0.002	.1377733	.6033719
ls	-.0170625	.1050737	-0.16	0.871	-.2230032	.1888781
edu	.0839356	.1743479	0.48	0.630	-.25778	.4256513
t	.3222047	.274804	1.17	0.241	-.2164012	.8608106
_cons	3.981378	.6149625	6.47	0.000	2.776074	5.186683
/mu	-7.218936	462.2765	-0.02	0.988	-913.2643	898.8264
/lnsigma2	.1975602	3.345199	0.06	0.953	-6.358909	6.75403
/ilgtgamma	-3.03209	72.74732	-0.04	0.967	-145.6142	139.55
sigma2	1.218426	4.075879			.0017313	857.5072
gamma	.045997	3.192246			5.76e-64	1
sigma_u2	.056044	4.076862			-7.934459	8.046547
sigma_v2	1.162382	.1502299			.8679373	1.456828

***(**)** significant at 10% level and 5% level of significance; significant at 10% level; sex (female=1, male=2); education (no education=0)

4.6 Estimation results: technical efficiency in smallholder agriculture in Malawi

Also obtained are technical efficiency levels of AIDS-affected and non-affected households (see Table 4.17). Two sample t-tests were carried out for equality of the mean technical efficiency levels (difference in difference) to examine the technical efficiency differentials between AIDS-affected and non-affected households. Presented below are results on the technical efficiency levels of farm households in rural Malawi. The results are disaggregated by gender of the household head, and mortality and morbidity. The results show that the mean technical efficiency levels of non-affected households under time varying and time-invariant models are at 73 percent and 75 percent, respectively. These efficiency levels are higher than the efficiency levels of AIDS-affected households, under time varying and time-invariant inefficiency models, at 69 percent and 71 percent, respectively. The difference in the technical efficiency levels is statistically insignificant at 10 percent level. The levels of technical efficiency of affected and non-affected households with prime-age adult mortality and morbidity are lower than those of non-affected households *without* prime-age adult mortality and morbidity of 76 percent and 78 percent under time varying and time-invariant models, respectively (see appendix I, Table B-4.15).

However, the results are in line with the findings on technical efficiency levels from Adeoti and Adeoti (2008); Yusuf et al. (2007), where the technical efficiency levels of AIDS-affected households are lower than those of non-affected households. Male headed households are technically more efficient than female headed households for both affected and non-affected households. Similarly households with morbidity are technically more efficient than households with mortality.

Table 4.17: Technical efficiency levels for AIDS-affected and non-affected farm households 2004/05-2006/07

	Time-varying model		Time invariant model		2 sample t-test
	Affected	Non-affected	Affected	Non-affected	H0: diff=0; Prob(|T|>0 Ha: diff>0
					Ho:diff=0;
All households	0.693	0.731	0.7129	0.7524	prob(|T|>|t|)
	(0.006)	(0.119)	(0.082)	(0.142)	0.040**
Female headed	0.652	0.701	0.671589	0.7255	(0.9564)
	(0.020)	(0.012)	(0.1982)	(0.106)	0.050*
Male headed	0.726	0.758	0.78003	0.8120	(0.9521)
	(0.21)	(0.022)	(0.125)	(0.0504)	0.032**
Mortality	0.456	0.526	0.51358	0.6574	(0.9608)
	(0.044)	(0.048)	(0.0639)	(0.052)	0.071*
Female headed	0.296	0.325	0.3015	0.3371	(0.9451)
	(0.072)	(0.057)	(0.223)	(0.184)	0.029**
Male headed	0.521	0.601	0.5562	0.664	(0.9643)
	(0.056)	(0.073)	(0.067)	(0.085)	0.081*

Morbidity	0.725	0.733	0.754	0.7684	(0.9315)
	(0.007)	(0.014)	(0.092)	(0.0671)	0.008*
Female headed	0.648	0.711	0.70285	0.7448	(0.9688)
	(0.025)	(0.012)	(0.0127)	(0.027)	0.0630
Male headed	0.742	0.753	0.7673	0.775	(0.9507)
	(0.006)	(0.022)	(0.008)	(0.069)	0.011
					(0.9685)

Source: Authors' estimation results from time varying and time invariant inefficiency models
The figures in brackets are standard errors. ** (*)means significant at 5% and 10% levels, respectively

In general, Malawian farmers are technically efficient and the mean technical efficiency levels of over 65 percent are relatively higher than those obtained in Tchale (2009) of 53 percent (using national survey for 2004/04), and in Chirwa (2007) of 46 percent for a cross-section of Malawian farmers in one district in Southern Malawi. This could be attributed to the role of the enhanced Government fertilizer subsidy programme. Nevertheless, the mean technical efficiency levels are comparable to those obtained for other African countries, whose means range from 55 percent to 79 percent (see Adeoti and Adeoti (2008); Yusuf et al. (2007); Obwona (2006); Al-Hassan (2008); Ogundele (2006); Nchare (2007)). The results by gender show that female headed households have lower technical efficiency levels compared to male headed households for both AIDS-affected and non-affected households with both morbidity and mortality. For both AIDS-affected and non-affected households, the mean technical efficiency levels of the households with morbidity are statistically higher then the mean technical efficiency levels of households with mortality. The lowest mean technical efficiency level recorded is for AIDS-affected female headed households with mortality at 29 percent. At this level, theses households are technically inefficient.

Regarding the distribution of technical efficiency, the majority of AIDS-affected and non-affected households have technical efficiency levels above 50 percent. For instance, 88 percent of affected female headed households and 95 percent of affected male headed households have technical efficiency levels above 50 percent. For non-affected households, all male headed households have technical efficiency levels above 50 percent (see Appendix I).

4.7 Conclusions and Policy Recommendations

This essay examined the determinants of technical efficiency and technical efficiency differentials between AIDS-affected and non-affected farm households in Malawi, using time-varying and time invariant inefficiency models.

The results show that for both AIDS-affected and non-affected households, among both female headed and male headed households, fertilizer, land and seeds are the major variables that contribute significantly towards technical efficiency. For both affected and non-affected households with mortality and morbidity, again fertilizer and seeds remain the statistically significant determinants of technical efficiency. These findings differ with Chirwa (2007) whose small sample of small-scale farmers in one of the districts in Southern Malawi found only labour as the statistically significant variable. They also differ with Obwona (2006) whose finding showed that education has a significant impact on technical efficiency. The estimated return to the scale for affected households of -0.04615 and 0.71238 for non-affected households imply that maize is produced at a decreasing and close to constant returns to scale, respectively on the same plots. This is lower compared to estimated returns to scale obtained in Chirwa (2007), where estimated returns to scale were at 0.97. Affected female and male headed households have estimated returns to scale at -0.9875 and 0.895277, respectively. Non-affected female and male headed households record estimated returns to scale at 0.655533 and 0.769227. The land variable is not a statistically significant contributor of technical efficiency. This could be due to the smallness of landholdings among smallholder farm households.

Turning to technical efficiency levels, the mean technical efficiency of non-affected households is significantly higher (73 percent) than the mean technical efficiency of affected households (69 percent). The mean technical efficiency levels are relatively higher than the one obtained in Chirwa (2007) who obtained the mean technical efficiency of 46 percent. The levels of technical efficiency are lower than those for non-affected households *without* mortality and morbidity of 76 percent and 78 percent under time varying and time-invariant models, respectively (see Appendix I, Table B-4.15). Nevertheless, the mean technical efficiency levels are comparable to those that were obtained for other African countries, where the means range from 55 percent to 79 percent (see Obwona (2006); Chirwa (2007); Al-hassan (2008); Ogundele (2006); Nchare (2007)). The impact of mortality and morbidity are dependent on the gender of the household head. Female headed households have lower technical efficiency levels compared to male headed households for both AIDS-affected and non-affected households with both morbidity and mortality. The effects are less dramatic for households with morbidity. For both AIDS-affected and non-affected households, the mean technical efficiency levels of households with morbidity are statistically higher then the mean technical efficiency of households with mortality. The lowest mean technical efficiency level recorded is for affected female headed households with mortality at 29 percent. At this level, theses households are technically inefficient.

These results reveal that government policy of subsidizing hybrid maize seeds and fertilizers since the 2005/06 agricultural season has enhanced technical efficiency of small-scale farmers. Nonetheless, there is still scope for improvement of the productivity of smallholder farmers, as some farm households, particularly female headed households, are still operating at low levels of technical efficiency. The average fertilizer application levels per hectare are still below the standard requirement of 5 bags per hectare.

Four policy issues emerge from the results of this study. First, Government needs to simultaneously expand the fertilizer subsidy programme and encourage farmers to use compost and other sources of manure as a supplement. Second, since the agricultural input and output markets remain underdeveloped, Government needs to remove all types of impediments that could limit the use of inputs. This should include completely liberalizing the purchase and distribution of such inputs and the developing some low-cost technology to reduce labour constraints on the farm. Third, since education is an important determinant of technical efficiency of particularly affected households, offering farmers with necessary skills and extension services would be a valuable investment and a better way of enhancing efficiency in maize production. Finally, there is need to develop social capital in smallholder farming by reviving farmers' clubs and/or by setting up agricultural cooperatives where farmers can share ideas and resources about crop husbandry in order to enhance crop production.

References

Adeoti A.I. & Adeoti J.O. (2008), "HIV/AIDS and Farm Production Efficiency in Benue State, Nigeria," *African Journal of Biomedical Research*, 11: 154-153

Aigner, D.K, Lovell C.K. & Schimidt, P. (1977), "Formulation and Estimation of Stochatsic: Frontier Production function Models," *Journal of Econometrics*, 6: 21-37

Ajani, O.I.Y. & Ugwe, P.C. (2008), "Impact of Adverse Health on Agricultural Productivity of Farmers in Kainji Basin North Central Nigeria Using a Stochastic production Frontier Approach," *Trends in Agricultural Economics*, 1(1): 1-7

Ajibefun, I.A. & Abdulkadri O.A. (1999), "An investigation of technical efficiency of farmers under the National Directorate of Employment in Ondo State, Nigeria," *Applied Economics Letter*, 6: 111–14, Routledge, London

Ajibefun, A.I. & Daramola. A.G. (2004), "*Efficiency of Microenterprises in the Nigerian Economy*," Research Paper 134. African Economic Research Consortium (AERC), Nairobi

Ajieh, P.C. & Okoh, R.N. (2009), "The effects of HIV/AIDS pandemic on agricultural production as perceived by farmers in the central agricultural zone of delta state, Nigeria," *ARPN Journal of Agricultural and Biological Science*, 4(4): 115-120

Ali, A.I. & Seiford, L.M. (1993), "The mathematical programming approach to efficiency analysis," in *The Measurement of Productive Efficiency: Techniques and Applications*, H. O. Fried, C. A. K. Lovell, and S. S. Schmidt, eds., Oxford University Press, New York

Al-Hassan, S. (2008), "*Technical Efficiency of Rice Farmers in Northern Ghana*," AERC Research paper 178, African Economic Research Consortium, Nairobi

Anselin, L. (1989), "*Some Robust Approaches to Testing and Estimation in Spatial Econometrics*," Regional Science and Urban Economics

Antle, J. M. & Pingali, P.L. (1994), "Pesticides, productivity, and farmer health: A Philippine case study," *American Journal of Agricultural Economics,* 76(3): 418–30.

Audibert, M. (1997), "Technical efficiency effects among paddy farmers in the villages of the Niger, Mali, West Africa," *Journal of Productivity Analysis*, 8: 379–94

Banker, R.D., Charnes, A. & Cooper, W.W. (1984), "Some models for estimating technical and scale inefficiencies in Data Development Analysis," *Management science*, 30: 1078-1092.

Bardhan, P.K. & Udry, C. (1999), "*Development microeconomics*," Pranab K. Bardhan and C. Udry, Clarendon Press, Oxford, UK

Battese, G.E. & Corra, G.S. (1977), "Estimation of production frontier model: application to pastoral zone of Eastern Australia," *Australian Journal of Agricultural Economics*, 21: 169–79.

Battese, G.E. & Coelli T.J. (1988), "Prediction of farm level technical efficiencies with a generalized frontier production function and panel data," *Journal of Economics*, 5: 338-387

Battese, G.E., Coelli, T.J. & Colby T.C. (1989), "Estimation of frontier production functions and the efficiencies of Indian farms using panel data from ICRISAT's village level studies". *Journal of Quantitative Economics*, 5: 327–48

Battese, G.E. (1992), "Frontier production functions and technical efficiency: A survey of empirical applications in agricultural economics," *Agricultural Economics,* 7: 185–208

Battesse, G.E. & Coelli, T.J. (1995), "A model for technical inefficiency effects in a stochastic frontier production function for panel data," *Empirical economics*, 20: 325 -332.

Battese, G.E., Malik, S.J. & Gill, M.A. (1996), "An investigation of technical inefficiencies of production of wheat farmers in four districts of Pakistan," *Journal of Agricultural Economics,* 47(1): 37-49

Becker, G. S. (1965), "A Theory of the Allocation of Time," *Economic Journal*, 75: 493-517

Bliss, C. J. & Stern, N. H. (1982), *Palanpur: The Economy of an Indian Village,* Clarendon Press, Oxford

Brümmer, B. (2001), "Estimating confidence intervals for technical efficiency: The case of private farms in Slovenia," *European Review of Agricultural Economics,* 28(3): 285-306.

Chapoto, T.S. & Jayne, T. (2005), "Measuring Impact of Working-Age Adult Mortality on Small-scale Farm Households in Kenya," *World Development*, 32 (1): 91-111

Chapoto, A. & Jayne. T. (2008), "Impact of AIDS-related mortality on farm households welfare in Zambia," *Economic Development and Cultural Change*, 56(2): 327-374.

Charnes, A., Cooper, W.W. & Rhodes, E. (1978), "Measuring the inefficiency of decision making unit," *European Journal of Operational Research*, 2: 429–44.

Chayanov, A.V. (1966), "*The Theory of Peasant Economy,"* ed. Daniel Thoner. Homewood, Ill, Richard, D. Irwin, Hunt

Chirwa, E.W. (2007), "S*ources of Technical Efficiency among Smallholder Maize Farmers in Southern Malawi,"* AERC Research Paper 172, African Economic Research Consortium, Nairobi, Kenya

Coelli, T.J. (1996), "*A Guide to Frontier 4.1: A computer Program for Stochastic Frontier Production and Cost Function Estimation*," CEPA Working Paper, Department of Econometrics, University of New England, Armidale, Australia.

Coelli, T.J. & Perelman, S. (1999), "A Comparison of Parametric and Non-parametric Distance Functions: With Application to European Railways," *European Journal of Operations Research*, 17: 326-339.

Coelli, T., Rao, D.S.P. & Battese, G.E. (1998), *An Introduction to Efficiency Analysis*, Kluwer Academic Publishers, USA

Croppenstedt, A. & Muller, C. (2000), "The Impact of Farmers' Health and Nutritional Status on their Productivity and Efficiency: Evidence from Ethiopia," *Economic Development and Cultural Change,* 48 (3): 475-502

Dasgupta, P. (1993), An inquiry into well-being and destitution, Clarendon Press, Oxford, UK

de Janvry, A. & Fafchamps, M. & Sadoulet, E. (1991), "Peasant Household Behaviour with Missing markets: Some paradoxes Explained," *Economic Journal,* Royal Economic Society, 10 (409): 1400-417

Donovan, C. & Mather, D. (2008), "*Impacts of Prime Age Adult Mortality on Rural Household Income, Assets, and Poverty in Mozambique: Analysis with Panel Data Set*," International Development Collaborative Policy Briefs MZ-MINAG-FL-49e, Department of Agricultural Economics, Michigan State University

Drimie, S. (2003), "HIV/Aids and land: case studies from Kenya, Lesotho and South Africa," Development *Southern Africa,* 5: 647-658.

Ellis, F. 1992, *Peasant Economics,* Cambridge University Press, Cambridge.

Ellis, F. (2000), *Peasant Economics*, Cambridge University Press, Cambridge

Fare, R., Grosskopf, S. and Lovell, C.K.A. (1985), "The Structure of Technical Efficiency," *Scandinavian Journal of Economics,* 2: 181-190

Farrel, M.J. (1957), "The Measurement of Productive Efficiency," *Journal of Royal Statistical Society*, 120 (3): 253-281.

Forsund, E. R., Lovell C.A.K. & Schmidt, P. (1980), "A Survey of Frontier Production Functions and Their Relationship to Efficiency Measurement," *Journal of Econometrics,* 13(5): 225-235

Fox, T. (2004), "The Impact of HIV/AIDS on labour productivity in Kenya. *Tropical Medicine and International Health,*" 9 (3): 318-324

Gill, J. (2001), *Generalized Linear Models: A Unified Approach*, Thousand Oaks, Sage, California.

Greene, W. H. (1980), “Maximum likelihood estimation of econometric frontier functions,” *Journal of Econometrics*, 13: 27-56.

Greene, W.H. (1990), “A gamma distributed stochastic frontier model,” *Journal of Econometrics*, 46: 141-163

Greene, W. H. (1997), *Econometric Analysis* (3rd ed.), Upper Saddle River, Prentice-Hall, New Jersey

Helfand S.M. & Levin E.S. (2003), “Farm size and determinants of productive efficiency in the Brazilian Centre-West,” *agricultural Economics*, 31: 241-249.

Huang, C.J. & Liu, J.T. (1994), “Estimation of a non-neutral stochastic frontier production function,”*Journal of Productivity Analysis*, 4: 171–80.

Jondrow, J., Lovel, C.A.K. Materov, I.S. & Schmidt, P. (1982), “On the estimation of technical inefficiency in the stochastic frontier production function,” *Journal of Econometrics*, 19: 233 -238

Kumbhakar, S.C., Gosh, S. & McGuckin, T.J. (1991), “A generalized production frontier approachfor estimating determinants of inefficiency in US daily farms,” *Journal of Business and Economic Statistics*, 9: 279-286

Lipton, A. (1986), “US Rule on Investment Bank Performance Fees,” *International Financial Law Review* (UK), 5 (86): 26-27.

Lipton, M., & Longhurst, R. (1989), *New Seeds and Poor People*, Unwin Hyman, London.

Lovel, C. A. K. (1993), “Production frontier and productive efficiency,” in Fried, H.O and Lovel, C.A.K., and Schmidt, S.S. (Eds), *Measurement of productive efficiency*, Oxford University Press, Newyork

Low, A. (1986), *Agricultural Development in Southern Africa. Farm household economics and food crisis*, James Currey, London.

Lyubov, A.K. & Jensen, H.H. (1998), "*Technical Efficiency of Grain Production in Ukraine*," Centre for Agricultural and Rural Development, Iowa State University, USA

Malawi Government (2002), Malawi National Land Policy. Ministry of Land, Survey and Physical Planning, Lilongwe, Malawi

Malawi Growth and Development Strategy (MGDS) (2006) Malawi government, Lilongwe

Mather, D. (2004), "*Household Responses to Prime Age Adult Mortality in Rural Mozambique: Implications for HIV/AIDS Mitigation Efforts and Rural Economic Development Policies*," Centre for Study of African Economies Conference, Oxford University

Mas-Colell, A., Whinston, M. D. & Green. J. R. (1995), M*icroeconomic Theory*, Oxford University Press, Oxford

Matthew, P.F. (2004), "The impact of HIV/AIDS on labour productivity in Kenya," *Tropical Medicine and International Health*, 9(3): 318-324

Meeusen, W. & van den Broeck, J. (1977), "Efficiency Estimation from Cobb-Douglas Functions with Composed Error," *International Economics Rev*, 18: 435-444

Meller, J.P. (1976), "*Efficiency Frontier for Industrial Establishments of Different Sizes*. *Explorations in Economic Research,"* Occasional Paper of the National Bureau of Economics Research, Massachusetts Avenue, Massachusetts, USA

Mendola, M. (2007), "Farm Household Production Theories: A Review of Institutional and Behavioural Responses," *Asian Development Review*, 24 (1): 49-68

Morduch, J. (1993), "*Risk, Production, and Saving: Theory and Evidence from Indian Households*," Harvard University, Cambridge, MA, USA

Morduch, J. (1994), "Poverty and Vulnerability,"*American Economic Review*, 84: 221–5.

NAADS (2003), "*The Impacts of HIV/AIDS on the Agricultural Sector in Uganda*," Baseline survey report, FAO's Integrated Programme, Rome

National Statistical Office (2005), "*Integrated Household Survey, 2004/05*," Final Report, Lilongwe, Malawi

Ntchare, A. (2007), "*Analysis of factors affecting the technical efficiency of Arabica coffee producers in Cameroon*," AERC Research Paper 163, African Economic Research Consortium, Nairobi, Kenya

Obwona, M. (2006), "*Determinants of technical efficiency differentials amongst small and medium-scale farmers in Uganda: A case of tobacco growers*," AERC Research Paper no. 152, African Economic Research Consortium, Nairobi, Kenya

Ogundele, O. (2006), "*Technical efficiency differentials in rice production technologies in Nigeria*," AERC Research Paper 154, African Economic Research Consortium, Nairobi, Kenya

Parker, D.C., Jaconsen, K.H. & Komwa, M.K. (2009), "A Qualitative Study of the Impact of HIV/AIDS on Agricultural Households in South-Eastern Uganda," *International Journal of Environmental Research and Public Health,* 6(8): 2113-2138

Pitt, MM & Rosenzweig, MR, 1986, Agricultural prices, food consumption, and the health and productivity of Indonesian farmers, In Singh, I, Squire, L & Strauss, J (Eds), *Agricultural Household Models*, Johns Hopkins University Press, Baltimore

Reifschneider, D. &. Stevenson. R. (1991), "Systematic departures from the frontier: A framework for the analysis of firm inefficiency," *International Economic Review*, 32: 715–23.

Roisenzweig, M.R. (1986), "*Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs and Their Effects on Birthweight*," Discussion Paper no. 437. New Haven, Conn, Economic Growth Center, Yale University, USA

Roumasset, J. A. (1976), *Rice and Risk, Amsterdam,* North Holland Publishing Company, Amsterdam

Schultz, T. W. (1964), *Transforming Traditional Agriculture*, University of Chicago Press, Chicago.

Schultz, P. (1999), "*Productive benefit of improving health: Evidence from low-income countries*," Mimeo, Yale University.

Seyoum E.T., Battese G.E. & Fleming, E.M. (1998), "Technical efficiency and productivity of maize producers in eastern Ethiopia: a study of farmers within and outside the Sasakawa-Global 2000 project," *Agricultural Economics*, 19: 341–348

Singh I., Squire, L. & Strauss, J. eds. (1986), *Agricultural Household Models: Extensions and Applications,* Johns Hopkins University Press, Baltimore, USA

Strauss, J. & Thomas, D. (1998), "Health, Nutrition and Economic Development," *Journal of Economic Literature*, 36 (4): 766-817

Taylor, J. Adelman, A. & Adelman.I. (2003), "Agricultural Household Models: Genesis, Evolution and Extensions," *Review of Economics of the Household*, 1(1): 33–58.

Tchale, H. (2009), "The efficiency of smallholder agriculture in Malawi," *African Journal of Agriculture and Resource Economics*, 3(2): 101-121

Townsend R.F., Kirsten R.F. & Vink N. (1998), "Farm size, productivity and returns to scale in agriculture revisited: A case study of wine producers in South Africa," *Agricultural Economics,* 19: 175-180.

Ulimwengu, J.M. (2009), "*Farmer's health Status, Agricultural Efficiency, and Poverty in Rural Ethiopia: A Stochastic Production Frontier*," IFRP Discussion Paper 00868

Walker, T. S. & Jodha, N S. (1986), “How Small Farm Households Adapt to Risk' in Crop Insurance for Agricultural Development,” *Issues and Experiences* (Hazell, P, Pomareda, C and Valdez, A, eds), John Hopkins UniversityP ress, Balti-more, USA

Weir, S. & Knight, J. (2000), “*Education Externalities in Rural Ethiopia: Evidence from average and stochastic frontier production functions*,” Working Paper No. 4. Centre for Study of African Economies, University of Oxford, Oxford

Yamano, T. & Jayne, T.S. (2004), “Measuring the Impacts of Prime-Age Adult Death on Rural Households in Kenya,” *World Development*, 32(1): 91-119.

Yusuf, S.A., Ukpebor, E.I. & Salimonu, K.K. (2007), “Impact of HIV/AIDS on Farmers’ Efficiency in Anambra State, Nigeria,” *Research Journal of Applied Sciences,* 2(3): 221-224

Chapter 5: Maize production differentials among small-holder farmers in Malawi: Difference in difference estimation technique

5.1 Introduction

The effects of HIV/AIDS epidemic on cultivated land, fertilizer application and agricultural production have been only partly researched. One of the reasons for this is that appropriate methods of measuring such effects of the epidemic are still being developed (Yamano and Jayne, 2004).

In general, maize production in Malawi increased during the 1990s well into the 2000s, although low production was recorded in some years due to poor rainfall, resulting in food shortages (MoAFS, 2008). Official figures show that maize production increased at an average rate of 2.1 percent per annum between 1990 and 2005. This was due to the two years of drought spell during 1991/92 and 1992/93, which were followed by two years of favourable rains coupled with distribution of free starter packs of fertilizers in 1998/9 and 1999/2000. As a result of a poor harvest in 2004/05, the government decided to implement a fertilizer subsidy programme in 2005/06. The objective of the programme was to support access to and use of fertilizers in maize production, in order to raise agricultural productivity and food security. The result was a record maize production of 2.6 million metric tonnes - a substantial increase from 1.2 million metric tones during 2005/06 season (MoAFS, 2008).

Following the successful outcomes of the 2005/06 input subsidy programme, Government repeated the programme in 2006/07. Government expanded the input subsidy programme by 38,000 metric tonnes of fertilizer. The scaled-up input subsidy programme coupled with good rains resulted in another record maize production of about 3.4 million metric tonnes, a substantial increase from the preceding season (MoAFS, 2008).

However, the success of the fertilizer subsidy program is not free from obstacles, one being the small size of land holding, and inequalities in access to land among Malawian farm households. Landholding per household in Malawi averages about 0.50 hectares. Traditionally, female members lack inheritance rights to family land, and widows usually face problems of property grabbing by extended family members following the death of their spouses.

Finally, extension services are still on a low scale compared to the 1970s and 1980s. Additionally, the input and output agricultural markets remain underdeveloped. The ADMARC, a parastatal input and output marketing body, has closed most of its offices in the rural areas because of deregulation of the agricultural sector and entry of new players in the market. During the 1970s and 1980s, ADMARC had a network of markets in every area. Similarly, farmer clubs/cooperatives, which were operational in all districts during the 1970s and 1980s, are now non-existent. These clubs enabled farmers to share ideas, skills and resources about crop production, and were also channels through which credit facilities were provided to the famers.

The majority of studies at household level have assessed the impact of mortality in AIDS-affected households in comparison with non-affected households. However, there are no studies that have distinguished morbidity and mortality that is AIDS-related[35] from that which is not. Among prominent studies have do not examine the distcintion between AIDS-affected households and other households with helath problems include Chapato and Jayne (2008), Chapato and Jayne (2005), and Yamano and Jayne (2004). This distinction is important as the effects of morbidity and mortality among AIDS-affected and non-affected households are likely to differ as mortality implies loss of an adult household member. In terms of morbidity, it is possible for the member of the household to contribute to farming activities depending on the nature of the illness.

This chapter reviews the relationship between health and technical efficiency. It examines maize production differentials between AIDS-affected and non-affected households and also assesses the impact of adult mortality and morbidity on maize production levels of AIDS-affected and non-affected households.

[35] AIDS-related morbidity refers to illnesses medically linked to HIV/AIDS e.g. chronic tuberculosis (TB), chronic pneumonia and chronic diarrhoea. AIDS-related mortality refers to death resulting from illnesses medically associated with HIV/AIDS e.g. chronic TB, chronic pneumonia and chronic diarrhoea. For more information see Section 1.5

5.2 Health and farm production

The link between health and farm production[36] is based on the theory of household production which was proposed by Becker (1965). In his framework, Becker treats households as both producers and consumers of goods and services. Pitt and Rosenzweig (1986) revise and extend the traditional agricultural household models in order to estimate the impact of changes in health on supply and productivity of labour and overall farm production. The extension involves including the health variable in the utility function and specifying a production function for health. Health is treated as a capital good, and it can either raise or reduce the productivity of a farm household. Schultz (1999) and Strauss and Thomas (1998) assent that there is a positive relationship between health and productivity (efficiency) of labour. Good health improves household farm production, while poor health will lead to reduction in the number of days worked and particularly if a household is facing financial constraints, will ultimately result in reduction in farm output (Antle and Pingali, 1994). Illness and death from such diseases as HIV/AIDS, malaria and tuberculosis lead to a reduction in labour productivity due to the loss or reduction of labour and household assets to cope with illness.

Several studies have assessed the impact of HIV/AIDS and poor health on crop production[37]. The findings show that AIDS-affected households experience a reduction in food production (see Adoeti and Adeoti, 2008; Thangata, 2007; Chamunika, 2006; Chapoto and Jayne, 2005; Mikael, 2004; Asingwire, 2003; Harvey, 2003; NAADS, 2003; SADC FANR VAC, 2003). This could be due to loss or reduction of labour and consequently, a reduction in cultivated land. The gender of the patient is an important factor in determining the impact of the epidemic on food production. The illness and subsequent loss of a male household head results in reduction in available labour as family members are expected to care of the patient. This leads to less food and cash crop production and this creates food security problems (Thangata, 2007; Muwanga, 2002; and Mutangadura, 2000).

The objectives of this essay are to (i) examine maize production differentials between AIDS-affected[38] and non- affected farm households; and (ii) to assess the impact of prime-

[36] For a comprehensive review of farm production theories and health, see Chapter 3
[37] A comprehensive literature review on the impact of HIV/ADS and poor health on maize production is provided in Chapter 2.

[38] Affected households are households in which one or more working adult was reported to have lost life due to or suffered from AIDS-related illnesses such chronic TB, chronic pneumonia and chronic diarrhoea over

age adult morbidity and mortality on maize production levels of AIDS-affected and non-affected households. The study uses the difference in difference estimation technique. It compares maize production of AIDS-affected households with prime-age adult mortality and morbidity, with maize production of non-affected households with prime-age mortality and morbidity. No previous study has distinguished the impact of mortality from that of morbidity for both AIDS-affected and non-affected households. The study conducts this comparison because morbidity and mortality may have different effects on maize production. It also investigates whether there are gender dimensions in maize production. This is done bearing in mind that there are often gender disparities in access to crucial inputs of production such as fertilizer and land in most African countries, particularly in patrilineal communities. The study utilizes data from the Integrated Household Survey carried out during 2004/05 and 2006/07 (NSO, 2005, 2008) which was discussed in Chapter 3.

5.3 Analytical Framework

This study uses difference in difference (DD) estimation methods to investigate the impact of affected and non-affected adult morbidity and mortality on maize production.

a) Difference in difference model

Since the influential work by Ashenfelter and Card (1985), the use of difference-in-differences methods has become common in empirical literature. The most basic case of difference in difference estimation is where one examines outcomes for two groups for two time periods.

In the standard case, there are two groups namely the treatment group and comparison group. The treatment group is subjected to a treatment in the second period only. The comparison group is not subjected to the treatment in either period. In cases where the same units within a group are observed during each time period, the average gain in control group is subtracted from the average gain in the treatment group. This removes biases when comparing units in comparison and treatment group in the second period. It also removes biases from comparisons over time in the treatment group coming from trends (Yamano and Jayne, 2004).

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the last one to five years. Non-affected households are those in which at least one working adult family member was reported to have died of or suffered from chronic non-AIDS related illnesses over at least one to five years. In this essay, we use the terms ‘AIDS-affected” and ‘affected’ interchangeably.

In this study, units in the treatment group (*Treat*) are households affected by AIDS-related chronic illness or death (AIDS-affected households). Units in the control/comparison group (*Control*) are households with non-AIDS related chronic illness or death (non-affected households). Yamano and Jayne (2004) state that difference in difference estimates and standard errors for these estimates are estimated using Ordinary Least Squares (OLS) in repeated cross-sections (a panel) of data on individuals in treatment and control groups. In our case, this is done for two periods 2004/05 and 2006/07. Assuming repeated cross-sections, the model for a standard unit member of any of groups can be written as,

$$y = \alpha_0 + \alpha_1 dQ + \lambda_0 d2 + \lambda_1 d2 * dQ + u \qquad (5.1)$$

Where y represents an outcome such as maize output, $d2$ is a dummy variable for the second time period. dQ is dummy variable representing possible differences between the comparison and treatment before policy change. The time period dummy, $d2$, represents factors that can cause changes in y even in without a change in policy – with ones representing the treating grop for both period. The coefficient of interest, λ_1, multiplies the interaction term, $d2 * dQ$. This is the same as a dummy variable being equal to one for observations in the treatment group in the second period. λ_1 is the difference-in-differences parameter (Yamano and Jayne, 2004).

One way of getting unbiased estimates of the impact of adult morbidity and mortality is by using difference-in-differences (DID) estimation. In order to obtain the difference-in-differences estimator, the study obtains the difference in the initial outcome (t = 0, representing 2004/05) and after (t = 1, representing 2006/07) the adult morbidity or mortality within the treatment group e.g. $E(\Delta Y_{Treat}) = E(Y_{Treat1}) - R(Y_{Treat0})$. Most likely, this estimator may pick up time trends or impacts of exogenous shocks that are not related to adult morbidity and mortality. In order to remove these unrelated trends or impacts, the study follows Yamano and Jayne (2004) by also taking the difference in outcomes within the control group (*control*) over time and then taking the difference-in-differences between the two groups (Yamano and Jayne 2004):

$$\begin{aligned} E(DID) &= E[(Y_{Treat1}) - E(Y_{Treat0})] - [E(Y_{Control1}) - E(Y_{Control0})] \\ &= E(\Delta Y_{Treat}) - E(\Delta Y_{Control}) \qquad (5.2) \end{aligned}$$

Following Yamano and Jayne (2004), the study can further analyze impact of adult morbidity and mortality by the gender of the household head. Thus there are have two treatment groups: households with the male headed households (M) and female headed households (F). The study estimates the DID for each treatment group:

$$E(DID^{M}) = E(\Delta Y^{M}_{Treat}) - E(\Delta Y^{M}_{Control}) \text{, and } E(DID^{F}) = E(\Delta Y^{F}_{Treat}) - E(\Delta Y^{F}_{control}) \qquad (5.3)$$

It is assumed that the exogenous household-level variables do not respond to the impacts of adult morbidity and mortality in the household (Yamano and Jayne, 2004).

The DID methodology is however not free from problems. Bertrand et al. (2004) pointed that the difference in difference estimation technique has endogeneity problem and that the resulting standard errors are inconsistent as they understate the standard deviations of the estimators.

5.4 Empirical Results - maize production differentials

The study carried out two sample t-tests for equality of the mean maize output to establish whether significant differences exist in maize output for AIDS-affected and non-affected households over 2004/05 and 2006/07 period (see tables 5.1 to 5.4 and appendix II).

5.4.1 Affected households

In terms of production per hectare, maize output among AIDS-affected households rose from 24.97 bags (of 50 kg) per hectare in the 2004/05 season to 57.26 bags in 2006/07 season. The increase emanated from both female headed households and male headed households in all categories. This results differ with findings from studies on other African countries, where AIDS-affected households realised lower crop production (see Adoeti and Adeoti (2008); Thangata, (2007); Chamunika, (2006); Chapoto and Jayne, (2005)). Again, this finding reflects the significance of the government funded subsidy program coupled with good rains. Affected households with morbidity recorded lower maize production (56.70 bags per ha) in 2006/07 compared to households with mortality cases (62.77 bags per ha). This is not surprising considering that affected households with mortality recorded higher fertilizer application per hectare than those with morbidity (see Table 4.7, Chapter 4). By gender, in general, male headed households recorded higher maize harvest output than female headed households. Again this could be attributed to the higher fertilizer application per hectare for male headed households compared to female headed households as shown in Table 4.7. This finding is in line with evidence from Gill (2010) and Mikael (2004).

AIDS-Affected households with household head/spouse morbidity recorded lower maize production levels than households with adult child morbidity during 2006/07 (see Table 5.1). On the other hand, AIDS-affected households with the death of an adult child realised lower maize production during 2006/07 compared to households with the death of household head/spouse. This can again be attributed to fertilizer application differentials as shown in Table 4.7, Chapter 4. A surprising result is that female headed households with mortality recorded higher maize production levels than male headed households with mortality during 2006/07.

Table 5.1 Difference in difference in maize production (no. of 50 kg bags per hectare) for AIDS-affected households

Maize production	2004/05	2006/07	Two sample t-test
Maize production per hectare			Ho: diff=0; Prob (|T|>|t|
AIDS-affected households	24.97	57.26	
	(1.40)	(3.90)	7.77
Female headed	21.57	55.69	(0.00)**
	(2.47)	(8.52)	3.85
Male headed	25.94	57.71	(0.0002)**
	(1.66)	(4.40)	6.74
Morbidity (chronic)	25.12	56.70	(0.000)**
	(1.49)	(3.97)	7.45
Female headed	22.31	50.78	(0.00)**
	(2.93)	(8.45)	3.18
Male headed	25.80	58.15	(0.002)*
	(1.71)	(4.49)	6.74
Head of households/spouse morbidity	24.92	48.67	(0.00)**
	(1.87)	(4.27)	5.11
Female headed	20.88	57.71	(0.00)**
	(3.38)	(12.51)	2.84

Male headed	25.79	46.74	(0.006)**
	(2.16)	(4.43)	4.25
Adult child morbidity	25.50	72.41	(0.000)**
	(2.44)	(8.05)	5.58
Female headed	24.39	40.70	(0.00)**
	(5.33)	(9.88)	1.45
Male headed	25.85	82.24	(0.15
	(2.76	(9.83)	5.52
Mortality	23.43	62.77	(0.00)**
	(4.16)	(16.60)	2.26
Female headed	18.46	76.09	(0.03)**
	(3.83)	(26.53)	2.15
Male headed	28.03	51.22	(0.04)**
	(7.13)	(21.20)	1.01
Head of household/spouse mortality	14.51	68.85	(0.32)
	(2.45)	(38.27)	1.42
Female headed	16.01	92.28	(0.02)**
	(3.48)	(56.22)	1.35
Male headed	11.52	21.99	(0.01)**
	(2.16)	(11.35)	0.91
Adult child mortality	27.88	59.89	(0.42)
	(5.89)	(17.32)	1.71
Female headed	23.6	70.13	(0.09)*
	(6.99)	(17.75)	2.44
Male headed	32.54	58.53	(0.03)**
	(8.62)	(26.17)	0.91
			(0.37

Source: Author's estimation results; *(**) significant at 10% and 5% levels, respectively. Figures in parenthesis are standard errors

5.4.2 Non-affected households

Non-affected households (see Table 5.2) recorded significantly higher maize production (54.09 bags per hectare) during 2006/07 season compared to 2004/05 season (24.50 bags). In general, male headed households recorded significantly higher maize output compared to female headed households, again probably due to the higher fertilizer application per hectare for male headed households (see Table 4.6, Chapter 4). Unlike the AIDS-affected households, non-affected households with morbidity realised higher maize production levels than the households with mortality during 2006/07. Non-affected households with household head morbidity realised lower maize production than the households with adult child morbidity during 2006/07. Similarly, non-affected households with the death of a household head recorded lower maize production levels than those with adult child mortality. All these outcomes are attributed to the fertilizer application differentials (see Table 4.6, Chapter 4). In terms of gender, the results are consistent with those for AIDS-affected households. In terms of morbidity and mortality, they differ with those for AIDS-affected households.

In general, the maize production levels per hectare for AIDS-affected and non-affected households are comparable with the global weighted average of 55.8 bags per hectare. However, the levels remain below the international maximum attainable maize production level of around 200 bags of 50kg per hectare.

Table 5.2 Difference in difference in maize production (no. of 50kg bags per hectare) for non-affected households

Maize production	2004/05	2006/07	Two sample t-test
Maize production per hectare			Ho: diff=0; Prob(|T|>|t|
Non-affected households	24.50	54.09	
	(1.73)	(2.62)	9.41
Female headed	18.51	50.91	(0.000)**
	(2.87)	(6.19)	4.71
Male headed	26.24	55.03	(0.000)**
	(2.06)	(2.87)	8.16
Morbidity (chronic)	26.66	56.82	(0.000)**
	(2.27)	(2.27)	7.61
Female headed	20.74	60.02	(0.00)**
	(3.88)	(8.05)	4.39
Male headed	28.36	56.32	(0.000)*

	(2.70)	(3.35)	6.50
Head of households/spouse morbidity	26.93	56.59	(0.00)**
	(2.55)	(3.33)	7.08
Female headed	21.29	59.31	(0.00)**
	(4.13)	(8.13)	4.17
Male headed	28.71	55.73	(0.000)**
	(3.09)	(3.55)	5.74
Adult child morbidity	24.80	60.65	(0.000)**
	(3.70)	(9.65)	3.41
Female headed	12.54	70.54	(0.001)**
	2.92)	(45.87)	1.26
Male headed	26.29	59.49	(0.24)
	(4.08)	(9.63)	3.12
Mortality	18.49	45.73	(0.003)**
	(1.43)	(4.63)	5.68
Female headed	12.43	27.68	(0.00)**
	(1.60)	(6.28)	2.24
Male headed	20.19	51.35	(0.03)**
	(1.75)	(5.57)	5.34
Head of household/spouse mortality	18.85	45.33	(0.00)**
	(1.76)	(5.57)	4.51
Female headed	13.98	28.65	(0.00)**
	(2.40)	(9.89)	1.40
Male headed	20.00	49.50	(0.17)
	(2.09)	(6.44)	4.35
Adult child mortality	17.25	46.15	(0.00)**
	(0.41)	(8.01)	3.43
Female headed	10.85	21.96	(0.001)**
	(2.08)	(5.61)	1.78
Male headed	20.75	56.89	(0.09)*
	(3.17)	(11.24)	3.09
			(0.003)**

Source: Author's estimation results; *(**) significant at 10% and 5% levels, respectively. Figures in parenthesis are standard errors

5.4.3 Comparing affected and non-affected households

The results on differences in mean maize output for AIDS-affected and non-affected households are shown Table 5.3 below. For all households, the AIDS-affected households recorded slightly higher maize production (57 bags per hectare) than non-affected households (54 bags per hectare). This could be attributed to the fact that the proportion of households applying fertilizer in 2006/07 was relatively higher for the AIDS-affected households compared to the non-affected households. The result differs with findings from Adoeti and Adeoti (2008); Thangata, (2007); Chamunika, (2006); Chapoto and Jayne, (2005), whose results indicated reductions in crop production for the AIDS-affected households. However, the difference in mean production of affected and non-affected households is not statistically significant, except for female headed households with mortality. This implies that in general, the maize production levels for AIDS-affected and non-affected households are statistically not different. This differs with findings in literature where AIDS-affected households realised statistically lower crop production levels compared to non-affected households (Adenegan and Adewusi, 2007). However, the results are not surprising as in our case we are dealing with morbidity and mortality cases of both AIDS-affected and non-affected households. The only statistically significant result is that maize production for the affected female headed households with mortality is higher than that for non-affected female headed households with mortality. This again could be attributed to higher fertilizer application levels for the affected households with mortality.

