HOUSEHOLD RESILIENCE TO EXOGENOUS SHOCKS: EVIDENCE FROM MALAWI

by

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STATEMENT BY AUTHOR

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Dedication

This is dedicated to my mother, Charity Chihana.

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Abstract

This paper uses survey data from 2,666 households in Malawi to examine the effect of household baseline characteristics on household resilience to exogenous shocks. I classify households into four groups depending on their inherent vulnerability and nurtured and/or built resilience using the approach from Briguglio et al. (2009). A household is resilient if it maintains food security after being faced with exogenous shocks or if it moves from being food insecure to being food secure after it is faced with exogenous shocks. Results from a logistic model suggest that having diversified income sources, having more productive assets, and having access to infrastructure such as electricity is important for household resilience. However, the majority of households in Malawi fall into the promising category, meaning the households have less diversified income sources, own no or few productive assets, and do not have access to non-agricultural employment. Although households in Malawi have varying levels of inherent vulnerability, the majority of these households have not built their resilience and appear to be trapped in the status quo.

Keywords: Resilience, diversification, food security, vulnerability

Chapter 1: Introduction

1.1 Shocks

Exposure to shocks threatens the livelihoods of individuals, households and communities and thus makes them vulnerable. Shocks are events that occur suddenly, without being expected and have high impacts on the affected individuals. They include slow onset events like drought which affects large numbers of people or small-scale incidents that affects fewer people such as a localized landslides. Shocks can occur due to natural forces in the environment such as variability in rainfall patterns, drought, earthquakes, volcanoes, and landslides. There can also be biological sources of shocks such as human epidemics, animal and plant disease, or pest outbreaks. There are also shocks such as conflict, war, and land evictions which are caused by the socio-political environment. There can also be macroeconomic shocks such as devaluation of currency, exchange rate crisis, and hyper-inflation. In addition, there are personal shocks that may affect individuals in households, businesses, or the economy such as the loss of a job. These shocks are significant if they cause unexpected changes to the livelihood of the affected individuals or groups. In this regard, a shock can be defined as an unexpected event that causes a significant negative effect on the affected individuals or groups and usually the individuals affected have no control over it.

The agricultural sector, like other sectors of the economy, faces diverse shocks. For example, shocks to the agricultural sector may include climate events, natural disasters, volatility of commodity prices, regional conflicts, policy shocks, the effects of globalization, and family shocks such as death and illness, particularly of main income earners. Smallholder farmers, are in many ways more vulnerable to shocks than larger-scale farmers. Because they are resource constrained, they are unable to adopt new technology, have few or no assets, and little or no access

to credit which makes it difficult for small-scale farmers to adapt when faced with shocks. Shocks faced by smallholder agriculture include economic crises such as slowdown in economic activity, increase in the prices of staple products, removal of subsidies, devaluation of local currency, fall in the value of returns to assets as well as environmental events such as floods, droughts, El Nino events, pest invasion and crop diseases (Chuku and Okoye, 2009; Mwangi and Kariuki, 2015).

1.2 Resilience

The concept of resilience has received a wide application in various fields of study. In engineering, for instance, systems are resilient if they are designed such that they are able to adapt to changing conditions without permanent loss of function. This implies that when an engineering system is being designed, hazards are acknowledged and the possibility of permanent loss of function in larger systems is reduced by intentionally allowing for failure at the subsystem level. As a result, resilience analysis improves the system's response to surprises which cannot be done using a traditional risk approach analysis which is only able to identify the hazards *ex post* (Park et al., 2013).

In a natural system, resilience is related to the continuity over time of an ecosystem and its ability to endure changes, disturbance and stresses, as well as its capacity to rebuild itself up to an equilibrium level, at which it is capable of reestablishing its ecosystems' functions and provide goods and services as before. Furthermore, resilient ecosystems take a shorter time to return to their original long-lasting equilibrium state compared to those that are not resilient and have a higher ability to tolerate disturbances and stresses. Ultimately, resilient ecosystems have a higher probability of maintaining an efficient ecosystem. A resilience index, which measures the resilience of a system by comparing the current state of the system, called the bio-volume, with

the equilibrium state of the ecosystem which is referred to as the potential eco-volume, has been used to examine the resilience of agricultural and natural systems (Torrico and Janssens 2010). Using this index, systems are divided into four categories: climax stage or stable systems, high resilience capacity, average resilience capacity and low resilient capacity systems. Systems that have a higher resilience index value are considered to be more resilient than those with lower values. In addition, the authors found that ecological and silvo-pastoral systems have the greatest resilience compared to cattle and vegetable systems.

In addition to its application in engineering and natural systems, resilience thinking has also been used to understand how individuals, communities, businesses, regions and countries respond to and/or adapt when they are faced with exogenous shocks.

1.2.1 Personal Resilience

Coutu (2002) examined how personal resilience works and concluded that resilient people possess three characteristics. The first characteristic is the acceptance of reality because this characteristic prepares the person to endure and survive extraordinary hardships, thus training oneself to survive before the fact. The second characteristic of resilience is having a deep belief that life is meaningful. This gives individuals the propensity to give meaning to difficult events or times. When living through hardships, resilient people, unlike those that are not resilient, do not see themselves as victims, but create some sort of meaning for themselves and others from their suffering. Resilient people also have strong value systems and these values offer ways to interpret and shape events and thus infuse an environment with meaning. The third characteristic of resilience is the ability to improvise. Thus despite suffering real hardships, resilient people do not falter and are able to bounce back. In addition, in examining the nature of personal resilience, the

questions that are often asked are why do some people crumble under pressure and what makes others bend and ultimately bounce back? Personal resilience is defined as the skill and capacity to be robust under conditions of enormous stress and change. It is something that a person realizes they have after the fact and it determines whether one succeeds or fails.

1.2.2 Community Resilience

In their case study of funeral societies and Filipino migration networks, Bernier, Meinzen-Dick and Suseela (2014) investigated the role that local forms of social capital-local organizations and social networks-play in enhancing resilience. They define resilience as the capacity of an individual, household, community or system to respond overtime to shocks and to proactively reduce the risk of future shocks, and that these actions contribute to growth and development rather than just working to maintain stability. In order to meet the reactive and proactive challenges posed by economic, political, environmental and social shocks, resilience requires a diverse set of capacities. The authors identified three central capacities for resilience. The first one is persistence or coping capacity which refers to the ability of a system that has been exposed to a shock to cope and to restore wellbeing to current levels after the events. The second one is adaptation or adaptive capacity which refers to preventive actions employed by individuals or communities to learn from experience or to reduce the impact of predicted shocks. These skills require mobilization of additional outside resources, thus distinguishing them from those that are required for coping. Lastly, when people have the ability to adapt on a larger scale and change the structures and systems in which they live, they have transformative capacities.

1.2.3 Business Resilience

McDonald et al. (2014) examined the impact of natural disasters on small business resilience by analyzing how informal and formal financial resources affect the ability of small businesses to reopen after a natural disaster and adopt an adaptive strategy to lessen the impact of future natural disasters. The authors used data from 395 businesses who experienced Hurricane Katrina in Mississippi in August 2005. Using the Small Business Disaster Recovery Framework, they characterize a business as resilient if it was adequately prepared to withstand the negative effects of the disaster with little impact on the business. Furthermore, if adjustments are made to the operations of the business to prepare for future shocks, then this business can be considered to be resilient. However, the resilience of this business is only tested after it experiences a similar disaster. The authors used a recursive bivariate probit and multivariate probit model with sample selection to analyze small business resilience to Hurricane Katrina. The results from this study showed that the preparedness of a business for a shock is an important factor for business resilience. Other important factors for business resilience are formal resources (i.e insurance payments and loans from small business). In addition, the authors identified sources of vulnerability such as proximity to the coast, type of business, business operated by a sole proprietor, business owned by females, and home based businesses.