Table 5.3 Difference in difference estimation: AIDS-affected versus non-naffected households

<table>
<tr><td>Maize production per hectare</td><td>2004/05
Two sample-test
2004/05
Ho: diff=0; Ha: diff>0</td><td>2006/07
Two sample t-test
2006/07
Ho: diff=0; Ha: diff>0</td></tr>
<tr><td>Maize production per hectare (no. of 50kg bags)
Affected households and non-affected households</td><td>Ho: diff=0; prob (|T|>|t|</td><td>Ho: diff=0; prob (|T|>|t|</td></tr>
<tr><td></td><td>-0.1917</td><td>-0.7001</td></tr>
<tr><td>Female headed</td><td>(0.8481)</td><td>(0.4840)</td></tr>
<tr><td></td><td>-0.48697</td><td>-0.4619</td></tr>
<tr><td>Male headed</td><td>(0.584)</td><td>(0.6447)</td></tr>
<tr><td></td><td>-0.2260</td><td>-0.5326</td></tr>
<tr><td>Morbidity (chronic)</td><td>(0.567)</td><td>(0.5945)</td></tr>
<tr><td></td><td>0.5318</td><td>0.0885</td></tr>
<tr><td>Female headed</td><td>(0.5951)</td><td>(0.9295)</td></tr>
<tr><td></td><td>-0.2965</td><td>0.7712</td></tr>
<tr><td>Male headed</td><td>(0.7673)</td><td>(0.4420)</td></tr>
<tr><td></td><td>0.7555</td><td>-0.3335</td></tr>
<tr><td>Head of households/spouse morbidity</td><td>(0.4503)</td><td>(0.7389)</td></tr>
<tr><td></td><td>0.5555</td><td>1.4606</td></tr>
<tr><td>Female headed</td><td>(0.5788)</td><td>(0.1448)</td></tr>
<tr><td></td><td>0.0623</td><td>0.1080</td></tr>
<tr><td>Male headed</td><td>(0.9505)</td><td>(0.9142)</td></tr>
<tr><td></td><td>0.6933</td><td>1.5824</td></tr>
<tr><td>Adult child morbidity</td><td>(0.4885)</td><td>(0.1144)</td></tr>
<tr><td></td><td>-0.1617</td><td>-0.8928</td></tr>
<tr><td>Female headed</td><td>(0.8718)</td><td>(0.3735)</td></tr>
<tr><td></td><td>-1.0375</td><td>1.0203</td></tr>
<tr><td>Male headed</td><td>(0.3094)</td><td>(0.3174)</td></tr>
<tr><td></td><td>0.0938</td><td>-1.5478</td></tr>
<tr><td>Mortality</td><td>(0.9254)</td><td>(0.1245)</td></tr>
</table>

	-1.3946	-1.3838
Female headed	(0.1652)	(0.1684)
	-1.7299	-2.4713
Male headed	(0.0914)*	(0.0176)*
	-1.4792	-0.9438
Head of household/spouse mortality	(01420)	(0.3473)
	0.7730	-1.1137
Female headed	(0.4414)	(0.2681)
	-0.4453	-1.7919
Male headed	(0.6607)	(0.869)
	0.8243	0.8641
Adult child mortality	(0.4125)	(.3903)
	-2.0087	-0.8251
Female headed	(0.0498)*	(0.4129)
	-1.8811	-2.3043
Male headed	(0.0772)*	(0.033)*
	-1.5869	-0.076
	(0.0610)*	(0.9465)

Source: Author's estimation results; *(**) significant at 10% and 5% level. Figures in parenthesis are standard errors

The difference in differences in mean maize harvests between AIDS-affected and non-affected households obtained from regression results over the 2004/05 and 2006/07 period are shown in Table 5.4. The results show that both AIDS-affected and non-affected households recorded statistically significant increases in maize output during the 2006/07 agricultural season from the production levels in the 2004/05 season. However, the difference in differences in maize output for AIDS-affected and non-affected households, over the 2004/05 to 2006/07 period is not statistically significant for all categories (see Table 5.4 and Appendix II, A-5.1 to A-5.6).

Table 5.4: Difference in difference in maize production regression results

	pt		treat		post		constant	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	coeff	t-stat
All households	-.112669	-0.99	.08960	1.12	.7920	11.22	2.695	54.31
	(.113590)	(0.321)	(.04195)	(0.263)	(.0705)	(0.00)**	(.049)	(0.00)
Female headed	-.22618	-.074	.3122	1.33	.8961	4.72	2.372	16.24
	(.3050)	(.459)	(.2340)	(.183)	(.1297)	(0.00)**	(.1461)	(0.00)
Male headed	-.1066	-.085	.0425	0.48	.7824	10.01	2.777	50.55
	(.1253)	(.395)	(.0882)	(0.630)	(.1481)	(0.00)	(.0449)	(0.00)
Mortality	-.0755	0.24	.1081	0.49	.8303	6.27	2.559	27.43
	(.3132)	(.810)	(.221)	(0.625)	(.1324)	(0.00)**	(.093)	(0.00)
Morbidity	-.1064	-0.84	.0530	0.061	0.7784	9.18	2.744	47.56
	(.1261)	(.399)	(.0874)	(0.544)	(0.1848)	(0.00)**	(0.058)	(0.00)

*(**) significant at 10 percent (5 percent) level Figures in parenthesis are standard errors
pt =the difference in difference coefficient; The t-statistic represents t-test for equality of the differences.
pt=post*treat; *treat* = 1 if the observation is in the treatment (affected) group, and 0 otherwise; *post* = 1 if the observation is in the post period (2006/07) & 0 otherwise.
All households: F(3, 1543) = 61.53; Prob > F = 0.0000; R-squared = 0.1069; Adj R-squared = 0.1051;
Female headed: F(3,284) = 10.50; Prob > F = 0.0000; R-squared = 0.0999; Adj R-squared=0.0904
Male headed: F(3, 1196) = 49.27; Prob > F= 0.0000; R-squared = 0.1100; Adj R-squared = 0.1078
Mortality: F(3, 298) = 15.54; Prob > F= 0.0000; R-squared = 0.1352; Adj R-squared = 0.1265
Morbidity: F(3, 1200) = 45.44; Prob > F = 0.0000; R-squared = 0.1020; Adj R-squared = 0.0998

It should also be noted that the average maize production levels of 54.04 bags and 57.26 bags in 2006/07 for the AIDS- affected and non-affected households, respectively are relatively lower than the average level for non-affected households *without* prime-age adult mortality and morbidity of 66.07 bags (see appendix II).

5.5 Conclusion and Policy Recommendations

This essay has assessed the impact on farm production of prime-age adult morbidity and mortality due to HIV/AIDS compared with that due to non-HIV/AIDS related illnesses using difference in difference estimation technique.

The results show that for both AIDS-affected and non-affected households, average maize production is higher during 2006/07 season compared to the 2004/05 season, which can be attributed to the higher fertilizer application for both affected and non-affected households coupled with good rains during 2006/07. The mean maize production level for the affected households is higher during 2006/07 compared to that for non-affected households, but the difference is not statistically significant at 10 percent. For both affected and non-affected households, the male headed households recorded higher maize production during 2006/07 than the female headed households. Whereas the affected households with mortality recorded higher maize production than the affected households with morbidity, the outcome was opposite for the non-affected households. The mixed outcome was due to differentials in fertilizer application per hectare for the affected and non-affected households. Both AIDS-affected and non-affected households with household head/spouse morbidity recorded lower maize production levels than affected households with adult child morbidity during 2006/07. Similarly, non-affected households with household head/spouse mortality recorded lower maize production levels than affected households with adult child mortality during 2006/07. However, the affected households with household head/spouse mortality realised higher maize production than the affected households with adult child mortality during 2006/07. Again, this outcome can be attributed to the differentials in fertilizer application levels. Overall, the difference in difference in maize production for the affected and non-affected households over the 2004/05 to 2006/07 period is not statistically significant.

In general, the maize production levels per hectare for the affected and non-affected households are comparable with the global weighted average of 55.8 bags per hectare, but are far below the international maximum maize production of around 200 bags per hectare. Nevertheless, the enhanced government fertilizer subsidy programme appears to have more than offset the anticipated negative impact of AIDS-related and non-AIDS related prime-age adult morbidity and mortality on maize production. Fertilizer application and maize production seem to be sensitive to gender. Non-significance in difference in differences in mean production for the affected and non-affected households over the 2004/05 and 2006/07 period imply that for both AIDS-affected and non-affected households, prime-age adult mortality and morbidity have the same impact of stagnating production.

These results suggest that mitigation and intervention measures need to cover other vulnerable groups besides those affected by HIV/AIDS. The results raise concerns about the standardized way of treating the affected households, especially when making requests for targeted support. The results also reveal the importance of using country-wide representative samples in assessing impacts of prime-age adult mortality and morbidity.

The most effective method of investigating the characteristics of affected households and measuring morbidity and mortality impacts is by collecting data using nationally representative samples.

Given the gender differentials in impact of morbidity and mortality, there is need to overcome gender barriers to women participation in training programs in crop husbandry practices and access to valuable inputs such as fertilizer. As noted earlier, female headed households possessed lower land holdings compared to the male headed households. Traditionally, female family members do not have rights to inherit land in patrilineal communities. As a result of these gender imbalances, women face the danger of losing their land after the death of their spouses. Thus there is need to modify the rules regarding women's rights and access to resources by working with communities to ensure that widows have access to land. Finally, for the majority of households, prime age mortality raises the demand for labour saving agricultural technology. This calls for more studies on the feasibility of alternative crop technologies especially for households facing labour and capital constraints from prime age mortality.

The low maize production per hectare (by international standards) points to the need to pursue policies that enhance organization of farming system in Malawi. As mentioned earlier, one of the main constraints facing agriculture in Malawi is the small size of cultivated land, which are becoming smaller and smaller through subdivision of family members. For a long time, from independence to 1992, small-scale agriculture was largely arranged around farmers clubs to ensure effective delivery of services and agricultural credit. However, the farmers' club systems collapsed in 1992, following the collapse of the agricultural credit system that worked through the club system raises the need for the revival of the farmer club system or development of farming cooperatives in Malawi. Finally, since Malawi's agricultural sector relies on rain-fed agriculture; thus government should encourage development of small-scale water saving and irrigation schemes.

References

Adenegan, K.O. & Adewusi, O.A. (2007), “Determinants of Food Security Status of Rural Households Living With HIV/AIDS in Southwestern Nigeria,” African *Journal of Biomedical Research,* 10(1): 9-18

Adeoti A.I. & Adeoti J.O. (2008), “HIV/AIDS and Farm Production Efficiency in Benue State, Nigeria,” *African Journal of Biomedical Research*, 11: 154-153

Antle, J. M. & Pingali, P.L. (1994), “Pesticides, productivity, and farmer health: A Philippine case study,” *American Journal of Agricultural Economics*, 76(3): 418–30

Ashenfelter, O. & Card, D. (1985), “Using longitudinal structure of earnings to estimate the effects of training programs,” *Review of Economics and Statistics*, 67(4): 648-660

Asingwire, N. & Kyomuhendo, S. (2003), “Development of a national overarching HIV/AIDS policy for Uganda,” *A review of the HIV/AIDS policy environment in Uganda*. Uganda AIDS Commission, Kampala, Uganda

Becker, G. S. (1965), “A Theory of the Allocation of Time,” *Economic Journal*, vol. 75 (299): 493-517

Bertrand, M., Duflo, E. & Mullainathan, S. (2004), “How much should we trust difference-in- differences estimates?” *The Quaterly Journal of Economics*, vol. 119 (1): 249-271.

Chamunika, M. (2006), “*Impact of HIV/AIDS on Agriculture and Food Security: The case of Limpopo Province in South Africa*,” FANRAPAN Working Document series reference NAT SA005

Cameron, A. C. & Trivedi, P.K. (2005), Microeconometrics: Methods and Applications, Cambridge University Press, UK

Chapoto, T.S. & Jayne, T. (2005), “Measuring Impact of Working-Age Adult Mortality on Small-scale Farm Households in Kenya,” *World Development*, 32 (1): 91-111

Chapoto, A. & Jayne. T. (2008), “Impact of AIDS-related mortality on farm households welfare in Zambia,” *Economic Development and Cultural Change*, 56(2): 327-374.

Gill, T.B. (2010), “Modeling the impact of HIV/AIDS upon food security of diverse rural households in Western Kenya,” *Agricultural systems*, 103 (5): 210-225

Greene, W. H. (1997), *Econometric Analysis* (3rd ed.), Upper Saddle River, Prentice-Hall, New Jersey, USA.

Harvey, P. (2003), *HIV/AIDS*: *The Implications for Humanitarian Action: A Literature Review*, Overseas Development Institute, London

Mikael, L. (2004), “*Exploring the impact of HIV/AIDS on household food security in rural Ethiopia: two case studies,”* A joint UNECA/UNDP/WFP study http://uneca.org/eca_programmes/policy_analysis/publications/AIDS_food_security-report.pdf

Ministry of Agriculture and Food Security, (MoAFS) (2008), “*Evaluation of the 2006/07 Agricultural Input Subsidy Programme*,”Final Report, Lilongwe, Malawi

Mutangadura, G.B. (2000), “*Household Welfare impacts of mortality of adult females in Zimbabwe: Implications for policy and program development*,” Paper presented at the AIDS and Economics Symposium organized by IAEN Network, Durban, South Africa

Muwanga, F.T. (2002), “*Impact of HIV/AIDS on Agriculture and the Private Sector in Swaziland. State of the World’s Forests/FAO*,”Eldis Report on HIV/AIDS, University of Sussex Institute of Development Studies, UK.

NAADS (2003), “*The Impacts of HIV/AIDS on the Agricultural Sector in Uganda*,” Baseline survey report, FAO’s Integrated Programme, Rome

National Statistical Office, Integrated Household Survey. (2005), Final Report, Lilongwe, Malawi

National Statistical Office, Integrated Household Survey. (2008), Final Report, Lilongwe, Malawi

Pitt, MM & Rosenzweig, MR, (1986), Agricultural prices, food consumption, and the health and productivity of Indonesian farmers, In Singh, I, Squire, L & Strauss, J (Eds), *Agricultural Household Models*, Johns Hopkins University Press, Baltimore

Roisenzweig, M.R. (1986), "*Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs and Their Effects on Birth weight*," Discussion Paper no. 437. New Haven, Conn, Economic Growth Centre, Yale University, USA

SADC FANR Vulnerability Assessment Committee., (2003), "*Towards identifying impacts of HIV/AIDS on food security in southern Africa and implications for response: Findings from Malawi, Zambia and Zimbabwe*," Harare, Zimbabwe

Schultz, P. (1999), "Productive benefit of improving health: Evidence from low-income countries," Mimeo, Yale University.

Strauss, J. & Thomas, D. (1998), "Health, Nutrition and Economic Development. *Journal of Economic Literature*," 36 (4): 766-817

Thangata, P.H. (2007), "Predicted Impact of HIV/AIDS on Improved Fallow Adoption and Rural Household Security in Malawi," *Sustainable Development*, 15: 205-215

Yamano, T. & Jayne, T.S. (2004), "Measuring the Impacts of Prime-Age Adult Death on Rural Households in Kenya,"*World Development*, 32(1): 91-119.

Woodridge, J.M. (2002), *Econometric Analysis of Cross Section and Panel data*, Massachusetts Institute of Technology, USA

Chapter 6: The coping and survival strategies for food-insecure households: Evidence from the Integrated Household Surveys

6.1 Introduction

When defining food security, four main aspects need to be taken into account: sufficiency, access, security and time. The World Bank (1986) states that food sufficiency means enough food to provide the required energy for all members of households to live a healthy and productive life. Access involves whether or not individuals and households have the ability to obtain adequate food either by producing or by buying using income (World Bank 1986). Security includes the capacity of households and individuals to endure crises that put under threat their realized level of food consumption (World Bank, 1986). Time refers to having access to enough food at all times (World Bank, 1986; Fraser et al. 2003). All the four aspects must be met before an individual or household can be truly described as being food secure.

The small size and fragmented nature of land holdings among farm households have been one of the constraints in achieving food security at household level in Malawi (Chirwa, 2007), and this has been exacerbated by the effects of HIV/AIDS. A decline in available household labour results in a decline in the cultivated land area and a drop in the range of crops that can be grown. It also leads to loss of potential cash income due to illness and death of household members (Haslwimmer, 1996). In times of food crisis, most households in Malawi engage in casual labour, working in other farmers' fields for cash or payment in kind and/or reducing food consumption.

As a result of the impact of HIV/AIDS, more households face food security problems during times of famine, regardless of whether the households were previously food-secure or not. In general, the majority of the AIDS-affected smallholder households do not produce enough food to take them through-out the whole year, even in food-secure years (Blackie & Conroy, 2007). Alumira et al. (2005) find that in Zomba District, in 2002, 92 percent of AIDS-affected households were found to be food-insecure compared with 47.3 percent of non-AIDS affected households. This confirms the findings of other studies e.g. SADC FANR, 2003 and Arrehag et al. (2006).

In recent years, the Malawi government implemented initiatives to ensure that people with HIV/AIDS can access to anti-retroviral drugs (ARVs). However, the success of these initiatives partly depends on the food security and nutritional status of their beneficiaries, as medical research shows that ARVs can be dangerous when taken on an empty stomach (Castleman et al. 2003). Good nutrition makes the drugs more effective (FAO, 2002). Faced with the HIV virus, the immune system works hard to fight the virus. Thus people carrying HIV and those suffering from AIDS require higher nutritional levels (FAO, 2002; Epstein, 1995).

This chapter examines coping and surviving strategies among households facing food security problems in Malawi. It investigates whether the coping and survival strategies of households with mortality differ from those with morbidity.

6.2 Food security, health and coping

In less developed countries, rural households typically face very high risks and uncertainties due to the unpredictability of weather, pest attacks on farm output and changes in prices of their commodities. The resulting fluctuations in income may lead to changes in consumption. This can be very serious, particularly when the household is very poor such that any reduction in consumption may imply starvation (Kinsey et al. 1998). Given that credit and insurance markets are either unavailable or operate very imperfectly, rural households have adopted alternative strategies for coping with risk. For instance, the households can try to smooth consumption by opting for less risky activities or by broadening their range of activities to reduce risk. But consumption smoothening can be problematic, particularly in situations where borrowing is difficult and also taking into account that rural households often have access to only a few assets to finance consumption. Additionally, food stocks may deteriorate, and livestock are subject to risks such as theft and disease (Kinsey et al. 1998). Researchers have used the concept of ‘coping’ to examine how household responses to famine. The main argument is that when individuals or households face difficulties, they make rational decisions to deal with the situation.

The empirical literature indicates that the affected households use various strategies to cope[39] with HIV/AIDS consequences[40]. The most common coping strategy strategies include selling livestock and assets, borrowing funds, hiring out labour, receiving social grants, food handouts, reducing consumption, withdrawing children from school and reducing household size (see Akinboade 2008; Nguthi and Niohoff 2008; Bukusuba et al. 2007; Chamunika, 2006; Chapoto and Jayne, 2005; Naidu and Harris 2006; Yamano and Jayne 2004; Manther, 2004; and Lundberg and Over, 2000)

The objectives of this essay are (i) to examine coping and surviving strategies among households facing food security problems in Malawi[41]; (ii) to investigate whether the coping and survival strategies of households with mortality differ from those with morbidity[42]; (iii) third, bearing in mind the gender differences in landholdings and access to inputs of production, to distinguish whether coping and survival strategies differ according to the gender of the household head; and finally, (iv) to explain the choice of coping strategies by households.

The term 'coping', it can be noted, implies success rather than failure. However, some of the so-called coping strategies in fact represent a failure to cope and a desperate struggle to survive. To say that households are coping suggests that the households are managing well or at least persevering, so some strategies are better considered as survival strategies (Rugalema, 2000). For instance, strategies from studies mentioned above include reducing consumption, withdrawing children from school and reducing household size, which reflect a failure to cope and suggest that the households are struggling to survive (Rugalema 2000). Thus we distinguish between coping strategies and survival strategies. This study examines rural households that are involved in agricultural farming.

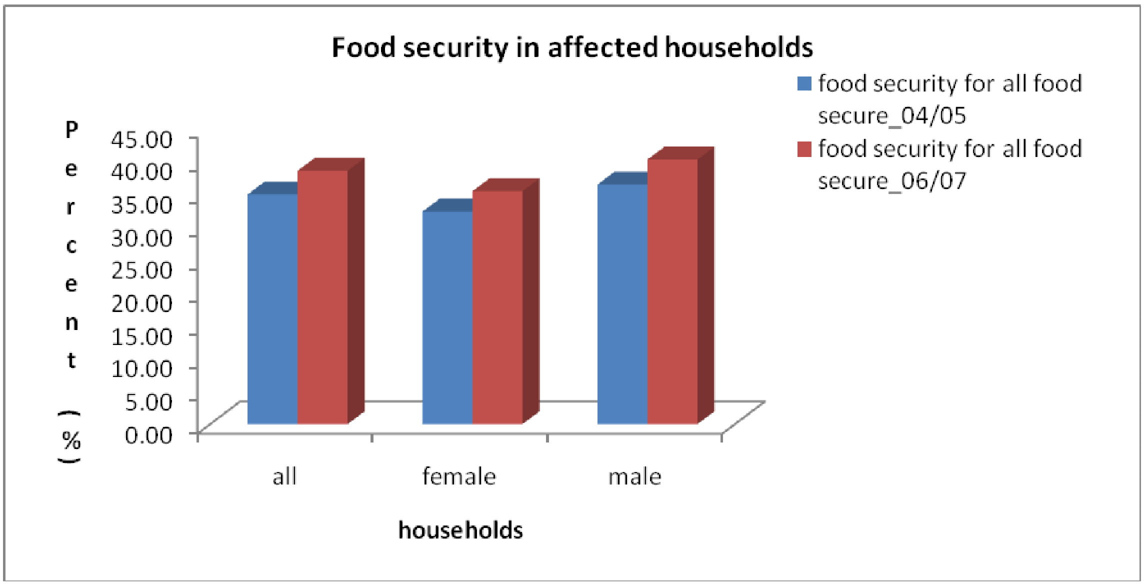
[39] Coping is an effort taken to manage specific external and/or internal demands that are deemed as exceeding the resources of the person. A strategy is a plan that is meant to achieve something over a period of time.
[40] A comprehensive literature review on coping strategies for households affected by HIV/AIDS is provided in Chapter 2.
[41] We are examing coping and survival strategies of the households facing food security problems, and these households comprise AIDS-affected and non-affected households (with prime-age adult mortality and morbidity)
[42] AIDS-affected households with mortality and morbidity are households that have at least one member who are reported to have lost their lives due to HIV/AIDS or suffered from an AIDS-related illnesses such chronic TB, chronic pneumonia and chronic diarrhoea over the last one to five years

6.3 Morbidity, mortality and food Security in Malawi

The Integrated Household Surveys on food availability and food security during the 2006/07 season found that 51 percent of all households had inadequate food consumption, compared with 57 percent during 2004/05.

Among AIDS-affected households, Figure 6.1 indicates that 38.5 percent of the affected households were food-secure during the 2006/07. This is a slight improvement from the 2004/05 when 34.9 percent of the affected households were food-secure and may be attributed to the fertiliser subsidy programme which the Malawi government began implementing since 2004. However, the 38.5 percent is far lower than the national average of 51 percent, a finding in line with the findings from empirical literature (e.g. Musita, Ariga, Kaseje, and Otieno 2009; Adenegan and Adewusi, 2007) where non-affected households were more food secure compared to affected households.

Figure 6.1: AIDS-affected households and food security

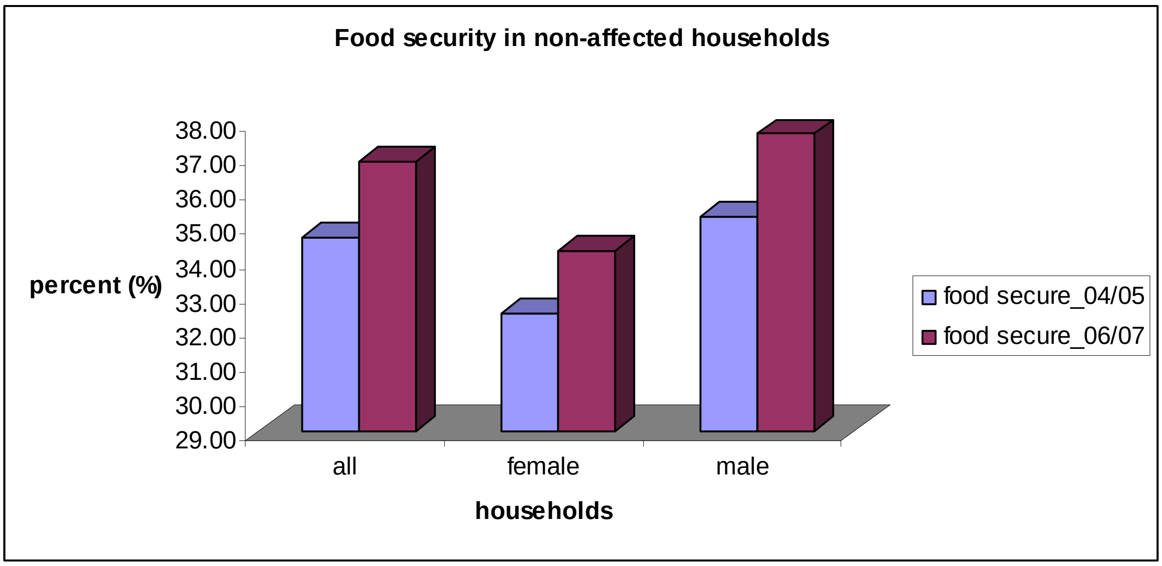


Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

An analysis of food security in the affected households by gender shows that the proportion of female headed households that are food-secure rose from 32.3 percent during 2004/05 to 35.4 percent in 2006/07 percent. On the other hand, the proportion of food-secure male headed households increased from 36.4 percent to 40.2 percent. In general, male headed households were relatively more food-secure than their female headed counterparts, in line with maize production levels for female and male headed households during 2006/07. Female headed households had lower cultivated area and lower fertilizer application per hectare, which could be attributed to the fact that, traditionally, women do not have inheritance rights to family lands, and may face land grabbing from extended family members upon death of their husbands (see tables 4.2 and 4.7, Chapter 4). Additionally, female headed households recorded lower maize harvests per hectare compared to male headed households (see Table 5.1, Chapter 5). These results are in line with findings from Gill (2010) and Mikael (2004), but differ with Adenegan and Adewusi (2007) who indicate that HIV/AIDS affected female headed households have higher food security than male headed households.

For non-affected households, about 36.8 percent of the non-affected households were food-secure during the 2006/07 (see Figure 6.2 below). This is a slight improvement from 2004/05 when 34.6 percent of the non-affected households were food-secure. This could again be attributed to the fertiliser subsidy programme which the Malawi government has been implementing since 2004.

Figure 6.2: Non-affected households and food security



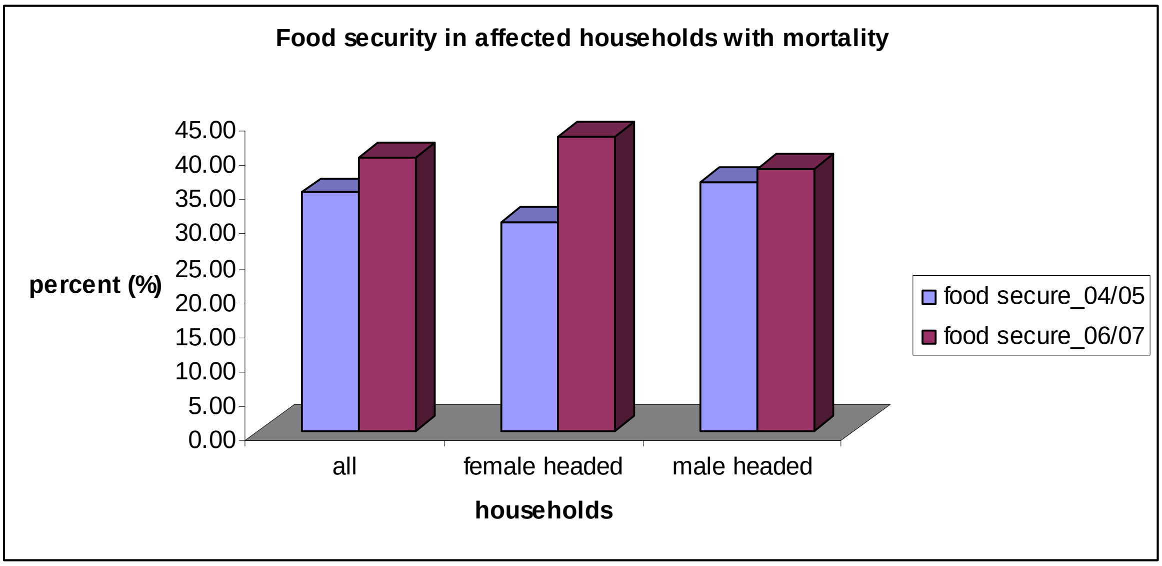
Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

An analysis of food security in non-affected households by gender shows that the proportion of female headed households that are food secure rose from 32.4 percent during

2004/05 to 34.2 percent in 2006/07. On the other hand, the proportion of food secure male headed households increased from 35.2 percent to 37.6 percent. In general, male headed households were relatively more food secure than their female headed counterparts. Again the gender differentials could be attributed to differences in maize production (see Table 5.2, Chapter 5).

Figure 6.3 show food security among affected households with mortality. AIDS-affected households that were food secure increased from 34.5 percent in 2004/05 to 39.6 percent in 2006/07. By gender, female headed and male headed households that were food secure rose from 30.3 percent and 36.0 percent to 42.5 percent and 38.0 percent, respectively. This finding is in line with maize production levels for non-affected female and male headed households with mortality (see table 5.1, Chapter 5)

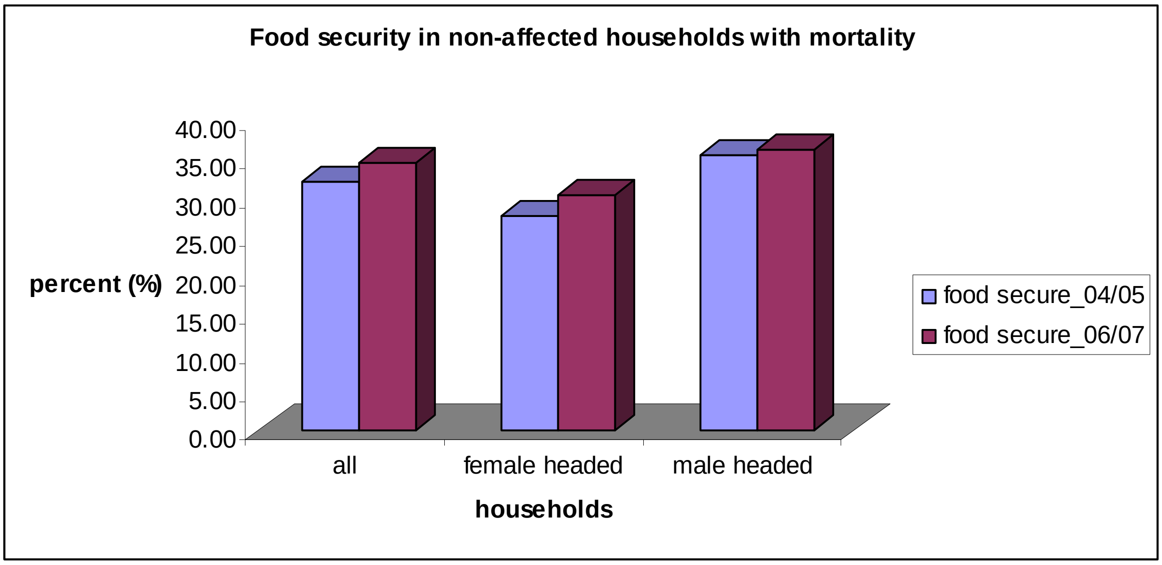
Figure 6.3: AIDS-affected households with mortality and food security



Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

For non-affected households with mortality, households that were food secure increased from 32.0 percent in 2004/05 to 34.5 percent in 2006/07. By gender, female and male headed households that were food secure rose from 27.6 percent and 35.3 percent to 30.2 percent and 36.1 percent, respectively. This finding is in line with maize production levels for non-affected female and male headed households with mortality, respectively (see Table 5.2).

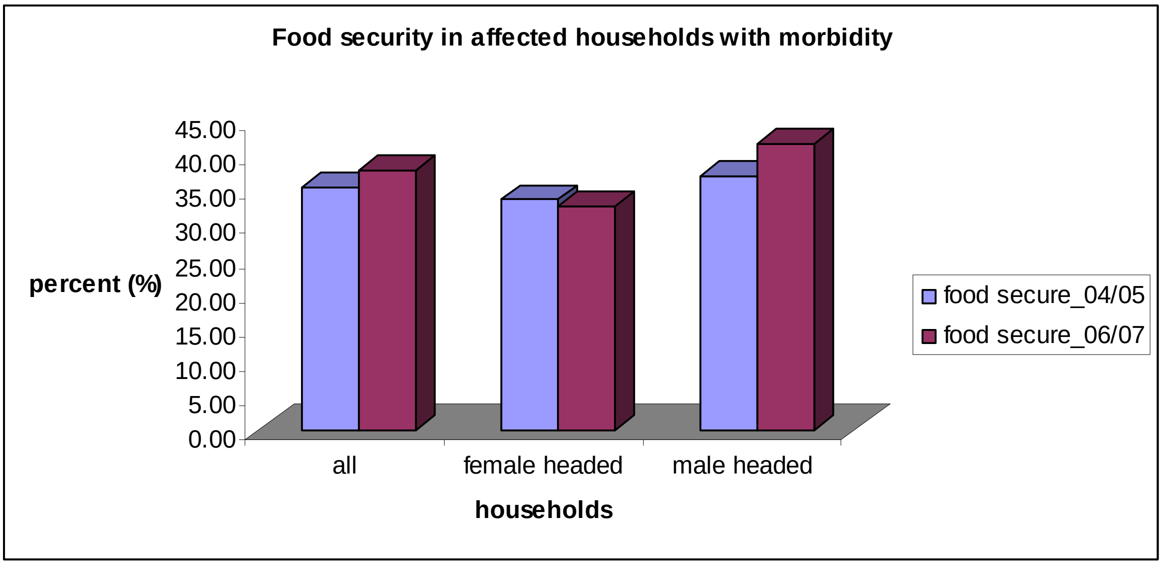
Figure 6.4 Non-affected households with mortality and food security



Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

Food secure affected households with morbidity increased from 35.2 percent in 2004/05 to 37.6 percent in 2006/07. Affected female headed households that are food secure dropped slightly from 33.4 percent to 32.5 percent (see Figure 6.5). On the other hand, food secure affected male headed households rose from 36.8 percent during 2005/06 to 41.5 percent during 2006/07 season. Thus although on average, male headed households are more food secure than female headed households, disaggregated data give mixed outcomes for households with mortality and morbidity.

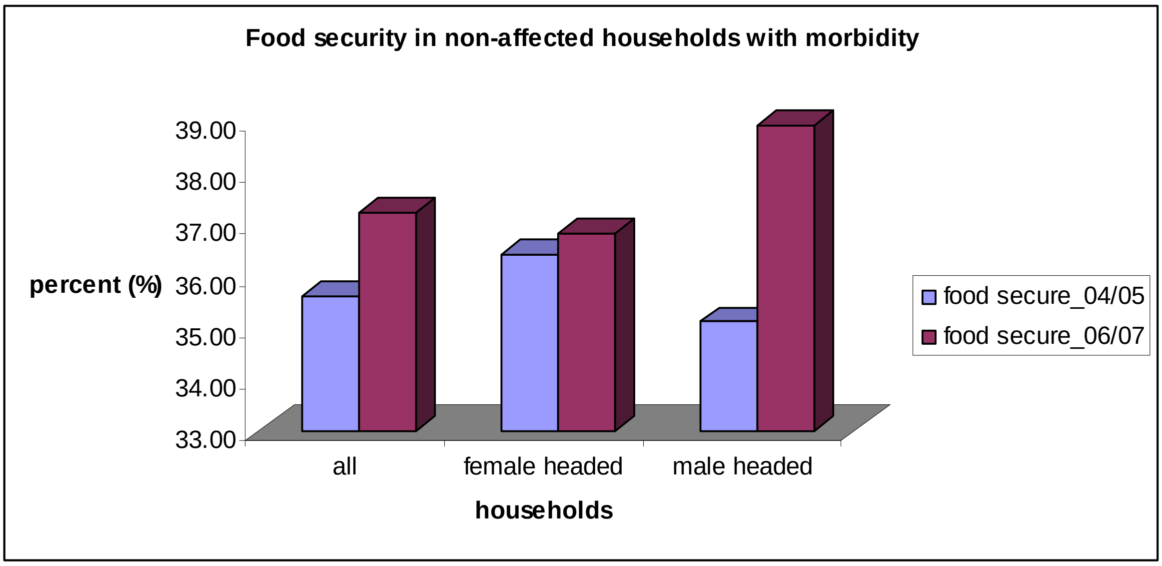
Figure 6.5 Affected households with morbidity and food security



Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

For non-affected households with morbidity, food secure households rose from 35.6 percent to 37.2 percent (see figure 6.6). Food secure non-affected female headed households rose from 36.4 percent during 2005/06 to 36.8 percent during 2006/07. On the other hand, food secure non-affected male headed households increased from 35.1 percent during 2004/05 to 38.9 percent during 2006/07.

Figure 6.6 Non-affected households with morbidity and food security



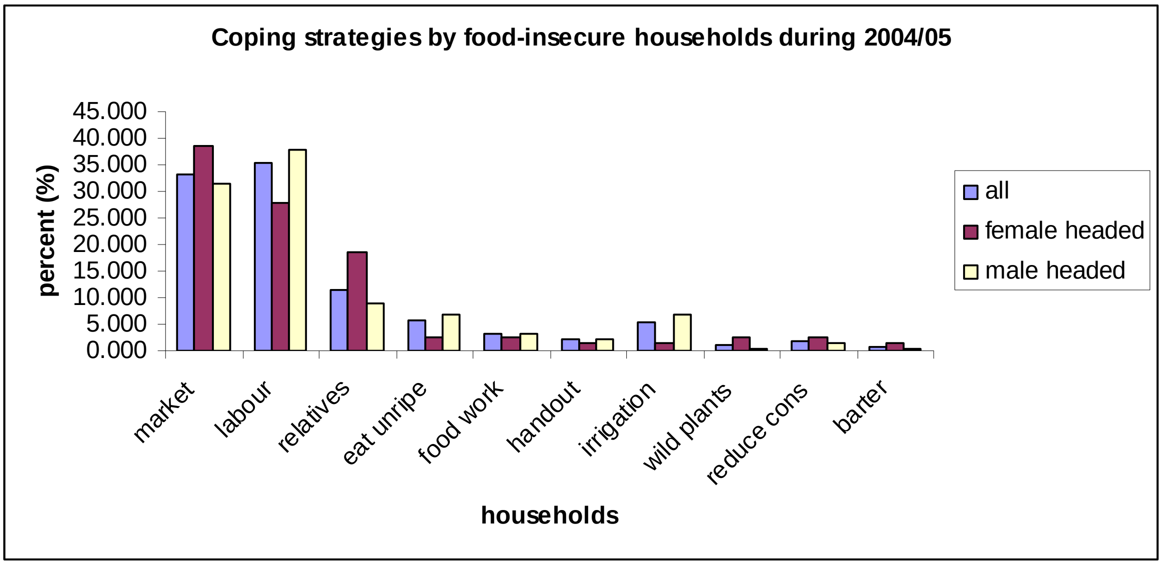
Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

We now turn to examine the coping strategies adopted by AIDS-affected and non-affected smallholder.

6.4 Coping strategies of food-insecure households

Figure 6.7 show coping strategies for food insecure households during the 2004/05. The results show that the dominant coping strategy during 2004/05 was casual labour (*labour*) at 35.4 percent, followed by buying food from the market (*market*) at 33.3 percent. The other strategies are obtaining food from relatives and friends (*relatives*) at 11.3 percent, eating unripe maize before harvest (*eat unripe*), food for work (*food work*), obtaining food handouts (*handout*), irrigation farming (*irrigation*), eating wild plants (*wild plants*), reducing food consumption (*reduce cons*), and barter trade (*barter*).Food secure households on the other hand did not report any coping strategy.

Figure 6.7 Coping strategies for food-insecure households during 2004/05

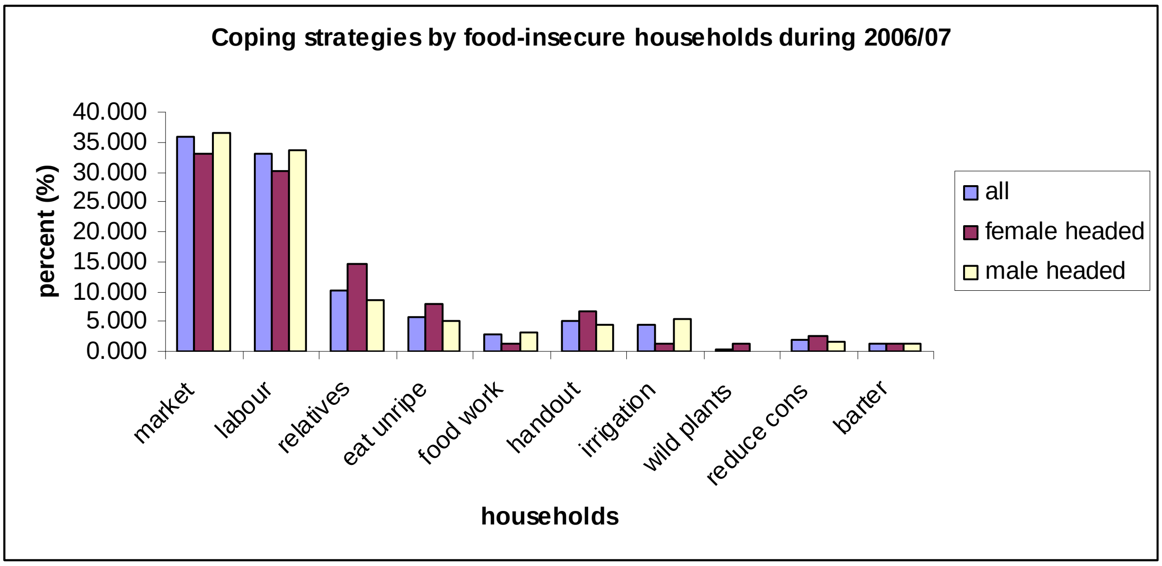


Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

Figure 6.8 show coping strategies for food insecure households during 2006/07. The results show that buying food from the market (*market*) is the dominant strategy at 35.7 percent, followed by casual labour (*labour*)[43] at 32.9 percent. The other strategies are obtaining food from relatives (*relatives*) at 10.0 percent, eating unripe maize before harvest (*eat unripe*), food for work (*food work*), obtaining food handouts (*handout*), irrigation farming (*irrigation*), eating wild plants (*wild plants*), reducing food consumption (*reduce cons*), and barter trade (*barter*)

[43] Although one could argue that both buying from market and labour are part of the same strategy as wages from labour are used to buy food from the market, in the context of rural farm households, which is the context of our study, most labour activities are paid for in kind (for instance with food)

Figure 6.8: Coping strategies for food-insecure households during 2006/07 season

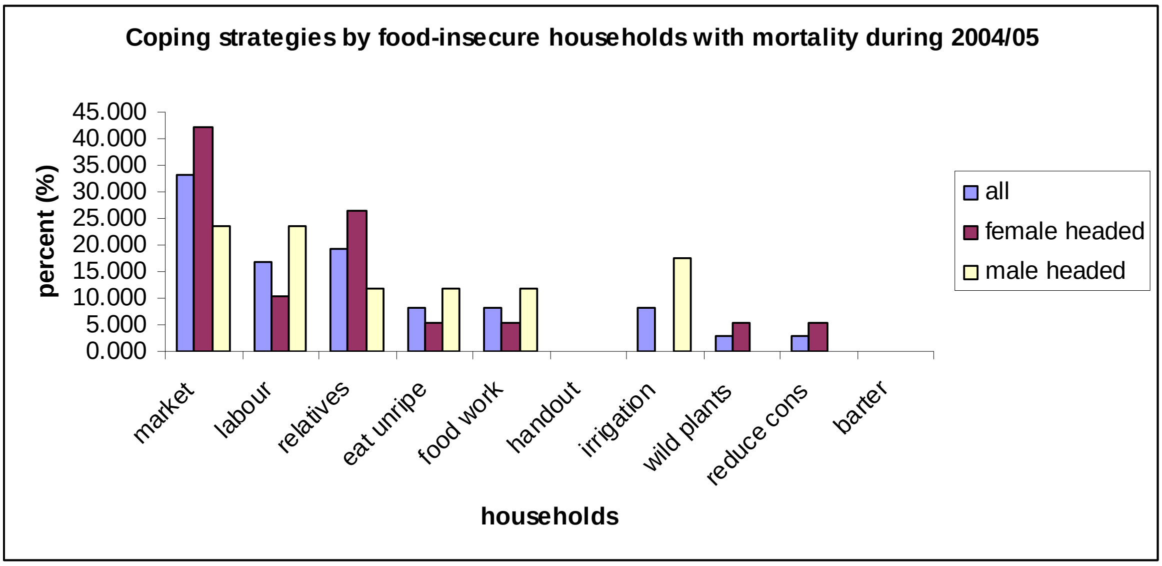


Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

Data analysis on coping strategies of food insecure households with prime-age adult mortality during 2004/05 reveal that the most dominant coping strategy is buying food from the market (*market*) at 33.3 percent, followed by obtaining food from relatives and friends (*relatives*) at 19.4 percent, casual labour (*labour*) at 16.7 percent, eating unripe maize before harvest (*unripe*), food for work (*food work*), irrigation farming (*irrigation*), reducing consumption (*reduce cons*), eating wild plants (*wild plants*) (see Table 6.9).

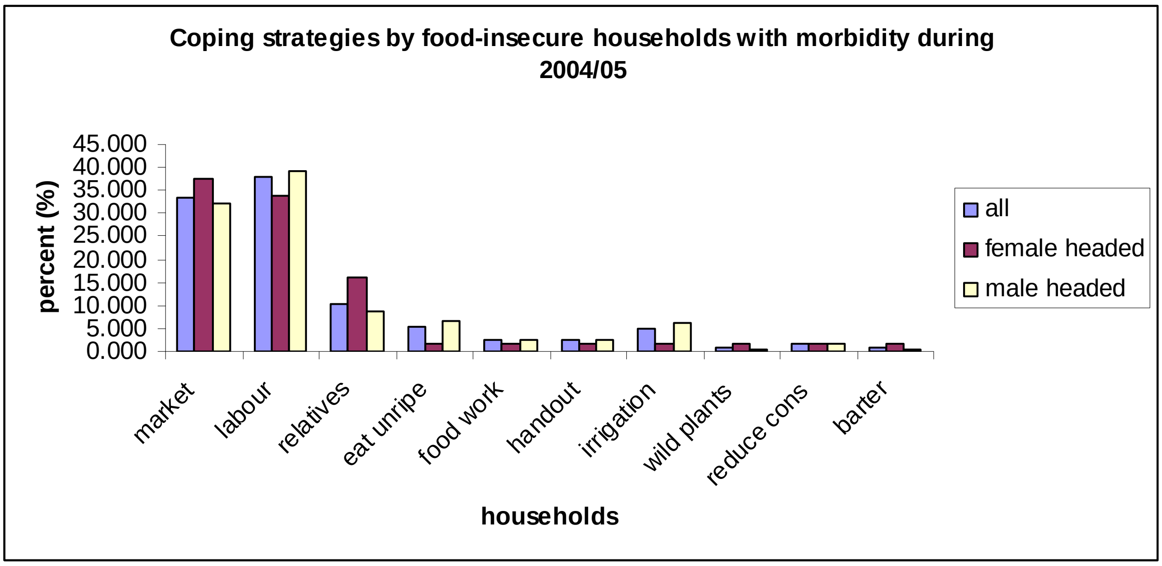
On the other hand, the dominant coping strategy for food insecure households with morbidity during 2004/05 is casual labour *(labour)* at 38.0 percent, followed by buying food from the market (*market*) at 33.3 percent, obtaining food from relatives (*relatives*) at 10.2 percent, eating unripe maize before harvest (*unripe*), food for work (*food work),* irrigation farming (*irrigation*), food handouts (handout), reducing consumption (*reduce cons*), barter trade (*barter*) and eating wild plants (*wild plant*) (see Table 9.10).

Figure 6.9: Coping strategies for households with prime-adult mortality during 2004/05 season



Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

Figure 6.10: Coping strategies for food-insecure households with morbidity during the 2004/05 agricultural season

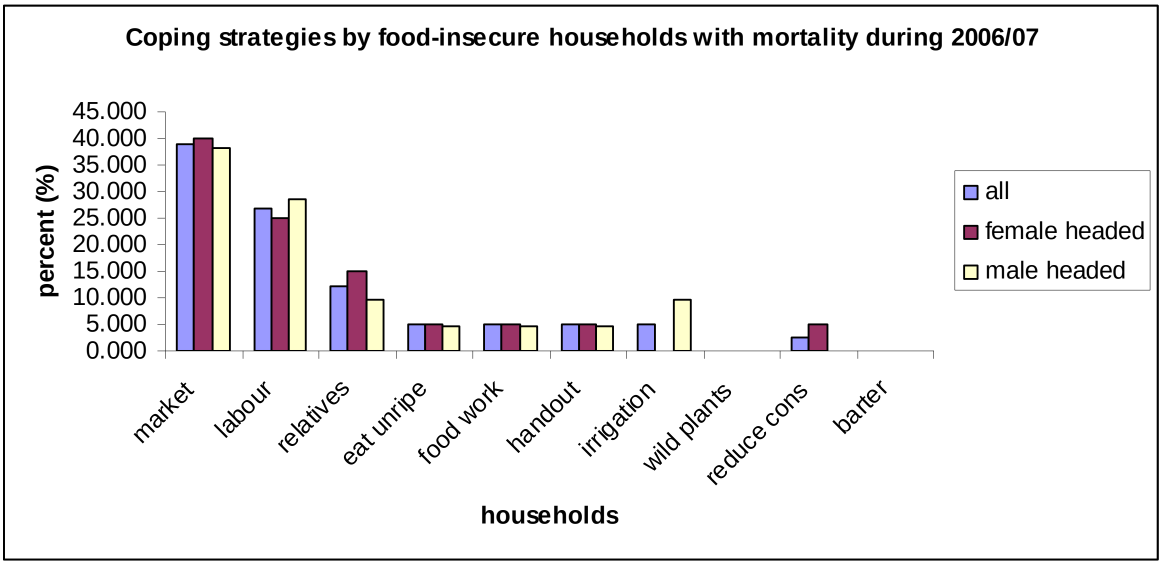


Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

Figure 6.11 and 6.12 provide corresponding results of coping strategies for food insecure households with mortality and morbidity during 2006/07. For households with prime-age adult mortality, the dominant coping strategy during 2006/07 is buying food from the market (market) at 39.0 percent, and unlike in 2004/05, this was followed by casual labour (*labour*), obtaining food from relatives *(relatives*), eating unripe maize before harvest (*eat unripe*), food for work (*food work*), obtaining food handouts (*handout*), irrigation farming (*irrigation*), and reducing consumption (*reduce cons*) (see Table 6.11)

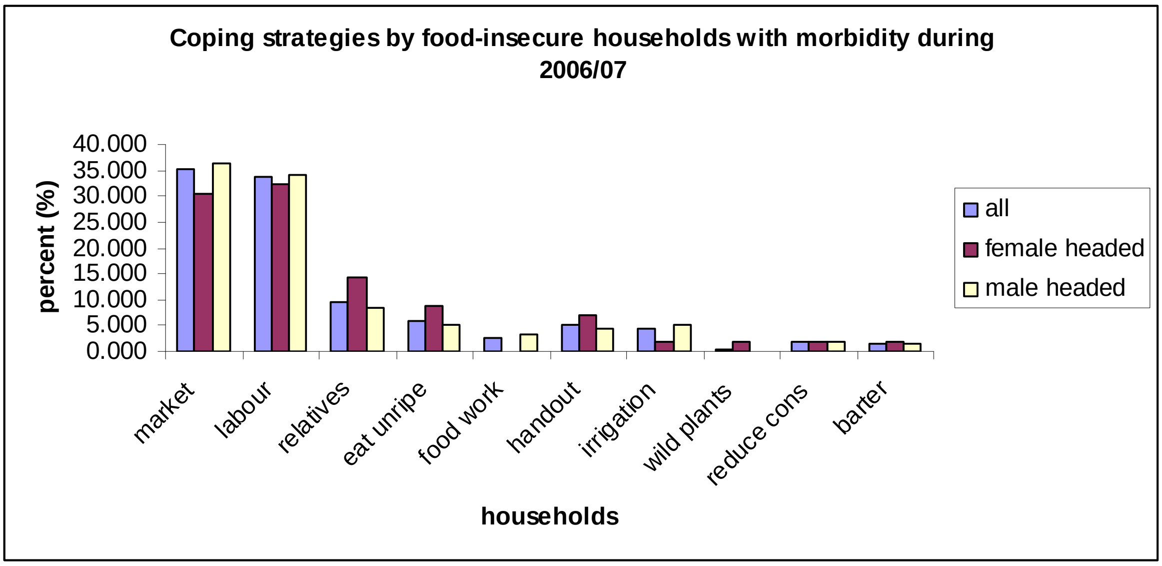
On the other hand, unlike during 2004/05, the dominant strategy for food insecure households with morbidity during 2006/07 is buying food from market (*market*) at 35.3 percent, followed by casual labour (*labour*) at 33.8 percent, obtaining food from relatives and friends (*relatives*), eating unripe maize before harvest (*eat unripe*), obtaining food handouts (*handout*), irrigation farming (*irrigation*), food for work (*food work*), reducing consumption (*reduce cons*), barter trade (*barter)*, and eating wild plants (*wild plants*) (see Table 6.12).

Figure 6.11: Coping strategies for food-insecure households with mortality during the 2006/07 agricultural season



Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

Figure 6.12 Coping strategies for food –insecure households with morbidity during the 2006/07 season



Source: Integrated household survey data, 2004/05 and 2006/07 (NSO, 2005, 2008)

It is worth noting that some households resort to bizarre strategies such as eating wild plants and reducing consumption, reinforcing the notion that these strategies are not just coping strategies - they are in fact survival strategies.

It should also be noted that descriptive statistics on coping strategies do not reveal much information. In the sample, there are some households that use more than one coping strategy which can be properly analyzed using choice modelling techniques such as the multinomial probit model.

6.5 Analytical framework

This study analyzes the choice of coping strategies by food-insecure households using a multinomial logit model, a multinomial probit model and discriminant analysis. It is not obvious which is the most suitable choice model to use, and recent studies which have used these models have not clarified the matter. The study thus compares results using each estimation method.

In most cases, the most statistical method is one that matches the stochastic process generating the observed data and is able to inform theoretical questions of interest. This implies that one must be able to differentiate multinomial probit model (MNP) and multinomial logit model (MNL) as models of data processes. The IIA, the main argument from theory for choosing MNP over the simpler MNL, is rarely relevant. If IIA does not hold, the parameter estimates and predictions of both models are inconsistent. As a result, more flexible models such as multinomial probit have therefore been suggested (Cameron and Trivedi 2005; Woodridge, 2002).

6.5.1 Multinomial logistic and multinomial probit models

A multinomial logit model is not usually appropriate as it assumes zero correlation in unobserved factors over alternatives (McFadden, 2000), which implies that alternatives can be substituted. However, it is not possible to always have this in reality. This assumption on substitution is usually called the Independent of Irrelevant Alternatives (IIA) property. Multinomial probit models, on the other hand, allow correlation in unobserved factors among alternatives (McFadden, 2000).

This study estimates a model choice of coping strategies using different statistical specifications. After estimating the widely used multinomial logit model, the study estimates an independent multinomial probit model. The multinomial probit model does not suffer does from the well-known independence of irrelevant alternatives (IIA), which is the main problem in using the multinomial logit model. In the estimation, we compare the elasticities estimated with these different statistical specifications. The study assesses the importance of the IIA assumption by comparing the predictions of three different models - the multinomial logit model, the independent multinomial probit model and multinomial probit model.

Let individuals *n* face a set of *J* mutually exclusive alternative coping strategies, each associated with an unobserved utility.

$$U_{ij} = x_{ij}^{'}\beta_i + \varepsilon_{nj} \tag{6.1}$$

where X_{ij} is an *m*-dimensional row set of individual characteristics, *n*, and alternative, *j*, β_i is a set of constant parameters, ε_{ij} is a random disturbance term (Cameron and Trivedi, 2005; Wooldridge, 2002).

a) Specification of multinomial logit model (MNL)

Following Cameron and Trivedi (2005) and Wooldridge (2002), the study specifies the probabilities to be estimated under multinomial logit model as follows:

$$prob(y_i = j \mid x_i) = \frac{e^{\beta_j^i x_i}}{1 + \sum_{k=1}^{J} e_k^{' \, x_i}} \qquad \text{for } j=0, 2, \ldots J, \qquad (6.2)$$

where x_i represents explanatory variables i.e. household characteristics such as age, education level, and gender (all of household head). The ratio of choice probabilities for alternative *j* and *k* (the odd-ratio of alternatives *j* and *l*) is:

$$\ln\left[\frac{p_{ij}}{p_{ik}}\right] y_i = x_i^{'}(\beta_j - \beta_k) = x_i^{'}\beta_j \qquad \text{if } k=0 \qquad (6.3)$$

The odd-ratio, *Pj /Pk,* is not dependent on other choices other than *j* and *k*, which follows from the independence of disturbances in the original model (Cameron and Trivedi, 2005; Wooldridge, 2002). The log-likelihood is a simplification of the binomial logit model:

$$\ln L = \sum_{i=1}^{n} \sum_{j=o}^{J} d_{ij} \ln prob(y_i = j) \qquad (6.4)$$

The derivatives take the following form:

$$\frac{\partial \ln L}{\partial \beta_j} = \sum_i (d_{ij} - P_{ij}) x_i , \qquad \text{for } j = 1 \ldots, J \qquad (6.5)$$

b) Specification of multinomial probit model (MNP)

As already stated, the model has an advantage in that it allows correlations among all alternatives or choices.

The probability “that an individual *n* chooses alternative *j* “is:

$$p_{ij} = pr[U_{ij} > U_{ik} \text{ for all } k \neq j] \qquad (6.6)$$

In the MNP, this probability can be calculated analytically to obtain

p_{ij}, is given by

$$p_{i1} = \Pr[y = 1] = \int_{-\infty}^{v_{1,12}^{*}} \int_{-\infty}^{v_{i,13}^{*}} f_1(\varepsilon_{i,21}^{*}, \varepsilon_{i,31}^{*}) d\varepsilon_{i,21}^{*} d\varepsilon_{i,31}^{*}$$

(6.7)

The explanatory variables include household characteristics such as age of the household head, education level of household head and gender (sex) of the household head. The log likelihood for multinomial probit model is specified as follows;

$$\ln L(\psi^*) = \sum_{i-1}^{N} \sum_{j=1}^{J} D_{ij} \ln(p_{ij} \mid \psi^*, V_{i,kj}^*) \qquad \forall j, j \neq k \qquad (6.8)$$

where ($p_{ij} \mid \psi^*, V_{i,kj}^*$) = $pr(\varepsilon_{ij}^* < \varepsilon_{ik}^* \quad \forall k \mid \psi^*, V_{ik} - V_{ij}), \psi^*$ s a vector of parameters and k represents the chosen alternative. The error terms $\varepsilon_{i,21}^*$ and $\varepsilon_{i,31}^*$ are assumed to have a density $f_1(\varepsilon_{i,21,}^* \varepsilon_{i,31}^*)$ derived from the density function $f(\varepsilon_i)$ and are bivariate normal with mean vectors zero (0).

6.5.2 Discriminant analysis

Discriminant analysis attempts to use the independent variables to distinguish among groups or categories of the dependent variable. The usefulness of a discriminant model is based upon its accuracy rate, or ability to predict the known group memberships in the categories of the dependent variable. Discriminant analysis works by creating a new variable called the discriminant function score which is used to predict which group a case belongs. The discriminate is similar to a regression equation in which the independent variables are multiplied by coefficients and summed to produce a score.

The study uses discriminant analysis to distinguish between coping strategies and survival strategies. This is premised on the fact that some households facing food security problems fail to cope as they struggle to survive. In this case, their strategies would be rather be specified as survival strategies rather than coping strategies. The study specifies the logistic discriminant function as follows:

$$D_i = \alpha_1 X_1 + \alpha_2 X_2 + ...\alpha_n X_n \qquad (6.9)$$

D_i represents *i*-th respondent discriminant score on the function

$X_1 \ldots X_n$ represent explanatory variables such as years of age (measured in numbers of years), education (No Education/ basic education =1, secondary education =2, Tertially/university education =3), gender of household head (female =1, male = 2); and age is measured by years of age. $\alpha_1 \ldots \alpha_n$ are standardized coefficients estimated from the data. In terms of food security, food secure households are those that have enough food throughout the year, while food insecure households are those that

6.6 Empirical Results

As a preliminary, the study estimated multinomial logistic and multinomial probit models to compare the estimates and marginal effects. The results from both models are identical (see appendix III, A-6.1 to A-6.4). This is due to the similarities in the shapes of the logit and probit probability distributions. Major differences would arise only if there were considerable differences in the estimated coefficients relative to their respective distributions. The study then proceeded to estimate multinomial logistic models with social economic characteristics of farm households. The study also has results under discriminant analysis to investigate whether adopted strategies represent ability to cope or rather failure to cope (i.e. survive).

The coefficients in any limited dependent variable can be misleading. Since the multinomial logit and multinomial probit models are probability models, the absolute level of a coefficient can represent a wrong picture of the impact of the regressor on the dependent variable. To deal with this problem, we compute marginal effects on the conditional mean functions. The marginal effects are derivatives of the conditional mean.

6.6.1 Coping strategies used by food-insecure households

Table 6.1 and 6.2 show estimation results of choice probabilities predicted by multinomial logistic model. The results indicate during 2004/05 and 2006/07, buying food from market (*mkt*) is the dominant coping strategy for households facing food security problems, with the highest choice probability of 0.379, followed by casual labour (*labour*), obtaining food from relatives and friends (*relative*), eating unripe maize before harvest (*unripe*), and irrigation farming (*irrig)*. The other coping strategies include food for work (*fwork*), obtaining food handouts (*fhand*), reducing consumption (*reduce*), and barter/exchange (see table 6.1 and 6.2). For more details, see appendix III, B-6.1 to B-6.8. Some coping strategies are similar to the findings of previous studies. For instance, Akinboade (2008), Chamunika (2006) and Mikael (2004) show that affected households received handouts; Akinboade (20080; Bukusuba et al. (2007); Mikael (2004) show that that affected households reduced consumption while Mikael (2004) indicate that affected households received assistance from relatives and friends. By gender, buying food from the market (*mkt*) is the most dominant coping strategy among female headed households during 2004/05 and 2006/07 with choice probability of 0.455 and 0.367, respectively. This is followed by casual labour (*labour*) and obtaining food from relatives, respectively (*relative*) (see tables 6.1 and 6.2). For male headed households, the most dominant coping strategy was casual labour (*labour*) in 2004/05 and buying food from the market (*mkt*) in 2006/07, with choice probabilities of 0.386 and 0.395, respectively. This was followed by buying food from the market (*mkt*) and casual labour (*labour*), respectively. The main coping strategy for food-insecure households with mortality during 2004/05 and 2006/07 is buying food from the market (*mkt*), followed by casual labour (*labour*). On the other hand, the main coping strategy of food-insecure households with morbidity during 2004/05 and 2006/07 is casual labour (*labour*) and buying food from market *(mkt*), respectively. This is followed by buying food from market (*mkt)* and casual labour (*labour*), respectively. The least ranked coping strategies are eating wild plants (*wplant*) and barter trade (*barter*).

Table 6.1: Probabilities on coping strategies for 2004/05 season

households	mkt	labour	relative	unripe	fwork	fhand	irrig	wplant	reduce	barter
All households	0.379	0.372	0.087	0.051	0.023	0.022	0.039	0.000	0.026	0.000
Female headed	0.455	0.310	0.176	0.000	0.008	0.012	0.000	0.000	0.029	0.008
Male headed	0.351	0.386	0.059	0.069	0.027	0.025	0.053	0.000	0.023	0.006
Mortality	0.548	0.128	0.188	0.071	0.065	…	0.000	0.000	0.000	…
Female headed	0.551	0.072	0.325	0.000	0.000	…	…	….	0.052	…
Male headed	0.412	0.305	0.048	0.043	0.022	….	…..	…	0.000	…
Morbidity	0.373	0.402	0.079	0.039	0.018	0.026	0.039	0.000	0.000	0.000
Female headed	0.446	0.338	0.138	0.000	0.000	0.017	0.000	0.000	0.000	0.010
Male headed	0.354	0.400	0.059	0.054	0.024	0.027	0.049	0.000	0.025	0.007

Source: author's estimation results; …. = not available

Table 6.2: Probabilities on coping strategies for 2006/07 season

households	mkt	labour	relative	unripe	fwork	fhand	irrig	wplant	reduce	barter
All households	0.386	0.351	0.074	0.054	0.021	0.035	0.035	0.000	0.014	0.029
Female headed	0.367	0.327	0.115	0.082	0.000	0.043	0.000	0.000	0.045	0.019
Male headed	0.395	0.359	0.065	0.046	0.023	0.033	0.045	….	0.000	0.033
Mortality	0.435	0.297	0.130	0.033	0.053	0.054	0.000	0.000	0.000	…
Female headed	0.510	0.257	0.144	0.000	0.000	0.042	0.047	….	0.047	…
Male headed	0.371	0.245	0.128	0.000	0.002	0.000	0.000	…	…..	…
Morbidity	0.389	0.371	0.069	0.057	0.000	0.032	0.034	0.000	0.011	0.037
Female headed	0.364	0.385.	0.0781	0.093	…	0.042	0.000	0.000	0.038	0.028
Male headed	0.399	0.367	0.061	0.045	0.018	0.029	0.042	….	0.000	0.038

Source: author's estimation results; …. = not available

6.6.2 Coping and survival of food-insecure households

Using discriminant analysis, the study divides the coping strategies into coping (ordinary) strategies and survival (serious) strategies. This is premised on the understanding that some strategies adopted by households represent non-coping i.e. survival, including obtaining food from relatives/friends, eating unripe maize before harvest, food handouts, eating wild plants, and reducing consumption.

The results show that for all households, ordinary coping strategies have a total score of 78.21 percent, much higher than survival strategies at 21.79 percent during 2004/05, an indication of much greater involvement in coping strategies than survival strategies. During 2006/07, the score for coping strategies dropped very slightly to 78.09 percent. The drop emanated from female headed households, especially among morbidity affected households. (See tables 6.3 to 6.6).

Table 6.3: Discriminant analysis results for 2004/05 season – coping strategies

households	mkt	labour	food for work	irrigation	barter	total
All households	35.02	34.63	2.72	428	1.56	78.21
Female headed	39.73	28.77	2.74	1.37	1.37	73.98
Male headed	33.15	36.96	2.72	5.43	1.63	79.89
Mortality	39.39	15.15	6.06	6.06	0.00	66.66
Female headed	44.44	11.11	5.56	0.00	0.00	61.10
Male headed	33.33	20.00	6.67	13..33	0.00	73.33
Morbidity	34.38	37.50	2.23	4.02	1.79	79.92
Female headed	38.18	34.55	1.82	1.82	1.82	78.19
Male headed	33.14	38.46	2.37	4.73	1.78	80.48

Source: author's estimation results; …. means not available

Table 6.4: Discriminant analysis results for 2006/07 season – coping strategies

households	mkt	labour	food for work	irrigation	barter	total
All households	35.69	32.86	2.12	3.89	3.53	78.09
Female headed	30.77	30.77	1.28	1.28	3.85	67.95
Male headed	37.56	33.56	2.44	4.88	3.41	81.95
Mortality	39.02	26.83	4.88	4.88	0.00	75.60
Female headed	40.00	25.00	5.00	0.00	0.00	70.00
Male headed	38.10	28.57	4.76	9.52	0.00	80.95
Morbidity	35.12	33.88	1.65	3.72	4.13	78.50
Female headed	27.59	32.76	0.00	1.72	5.17	67.24
Male headed	37.50	34.24	2.17	4.35	3.80	82.06

Source: author's estimation results; …. = not available

In general, male headed households have higher scores for coping strategies compared to female headed households over the 2004/05 and 2006/07 period. This implies that female headed households were more engaged in survival strategies compared to male headed households both during 2004/05 and 2006/07. This is in line with findings showing that overall, male headed households recorded higher maize production than female headed households (see tables 5.1 and 5.2).

Table 6.5: Discriminant analysis results for 2004/05 season – survival strategies

households	obtain from relatives/friends	eat unripe	food handouts	eat wild plants	reduce consumption	total
All households	10.12	6.23	2.23	0.78	2.33	21.79
Female headed	17.81	2.71	1.37	1.37	2.74	26.03
Male headed	7.07	7.61	2.72	0.54	2.17	20.17
Mortality	18.18	12.12	0.00	0.00	3.04	33.34
Female headed	27.78	5.56	0.00	0.00	5.56	38.90
Male headed	6.67	20.00	0.00	0.00	0.00	26.67
Morbidity	8.93	5.35	2.68	0.89	2.23	20.08
Female headed	18.18	1.82	1.82	1.82	1.82	21.83
Male headed	7.1	6.51	2.96	0.59	2.37	19.52

Source: author's estimation results; …. = not available

Table 6.6: Discriminant analysis results for 2006/07 season – survival strategies

households	obtain from relatives/friends	eat unripe	food handouts	eat wild plants	reduce consumption	total
All households	9.19	5.30	4.95	0.35	2.12	21.93
Female headed	14.01	7.69	5.13	1.23	3.85	32.05
Male headed	7.32	4.39	4.88	0.00	1.46	18.05
Mortality	12.2	4.88	4.88	0.00	2.44	24.40
Female headed	15.00	5.00	5.00	0.00	5.00	30.00
Male headed	9.52	4.76	4.76	0.00	0.00	19.04
Morbidity	8.93	5.35	2.68	0.89	2.23	20.08
Female headed	13.79	8.62	5.17	1.72	3.46	32.76
Male headed	7.07	4.35	4.89	0.00	1.63	17.94

Source: author's estimation results; …. = not available

6.6.3 Determinants of coping strategies

In determining the probability of choosing coping strategies, household characteristics such as age, gender and education have statistically significant influence on the choice of coping strategy (see tables 6.7 and 6.8). The coefficients for age and education have positive signs on buying food from market (*mkt*), obtaining food from relatives and friends (*relative*), food for work (*fwork*), food handouts (*fhand*), and barter trade (*barter*), suggesting that older and more educated household heads are more likely to choose these coping strategies. On the other hand, the negative signs of age and education for casual labour (*labou*r), eating unripe maize before harvest (*unripe*) and irrigation farming (*irrig*) suggest that being younger and less educated household head increases the likelihood of engaging in these strategies.

Table 6.7: Marginal effects on the conditional mean function for 2004/05 season

households	mkt	labour	relative	unripe	fwork	fhand	irrig	wplant	reduce	barter
All households										
Gender	-.113	.079	-.069	0.045	-002	0.013	0.054	0.00	-.008	0.000
(female=1)	(0.07)	(0.07)	(0.03)	(0.04)	(0.02)	(0.02)	(0.03)	(0.00)	(0.02)	(0.00)
Age	0.000	-.003	0.002	-.001	0.00	0.000	-.000	0.00	-.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Edu	.109	-.113	0.021	-.035	0.017	0.012	-.013	0.00	0.002	0.000
(*no education=0)*	(0.05)	(0.05)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.00)
Female headed										
Age	0.002	-.006	0.003	0.00	0.00	-.000	0.00	0.00	0.00	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Edu	0.067	.009	-.101	0.00	.013	.009	0.00	0.00	-.007	0.011
	(0.11)	(0.09)	(0.09)	(0.00)	(0.02)	(0.02)	(0.00)	(0.01)	(0.04)	(0.01)
Male headed										
Age	0.00	-.002	0.002	-.001	0.001	0.001	0.00	0.00	-.0002	0.000
	(0.0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Edu	0.13	-.166	0.055	-.033	0.012	0.013	-.038	0.00	0.008	0.014
	(0.06)	(0.06)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.00)	(0.02)	(0.01)
Mortality										
Gender	-.1863	.1250	-.220	.2759	.006	….	0.00	….	-.000	….
	(0.65)	(.200)	(.293)	(0.16)	(0.17)	…..	(0.00)	…..	(1.11)	…..
Age	0.002	-.005	.005	-.006	.004	….	0.00	….	0.000	….
	(0.00)	(.005)	(.006)	(0.00)	(0.00)	…	(0.00)	…	(0.00)	…
Edu	0.2123	.115	-.092	-.259	.024	…	0.00	…	0.000	…
	(0.29)	(.157)	(.233)	(0.18)	(0.16)	….	(0.00)	….	(0.07)	….
Female headed										

Age	-.000	-.004	.005	0.00	0.00	…..	…..	…..	-.000	…..
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	…..	…..	…..	(0.00)	…..
Edu	0.009	.037	-.092	0.00	0.00	….	….	….	0.047	….
	(0.31)	(.104)	(0.31)	(0.29)	(0.36)	…..	…..	…..	(0.10)	…..`
Male headed										
Age	0.000	0.00	0.00	-.002	0.00	…..	0.00	…..	…..	…..
	(0.01)	(0.01)	(0.00)	(1.29)	(1.33)	…..	(0.00)	…..	…..	…..
edu	0.529	0.27	0.00	-.269	0. 12	….	-.629	….	….	….
	(0.18)	(0.16)	(0.00)	(0.34)	(.109)	…..	(.319)	…..	…..	…..
Morbidity										
Gender	-.088	0.04	-.042	0.034	0.003	.012	0.03	0.00	.006	001
	(0.08)	(0.08)	(0.04)	(0.04)	(0.02)	(0.03)	(0.04)	(0.00)	(0.03)	(.001)
Age	0.00	-.000	0.00	-.001	0.00	0.00	-0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
edu	.101	-.139	0.029	-.022	0.02	0.01	0.00	0.00	-.001	0.00
	(0.05)	(0.05)	(0.03)	(0.02)	(0.01)	(0.02)	(0.02)	(0.00)	(0.02)	(0.00)
Female headed										
Age	.003	-.006	.003	0.00	0.00	-.000	0.00	0.00	0.00	…
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	….
Edu	.079	-.004	-.101	0.00	0.00	.012	0.00	0.00	0.00	…
	(0.12)	(0.12)	(0.08)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00	(0.00	….
Male headed										
Age	0.00	-.000	.001	-.002	0.00	0.00	-.000	0.00	-.000	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Edu	0.121	-1.88	0.06	-.025	.009	.0112	-.016	0.00	.008	0.016
	(0.06)	(0.06)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.00)	(0.02)	(0.01)

Source: author's estimation results; …. = not available

In terms of the sex of the household head, the gender coefficient has a negative sign on buying food from market (*mkt*), obtaining food from relatives and friends (*relative*), food for work (*fwork*), and eating wild plants (*wplant*), suggesting that female headed households are more likely to adopt these strategies. This pattern is observed for food insecure households during 2004/05, except for households with mortality, where the less education is associated with obtaining food from relatives, while more education is linked with reducing consumption (*reduce*). Having a female head and less education increases the probability of adopting survival strategies.

Table 6.8: Marginal effects on conditional mean function, for 2006/07 season

households	mkt	labour	relative	unripe	fwork	fhand	irrig	wplant	reduce	barter
All households										
	.022	.037	-.051	-.034	.0124	-.008	0.045	0.00	-.0103	-.010
Gender	(0.07)	(0.69)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.00)	(0.02)	(0.02)
	-.002	-.001	0.002	-.001	-0.00	0.002	-.000	0.00	-.000	-0.000
(female=1)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age	.103	-.125	0.03	-.018	-.009	0.032	-.019	0.00	-.019	.03155
	(0.05)	(0.05)	(0.03)	(0.02)	(0.01)	(0.02)	(0.02)	(0.00)	(0.01)	(0.01)
Edu										
(*no*										
education=0)	-.001	-.007	0.006	-.002	0.00	.002	0.00	0.00	0.00	-.000
Female headed	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	-	.-.081	.023	-.009	.000	.055	0.00	0.00	.011	0.033
Age	.0306	(0.10)	(0.07)	(0.06)	(0.00)	(0.03)	(0.00)	(0.00)	(0.04)	(0.03)
	(0.11)									
Edu										
		-.002	0.002	-.000	0.001	0.002	-.000	….	-.0002	-.000
Male headed	-.005	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	….	(0.00)	(0.00)
	(0.00)	-.173	0.033	-.026	0.002	0.021	-.048	….	0.008	0.028
Age	0.168	(0.06)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	….	(0.02)	(0.02)
	(0.06)									
Edu										
		.0959	-.058	.0300	.0133	.0146	0.00	….	-.000	….
Mortality	-	(.175)	(.119)	(0.05)	(0.08)	(.082)	(0.00)	…..	(0.271	…..
	.0956	-.010	.004	-.002	.000	.000	0.00	….	)	….
Gender	(0.27)	(.001)	(.005)	(0.00)	(0.00)	(0.00)	(0.00)	…	0.000	…
	0.007	-.115	.0253	-.064	-.413	-.051	0.00	…	(0.00)	…
Age	(0.01)	(.196)	(.148)	(0.07)	(0.09)	(0.09)	(0.00)	….	0.000	….
	0.285								(0.01)	
Edu	(0.22)									
Female headed		-.011	.006	0.00	0.00	.002	…..	…..		…..
		(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	…..	…..	-.000	…..
Age	.0033	-.042	-.036	0.00	0.00	.076	….	….	(0.00)	….
	(0.00)	(.23)	(0.22)	(0.06)	(0.08)	(0.08)	…..	…..	0.037	…..`
Edu	-								(0.09)	
	.0343									
Male headed	(0.27)	-.000	-.000	0.00	0.00	0.00	0.00	…..		…..
		(0.00)	(0.00)	(0.00)	(0.27)	(0.00)	(0.00)	…..	…..	…..
Age		-.217	-.117	0.00	0. 71	-.212	-.323	….	…..	….
	0.000	(0.30)	(0.09)	(0.00)	(0.07)	(0.23)	(0.26)	…..	….	…..
edu	(0.00)								…..	
	0.564									
Morbidity	(0.14)	0.030	-.048	0.043	0.004	-.008	0.03	0.00		-.0195
		(0.08)	(0.03)	(0.03)	(0.02)	(0.02)	(0.04)	(0.00)	.007	(0.03)
Gender		-.000	0.003	-.001	-.000	0.002	-0.00	0.00	(0.01)	-.000
	0.063	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	-.000	(0.00)
Age	(0.08)	-.148	0.023	-.015	-.000	0.032	-.000	0.00	(0.00)	.037
	-.003	(0.05)	(0.03)	(0.02)	(0.00)	(0.02)	(0.02)	(0.00)	-.0216	(0.02)
edu	(0.00)								(0.01)	
	.097									
Female	(0.05)	…	.006	-.002	…	0.00	0.00	0.00		-.000

headed		…	(0.00)	(0.00)	…	(0.00)	(0.00)	(0.00)	0.00	(0.00)
		…	.0253	0.031	…	.0498	0.00	0.00	(0.00)	0.048
Age	.0003	…	(0.07)	(0.07)	…	(0.04)	(0.00)	(0.01)	-.004	(0.04)
	(0.00)								(0.05	
Edu	-									
	.0440	0.003	0.002	0.000	-.001	0.002	-.001	….		-.000
Male	(0.12)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	…	0.000	(0.00)
headed		-1.76	0.03	-.031	-.004	0.027	-.026	…	(0.00)	0.029
		(0.06)	(0.03)	(0.03)	(0.01)	(0.02)	(0.02)	….	0.000	(0.02)
Age	0.005								(0.00)	
	(0.00)									
Edu	0.153									
	(0.06)									

Source: author’s estimation results; …. = not available

6.7 Conclusion and policy recommendations

This essay has examined the coping strategies for households facing food security problems. It employs a two-step analytical procedure - the multinomial logistic and multinomial probit model - to model the choice probability of coping strategies for households facing food security problems; and, by distinguishing ordinary coping strategies from survival strategies, uses the logistic discriminant analysis to compare the two sets of strategies.

The results from both multinomial logistic and multinomial probit models for periods 2004/05 and 2006/07 show that the dominant coping strategy among affected households facing food security problems is buying food from market, followed by labour, obtaining food from relatives and friends, eating unripe maize before harvest, and irrigation farming. The other coping strategies include obtaining food handouts, reducing consumption and barter trade. The least used coping strategies are eating wild plants and food for work. The results from discriminant analysis indicate that for all households, ordinary coping strategies are used by the majority of the households, accounting for close to 80 percent of the strategies while survival strategies represents 20 percent of the adopted strategies during 2004/05. This implies that a relatively small proportion of the households were just surviving. During 2006/07, the percentage of households that were surviving rose slightly, emanating from female headed households, especially among morbidity affected households. In general, more female headed households are engaged in survival strategies compared to male headed households over the 2004/05 and 2006/07 period.

Household characteristics have a significant impact on the choice probability of coping strategies. Higher levels of education are more associated with casual labour activities in recent years while lower ages and less education are more associated with food for work activities. Male headed households are more linked with casual labour and food for work activities. On the other hand, female headed households are more associated in eating unripe maize before harvest and obtaining food handouts. In terms of mortality and morbidity, higher age is associated with buying food and food for work from the market with mortality compared to those with morbidity. Less education is more associated with obtaining food handouts for households with mortality compared to those with morbidity. Thus female headed households and less education is more associated with survival strategies.

The results imply that, despite Malawi's record success in food security at national level in recent years, incidences of food insecurity remain at household level, especially among vulnerable households. The problem is more acute among AIDS-affected female headed households with mortality. Thus Government should focus on ensuring food security for affected households by supplying the food insecure households with food handouts and also ensuring food availability in rural markets. There is also need to conduct the necessary balancing act between investing in productivity growth (education, extension services, infrastructure and markets) and targeted assistance to the food-insecure households. Since financial resources are always inadequate in most developing countries, there is need for governments to examine which investments provide greatest benefit.

Considering that buying food from the market is the dominant coping strategy, Government should strengthen the performance of food markets, particularly in rural areas, by developing the infrastructure and markets to ensure that food is available at affordable prices. It should also be noted that the major constraints to food security include Malawi's dependence on rain-fed agriculture and treatment of maize, a crop not resistant to drought, as main staple food by the majority of Malawians. Thus government should put in place deliberate policies to simultaneously promote diversification into drought-resistant crops such as cassava, and small-scale irrigation through farmer association.

Finally, as labour is the second dominant coping strategy, Government needs to promote income generating activities as a source of livelihood for the food insecure households.

This might include expansion of the already existing public works programs such as rehabilitation of earth roads and road maintenance.

References

Adenegan, K.O. & Adewusi, O.A. (2007), "Determinants of Food Security Status of Rural Households living with HIV/AIDS in South-western Nigeria," *African Journal of Biomedical Research*, 10(1): 9-18

Akinboade, O.A. (2008), "Gender, HIV/AIDS, land, restitution and survival strategies in the Capricon district of South Africa," *International Journal of Social Economics*, 35 (11): 857-877

Alumira, J.D., Kambewa, P.S. & Binauli, L.D. (2005), *"Impact of HIV/AIDS on Inter- and Intra-Generational Information Flows among Smallholder Farmers in Malawi,"* ICRISAT, Malawi and RENEWAL, International Food Policy and Research Institute, Washington, D.C.

Arrehag, L., Durevall D., Sjoblom, M. & De Vylder, S. (2006), *"The Impact of HIV/AIDS on the Economy, Livelihoods and Poverty of Malawi,"* Country Economic Report, Department for Policy and Methodology, SIDA, Sweeden

Bukusuba, J., Kikafunda J.K. & Whitehead, R.G. (2007), "Food security status in households of people living with HIV & AIDS (PLWHA) in a Ugandan urban setting," *Br Journal of Nutrition*, 98: 211-7.

Bardhan, P. & Udry C. (1999), *"Development Microeconomics,"* Oxford University Press, Oxford.

Barnett, T. & Grellier, R. (2003), *"Mitigation of the impact of HIV/AIDS on rural livelihoods through low-labour input agriculture and related activities,"* A report submitted to the department for international development, Overseas Development Group University of East Anglia, UK

Blackie, M. & Conroy, A. (2007), "The collapse of agriculture," In: Conroy, A., Blackie, M., Whiteside, A., Malewezi, J. & Sachs, J. (eds.) *Poverty, AIDS and Hunger: Breaking the Poverty Trap in Malawi, Palgrave* Macmillan, Basingstoke, UK

Booysen, F. R. (2002), "Financial Responses of Households in the Free State province to HIV/AIDS-related Morbidity and Mortality," *South African Journal of Economics*, 70(7): 1193-1215

Cameron, A. C. & Trivedi, P.K. (2005), *Microeconometrics: Methods and Applications*, Cambridge University Press, UK

Castleman, T., Seumo-Fosso, E. & Cogill, B. (2003), "*Food and Nutrition Implications of Antiretroviral Therapy in Resource Limited Settings*," Academy for Educational Development Technical Note 7, Food and Nutrition Technical Assistance Project, Washington DC.

Chamunika, M. (2006), "*Impact of HIV/AIDS on Agriculture and Food Security: The case of Limpopo Province in South Africa*," FANRAPAN Working Document, Series Ref: NAT SA005

Chapoto, T.S. & Jayne, T. (2005), "Measuring Impact of Working-Age Adult Mortality on Small-scale Farm Households in Kenya," *World Development*, 32 (1): 91-111

Chirwa, E.W. (2007), "*Sources of technical efficiency among smallholder farmers in Southern Malawi,"*AERC research paper 172. African Economic Research Consortium, Nairobi, Kenya

Cromwell, E. & Kyehombe, N. (2005), "*Food security options in Malawi: good neighbours make good friends?"* Forum for Food Security in Southern Africa, unpublished report,. www.odi.org.uk/food-security-forum

Croppenstedt, A. & Muller C. (2000), "The Impact of Health and Nutritional Status of Farmers on their Productivity and Efficiency: Evidence from Ethiopia," *Economic Development and Cultural Change*, 48(3): 475-502.

Dasgupta, P. (1993), *An Inquiry into Well-Being and Destitution*, Clarendon Press, Oxford

De Waal, A. (2007), “AIDS, hunger and destitution: theory and evidence for the 'new variant famines' hypothesis in Africa,” in: Devereux, S. (ed.), *The New Famines: Why Famines Persist in an Era of Globalisation*, Routledge, London,

De Waal, A. & Whiteside, A. (2003), “New Variant Famine: AIDS and food crisis in southern Africa,” *The Lancet*, 362: 1234-1237

Epstein, L. (1995), "*Food for People Living with HIV/AIDS”, Report*, Network of Zambian People Living with HIV/AIDS (NZP), Lusaka

Food and Agricultural Organisation (FAO) (2002), “*Focus: Food Insecurity and AIDS: a Vicious Circle*,” http://www.fao.org/Focus/E/aids/aids1-e.htm

Fraser, E., Mabee, W. & Slaymaker, O. (2003), “Mutual vulnerability, mutual dependence: the reflective notion between human society and the environment,” *Global Environmental Change*, 13: 137–144.