1.2.4 Resilience of Regions

The concept of resilience has also been applied to regional economies. Chia-Yun et al. (2015) measured the economic resilience of the rural West of the United States using the county as the unit of measurement to understand the key county-level characteristics that contribute to resilience and vulnerability. The paper constructed two indices following Briguglio et al. (2009),

a resilience index and a vulnerability index that were used to group the counties into vulnerable and resilient counties. An index model and linear regression model was used to measure a county's ability to withstand or recover from an economic shock. Their results showed that counties with citizens that have more education, health insurance, oil wealth, and no right-to-work law have the highest resilience. On the other hand, counties with greater distance to a metropolitan area, a larger percentage of public land, and a natural environment less suitable for people had the highest level of vulnerability.

Martin (2011) also applied the concept of resilience to regional or local economies. The author compared the experiences of four UK regions (i.e South East, greater London, East Midlands, and Yorkshire and Humber) in order to identify regional differences in resistance, recovery and renewal after they experienced a recession shock. Resistance was defined in terms of how sensitive or deep the reaction of the regional economy was to a recessionary shock. Recovery was defined by looking at the speed and degree of recovery of a regional economy from a recessionary shock. Renewal was defined as the extent to which a regional economy renewed its growth path by maintaining its prerecession path or by shifting to a new growth trend. The author found that different UK regions had varying levels of resilience after they experience recessionary shocks. The level of resilience for a region depended on its economic structure, especially the relative dependence on manufacturing. Therefore, regions that depended more on manufacturing were hit more by the recession and were thus less resilient.

1.2.5 Resilience of Countries

According to Briguglio et al. (2009), a country is economically resilient if its economy has a policy-induced and/or nurtured ability to withstand or recover from the effects of adverse exogenous shocks arising out of economic openness (i.e economic vulnerability). The authors used

data from 87 countries to construct two indices (the vulnerability and resilience indices). Vulnerability was confined to permanent and quasi-permanent features of the economy which expose a country to the adverse effects of exogenous shocks. The vulnerability index was constructed using the degree of economic openness, export concentration, and dependence on strategic imports. The authors hypothesized that these factors make a country prone to exogenous shocks.

The authors constructed their resilience index using four variables: macroeconomic stability, microeconomic market efficiency, good governance, and social development. These factors are hypothesized to be policy-induced and thus enable a country to bounce back or withstand the negative effects of exogenous shocks. The two indices were combined to indicate a country's overall risk of being affected by exogenous shocks given its vulnerability features counterbalanced to different extents by policy measures. The result was a matrix with countries classified into four categories. Countries with a high degree of economic vulnerability and high resilience levels were classified as "self-made". Countries with a relatively low degree of inherent economic vulnerability and low levels of resilience fell within the "prodigal son" category. Countries in the "best-case" category had a relatively low degree of inherent economic vulnerability and high levels of resilience. The remaining countries fell in the "worst-case" category because they were characterized by a high degree of inherent economic vulnerability and low levels of resilience.

1.2.6 Resilience and International Development

Barrett and Constas (2014), apply the theory of resilience to international development challenges thereby introducing a concept known as development resilience which they define as a

person's, household's or other aggregate unit's capacity to avoid poverty in the face of various stressors and in the wake of myriad shocks overtime. A resilient unit is one whose capacity to manage shocks increases over time. The authors conceptually model the well-being of the poor and non-poor as well as aggregate units of social organization such as communities. Stressors and shocks play a central role in human welfare because they can catastrophically change lives. Therefore, development resilience is concerned with the stochastic dynamics of the well-being of people, and because there is an inverse relationship between the likelihood of being and remaining poor and development resilience, development resilience is a desired development goal.

The common thread among the definitions of resilience is that when a unit or system is exposed to shocks it must have the capacity to proactively respond and bounce back overtime. There is also the idea of resilience being dynamic, in that it can only be observed over time after a unit or system has been exposed to a shock. The concept of resilience has received a lot of attention in many fields of study but there exists potential to extend resilience analysis to agricultural households in order to understand how these households respond to large scale exogenous shocks.

Development agencies (e.g USAID, DFID, and the World Bank) are shifting their attention from just responding to shocks such as natural disasters, economic instability, and conflict, to building the capacity of disadvantaged people. This policy shift requires a clearer understanding of the factors that affect households, communities and countries' ability to anticipate, adapt to, and/or recover from the potential effects of shocks in a manner that protects livelihoods, accelerates and sustains recovery, and supports economic and social development. At the household level, such a policy shift begs the following questions. What determines the resilience of households? Are there strategies that can be adopted in order to strengthen or build resilience

of households that are not resilient? These are the questions that this paper seeks to answer with a focus on agricultural households in Malawi.

The objectives of this current research are to:

1. Review the literature to gain an understanding of how agricultural households respond to shocks.
2. Classify households according to their inherent vulnerability and nurtured resilience.
3. Econometrically explore the contributing factors to resilience.

This research is organized as follows: Chapter 2 is a review of the literature and starts by discussing agricultural shocks and managerial resilience in general, then specifically discusses resilience in African agriculture which is followed by an overview of the Malawian economy and agricultural sector in Chapter 3. Chapter 4 is a discussion of the conceptual model, household classification strategy and econometric strategy, the data, and data sources and provides a descriptive analysis of key elements of the dataset. Chapter 5 is a discussion of the results. The final chapter includes a summary of the research and implications for development policy and further research.

Chapter 2: Literature Review

2.1 Agricultural shocks and managerial resilience.

In agriculture, managerial resilience has for a long time been modelled in the form of farm-level risk analysis (Patrick et al., 1985). In this study, 149 agricultural producers from 12 states in the United States were surveyed to elicit information on producer risk perceptions and management responses which were used to generate hypothesis for farm risk management. The authors found that the major sources of variability in crop production, as ranked by producers, are weather and crop prices, and that crop prices are directly linked to other factors such as weather and government programs. Inflation, input prices, pests and diseases, world events and personal health were also found to be important sources of risk in crop production. For livestock production, the most important sources of variability were livestock prices. Operating input costs, weather, diseases and pests, inflation, safety as well as health, and government laws and regulations were also important sources of variability. For both types of production, empirical evidence shows that factors where the farmer has no control, such as weather, inflation and world events contribute significantly to variability. Some of the management responses to variability include pacing of investment and expansion to avoid becoming overextended, as well as obtaining market information.

Ellis (2000), explored the reasons for rural households in developing countries to adopt multiple livelihood strategies. The author defined diversification as having a variety of dissimilar income sources (e.g on-farm income, off-farm income, remittances, etc.) and identified six determinants of livelihood diversification. One reason why households diversify their income

sources is to reduce seasonal income variability. Another reason is that livelihood diversification is used as a risk strategy in order for a household to achieve an income portfolio with low covariate risk between its components. Other reasons for livelihood diversification include credit market failures, taking advantage of opportunities in the labor market, and making investment in order to increase income generating capabilities in the future (i.e asset strategies). Finally, rural households also diversify their livelihoods as a coping behavior and adaptation. The author highlights the importance of livelihood diversification as a common strategy for coping with and/or adapting to the effects of shocks.