Gibbs, A. (2008), “Gender, famine and HIV/AIDS: rethinking new variant famine in Malawi,” *African Journal of AIDS research*, 7(1): 56-78

Gill, J. (2001), *Generalized Linear Models: A Unified Approach*, Thousand Oaks, Sage, California, USA

Greene, W. H. (1997), *Econometric Analysis*, (3rd ed.), Upper Saddle River, Prentice-Hall, New Jersey, USA

Haslwimmer, M. (1996), “*AIDS and Agriculture in Sub-Saharan Africa*,” FAO Farm Management and Production Economics Service (AGSP).
http://www.fao.org/waicent/faoinfo/sustdev/WPdirect/WPre0003.htm

Harvey, P. (2003), “*HIV/AIDS and humanitarian action?”* Draft, Overseas Development Institute, Humanitarian Policy Group, UK, Unpublished report.

Kinsey, B., Burger, K. & Gunning, J. W. (1998), “Coping with drought in Zimbabwe: Survey evidence on responses of rural households to risks,” *World Development*, 26 (1): 89-110.

Luce, D. (1959) *Individual Choice Behaviour*, Wiley, New York

Lundberg, M. & Over. M. (2000), “Sources of financial assistance for households suffering an adult death in Kagera, Tanzania,” *The South African Journal of Economics*, 68 (5): 1-39.

Malawi Growth and Development Strategy (MGDS) (2007), IMF country report 07/55, http://www.imf.org/external/pubs/cat/longres.cfm?sk=20417.0

Mather, D. (2004), “*Household Responses to Prime Age Adult Mortality in Rural Mozambique: Implications for HIV/AIDS Mitigation Efforts and Rural Economic Development Policies*,” Centre for Study of African Economies Conference, Oxford University, UK

Marschak, J. (1960), “*Binary Choice Constraints on Random Utility Indicators. Arrow, K, ed., Stanford Symposium on Mathematical Methods in Social Sciences*,” Stanford University Press, California

McFadden, D. (1968), “*The Revealed Preferences of a Public Bureaucracy*,” Department of Economics, University of California, Berkeley, USA

McFadden, D. (1976), “The Revealed Preferences of a Bureaucratic Government: Empirical Evidence,” *The Bell Journal of Economics and Management Science*, 7: 55-72

McFadden, D.L. (2000), “*Economic choices*,” Nobel Prize lecture http://nobelprize.org/nobel_prizes/economics/laureates/2000/mcfadden-lecture.pdf

Mikael, L. (2004), “*Exploring the impact of HIV/AIDS on household food security in rural Ethiopia: two case studies,*” A joint UNECA/UNDP/WFP study http://uneca.org/eca_programmes/policy_analysis/publications/AIDS_food_security-report.pdf

Mtika, M. (2001), “The AIDS epidemic in Malawi and its threat to household food security,” *Human Organisation*, 60(2): 178-188

Munthali, A. (2002), "*Adaptive Strategies and Coping Mechanisms of Famines and Communities Affected by HIV/AIDS in Malawi,"* United Nations Research Institute for Social Development (UNRISD), Geneva, Switzerland

Musita, C.P., Ariga, E.S., Kaseje, D.K. & Otieno, A. (2009), "Impact of HIV and AIDS on household food and nutrition security in suba district, Kenya," *AIDS,* 9 (7): 1452-1467

Mutangadura, G.B. (2000), "*Household Welfare impacts of mortality of adult females in Zimbabwe: Implications for policy and program development,*" Paper presented at the AIDS and Economics Symposium organized by IAEN Network, Durban, South Africa

Muwanga, F.T. (2002), "*Impact of HIV/AIDS on Agriculture and the Private Sector in Swaziland. State of the World's Forests/FAO,*" Eldis Report on HIV/AIDS, University of Sussex Institute of Development Studies, UK.

NAADS (2003), "*The Impacts of HIV/AIDS on the Agricultural Sector in Uganda*," Baseline survey report, FAO's Integrated Programme, Rome

Naidu, V. & Harris, G. (2006), "Survival Strategies of HIV/AIDS affected households in Soweto," *Development Southern Africa*, 23(3): 417-426

National Statistical Office. (2005) Integrated Household Survey, 2004/05, Final Report, Lilongwe, Malawi

Nguthi, F.N. & Niohoff, A. (2008), "Effects of HIV/AIDS on the livelihood of banana farming households in Central Kenya," *International Journal of Life Sciences*, 50 (3): 179-190

Roumasset, J. (1976), *Rice and Risk: Decision Making among Low-income Farmers*, North-Holland Publishing, Amsterdam

Rugalema, G (1998), "*AIDS and African Rural Livelihoods: From Knowledge to Action*', keynote paper presented at the 'International Conference on AIDS, Livelihood and Social Change in Africa,". Wageningen, The Netherlands

Rugalema, G. (2000), "Coping or struggling: A journey into the impact of HIV/AIDS in southern Africa," *Review of African Political Economy*, 86: 537-545

SADC FANR Vulnerability Assessment Committee. (2003), "*Towards identifying impacts of HIV/AIDS on food security in southern Africa and implications for response: Findings from Malawi, Zambia and Zimbabwe,"* Report, Harare, Zimbabwe

Sarma, S. & Simpson, W. A. (2007), "Panel multinomial logit analysis of elderly living arrangements: Evidence from aging in Manitoba longitudinal data, Canada," Social *Science & Medicine,* 65 (12): 2539-2552

Thurstone, L.L. (1927), "Law of Comparative Judgement," *Psychological Review*, 34: 273-286

Train K., (2003), *Discrete Choice Methods with Simulation*, First Edition, Cambridge University Press,UK

Wagner, P.A. (1986), "Meeting Human Nutritional Needs," in: (Art Hansen and Della E. Mc Millan (eds), *Food in sub-Saharan Africa,* American Athropologist, 89(4): 965-966

World Bank (WB). (1986), Annual Economic Report, World Bank, Wahsington D.C.

Wooldridge, J.M. (2002), *Econometric Analysis of Cross Section and Panel data*, Massachusetts Institute of Technology, USA

Yamano, T. & Jayne, T.S. (2004), "Measuring the Impacts of Prime-Age Adult Death on Rural Households in Kenya," *World Development,* 32(1): 91-119.

Chapter 7: An overview of the study

7.1 Introduction

The broad objective of this study is to investigate the economic impact of prime-age adult mortality and morbidity of AIDS-affected and non-affected households on smallholder farm households in order to provide policy recommendations for impact mitigation. The first essay examines the levels of technical efficiency among AIDS-affected and non-affected households. Specifically, we examine the socio-economic determinants of technical efficiency and analyze the technical efficiency differentials among AIDS-affected and non-affected households. The second essay investigates maize production differentials between the affected and non-affected farm households. The third essay examines the responses of farm households to food security problems. Specifically, it examines the coping and survival strategies of households facing food security problems. Finally the study identifies policy recommendations that can be used in developing mitigation policies and programs in the agricultural sector.

7.2 Empirical Results

Using time varying and time invariant inefficiency models, the results from the first essay show that for both AIDS-affected and non-affected households across gender divide, land, fertilizer and seeds are the only variables that contribute significantly towards technical efficiency. For both affected and non-affected households with prime-age adult mortality and morbidity, again fertilizer and seeds remain the statistically significant determinants of technical efficiency. The findings differ with other studies on Malawi. They differ with Tchale (2009), whose study show that only the education level of household head was significant. They also differ with Chirwa (2007) who used a small sample of smallholder farmers in one of the districts in Southern Malawi, and found labour as the only statistically significant variable. They further differ with findings from studies on other African countries. For instance, Obwona (2006) indicates that education has a significant impact on technical efficiency. The results also show that the land variable is not a statistically significant contributor of technical efficiency. This could be due to the smallness of landholdings among smallholder farm households. Turning to efficiency levels, the results show that the technical efficiency levels of non-affected households under time varying and time-invariant models are at 71 percent and 75 percent, respectively. These efficiency levels are slightly higher than the technical efficiency levels of AIDS- affected households, under time varying and time-invariant inefficiency models, at 69 percent and 71 percent, respectively. However, the differences in the technical efficiency levels are not statistically significant at 10 percent level. These levels of technical efficiency are relatively lower than those for non-affected households *without* mortality and morbidity of 76 percent and 78 percent under time varying and time-invariant models, respectively. The results also differ with the findings on technical efficiency levels from Adeoti and Adeoti (2008) and Yusuf et al. (2007), where technical efficiency levels for the affected households are lower and the differences are statistically significant. The male headed households are technically more efficient than the female headed households for both the affected and non-affected households. Similarly households with morbidity are technically more efficient than households with mortality. In general, Malawian farmers are technically efficient and the mean technical efficiency levels of around 70 percent are relatively higher than those obtained in Tchale (2009) and in Chirwa (2007) of around 53 percent and 46 percent, respectively. This could be attributed to the role of the enhanced Government fertilizer subsidy programme. Nevertheless, the mean efficiency levels are comparable to those obtained for other African countries whose means range from 55 percent to 79 percent (see Adeoti and Adeoti (2009); Yusuf et al. (2007); Obwona (2006); Seidu Al-Hassan (2008); Ogundele (2006); Nchare (2007)). The results by gender show that female headed households have lower technical efficiency levels compared to male headed households under for both affected and non-affected households under both morbidity and mortality. For both affected and non-affected households, the mean technical efficiency levels for households with morbidity are statistically higher then mean technical efficiency for households with mortality. The lowest mean technical efficiency recorded is for female headed affected households under mortality at 29 percent. At this level, these households are technically inefficient.

Using different in difference estimation method, the results from the second essay show that average maize production for both AIDS-affected and non-affected households (with morbidity and mortality) is higher during 2006/07 season compared to the 2004/05 season. This is attributed to higher fertilizer application for both affected and non-affected households due to the fertilizer subsidy programme coupled with good rains during 2006/07 seasons. The mean maize production for affected households is slightly higher during 2006/07 than the mean production level for non-affected households. However, the difference is not statistically significant. For both affected and non-affected households, male headed households recorded higher maize production during 2006/07 than female headed households. Whereas affected households with mortality recorded higher maize production than affected households with morbidity, the outcome was opposite for non-affected households. The mixed outcome was due to the differentials in fertilizer application per hectare for affected and non-affected households. Both affected and non-affected households with household head/spouse morbidity recorded lower maize production levels than affected households with adult child morbidity during 2006/07. Similarly, non-affected households with household head/spouse mortality recorded lower maize production levels than affected households with adult child mortality during 2006/07. However, affected households with household head/spouse mortality realised higher maize production than affected households with adult child mortality during 2006/07. Again, this outcome can be attributed to differentials in fertilizer application levels for affected and non-affected households. Overall, the difference in difference in maize production for affected and non-affected households over the two periods is not statistically significant. In general, maize production levels per hectare for affected and non-affected households are comparable with global weighted average of 55.8 bags per hectare. However, the production levels still lie below the international maximum maize production of around 200 bags of 50kg per hectare. Nevertheless, the enhanced government fertilizer subsidy programme appears to have more than offset the anticipated negative impact of AIDS-related and non-AIDS related adult morbidity and mortality on maize production. Fertilizer application and maize production seem to be sensitive to gender. The non-significance in differences in mean production for affected and non-affected households over the two periods suggests that mitigation and intervention measures need to cover other vulnerable groups besides those affected by HIV/AIDS.

Results from the third essay show that both multinomial logistic and multinomial probit models for periods 2004/05 and 2006/07 seasons show that the dominant coping strategy among affected households facing food security problems is buying food from market followed by labour, obtaining food from relatives, and eating unripe maize before harvest. The other coping strategies include handouts, reducing consumption and barter/exchange. The least coping strategy is eating wild plants and food for work. The results from discriminant analysis indicate that for all households, ordinary coping strategies have a total score of about 80 percent much higher than survival strategies about 20 percent during

2004/05 and 2006/07. This implies that a relatively small proportion of the households were surviving. In general, more female headed households are engaged in survival strategies compared to male headed households over the two periods. Household characteristics have a significant impact on the choice probability of coping strategies. Higher education is more associated with labour activities in recent years while lower ages and less education are more associated with food for work activities. Male headed households are more linked with labour and food for work activities. On the other hand, female headed households are more associated in eating unripe food and food handouts. In terms of mortality and morbidity, higher age is associated with buying food and food for work from the market under mortality compared to morbidity. Less education is more associated with food handouts under mortality compared to morbidity. Thus female headed households and less education is more associated with survival strategies.

7.3 Conclusion and policy recommendations

The results reveal that government policy of subsidizing hybrid maize seeds and fertilizers since the 2006/07 agricultural season has enhanced technical efficiency levels of the smallholder farmers. Nonetheless, there is still scope for improvement of the productivity of smallholder farmers, as some farm households, particularly female headed households, are still operating at low levels of technical efficiency. The results also raise concerns about the standardized way of treating ‘affected households,’ especially when making requests for targeted support. This has significant implications when formulating mitigation measures. The results also reveal the importance of using country-wide representative samples in assessing impacts of prime-age adult mortality and morbidity.

The government needs to simultaneously expand the fertilizer subsidy programme and encourage farmers to use compost and other sources of manure as a supplement. As already observed, the agricultural input and output markets remain underdeveloped. Thus government needs to remove all types of impediments that could limit the use of inputs. This should include completely liberalizing the purchase and distribution of such inputs and developing some low-cost technology to reduce labour constraints on the farm. As already noted, age is an important determinant of technical efficiency. This suggests that experienced farmers are more efficient, and thus offering farmers with necessary skills and extension services would be a valuable investment and a better way of enhancing technical efficiency in maize production. There is also need to develop social capital in smallholder farming by reviving farmers' clubs which were operational during the 1970s and 1980s These clubs help farmers to share ideas and resources about crop husbandry in order to enhance crop production.

Given the gender differentials in impact of morbidity and mortality, there is need to overcome gender barriers to women participation in training programs in crop husbandry practices and access to valuable inputs such as fertilizer. As noted earlier, female headed households possessed lower land holdings compared to male headed households. Traditionally, female family members do not have rights to inherit land among patrilineal communities. As a result of these gender imbalances, women face the danger of losing their land after the death of their spouses. This calls for initiatives to modify rules regarding women's rights and access to resources by working with communities to ensure that widows have access to land. From the results, prime age mortality and morbidity raise the demand for labour saving agricultural technology. This calls for more studies on the feasibility of alternative crop technologies especially for households facing labour and capital constraints from prime age mortality.

The low maize production per hectare (by international standards) points to the need to pursue policies that enhance organization of farming system in Malawi. One of the main constraints facing agriculture in Malawi is the small size of cultivated land, which are becoming smaller and smaller through subdivision of family land among members of the family. As Malawi's agricultural sector relies on rain-fed agriculture, Government should encourage development of small-scale irrigation schemes and water harvesting.

The results on coping strategies imply that, despite Malawi's record success in food security at national level in recent years, incidences of food insecurity remain at household level, especially among vulnerable households. The problem is more acute among female headed households with mortality. Thus Government should focus on ensuring food security for affected households by supplying the food insecure households with food handouts and also ensuring food availability in rural markets. There is also need for the necessary balancing act between investing in productivity growth (education, extension services, infrastructure and markets) and targeted assistance to affected households. Since financial resources are always inadequate for developing countries, there is need for government to examine which investments provide greatest benefit. Government is also required to work with non-governmental organizations to help target assistance to households most affected by HIV/AIDS. Granted the international community has been responding, but there is need for developing countries to adopt new responses as they learn more about how to effectively deal with the epidemic.

Considering that buying from the market is the dominant coping strategy, Government should strengthen performance of food markets particularly in rural areas by developing infrastructure and markets to ensure that food is available at affordable prices. It should also be noted that major constraints to food security include Malawi's dependence on rain-fed agriculture and treatment of maize, a crop not resistant to drought, as main staple food by the majority of Malawians. Thus government should put in place deliberate policies to simultaneously promote diversification into drought-resistant crops such as cassava and small-scale irrigation through farmer association. Finally, as labour is the second dominant coping strategy, Government needs to promote income generating activities as a source of livelihood for the food insecure households. This can include expansion of the already existing public works programs such as rehabilitation of earth roads and road maintenance.

7.4 Areas of further research

This study has revealed new areas for future research. First, there is need for future studies to control for household break-ups as a result of AIDS-related mortality and morbidity. Second, there is need to distinguish short-term impacts of prime-age adult mortality and morbidity from the long-term impacts, as the longer-term impacts are likely to be worse, especially for widows/widowers. Second, there is need to take into account intra-household effects of mortality and morbidity as impacts of prime-adult mortality and morbidity effects are passed across households.

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Appendix I

A-4.1 Empirical results for affected households by gender

Table A-4.1: HIV/AIDS affected female headed households

Time-varying decay inefficiency model — Number of obs = 84
Group variable: id — Number of groups = 56

Time variable: t — Obs per group: min = 1; avg = 1.5; max = 2

Wald chi2(7) = 69.17

Log likelihood = -95.434398 — Prob > chi2 = 0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.1464857	.2081148	2.61**	0.010	-.5543833	.2614119
lb	-.0239417	.1408583	-0.17	0.865	-.3000189	.2521355
lf	.291392	.082366*	3.54**	0.000	.1299575	.4528265
ls	.4253015	.1882309	2.26**	0.024	.0563757	.7942274
edu	.4591335	.1752686	2.62**	0.009	.1156133	.8026537
age	.0104994	.0048185	2.18**	0.029	.0010554	.0199435
t	.5872303	.2333192	2.52	0.012	.1299331	1.044527
_cons	2.910739	.6584723	4.42	0.000	1.620157	4.201321
/mu |	-13.59856	99.44494	-0.14	0.891	-208.5071	181.3099
/eta |	-.7416717	.5430449	-1.37	0.172	-1.80602	.3226768
/lnsigma	2 2.333394	6.278556	0.37	0.710	-9.97235	14.63914
/ilgtgamma	3.396715	6.429311	0.53	0.597	-9.204504	15.99793
Sigma	210.31288	64.74999			.0000467	2278749
Gamma	.9676017	.2015502			.0001006	.9999999
sigma_u	29.978759	64.72925			-116.8882	136.8457
sigma_v2	.3341197	.083358			.1707411	.4974984

Table A-4.2: HIV/AIDS affected female headed households

Time-invariant inefficiency model — Number of obs = 84
Group variable: id — Number of groups = 56

Obs per group: min = 1; avg = 1.5; max = 2

Wald chi2(5) = 47.93

Log likelihood = -101.15863 — Prob > chi2 = 0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.2125451	.2221401	-3.19**	0.015	-.6479317	.2228415
lb	-.0014876	.1479815	-0.01	0.992	-.2915259	.2885507
lf	.2915391	.0817654	4.36**	0.000	.1989238	.5235543
ls	.4600556	.2041268	2.25**	0.024	.0599745	.8601368
t	.3615004	.1868881	1.93	0.053	-.0047934	.7277943
_cons	3.65666	.6903172	5.30	0.000	2.303663	5.009657
/mu |	-683.0762	6574.975	-0.10	0.917	-13569.79	12203.64
/lnsigma2 |	5.953372	9.596864	0.62	0.535	-12.85614	24.76288

/ilgtgamma	6.814653	9.611913	0.71	0.478	-12.02435	25.65366
sigma2	385.0496	3695.269			2.61e-06	5.68e+10
gamma	.9989036	.0105267			6.00e-06	1
sigma_u2	384.6274	3695.269			-6857.967	7627.222
sigma_v2	.422157	.0981351			.2298158	.6144982

Table A-4.3: HIV/AIDS affected male headed households

```
Time-varying decay inefficiency model          Number of obs      =       326
Group variable: id                            Number of groups   =       207

Time variable: t                               Obs per group: min =         1

                                                             avg =       1.6

                                                             max =         2

                                                Wald chi2(7)       =    154.38
Log likelihood  = -410.18861                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.160703	.1158756	8.85**	0.000	-.0664089	.3878149
lb	.1718361	.1086481	1.58	0.114	-.0411102	.3847824
lf	.4550206	.0316567	8.81**	0.000	.3537754	.5562659
ls	.1077177	.1004148	1.07	0.283	-.0890916	.304527
age	-.0019778	.0033057	-0.60	0.550	-.0084569	.0045014
edu	-.1470649	.0800287	-1.84*	0.066	-.3039183	.0097884
t	. 1629195	.1686683	0.97	0.334	-.1676644	.4935034
_cons	4.630223	.4604201	10.06	0.000	3.727816	5.53263
/mu	-3.727407	19.03826	-0.20	0.845	-41.04172	33.5869
/eta	-.400697	.4228422	-0.95	0.343	-1.229452	.4280585
/lnsigma2	.9219152	2.965069	0.31	0.756	-4.889513	6.733343
/ilgtgamma	1.139702	3.884281	0.29	0.769	-6.47335	8.752753
sigma2	2.514101	7.454481			.0075251	839.9505
gamma	.7576249	.7132683			.0015417	.999842
sigma_u2	1.904745	7.439822			-12.67704	16.48653
sigma_v2	.6093555	.0738493			.4646136	.7540975

Table A-4.4: HIV/AIDS affected male headed households

```
Time-invariant inefficiency model               Number of obs      =       326
Group variable: id                              Number of groups   =       207

                                                Obs per group: min =         1
                                                               avg =       1.6
                                                               max =         2

                                                Wald chi2(7)       =    150.66
Log likelihood  = -410.62175                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.155736	.1149688	8.21**	0.000	-.0695986	.3810707
lb	.1625474	.1086214	1.50	0.135	-.0503465	.3754413
lf	.4560497	.0293809	8.71**	0.000	.3533851	.5587143
ls	.2203033	.0996142	1.11	0.268	-.0849369	.3055436
age	-.0017558	.0033166	-0.53	0.597	-.0082562	.0047447
edu	-.1401075	.0793258	-1.77*	0.077	-.2955831	.0153682
t	.0441724	.1117666	0.40	0.693	-.1748861	.2632309
_cons	4.731005	.432139	10.95	0.000	3.884028	5.577982

/mu	-50.21051	483.6436	-0.10	0.917	-998.1345	897.7135
/lnsigma2	2.798489	9.083801	0.31	0.758	-15.00543	20.60241
/ilgtgamma	3.207509	9.448778	0.34	0.734	-15.31176	21.72677
sigma2	16.41982	149.1544			3.04e-07	8.86e+08
gamma	.9611159	.353121			2.24e-07	1
sigma_u2	15.78135	149.1524			-276.552	308.1147
sigma_v2	.6384701	.0686842			.5038515	.7730886

Table A-4.4.1 Frequencies and percentages of technical efficiency for affected female and male headed households

Technical efficeincy	*Affected female headed*	*Affected male headed*
Below 0.1	1 (1.19%)	0
0.1-0.2	3 (3.57%)	0
0.2-0.3	2 (2.38%)	1 (0.31%)
0.3-0.4	4 (4.76%	6 (1.83%)
0.4-0.5	4 (4.76%)	9 (2.75%)
0.5-0.6	13 (15.47%)	31 (9.48%)
0.6-0.7	18 (21.42%)	82 (25.08%)
0.7-0.8	23 (27.37%)	140 (42.81%)
0.8-0.9	13 (15.47%)	57 (17.43%)
Over 0.9	3 (3.57%)	1 (0.31)
Total	84 (100%)	327 (100)

A-4.2: HIV/AIDS affected households with mortality

Table A-4.5: HIV/AIDS affected mortality female headed households

```
Time-varying decay inefficiency model         Number of obs      =        19
Group variable: id                            Number of groups   =        13

Time variable: t                              Obs per group: min =         1
                                                             avg =       1.5
                                                             max =         2

                                            Wald chi2(5)       =    265.81
Log likelihood  = -24.755643                Prob > chi2        =    0.0000
```

Ly	oef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.7419949	.3520812	-2.11**	0.035	-1.432061	-.0519283
lb	.6338109	.5510901	1.15	0.250	-.4463058	1.713928
lf	.2409117	.2905433	0.83	0.407	-.3285428	.8103661
ls	1.203317	.2672784	4.50**	0.000	.6794611	1.727173
t	1.450955	.8234236	1.76	0.078	-.1629256	3.064836
/mu	.8702767	.785158	1.11	0.268	-.6686048	2.409158
/eta	-14.33252	1296.575	-0.01	0.991	-2555.573	2526.908
/lnsigma2	-.139472	.4622642	-0.30	0.763	-1.045493	.7665491
/ilgtgamma	-1.250002	3.093208	-0.40	0.686	-7.312579	4.812575
sigma2	.8698174	.4020854			.3515184	2.152326
gamma	.2226998	.5354485			.0006666	.9919386
sigma_u2	.1937081	.530378			-.8458137	1.23323
sigma_v2	.6761093	.3433052			.0032434	1.348975

Table A-4:6: HIV/AIDS affected mortality female headed households

Time-varying decay inefficiency model — Number of obs = 18
Group variable: id — Number of groups = 12

Time variable: t — Obs per group: min = 1

avg = 1.5

max = 2

Wald chi2(7) = 15.34
Log likelihood = -16.218075 — Prob > chi2 = 0.0318

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.4171681	.3288225	2.27**	0.025	-.2273122	1.061648
lb	.4353684	.3795035	1.15	0.251	-.3084448	1.179182
lf	-.1990521	.2299681	-0.87	0.387	-.6497813	.2516771
ls	.3020873	.3106511	0.97	0.331	-.3067777	.9109523
t	1.126664	.6827427	1.65	0.099	-.2114868	2.464815
age	.022619	.0088062	2.57**	0.010	.0053593	.0398788
edu	.8857191	.4420558	2.00**	0.045	.0193057	1.752133
_cons	3.054557	1.093482	2.79	0.005	.9113709	5.197743
/mu	.404547	.6920009	0.58	0.559	-.9517499	1.760844
/eta	-14.33729	3200.9	-0.00	0.996	-6287.986	6259.311
/lnsigma2	-.9135261	.5784076	-1.58	0.114	-2.047184	.220132
/ilgtgamma	-1.186563	3.464482	-0.34	0.732	-7.976823	5.603697
sigma2	.4011074	.2320036			.1290979	1.246241
gamma	.2338742	.6207556			.0003432	.9963293
sigma_u2	.0938087	.2924249			-.4793336	.6669509
sigma_v2	.3072987	.1618574			-.0099359	.6245334

Table A-4.7: HIV/AIDS affected mortality female headed households

Time-invariant inefficiency model — Number of obs = 19
Group variable: id — Number of groups = 13

Obs per group: min = 1

avg = 1.5

max = 2

Wald chi2(5) = 3641.53
Log likelihood = -39.940385 — Prob > chi2 = 0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	2.920912	.1142717	25.56**	0.000	2.696944	3.14488
lb	23.7209	.8196522	28.94**	0.000	22.11441	25.32739
lf	-6.86675	.2419852	-28.38**	0.000	-7.341032	-6.392468
ls	8.101675	.2572383	31.49**	0.000	7.597498	8.605853
t	.5705364	.0395902	14.41	0.000	.4929411	.6481317
_cons	12.7545	.393754	32.39	0.000	11.98275	13.52624
/mu	14.28872	7.585885	1.88	0.060	-.5793406	29.15678
/lnsigma2	5.379941	.6984001	7.70	0.000	4.011102	6.74878
/ilgtgamma	11.9919	.9298348	12.90	0.000	10.16946	13.81435

sigma2	217.0095	151.5595		55.20768	853.0177
gamma	.9999938	5.76e-06		.9999617	.999999
sigma_u2	217.0082	151.5595		-80.04298	514.0593
sigma_v2	.0013442	.0007999		-.0002236	.002912

.

Table A-4.8: HIV/AIDS affected mortality male headed households

```
Time-varying decay inefficiency model           Number of obs      =        23
Group variable: id                              Number of groups   =        14

Time variable: t                                Obs per group: min =         1
                                                               avg =       1.6
                                                               max =         2

                                                Wald chi2(7)       =    458.38
Log likelihood  = -11.296244                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	1.059888	.2776076	3.82**	0.000	.5157874	1.603989
lb	-.4184487	.1094347	-3.82**	0.000	-.6329368	-.2039607
lf	.0654788	.0701296	0.93	0.350	-.0719727	.2029302
ls	-.505365	.0753766	-6.70**	0.000	-.6531004	-.3576295
age	.0033019	.0094799	0.35	0.728	-.0152784	.0218822
edu	.5374869	.066383	8.10**	0.000	.4073785	.6675953
t	2.15447	.421728	5.11	0.000	1.327898	2.981043
_cons	6.298853	.553291	11.38	0.000	5.214422	7.383283
/mu	2.454011	.4428013	5.54	0.000	1.586136	3.321886
/eta	-1.146055	.1132057	-10.12	0.000	-1.367934	-.9241755
/lnsigma2	.3851794	.4684391	0.82	0.411	-.5329444	1.303303
/ilgtgamma	5.613587	.7070091	7.94	0.000	4.227874	6.999299
sigma2	1.469878	.6885484			.5868744	3.681437
gamma	.9963653	.0025604			.9856263	.9990883
sigma_u2	1.464535	.688743			.114624	2.814447
sigma_v2	.0053426	.0026366			.0001749	.0105102

Table A-4.9: HIV/AIDS affected mortality male headed households

```
Time-invariant inefficiency model               Number of obs      =        23
Group variable: id                              Number of groups   =        14

                                                Obs per group: min =         1
                                                                avg =       1.6
                                                               max =         2

                                                 Wald chi2(7)       =     10.46
Log likelihood  = -24.114398                     Prob > chi2        =    0.1637
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.1779877	.502934	3.35**	0.000	-1.16372	.8077448
lb	-.6643129	.4243645	-1.57	0.117	-1.496052	.1674263
lf	.1459039	.1852428	0.79	0.431	-.2171653	.5089732
ls	-.0813697	.2157892	-0.38	0.706	-.5043088	.3415694
age	.0311906	.02307	1.35	0.176	-.0140259	.0764071
edu	.6478793	.328279	1.97*	0.048	.0044642	1.291294
t	-.51764	.4361197	-1.19	0.235	-1.372419	.337139
_cons	6.780316	1.641987	4.13	0.000	3.562081	9.998552
/mu	1.464974	1.056832	1.39	0.166	-.6063794	3.536327
/lnsigma2	-.3977745	.4699102	-0.85	0.397	-1.318782	.5232325
/ilgtgamma	.9689354	1.024059	0.95	0.344	-1.038184	2.976055

sigma2	.6718135	.315692			.267461	1.687474
gamma	.7249073	.2042146			.2615005	.9514806
sigma_u2	.4870025	.337795			-.1750635	1.149068
sigma_v2	.184811	.1003974			-.0119643	.3815863

Table A-4.10: HIV/AIDS affected mortality adult child male headed households

```
Time-invariant inefficiency model              Number of obs      =        18
Group variable: id                             Number of groups   =        11

                                               Obs per group: min =         1
                                                              avg =       1.6
                                                              max =         2

                                               Wald chi2(5)       =      4.08
Log likelihood  = -20.658476                   Prob > chi2        =    0.5374
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.0335404	.4103353	4.08**	0.000	-.7707021	.8377829
lb	-.5094905	.4293072	-1.19	0.235	-1.350917	.3319361
lf	.202305	.2087156	0.97	0.332	-.2067701	.61138
ls	-.0893829	.2410815	-0.37	0.711	-.5618939	.3831282
t	-.2479729	.4364022	-0.57	0.570	-1.103306	.6073597
_cons	7.699114	1.432686	5.37	0.000	4.891101	10.50713
/mu	.4538987	1.913077	0.24	0.812	-3.295663	4.20346
/lnsigma2	-.10982	1.24335	-0.09	0.930	-2.546742	2.327102
/ilgtgamma	.4178012	2.436236	0.17	0.864	-4.357134	5.192736
sigma2	.8959954	1.114036			.0783365	10.2482
gamma	.602957	.5832346			.0126529	.9944739
sigma_u2	.5402467	1.168891			-1.750737	2.83123
sigma_v2	.3557487	.2144015			-.0644705	.775968

A-4.3 Morbidity HIV/AIDS affected households

Table A-4:11: HIV/AIDS affected morbidity female headed

```
Time-varying decay inefficiency model          Number of obs      =        65
Group variable: id                             Number of groups   =        43

Time variable: t                               Obs per group: min =         1

                                                              avg =       1.5

                                                          max =         2

                                               Wald chi2(7)       =     57.86
Log likelihood  = -74.233946                   Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.2031123	.2628418	3.97**	0.000	-.7182727	.3120481
lb	-.0331746	.1500413	-0.22	0.825	-.3272501	.2609009
lf	.3301567	.0864821	3.82**	0.000	.1606548	.4996586
ls	.4393962	.2547851	1.72*	0.085	-.0599735	.9387658
edu	.5092522	.1981673	2.57**	0.010	.1208513	.897653
age	.0100723	.0055208	1.82*	0.068	-.0007482	.0208928
t	.4937315	.2500398	1.97	0.048	.0036625	.9838006
_cons	2.844913	.8631634	3.30	0.001	1.153144	4.536682

/mu	-145.5931	1343.048	-0.11	0.914	-2777.918	2486.732
/eta	-.7383115	.5916988	-1.25	0.212	-1.89802	.4213967
/lnsigma2	4.638783	9.083271	0.51	0.610	-13.1641	22.44167
/ilgtgamma	5.776573	9.108355	0.63	0.526	-12.07547	23.62862
sigma2	103.4184	939.3772			1.92e-06	5.58e+09
gamma	.9969103	.0280555			5.70e-06	1
sigma_u2	103.0988	939.3749			-1738.042	1944.24
sigma_v2	.319536	.0851315			.1526814	.4863906

Table A-4:12 HIV/AIDS affected morbidity female headed households

```
Time-invariant inefficiency model                Number of obs      =        65
Group variable: id                               Number of groups   =        43

                                                 Obs per group: min =         1

                                                                avg =       1.5

                                                                max =         2

                                                 Wald chi2(4)       =     33.74
Log likelihood  = -80.012834                     Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.3402133	.2959679	6.15**	0.000	-.9202997	.2398732
lb	.0207647	.160764	0.13	0.897	-.2943268	.3358563
lf	.4402592	.0855962	5.14**	0.000	.2724937	.6080247
ls	.5023504	.2976498	1.69*	0.091	-.0810324	1.085733
_cons	3.645376	.9761258	3.73	0.000	1.732205	5.558548
/mu	-146.8482	1560.185	-0.09	0.925	-3204.755	2911.059
/lnsigma2	4.43277	10.46204	0.42	0.672	-16.07244	24.93798
/ilgtgamma	5.218946	10.52072	0.50	0.620	-15.40128	25.83918
sigma2	84.16424	880.5294			1.05e-07	6.77e+10
gamma	.9946161	.0563374			2.05e-07	1
sigma_u2	83.71111	880.5288			-1642.094	1809.516
sigma_v2	.4531309	.120602			.2167554	.6895065

Table A-4:13: HIV/AIDS affected morbidity male headed households

Time-varying decay inefficiency model — Number of obs = 304
Group variable: id — Number of groups = 193

Time variable: t — Obs per group: min = 1

avg = 1.6

max = 2

Wald chi2(6) = 150.17
Log likelihood = -381.90447 — Prob > chi2 = 0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1363667	.1262654	6.08**	0.000	-.1111089	.3838423
lb	.2287805	.1114624	2.05**	0.040	.0103182	.4472428
lf	.4475281	.0542074	8.26**	0.000	.3412836	.5537726
ls	.1326265	.1210627	1.10	0.273	-.1046519	.369905
age	.0004276	.0032737	0.13	0.896	-.0059887	.0068439
t	.1035688	.1625569	0.64	0.524	-.2150368	.4221744
_cons	4.356859	.4871646	8.94	0.000	3.402034	5.311684
/mu	-41.84811	377.4551	-0.11	0.912	-781.6465	697.9503
/eta	-.0687906	.3889065	-0.18	0.860	-.8310333	.6934522
/lnsigma2	2.755031	8.432021	0.33	0.744	-13.77143	19.28149
/ilgtgamma	3.20196	8.767867	0.37	0.715	-13.98274	20.38666
sigma2	15.72153	132.5642			1.05e-06	2.37e+08
gamma	.960908	.3293549			8.46e-07	1
sigma_u2	15.10694	132.5595			-244.705	274.9189
sigma_v2	.6145866	.0701236			.4771469	.7520263

Table A-4.14: .HIV/AIDS affected morbidity male headed households

Time-invariant inefficiency model — Number of obs = 304
Group variable: id — Number of groups = 193

Obs per group: min = 1

avg = 1.6

max = 2

Wald chi2(6) = 151.03
Log likelihood = -381.91877 — Prob > chi2 = 0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1367868	.1259904	2.09**	0.028	-.1101498	.3837235
lb	.2274729	.1111834	2.05**	0.041	.0095575	.4453883
lf	.447902	.0542489	8.26**	0.000	.3415761	.5542279
ls	.131365	.1205611	1.09	0.276	-.1049303	.3676604
age	.0004741	.003266	0.15	0.885	-.0059272	.0068753
t	.0834623	.1159569	0.72	0.472	-.143809	.3107336
_cons	4.381405	.4613877	9.50	0.000	3.477102	5.285708
/mu	-218.0661	2060.827	-0.11	0.916	-4257.213	3821.081
/lnsigma2	4.315192	9.330135	0.46	0.644	-13.97154	22.60192
/ilgtgamma	4.788062	9.408688	0.51	0.611	-13.65263	23.22875
sigma2	74.828	698.1553			8.56e-07	6.54e+09
gamma	.9917402	.0770719			1.18e-06	1
sigma_u2	74.20993	698.1554			-1294.15	1442.569
sigma_v2	.6180635	.067895			.4849918	.7511353

Table A-4.15: HIV/AIDS affected morbidity adult child female headed households

Time-varying decay inefficiency model	Number of obs = 26
Group variable: id	Number of groups = 16
Time variable: t	Obs per group: min = 1
	avg = 1.6
	max = 2
	Wald chi2(7) = 68.51
Log likelihood = -21.366993	Prob > chi2 = 0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-1.535682	.6160277	2.49**	0.009	-2.743074	-.3282898
lb	-.1590467	.4346595	-0.37	0.714	-1.010964	.6928702
lf	.569876	.2149111	2.65**	0.008	.1486579	.9910941
ls	1.478806	.8334513	1.77*	0.076	-.1547287	3.11234
age	.0095274	.0089367	1.07	0.286	-.0079883	.0270431
edu	.5114943	.283237	1.81*	0.071	-.04364	1.066629
t	.5410114	1.210243	0.45	0.655	-1.83102	2.913043
_cons	.0292813	4.190393	0.01	0.994	-8.183737	8.2423
/mu	2.447677	4.450451	0.55	0.582	-6.275047	11.1704
/eta	-.6212211	.6867677	-0.90	0.366	-1.967261	.7248189
/lnsigma2	-.575968	.6994082	-0.82	0.410	-1.946783	.7948469
/ilgtgamma	1.642892	1.704046	0.96	0.335	-1.696978	4.982761
sigma2	.5621604	.3931796			.1427325	2.214102
gamma	.837928	.2314174			.1548604	.9931916
sigma_u2	.47105	.4506928			-.4122917	1.354392
sigma_v2	.0911104	.0772295			-.0602565	.2424774

Table A-4.16: HIV/AIDS affected morbidity adult child female headed households

Time-invariant inefficiency model	Number of obs = 26
Group variable: id	Number of groups = 16
	Obs per group: min = 1
	avg = 1.6
	max = 2
	Wald chi2(7) = 44.62
Log likelihood = -23.304368	Prob > chi2 = 0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-1.840571	.5405144	-3.41**	0.001	-2.89996	-.7811827
lb	-.2545981	.2206358	-1.15	0.249	-.6870363	.1778401
lf	.3431423	.159265	2.15**	0.031	.0309885	.655296
ls	2.45184	.6990133	3.51**	0.000	1.081799	3.82188
age	.01863	.0088479	2.11**	0.035	.0012884	.0359717
edu	.619161	.3071942	2.02**	0.044	.0170713	1.221251
t	-.1403974	.2866708	-0.49	0.624	-.7022618	.421467
_cons	-1.556455	118.0803	-0.01	0.989	-232.9896	229.8767
/mu	1.292435	118.0537	0.01	0.991	-230.0886	232.6735
/lnsigma2	-1.036647	.2831382	-3.66	0.000	-1.591587	-.481706
/ilgtgamma	-1.744978	3.848652	-0.45	0.650	-9.288198	5.798241

sigma2	.3546419	.1004127			.2036022	.6177286
gamma	.1486817	.4871448			.0000925	.9969763
sigma_u2	.0527288	.176373			-.292956	.3984135
sigma_v2	.3019132	.1766681			-.0443499	.6481763

Table A-4.17: HIV/AIDS affected morbidity household head female headed households

```
Time-varying decay inefficiency model          Number of obs      =        39
Group variable: id                             Number of groups   =        27

Time variable: t                               Obs per group: min =         1
                                                              avg =       1.4
                                                              max =         2

                                                Wald chi2(7)       =     33.98
Log likelihood  = -44.471259                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.0547823	.3149145	-0.17	0.862	-.6720034	.5624387
lb	-.0025623	.1762674	-0.01	0.988	-.3480401	.3429155
lf	.2883801	.1545953	1.87*	0.062	-.0146212	.5913813
ls	.506223	.2748738	1.84*	0.066	-.0325199	1.044966
age	.003928	.0110024	0.36	0.721	-.0176362	.0254922
edu	.1432337	.3218109	0.45	0.656	-.4875041	.7739715
t	.883242	.3967371	2.23	0.026	.1056516	1.660833
_cons	3.139625	1.072693	2.93	0.003	1.037186	5.242064
/mu	-15.31486	167.8918	-0.09	0.927	-344.3767	313.747
/eta	-.1793475	.4365336	-0.41	0.681	-1.034938	.6762427
/lnsigma2	2.644051	9.341393	0.28	0.777	-15.66474	20.95284
/ilgtgamma	4.048704	9.149896	0.44	0.658	-13.88476	21.98217
sigma2	14.07008	131.4342			1.57e-07	1.26e+09
gamma	.9828541	.154193			9.33e-07	1
sigma_u2	13.82884	131.3473			-243.6072	271.2649
sigma_v2	.2412436	.1405686			-.0342658	.5167531

Table A-4.18 HIV/AIDS affected morbidity household head female headed households

```
Time-invariant inefficiency model               Number of obs      =        39
Group variable: id                              Number of groups   =        27

                                                Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         2

                                                Wald chi2(7)       =     91.74
Log likelihood  = -43.847786                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1769172	.2804403	2.63**	0.017	-.7265701	.3727356
lb	.2063507	.1437535	1.44	0.151	-.075401	.4881024
lf	.28749	.1234361	2.33**	0.020	.0455597	.5294204
ls	.7789191	.2763075	2.82**	0.005	.2373663	1.320472
age	.0080558	.00757	1.06	0.287	-.0067811	.0228926
edu	.1484331	.2499138	0.59	0.553	-.3413889	.6382551
t	.9497709	.2903634	3.27	0.001	.380669	1.518873
_cons	2.776751	.9896166	2.81	0.005	.837138	4.716364
/mu	1.484469	.6330824	2.34	0.019	.24365	2.725287
/lnsigma2	.1342513	.4695326	0.29	0.775	-.7860157	1.054518

/ilgtgamma	2.255945	.7624143	2.96	0.003	.7616403	3.75025
sigma2	1.14368	.5369951			.4556567	2.870592
gamma	.9051621	.0654484			.6817098	.9770282
sigma_u2	1.035216	.5442223			-.0314401	2.101872
sigma_v2	.1084642	.0500579			.0103525	.206576

Table A-4.19: HIV/AIDS affected morbidity adult child male headed households

```
Time-varying decay inefficiency model           Number of obs      =       106
Group variable: id                              Number of groups   =        65

Time variable: t                                Obs per group: min =         1
                                                               avg =       1.6
                                                               max =         2

                                                Wald chi2(7)       =     49.92
Log likelihood  = -134.78751                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.0180427	.2339773	3.08**	0.000	-.4405444	.4766298
lb	.2535743	.1999881	1.27	0.205	-.1383951	.6455438
lf	.4306758	.0959565	4.49**	0.000	.2426046	.6187471
ls	.2270149	.1962302	1.16	0.247	-.1575893	.611619
age	-.0115666	.0063641	-1.82*	0.069	-.0240401	.0009068
edu	-.3883609	.139772	-2.78**	0.005	-.6623089	-.1144129
t	.4517733	.3373885	1.34	0.181	-.2094959	1.113043
_cons	4.572101	.9154826	4.99	0.000	2.777788	6.366414
/mu	-4.052069	34.93182	-0.12	0.908	-72.51719	64.41305
/eta	-.2983377	.7090917	-0.42	0.674	-1.688132	1.091457
/lnsigma2	1.01603	5.146671	0.20	0.844	-9.071261	11.10332
/ilgtgamma	1.245574	6.583251	0.19	0.850	-11.65736	14.14851
-						
sigma2	2.762207	14.21617			.0001149	66391.25
gamma	.7765327	1.142389			8.66e-06	.9999993
sigma_u2	2.144944	14.19288			-25.67258	29.96247
sigma_v2	.6172628	.1283675			.3656671	.8688585

Table A-4.20: HIV/AIDS affected morbidity adult child male headed households

```
Time-invariant inefficiency model               Number of obs      =       106
Group variable: id                              Number of groups   =        65

                                                Obs per group: min =         1
                                                               avg =       1.6
                                                             max =         2

                                                Wald chi2(7)       =     54.15
Log likelihood  = -134.86963                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
-						
lh	.0053911	.2286489	4.02**	0.000	-.4427524	.4535346
lb	.2490683	.2009606	1.24	0.215	-.1448073	.6429439
lf	.4270905	.0957494	4.46**	0.000	.2394251	.6147559
ls	.2282259	.193655	1.18	0.239	-.1513309	.6077827
age	-.010888	.0061851	-1.76*	0.078	-.0230106	.0012345
edu	-.383878	.1399495	-2.74**	0.006	-.6581739	-.1095821
t	.3464554	.2030702	1.71	0.088	-.051555	.7444657
_cons	4.6557	.8536241	5.45	0.000	2.982627	6.328772
/mu	-126.6169	1510.209	-0.08	0.933	-3086.571	2833.338
/lnsigma2	3.811366	11.6712	0.33	0.744	-19.06377	26.6865

/ilgtgamma	4.250462	11.84104	0.36	0.720	-18.95754	27.45847
sigma2	45.21214	527.6799			5.26e-09	3.89e+11
gamma	.9859428	.1641122			5.85e-09	1
sigma_u2	44.57659	527.6811			-989.6594	1078.813
sigma_v2	.635557	.1197076			.4009344	.8701796

Table A-4.21 HIV/AIDS affected morbidity household head male headed households

```
Time-varying decay inefficiency model          Number of obs      =       198
Group variable: id                             Number of groups   =       129

Time variable: t                               Obs per group: min =         1
                                                              avg =       1.5
                                                              max =         2

                                               Wald chi2(6)       =    126.79
Log likelihood  = -236.42802                   Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.2958161	.1478398	2.00**	0.045	.0060555	.5855767
lb	.237298	.1288521	1.84*	0.066	-.0152476	.4898435
lf	.4525344	.0636463	7.11**	0.000	.3277899	.5772788
ls	.0065286	.149752	0.04	0.965	-.28698	.3000372
age	.0028109	.0037703	0.75	0.456	-.0045789	.0102006
t	-.0061563	.1778005	-0.03	0.972	-.3546388	.3423262
_cons	4.808536	.5647825	8.51	0.000	3.701583	5.915489
/mu	-317.1403	3313.299	-0.10	0.924	-6811.086	6176.806
/eta	-.001031	.3601025	-0.00	0.998	-.706819	.7047569
/lnsigma2	4.84044	10.36886	0.47	0.641	-15.48215	25.16303
/ilgtgamma	5.520821	10.41156	0.53	0.596	-14.88546	25.92711
sigma2	126.5251	1311.92			1.89e-07	8.48e+10
gamma	.9960134	.0413413			3.43e-07	1
sigma_u2	126.0207	1311.92			-2445.296	2697.337
sigma_v2	.5044053	.0738662			.3596301	.6491805

Table A-4.22: HIV/AIDS affected morbidity household head male headed households

```
Time-invariant inefficiency model              Number of obs      =       198
Group variable: id                             Number of groups   =       129

                                               Obs per group: min =         1
                                                              avg =       1.5

                                                              max =         2

                                               Wald chi2(6)       =    126.80
Log likelihood  = -236.42802                   Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.2958442	.1475063	2.01**	0.045	.0067372	.5849513
lb	.2372703	.1284868	1.85*	0.065	-.0145592	.4890999
lf	.4525562	.0631874	7.16**	0.000	.3287111	.5764013
ls	.0065018	.1494569	0.04	0.965	-.2864282	.2994319
age	.002811	.00377	0.75	0.456	-.004578	.0102001
t	-.0064901	.1342891	-0.05	0.961	-.2696919	.2567118
_cons	4.809044	.5359398	8.97	0.000	3.758622	5.859467
/mu	-318.6161	3174.385	-0.10	0.920	-6540.296	5903.064
/lnsigma2	4.844668	9.889214	0.49	0.624	-14.53783	24.22717

/ilgtgamma	5.525015	9.930009	0.56	0.578	-13.93744	24.98748
sigma2	127.0611	1256.534			4.86e-07	3.32e+10
gamma	.99603	.0392655			8.85e-07	1
sigma_u2	126.5567	1256.535			-2336.206	2589.319
sigma_v2	.5044305	.0733637			.3606402	.6482208

B-4.1 Non-affected households by gender

Table B- 4.1: Non-affected households female headed households

```
Time-invariant inefficiency model              Number of obs      =       120
Group variable: id                             Number of groups   =        86

                                               Obs per group: min =         1
                                                              avg =       1.4
                                                              max =         2

                                               Wald chi2(6)       =     37.03
Log likelihood  = -179.28624                   Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1516798	.1748581	3.87**	0.000	-.1910358	.4943955
lb	.232685	.1886791	1.23	0.217	-.1371192	.6024892
lf	.4846814	.0441878	3.37**	0.001	.1608775	.6084853
ls	-.0113513	.1048879	-0.11	0.914	-.2169278	.1942253
age	.002679	.005139	0.52	0.602	-.0073933	.0127513
t	.3098368	.2731376	1.13	0.257	-.2255031	.8451766
_cons	3.823813	.7814863	4.89	0.000	2.292128	5.355498
/mu	-5.045455	757.306	-0.01	0.995	-1489.338	1479.247
/lnsigma2	.1706477	4.754444	0.04	0.971	-9.147892	9.489187
/ilgtgamma	-3.881292	235.398	-0.02	0.987	-465.253	457.4904
sigma2	1.186073	5.639117			.0001064	13216.05
gamma	.0202074	4.660658			8.8e-203	1
sigma_u2	.0239674	5.641791			-11.03374	11.08167
sigma_v2	1.162105	.1501363			.8678437	1.456367

Table B-4.2: Non-affected households female headed households.

```
Time-invariant inefficiency model              Number of obs      =       120
Group variable: id                             Number of groups   =        86

                                               Obs per group: min =         1
                                                              avg =       1.4
                                                              max =         2

                                               Wald chi2(6)       =     36.98
Log likelihood  = -179.30621                   Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1529719	.174869	3.87**	0.000	-.1897649	.4957088
lb	.2215137	.1875177	1.18	0.237	-.1460143	.5890417
lf	.4705726	.0587773	3.12**	0.002	.1377733	.6033719
ls	-.0170625	.1050737	-0.16	0.871	-.2230032	.1888781
edu	.0839356	.1743479	0.48	0.630	-.25778	.4256513
t	.3222047	.274804	1.17	0.241	-.2164012	.8608106
_cons	3.981378	.6149625	6.47	0.000	2.776074	5.186683
/mu	-7.218936	462.2765	-0.02	0.988	-913.2643	898.8264
/lnsigma2	.1975602	3.345199	0.06	0.953	-6.358909	6.75403
/ilgtgamma	-3.03209	72.74732	-0.04	0.967	-145.6142	139.55

```
-------------+----------------------------------------------------------------
      sigma2 |   1.218426   4.075879                          .0017313    857.5072
       gamma |    .045997   3.192246                          5.76e-64           1
    sigma_u2 |    .056044   4.076862                         -7.934459    8.046547
    sigma_v2 |   1.162382   .1502299                          .8679373    1.456828
```

Table B-4.3 Non-affected male headed households

```
Time-varying decay inefficiency model           Number of obs      =        89
Group variable: id                              Number of groups   =        64

Time variable: t                                Obs per group: min =         1

                                                               avg =       1.4

                                                               max =         2

                                                 Wald chi2(6)       =     12.57
Log likelihood  =          0                     Prob > chi2        =    0.0504

          ly |  Coef.   Std. Err.         z    P>|z|     [95% Conf. Interval]

          lh |   .0728867    .264469     0.28   0.783      -.445463    .5912364
          lb |   .5799829   .2622139     2.21** 0.027       .066053    1.093913
          lf |   .8834944   .0321394     0.63   0.527     -.1754941    .3424829
          ls |   .0328632   .2235375     0.15   0.883     -.4052622    .4709887
         age |  -.0123291   .0074576    -1.65*  0.098     -.0269458    .0022876
           t |   .4758284   .3009817     1.58   0.114     -.1140849    1.065742
       _cons |   5.142039   .9183292     5.60   0.000      3.342146    6.941931

         /mu |   .1460862          .        .       .             .           .
        /eta |  -9.300796   396.1137    -0.02   0.981     -785.6693    767.0677
   /lnsigma2 |   .1831447   .1467638     1.25   0.212      -.104507    .4707963
  /ilgtgamma |  -50.22023   .0009449 -5.3e+04   0.000     -50.22208   -50.21838

      sigma2 |   1.200988   .1762615                          .9007685    1.601269
       gamma |   1.55e-22   1.46e-25                          1.54e-22    1.55e-22
    sigma_u2 |   1.86e-22   2.73e-23                          1.32e-22    2.39e-22
    sigma_v2 |   1.200988   .1762615                          .8555219    1.546454
```

Table 4.3.1 Frequencies and percentages of technical efficiency for affected male headed households

Technical efficeincy	*Affected male headed*
Below 0.1	0
0.1-0.2	0
0.2-0.3	0
0.3-0.4	0
0.4-0.5	0
0.5-0.6	0
0.6-0.7	0
0.7-0.8	64 (71.68%)
0.8-0.9	0
Over 0.9	25(28.00%)
Total	89 (100%)

B-4.2 Non-affected households with mortality

Table B-4.4: Non-affected female headed households with adult child mortality

Time-invariant inefficiency model		Number of obs =	16
Group variable: id		Number of groups =	11
		Obs per group: min =	1
		avg =	1.5
		max =	2
		Wald chi2(4) =	2306.44
Log likelihood = -14.725699		Prob > chi2 =	0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.9506388	.0604128	15.74**	0.000	.8322319	1.069046
lb	.4763789	.112685	4.23**	0.000	.2555204	.6972375
lf	-.1536098	.0360761	-4.26**	0.000	-.2243176	-.082902
ls	1.714926	.0621013	27.61**	0.000	1.59321	1.836643
_cons	6.085625	.2266538	26.85**	0.000	5.641392	6.529858
/mu	2.750938	.7633953	3.60	0.000	1.254711	4.247166
/lnsigma2	1.155871	.6028661	1.92	0.055	-.0257253	2.337467
/ilgtgamma	6.88428	.9043952	7.61	0.000	5.111698	8.656862
sigma2	3.176788	1.915178			.9746028	10.35497
gamma	.9989773	.000924			.9940102	.9998261
sigma_u2	3.173539	1.915245			-.5802721	6.92735
sigma_v2	.0032489	.0021264			-.0009188	.0074166

Table B-4.5: Non-affected female headed households with household head mortality

Time-varying decay inefficiency model		Number of obs =	19
Group variable: id		Number of groups =	13
Time variable: t		Obs per group: min =	1
		avg =	1.5
		max =	2
		Wald chi2(7) =	39.70
Log likelihood = -16.992657		Prob > chi2 =	0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.5670743	.2820228	-2.01**	0.044	-1.119829	-.0143198
lb	.0038995	.3755522	0.01	0.992	-.7321693	.7399683
lf	.5064942	.2198101	2.30**	0.021	.0756744	.937314
ls	.0769618	.1746664	0.44	0.659	-.2653781	.4193017
edu	.9383116	.2899293	3.24**	0.001	.3700607	1.506562
age	.0213179	.0097286	2.19**	0.028	.0022502	.0403857
t	-.6366373	.407434	-1.56	0.118	-1.435193	.1619187
_cons	3.797808	17.32782	0.22	0.827	-30.16409	37.75971
/mu	1.569971	17.32098	0.09	0.928	-32.37852	35.51846
/eta	-1.612578	44.28867	-0.04	0.971	-88.41677	85.19162
/lnsigma2	-1.049176	.3244429	-3.23	0.001	-1.685073	-.4132798
/ilgtgamma	-15.73996	1708.683	-0.01	0.993	-3364.697	3333.217
sigma2	.3502261	.1136284			.185431	.6614771
gamma	1.46e-07	.0002494			.	1

sigma_u2	5.11e-08	.0000873			-.0001711	.0001712
sigma_v2	.3502261	.1136284			.1275186	.5729336

Table: B-4.6: Non-affected mortality adult child male headed

Time-varying decay inefficiency model		Number of obs =	37
Group variable: id		Number of groups =	24
Time variable: t		Obs per group: min =	1
		avg =	1.5
		max =	2
		Wald chi2(7) =	30.31
Log likelihood = -39.097967		Prob > chi2 =	0.0001

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.5580222	.2989457	1.87*	0.062	-.0279007	1.143945
lb	.1564195	.4011751	0.39	0.697	-.6298694	.9427083
lf	.3308812	.1454193	2.28**	0.023	.0458646	.6158979
ls	-.2751235	.1968547	-1.40	0.162	-.6609517	.1107047
age	-.0096621	.0086062	-1.12	0.262	-.0265298	.0072057
edu	.0133947	.2335084	0.06	0.954	-.4442734	.4710628
t	-.0152195	.4319471	-0.04	0.972	-.8618202	.8313813
_cons	6.601007	21.71879	0.30	0.761	-35.96703	49.16904
/mu	.3589325	21.68941	0.02	0.987	-42.15153	42.8694
/eta	.6227245	28.01107	0.02	0.982	-54.27797	55.52342
/lnsigma2	-.7244737	.2324953	-3.12	0.002	-1.180156	-.2687914
/ilgtgamma	-16.07849	1061.143	-0.02	0.988	-2095.88	2063.723
sigma2	.4845795	.1126624			.3072308	.7643027
gamma	1.04e-07	.0001104			.	1
sigma_u2	5.04e-08	.0000535			-.0001048	.0001049
sigma_v2	.4845795	.1126625			.2637651	.7053938

B-4.3 Non-affected households with morbidity

Table B-4.7 Non-affected female headed households with morbidity

Time-varying decay inefficiency model		Number of obs =	85
Group variable: id		Number of groups =	62
Time variable: t		Obs per group: min =	1
		avg =	1.4
		max =	2
		Wald chi2(7) =	34.14
Log likelihood = -126.4204		Prob > chi2 =	0.0000

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1482434	.2083186	1.71*	0.077	-.2600535	.5565404
lb	.419031	.2170507	1.93*	0.054	-.0063804	.8444425
lf	.2814538	.1491286	1.89*	0.059	-.010833	.5737405
ls	-.0627786	.1291813	-0.49	0.627	-.3159693	.190412
age	.0049221	.0072724	0.68	0.499	-.0093315	.0191757
edu	.2343572	.2492526	0.94	0.347	-.2541689	.7228832
t	.7005112	.4109851	1.70	0.088	-.1050048	1.506027
_cons	4.302013	2.041751	2.11	0.035	.3002539	8.303771

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
/mu	.9612605	1.93074	0.50	0.619	-2.822921	4.745442
/eta	-.2350819	.7654193	-0.31	0.759	-1.735276	1.265112
/lnsigma2	.1587748	.1879613	0.84	0.398	-.2096225	.5271721
/ilgtgamma	-1.855636	1.859784	-1.00	0.318	-5.500746	1.789475
sigma2	1.172074	.2203045			.8108903	1.694135
gamma	.1352125	.2174648			.0040671	.8568629
sigma_u2	.1584791	.2657546			-.3623904	.6793486
sigma_v2	1.013595	.2659752			.4922931	1.534897

Table B-4.8: Non-affected female headed households with morbidity

```
Time-invariant inefficiency model               Number of obs      =        85
Group variable: id                              Number of groups   =        62

                                                Obs per group: min =         1

                                                               avg =       1.4

                                                               max =         2

                                                Wald chi2(7)       =     35.09
Log likelihood  = -126.56341                    Prob > chi2        =    0.0000
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1583597	.2079422	2.76**	0.017	-.2491994	.5659189
lb	.4348164	.2152796	2.02**	0.043	.0128761	.8567567
lf	.2960167	.146797	2.02**	0.044	.0083	.5837334
ls	-.0561895	.1294025	-0.43	0.664	-.3098138	.1974349
age	.0041811	.0071435	0.59	0.558	-.0098199	.0181822
edu	.2414034	.2496528	0.97	0.334	-.247907	.7307139
t	.5689879	.3298821	1.72	0.085	-.0775693	1.215545
_cons	5.458077	64.10902	0.09	0.932	-120.1933	131.1094
/mu	1.910412	64.10724	0.03	0.976	-123.7375	127.5583
/lnsigma2	.143156	.153818	0.93	0.352	-.1583217	.4446338
/ilgtgamma	-2.13597	2.087288	-1.02	0.306	-6.226979	1.955039
sigma2	1.15391	.1774921			.8535751	1.559919
gamma	.1056496	.1972231			.0019715	.875995
sigma_u2	.1219101	.2297288			-.3283501	.5721703
sigma_v2	1.032	.2676548			.5074059	1.556594

Table 4.9: Non-affected male headed households with morbidity

```
Time-varying decay inefficiency model           Number of obs      =        65
Group variable: id                              Number of groups   =        47

Time variable: t                                Obs per group: min =         1

                                                               avg =       1.4

                                                               max =         2

                                                Wald chi2(7)       =     22.35
Log likelihood  = -85.637484                    Prob > chi2        =    0.0022
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1644587	.2587545	-2.64**	0.006	-.6716082	.3426909
lb	-.1603972	.3494755	-0.46	0.646	-.8453566	.5245623
lf	.2264453	.1417567	1.60	0.110	-.0513927	.5042833
ls	.2875034	.2258452	1.27	0.203	-.155145	.7301518
age	-.0252816	.0084568	-2.99**	0.003	-.0418566	-.0087066
edu	-.392418	.2023597	-1.94*	0.052	-.7890358	.0041998
t	.589534	.4056847	1.45	0.146	-.2055934	1.384661
_cons	7.322534	3.628165	2.02	0.044	.2114607	14.43361
/mu	1.802014	3.724173	0.48	0.628	-5.497231	9.101259
/eta	-.2402824	.6213243	-0.39	0.699	-1.458056	.9774909
/lnsigma2	-.1640547	.1914714	-0.86	0.392	-.5393317	.2112223
/ilgtgamma	-1.120995	1.951833	-0.57	0.566	-4.946517	2.704528
sigma2	.8486956	.1625009			.5831379	1.235187
gamma	.2458269	.3618621			.007058	.9372933
sigma_u2	.2086322	.3226949			-.4238381	.8411025
sigma_v2	.6400634	.2900358			.0716036	1.208523

Table B-4.10: Non-affected male headed households with morbidity

```
Time-invariant inefficiency model               Number of obs      =        65
Group variable: id                              Number of groups   =        47

                                                Obs per group: min =         1

                                                avg =       1.4

                                                max =         2

                                                Wald chi2(7)       =     20.59
Log likelihood  = -86.215975                    Prob > chi2        =    0.0044
```

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.194888	.2563895	1.76**	0.077	-.6974022	.3076262
lb	-.1155421	.3474768	-0.33	0.739	-.7965841	.5654998
lf	.2590749	.1390502	1.86*	0.062	-.0134585	.5316084
ls	.3149879	.2247784	1.40	0.161	-.1255697	.7555454
age	-.0247343	.0085426	-2.90**	0.004	-.0414776	-.0079911
edu	-.3669647	.2018403	-1.82*	0.069	-.7625645	.028635
t	.3110738	.3113824	1.00	0.318	-.2992246	.9213721
_cons	8.50869	93.53492	0.09	0.928	-174.8164	191.8338
/mu	2.793509	93.53283	0.03	0.976	-180.5275	186.1145
/lnsigma2	-.1607041	.1852285	-0.87	0.386	-.5237453	.2023371
/ilgtgamma	-.8954663	1.647743	-0.54	0.587	-4.124983	2.334051
sigma2	.851544	.1577302			.5922981	1.224261
gamma	.2899831	.3392586			.0159067	.9116581
sigma_u2	.2469333	.3066579			-.354105	.8479717

sigma_v2	.6046107	.274263		.0670651	1.142156

Table-4.11: Non-affected female headed households with household head morbidity

Time-varying decay inefficiency model		Number of obs =	80
Group variable: id		Number of groups =	58
Time variable: t		Obs per group: min =	1
		avg =	1.4
		max =	2
		Wald chi2(7) =	28.37
Log likelihood = -119.35942		Prob > chi2 =	0.0002

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1418965	.2146695	1.66*	0.078	-.278848	.5626409
lb	.3938208	.2211595	1.78*	0.075	-.0396438	.8272854
lf	.2609898	.1523045	1.71*	0.087	-.0375216	.5595011
ls	-.0756937	.1308297	-0.58	0.563	-.3321152	.1807278
age	.0045872	.0079165	0.58	0.562	-.0109289	.0201032
edu	.2255225	.2571115	0.88	0.380	-.2784068	.7294518
t	.6944594	.4246069	1.64	0.102	-.1377548	1.526674
_cons	4.297399	2.639528	1.63	0.104	-.8759801	9.470779
/mu	.8039774	2.551801	0.32	0.753	-4.197462	5.805416
/eta	-.2484765	1.1572	-0.21	0.830	-2.516546	2.019593
/lnsigma2	.1645886	.2102376	0.78	0.434	-.2474695	.5766466
/ilgtgamma	-2.143422	2.396906	-0.89	0.371	-6.841271	2.554428
sigma2	1.178908	.2478507			.7807741	1.780059
gamma	.1049475	.2251499			.0010676	.9278704
sigma_u2	.1237235	.274575			-.4144337	.6618807
sigma_v2	1.055185	.2886595			.4894224	1.620947

Table B-4.12: Non-affected female headed households with with household morbidity

Time-invariant inefficiency model		Number of obs =	80
Group variable: id		Number of groups =	58
		Obs per group: min =	1
		avg =	1.4
		max =	2
		Wald chi2(7) =	29.42
Log likelihood = -119.46236		Prob > chi2 =	0.0001

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.1508762	.2140235	1.70*	0.069	-.2686022	.5703546
lb	.4054324	.2198379	1.84*	0.065	-.0254419	.8363067
lf	.2743143	.1485384	1.85*	0.065	-.0168155	.5654442
ls	-.0711128	.1308704	-0.54	0.587	-.327614	.1853885
age	.0038132	.0076595	0.50	0.619	-.0111991	.0188255
edu	.2262326	.2573935	0.88	0.379	-.2782495	.7307146
t	.5797051	.3374027	1.72	0.086	-.0815921	1.241002
_cons	5.288683	50.71796	0.10	0.917	-94.1167	104.6941
/mu	1.604568	50.71431	0.03	0.975	-97.79366	101.0028
/lnsigma2	.1503161	.1583605	0.95	0.343	-.1600648	.4606969
/ilgtgamma	-2.482824	2.913027	-0.85	0.394	-8.192252	3.226603

sigma2	1.162202	.1840468			.8520886	1.585178
gamma	.0770711	.2072068			.0002767	.9618232
sigma_u2	.0895721	.2420226			-.3847835	.5639276
sigma_v2	1.072629	.286843			.5104275	1.634831

Table B-4.13: Non-affected male headed households with adult child morbidity

Time-varying decay inefficiency model	Number of obs = 49
Group variable: id	Number of groups = 37
Time variable: t	Obs per group: min = 1
	avg = 1.3
	max = 2
	Wald chi2(7) = 22.82
Log likelihood = -63.402279	Prob > chi2 = 0.0018

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	.0973137	.3851471	-2.25**	0.025	-.8521882	.6575608
lb	-.3348706	.3881334	-0.86	0.388	-1.095598	.4258568
lf	.1756528	.1551777	1.13	0.258	-.1284899	.4797955
ls	.4689711	.303584	1.54	0.122	-.1260426	1.063985
age	-.0259104	.0117994	-2.20**	0.028	-.0490369	-.002784
edu	-.5701509	.2473467	-2.31**	0.021	-1.054942	-.0853601
t	.845124	.4356693	1.94	0.052	-.008772	1.69902
_cons	8.039654	3.143202	2.56	0.011	1.879091	14.20022
/mu	2.493663	3.04526	0.82	0.413	-3.474937	8.462264
/eta	-.0625855	.1830888	-0.34	0.732	-.421433	.296262
/lnsigma2	-.1653204	.228906	-0.72	0.470	-.613968	.2833271
/ilgtgamma	.0540135	1.192844	0.05	0.964	-2.283918	2.391945
sigma2	.8476221	.1940258			.5411991	1.327539
gamma	.5135001	.2979936			.0924637	.916211
sigma_u2	.435254	.3107722			-.1738483	1.044356
sigma_v2	.4123681	.2259609			-.0305071	.8552432

Table B-4.14: Non-affected male headed households with adult child morbidity

Time-invariant inefficiency model	Number of obs = 49
Group variable: id	Number of groups = 37
	Obs per group: min = 1
	avg = 1.3
	max = 2
	Wald chi2(7) = 24.11
Log likelihood = -63.483368	Prob > chi2 = 0.0011

ly	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh	-.1186645	.3826882	-2.31**	0.026	-.8687196	.6313906
lb	-.3294072	.3872853	-0.85	0.395	-1.088472	.4296581
lf	.1804145	.1555207	1.16	0.246	-.1244005	.4852295
ls	.4980054	.2957363	1.68*	0.092	-.0816271	1.077638
age	-.0257352	.0118413	-2.17**	0.030	-.0489438	-.0025265
edu	-.5571989	.2442323	-2.28**	0.028	-1.035885	-.0785124
t	.7425546	.3531225	2.10	0.035	.0504472	1.434662
_cons	8.833739	61.43493	0.14	0.886	-111.5765	129.244

/mu	3.226264	61.42774	0.05	0.958	-117.1699	123.6224
/lnsigma2	-.1730935	.2265497	-0.76	0.445	-.6171228	.2709359
/ilgtgamma	.0388976	1.215827	0.03	0.974	-2.344079	2.421874
sigma2	.841059	.1905417			.5394944	1.311191
gamma	.5097232	.3038417			.0875376	.9184802
sigma_u2	.4287073	.3117677			-.1823461	1.039761
sigma_v2	.4123517	.2289719			-.0364249	.8611284

Table B-4.15: Technical efficiency levels for non-affected farm households (without morbidity and mortality)2004/05-2006/07 (without prime-age adult morbidity and mortality)

	Time-varying model	Time invariant model	2 sample t-test H0: diff=0; Prob(|T|>0 Ha: diff>0
			Ho:diff=0; prob(|T|>|t|)
All households	0.764	0.7845	0.040
	(0.120)	(0.142)	(0.9605)
Female headed	0.7462	0.7601	0.050
	(0.011)	(0.107)	(0.9564)
Male headed	0.7734	0.8246	0.032
	(0.031)	(0.0402)	(0.9613)

Appendix II: Difference in difference estimation results

A-5.1 maize production differentials for all households

Table A-5.1 Difference in mean production for control year 1 and treatment year1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_04	479	24.50091	1.725312	37.76031	21.11078	27.89105
aff_04	302	24.969	1.403406	24.38859	22.20727	27.73073
combined	781	24.68192	1.188598	33.21701	22.34869	27.01515
diff		-.4680871	2.442211		-5.262181	4.326007

diff = mean(non_04) - mean(aff_04) t = -0.1917
Ho: diff = 0 degrees of freedom = 779

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.4240	Pr(|T| > |t|) = 0.8481	Pr(T > t) = 0.5760

Table 5.2 Difference in mean production for control year 2 and control year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	481	54.0878	2.626154	57.59606	48.92762	59.24798
non_04	479	24.50091	1.725312	37.76031	21.11078	27.89105
combined	960	39.32518	1.64258	50.89348	36.10171	42.54864
diff		29.58689	3.144809		23.41538	35.7584

diff = mean(non_07) - mean(non_04) t = 9.4082
Ho: diff = 0 degrees of freedom = 958

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 1.0000	Pr(|T| > |t|) = 0.0000	Pr(T > t) = 0.0000

Table A-5.3: .Difference in mean production for treatment year 2 and treatment year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07	303	57.2617	3.904624	67.96738	49.57798	64.94541
aff_04	302	24.969	1.403406	24.38859	22.20727	27.73073
combined	605	41.14204	2.177016	53.5475	36.8666	45.41748
diff		32.29269	4.154479		24.13369	40.4517

diff = mean(aff_07) - mean(aff_04) t = 7.7730
Ho: diff = 0 degrees of freedom = 603

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 1.0000	Pr(|T| > |t|) = 0.0000	Pr(T > t) = 0.0000

.
For affected households, production in year 2 (2006/007)m was not significantly different from production in 2004/05.

Table A-5.4: Difference in mean production for control year 2 treatment year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	481	54.0878	2.626154	57.59606	48.92762	59.24798
aff_07	303	57.2617	3.904624	67.96738	49.57798	64.94541
combined	784	55.31445	2.206709	61.78784	50.98268	59.64621
diff		-3.173895	4.533239		-12.07265	5.724863

diff = mean(non_07) - mean(aff_07) t = -0.7001
Ho: diff = 0 degrees of freedom = 782

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.2420	Pr(|T| > |t|) = 0.4840	Pr(T > t) = 0.7580

Table A-5.5: Difference in differences in mean production for affected and non-affected households

. regress ly pt treat post

Source	SS	df	MS
Model	218.280831	3	72.7602771
Residual	1824.57917	1543	1.18248812
Total	2042.86	1546	1.32138422

Number of obs =	1547
F(3, 1543) =	61.53
Prob > F =	0.0000
R-squared =	0.1169
Adj R-squared =	0.1051
Root MSE =	1.0874

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pt	-.1126699	.1135908	-0.99	0.321	-.3354786	.1101387
treat	.089602	.0799503	1.12	0.263	-.0672207	.2464247
post	.792019	.0705652	11.22**	0.000	.6536052	.9304329
_cons	2.695565	.0496338	54.31	0.000	2.	

A-5.2 Maize production differentials by gender

5.2.1 Female headed households

Table A- 5.6 Difference in mean production between control year 1 and treatment year1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_f~04	108	18.51293	2.886848	30.00101	12.79009	24.23577
aff_f~04	67	21.56545	2.473167	20.24375	16.62761	26.50329
combined	175	19.68161	2.015858	26.66729	15.70293	23.66029
diff		-3.052516	4.152629		-11.24886	5.143824

diff = mean(non_fem04) - mean(aff_fem04) t = -0.7351

```
Ho: diff = 0                                     degrees of freedom =      173

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2316         Pr(|T| > |t|) = 0.4633          Pr(T > t) = 0.7684
```

Table A- 5.7 Difference in mean production for non affected households year 1 and years2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_f~07	110	50.90782	6.198464	65.01004	38.62266	63.19297
non_f~04	108	18.51293	2.886848	30.00101	12.79009	24.23577
combined	218	34.85898	3.603161	53.20003	27.7573	41.96065
diff		32.39488	6.878766		18.83678	45.95298

```
    diff = mean(non_fem07) - mean(non_fem04)                      t =   4.7094
Ho: diff = 0                                     degrees of freedom =      216

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A-5.8 Difference in mean production for affected households year 1 and years2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_f~07	67	55.69085	8.515182	69.69977	38.68974	72.69195
aff_f~04	67	21.56545	2.473167	20.24375	16.62761	26.50329
combined	134	38.62815	4.658049	53.92081	29.41471	47.84159
diff		34.1254	8.867067		16.58546	51.66533

```
    diff = mean(aff_fem07) - mean(aff_fem04)                      t =   3.8486
Ho: diff = 0                                     degrees of freedom =      132

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9999         Pr(|T| > |t|) = 0.0002          Pr(T > t) = 0.0001
```

Table A-5.9 Difference in mean production for affected and non-affected households years2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_f~07	110	50.90782	6.198464	65.01004	38.62266	63.19297
aff_f~07	67	55.69085	8.515182	69.69977	38.68974	72.69195
combined	177	52.71834	5.011068	66.66792	42.82883	62.60786
diff		-4.78303	10.35482		-25.21943	15.65337

```
    diff = mean(non_fem07) - mean(aff_fem07)                      t =  -0.4619
Ho: diff = 0                                     degrees of freedom =      175

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.3224         Pr(|T| > |t|) = 0.6447          Pr(T > t) = 0.6776
```

Table A-5.10 Difference in difference in mean production for affected and non-affected households

```
. reg ly pt post treat

      Source |       SS       df       MS              Number of obs =     288
-------------+------------------------------           F(  3,   284) =   10.50
       Model |  48.4280463     3  16.1426821           Prob > F      =  0.0000
    Residual |  436.478619   284  1.53689655           R-squared     =  0.1199
-------------+------------------------------           Adj R-squared =  0.0984
       Total |  484.906665   287  1.68957026           Root MSE      =  1.2397

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |  -.2261871   .3050217    -0.74   0.459    -.8265773     .374203
        post |   .8961141   .1896916     4.72** 0.000     .5227342    1.269494
       treat |   .3122289   .2340012     1.33   0.183    -.1483679    .7728257
       _cons |   2.372684    .146102    16.24   0.000     2.085104    2.660265
.
```

5.2.2 maize production differentials for male headed households

Table A-5.11 Difference in mean production between control year 1 and treatment year1

```
Two-sample t test with equal variances

Variable |      Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

 non_04m |      371    26.24405    2.055977     39.6009    22.20118    30.28691
 aff_04m |      235    25.93938    1.657043    25.40198    22.67475      29.204

combined |      606     26.1259    1.412274    34.76604    23.35234    28.89945

    diff |             .3046703    2.900855               -5.392316    6.001657

    diff = mean(non_04m) - mean(aff_04m)                          t =   0.1050
Ho: diff = 0                                     degrees of freedom =      604

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5418         Pr(|T| > |t|) = 0.9164          Pr(T > t) = 0.4582
```

Table A-5.12: difference in mean production for non-affected households between year 1 and year2

```
Two-sample t test with equal variances

Variable |      Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07m |     371    55.03065    2.869388    55.26832     49.3883    60.67301
 non_04m |      371    26.24405    2.055977     39.6009    22.20118    30.28691
```

```
combined |     742    40.63735    1.841326    50.15712    37.02251    44.25219

    diff |            28.78661    3.529933                21.85673    35.71648

    diff = mean(non_07m) - mean(non_04m)                          t =   8.1550
Ho: diff = 0                                     degrees of freedom =      740

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A- 5.13: difference in mean production between affected and non-affected households year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

aff_07m |     236    57.70766    4.401145    67.61168    49.03692     66.3784
 aff_04m |     235    25.93938    1.657043    25.40198    22.67475      29.204

combined |     471    41.85724    2.464081     53.4768    37.01526    46.69922

    diff |            31.76828    4.710288                 22.5124    41.02416

    diff = mean(aff_07m) - mean(aff_04m)                          t =   6.7444
Ho: diff = 0                                     degrees of freedom =      469

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A - 5.14   Difference between affected and non-affected year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07m |     371    55.03065    2.869388    55.26832     49.3883    60.67301
 aff_07m |     236    57.70766    4.401145    67.61168    49.03692     66.3784

combined |     607    56.07147    2.448626     60.3277    51.26264    60.88029

-
    diff |           -2.677004    5.026029               -12.54759    7.193579

    diff = mean(non_07m) - mean(aff_07m)                          t =  -0.5326
Ho: diff = 0                                     degrees of freedom =      605

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2972         Pr(|T| > |t|) = 0.5945          Pr(T > t) = 0.7028
```

Table A-5.15: difference in difference in differences mean mean production between affected and non-affected households

```
.
. reg  ly pt post treat

      Source |       SS       df       MS              Number of obs =    1200
-------------+------------------------------           F(  3,  1196) =   49.27
       Model |  165.534375     3  55.1781248           Prob > F      =  0.0000
    Residual |  1339.36182  1196  1.11986775           R-squared     =  0.1100
```

Total	1504.8962	1199	1.2551261		Adj R-squared =	0.1078
					Root MSE =	1.0582

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pt	-.1066982	.1253669	-0.85	0.395	-.3526617	.1392652
post	.7824135	.0781252	10.01**	0.000	.6291358	.9356912
treat	.0425431	.0882264	0.48	0.630	-.1305528	.2156389
_cons	2.777119	.054941	50.55	0.000	2.669327	2.88491

A-5.3 Maize production differentials for households with mortality

Table A-5.15 difference in mean production for affected and non-affected households year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_04	124	18.49918	1.427577	15.89683	15.67338	21.32499
aff_04	27	23.42756	4.158768	21.60959	14.87908	31.97603
combined	151	19.38042	1.390016	17.08081	16.63388	22.12696
diff		-4.928372	3.617162		-12.07593	2.219187

diff = mean(non_04) - mean(aff_04) t = -1.3625
Ho: diff = 0 degrees of freedom = 149

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.0875	Pr(|T| > |t|) = 0.1751	Pr(T > t) = 0.9125

Table A-5.16 difference in mean production for non-affected households year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	121	45.73282	4.630031	50.93034	36.56568	54.89996
non_04	124	18.49918	1.427577	15.89683	15.67338	21.32499
combined	245	31.94927	2.546889	39.86513	26.93257	36.96596
diff		27.23364	4.796366		17.78588	36.6814

diff = mean(non_07) - mean(non_04) t = 5.6780
Ho: diff = 0 degrees of freedom = 243

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 1.0000	Pr(|T| > |t|) = 0.0000	Pr(T > t) = 0.0000

Table A- 5.17 difference in mean production for affected households year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07	28	62.77026	16.60806	87.88158	28.69334	96.84718
aff_04	27	23.42756	4.158768	21.60959	14.87908	31.97603
combined	55	43.45657	9.025643	66.93596	25.36124	61.55189
diff		39.3427	17.40408		4.434532	74.25088

```
    diff = mean(aff_07) - mean(aff_04)                          t =   2.2605
Ho: diff = 0                                 degrees of freedom =       53

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9860         Pr(|T| > |t|) = 0.0279          Pr(T > t) = 0.0140
```

Table A-5.18: difference in mean production for affected and non-affected households year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	121	45.73282	4.630031	50.93034	36.56568	54.89996
aff_07	28	62.77026	16.60806	87.88158	28.69334	96.84718
combined	149	48.93449	4.885752	59.6382	39.27964	58.58933
diff		-17.03744	12.47034		-41.68173	7.606859

```
    diff = mean(non_07) - mean(aff_07)                          t =  -1.3662
Ho: diff = 0                                 degrees of freedom =      147

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0870         Pr(|T| > |t|) = 0.1740          Pr(T > t) = 0.9130
```

Table A- 5.19 difference in difference in mean production for affected and non-affected

. . reg ly pt treat post

Source	SS	df	MS
Model	50.6729812	3	16.8909937
Residual	323.99594	298	1.0872347
Total	374.668921	301	1.24474725

```
Number of obs =     302
F(  3,   298) =   15.54
Prob > F      =  0.0000
R-squared     =  0.1352
Adj R-squared =  0.1265
Root MSE      =  1.0427
```

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pt	-.0755409	.3131662	-0.24	0.810	-.6918384	.5407566
treat	.1081288	.2212822	0.49	0.625	-.327345	.5436026
post	.8303141	.132428	6.27**	0.000	.5697015	1.090927
_cons	2.558578	.0932624	27.43	0.000	2.375041	2.742114

A-5.4 Maize production differentials for households with morbidity

Table A-5.20: difference in mean production between affected and non-affected households year1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_04	354	26.65751	2.270123	42.7121	22.19285	31.12218
aff_04	275	25.12034	1.487948	24.67482	22.19108	28.04961
combined	629	25.98546	1.43302	35.93997	23.17137	28.79955
diff		1.537168	2.890568		-4.139198	7.213535

```
    diff = mean(non_04) - mean(aff_04)                        t =   0.5318
Ho: diff = 0                                 degrees of freedom =      627

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7025         Pr(|T| > |t|) = 0.5951          Pr(T > t) = 0.2975
```

Table A-5.21: difference in mean production for non-affected households between year 1 and year2

.

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	311	56.81835	3.344158	58.97486	50.23824	63.39847
non_04	354	26.65751	2.270123	42.7121	22.19285	31.12218
combined	665	40.76281	2.059436	53.1079	36.71902	44.8066
diff		30.16084	3.961057		22.38312	37.93857

```
    diff = mean(non_07) - mean(non_04)                        t =   7.6143
Ho: diff = 0                                 degrees of freedom =      663

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A-5.22: difference in mean production for affected households between year 1 and year2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07	275	56.70082	3.966761	65.78129	48.89162	64.51003
aff_04	275	25.12034	1.487948	24.67482	22.19108	28.04961
combined	550	40.91058	2.221098	52.08937	36.54769	45.27347
diff		31.58048	4.236648		23.25842	39.90254

```
    diff = mean(aff_07) - mean(aff_04)                        t =   7.4541
Ho: diff = 0                                 degrees of freedom =      548

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A- 5.23 difference in mean production between affected and non-affected households year2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	311	56.81835	3.344158	58.97486	50.23824	63.39847
aff_07	275	56.70082	3.966761	65.78129	48.89162	64.51003
combined	586	56.7632	2.569781	62.20781	51.71608	61.81032
diff		.117531	5.153692		-10.0045	10.23956

diff = mean(non_07) - mean(aff_07)   t = 0.0228
Ho: diff = 0   degrees of freedom = 584

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.5091	Pr(|T| > |t|) = 0.9818	Pr(T > t) = 0.4909

Table A-5.24: difference in difference mean production between affected and non-affected households

. reg ly pt treat post

Source	SS	df	MS
Model	161.067721	3	53.6892403
Residual	1417.92842	1200	1.18160702
Total	1578.99614	1203	1.31254875

Number of obs = 1204
F(3, 1200) = 45.44
Prob > F = 0.0000
R-squared = 0.1020
Adj R-squared = 0.0998
Root MSE = 1.087

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pt	-.1064046	.1260752	-0.84	0.399	-.3537569	.1409478
treat	.0530402	.0874123	0.61	0.544	-.1184576	.2245381
post	.7784002	.0847935	9.18**	0.000	.6120403	.9447601
_cons	2.7438	.0576929	47.56	0.000	2.63061	2.85699

A-5.5 Maize production differentials for households with mortality by gender

5.9.1 Female headed households with mortality

Table A-5.25 Difference in mean production between affected and non-affected households year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_m~04	29	12.4344	1.601037	8.621848	9.154821	15.71397
aff_m~04	13	18.46646	3.82662	13.79708	10.12897	26.80395
combined	42	14.30146	1.650737	10.698	10.96773	17.6352
diff		-6.032065	3.487002		-13.07956	1.01543

diff = mean(non_mortf04) - mean(aff_mortf04)   t = -1.7299
Ho: diff = 0   degrees of freedom = 40

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.0457	Pr(|T| > |t|) = 0.0914	Pr(T > t) = 0.9543

.