Farm resilience covers buffer capability, adaptive capability and transformative capability (Darnhoper, 2014). Buffer capability refers to the ability of a farmer to maintain the farm through a disruption through their ability to mobilize resources and is thus important in the initial phases of coping with large shocks and to buffer small disturbances. However, in order to cope with changes that build up over time, farms draw on their adaptive capability. Transformative capability on the other hand is a qualitative change in which new operating assumptions are adopted by a farm which result in the creation of a fundamentally different farm with new linkages and feedbacks. According to the author, a farm's ability to address sudden shocks, unpredictable 'surprises" as well as slow-onset changes through its ability to integrate and balance the three capabilities (i.e buffer, adaptive and transformative) is considered resilience. Some implications of resilience thinking for farm management include compatibility between the overall goal pursued by family farms of ensuring farm continuity and intergenerational success and resilience's focus on the persistence of the farm over the long term. In addition, policy measures and family dynamics can either strengthen or erode farm resilience.

Abson et al. (2013) determined whether the volatility and resilience in agricultural landscapes is influenced by land use diversity. In particular, whether having a more specialized landscape (i.e landscapes with lower land use diversity) is linked to having higher gross margins (GMs), or whether such landscapes have more volatile returns. These relationships were examined at a range of different spatial scales. The authors used data from three representative lowland agricultural regions in Southern England for which data on agricultural land cover was available. In order to quantify spatially explicit agricultural land-use patterns in each region, published satellite-derived land-cover data and livestock estimates was used. The land-use data was also used to calculate the Shannon's diversity index score for each landscape unit. This index, which has the ability of comparing diversity between similar landscapes was used to assess diversity. Furthermore, average GMs (including income from agricultural subsidies) of the farming activities found in each region over the period 1966 to 2010 was calculated using published annual forecasts of expected agricultural GMs. These average GMs were used to assess expected agricultural GMs. For analysis, the volatility of agricultural returns was quantified in terms of the expected standard deviation (SD) of GMs. In addition, the coefficient of variation (CV), which is a measure of dispersion of a probability distribution and defined as the ratio of the expected GMs to the expected SD of the expected GM was used as a measure of economic resilience. The authors found that specialization in farmscapes is associated with maximized mean returns, however the returns have higher volatility. Hence there exists a trade-off between expected mean returns and the volatility of those returns. The authors also found a positive correlation between the resilience of agricultural returns and the diversity of agricultural land use.

Heltberg et al. (2013) examined how people with low incomes cope with stresses or shocks that originate from the global economy. The authors use qualitative research data from sites in 17

countries on how selected groups of people coped with or responded to the local effects of the global, fuel, and financial crises that occurred from 2008 to 2011. The qualitative data were collected from, sites in Bangladesh, Cambodia, Central African Republic (CAR), Ghana, Indonesia, Jamaica, Kazakhstan, Kenya, Mongolia, Philippines, Senegal, Serbia, Thailand, Ukraine, Vietnam, Yemen, and Zambia. The data were collected using participatory focus group discussions. Household case studies were also undertaken using individual semi-structured interviews and these were repeated in several rounds with between 200 and 300 people being involved in each country. In addition, key informant interviews were undertaken with social workers, staff of non-governmental organizations, business people, officials, chiefs, and community leaders. These were used for triangulation of findings or for gaining an institutional perspective, and collection of relevant secondary data of aggregate crisis impact.

The topics that were covered in these interviews included livelihoods, coping strategies, changes in paid and unpaid work, migration, borrowing, asset sales, social relations, community and private charitable support, social protection, and other government programs. Farmers, farm owners, informal sector workers, and formal export sector workers were the occupational groups selected as research participants. Thus the respondents in this research came from diverse economic and occupational backgrounds. The authors found that the financial crisis impacted different players in the economy in varying ways. For instance, it was found that although formal sector workers were directly affected during the crisis through layoffs that reduced working hours and benefits, they turned out to be relatively resilient as they were able to live off their savings or received severance payments. On the other hand, informal sector workers such as farmers who were generally worse off even before the crisis, were more affected by the crisis and for a longer period of time. They also struggled to recover, hence they were relatively less resilient. In addition,

the authors also found that the most severe and widely felt impact of the financial crisis was food insecurity and that local shocks such as political violence and prolonged drought (e.g. Kenya) and an energy crisis (e.g. Central African Republic) compounded the problem, thus making it more pronounced in such areas. Some of the responses to the financial crisis that were reported included selling assets and getting into debt, increase in use of counselling and social worker assistance (this was the case in Eastern Europe) as well as working longer hours and getting into informal employment. There were also gendered effects that were reported from the financial crisis. Although both men and women were affected by the crisis, women were more impacted and bore a heavier burden. For instance, it was reported that women acted as shock absorbers, managing tighter household budgets as well as saving and remitting money to relatives during the difficult times. It was also reported that there was increased crime, drug and alcohol abuse and weaker solidarity across the communities due to increased economic hardships that resulted from the financial crisis. Some of the reported sources of support during the financial crisis included bank credit, microfinance institutions, nongovernmental organizations, religious organizations, informal safety nets such as family, friends, neighbors as well as social safety nets such as school feeding programs. However, the benefits from these were limited, with inadequate coverage and were unsustainable.

2.2 Resilience in African Agriculture: A Review of the Academic Literature

Seo (2010) examined the resilience of African farms to climate change. The author was interested in knowing whether the response to climate change was substantially different between farms with only crops from those that manage both crops and livestock (i.e integrated farms). African agricultural households were classified into three farming types: a specialized crop farm, a specialized livestock farm, and an integrated farm that owns both crops and livestock for

purposes of empirically exploring whether the farms are substantially different in regard to their response. After this classification was made, the author then examined whether a farmer's decision to adopt one of these farm types depended on climate change. In addition, the net revenue of each farm type against climate change and other control variables was estimated using a micro-economic model that corrects for selection bias. This estimation was done using data from 9,597 farms located in 10 African countries (i.e Niger, Burkina Faso, Senegal, Ghana, Cameroon, Kenya, Ethiopia, South Africa, Zambia and Egypt). The author uses multinomial logit model to test the hypothesis that the choice of an integrated farm that owns both crops and livestock is dependent upon climate. In their regression, the author controls for soils, water flows, electricity provision, precipitation, temperature and country dummies (i.e the country dummies control for different stage of economic development, trade and agricultural policies). The author found that a mixed farm is preferred by farms that have electricity and that farms in Burkina Faso and Senegal do not tend to specialize in livestock, but instead mix crops and livestock to offset the losses in the crop sector. On the other hand, farms in Zambia prefer livestock only farms. In addition, farmers avoid livestock only systems when water flow in the spring is high and use this abundant water to irrigate their land and store it for the summer season for crop production.

Bryan et al. (2013) examined the determinants of household strategies for adaptation of agriculture to climate change at the household level in Kenya. Climate change was defined as perceived changes in average temperature or rainfall variability over the previous 20 years. The authors used data from 710 households and Participatory Rural Appraisal across different agro-ecological zones in Kenya. The data contained information on household socioeconomic status, social capital, land tenure, crop and livestock management, input use and expenses, productive investment, food consumption patterns and expenditure, access to information, technology,

markets and credits, coping response to climate shocks and constraints to adaptation. A multinomial logit was used to analyze the factors that affect perceptions regarding long-term change in average temperature and precipitation. In addition, a logit model was used to determine factors that influence farmers' decisions to adopt a particular adaptation option. The authors found that in response to climate change, farming households in Kenya made small adjustments to their farming practices such as changing planting decisions but were unable to make costly investments in agroforestry or irrigation despite their desire to do so.