Table A-5.26 Difference in mean production for non-affected households between year 1 and year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_m~07 |      31    27.67984    6.377741    35.50976    14.65476    40.70493
non_m~04 |      29     12.4344    1.601037    8.621848    9.154821    15.71397

combined |      60    20.31121    3.501097    27.11938    13.30553    27.31689

    diff |            15.24545    6.776744                 1.68032    28.81057

    diff = mean(non_mortf07) - mean(non_mortf04)                  t =   2.2497
Ho: diff = 0                                     degrees of freedom =       58

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9859         Pr(|T| > |t|) = 0.0283          Pr(T > t) = 0.0141
```

Table A-5.27 Difference in mean production for affected households between year 1 and year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
-aff_m~07 |      13    76.09383    26.53034    95.65652    18.28917    133.8985
aff_m~04 |      13    18.46646     3.82662    13.79708    10.12897    26.80395

combined |      26    47.28014    14.34049    73.12244    17.74535    76.81494

    diff |            57.62737    26.80489                 2.30479    112.9499

    diff = mean(aff_mortf07) - mean(aff_mortf04)                  t =   2.1499
Ho: diff = 0                                     degrees of freedom =       24

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9791         Pr(|T| > |t|) = 0.0419          Pr(T > t) = 0.0209
```

Table A-5.28 Difference in mean production between affected and non-affected households year 2

```
ttest  aff_07f = aff_04f , unpaired

Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

aff_07f |      13    76.09383    26.53034    95.65652    18.28917    133.8985
 aff_04f |      13    27.67984       3.82662    13.79708    10.12897    26.80395

combined |      26    47.28014    14.34049    73.12244    17.74535    76.81494

    diff |            48.41399    26.80489                 2.30479    112.9499

    diff = mean(aff_07f) - mean(aff_04f)                          t =   2.1499
Ho: diff = 0                                     degrees of freedom =       24

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9791         Pr(|T| > |t|) = 0.0419          Pr(T > t) = 0.0209
```

Table A-5.29 Difference in difference mean production between affected and non-affected households

```
. reg  ly pt treat post

      Source |       SS       df       MS              Number of obs =      84
-------------+------------------------------           F(  3,    80) =    6.23
       Model |  23.3497965     3   7.7832655           Prob > F      =  0.0007
    Residual |  99.9340746    80  1.24917593           R-squared     =  0.1894
-------------+------------------------------           Adj R-squared =  0.1590
       Total |  123.283871    83  1.48534784           Root MSE      =  1.1177

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |   .9291051   .5337628     1.74*  0.086    -.1331166    1.991327
       treat |    .077093   .3730489     0.21   0.837     -.665298     .819484
        post |   .5707126   .2910571     1.96*  0.053    -.0085094    1.149935
       _cons |   2.274861   .2075453    10.96   0.000     1.861832    2.687889
```

5.10 Male headed households with mortality

Table A-5.30: difference in ean production between affected and non-affected households year 1

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_04m |      96    20.19356    1.746999    17.11702    16.72532    23.66179
 aff_04m |      14    28.03429    7.125237     26.6602    12.64115    43.42742

combined |     110    21.19147     1.77616    18.62852    17.67118    24.71176

    diff |            -7.84073     5.30055                -18.34734     2.66588

    diff = mean(non_04m) - mean(aff_04m)                          t =  -1.4792
Ho: diff = 0                                     degrees of freedom =      108

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0710         Pr(|T| > |t|) = 0.1420          Pr(T > t) = 0.9290
```

Table A-5.31: difference in mean production for non-affected households between year 1 and year2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07m |      96    51.34653     5.56928    54.56758    40.29011    62.40295
 non_04m |      96    20.19356    1.746999    17.11702    16.72532    23.66179

combined |     192    35.77004    3.121366    43.25092    29.61327    41.92682

    diff |            31.15298    5.836856                 19.63961    42.66634

    diff = mean(non_07m) - mean(non_04m)                          t =   5.3373
Ho: diff = 0                                     degrees of freedom =      190

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A-5.32 difference in mean production for affected households between year 1 and year2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

aff_07m |      15    51.22317    21.20376    82.12179    5.745636     96.7007
 aff_04m |      14    28.03429    7.125237     26.6602    12.64115    43.42742

combined |      29    40.02854    11.50871    61.97628    16.45402    63.60305
    diff |            23.18888    23.02525               -24.05502    70.43279

    diff = mean(aff_07m) - mean(aff_04m)                          t =   1.0071
Ho: diff = 0                                     degrees of freedom =       27

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8386         Pr(|T| > |t|) = 0.3228          Pr(T > t) = 0.1614
```

Table A-5.33: difference in mean production between affected and non-affected households year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_m07 |      96    51.34653     5.56928    54.56758    40.29011    62.40295
 aff_07m |      15    51.22317    21.20376    82.12179    5.745636     96.7007

combined |     111    51.32986    5.558784    58.56542    40.31366    62.34607

    diff |            .1233633    16.33445               -32.25099    32.49771
------------------------------------------------------------------------------
    diff = mean(non_m07) - mean(aff_07m)                          t =   0.0076
Ho: diff = 0                                     degrees of freedom =      109

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5030         Pr(|T| > |t|) = 0.9940          Pr(T > t) = 0.4970
```

Table 5.34: difference in diffeence in mean production between affected and non-affected households year 1

```
. reg  ly pt treat post

      Source |       SS       df       MS              Number of obs =     218
-------------+------------------------------           F(  3,   214) =   14.15
       Model |  40.2206597     3  13.4068866           Prob > F      =  0.0000
    Residual |  202.826679   214  .947788221           R-squared     =  0.1655
-------------+------------------------------           Adj R-squared =  0.1538
       Total |  243.047339   217  1.12003382           Root MSE      =  .97354

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |  -.8016026   .3885217    -2.06*  0.040    -1.567422   -.0357831
       treat |   .3146932   .2785174     1.13   0.260    -.2342956     .863682
        post |    .919872   .1416477     6.49** 0.000     .6406686    1.199075
       _cons |   2.644284   .0993619    26.61   0.000     2.448431    2.840137
```

A-5.6 Maize production differentials for households with morbdity by gender

5.11 Female headed households with morbidity

Table 5.35: :Difference in mean production between affected and non-affected households year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_f04	79	20.7443	3.879895	34.48526	13.02002	28.46857
aff_04f	54	22.3115	2.932278	21.54775	16.4301	28.19291
combined	133	21.38061	2.586476	29.8287	16.2643	26.49691
diff		-1.567206	5.285126		-12.02245	8.888034

diff = mean(non_f04) - mean(aff_04f) t = -0.2965
Ho: diff = 0 degrees of freedom = 131

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.3836	Pr(|T| > |t|) = 0.7673	Pr(T > t) = 0.6164

Table A-5.36:Difference in mean production for non-affected households between year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07f	79	60.02259	8.052389	71.5712	43.99151	76.05366
non_f04	79	20.7443	3.879895	34.48526	13.02002	28.46857
combined	158	40.38344	4.722614	59.36233	31.05539	49.7115
diff		39.27829	8.938375		21.62243	56.93415

diff = mean(non_07f) - mean(non_f04) t = 4.3943
Ho: diff = 0 degrees of freedom = 156

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 1.0000	Pr(|T| > |t|) = 0.0000	Pr(T > t) = 0.0000

Table A-5.37:Difference in mean production for affected between year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07f	54	50.77902	8.445064	62.05829	33.84036	67.71767
aff_04f	54	22.3115	2.932278	21.54775	16.4301	28.19291
combined	108	36.54526	4.656831	48.39521	27.31364	45.77688
diff		28.46751	8.939651		10.74379	46.19124

diff = mean(aff_07f) - mean(aff_04f) t = 3.1844
Ho: diff = 0 degrees of freedom = 106

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.9990	Pr(|T| > |t|) = 0.0019	Pr(T > t) = 0.0010

Table A-5.38:Difference in mean production between affected and non-affected households year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07f	79	60.02259	8.052389	71.5712	43.99151	76.05366
aff_07f	54	50.77902	8.445064	62.05829	33.84036	67.71767
combined	133	56.26956	5.877179	67.77894	44.64392	67.8952
diff		9.243572	11.9861		-14.46779	32.95494

diff = mean(non_07f) - mean(aff_07f) t = 0.7712
Ho: diff = 0 degrees of freedom = 131

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.7790	Pr(|T| > |t|) = 0.4420	Pr(T > t) = 0.2210

Table A-5.39:Difference in difference in mean production between affected and non-affected households

. reg ly pt treat post

Source	SS	df	MS
Model	40.8332605	3	13.6110868
Residual	351.281635	259	1.35629975
Total	392.114895	262	1.49662174

Number of obs = 263
F(3, 259) = 10.04
Prob > F = 0.0000
R-squared = 0.1041
Adj R-squared = 0.0938
Root MSE = 1.1646

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pt	-.4248187	.2928296	-1.45	0.148	-1.001449	.1518112
treat	.2686135	.2062627	1.30	0.194	-.1375519	.6747789
post	.9286689	.1859248	4.99*	0.000	.5625522	1.294786
_cons	2.469864	.1302066	18.97	0.000	2.213466	2.726262

5.12: Male headed households with morbidity

TableA- 4.40: difference in ean production between affected and non-affected households year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_04m	275	28.35622	2.695988	44.7079	23.04873	33.6637
aff_04m	221	25.80667	1.707086	25.37767	22.44233	29.171
combined	496	27.22023	1.676598	37.33962	23.9261	30.51435
diff		2.549551	3.374711		-4.081007	9.180108

diff = mean(non_04m) - mean(aff_04m) t = 0.7555
Ho: diff = 0 degrees of freedom = 494

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

```
 Pr(T < t) = 0.7748         Pr(|T| > |t|) = 0.4503          Pr(T > t) = 0.2252
```

Table A-5.41: difference in mean production for non-affected households between year 1 and year2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07m |     275    56.31675    3.349901    55.55183    49.72193    62.91156
 non_04m |     275    28.35622    2.695988     44.7079    23.04873     33.6637

combined |     550    42.33648     2.22938    52.28359    37.95732    46.71564

    diff |            27.96053    4.300022                19.51399    36.40707

    diff = mean(non_07m) - mean(non_04m)                          t =   6.5024
Ho: diff = 0                                     degrees of freedom =      548

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A-5.42: difference in mean production for affected households between year 1 and year2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

aff_07m |     221    58.14778    4.487689    66.71429    49.30342    66.99214
 aff_04m |     221    25.80667    1.707086    25.37767    22.44233      29.171

combined |     442    41.97722     2.51858    52.95011    37.02731    46.92713

    diff |            32.34112    4.801405                22.90458    41.77765

    diff = mean(aff_07m) - mean(aff_04m)                          t =   6.7358
Ho: diff = 0                                     degrees of freedom =      440

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table 5.43: difference in mean production between affected and non-affected households year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07m |     275    56.31675    3.349901    55.55183    49.72193    62.91156
 aff_07m |     221    58.14778    4.487689    66.71429    49.30342    66.99214

combined |     496    57.13259    2.726503    60.72211    51.77564    62.48954
```

```
    diff |           -1.831034    5.490545               -12.61873    8.956667
------------------------------------------------------------------------------
    diff = mean(non_07m) - mean(aff_07m)                          t =  -0.3335
Ho: diff = 0                                     degrees of freedom =      494

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.3695         Pr(|T| > |t|) = 0.7389          Pr(T > t) = 0.6305
```

Table A-5.44: Difference in difference in mean production between affected and non-affected households

```
. reg  ly pt treat post

      Source |       SS       df       MS              Number of obs =     982
-------------+------------------------------           F(  3,   978) =   37.25
       Model |  129.248699     3  43.0828995           Prob > F      =  0.0000
    Residual |  1131.15365   978  1.15659882           R-squared     =  0.1025
-------------+------------------------------           Adj R-squared =  0.0998
       Total |  1260.40234   981  1.28481381           Root MSE      =  1.0755
------------------------------------------------------------------------------
          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------------------------------------------------------------------------
          pt |  -.0208719   .1381217    -0.15   0.880     -.291921    .2501771
       treat |  -.0126537    .097156    -0.13   0.896     -.203312    .1780045
        post |   .7344495   .0921386     7.97** 0.000     .5536375    .9152615
       _cons |    2.82349   .0648522    43.54   0.000     2.696225    2.950756
------------------------------------------------------------------------------
```

5.13 Female headed households with adult child mortality

Table A-5.45: Difference between affected and non-affected households year 1

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
------------------------------------------------------------------------------
non_04f |      10    10.85145    2.079831    6.577004    6.146546    15.55636
 aff_04f |       6        23.6    6.997905     17.1413    5.611314    41.58869
------------------------------------------------------------------------------
combined |      16    15.63216    3.206701     12.8268    8.797236    22.46708
------------------------------------------------------------------------------
    diff |           -12.74855    5.949682               -25.50935    .0122507
------------------------------------------------------------------------------
    diff = mean(non_04f) - mean(aff_04f)                          t =  -2.1427
Ho: diff = 0                                     degrees of freedom =       14

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0251         Pr(|T| > |t|) = 0.0502          Pr(T > t) = 0.9749
```

TableA- 5.46: difference between affected and non-affected households year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
------------------------------------------------------------------------------
non_07f |      11     21.9591    5.613954    18.61938    9.450434    34.46777
aff_07ff |       6     70.1251    17.74744    43.47217    24.50386    115.7463
------------------------------------------------------------------------------
--
combined |      17    38.95887    8.977684    37.01594    19.92703    57.99071
------------------------------------------------------------------------------
```

```
    diff |             -48.166    14.89259                -79.9088    -16.4232

    diff = mean(non_07f) - mean(aff_07ff)                        t =  -3.2342
Ho: diff = 0                                     degrees of freedom =       15

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0028         Pr(|T| > |t|) = 0.0056          Pr(T > t) = 0.9972
```

Table A-5.47: Ddifference between non-affected households year 1 and year2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07f |      11     21.9591    5.613954    18.61938    9.450434    34.46777
 non_04f |      10    10.85145    2.079831    6.577004    6.146546    15.55636

combined |      21    16.66975    3.274142      15.004    9.840005    23.49949

    diff |            11.10765     6.22461               -1.920605    24.13591

    diff = mean(non_07f) - mean(non_04f)                         t =   1.7845
Ho: diff = 0                                     degrees of freedom =       19

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9548         Pr(|T| > |t|) = 0.0903          Pr(T > t) = 0.0452
```

Table A-5.48 Ddifference between affected households year 1 and year2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

aff_07ff |       6     70.1251    17.74744    43.47217    24.50386    115.7463
 aff_04f |       6        23.6    6.997905     17.1413    5.611314    41.58869

combined |      12    46.86255    11.48518    39.78582    21.58385    72.14125

    diff |             46.5251    19.07727                4.018297    89.03191

    diff = mean(aff_07ff) - mean(aff_04f)                        t =   2.4388
Ho: diff = 0                                     degrees of freedom =       10

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9825         Pr(|T| > |t|) = 0.0349          Pr(T > t) = 0.0175
```

TableA- 5.49: Ddifference in difference between affected households

```
reg  ly  pt treat post

      Source |       SS       df       MS              Number of obs =      37
-------------+------------------------------           F(  3,    33) =    5.50
       Model |  11.9329908     3  3.97766358           Prob > F      =  0.0035
    Residual |  23.8498233    33  .722721917           R-squared     =  0.3335
-------------+------------------------------           Adj R-squared =  0.2729
       Total |   35.782814    36  .993967056           Root MSE      =  .85013

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
```

pt	.379001	.5782371	0.66	0.517	-.7974312	1.555433
treat	.5013041	.4189489	1.20	0.240	-.3510539	1.353662
post	.7940095	.3575838	2.22**	0.033	.0664997	1.521519
_cons	2.160125	.2688349	8.04	0.000	1.613176	2.707074

5.14 Female headed households with household head mortality

Table A-5.50: Difference in mean production between affected and non-affected households year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_04f	17	13.98135	2.403708	9.910743	8.885719	19.07699
aff_04	6	16.01067	3.477333	8.517692	7.071897	24.94944
combined	23	14.51074	1.964398	9.420924	10.43683	18.58465
diff		-2.029314	4.557413		-11.50697	7.448346

diff = mean(non_04f) - mean(aff_04)   t = -0.4453
Ho: diff = 0   degrees of freedom = 21

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.3303	Pr(|T| > |t|) = 0.6607	Pr(T > t) = 0.6697

Table A- 5.51: Difference in mean production for non-affected households year 1and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	18	28.65468	9.89938	41.99951	7.768815	49.54055
non_04f	17	13.98135	2.403708	9.910743	8.885719	19.07699
combined	35	21.52764	5.301123	31.36187	10.75446	32.30081
diff		14.67333	10.45868		-6.605025	35.95168

diff = mean(non_07) - mean(non_04f)   t = 1.4030
Ho: diff = 0   degrees of freedom = 33

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.9150	Pr(|T| > |t|) = 0.1700	Pr(T > t) = 0.0850

.

Table A-5.52: Difference in mean production for affected households year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07	6	92.27572	56.2177	137.7047	-52.23648	236.7879
aff_04	6	16.01067	3.477333	8.517692	7.071897	24.94944
combined	12	54.14319	29.20989	101.186	-10.14734	118.4337

```
    diff |            76.26505    56.32514               -49.23518    201.7653

    diff = mean(aff_07) - mean(aff_04)                            t =   1.3540
Ho: diff = 0                                     degrees of freedom =       10

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8972         Pr(|T| > |t|) = 0.2055          Pr(T > t) = 0.1028
```

Table A-5:53: Difference in mean production between affected and non-affected year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

  non_07 |      18    28.65468     9.89938    41.99951    7.768815    49.54055
  aff_07 |       6    92.27572     56.2177    137.7047   -52.23648    236.7879

combined |      24    44.55994     16.0961    78.85445    11.26263    77.85725

    diff |           -63.62104    35.50504                -137.254    10.01191

    diff = mean(non_07) - mean(aff_07)                            t =  -1.7919
Ho: diff = 0                                     degrees of freedom =       22

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0435         Pr(|T| > |t|) = 0.0869          Pr(T > t) = 0.9565
```

Table A-5.54: Difference in difference in mean production between affected and non-affected households

```
. regress  ly pt treat post

      Source |       SS       df       MS              Number of obs =      45
-------------+------------------------------           F(  3,    41) =    2.14
       Model |  11.5913604     3  3.86378681           Prob > F      =  0.1093
    Residual |   73.863735    41  1.80155451           R-squared     =  0.1356
-------------+------------------------------           Adj R-squared =  0.0924
       Total |  85.4550954    44  1.94216126           Root MSE      =  1.3422

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |   1.500319   .9340865     1.61   0.116    -.3861069    3.386745
       treat |  -.3868392    .637364    -0.61   0.547    -1.674022    .9003436
        post |   .3848179   .4603777     0.84   0.408    -.5449336    1.314569
       _cons |   2.377738   .3255362     7.30   0.000     1.720304    3.035172
```

5.**15 Male headed households with adult child mortality**

Table A-5.55 difference in mean production between affected and non-affected households year 1

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_04m |     24      20.752    3.173888    15.54881    14.18631    27.31769
  aff_04 |      11    32.53818    8.618452    28.58417    13.33507    51.74129

combined |      35    24.45623    3.524102    20.84887    17.29439    31.61807

    diff |           -11.78618     7.42726               -26.89706    3.324692
```

```
    diff = mean(non_04m) - mean(aff_04)                               t =  -1.5869
Ho: diff = 0                                         degrees of freedom =       33

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0610         Pr(|T| > |t|) = 0.1221          Pr(T > t) = 0.9390
```

Table A-5.56 difference in mean production for non-affected households year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	24	56.88944	11.23593	55.0446	33.64615	80.13274
non_04m	24	20.752	3.173888	15.54881	14.18631	27.31769
combined	48	38.82072	6.348321	43.98246	26.04955	51.5919
diff		36.13744	11.6756		12.63567	59.63921

```
    diff = mean(non_07) - mean(non_04m)                               t =   3.0951
Ho: diff = 0                                         degrees of freedom =       46

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9983         Pr(|T| > |t|) = 0.0033          Pr(T > t) = 0.0017
```

Table A- 5.57 difference in mean production for affected between year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07	12	58.53021	26.17539	90.67422	.9185519	116.1419
aff_04	11	32.53818	8.618452	28.58417	13.33507	51.74129
combined	23	46.09924	14.23183	68.25347	16.58423	75.61425
diff		25.99202	28.60414		-33.49354	85.47759

```
    diff = mean(aff_07) - mean(aff_04)                                t =   0.9087
Ho: diff = 0                                         degrees of freedom =       21

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8131         Pr(|T| > |t|) = 0.3738          Pr(T > t) = 0.1869
```

Table A-5.58: difference in mean production for affected and non-affected households between year 1 and year

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	24	56.88944	11.23593	55.0446	33.64615	80.13274
aff_07	12	58.53021	26.17539	90.67422	.9185519	116.1419
combined	36	57.43636	11.27398	67.6439	34.54896	80.32377
diff		-1.640763	24.26325		-50.94962	47.66809

```
    diff = mean(non_07) - mean(aff_07)                                t =  -0.0676
Ho: diff = 0                                         degrees of freedom =       34

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.4732         Pr(|T| > |t|) = 0.9465          Pr(T > t) = 0.5268
```

Table A-5.59 difference in difference in mean production between affected and non-affected households

```
reg  ly pt treat post

      Source |       SS       df       MS              Number of obs =      70
-------------+------------------------------           F(  3,    66) =    4.29
       Model |  12.0859552     3  4.02865173           Prob > F      =  0.0080
    Residual |  62.0456536    66  .940085661           R-squared     =  0.1630
-------------+------------------------------           Adj R-squared =  0.1250
       Total |  74.1316088    69  1.07437114           Root MSE      =  .96958

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |  -.9413738    .493808    -1.91   0.061    -1.927293    .0445456
       treat |   .3859253   .3530334     1.09   0.278    -.3189286    1.090779
        post |   1.009875   .2829196     3.57*  0.001     .4450079    1.574742
       _cons |   2.724987   .1979147    13.77   0.000     2.329838    3.120137
```

5.16 Male headed households with household head mortality

Table A-5.60 difference in mean production between affected and non-affected year 1

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_04m |      72    20.00741    2.086907      17.708    15.84623    24.16858
 aff_04m |       3       11.52     2.16444     3.74892    2.207167    20.83283

combined |      75    19.66791    2.013435    17.43686    15.65605    23.67977

    diff |             8.487407     10.2971               -12.03468     29.0095

    diff = mean(non_04m) - mean(aff_04m)                              t =   0.8243
Ho: diff = 0                                         degrees of freedom =       73

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7938         Pr(|T| > |t|) = 0.4125          Pr(T > t) = 0.2062
```

Table A-5.61 difference in mean production between affected and non-affected year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07m	72	49.4989	6.442883	54.66967	36.65215	62.34564
aff_07	3	21.99502	11.34544	19.65087	-26.82045	70.81049
combined	75	48.39874	6.226271	53.92109	35.99262	60.80486
diff		27.50387	31.82782		-35.92888	90.93662

diff = mean(non_07m) - mean(aff_07) t = 0.8641
Ho: diff = 0 degrees of freedom = 73

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.8048	Pr(|T| > |t|) = 0.3903	Pr(T > t) = 0.1952

Table A-5.62 difference in mean production for non-affected year 1and year2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07m	72	49.4989	6.442883	54.66967	36.65215	62.34564
non_04m	72	20.00741	2.086907	17.708	15.84623	24.16858
combined	144	34.75315	3.592608	43.1113	27.65167	41.85463
diff		29.49149	6.772438		16.10366	42.87932

diff = mean(non_07m) - mean(non_04m) t = 4.3546
Ho: diff = 0 degrees of freedom = 142

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 1.0000	Pr(|T| > |t|) = 0.0000	Pr(T > t) = 0.0000

Table A-5.63 difference in mean production for affected households year 1and year2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07m	3	21.99502	11.34544	19.65087	-26.82045	70.81049
aff_04m	3	11.52	2.16444	3.74892	2.207167	20.83283
combined	6	16.75751	5.6716	13.89253	2.178199	31.33682
diff		10.47502	11.55005		-21.59306	42.54311

diff = mean(aff_07m) - mean(aff_04m) t = 0.9069
Ho: diff = 0 degrees of freedom = 4

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.7921	Pr(|T| > |t|) = 0.4157	Pr(T > t) = 0.2079

Table A-5.64: difference in differences in mean production between affected and non-affected

reg ly pt treat post

```
      Source |       SS       df       MS              Number of obs =     148
-------------+------------------------------           F(  3,   144) =   10.38
       Model |  29.8278394     3  9.94261312           Prob > F      =  0.0000
    Residual |  137.870865   144  .957436565           R-squared     =  0.1779
-------------+------------------------------           Adj R-squared =  0.1607
       Total |  167.698705   147  1.14080752           Root MSE      =  .97849

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |  -.6239872   .8156387    -0.77   0.446    -2.236158    .9881838
       treat |  -.2155019   .5765789    -0.37   0.709    -1.355153    .9241496
        post |   .8906838   .1642419     5.42** 0.000     .5660474    1.21532
       _cons |   2.617383   .1153158    22.70   0.000     2.389453    2.845313
```

4.17 Female headed households with adult child morbidity

Table A-5.65: difference in mean production between affected and non-affected households for year 1

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_04f |       5      12.544    2.917796    6.524391    4.442899     20.6451
  aff_04 |      22    24.38987    5.326456    24.98329     13.3129    35.46684

combined |      27    22.19619    4.441681    23.07965    13.06618     31.3262

    diff |           -11.84587    11.41767                 -35.361    11.66926

    diff = mean(non_04f) - mean(aff_04)                           t =  -1.0375
Ho: diff = 0                                     degrees of freedom =       25

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.1547         Pr(|T| > |t|) = 0.3094          Pr(T > t) = 0.8453
```

Table A-5.66 difference in mean production between affected and non-affected households for year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07f |       5    70.54321    45.87455    102.5786   -56.82495    197.9114
  aff_07 |      22     40.6999     9.87548    46.32011    20.16272    61.23708

combined |      27    46.22644    11.37139    59.08746    22.85222    69.60066

    diff |            29.84331    29.25091               -30.40008     90.0867

    diff = mean(non_07f) - mean(aff_07)                           t =   1.0203
Ho: diff = 0                                     degrees of freedom =       25

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8413         Pr(|T| > |t|) = 0.3174          Pr(T > t) = 0.1587
```

Table A- 5.67: difference in mean production for non-affected households for year 1 and year2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07f	5	70.54321	45.87455	102.5786	-56.82495	197.9114
non_04f	5	12.544	2.917796	6.524391	4.442899	20.6451
combined	10	41.5436	23.72751	75.03297	-12.13175	95.21896
diff		57.99921	45.96724		-48.00144	163.9999

```
    diff = mean(non_07f) - mean(non_04f)                       t =   1.2618
Ho: diff = 0                                  degrees of freedom =        8

    Ha: diff < 0               Ha: diff != 0              Ha: diff > 0
 Pr(T < t) = 0.8787         Pr(|T| > |t|) = 0.2426        Pr(T > t) = 0.1213
```

Table A- 5.68: difference in mean production for affected households for year 1 and year2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07	22	40.6999	9.87548	46.32011	20.16272	61.23708
aff_04	22	24.38987	5.326456	24.98329	13.3129	35.46684
combined	44	32.54489	5.682316	37.69222	21.0854	44.00437
diff		16.31003	11.22035		-6.333551	38.95361

```
    diff = mean(aff_07) - mean(aff_04)                         t =   1.4536
Ho: diff = 0                                  degrees of freedom =       42

    Ha: diff < 0               Ha: diff != 0              Ha: diff > 0
 Pr(T < t) = 0.9233         Pr(|T| > |t|) = 0.1535        Pr(T > t) = 0.0767
```

Table A- 5.69: difference in difference in mean production for affected and non-affected households

```
. reg  ly pt treat post

      Source |       SS       df       MS              Number of obs =      53
-------------+------------------------------           F(  3,    49) =    0.34
       Model |  1.84290784     3  .614302614           Prob > F      =  0.7936
    Residual |  87.5111578    49  1.78594199           R-squared     =  0.1206
-------------+------------------------------           Adj R-squared =  0.0993
       Total |  89.3540656    52  1.71834742           Root MSE      =  1.3364

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |  -.6470134   .9082594    -0.71   0.480    -2.472229    1.178202
       treat |   .2396729    .618629     0.39   0.700    -1.003509    1.482854
        post |   .7767752   .8092252     0.96   0.342    -.8494237    2.402974
       _cons |   2.538134   .5455795     4.65   0.000     1.441751    3.634518
```

5.18: Female headed households with household head morbidity

Table A-4.70: difference in mean production between affected and non-affected households in year 1

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_04f |      74    21.29837    4.132008    35.54488    13.06329    29.53345
  aff_04 |      32    20.88263    3.381098    19.12638    13.98683    27.77842

combined |     106    21.17286    3.050565    31.40749    15.12415    27.22157

    diff |            .4157452    6.676752                -12.8245      13.656

    diff = mean(non_04f) - mean(aff_04)                           t =   0.0623
Ho: diff = 0                                     degrees of freedom =      104

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5248         Pr(|T| > |t|) = 0.9505          Pr(T > t) = 0.4752
```

Table A-5.71: difference in mean production between affected and non-affected households in year 2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07f |      74    59.31174    8.127886    69.91872    43.11288    75.51059
  aff_07 |      32    57.70841    12.51158    70.77616    32.19088    83.22594

combined |     106    58.82771    6.783882    69.84434    45.37653     72.2789

    diff |            1.603326    14.84728               -27.83939    31.04604

    diff = mean(non_07f) - mean(aff_07)                           t =   0.1080
Ho: diff = 0                                     degrees of freedom =      104

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
```

```
 Pr(T < t) = 0.5429         Pr(|T| > |t|) = 0.9142          Pr(T > t) = 0.4571
```

Table A-5.72: difference in mean production for non-affected households in year 1 and year2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

non_07f |      74    59.31174    8.127886    69.91872    43.11288    75.51059
 non_04f |      74    21.29837    4.132008    35.54488    13.06329    29.53345

combined |     148    40.30505    4.806259    58.47066    30.80676    49.80334

    diff |            38.01337    9.117895                19.99325    56.03348
-
    diff = mean(non_07f) - mean(non_04f)                          t =   4.1691
Ho: diff = 0                                     degrees of freedom =      146

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0001          Pr(T > t) = 0.0000
```

Table A-5.73: difference in mean production for affected households in year 1 and year2

```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

  aff_07 |      32    57.70841    12.51158    70.77616    32.19088    83.22594
  aff_04 |      32    20.88263    3.381098    19.12638    13.98683    27.77842

combined |      64    39.29552     6.83431    54.67448    25.63824     52.9528
    diff |            36.82579    12.96038                10.91836    62.73321

    diff = mean(aff_07) - mean(aff_04)                            t =   2.8414
Ho: diff = 0                                     degrees of freedom =       62

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9970         Pr(|T| > |t|) = 0.0061          Pr(T > t) = 0.0030
```

Table A-5.74: difference in difference mean production for affected and non-affected households

```
. reg  ly pt treat post

      Source |       SS       df       MS              Number of obs =     210
-------------+------------------------------           F(  3,   206) =   11.20
       Model |  42.3616196     3  14.1205399           Prob > F      =  0.0000
    Residual |  259.751347   206  1.26092887           R-squared     =  0.1402
-------------+------------------------------           Adj R-squared =  0.1273
       Total |  302.112966   209  1.44551659           Root MSE      =  1.1229

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |  -.1906659   .3366906    -0.57   0.572     -.854467    .4731353
       treat |   .2483386   .2375786     1.05   0.297    -.2200587     .716736
        post |   .9400115    .185883     5.06** 0.000     .5735346    1.306488
       _cons |   2.464328   .1305357    18.88   0.000     2.206971    2.721686
```

5.19 Male headed households with adult child morbidity

Table A-5.75: difference in mean production between affected and non-affected households in year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_04m	41	26.29835	4.082654	26.14174	18.047	34.5497
aff_04	71	25.8503	2.761164	23.26598	20.34333	31.35727
combined	112	26.01432	2.29066	24.24207	21.47522	30.55342
diff		.4480507	4.776452		-9.017755	9.913856

diff = mean(non_04m) - mean(aff_04) t = 0.0938
Ho: diff = 0 degrees of freedom = 110

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.5373 Pr(|T| > |t|) = 0.9254 Pr(T > t) = 0.4627

Table A- 5.76 difference in mean production between affected and non-affected households in year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07m	43	59.49725	9.630397	63.15074	40.06232	78.93218
aff_07m	71	82.24124	9.829366	82.82371	62.63719	101.8453
combined	114	73.66237	7.166125	76.51327	59.46498	87.85975
diff		-22.744	14.69469		-51.85964	6.371645

diff = mean(non_07m) - mean(aff_07m) t = -1.5478
Ho: diff = 0 degrees of freedom = 112

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0622 Pr(|T| > |t|) = 0.1245 Pr(T > t) = 0.9378

Table A-5.77 difference in mean production for non-affected households in year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	43	59.49725	9.630397	63.15074	40.06232	78.93218
non_04m	41	26.29835	4.082654	26.14174	18.047	34.5497
combined	84	43.29302	5.59132	51.2453	32.17211	54.41393
diff		33.1989	10.63989		12.03277	54.36502

diff = mean(non_07) - mean(non_04m) t = 3.1202
Ho: diff = 0 degrees of freedom = 82

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9988 Pr(|T| > |t|) = 0.0025 Pr(T > t) = 0.0012

Table A-5.78: difference in mean production for affected households in year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07	71	82.24124	9.829366	82.82371	62.63719	101.8453
aff_04	71	25.8503	2.761164	23.26598	20.34333	31.35727
combined	142	54.04577	5.613687	66.8948	42.9479	65.14365
diff		46.39094	10.20982		36.20558	76.57631

```
    diff = mean(aff_07) - mean(aff_04)                            t =   5.5232
Ho: diff = 0                                     degrees of freedom =      140

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A-5.79: difference in mean production for affected and no-affected households

. ly pt treat post

Source	SS	df	MS
Model	46.5833921	3	15.5277974
Residual	279.009982	220	1.26822719
Total	325.593375	223	1.46005998

Number of obs	224
F(3, 220)	12.24
Prob > F	0.0000
R-squared	0.1431
Adj R-squared	0.1314
Root MSE	1.1262

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pt	.220666	.3123931	0.71	0.481	-.3950001	.8363321
treat	.0907527	.2208953	0.41	0.682	-.344589	.5260943
post	.7449932	.2487262	3.00**	0.003	.2548021	1.235184
_cons	2.780313	.175876	15.81	0.000	2.433696	3.12693

5.20 Male headed households with household head morbdity

Table A-5.80: difference in mean production between affected and non affected households in year 1

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_04	234	28.71678	3.088661	47.24743	22.63151	34.80206
aff_04	150	25.78601	2.155001	26.39327	21.5277	30.04432
combined	384	27.57195	2.060982	40.38683	23.5197	31.62421
diff		2.930771	4.227138		-5.380601	11.24214

```
    diff = mean(non_04) - mean(aff_04)                            t =   0.6933
Ho: diff = 0                                     degrees of freedom =      382
```

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.7557	Pr(|T| > |t|) = 0.4885	Pr(T > t) = 0.2443

Table A-5.81: difference in mean production between affected and non affected households in year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	232	55.72726	3.555672	54.15839	48.72156	62.73295
aff_07	150	46.74354	4.428239	54.23463	37.99328	55.4938
combined	382	52.19962	2.777981	54.29514	46.73753	57.66171
diff		8.983715	5.677375		-2.179289	20.14672

diff = mean(non_07) - mean(aff_07)   t = 1.5824
Ho: diff = 0   degrees of freedom = 380

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.9428	Pr(|T| > |t|) = 0.1144	Pr(T > t) = 0.0572

.
Table A-5.82: difference in mean production for non-affected households between year 1and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
non_07	232	55.72726	3.555672	54.15839	48.72156	62.73295
non_04	234	28.71678	3.088661	47.24743	22.63151	34.80206
combined	466	42.16406	2.432983	52.52089	37.38305	46.94506
diff		27.01048	4.707097		17.76061	36.26034

diff = mean(non_07) - mean(non_04)   t = 5.7382
Ho: diff = 0   degrees of freedom = 464

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 1.0000	Pr(|T| > |t|) = 0.0000	Pr(T > t) = 0.0000

Table A-5.83: difference in mean production for affected households iin year 1 and year 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
aff_07	150	46.74354	4.428239	54.23463	37.99328	55.4938
aff_04	150	25.78601	2.155001	26.39327	21.5277	30.04432
combined	300	36.26478	2.531856	43.85303	31.28226	41.24729
diff		20.95753	4.924767		11.2658	30.64926

diff = mean(aff_07) - mean(aff_04)   t = 4.2555
Ho: diff = 0   degrees of freedom = 298

```
    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Table A-5.84 difference in difference in mean production between affected and non affected households

```
. reg  ly pt post treat

      Source |       SS       df       MS              Number of obs =     760
-------------+------------------------------           F(  3,   756) =    2.36
       Model |  7.78812597     3  2.59604199           Prob > F      =  0.0706
    Residual |  832.743157   756  1.10151211           R-squared     =  0.1093
-------------+------------------------------           Adj R-squared =  0.0923
       Total |  840.531283   759  1.10741935           Root MSE      =  1.0495

          ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

          pt |  -.1409529    .156058    -0.90   0.367    -.4473115    .1654056
        post |   .1828081   .0975572     1.878* 0.061    -.0087071    .3743234
       treat |  -.0750344   .1097758    -0.68   0.494    -.2905361    .1404673
       _cons |   6.170713   .0686099    89.94   0.000     6.036024    6.305401
```

Table A-5.85 Difference in difference in maize production (no. of 50kg bags per hectare) for non-affected households without mortality and morbidity

Maize production	2004/05	2006/07	Two sample t-test
Maize production per hectare			Ho: diff=0; Prob(|T|>|t|
Non-affected households	35.60	66.08	8.42
	(1.32)	(2.62)	(0.000)**
Female headed	32.04	65.23	4.66
	(2.87)	(6.19)	(0.000)**
Male headed	34.23	68.24	8.12
	(2.06)	(2.87)	(0.000)**

Source: Author's estimation results; *(**) significant at 10% and 5% levels, respectiv

Appendix III

A-6.1 Probabilities on coping strategies for all households for 2004/05 season - multinomial logit

Table A-6.1 Probabilities on coping strategies for all households for 2004/05 season using logit model

households	mkt	labour	relative	unripe	fwork	fhand	irrig	wplant	reduce	barter
All households	0.379	0.372	0.087	0.051	0.023	0.022	0.039	0.000	0.026	0.000
Female headed	0.455	0.310	0.176	0.000	0.008	0.012	0.000	0.000	0.029	0.008
Male headed	0.351	0.386	0.059	0.069	0.027	0.025	0.053	0.000	0.023	0.006
Mortality	0.548	0.128	0.188	0.071	0.065	…	0.000	0.000	0.000	…
Female headed	0.551	0.072	0.325	0.000	0.000	…	…	….	0.052	…
Male headed	0.412	0.305	0.048	0.043	0.022	….	…..	…	0.000	…
Morbidity	0.373	0.402	0.079	0.039	0.018	0.026	0.039	0.000	0.000	0.000
Female headed	0.446	0.338	0.138	0.000	0.000	0.017	0.000	0.000	0.000	0.010
Male headed	0.354	0.400	0.059	0.054	0.024	0.027	0.049	0.000	0.025	0.007

Source: author's estimation results; …. = not available

A-6.2 Probabilities on coping strategies for all households for 2004/05 season - multinomial probit

Table A-6.2 Probabilities on coping strategies for all households for 2004/05 seaoson using probit model

households	mkt	labour	relative	unripe	fwork	fhand	irrig	wplant	reduce	barter
All households	0.378	0.372	0.086	0.051	0.023	0.023	0.039	0.000	0.027	0.000
Female headed	0.454	0.311	0.175	0.000	0.008	0.012	0.000	0.000	0.028	0.008
Male headed	0.350	0.386	0.059	0.069	0.027	0.025	0.053	0.000	0.023	0.006
Mortality	0.547	0.128	0.188	0.072	0.065	…	0.000	0.000	0.000	…
Female headed	0.550	0.072	0.326	0.000	0.000	…	…	….	0.052	…
Male headed	0.411	0.305	0.048	0.044	0.022	….	…..	…	0.000	…
Morbidity	0.372	0.402	0.079	0.039	0.018	0.027	0.039	0.000	0.000	0.000
Female headed	0.445	0.338	0.138	0.000	0.000	0.018	0.000	0.000	0.000	0.010
Male headed	0.353	0.400	0.059	0.054	0.025	0.027	0.049	0.000	0.025	0.007

Source: author's estimation results; …. = not available

A-6.3 Probabilities on coping strategies for all households for 20064/07 season - multinomial logit

Table A-6.3 Probabilities on coping strategies for all households for 200606 seaoson using multinomial logit model

households	mkt	labour	relative	unripe	fwork	fhand	irrig	wplant	reduce	barter
All households	0.386	0.351	0.074	0.054	0.021	0.035	0.035	0.000	0.014	0.029
Female headed	0.367	0.327	0.115	0.082	0.000	0.043	0.000	0.000	0.045	0.019
Male headed	0.395	0.359	0.065	0.046	0.023	0.033	0.045	….	0.000	0.033
Mortality	0.435	0.297	0.130	0.033	0.053	0.054	0.000	0.000	0.000	…
Female headed	0.510	0.257	0.144	0.000	0.000	0.042	0.047	….	0.047	…
Male headed	0.371	0.245	0.128	0.000	0.002	0.000	0.000	…	…..	…
Morbidity	0.389	0.371	0.069	0.057	0.000	0.032	0.034	0.000	0.011	0.037
Female headed	0.364	0.385.	0.0781	0.093	…	0.042	0.000	0.000	0.038	0.028
Male headed	0.399	0.367	0.061	0.045	0.018	0.029	0.042	….	0.000	0.038

Source: author's estimation results; …. = not available

A-6.4 Probabilities on coping strategies for all households for 2006/07 season - multinomial logit

Table A-6.4 Probabilities on coping strategies for all households for 2006/07 seaoson using multinomial logit model

households	mkt	labour	relative	unripe	fwork	fhand	irrig	wplant	reduce	barter
All households	0.385	0.352	0.073	0.055	0.021	0.035	0.035	0.000	0.014	0.029
Female headed	0.366	0.328	0.114	0.083	0.000	0.043	0.000	0.000	0.045	0.019
Male headed	0.394	0.359	0.064	0.047	0.023	0.033	0.045	….	0.000	0.033
Mortality	0.434	0.298	0.130	0.033	0.053	0.054	0.000	0.000	0.000	…
Female headed	0.510	0.258	0.143	0.000	0.000	0.043	0.047	….	0.047	…
Male headed	0.370	0.246	0.127	0.000	0.003	0.000	0.000	…	…..	…
Morbidity	0.388	0.372	0.069	0.057	0.000	0.032	0.034	0.000	0.011	0.037
Female headed	0.363	0.386	0.0780	0.093	…	0.043	0.000	0.000	0.038	0.028

Male headed	0.398	0.368	0.060	0.045	0.019	0.029	0.042	….	0.000	0.038

Source: author's estimation results; …. = not available

B-6.1 Probabilities on coping strategies for all households for 2004/05 season - multinomial

In this section, the coping strategies are denoted as follows: 0= barter/exchange; 1= buying food from market; 2-=labour; 3=obtaining food from relatives/friends; 4=eating unripe maize before harvest; 5=food for work; 6=food handouts; 7=irrigation farming; 8=eating wild plants; 9=reducing consumption.

B-6.1 Coping strategies for all households 2004/05 (social economic factors)

Table B-6.1 Table Multinomial (polytomous) logistic model 2004/05

```
nomial logistic regression                          Number of obs   =        254
                                                    LR chi2(27)     =      46.27
                                                    Prob > chi2     =     0.0119
Log likelihood =  -391.6022                         Pseudo R2       =     0.0558
```

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
gender	-19.56447	2.207338	-8.86	0.000	-23.89078	-15.23817
age	-.0164973	.0396364	-0.42	0.677	-.0941832	.0611886
ed	-2.100296	1.196375	-1.76	0.079	-4.445147	.2445559
_cons	45.67386	3.373149	13.54	0.000	39.06261	52.28511
2						
gender	-19.05192	2.206256	-8.64	0.000	-23.37611	-14.72774
age	-.0274894	.039761	-0.69	0.489	-.1054195	.0504408
ed	-2.690627	1.202117	-2.24	0.025	-5.046734	-.3345205
_cons	45.7189	3.368341	13.57	0.000	39.11708	52.32073
3						
gender	-20.07004	2.233749	-8.98	0.000	-24.44811	-15.69198
age	.0116292	.0411918	0.28	0.778	-.0691052	.0923637
ed	-2.148744	1.233463	-1.74	0.082	-4.566287	.268798
_cons	43.88634	3.478254	12.62	0.000	37.06908	50.70359
4						
gender	-18.37474	2.322353	-7.91	0.000	-22.92647	-13.82302
age	-.0439748	.0421033	-1.04	0.296	-.1264957	.0385461
ed	-3.082713	1.27183	-2.42	0.015	-5.575455	-.589972
_cons	43.59095	3.690357	11.81	0.000	36.35798	50.82392
5						
gender	-19.33433	2.361459	-8.19	0.000	-23.9627	-14.70595
age	.0213877	.0461591	0.46	0.643	-.0690825	.111858
ed	-1.636532	1.329267	-1.23	0.218	-4.241847	.9687827
_cons	40.45401	4.015044	10.08	0.000	32.58467	48.32335
6						
gender	-18.67501	2.462003	-7.59	0.000	-23.50044	-13.84957
age	.0032486	.0464592	0.07	0.944	-.0878098	.0943069
ed	-1.8408	1.353275	-1.36	0.174	-4.49317	.8115695
_cons	40.24737	4.211706	9.56	0.000	31.99258	48.50217
7						
gender	-17.90616	2.433342	-7.36	0.000	-22.67542	-13.1369
age	-.0256173	.0428687	-0.60	0.550	-.1096384	.0584038
ed	-2.722387	1.289022	-2.11	0.035	-5.248824	-.1959496
_cons	41.46009	3.995673	10.38	0.000	33.62871	49.29146
8						
gender	-19.53458	1.7684	-11.05	0.000	-23.00058	-16.06858
age	-.0018374	.053473	-0.03	0.973	-.1066426	.1029678
ed	-34.67049	5953414	-0.00	1.000	-1.17e+07	1.17e+07

_cons	42.39709	.	.	.	.	.
.	.					
9						
gender	-19.58709	2.365487	-8.28	0.000	-24.22336	-14.95083
age	-.0192988	.0459041	-0.42	0.674	-.1092692	.0706716
ed	-2.27395	1.356235	-1.68	0.094	-4.932122	.3842225
_cons	43.27568	3.87767	11.16	0.000	35.67559	50.87578

(cop==0 is the base outcome).

.Table B- 6.2: Marginal effects for multinomial logistic model 2004/05

Marginal effects from multinomial logit

y = Pr(cop=0)
= .00002522

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0004859	.00049	0.98	0.326	-.000483	.001455	1.72047
age	4.71e-07	.00000	0.41	0.683	-1.8e-06	2.7e-06	43.3543
ed	.0000602	.00005	1.32	0.187	-.000029	.00015	.799213

Marginal effects from multinomial logit

y = Pr(cop=1)
= .37989071

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.1133456	.07165	-1.58	0.114	-.253769	.027078	1.72047
age	.0008243	.00183	0.45	0.653	-.002771	.00442	43.3543
ed	.1088022	.051	2.13	0.033	.008854	.208751	.799213

Marginal effects from multinomial logit

y = Pr(cop=2)
= .37181912

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0796389	.07379	1.08	0.280	-.064983	.224261	1.72047
age	-.0032803	.00181	-1.81	0.070	-.006831	.00027	43.3543
ed	-.113006	.0517	-2.19	0.029	-.214334	-.011678	.799213

Marginal effects from multinomial logit

y = Pr(cop=3)
= .08676755

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0697553	.03482	-2.00	0.045	-.137995	-.001516	1.72047
age	.0026287	.00097	2.71	0.007	.00073	.004527	43.3543
ed	.0206468	.02806	0.74	0.462	-.034344	.075637	.799213

Marginal effects from multinomial logit
y = Pr(cop=4)
= .0507771

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X

gender	.045261	.03597	1.26	0.208	-.025243	.115764	1.72047
age	-.0012851	.00072	-1.79	0.073	-.002691	.000121	43.3543
ed	-.0353416	.02118	-1.67	0.095	-.076852	.006169	.799213

Marginal effects from multinomial logit

y = Pr(cop=5)
= .02285393

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	-.001559	.01961	-0.08	0.937	-.039994	.036876	1.72047
age	.0009154	.00048	1.90	0.058	-.00003	.001861	43.3543
ed	.0171443	.01308	1.31	0.190	-.008499	.042788	.799213

Marginal effects from multinomial logit

y = Pr(cop=6)
= .02235766

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	.0132157	.02382	0.55	0.579	-.033475	.059906	1.72047
age	.00049	.00053	0.92	0.357	-.000553	.001533	43.3543
ed	.012205	.01415	0.86	0.388	-.015525	.039935	.799213

Marginal effects from multinomial logit

y = Pr(cop=7)
= .03990976

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	.0542752	.03494	1.55	0.120	-.014204	.122755	1.72047
age	-.0002774	.00068	-0.41	0.681	-.001601	.001046	43.3543
ed	-.0133972	.0194	-0.69	0.490	-.051419	.024625	.799213

Marginal effects from multinomial logit

y = Pr(cop=8)
= 1.413e-13

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	-3.81e-14	0	.	.	-3.8e-14	-3.8e-14	1.72047
age	2.38e-15	0	.	.	2.4e-15	2.4e-15	43.3543
ed	-4.56e-12	.	.	.	.	.	.799213

Marginal effects from multinomial logit

y = Pr(cop=9)
= .02559894

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	-.0082168	.02221	-0.37	0.711	-.05175	.035316	1.72047
age	-.0000162	.0006	-0.03	0.979	-.001197	.001165	43.3543
ed	.0028863	.01657	0.17	0.862	-.029594	.035367	.799213

B-6.2 Coping strategies for all households 2006/07 (household charcteristics)

Table B-6.3 Multinomial (polytomous) logistic model 2006/07

```
Multinomial logistic regression                   Number of obs   =        280
                                                  LR chi2(27)     =      52.86
                                                  Prob > chi2     =     0.0021
Log likelihood = -444.43608                       Pseudo R2       =     0.0561

------------------------------------------------------------------------------
         cop |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
1            |
      gender |   .4021771   .7380763     0.54   0.586    -1.044426     1.84878
         age |   .0117431   .0243643     0.48   0.630    -.0360101    .0594963
         edu |  -.7877456   .5547607    -1.42   0.156    -1.875057    .2995654
       _cons |   1.924901   1.755668     1.10   0.273    -1.516145    5.365947
-------------+----------------------------------------------------------------
2            |
      gender |   .4524725   .7487949     0.60   0.546    -1.015138    1.920083
         age |   .0150243   .0245327     0.61   0.540     -.033059    .0631076
         edu |  -1.408676   .5666082    -2.49   0.013    -2.519208   -.2981448
       _cons |   2.079043   1.777051     1.17   0.242    -1.403912    5.561998
-------------+----------------------------------------------------------------
3            |
      gender |  -.3449427   .8299583    -0.42   0.678    -1.971631    1.281746
         age |   .0565737   .0272822     2.07   0.038     .0031016    .1100458
         edu |   -.715298   .6440967    -1.11   0.267    -1.977704    .5471083
       _cons |  -.6179047   2.025397    -0.31   0.760    -4.587611    3.351801
-------------+----------------------------------------------------------------
4            |
      gender |  -.2835222   .8831811    -0.32   0.748    -2.014525    1.447481
         age |   .0008191   .0290647     0.03   0.978    -.0561467    .0577848
         edu |  -1.397372    .692509    -2.02   0.044    -2.754665   -.0400794
       _cons |    2.14124   2.084889     1.03   0.304    -1.945068    6.227547
-------------+----------------------------------------------------------------
5            |
      gender |   .9298068   1.309514     0.71   0.478    -1.636793    3.496407
         age |  -.0003278   .0362744    -0.01   0.993    -.0714242    .0707687
         edu |  -1.488519   .8776874    -1.70   0.090    -3.208755    .2317168
       _cons |  -.7595958   2.980984    -0.25   0.799    -6.602217    5.083026
-------------+----------------------------------------------------------------
6            |
      gender |   .1200649   .9398054     0.13   0.898     -1.72192     1.96205
         age |   .0740732   .0304609     2.43   0.015      .014371    .1337754
         edu |  -.1393947   .7083629    -0.20   0.844    -1.527761    1.248971
       _cons |  -3.458465    2.40364    -1.44   0.150    -8.169514    1.252584
-------------+----------------------------------------------------------------
7            |
      gender |   1.647828   1.270836     1.30   0.195    -.8429635     4.13862
         age |   .0025163   .0311525     0.08   0.936    -.0585415    .0635741
         edu |  -1.607707    .749855    -2.14   0.032    -3.077396   -.1380181
       _cons |  -1.545502   2.828905    -0.55   0.585    -7.090054    3.999051
-------------+----------------------------------------------------------------
8            |
      gender |  -21.06601   3.496066    -6.03   0.000    -27.91817   -14.21385
         age |   .0111545   .0604736     0.18   0.854    -.1073717    .1296807
         edu |  -34.16066   1.39e+07    -0.00   1.000    -2.72e+07    2.72e+07
       _cons |   21.33078          .         .        .             .            .
.        .
-------------+----------------------------------------------------------------
9            |
      gender |  -.6253121   1.100844    -0.57   0.570    -2.782926    1.532302
         age |  -.0123195   .0357016    -0.35   0.730    -.0822933    .0576542
         edu |  -2.477916   .9893798    -2.50   0.012    -4.417065   -.5387673
       _cons |   2.851235   2.542586     1.12   0.262    -2.132142    7.834612
------------------------------------------------------------------------------
 (cop==0 is the base outcome)
```

Table B-6.4 Marginal effects multinomial logistic model 2006/07

Marginal effects from multinomial logit

y = Pr(cop=0)
= .02993636

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
gender	-.010359	.02097	-0.49	0.621	-.051454	.030736	1.72857
age	-.0004955	.00068	-0.73	0.464	-.001822	.000831	47.4821
edu	.0315534	.01428	2.21	0.027	.003557	.05955	.789286

Marginal effects from multinomial logit

y = Pr(cop=1)
= .38567553

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
gender	.021653	.07027	0.31	0.758	-.116064	.15937	1.72857
age	-.0018545	.00197	-0.94	0.347	-.00572	.002011	47.4821
edu	.1026939	.05017	2.05	0.041	.004355	.201033	.789286

Marginal effects from multinomial logit

y = Pr(cop=2)
= .35135069

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
gender	.0373972	.06886	0.54	0.587	-.097569	.172363	1.72857
age	-.0005366	.00189	-0.28	0.777	-.00425	.003177	47.4821
edu	-.1246103	.05013	-2.49	0.013	-.222871	-.026349	.789286

Marginal effects from multinomial logit
y = Pr(cop=3)
= .07418602

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
gender	-.0512608	.03144	-1.63	0.103	-.112885	.010363	1.72857
age	.0029691	.0009	3.30	0.001	.001208	.00473	47.4821
edu	.0251281	.02554	0.98	0.325	-.024922	.075178	.789286

Marginal effects from multinomial logit

y = Pr(cop=4)
= .0538494

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
gender	-.0339012	.02758	-1.23	0.219	-.087966	.020164	1.72857
age	-.0008472	.00087	-0.97	0.330	-.00255	.000856	47.4821
edu	-.0184895	.02265	-0.82	0.414	-.062876	.025897	.789286

Marginal effects after mlogit
y = Pr(cop=5)
= .02124848

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0124043	.02238	0.55	0.579	-.03145	.056259	1.72857
age	-.0003587	.00056	-0.64	0.524	-.001463	.000745	47.4821
edu	-.0092325	.0143	-0.65	0.518	-.037257	.018792	.789286

Marginal effects from multinomial logit

y = Pr(cop=6)
= .0349977

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0079084	.02173	-0.36	0.716	-.05049	.034674	1.72857
age	.0020131	.0006	3.38	0.001	.000846	.00318	47.4821
edu	.0320096	.01548	2.07	0.039	.001666	.062353	.789286

Marginal effects from multinomial logit

y = Pr(cop=7)
= .03490049

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0454333	.0311	1.46	0.144	-.015519	.106386	1.72857
age	-.0004898	.00069	-0.71	0.478	-.001844	.000865	47.4821
edu	-.0193241	.01758	-1.10	0.272	-.05379	.015142	.789286

Marginal effects from multinomial logit

y = Pr(cop=8)
= 2.792e-20

variable	dy/dx	X
gender	0	1.72857
age	.	47.4821
edu	0	.789286

Marginal effects from multinomial logit

y = Pr(cop=9)
= .01385534

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0134583	.01191	-1.13	0.258	-.036802	.009886	1.72857
age	-.0004	.00037	-1.08	0.279	-.001125	.000325	47.4821
edu	-.0197286	.01028	-1.92	0.055	-.039883	.000426	.789286

B-6.3 Coping strategies by gender during 2004/05 agricultural season

Table B-6.5: Multinomial logistic model for women headed households 2004/05

Multinomial logistic regression	Number of obs = 73
	LR chi2(18) = 27.48
	Prob > chi2 = 0.0705
Log likelihood = -100.376	Pseudo R2 = 0.1204

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	-.0653698	.0723367	-0.90	0.366	-.2071472	.0764075
ed	-1.24755	1.53299	-0.81	0.416	-4.252156	1.757056
_cons	8.048894	5.295947	1.52	0.129	-2.330973	18.42876
2						
age	-.0892909	.0731758	-1.22	0.222	-.2327128	.0541309
ed	-1.364656	1.560136	-0.87	0.382	-4.422467	1.693154
_cons	8.895126	5.325547	1.67	0.095	-1.542754	19.33301
3						
age	-.0498822	.0734251	-0.68	0.497	-.1937928	.0940284
ed	-1.967614	1.607648	-1.22	0.221	-5.118545	1.183317
_cons	6.817355	5.36903	1.27	0.204	-3.70575	17.34046
4						
age	-.1252252	.0853149	-1.47	0.142	-.2924394	.041989
ed	-35.88787	1.77e+07	-0.00	1.000	-3.46e+07	3.46e+07
_cons	8.9772	5.587159	1.61	0.108	-1.973431	19.92783
5						
age	.0330757	.0936259	0.35	0.724	-.1504276	.216579
ed	.2522849	1.782897	0.14	0.887	-3.242128	3.746698
_cons	-1.706924	7.048056	-0.24	0.809	-15.52086	12.10701
6						
age	-.0922862	.0997876	-0.92	0.355	-.2878663	.1032939
ed	-.6689497	2.207867	-0.30	0.762	-4.996289	3.65839
_cons	5.378385	6.403654	0.84	0.401	-7.172546	17.92932
7						
age	-6.033942	.1290926	-46.74	0.000	-6.286958	-5.780925
ed	66.79626	.	.	.	.	.
_cons	16.0458	.	.	.	.	.
.						
8						
age	-.0755294	.0887199	-0.85	0.395	-.2494171	.0983583
ed	-36.03379	3.00e+07	-0.00	1.000	-5.87e+07	5.87e+07
_cons	6.148356	6.022248	1.02	0.307	-5.655034	17.95174
9						
age	-.0528883	.0831115	-0.64	0.525	-.2157838	.1100072
ed	-1.637262	1.984707	-0.82	0.409	-5.527216	2.252692
_cons	4.965526	5.904627	0.84	0.400	-6.607331	16.53838

(cop==0 is the base outcome)

Table B-6.6: Marginal effects multinomial logistic model for women 2004/05

Marginal effects from multinomial logit

y = Pr(cop=0)
= .00760179

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0005226	.00058	0.90	0.370	-.00062	.001665	48.2329
ed	.0105953	.01447	0.73	0.464	-.017768	.038959	.643836

Marginal effects after mlogit
y = Pr(cop=1)
= .45535834

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0015375	.00374	0.41	0.681	-.005789	.008864	48.2329
ed	.0665948	.10543	0.63	0.528	-.140044	.273233	.643836

Marginal effects after mlogit
y = Pr(cop=2)
= .31048545

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0063788	.00356	-1.79	0.073	-.01336	.000602	48.2329
ed	.0090477	.09712	0.09	0.926	-.181305	.199401	.643836

Marginal effects from multinomial logit

y = Pr(cop=3)
= .17643595

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0033283	.00272	1.22	0.221	-.002006	.008663	48.2329
ed	-.101242	.0853	-1.19	0.235	-.268426	.065942	.643836

Marginal effects from multinomial logit
y = Pr(cop=4)
= 1.324e-11

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-7.48e-13	.00004	-0.00	1.000	-.000072	.000072	48.2329
ed	-4.57e-10	.00497	-0.00	1.000	-.009747	.009747	.643836

Marginal effects from multinomial logit

y = Pr(cop=5)
= .00799828

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0008144	.00088	0.93	0.352	-.000901	.00253	48.2329
ed	.0131658	.01703	0.77	0.439	-.020214	.046546	.643836

Marginal effects from multinomial logit
y = Pr(cop=6)
= .01248896

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.000294	.00081	-0.36	0.716	-.001879	.001291	48.2329
ed	.0090526	.01914	0.47	0.636	-.028464	.046569	.643836

Marginal effects from multinomial logit
y = Pr(cop=7)
= 1.36e-103

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	0	0	.	.	0	0	48.2329
ed	2.99e-59	0	.	.	3.0e-59	3.0e-59	.643836

Marginal effects from multinomial logit
y = Pr(cop=8)
= 7.824e-12

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-5.31e-14	0	.	.	-5.3e-14	-5.3e-14	48.2329
ed	-2.71e-10	.00502	-0.00	1.000	-.009842	.009842	.643836

Marginal effects from multinomial logit

y = Pr(cop=9)
= .02963123

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0004699	.00121	0.39	0.698	-.001902	.002842	48.2329
ed	-.0072142	.03749	-0.19	0.847	-.080685	.066257	.643836

Table B-6.7 Multinomial logit model men 2004/05

Multinomial logistic regression	Number of obs = 183
	LR chi2(18) = 29.46
	Prob > chi2 = 0.0431
Log likelihood = -286.2679	Peudo R2 = 0.0489

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	-.0198802	.0397406	-0.50	0.617	-.0977704	.05801
ed	-2.091435	1.20636	-1.73	0.083	-4.455857	.2729878
_cons	6.691605	2.882551	2.32	0.020	1.04191	12.3413
2						
age	-.025079	.0399519	-0.63	0.530	-.1033832	.0532252
ed	-2.905063	1.217154	-2.39	0.017	-5.290642	-.5194849
_cons	7.705661	2.890096	2.67	0.008	2.041178	13.37014
3						
age	.0114049	.0427987	0.27	0.790	-.0724791	.0952888
ed	-1.541262	1.269467	-1.21	0.225	-4.029372	.9468474
_cons	3.14022	3.058961	1.03	0.305	-2.855234	9.135674
4						
age	-.0407922	.0424234	-0.96	0.336	-.1239405	.0423561
ed	-2.963523	1.288441	-2.30	0.021	-5.488821	-.4382244
_cons	6.686714	2.959405	2.26	0.024	.8863862	12.48704
5						
age	.0012457	.047809	0.03	0.979	-.0924583	.0949497
ed	-2.011467	1.402	-1.43	0.151	-4.759336	.7364022
_cons	3.1776	3.300136	0.96	0.336	-3.290548	9.645749
6						
age	.0115534	.0483669	0.24	0.811	-.083244	.1063507
ed	-1.956175	1.404028	-1.39	0.164	-4.708019	.7956691
_cons	2.624297	3.366552	0.78	0.436	-3.974023	9.222617
7						
age	-.0197752	.0431995	-0.46	0.647	-.1044446	.0648943
ed	-3.199542	1.321607	-2.42	0.015	-5.789845	-.6092398
_cons	5.762118	3.007501	1.92	0.055	-.1324769	11.65671
8						
age	.0150307	.0639666	0.23	0.814	-.1103415	.1404029
ed	-34.65779	6954048	-0.00	1.000	-1.36e+07	1.36e+07
_cons	2.499474	4.207443	0.59	0.552	-5.746963	10.74591
9						
age	-.0316235	.0485997	-0.65	0.515	-.1268772	.0636302
ed	-2.120251	1.443901	-1.47	0.142	-4.950244	.7097425
_cons	4.459534	3.22646	1.38	0.167	-1.864211	10.78328

(cop==0 is the base outcome)

Table B-6.8 Marginal effects multinomial logit model male headed 2004/05

Marginal effects from multinomial logit
y = Pr(cop=0)
= .0060502

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0001226	.00025	0.49	0.622	-.000365	.00061	41.4863
ed	.014976	.01125	1.33	0.183	-.007076	.037028	.863388

-

Marginal effects from multinomial logit

y = Pr(cop=1)
= .35115232

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.000136	.00212	0.06	0.949	-.00401	.004282	41.4863
ed	.1347908	.06042	2.23	0.026	.016363	.253219	.863388

Marginal effects from multinomial logit

y = Pr(cop=2)
= .38649506

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0018596	.00212	-0.88	0.380	-.006014	.002295	41.4863
ed	-.1661063	.06215	-2.67	0.008	-.287916	-.044296	.863388

Marginal effects from multinomial logit

y = Pr(cop=3)
= .05930832

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0018784	.00097	1.94	0.053	-.000021	.003778	41.4863
ed	.0553955	.02554	2.17	0.030	.005334	.105457	.863388

Marginal effects from multinomial logit
y = Pr(cop=4)
= .06911813

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0014186	.00101	-1.40	0.161	-.003401	.000563	41.4863
ed	-.0337459	.03018	-1.12	0.264	-.092898	.025407	.863388

.
Marginal effects from multinomial logit

y = Pr(cop=5)
= .02691532

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.000579	.00069	0.84	0.403	-.000779	.001937	41.4863

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
ed	.0124839	.01929	0.65	0.517	-.025322	.050289	.863388

Marginal effects from multinomial logit

y = Pr(cop=6)
= .02489723

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0007923	.00063	1.27	0.205	-.000434	.002018	41.4863
ed	.0129245	.0179	0.72	0.470	-.022157	.048006	.863388

Marginal effects from multinomial logit

y = Pr(cop=7)
= .05348299

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0000263	.00092	0.03	0.977	-.001781	.001833	41.4863
ed	-.0387353	.02628	-1.47	0.141	-.090246	.012775	.863388

Marginal effects from multinomial logit

y = Pr(cop=8)
= 1.389e-14

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
-							
age	4.95e-16	0	.	.	5.0e-16	5.0e-16	41.4863
ed	-4.95e-13	.00001	-0.00	1.000	-.000015	.000015	.863388

Marginal effects from multinomial logit

y = Pr(cop=9)
= .02258042

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-.0002564	.00063	-0.40	0.686	-.0015	.000987	41.4863
ed	.0080169	.01795	0.45	0.655	-.027158	.043192	.863388

B-6.4 Coping strageies by gender for 2006/07 agricultural season

Table B-6.9: Multinomial logit female headed 2006/07

```
Multinomial logistic regression                         Number of obs   =         77
                                                        LR chi2(18)     =      31.04
                                                        Prob > chi2     =     0.0285
Log likelihood = -121.29977                             Pseudo R2       =     0.1134
```

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	.0392663	.0499347	0.79	0.432	-.058604	.1371366
edu	-1.784528	1.122423	-1.59	0.112	-3.984437	.4153805
_cons	2.104195	2.611562	0.81	0.420	-3.014372	7.222762
2						
age	.0139757	.0501443	0.28	0.780	-.0843053	.1122567
edu	-1.94961	1.125537	-1.73	0.083	-4.155622	.2564027
_cons	3.363774	2.605004	1.29	0.197	-1.74194	8.469487
3						
age	.0908971	.053009	1.71	0.086	-.0129987	.1947929
edu	-1.50135	1.217971	-1.23	0.218	-3.88853	.8858294
_cons	-1.828057	2.937499	-0.62	0.534	-7.585448	3.929335
4						
age	.0087858	.0554616	0.16	0.874	-.0999169	.1174885
edu	-1.819481	1.276914	-1.42	0.154	-4.322187	.6832255
_cons	2.163456	2.882582	0.75	0.453	-3.486302	7.813213
5						
age	.054263	.0759442	0.71	0.475	-.094585	.2031109
edu	-40.99871	3.67e+08	-0.00	1.000	-7.18e+08	7.18e+08
_cons	-1.232318	4.55572	-0.27	0.787	-10.16137	7.69673
6						
age	.0812892	.0574427	1.42	0.157	-.0312963	.1938747
edu	-.4254775	1.303314	-0.33	0.744	-2.979925	2.12897
_cons	-3.019141	3.34956	-0.90	0.367	-9.584158	3.545875
7						
age	-5.915451	.059474	-99.46	0.000	-6.032018	-5.798884
edu	67.27908	.	.	.	.	.
_cons	26.32054	.	.	.	.	.
.						
8						
age	.0294485	.0738619	0.40	0.690	-.1153181	.1742151
edu	-41.33734	3.63e+08	-0.00	1.000	-7.12e+08	7.12e+08
_cons	.2333229	4.085211	0.06	0.954	-7.773543	8.240189
9						
age	.048579	.0602891	0.81	0.420	-.0695855	.1667435
edu	-1.458862	1.456241	-1.00	0.316	-4.313042	1.395317
_cons	-.6592133	3.395266	-0.19	0.846	-7.313812	5.995386

(cop==0 is the base outcome)

Table B-6.10: Marginal effects multinomial logit female 2006/07

Marginal effects from multinomial logit

y = Pr(cop=0)
= .01940657

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-.0006965	.00086	-0.81	0.418	-.002381	.000988	50.2208
edu	.0330122	.02655	1.24	0.214	-.01902	.085044	.636364

Marginal effects after mlogit
y = Pr(cop=1)
= .36730043

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0012399	.00364	0.34	0.734	-.005899	.008379	50.2208
edu	-.0306496	.10458	-0.29	0.769	-.235616	.174317	.636364

Marginal effects from multinomial logit

y = Pr(cop=2)
= .32720811

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-.0071707	.00363	-1.97	0.049	-.014295	-.000047	50.2208
edu	-.08132	.10304	-0.79	0.430	-.283274	.120634	.636364

Marginal effects from multinomial logit

y = Pr(cop=3)
= .11524651

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0063393	.00218	2.91	0.004	.002063	.010616	50.2208
edu	.0230185	.06518	0.35	0.724	-.104726	.150763	.636364

Marginal effects from multinomial logit

y = Pr(cop=4)
= .08247094

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-.0022354	.002	-1.12	0.264	-.006156	.001686	50.2208
edu	-.0097644	.0573	-0.17	0.865	-.122071	.102542	.636364

Marginal effects from multinomial logit

y = Pr(cop=5)
= 4.032e-13

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	7.40e-15	0	.	.	7.4e-15	7.4e-15	50.2208
edu	-1.58e-11	.	.	.	.	.	.636364

Marginal effects from multinomial logit

```
      y  = Pr(cop=6)
         =   .0428677
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0019461	.00134	1.46	0.146	-.000675	.004567	50.2208
edu	.0546823	.03377	1.62	0.105	-.011506	.120871	.636364

Marginal effects from multinomial logit

```
      y  = Pr(cop=7)
         =  1.96e-101
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	0	0	.	.	0	0	50.2208
edu	4.08e-58	0	.	.	4.1e-58	4.1e-58	.636364

Marginal effects from multinomial logit

```
      y  = Pr(cop=8)
         =  4.048e-13
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-2.61e-15	0	.	.	-2.6e-15	-2.6e-15	50.2208
edu	-1.60e-11	.	.	.	.	.	.636364

-

Marginal effects from multinomial logit

```
      y  = Pr(cop=9)
         =  .04549973
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0005773	.0016	0.36	0.719	-.002564	.003719	50.2208
edu	.011021	.04462	0.25	0.805	-.076431	.098473	.636364

Table B-6.11: Multinomial logit model male headed households 2006/07

Multinomial logistic regression

Number of obs = 204
LR chi2(16) = 42.53
Prob > chi2 = 0.0003
Log likelihood = -309.26561
Pseudo R2 = 0.0643

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	-.0010396	.0287963	-0.04	0.971	-.0574792	.0554
edu	-.4162377	.6764544	-0.62	0.538	-1.742064	.9095886
_cons	2.889896	1.565129	1.85	0.065	-.1776995	5.957492
2						
age	.0173296	.0289701	0.60	0.550	-.0394508	.07411
edu	-1.32556	.6933817	-1.91	0.056	-2.684563	.0334427
_cons	2.703632	1.574064	1.72	0.086	-.3814768	5.788741
3						
age	.041628	.0333055	1.25	0.211	-.0236495	.1069055
edu	-.3464581	.8091427	-0.43	0.669	-1.932349	1.239432
_cons	-.9578664	1.913159	-0.50	0.617	-4.707589	2.791856
4						
age	.0042053	.0357036	0.12	0.906	-.0657725	.074183
edu	-1.401919	.8801811	-1.59	0.111	-3.127042	.3232044
_cons	1.32938	1.878836	0.71	0.479	-2.35307	5.011829
5						
age	-.0262871	.0448401	-0.59	0.558	-.1141721	.0615978
edu	-.9540067	.9960851	-0.96	0.338	-2.906298	.9982842
_cons	1.694984	2.148693	0.79	0.430	-2.516376	5.906345
6						
age	.0747687	.0369523	2.02	0.043	.0023436	.1471938
edu	-.1880861	.8860663	-0.21	0.832	-1.924744	1.548572
_cons	-3.325723	2.291311	-1.45	0.147	-7.816611	1.165164
7						
age	.0071552	.0346976	0.21	0.837	-.0608507	.0751612
edu	-1.933014	.8834134	-2.19	0.029	-3.664472	-.2015557
_cons	1.610511	1.825872	0.88	0.378	-1.968133	5.189154
9						
age	-.0598798	.0661466	-0.91	0.365	-.1895248	.0697652
edu	-34.06421	6826810	-0.00	1.000	-1.34e+07	1.34e+07
_cons	3.531986	2.53418	1.39	0.163	-1.434915	8.498888

(cop==0 is the base outcome)

Table B-6.12: Marginal effects multinomial logit model male headed 2006/07

Marginal effects from multinomial logit
y = Pr(cop=0)
= .03275303

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0003571	.00088	-0.40	0.687	-.002091	.001377	46.6716
edu	.02762	.01911	1.45	0.148	-.009839	.065079	.843137

Marginal effects from multinomial logit
y = Pr(cop=1)

= .39521352

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0047193	.00248	-1.90	0.057	-.009586	.000148	46.6716
edu	.1687735	.06184	2.73	0.006	.047571	.289976	.843137

Marginal effects from multinomial logit

y = Pr(cop=2)
= .35917045

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0023088	.00233	0.99	0.322	-.002264	.006882	46.6716
edu	-.1732203	.06143	-2.82	0.005	-.29363	-.052811	.843137

Marginal effects from multinomial logit

y = Pr(cop=3)
= .06548754

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0020122	.00109	1.85	0.064	-.000118	.004142	46.6716
edu	.0325357	.02936	1.11	0.268	-.025012	.090084	.843137

Marginal effects from multinomial logit

y = Pr(cop=4)
= .04618392

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0003093	.001	-0.31	0.758	-.002277	.001659	46.6716
edu	-.0258001	.02532	-1.02	0.308	-.075419	.023818	.843137

-

Marginal effects from multinomial logit

y = Pr(cop=5)
= .02340055

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X

age	-.0008702	.00072	-1.22	0.224	-.002272	.000531	46.6716
edu	-.002591	.01745	-0.15	0.882	-.036798	.031616	.843137

Marginal effects after mlogit
y = Pr(cop=6)
= .03292603

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0021029	.0007	3.01	0.003	.000736	.00347	46.6716
edu	.021573	.01854	1.16	0.245	-.014759	.057905	.843137

Marginal effects from multinomial logit

y = Pr(cop=7)
= .04486496

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0001681	.00091	-0.19	0.853	-.001943	.001607	46.6716
edu	-.0488908	.02253	-2.17	0.030	-.09305	-.004732	.843137

Marginal effects from multinomial logit
y = Pr(cop=9)
= 2.302e-14

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-1.65e-15	0	.	.	-1.7e-15	-1.7e-15	46.6716
edu	-7.81e-13	.00001	-0.00	1.000	-.000023	.000023	.843137

B-6.5 Coping strategies for households with mortality 2004/05

Table B-6.13: Multinomial logistic model 2004/05 mortality

```
Multinomial logistic regression                   Number of obs   =         33
                                                  LR chi2(18)     =      27.14
                                                  Prob > chi2     =     0.0763
Log likelihood = -41.352922                       Pseudo R2       =     0.2471
```

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
gender	19.78962	20299.05	0.00	0.999	-39765.61	39805.19
age	.0087967	.0927169	0.09	0.924	-.1729251	.1905185
ed	-.8126421	2.247189	-0.36	0.718	-5.217051	3.591767
_cons	-17.40897	20299.05	-0.00	0.999	-39802.81	39767.99
2						
gender	21.10365	20299.05	0.00	0.999	-39764.3	39806.5
age	-.038949	.102106	-0.38	0.703	-.2390732	.1611751
ed	-.30067	2.497044	-0.12	0.904	-5.194785	4.593445
_cons	-18.64812	20299.05	-0.00	0.999	-39804.05	39766.75
3						
gender	18.95671	20299.05	0.00	0.999	-39766.44	39804.36
age	.0323437	.0979598	0.33	0.741	-.1596541	.2243414
ed	-1.692949	2.566973	-0.66	0.510	-6.724124	3.338226
_cons	-17.91616	20299.05	-0.00	0.999	-39803.32	39767.49
4						
gender	24.03953	20299.05	0.00	0.999	-39761.36	39809.44
age	-.0781022	.1045208	-0.75	0.455	-.2829592	.1267548
ed	-4.875526	3.065805	-1.59	0.112	-10.88439	1.133342
_cons	-18.59685	20299.05	-0.00	0.999	-39804	39766.8
5						
gender	20.2189	20299.05	0.00	0.999	-39765.18	39805.62
age	.0642899	.1238688	0.52	0.604	-.1784884	.3070683
ed	-.8278986	3.512227	-0.24	0.814	-7.711738	6.055941
_cons	-23.00163	20299.05	-0.00	0.999	-39808.4	39762.4
7						
gender	44.04452	10149.52	0.00	0.997	-19848.66	19936.75
age	-.0758679	.1236756	-0.61	0.540	-.3182676	.1665318
ed	-42.08271	6.54e+07	-0.00	1.000	-1.28e+08	1.28e+08
_cons	-58.13955	.	.	.	.	.

(cop==9 is the base outcome)

Tbale B-6.14: Marginal effects mortality 2004/05

Marginal effects from multinomial logit

y = Pr(cop=1)
= .54812082

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.1863398	.65482	-0.28	0.776	-1.46977	1.09709	1.45455
age	.0023174	.00849	0.27	0.785	-.014327	.018962	51.303
ed	.2123207	.29371	0.72	0.470	-.363345	.787986	.636364

Marginal effects from multinomial logit

y = Pr(cop=2)
= .12837594

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.1250467	.20051	0.62	0.533	-.267948	.518042	1.45455
age	-.0055866	.00554	-1.01	0.313	-.016449	.005275	51.303
ed	.1154528	.15778	0.73	0.464	-.193793	.424699	.636364

Marginal effects from multinomial logit

y = Pr(cop=3)
= .18785003

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
--							
gender	-.2203234	.29734	-0.74	0.459	-.803093	.362446	1.45455
age	.0052175	.00645	0.81	0.419	-.007431	.017866	51.303
ed	-.0925999	.2338	-0.40	0.692	-.550846	.365646	.636364

Marginal effects from multinomial logit

y = Pr(cop=4)
= .07057378

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.2759397	.16394	1.68	0.092	-.045387	.597266	1.45455
age	-.0058344	.00428	-1.36	0.172	-.014216	.002547	51.303
ed	-.2593955	.18172	-1.43	0.153	-.615562	.096771	.636364

Marginal effects from multinomial logit

y = Pr(cop=5)
= .06507271

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0058119	.16691	0.03	0.972	-.321328	.332951	1.45455
age	.0038862	.00424	0.92	0.360	-.004431	.012203	51.303
ed	.0242139	.16449	0.15	0.883	-.298186	.346614	.636364

Marginal effects from multinomial logit

y = Pr(cop=7

= 1.201e-16

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	1.19e-14	0	.	.	1.2e-14	1.2e-14	1.45455
age	0	0	.	.	0	0	51.303
ed	0	0	.	.	0	0	.636364

Marginal effects from multinomial logit

y = Pr(cop=9)
= 6.714e-06

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0001351	1.11068	-0.00	1.000	-2.17703	2.17676	1.45455
age	-3.07e-08	.00028	-0.00	1.000	-.000555	.000555	51.303
ed	8.06e-06	.07433	0.00	1.000	-.145684	.145701	.636364

Table B-6.15: Multinomial logit model mortality female 2004/05

Multinomial logistic regression — Number of obs = 18; LR chi2(10) = 7.11; Prob > chi2 = 0.7151

Log likelihood = -22.403059 — Pseudo R2 = 0.1369

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
1						
age	.010731	.0914947	0.12	0.907	-.1685953	.1900574
ed	-.8865058	2.225249	-0.40	0.690	-5.247914	3.474902
_cons	2.333625	5.314411	0.44	0.661	-8.082429	12.74968
2						
age	-.044087	.110712	-0.40	0.690	-.2610786	.1729046
ed	-.387746	2.485384	-0.16	0.876	-5.259009	4.483517
_cons	2.719004	5.869677	0.46	0.643	-8.785352	14.22336
3						
age	.0278975	.0953881	0.29	0.770	-.1590596	.2148547
ed	-1.188238	2.432197	-0.49	0.625	-5.955257	3.578782
_cons	1.125824	5.64556	0.20	0.842	-9.93927	12.19092
4						
age	-.0457833	.1062749	-0.43	0.667	-.2540783	.1625118
ed	-36.22709	2.50e+07	-0.00	1.000	-4.89e+07	4.89e+07
_cons	4.152052	5.917261	0.70	0.483	-7.445566	15.74967
5						
age	.0413868	.1221862	0.34	0.735	-.1980937	.2808673
ed	-34.80371	3.25e+07	-0.00	1.000	-6.37e+07	6.37e+07
_cons	-.9311363	7.78619	-0.12	0.905	-16.19179	14.32952

(cop==9 is the base outcome)

Table B-6.16: Marginal effects mortality female headed 2004/05

Marginal effects from multinomial logit

y = Pr(cop=1)
= .55173735

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0005899	.00973	-0.06	0.952	-.019669	.018489	49.2222
ed	.0089701	.30776	0.03	0.977	-.594231	.612171	.555556

Marginal effects from multinomial logit

y = Pr(cop=2)
= .0720438

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0040263	.00411	-0.98	0.327	-.012084	.004031	49.2222
ed	.0371038	.10425	0.36	0.722	-.167222	.24143	.555556

Marginal effects from multinomial logit

y = Pr(cop=3)
= .32460731

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0052253	.00952	0.55	0.583	-.013426	.023876	49.2222
ed	-.0926669	.31268	-0.30	0.767	-.705504	.52017	.555556

Marginal effects from multinomial logit

y = Pr(cop=4)
= 6.260e-10

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-3.60e-11	.	.	.	.	.	49.2222
ed	-2.21e-08	.29104	-0.00	1.000	-.570435	.570435	.555556

Marginal effects from multinomial logit

y = Pr(cop=5)
= 6.249e-10

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	1.85e-11	.	.	.	.	.	49.2222
ed	-2.12e-08	.36247	-0.00	1.000	-.710435	.710435	.555556

Marginal effects from multinomial logit

y = Pr(cop=9)

= .05161153

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-.000609	.0043	-0.14	0.887	-.009028	.00781	49.2222
ed	.046593	.10166	0.46	0.647	-.152647	.245834	.555556

Table B-6.16: Multinomial logit model mortality male headed households 2004/05

Multinomial logistic regression

Number of obs = 15
LR chi2(10) = 17.48
Prob > chi2 = 0.0645
Log likelihood = -15.857448
Pseudo R2 = 0.3553

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	.0839101	.1337956	0.63	0.531	-.1783244	.3461445
ed	45.39778	19072	0.00	0.998	-37335.03	37425.83
_cons	-27.38989	.	.	.	.	.
2						
age	.0442156	.1364942	0.32	0.746	-.2233081	.3117393
ed	43.42615	19072	0.00	0.998	-37337	37423.85
_cons	-23.96209	.	.	.	.	.
3						
age	.8954952	.0186683	47.97	0.000	.858906	.9320844
ed	9.312502	1.45e+07	0.00	1.000	-2.85e+07	2.85e+07
_cons	-72.256	.	.	.	.	.
4						
age	-.0222362	.0880923	-0.25	0.801	-.1948939	.1504216
ed	21.39474	19072	0.00	0.999	-37359.03	37401.82
_cons	.6677781	5.461655	0.12	0.903	-10.03687	11.37243
- 5						
age	.2173251	.2791643	0.78	0.436	-.3298268	.764477
ed	46.92265	.	.	.	.	.
_cons	-37.73695	19072	-0.00	0.998	-37418.18	37342.7

(cop==7 is the base outcome)

Table B-6.17: Marginal effects mortality male headed 2004/05

Marginal effects from multinomial logit

y = Pr(cop=1)
= .00854936

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0008933	.01665	0.05	0.957	-.031737	.033523	53.8
ed*	.5288386	.17639	3.00	0.003	.183112	.874565	.733333

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=2)
= .00733189

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0004751	.01256	0.04	0.970	-.024148	.025098	53.8
ed*	.2680819	.15656	1.71	0.087	-.038779	.574942	.733333

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=3)
= 8.261e-15

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	7.79e-15	0	.	.	7.8e-15	7.8e-15	53.8
ed*	-2.20e-11	.	.	.	.	.	.733333

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=4)
= .98301909

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0016299	1.29835	-0.00	0.999	-2.54636	2.5431	53.8
ed*	-.2699082	.33792	-0.80	0.424	-.932217	.392401	.733333

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=5)
= .0010994

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0002616	1.32729	0.00	1.000	-2.60117	2.60169	53.8
ed*	.1021276	.1094	0.93	0.351	-.112297	.316553	.733333

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=7)
= 2.560e-07

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	5.27e-09	.00007	0.00	1.000	-.000145	.000145	53.8
ed*	-.6291398	.31903	-1.97	0.049	-1.25443	-.003852	.733333