When faced with large scale co-variant shocks like drought, agricultural households respond in a myriad of ways. Hoddinott (2006) examined how households in Zimbabwe responded when they were faced with a drought shock. The author used longitudinal data from rural households (which had information on the key assets held and livestock) and individual level data (on body mass index for adults and growth rates for children under six years of age) in Zimbabwe collected between 1994 and 1999. Data was also available on the drought which Zimbabwe experienced in 1994–95 with rainfall levels lower than long-term averages by 20–40 percent which led to marked reductions in both crop and total household incomes. The author found that after being faced with a drought shock that led to significant reductions in crop and total household incomes, rural households in Zimbabwe responded by selling livestock such as oxen and cows. These assets were the main assets that these households had. The response of the household depended on the pre-drought asset levels of the household, with those households that had more than two cows/oxen being more likely to sell than those that had two or less. This result shows that households that are better-off draw down assets following an income shock but because of the threat of a poverty trap, households that are relatively less well-off do not draw down on livestock assets.

Mutabazi et al. (2015) evaluated the influence of livelihood resources on adaptive strategies that enhance climate resilience of farm households in Tanzania. The authors used data from a sample of 240 farming households in six villages of Fulwe, Mlali, Rudewa, Msowero, Kigunge and Kiwege located in the Morogoro Region. A pre-tested questionnaire was used to elicit information on household and farm characteristics as well as farm-level actions that aim to cushion the impacts of climate change. A resilience-building adaptive strategy (REBAS) index was then constructed using indicators such as intensification, diversification and migration that are related to the identified adaptive strategies that help farming systems maintain economic stability in the face of climatic challenges. Principal component analysis (PCA) was used to help derive an objective weighing scheme for aggregating indicators. The REBAS was then standardized to ensure that it only took values from 0-100. Multiple regression analysis was used to quantify the linkage between variables representing various forms of capital such as human, social and financial capital to the composite index of REBAS. The results indicated that having social capital (i.e membership in associations and other social networks), larger farm size, access to credit, land ownership, and living in an area that has a high agricultural potential (i.e productive land) increases the resilience of farming households. In addition, the study also found that the perception of the farmer about climate change was an important determinant of resilience. This is because farmers who were more likely to act in ways that enhance farm household resilience against climate change are those that believed that the negative consequences of climate change already experienced or anticipated in future are human driven. This study provides insights on resilience of farming households, however, it uses an index as the dependent variable in the multiple regression analysis, which makes it difficult to interpret the results of such an analysis.

Daressa et al. (2009) used cross-sectional survey data from 1000 farming households in the Nile basin of Ethiopia to analyze the factors affecting farmers' choice of adaptation methods in crop production systems to climate change. Six adaptation strategies were considered and they included: no adaptation, planting trees, soil conservation, using different crop varieties, irrigation as well as timing of planting. Results from a multinomial logit model showed that education, farm and non-farm income, access to information on climate change, livestock ownership, temperature and precipitation significantly determined the adaptation strategy used. However, the use of cross-sectional data for analysis made it difficult to determine the change in well-being as a result of using different adaptation strategies to mitigate climate change.

Lastly, the results from a case study of a female run Hleketanu community garden that was formed in 1992 in northeastern Limpopo province of South Africa shows that small-scale collaborative food farming has the potential to support personal and social resilience (Vibert, 2016). Some of the benefits of this cooperative include poverty reduction, improvement in health outcomes of children and the community as well as community building. This highlights the importance of gender sensitive programming as a way of increasing the resilience of women, and the entire households.

The results from literature point to diversification as one strategy that increases the resilience of farms. For example, this diversification can be in terms of the number of enterprises that a farm manages, i.e where a farm that manages a diversified portfolio such as crop and livestock is more resilient that one that manages a specialized crop or livestock farm. In addition, diversification can also be in terms of land use. The resilience of agricultural households has been modelled in terms of profitability as well as adoption of techniques that enable a farm to bounce back when faced with a shock. In general, the results suggest that some of the factors that increase

the resilience of agricultural households include having access to credit, access to information, social capital, ownership of land as well as ownership of assets that can be drawn upon when faced with stresses or shocks.

Although many studies have looked at the resilience of agricultural households in developing countries, most of these studies have framed resilience in terms of how households respond to climate change (Bryan et al., 2013; Daressa et al., 2009; Mutabazi et al (2015); Seo 2010), and drought (Hoddinott 2006), and have tended to group together different countries with different cultures and economic backgrounds (Heltberg et al., 2012). None of this previous research has specifically looked at the resilience of Malawian agricultural households to macroeconomic (devaluation) and weather shocks. This is important because the response of agricultural households differ depending on their context. For instance, how households in one country responds to macroeconomic and weather shocks may differ due to differences in cultures, attitudes, and experiences. In addition, despite knowing the shocks that agricultural households face, to the best of my knowledge, there is no empirical research on how agricultural households respond to macroeconomic and weather shocks, particularly in the Malawian context. Thus this study makes a contribution to the body of knowledge by looking at how households in a Malawi context respond to exogenous shocks.

Chapter 3: The Malawian Economy

3.1 General

Malawi is a long and narrow landlocked country in southeast Africa bordered by Zambia to the west, Tanzania to the north and Mozambique to the south. It covers an area of about 118,484 square kilometers of which 94,080 square kilometers is land and 24,404 square kilometers is water. Lake Malawi takes up one fifth of the country's total area. Malawi has a subtropical climate which varies widely across the regions and is relatively dry and strongly seasonal. The country is divided into three regions: southern, central and northern regions. The three regions have a vast range of geographical features. While the northern and central regions have high plateaus, the southern region is highly mountainous. The national and administrative capital city, Lilongwe is located in the central region. The southern region is the country's commercial and manufacturing hub and its provincial capital is Blantyre City. The main town in the northern region is Mzuzu (see Figure A1 in Appendix A). Malawi's population is estimated at 18 million, of which 80 percent of the population live in rural areas (Food and Agricultural Organization 2018; United Nations 2018).

Malawi's gross domestic product (GDP) per capita stood at 1,200 US dollars in 2017 when adjusted for purchasing power parity. The country has one of the lowest GDP per capita in the world and ranked among the bottom six countries in the world in terms of GDP per capita in 2017. Malawi has high poverty levels with an estimated 51 percent of the population living below the poverty line in 2014. Malawi had a Gini coefficient index of 46.1 in 2013 (Central Intelligence Agency 2018).

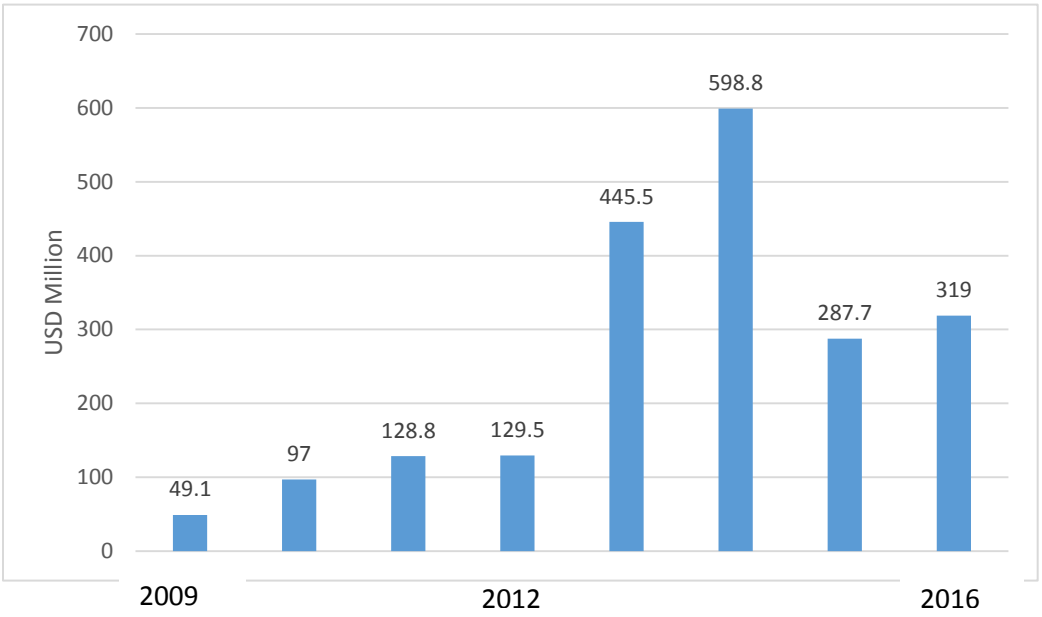
Although Malawi's Human Development Index (HDI) value increased by 46.4 percent (i.e from 0.325 to 0.476) between 1990 and 2015, driven by an increase in life expectancy at birth and

mean years of schooling, the country still remains in the low human development category with a ranking of 170 out of 188 countries and territories (UNDP Human Development Report 2016). According to Transparency International (2017), Malawi is ranked 122 out of 180 countries and territories by its perceived levels of public sector corruption according to experts and business people.

Malawi is a World Trade Organization member. Although South Africa is its major export and import partner, Malawi also trades with other countries including Zambia, United States, China, etc. Tobacco is the country's major export item, but Malawi also exports tea, cotton, sugar, peas, etc. The country imports petroleum oils, medicines, and consumer goods. In addition, because Malawi's industrial sector is not fully developed, almost all industrial products are imported. However, because the country is landlocked, and thus lacks free access to a port, it faces high import and export costs. Overall, over the past decade, imports have exceeded exports (i.e balance of trade in Malawi average -18652 million Malawian Kwacha (MWK) from 2000 until 2015) (Malawi Market Report, 2016).

Domestic and foreign investment is encouraged in most sectors of Malawi's economy by government without major restrictions, except based on environmental, health, and national security concerns. Adequate legal instruments to protect investors are available (U.S. Department of State, 2014). Foreign Direct Investment has been positive in Malawi over the last decade (see Figure 3.1). Sources of Malawi's FDI include United States, China, Japan, Switzerland, etc. (Trading Economics 2018).

Figure 3.1: Malawi foreign direct investment 2009 to 2016



Source: Malawi Annual Economic Report for 2013 and 2016

3.2 Agricultural Economy

Malawi has a relatively dry and strongly seasonal sub-tropical climate with three main seasons. The cold-dry winter season stretches from May to August. During this season, mean temperatures vary between 17 and 27 degrees Celsius and temperatures can fall to 4 degrees Celsius with frost occurring in some isolated places. From September to October there is a hot-dry season during which average temperatures range from 25 and 37 degrees Celsius. The warm-wet season stretches from November to April, during which 95 percent of the annual precipitation takes place and thus corresponds to the rainy season. In Malawi, annual average rainfall varies from 725 mm to 2,500mm (Malawi Department of Climate Change and Meteorological Services 2018). Most of Malawi's agriculture is rain-fed.

Wilson (2014) shows that for the majority of the people in Malawi land is the key productive asset other than their own human labor. On average one hectare of land supports a family of five. There is land fragmentation due to matrilineal and patrilineal inheritance rules. In Malawi, land tenure falls into three main classifications; private, public, and customary land. Customary land is the most common land tenure system and most of the land (i.e approximately 70 percent) falls into this category. In addition, most of the land that is farmed by smallholders fall under the customary land tenure system. Local chiefs in Malawi serve as trustees over customary land which is managed as community property. The customary land within the community is managed by chiefs who allocate it to the community members. The land, once acquired by a community member can be passed along to heirs on a "quasi-permanent basis".

In 1998, Malawi adopted the vision 2020 which identifies agriculture and food security as key priority areas to foster the country's economic growth and development. Malawi's agricultural sector, which is characterized by a dualistic cash, export-oriented production system and a subsistence, food crop production system is an important contributor to the economy. In fact, the economy of Malawi is mainly driven by the agricultural sector which in 2016 accounted for about 42 percent of the total GDP and 81 percent of export earnings. In addition, agriculture is also a major contributor to the food and nutritional security of Malawi (Food Agriculture Organization 2017; Wilson 2014).

Malawi agriculture is composed of two main subsectors: small-scale farmers and estates. The estate sector comprises a much smaller number of large-scale farmers, producing almost entirely for the export market. Small-scale farmers, on the other hand, mainly grow food for their own consumption and their cultivated farm size is determined by the availability of farm labor as well as the availability of cash to hire farm labor during critical times of the year and to buy inputs.

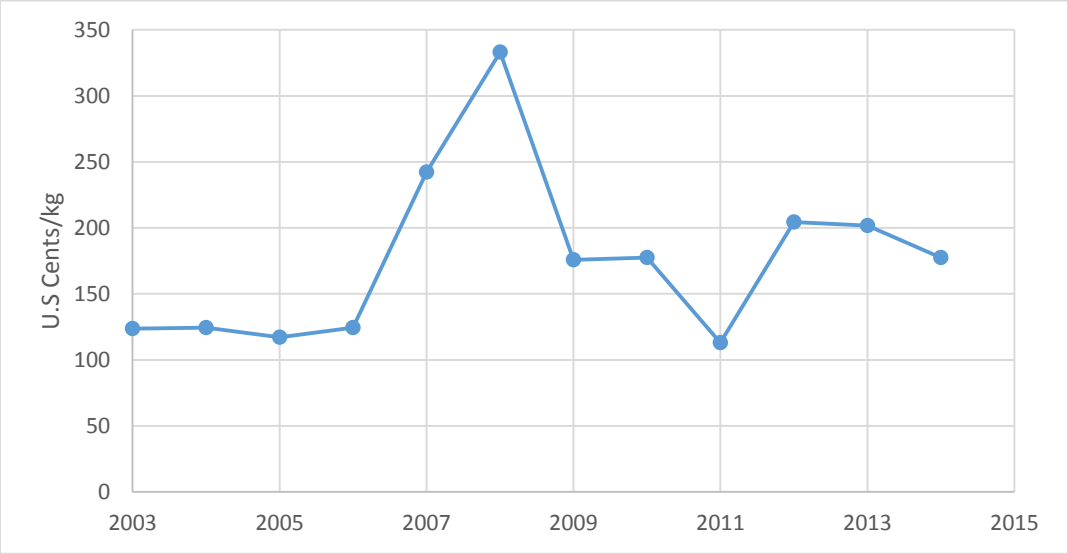
In addition to farm income, smallholder farmers have non-farm income sources (i.e agricultural wage income, nonagricultural wage income and non-farm self-employment) which accounts for 30-100 percent of the annual cash income for the households. Thus livelihood diversified is the major livelihood strategy for smallholder farmers in Malawi (Wilson, 2014).

The major and dominant cash crop in Malawi is burley tobacco. It accounts for approximately 63 percent of the country's total export earnings, and income from this trade plays an important role in the balance of payments (Food Agriculture Organization 2017). Before 1989, tobacco production was tightly controlled by the government and was restricted to estates and landowners excluding smallholder farmers from tobacco production. However, starting in early 1995 structural reforms were adopted to pave the way for smallholder farmers to participate in tobacco production. Thus tobacco production was added to the crop mix of smallholder farmers making it a major source of income and employment for rural households.