(*) dy/dx is for discrete change of dummy variable from 0 to 1

B-6.6 Coping strategies household morbidity 2004/05

Table -5.18: Multinomial logit model morbidity 2004/05

Multinomial logistic regression

Log likelihood = -333.56002

Number of obs	=	221
LR chi2(27)	=	38.30
Prob > chi2	=	0.0733
Pseudo R2	=	0.0543

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
gender	-19.61417	2.207778	-8.88	0.000	-23.94133	-15.287
age	-.0176616	.0394019	-0.45	0.654	-.0948879	.0595648
ed	-2.02851	1.188358	-1.71	0.088	-4.357649	.3006285
_cons	45.64013	3.41426	13.37	0.000	38.94831	52.33196
2						
gender	-19.28118	2.202885	-8.75	0.000	-23.59876	-14.96361
age	-.0253971	.0395184	-0.64	0.520	-.1028517	.0520576
ed	-2.648139	1.193998	-2.22	0.027	-4.988333	-.3079454
_cons	45.96554	3.398428	13.53	0.000	39.30475	52.62634
3						
gender	-19.91728	2.247939	-8.86	0.000	-24.32316	-15.5114
age	.008384	.0413188	0.20	0.839	-.0725994	.0893673
ed	-1.931132	1.230583	-1.57	0.117	-4.34303	.4807664
_cons	43.44562	3.573483	12.16	0.000	36.44173	50.44952
4						
gender	-18.35958	2.431461	-7.55	0.000	-23.12516	-13.59401
age	-.0546395	.0430374	-1.27	0.204	-.1389912	.0297123
ed	-2.893856	1.285562	-2.25	0.024	-5.413513	-.3742004
_cons	43.43878	4.001986	10.85	0.000	35.59503	51.28253
5						
gender	-19.19862	2.47932	-7.74	0.000	-24.058	-14.33925
age	.0111456	.0479317	0.23	0.816	-.0827989	.1050901
ed	-1.276945	1.369097	-0.93	0.351	-3.960325	1.406435
_cons	40.04877	4.406574	9.09	0.000	31.41204	48.68549
6						
gender	-18.90144	2.461029	-7.68	0.000	-23.72497	-14.07791
age	.0043275	.0460684	0.09	0.925	-.0859649	.0946198
ed	-1.815317	1.337952	-1.36	0.175	-4.437656	.8070208
_cons	40.6141	4.25499	9.55	0.000	32.27447	48.95373
7						
gender	-18.60514	2.438434	-7.63	0.000	-23.38438	-13.8259
age	-.0395742	.0434725	-0.91	0.363	-.1247787	.0456304
ed	-2.229079	1.2872	-1.73	0.083	-4.751944	.2937857
_cons	42.69754	4.046701	10.55	0.000	34.76615	50.62893
8						
gender	-19.82288	1.748034	-11.34	0.000	-23.24896	-16.39679
age	.003517	.0533624	0.07	0.947	-.1010714	.1081054
ed	-37.41868	2.46e+07	-0.00	1.000	-4.83e+07	4.83e+07
_cons	42.61562	.	.	.	.	.
9						
gender	-19.11239	2.467653	-7.75	0.000	-23.94891	-14.27588
age	-.0136753	.0467507	-0.29	0.770	-.105305	.0779543
ed	-2.35609	1.376418	-1.71	0.087	-5.053818	.3416391
_cons	42.12966	4.209317	10.01	0.000	33.87955	50.37977

(cop==0 is the base outcome)

Table B-6.19: .Marginal effects morbidity 2004/05

Marginal effects from multinomial logit

y = Pr(cop=0)
= .00006208

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	.001203	.00121	1.00	0.319	-.001164	.00357	1.76018
age	1.23e-06	.00000	0.44	0.658	-4.2e-06	6.7e-06	42.1674
ed	.0001428	.0001	1.41	0.159	-.000056	.000342	.823529

Marginal effects from multinomial logit

y = Pr(cop=1)
= .37282845

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	-.0884302	.07979	-1.11	0.268	-.244809	.067949	1.76018
age	.0008005	.00195	0.41	0.682	-.003024	.004625	42.1674
ed	.1011836	.05291	1.91	0.056	-.002522	.204889	.823529

Marginal effects from multinomial logit

y = Pr(cop=2)
= .40188506

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	.0384982	.0831	0.46	0.643	-.124374	.201371	1.76018
age	-.0022459	.00197	-1.14	0.254	-.006105	.001614	42.1674
ed	-.1399503	.05489	-2.55	0.011	-.247536	-.032365	.823529

--

Marginal effects from multinomial logit

y = Pr(cop=3)
= .07916549

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	-.0427731	.03803	-1.12	0.261	-.117302	.031756	1.76018
age	.0022319	.00099	2.24	0.025	.000283	.00418	42.1674
ed	.0291941	.02762	1.06	0.291	-.024947	.083335	.823529

Marginal effects from multinomial logit

y = Pr(cop=4)
= .03871241

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	.0393858	.03764	1.05	0.295	-.034392	.113164	1.76018
age	-.0013484	.00066	-2.06	0.040	-.002633	-.000064	42.1674
ed	-.0229933	.01877	-1.22	0.221	-.059783	.013797	.823529

```
Marginal effects from multinomial logit

      y  = Pr(cop=5)
         =   .0180806

variable |       dy/dx    Std. Err.      z     P>|z|  [     95% C.I.   ]       X

  gender |   .0032247       .02045    0.16    0.875  -.036854  .043304   1.76018
     age |   .0005597       .00048    1.18    0.239  -.000372  .001492   42.1674
      ed |   .0184957       .01174    1.57    0.115  -.004522  .041514   .823529
```

```
Marginal effects from multinomial logit

      y  = Pr(cop=6)
         =  .02585245

variable |       dy/dx    Std. Err.      z     P>|z|  [     95% C.I.   ]       X

  gender |   .0122939       .02796    0.44    0.660    -.0425  .067088   1.76018
     age |    .000624        .0006    1.04    0.296  -.000547  .001795   42.1674
      ed |   .0125278       .01604    0.78    0.435  -.018918  .043973   .823529
```

```
Marginal effects from multinomial logit

      y  = Pr(cop=7)
         =  .03907228

variable |       dy/dx    Std. Err.      z     P>|z|  [     95% C.I.   ]       X

  gender |   .0301574       .03876    0.78    0.437   -.04582  .106134   1.76018
     age |  -.0007723       .00072   -1.07    0.283  -.002181  .000637   42.1674
      ed |   .0027673       .02006    0.14    0.890  -.036542  .042076   .823529
```

```
Marginal effects from multinomial logit
      y  = Pr(cop=8)

         =  6.743e-15

variable |       dy/dx    Std. Err.      z     P>|z|  [     95% C.I.   ]       X

  gender |          0            0       .        .         0        0   1.76018
     age |   1.57e-16            0       .        .   1.6e-16  1.6e-16   42.1674
      ed |          0            0       .        .         0        0   .823529
```

```
Marginal effects from multinomial logit

Marginal effects after mlogit
      y  = Pr(cop=9)
         =  .02434117
variable |       dy/dx    Std. Err.      z     P>|z|  [     95% C.I.   ]       X

  gender |   .0064403       .02719    0.24    0.813  -.046857  .059737   1.76018
     age |   .0001493       .00062    0.24    0.810  -.001066  .001364   42.1674
      ed |  -.0013676       .01714   -0.08    0.936  -.034956  .032221   .823529
```

Table B-6.20: Multinomial logit model morbidity female headed 2004/05

Multinomial logistic regression		
	Number of obs	= 55
	LR chi2(18)	= 28.64
	Prob > chi2	= 0.0530
Log likelihood = -69.570616	Pseudo R2	= 0.1707

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	-.0622721	.0742051	-0.84	0.401	-.2077114	.0831672
ed	-1.167571	1.69148	-0.69	0.490	-4.482811	2.147668
_cons	7.527159	5.460528	1.38	0.168	-3.175278	18.2296
2						
age	-.0845507	.0748638	-1.13	0.259	-.231281	.0621797
ed	-1.355045	1.713746	-0.79	0.429	-4.713924	2.003835
_cons	8.583275	5.481872	1.57	0.117	-2.160997	19.32755
3						
age	-.0450292	.0759585	-0.59	0.553	-.1939052	.1038467
ed	-2.074366	1.80629	-1.15	0.251	-5.614629	1.465898
_cons	6.142131	5.572519	1.10	0.270	-4.779805	17.06407
4						
age	-.1796603	.1456863	-1.23	0.218	-.4652003	.1058797
ed	-35.25548	2.29e+07	-0.00	1.000	-4.48e+07	4.48e+07
_cons	9.68443	6.469198	1.50	0.134	-2.994965	22.36382
5						
age	.6016404	359.3764	0.00	0.999	-703.7631	704.9664
ed	21.77383	11859.42	0.00	0.999	-23222.26	23265.81
_cons	-81.49713	.	.	.	.	.
6						
age	-.0922944	.1000523	-0.92	0.356	-.2883934	.1038046
ed	-.6103501	2.293602	-0.27	0.790	-5.105727	3.885026
_cons	5.335612	6.470389	0.82	0.410	-7.346117	18.01734
7						
age	-6.183168	.1333963	-46.35	0.000	-6.44462	-5.921716
ed	68.28047	.	.	.	.	.
_cons	16.4122	.	.	.	.	.
8						
age	-.0647877	.0902163	-0.72	0.473	-.2416084	.1120331
ed	-36.06281	3.12e+07	-0.00	1.000	-6.11e+07	6.11e+07
_cons	5.601684	6.167396	0.91	0.364	-6.48619	17.68956
9						
age	-.0182956	.0938031	-0.20	0.845	-.2021463	.1655551
ed	-35.43545	2.78e+07	-0.00	1.000	-5.44e+07	5.44e+07
_cons	2.798413	6.807465	0.41	0.681	-10.54397	16.1408

(cop==0 is the base outcome)

Table B-6.21: marginal effects multinomial logit 2004/05

Marginal effects from multinomial logit

y = Pr(cop=0)
= .01039244

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0007109	.00079	0.89	0.371	-.000847	.002269	47.9091
ed	.0139696	.01996	0.70	0.484	-.025146	.053085	.672727

Marginal effects from multinomial logit

y = Pr(cop=1)
= .4455814

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0027336	.00431	0.63	0.526	-.005721	.011188	47.9091
ed	.0787057	.11992	0.66	0.512	-.15633	.313741	.672727

Marginal effects from multinomial logit

y = Pr(cop=2)
= .38839849

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0062702	.00433	-1.45	0.147	-.014747	.002207	47.9091
ed	-.0042093	.1174	-0.04	0.971	-.234311	.225893	.672727

Marginal effects from multinomial logit

y = Pr(cop=3)
= .13843732

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0032364	.00273	1.18	0.236	-.002119	.008592	47.9091
ed	-.1010812	.08467	-1.19	0.233	-.267034	.064872	.672727

Marginal effects from multinomial logit

y = Pr(cop=4)
= 1.528e-12

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-1.70e-13	0	.	.	-1.7e-13	-1.7e-13	47.9091
ed	-5.18e-11	.	.	.	.	.	.672727

Marginal effects from multinomial logit
y = Pr(cop=5)
= 3.181e-19

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	1.54e-17	0	.	.	1.5e-17	1.5e-17	47.9091
ed	3.14e-16	0	.	.	3.1e-16	3.1e-16	.672727

Marginal effects from multinomial logit

y = Pr(cop=6)
= .01719035

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0004106	.00109	-0.38	0.705	-.00254	.001719	47.9091
ed	.0126153	.0261	0.48	0.629	-.038541	.063771	.672727

Marginal effects from multinomial logit

y = Pr(cop=7)
= 2.77e-104

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	0	0	.	.	0	0	47.9091
ed	2.15e-50	0	.	.	2.1e-50	2.1e-50	.672727

--

Marginal effects from multinomial logit

y = Pr(cop=8)
= 3.675e-12

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	1.33e-14	0	.	.	1.3e-14	1.3e-14	47.9091
ed	-1.28e-10	.0026	-0.00	1.000	-.005097	.005097	.672727

Marginal effects from multinomial logit

y = Pr(cop=9)
= 3.151e-12

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	1.58e-13	0	.	.	1.6e-13	1.6e-13	47.9091
ed	-1.07e-10	.00198	-0.00	1.000	-.003881	.003881	.672727

Table B-6.22: Multinomial logit model morbidity male headed

Multinomial logistic regression		Number of obs =	168
		LR chi2(18) =	28.43
		Prob > chi2 =	0.0558
Log likelihood = -257.94071		Pseudo R2 =	0.0522

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	-.0202252	.0393994	-0.51	0.608	-.0974466	.0569962
ed	-2.019711	1.197934	-1.69	0.092	-4.367619	.3281967
_cons	6.520334	2.830616	2.30	0.021	.9724296	12.06824
2						
age	-.0227262	.0396045	-0.57	0.566	-.1003496	.0548972
ed	-2.831703	1.208408	-2.34	0.019	-5.200139	-.4632678
_cons	7.455792	2.837423	2.63	0.009	1.894545	13.01704
3						
age	.0034627	.0424083	0.08	0.935	-.0796561	.0865815
ed	-1.296622	1.263926	-1.03	0.305	-3.773872	1.180628
_cons	3.139317	2.998304	1.05	0.295	-2.73725	9.015884
4						
age	-.0500867	.043125	-1.16	0.245	-.1346101	.0344367
ed	-2.826076	1.301261	-2.17	0.030	-5.376502	-.2756511
_cons	6.558909	2.922363	2.24	0.025	.8311836	12.28663
5						
age	-.0045038	.0489942	-0.09	0.927	-.1005307	.0915232
ed	-1.985011	1.430414	-1.39	0.165	-4.788571	.8185493
_cons	3.177556	3.28246	0.97	0.333	-3.255948	9.61106
6						
age	.0140393	.0479376	0.29	0.770	-.0799167	.1079952
ed	-1.917201	1.387116	-1.38	0.167	-4.635897	.8014959
_cons	2.457352	3.296808	0.75	0.456	-4.004273	8.918977
7						
age	-.0327014	.0438989	-0.74	0.456	-.1187416	.0533389
ed	-2.68287	1.321501	-2.03	0.042	-5.272965	-.0927751
_cons	5.636685	2.969056	1.90	0.058	-.1825573	11.45593
8						
age	.0228323	.0654888	0.35	0.727	-.1055234	.1511879
ed	-33.42931	3973384	-0.00	1.000	-7787723	7787656
_cons	2.008964	4.256917	0.47	0.637	-6.334439	10.35237
9						
age	-.0290268	.0483735	-0.60	0.548	-.1238371	.0657836
ed	-2.032649	1.425905	-1.43	0.154	-4.827371	.7620732
_cons	4.237837	3.168376	1.34	0.181	-1.972065	10.44774

(cop==0 is the base outcome)

Table B-6.23: Marginal effects morbidity male headed

Marginal effects from multinomial logit
y = Pr(cop=0)
= .00690746

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0001441	.00028	0.51	0.607	-.000405	.000693	40.3869
ed	.0163137	.01197	1.36	0.173	-.007144	.039771	.875

Marginal effects from multinomial logit

y = Pr(cop=1)

= .35384434

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0002241	.00221	0.10	0.919	-.004115	.004563	40.3869
ed	.1210264	.06168	1.96	0.050	.000144	.241909	.875

Marginal effects from multinomial logit

y = Pr(cop=2) (predict, outcome(2))
= .40054025

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-.0007481	.00226	-0.33	0.740	-.005174	.003678	40.3869
ed	-.1882376	.0645	-2.92	0.004	-.314652	-.061823	.875

Marginal effects from multinomial logit

y = Pr(cop=3) (predict, outcome(3))
= .05898146

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0014345	.00102	1.40	0.160	-.000568	.003437	40.3869
ed	.0628225	.02551	2.46	0.014	.012832	.112813	.875

Marginal effects from multinomial logit

Marginal effects after mlogit
y = Pr(cop=4)
= .05437187

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-.0015892	.0009	-1.77	0.077	-.003352	.000174	40.3869
ed	-.0252466	.02692	-0.94	0.348	-.078007	.027514	.875

Marginal effects from multinomial logit

y = Pr(cop=5)
= .02432197

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0003978	.0007	0.57	0.570	-.000976	.001771	40.3869
ed	.0091629	.01913	0.48	0.632	-.02833	.046656	.875

Marginal effects from multinomial logit

y = Pr(cop=6)
= .02655998

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0009269	.00065	1.42	0.156	-.000353	.002207	40.3869
ed	.0118071	.01885	0.63	0.531	-.025145	.048759	.875

Marginal effects from multinomial logit

y = Pr(cop=7)
= .04945531

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0005857	.00096	-0.61	0.543	-.002473	.001301	40.3869
ed	-.0158814	.02728	-0.58	0.560	-.06934	.037577	.875

Marginal effects from multinomial logit

y = Pr(cop=8)
= 2.564e-14

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	1.12e-15	0	.	.	1.1e-15	1.1e-15	40.3869
ed	-8.12e-13	.00001	-0.00	1.000	-.000015	.000015	.875

Marginal effects from multinomial logit

y = Pr(cop=9)
= .02501736

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0002043	.00071	-0.29	0.774	-.0016	.001191	40.3869
ed	.0082331	.01947	0.42	0.672	-.029927	.046393	.875

B-6.7 Coping strategies for households by mortality 2006/07

Table B-6.24: Multinomial logit mortality 2006/07

```
Multinomial logistic regression                   Number of obs   =         41
                                                  LR chi2(21)     =      18.37
                                                  Prob > chi2     =     0.6253
Log likelihood = -58.739546                       Pseudo R2       =     0.1352
```

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
gender	20.02863	19318.61	0.00	0.999	-37843.74	37883.8
age	.0335112	.0930224	0.36	0.719	-.1488093	.2158318
edu	-.3498972	2.180004	-0.16	0.872	-4.622626	3.922832
_cons	-19.22307	19318.61	-0.00	0.999	-37882.99	37844.55
2						
gender	20.57185	19318.61	0.00	0.999	-37843.2	37884.34
age	-.0150127	.0941325	-0.16	0.873	-.199509	.1694835
edu	-1.527742	2.260855	-0.68	0.499	-5.958937	2.903452
_cons	-17.08049	19318.61	-0.00	0.999	-37880.85	37846.69
3						
gender	19.79947	19318.61	0.00	0.999	-37843.97	37883.57
age	.0496026	.0987332	0.50	0.615	-.1439108	.2431161
edu	-.8108547	2.445159	-0.33	0.740	-5.603278	3.981569
_cons	-20.61388	19318.61	-0.00	0.999	-37884.39	37843.16
4						
gender	21.1708	19318.61	0.00	0.999	-37842.6	37884.94
age	-.0716173	.1160839	-0.62	0.537	-.2991376	.155903
edu	-2.964312	2.707532	-1.09	0.274	-8.270977	2.342353
_cons	-16.25027	19318.61	-0.00	0.999	-37880.02	37847.52
5						
gender	20.50151	19318.61	0.00	0.999	-37843.27	37884.27
age	.0319055	.1070912	0.30	0.766	-.1779895	.2418005
edu	-1.79005	2.827849	-0.63	0.527	-7.332533	3.752433
_cons	-20.97835	19318.61	-0.00	0.999	-37884.75	37842.79
6						
gender	20.51998	19318.61	0.00	0.999	-37843.25	37884.29
age	.0226896	.1064559	0.21	0.831	-.18596	.2313393
edu	-1.94966	2.794027	-0.70	0.485	-7.425852	3.526531
_cons	-20.39861	19318.61	-0.00	0.999	-37884.17	37843.37
7						
gender	41.58334	9659.304	0.00	0.997	-18890.3	18973.47
age	.0451897	.1160932	0.39	0.697	-.1823487	.2727282
edu	-43.17458	4.85e+08	-0.00	1.000	-9.50e+08	9.50e+08
_cons	-62.09479	.	.	.	.	.

(cop==9 is the base outcome)

Table B-6.25: Marginal effects mortality 2006/07

Marginal effects after mlogit
y = Pr(cop=1)
= .43454928

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0956063	.26991	-0.35	0.723	-.624627	.433414	1.5122
age	.0071287	.0073	0.98	0.329	-.007188	.021446	52.3659
edu	.2852215	.22383	1.27	0.203	-.153471	.723914	.682927

Marginal effects from multinomial logit

y = Pr(cop=2)
= .29676942

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0959169	.17546	0.55	0.585	-.247984	.439818	1.5122
age	-.009532	.00682	-1.40	0.162	-.022896	.003832	52.3659
edu	-.1547603	.19619	-0.79	0.430	-.539284	.229763	.682927

Marginal effects from multinomial logit

y = Pr(cop=3)
= .12964446

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0582336	.11879	-0.49	0.624	-.291064	.174597	1.5122
age	.004213	.00454	0.93	0.354	-.004693	.013118	52.3659
edu	.0253331	.14767	0.17	0.864	-.264097	.314763	.682927

Marginal effects from multinomial logit

y = Pr(cop=4)
= .03257974

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0300434	.05448	0.55	0.581	-.07674	.136827	1.5122
age	-.0028906	.00219	-1.32	0.186	-.007175	.001394	52.3659
edu	-.0637929	.06491	-0.98	0.326	-.191018	.063432	.682927

Marginal effects from multinomial logit

y = Pr(cop=5)
= .05279988

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0133511	.08485	0.16	0.875	-.152946	.179648	1.5122
age	.0007814	.00287	0.27	0.786	-.004853	.006416	52.3659
edu	-.0413841	.09352	-0.44	0.658	-.224678	.14191	.682927

Marginal effects from multinomial logit
y = Pr(cop=6)
= .05365574

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0145588	.0822	0.18	0.859	-.146556	.175673	1.5122
age	.0002996	.0029	0.10	0.918	-.005381	.005981	52.3659
edu	-.0506189	.09134	-0.55	0.579	-.229652	.128414	.682927

Marginal effects from multinomial logit

y = Pr(cop=7)
= 5.483e-18

variable	dy/dx	X
gender	1.30e-15	1.5122
age	.	52.3659
edu	0	.682927

. Marginal effects from multinomial logit

y = Pr(cop=9)
= 1.495e-06

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0000303	.27063	-0.00	1.000	-.530452	.530391	1.5122
age	-2.56e-08	.00025	-0.00	1.000	-.000496	.000496	52.3659
edu	1.50e-06	.01488	0.00	1.000	-.02917	.029173	.682927

Table B-6.26: Multinomial logit mortality female headed 2006/07

Multinomial logistic regression

Number of obs = 20
LR chi2(12) = 8.89
Prob > chi2 = 0.7124
Log likelihood = -27.49173
Pseudo R2 = 0.1392

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	.0254786	.0948757	0.27	0.788	-.1604743	.2114315
edu	-.8545388	2.274152	-0.38	0.707	-5.311795	3.602717
_cons	1.580457	5.587685	0.28	0.777	-9.371203	12.53212
2						
age	-.0230271	.0974809	-0.24	0.813	-.2140862	.168032
edu	-.9520718	2.316356	-0.41	0.681	-5.492047	3.587903
_cons	3.443601	5.622705	0.61	0.540	-7.576699	14.4639
3						
age	.0615016	.1043989	0.59	0.556	-.1431164	.2661196
edu	-1.038263	2.727251	-0.38	0.703	-6.383577	4.307051
_cons	-1.422244	6.47501	-0.22	0.826	-14.11303	11.26854
4						
age	-.0358295	.1123933	-0.32	0.750	-.2561164	.1844573
edu	-37.22357	4.28e+07	-0.00	1.000	-8.38e+07	8.38e+07
_cons	3.82469	6.307714	0.61	0.544	-8.538202	16.18758
5						
age	.0170894	.1106403	0.15	0.877	-.1997617	.2339405
edu	-36.78668	5.09e+07	-0.00	1.000	-9.97e+07	9.97e+07
_cons	.9161131	6.696331	0.14	0.891	-12.20845	14.04068
6						
age	.0681386	.1351423	0.50	0.614	-.1967356	.3330127
edu	.995631	3.190853	0.31	0.755	-5.258326	7.249588

_cons	-4.207466	8.907995	-0.47	0.637	-21.66682	13.25188

(cop==9 is the base outcome)

Table B-6.27: .Marginal effects mortality female headed

Marginal effects from multinomial logit

y = Pr(cop=1)
= .50959795

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.003391	.00909	0.37	0.709	-.014421	.021203	51.35
edu	-.0343216	.2746	-0.12	0.901	-.572518	.503875	.6

Marginal effects from multinomial logit

y = Pr(cop=2)
= .25659008

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0107386	.00817	-1.31	0.189	-.026751	.005273	51.35
edu	-.0423074	.22548	-0.19	0.851	-.484242	.399627	.6

Marginal effects from multinomial logit

y = Pr(cop=3)
= .14409431

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0061496	.00618	0.99	0.320	-.005964	.018264	51.35
edu	-.0361785	.22043	-0.16	0.870	-.46822	.395863	.6

Marginal effects from multinomial logit
y = Pr(cop=4)

= 6.882e-11

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-3.76e-12	.00019	-0.00	1.000	-.000377	.000377	51.35
edu	-2.51e-09	.06139	-0.00	1.000	-.120323	.120323	.6

Marginal effects from multinomial logit
y = Pr(cop=5)
= 7.388e-11

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-1.28e-13	0	.	.	-1.3e-13	-1.3e-13	51.35
edu	-2.66e-09	.07745	-0.00	1.000	-.151796	.151796	.6

Marginal effects from multinomial logit

y = Pr(cop=6)
= .04236788

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0020893	.00365	0.57	0.567	-.005068	.009246	51.35
edu	.0755343	.08342	0.91	0.365	-.087975	.239043	.6

Marginal effects from multinomial logit

y = Pr(cop=9)
= .04734978

---

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0008913	.00401	-0.22	0.824	-.00875	.006967	51.35
edu	.0372732	.09227	0.40	0.686	-.143573	.21812	.6

Table B-6.28: Multinomial logit model mortality male headed 2006/07

Multinomial logistic regression

Number of obs = 21
LR chi2(12) = 21.11
Prob > chi2 = 0.0487
Log likelihood = -23.21938
Pseudo R2 = 0.3126

cop		Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1							
	age	.0158128	.1112146	0.14	0.887	-.2021638	.2337894
	edu	41.7759	10759.22	0.00	0.997	-21045.91	21129.46
	_cons	-21.85321	.	.	.	.	.
2							
	age	-.0370948	.0779011	-0.48	0.634	-.1897782	.1155886
	edu	19.57942	10759.22	0.00	0.999	-21068.11	21107.26
	_cons	2.34295	5.0139	0.47	0.640	-7.484114	12.17001
3							
	age	-.0490541	.1344035	-0.36	0.715	-.3124802	.214372
	edu	39.81119	10759.22	0.00	0.997	-21047.88	21127.5
	_cons	-17.99746	.	.	.	.	.
4							
	age	-15.82163	283.1374	-0.06	0.955	-570.7607	539.1175
	edu	-65.60535	.	.	.	.	.
	_cons	688.33	.	.	.	.	.
5							
	age	.0245555	.1674573	0.15	0.883	-.3036548	.3527659
	edu	40.95651	.	.	.	.	.
	_cons	-23.57445	10759.22	-0.00	0.998	-21111.27	21064.12
6							
	age	-.0249355	.0928028	-0.27	0.788	-.2068256	.1569547
	edu	-14.44275	1.85e+07	-0.00	1.000	-3.63e+07	3.63e+07
	_cons	.9082663	6.016049	0.15	0.880	-10.88297	12.6995

(cop==7 is the base outcome)

Table B-6.29: .marginal effects mortality male headed 2006/07

Marginal effects from multinomial logit

y = Pr(cop=1)
= .01133569

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0005922	.00595	0.10	0.921	-.011069	.012253	53.3333
edu*	.5638518	.13602	4.15	0.000	.297256	.830448	.761905

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=2)
= .98316256

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0006502	.26297	-0.00	0.998	-.516064	.514764	53.3333
edu*	-.2172707	.30074	-0.72	0.470	-.806704	.372163	.761905

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=3)
= .00377053

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0000476	.00087	-0.05	0.957	-.001762	.001666	53.3333
edu*	.1174793	.09107	1.29	0.197	-.061018	.295976	.761905

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=4)
= 1.315e-96

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	0	0	.	.	0	0	53.3333
edu*	-9.57e-69	0	.	.	-9.6e-69	-9.6e-69	.761905

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=5)
= .00173099

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0001056	.26951	0.00	1.000	-.528125	.528336	53.3333
edu*	.070841	.06848	1.03	0.301	-.063372	.205054	.761905

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=6)
= 2.475e-12

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	2.85e-14	0	.	.	2.8e-14	2.8e-14	53.3333
edu*	-.2118894	.22556	-0.94	0.348	-.653983	.230204	.761905

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects from multinomial logit

y = Pr(cop=7)
= 2.268e-07

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	8.26e-09	.00007	0.00	1.000	-.000133	.000133	53.3333
edu*	-.323012	.26123	-1.24	0.216	-.835004	.18898	.761905

(*) dy/dx is for discrete change of dummy variable from 0 to 1

B-6.8 Coping strategies for households by morbidity 2006/07

Table B-5.30: Multinomial logit model morbidity 2006/07

Multinomial logistic regression — Number of obs = 239
LR chi2(27) = 55.22
Prob > chi2 = 0.0011
Log likelihood = -372.18972 — Pseudo R2 = 0.0691

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
gender	.6892528	.7531543	0.92	0.360	-.7869024	2.165408
age	.006913	.0238177	0.29	0.772	-.0397689	.0535949
edu	-.7398209	.5444157	-1.36	0.174	-1.806856	.3272144
_cons	1.409221	1.754227	0.80	0.422	-2.029	4.847442
2						
gender	.6087022	.761723	0.80	0.424	-.8842475	2.101652
age	.016326	.0239519	0.68	0.495	-.0306189	.0632709
edu	-1.38793	.5570055	-2.49	0.013	-2.479641	-.2962196
_cons	1.587446	1.772562	0.90	0.370	-1.886712	5.061604
3						
gender	-.1626336	.8660744	-0.19	0.851	-1.860108	1.534841
age	.055953	.0274335	2.04	0.041	.0021844	.1097215
edu	-.6596711	.6498957	-1.02	0.310	-1.933443	.6141011
_cons	-1.162722	2.089572	-0.56	0.578	-5.258208	2.932764
4						
gender	-.2300119	.9108878	-0.25	0.801	-2.015319	1.555295
age	.0039662	.0290358	0.14	0.891	-.0529429	.0608754
edu	-1.259847	.6934063	-1.82	0.069	-2.618899	.0992042
_cons	1.662923	2.113775	0.79	0.431	-2.48	5.805845
5						
gender	18.79101	1.071631	17.53	0.000	16.69065	20.89136
age	-.0403639	.0502082	-0.80	0.421	-.1387702	.0580424
edu	-1.152401	.9618201	-1.20	0.231	-3.037534	.7327313
_cons	-35.40431	.	.	.	.	.
6						
gender	.2878585	.9943294	0.29	0.772	-1.660991	2.236708
age	.0761442	.0311207	2.45	0.014	.0151487	.1371396

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
edu	.00057	.7191033	0.00	0.999	-1.408847	1.409987
_cons	-4.197953	2.55287	-1.64	0.100	-9.201486	.80558
7						
gender	1.335679	1.274406	1.05	0.295	-1.162111	3.833468
age	-.022422	.034419	-0.65	0.515	-.0898819	.045038
edu	-1.110865	.7480973	-1.48	0.138	-2.577109	.3553785
_cons	-.5011798	2.813416	-0.18	0.859	-6.015374	5.013015
8						
gender	-21.97656	3.553908	-6.18	0.000	-28.94209	-15.01103
age	.0162671	.0616463	0.26	0.792	-.1045575	.1370916
edu	-30.65966	2600904	-0.00	1.000	-5097708	5097647
_cons	21.9061	.	.	.	.	.
9						
gender	-.1577036	1.194312	-0.13	0.895	-2.498512	2.183105
age	-.008004	.0371341	-0.22	0.829	-.0807856	.0647776
edu	-3.031255	1.214092	-2.50	0.013	-5.410831	-.651678
_cons	1.845862	2.763645	0.67	0.504	-3.570782	7.262507

(cop==0 is the base outcome)

Table B-6.31: .Marginal effects morbidity 2006/07

Marginal effects from multinomial logit

y = Pr(cop=0)
= .03705786

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
gender	-.0195322	.02595	-0.75	0.452	-.070389	.031324	1.76569
age	-.0005355	.00081	-0.66	0.511	-.002133	.001062	46.6444
edu	.0366728	.01711	2.14	0.032	.003139	.070207	.807531

Marginal effects from multinomial logit

y = Pr(cop=1)
= .38905935

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
gender	.0630979	.08212	0.77	0.442	-.097846	.224041	1.76569
age	-.0029329	.00216	-1.36	0.175	-.007172	.001306	46.6444
edu	.0971826	.05362	1.81	0.070	-.007912	.202277	.807531

Marginal effects from multinomial logit

y = Pr(cop=2)
= .3707111

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
gender	.0302611	.08026	0.38	0.706	-.127051	.187573	1.76569
age	.0006949	.00209	0.33	0.740	-.003409	.004799	46.6444
edu	-.1476619	.05457	-2.71	0.007	-.254618	-.040706	.807531

Marginal effects from multinomial logit

y = Pr(cop=3)
= .06939269

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0478605	.03401	-1.41	0.159	-.114528	.018807	1.76569
age	.0028799	.00093	3.10	0.002	.001059	.004701	46.6444
edu	.0228953	.02602	0.88	0.379	-.028107	.073897	.807531

Marginal effects from multinomial logit

y = Pr(cop=4)
= .05665095

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0428895	.03122	-1.37	0.169	-.104071	.018292	1.76569
age	-.000594	.00098	-0.61	0.544	-.002514	.001326	46.6444
edu	-.0153092	.02498	-0.61	0.540	-.064263	.033645	.807531

Marginal effects after mlogit
y = Pr(cop=5)
= .00024025

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0043879	.00343	1.28	0.201	-.002332	.011107	1.76569
age	-.0000132	.00001	-1.89	0.059	-.000027	5.1e-07	46.6444
edu	-.0000391	.0002	-0.20	0.843	-.000426	.000348	.807531

Marginal effects from multinomial logit

y = Pr(cop=6)
= .03229626

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0077257	.02278	-0.34	0.734	-.052366	.036914	1.76569
age	.0019924	.00063	3.14	0.002	.000749	.003236	46.6444
edu	.0319791	.01567	2.04	0.041	.001271	.062687	.807531

Marginal effects from multinomial logit

y = Pr(cop=7)
= .03401421

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	.0275041	.03367	0.82	0.414	-.038485	.093494	1.76569
age	-.0012542	.00076	-1.65	0.099	-.002744	.000236	46.6444
edu	-.0041244	.0181	-0.23	0.820	-.039603	.031354	.807531

Marginal effects from multinomial logit

y = Pr(cop=8)
= 6.416e-20

----

variable	dy/dx	X
gender	0	1.76569
age	.	46.6444
edu	0	.807531

Marginal effects from multinomial logit

Marginal effects after mlogit

y = Pr(cop=9)
= .01057732

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gender	-.0072431	.0108	-0.67	0.502	-.028404	.013918	1.76569
age	-.0002375	.00033	-0.72	0.469	-.000881	.000406	46.6444
edu	-.0215951	.01101	-1.96	0.050	-.043171	-.000019	.807531

Table B-6.32: Multinomial logit model morbidity female headed 2006/07

Multinomial logistic regression

Number of obs = 57
LR chi2(16) = 25.62
Prob > chi2 = 0.0595
Log likelihood = -88.59291
Pseudo R2 = 0.1263

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	.0361515	.0472685	0.76	0.444	-.0564931	.1287961
edu	-1.838547	1.145541	-1.60	0.109	-4.083767	.4066724
_cons	1.864469	2.498474	0.75	0.456	-3.03245	6.761388
2						
age	.017163	.0472093	0.36	0.716	-.0753656	.1096915
edu	-2.006213	1.141294	-1.76	0.079	-4.243108	.2306815
_cons	2.980236	2.474573	1.20	0.228	-1.869838	7.83031
3						
age	.0920581	.0514368	1.79	0.073	-.0087562	.1928724
edu	-1.476736	1.239666	-1.19	0.234	-3.906438	.9529652
_cons	-2.263196	2.928051	-0.77	0.440	-8.002071	3.475678
4						
age	.0101213	.0531394	0.19	0.849	-.09403	.1142727
edu	-1.374896	1.263649	-1.09	0.277	-3.851601	1.10181
_cons	1.579159	2.78202	0.57	0.570	-3.8735	7.031817
6						
age	.0837663	.0574212	1.46	0.145	-.0287772	.1963098
edu	-.5245964	1.350756	-0.39	0.698	-3.172029	2.122837
_cons	-3.429831	3.467464	-0.99	0.323	-10.22593	3.366273
7						
age	-5.980016	.0584908	-102.24	0.000	-6.094655	-5.865376
edu	68.10699	.	.	.	.	.
_cons	26.20664	.	.	.	.	.
8						
age	.0336074	.0721886	0.47	0.642	-.1078796	.1750944
edu	-35.21885	1.82e+07	-0.00	1.000	-3.57e+07	3.57e+07
_cons	-.0578537	4.015684	-0.01	0.989	-7.92845	7.812742
9						
age	.0590701	.0621552	0.95	0.342	-.0627519	.1808921
edu	-1.802144	1.649908	-1.09	0.275	-5.035904	1.431616
_cons	-1.46142	3.653489	-0.40	0.689	-8.622127	5.699288

(cop==0 is the base outcome)

Table B-6.33: marginal effects

Marginal effects from multinomial logit

y = Pr(cop=0)
= .02816091

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0009868	.00118	-0.84	0.402	-.003292	.001319	49.8246
edu	.0480591	.03651	1.32	0.188	-.023501	.119619	.649123

Marginal effects from multinomial logit

y = Pr(cop=1)
= .33368325

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0003705	.00403	0.09	0.927	-.007536	.008277	49.8246
edu	-.0440317	.11548	-0.38	0.703	-.270374	.182311	.649123

Marginal effects from multinomial logit

y = Pr(cop=3)
= .1102674

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0062871	.0024	2.62	0.009	.001575	.010999	49.8246
edu	.0253455	.0685	0.37	0.711	-.108907	.159598	.649123

Marginal effects from multinomial logit

y = Pr(cop=4)
= .0926574

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.002309	.00244	-0.95	0.345	-.007097	.002479	49.8246
edu	.030734	.06677	0.46	0.645	-.100141	.161609	.649123

Marginal effects from multinomial logit

y = Pr(cop=6)
= .04214836

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0020537	.00149	1.38	0.167	-.000857	.004965	49.8246
edu	.0498191	.03858	1.29	0.197	-.025799	.125437	.649123

Marginal effects from multinomial logit

y = Pr(cop=7)
= 4.29e-101

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	0	0	.	.	0	0	49.8246
edu	2.21e-57	0	.	.	2.2e-57	2.2e-57	.649123

Marginal effects from multinomial logit

y = Pr(cop=8)
= 1.672e-11

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	-2.40e-14	0	.	.	-2.4e-14	-2.4e-14	49.8246
edu	-5.60e-10	.00632	-0.00	1.000	-.012385	.012385	.649123

Marginal effects from multinomial logit

y = Pr(cop=9)
= .03846867

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
age	.0009244	.00156	0.59	0.553	-.002127	.003976	49.8246
edu	-.0036758	.04725	-0.08	0.938	-.096282	.088931	.649123

Table B-6.34: Multinomial logit model morbidity male headed 2006/07

Multinomial logistic regression — Number of obs = 183; LR chi2(16) = 41.10; Prob > chi2 = 0.0005

Log likelihood = -274.28802 — Pseudo R2 = 0.0697

cop	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1						
age	-.0054839	.0282338	-0.19	0.846	-.0608211	.0498533
edu	-.3887562	.6590448	-0.59	0.555	-1.68046	.9029478
_cons	2.944855	1.520065	1.94	0.053	-.0344184	5.924128
2						
age	.0156772	.0283488	0.55	0.580	-.0398855	.0712399
edu	-1.250495	.6757221	-1.85	0.064	-2.574886	.0738956
_cons	2.624205	1.52803	1.72	0.086	-.3706796	5.619089
3						
age	.0431807	.0333252	1.30	0.195	-.0221355	.1084968
edu	-.3380029	.8101759	-0.42	0.677	-1.925918	1.249913
_cons	-1.213053	1.922137	-0.63	0.528	-4.980372	2.554266
4						
age	.0089661	.0355096	0.25	0.801	-.0606314	.0785636
edu	-1.457184	.8876386	-1.64	0.101	-3.196924	.2825554
_cons	1.011028	1.863161	0.54	0.587	-2.640702	4.662757
5						
age	-.047023	.052407	-0.90	0.370	-.1497388	.0556929
edu	-.9677696	1.033978	-0.94	0.349	-2.994328	1.058789
_cons	2.242025	2.262101	0.99	0.322	-2.191611	6.67566
6						
age	.0729801	.0373018	1.96	0.050	-.00013	.1460902
edu	.1366629	.8893085	0.15	0.878	-1.60635	1.879676
_cons	-3.695777	2.354123	-1.57	0.116	-8.309774	.9182188
7						
age	-.0178477	.0376327	-0.47	0.635	-.0916065	.0559111
edu	-1.389708	.8813287	-1.58	0.115	-3.11708	.3376646

_cons	2.11846	1.8514	1.14	0.253	-1.510219	5.747138
9						
age	-.0587127	.0665885	-0.88	0.378	-.1892237	.0717983
edu	-32.99258	4244173	-0.00	1.000	-8318460	8318394
_cons	3.38667	2.524164	1.34	0.180	-1.5606	8.333939

(cop==0 is the base outcome)

Table B-6.35: Marginal effects morbidity male headed households

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Marginal effects from multinomial logit

y = Pr(cop=0)
= .03763102

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0002705	.00099	-0.27	0.785	-.002213	.001673	45.9071
edu	.0290683	.02136	1.36	0.174	-.012804	.07094	.852459

Marginal effects from multinomial logit

y = Pr(cop=1)
= .39922954

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0050589	.0026	-1.94	0.052	-.010164	.000046	45.9071
edu	.1531844	.0634	2.42	0.016	.028915	.277454	.852459

Marginal effects from multinomial logit

y = Pr(cop=2)
= .36713581

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0031168	.00246	1.27	0.206	-.001712	.007946	45.9071
edu	-.1755052	.0637	-2.76	0.006	-.300352	-.050658	.852459

Marginal effects from multinomial logit

y = Pr(cop=3)
= .06088223

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0021913	.00105	2.09	0.037	.000133	.004249	45.9071
edu	.0264505	.02909	0.91	0.363	-.030574	.083475	.852459

Marginal effects from multinomial logit

y = Pr(cop=4)
= .0450726

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0000802	.00101	0.08	0.937	-.001896	.002057	45.9071
edu	-.0308625	.02538	-1.22	0.224	-.080601	.018876	.852459

Marginal effects from multinomial logit

y = Pr(cop=5)
= .0179247

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0009717	.00062	-1.56	0.119	-.002194	.000251	45.9071
edu	-.0035009	.01466	-0.24	0.811	-.032231	.025229	.852459

Marginal effects from multinomial logit

y = Pr(cop=6)
= .02992986

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	.0019692	.00072	2.74	0.006	.000559	.003379	45.9071
edu	.0272098	.01763	1.54	0.123	-.007348	.061767	.852459

Marginal effects from multinomial logit

y = Pr(cop=7)
= .04219424

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0010564	.00102	-1.04	0.301	-.003057	.000944	45.9071
edu	-.0260445	.02422	-1.08	0.282	-.073513	.021424	.852459

Marginal effects from multinomial logit

y = Pr(cop=9)
= 4.585e-14

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-3.03e-15	0	.	.	-3.0e-15	-3.0e-15	45.9071
edu	-1.48e-12	.00001	-0.00	1.000	-.000027	.000027	.852459