Burley tobacco is formally marketed using one of the three auction floors: Mzuzu, Lilongwe, and Limbe. For a farmer to use this formal marketing channel, they are required to be a part of a club, and for them to be a member of these clubs they have to sell a bale of tobacco (80 to 120 kg each) each year. These clubs are the link to the farmer organizations: the Tobacco Association of Malawi (TAMA) and the National Smallholder Farmers' Association of Malawi (NASFAM) that participate in the auction floors on behalf of smallholder farmers. However, many smallholder farmers produce small quantities of tobacco (i.e less than a bale) and are unable to participate in these formal markets. Therefore, they resort to marketing their tobacco through unofficial channels to private traders. Figure 3.2 shows average tobacco auction floor price between 2003 and 2014. The auction floor prices between these periods were highly variable ranging from 113.1 to 333.1 U.S. cents per KG (National Statistical Office 2016). In addition to

burley tobacco, raw sugar, cotton, tea and rubber are the other high value export crops (on a per ton basis) but account for a smaller export share. Wilson (2014), however, notes that the dependence of Malawi's economy on the export of a high-value crop like tobacco makes it sensitive to tobacco export earnings. Furthermore, the competiveness of other agricultural and non-agricultural earnings are undermined, opportunities for import substitution are limited, and the development of new export industries is discouraged.

Figure 3. 2: Average burley tobacco auction prices in Malawi between 2003 and 2014



Source: National Statistical Office Statistical Yearbook 2016

The major food crop in terms of policy and hectares planted is corn. It is Malawi's staple crop and is widely consumed in the country, making Malawi the number one per capita consumer of corn for food in the world (Wilson 2014). Corn acreage in Malawi is determined by food security, with producers responding more to family consumption needs than crop price when making cropping decisions. Local, improved open pollinated varieties (OPV), and hybrids are the three main varieties of corn cultivated in Malawi. Corn accounts for nearly 90 percent of the

cultivated land, and is supplemented by sorghum, millet, pulses, rice, root crops (e.g cassava), vegetables, and fruits. The corn that is not consumed by smallholder farmers is sold to other households, small intermediaries, and to the Agricultural Development and Marketing Corporation (ADMARC).

3.3 Recent Shocks, 2010-2013

Most of the agriculture in Malawi is rain-fed. The country receives 725-2,500 mm of rain per year, which is adequate for rain-fed agriculture. However, in the recent past Malawi has faced several climate related shocks which have negatively affected the food security of farming households. From mid-December 2012 to mid-January 2013, Malawi received heavy rains resulting in flooding in several districts, with the Mangochi district in the southern region being the most affected. The floods had several negative effects including washing away livestock and crops, collapsing houses, contaminating water and rendering roads impassable. Malawi's Department of Disaster Management Affairs estimated that a total of 12,877 households throughout Malawi were affected by these floods (Disaster Relief Emergency Fund Report, 2013).

In the last two decades, Malawi also has faced severe shortage of foreign exchange, which resulted into shortages of critical imports including fuel, inputs for production, and medicines. However, in 2011 because of lower tobacco earnings and reductions in external aid, the foreign exchange problems intensified. In an effort to address this chronic balance of payments problem and to halt the slowdown in economic activity arising from the shortages of foreign exchange and critical imports, the government of Malawi devalued the exchange rate from K167 to K250 per U.S. dollar (a 33 percent devaluation), and also adopted a floating exchange rate regime (IMF Report 2012).

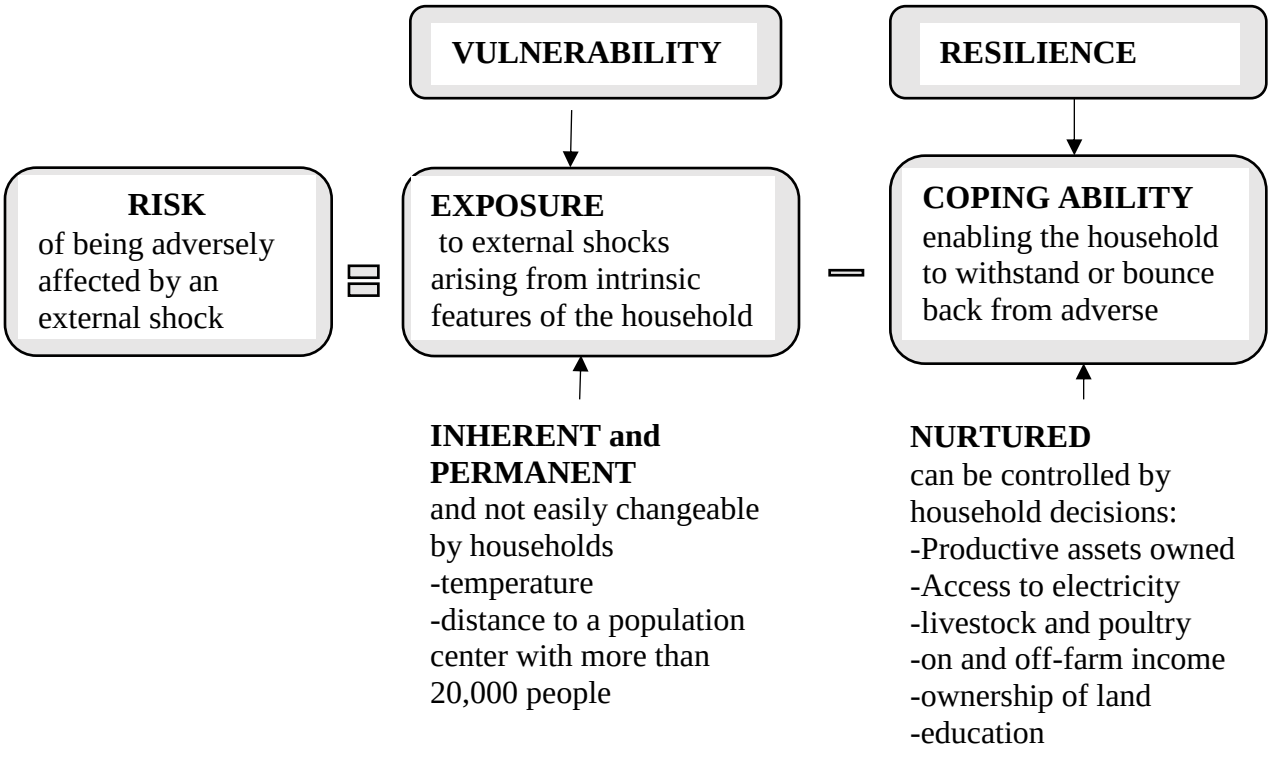
Prakash and Maiti (2016) investigated the effectiveness of devaluation in improving trade balance in Fiji (a small island economy). The authors found that while devaluation strongly contributed to the country's domestic inflation, it was quite weak on stimulating aggregate demand. In the case of Malawi, the devaluation and depreciation of the local currency significantly lowered consumer purchasing power as prices of basic commodities and staple food rose significantly (Reliefweb 2012). This policy had differential effects on players in the economy as it was an unexpected shock, especially for the rural poor who are mainly farmers. Thus the devaluation of the Malawian currency and weather shocks provides a natural experiment for assessing the resilience of agricultural households to exogenous shocks.

4: Methods, procedures, and data

4.1 Conceptual Framework

Households operate in an environment in which they are at risk of facing exogenous shocks. The effect of exogenous shocks on a household depends on how vulnerable or resilient a household is. A household is made vulnerable by its inherent features which are permanent or quasi-permanent. These features are usually outside the control of the household. On the other hand, a household can nurture and/or build its resilience which can enable it to withstand or bounce back from the negative effects of a shock. Therefore, a household's ability to withstand and/or bounce back from the negative effects of an exogenous shock depends on the interplay between its inherent vulnerability features and its nurtured resilience (Briguglio et al., 2009). Figure 4.1 is a representation of how a household can build its resilience.

Figure 4.1: Conceptual framework for household resilience



Source: Adapted from Briguglio et al., 2009

Household resilience to exogenous shocks is strengthened by factors such as having diversified income sources, having access to infrastructure such as electricity, and having assets. In addition, having social capital (i.e membership in associations and other social networks), access to credit, land ownership, and living in an area that has a high agricultural potential (i.e productive land) increases the resilience of farming households. Other factors that increase the resilience of agricultural households include having access to information, education as well as having access to on- and off-farm income (Mutabazi et al. 2015; Abson et al., 2013; Seo 2010; Daressa et al. 2009; Hoddinott 2006).

4.2 Classification Strategy

Following the approach from Briguglio et al. (2009), I classify Malawian households into four categories depending on their nurtured resilience and inherent vulnerability. Two indices are used to make this classification: the resilience index and the vulnerability index. The resilience index is constructed from factors that contribute to resilience building as informed from economic theory and the literature. Resilience building factors are those household characteristics which are highly influenced by household decisions and contribute to nurturing and/or building resilience and enable households to bounce back from the consequences of adverse exogenous shocks. For example, the literature shows that factors such as ownership of assets, education, having diversified income sources, and rearing livestock contribute to building resilience of households. On the other hand, factors that increase the vulnerability of households to exogenous shocks are usually inherently permanent or quasi-permanent and are outside the control of a household. In the case of rural households, factors such as the soils, topography, precipitation, temperature, etc. contribute to their vulnerability. For example, if an agricultural household is located in an area

with poor agricultural potential due to inadequate or too much precipitation, then it is more likely to be highly vulnerable to shocks.

The resilience index was constructed from six factors that are hypothesized to contribute to a household's ability to withstand and/or bounce back from the negative effects of an exogenous shock. These are number of productive assets that a household owns, whether the household head is literate or not, the age of the head of the household, the number of livestock owned, access to non-agricultural employment, and ownership of land.

The first step in the construction of the resilience index was making sure that all observations of the component are standardized to ensure that the values of observations in a particular variable array take a range of values from 0 to 1. Thus all observations of the components were standardized using the following transformation:

$$XS_{ij} = (X_{ij} - Min_j)/(Max_j - Min_j) \qquad (1)$$

where XS_{ij} is the value of the standardized observation *i* of variable j, X_{ij} is the actual value of the same observation, Min_j and Max_j are the minimum and maximum values of variable j, respectively. The number of households (*i)* takes values from 1 to 2666. After that, the resilience index was computed by taking a simple average of the six components. The resilience index takes values between 0 and 1, with households that have values of 0.5 and above being interpreted as having more resilience capacity while those that have values less than 0.5 have less resilience capacity.

The vulnerability index was constructed from three variables that are hypothesized to contribute to a household's inherent features that increase its vulnerability to exogenous shocks.

These are precipitation, household distance to nearest population center with more than 20,000 people, and household distance to the nearest Agricultural Development and Marketing Corporation (ADMARC) outlet. Households that are located far from ADMARC outlets have to travel long distances before they can access the services that are provided by these outlets such as marketing and storage of agricultural products. In addition, being located in an area that is far from large populations makes it difficult for household members to seek and access work opportunities. The amount of precipitation a household receives has an effect on what and how much they produce, since most of the households depend on rain-fed agriculture. Thus these variables are selected to be included in the construction of the vulnerability index because literature shows that they contribute to household vulnerability.

Like the resilience index, the first step in the construction of the vulnerability index was ensuring that all observations of the component are standardized to make sure that the values of observations in a particular variable array take a range of values from 0 to 1. Thus all observations of the components were standardized using equation (1). After that, the vulnerability index was computed by taking a simple average of the three components. The vulnerability index takes values between 0 and 1, with households that have values of 0.5 and above being interpreted as having higher levels of vulnerability while those that have values less than 0.5 are less vulnerable.

The overall risk of the effect of household exposure to exogenous shocks is indicated by the combination of the vulnerability and resilience indices. This combined measure is used to classify households into four categories depending on their risk of being harmed by external shocks due to their inherent vulnerability features counterbalanced to different extents by their nurtured resilience. The four categories are “trapped”, “strategic”, “promising”, and “precautionary”.

Figure 4.2: Characterization of households according to their vulnerability and resilience index

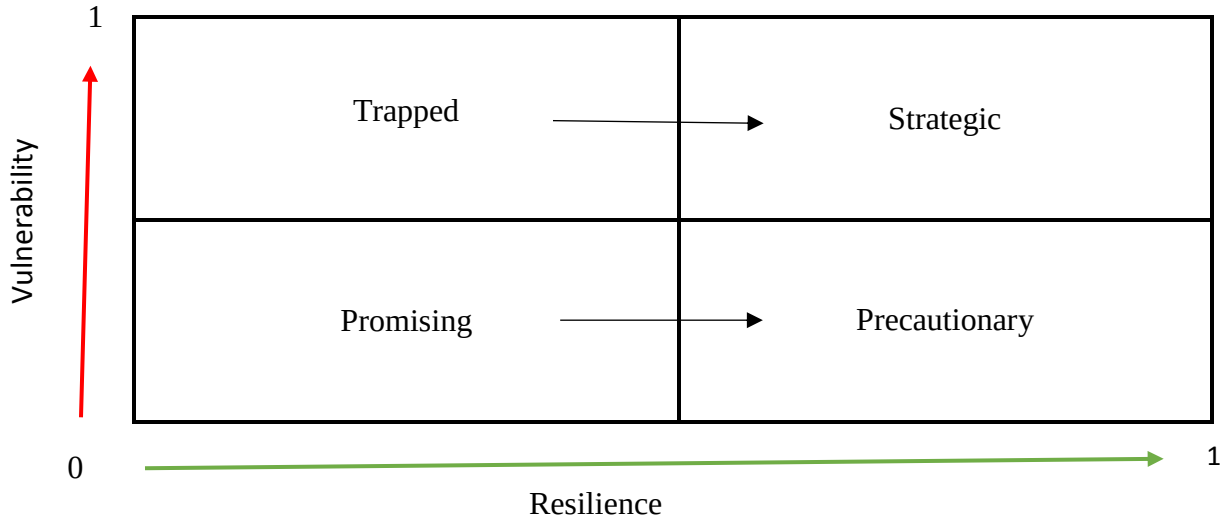


Figure 4.2 shows four scenarios for classifying or characterizing households according to their vulnerability and resilience levels. Households characterized by high vulnerability and low resilience are classified as "trapped" while those that, despite having high inherent vulnerability have high resilient are classified as "strategic". They are strategic because they are able to reduce the effect of shocks by adopting strategies that enable them to mitigate their high vulnerability by building their resilience. Households that have both low levels of vulnerability and resilience are classified as "promising" because there appears to be little effort or success to take actions to increase resilience. Households that are classified as "precautionary" are those that adopt strategies that help them reduce the effect of shocks and thus have high resilience despite having low levels of vulnerability. The black arrows in Figure 4.2 shows that households can adopt strategies that enable them to build their resilience and hence move from being promising and trapped to being precautionary and strategic, respectively.

4.3 Econometric strategy

This section discusses the model specification for econometrically exploring the factors that contribute to the resilience of households in Malawi. Households in Malawi operate in an

environment where they are faced with shocks which affect their livelihoods. Thus there is a need to understand this environment and how households respond when faced with exogenous shocks. This study, following Upton et al., (2016), uses food security as a proxy for household resilience to economic shocks. The food security variable is constructed from a question "in the last 7 days, did you worry that your household would not have enough food?"). As discussed in Chapter 3, there were shocks during the period 2010-2013, including a devaluation of the Malawian Kwacha in April 2012 and a weather shock which affected all economic actors, especially agricultural households in Malawi. So, 2010 represents a period before households were faced with exogenous shocks, while 2013 is the period after households experienced the shocks. Thus, a household is defined as being resilient if it is food secure in both 2010 and 2013 or food insecure in 2010 but food secure in 2013. If a household is food insecure in both 2010 and 2013 or if it is food secure in 2010 but food insecure in 2013, then the household is classified as not resilient. Because resilience is defined as a binary response, a logistic regression model can be used to model factors that contribute to household resilience. From this analysis, I explore factors that increase household resilience, called resilience building factors as well as factors that increase the vulnerability of households to shocks.

The resilience of a household to exogenous shocks can be modelled as a binary choice. Thus a household is either resilient to exogenous shocks or not. I use a logistic regression model to econometrically explore the contributing factors to the resilience of Malawian households to shocks during the period 2010-2013, including a major devaluation and devastating flooding. This is a typical technique of analysis if an outcome variable is dichotomous (see Hosmer and Lemeshow 2000). Following Agresti (2013), the logistic regression for household resilience can therefore be specified as:

$$Logit\ P_i = \log\frac{P_i}{1-P_i} = \boldsymbol{\beta}' x_i \qquad i=1,\ldots,2{,}666 \qquad (2)$$

where P_i=Pr(Y_i=1) is the probability that a household is resilient to an exogenous shock (i.e the household is food secure in both 2010 and 2013 or food insecure in 2010 but food secure in 2013); 1-P_i=Pr(Y_i=0) is the probability that a household is not resilient (i.e household is food insecure in both 2010 and 2013 or if it is food secure in 2010 but food insecure in 2013). This specification measures the change in food security between 2010 and 2013, thus is referred to as resilience of households. βs are parameters to be estimated and x_i is a vector of baseline characteristics that are hypothesized to influence the resilience of agricultural households to shocks. The number of households *i* is from 1 to 2666.

The dependent variable, which is a measure of household resilience is designed to measure how households are able to bounce back, adapt and/or cope when they are faced with shocks during this period. Therefore, households that are able to maintain their food security between the periods before and after the shocks are defined as being resilient because they are able to maintain their food security and/or bounce back to their pre-shock levels. Similarly, households that move from being food insecure to food secure are also defined as being resilient because they are able to adapt to the negative effects of the exogenous shocks and improve their food security in the post-shock period. On the other hand, households that maintain food insecurity between the baseline period and after are defined as not being resilient. Similarly, households that move from being food secure to food insecure after they are affected by the exogenous shocks are defined as not being resilient. These households are defined this way because they are neither able to bounce back nor adapt after they are faced with negative exogenous shocks.

In addition to the logistic regression that measures resilience (i.e change is food security), I also specify two simple logistic regression models that explore the factors that contribute to household food security in each year, 2010 and 2013 using only cross-sectional data for each of these years. In these specifications of the logistic regression model, the outcome variable is defined as 1 if the household is food secure in 2010 and 0 if it is food insecure in the same year. Similarly, for 2013, the outcome variable is defined as 1 if the household is food secure in 2013 and 0 if it is food insecure in the same year. The purpose of running the 2010 and 2013 logistic regression models separately is two-fold: first to establish how the factors that affect food security compare between the two years, and second to determine the key drivers of food security in a statistical sense.

Table 4.1 shows the explanatory variables used in the regression models, and their hypothesized signs, based on economic theory and my review of the literature. These variables include control variables, resilience building variables, vulnerability variables as well as variables that can either contribute to a household's resilience or vulnerability. There are also two interaction variables between gender dummy and area of corn planted, and also gender dummy and area of tobacco planted. The purpose of these interaction variables is to test the hypothesis that female managed plots are on average less productive than male managed plots.

Table 4.1: Description of explanatory variables and their hypothesized sign

Variable	Description	Hypothesized sign
Control variables		
Age	Age of household head in years	+/-
Age squared	Aged squared	+/-
Gender dummy	1=female, 0=male	+/-
Household size	Number of household members	-
Proportion of adults	Proportion of adults to total members in household	+
Resilience building variables		
Literate dummy	1=if head can read and write in Chichewa or English, 0=otherwise, proxy for learning outcomes	+
Productive (farming) assets	Number of agricultural machinery and buildings assets for agriculture production that a household owns	+
Land ownership dummy	1=if owns or cultivated a plot in 2009/10 season, 0=otherwise	+
Number of livestock	Number of livestock such as cattle, pigs, goats, etc. a household owned 12 months prior to baseline	+
Number of poultry	Number of poultry such as chickens, turkeys, ducks etc. a household owned 12 months prior to baseline	+
Corn planted (hectares)	Area of corn a household planted in hectares during the 2009/10 season	+
Tobacco planted (hectares)	Area of corn a household planted in hectares during the 2009/10 season	+
Non-agricultural employment dummy	1=household has access to non-agricultural (non-farm) employment income, 0= if a household has no access	+
Ganyu dummy	Ganyu is when a household hires out agricultural labor. 1=household has access to agricultural labor income, 0= if a household has no access	+
Non-agricultural employment * Ganyu	Interaction between access to non-agricultural employment and access to agricultural labor income. Proxy for having diversified income sources	+
Vulnerability variables		
Distance to population center (km)	Household distance in kilometers to nearest population center with 20,000 people	-
Distance to ADMARC (km)	Households distance in kilometers to nearest Agricultural Development and Marketing Corporation (ADMARC) center	-
Temperature of wettest quarter (^{o}C)	Temperature of the wettest quarter of the year in degrees Celsius	+/-
Precipitation of wettest quarter (mm)	Precipitation of the wettest quarter of the year in millimeters	+/-

Table 4.1: Continued

Variable	Description	Hypothesized sign
Vulnerability/Resilience variables		
Electricity dummy	1=household has access to electricity, 0=otherwise	+
Access to credit dummy	1=household has access to credit, 0=otherwise	+
Northern region dummy	1=Northern region, reference region	+/-
Central region dummy	1=Central region	+/-
Southern Region	1=Southern region	+/-
Variables to testing productivity of female owned plots		
Gender dummy* Corn planted (hectares)	Interaction between the number of hectares of corn planted by the household and female household head	-
Gender dummy* Tobacco planted (hectares)	Interaction between the number of hectares of tobacco planted by the household and female household head	-

4.4 Data

This study uses representative panel data from the Integrated Household Panel Survey (IHPS) that was collected from households in Malawi by the National Statistical Office (NSO) of Malawi. The IHPS is a multi-topic panel survey with a strong focus on agriculture. Particularly, this study uses data from the household and agricultural surveys that were conducted in 2010 and 2013. The household survey obtained data on household characteristics, such as household demographics, household economic activities, agriculture, vulnerability measures, welfare and other household characteristics. The agricultural survey collected information on the crops grown by the household, and the number of livestock owned.

The baseline survey was conducted between March and November 2010 and it consisted of 3,246 households. During the follow-up survey in 2013 from April to December, there was an

attempt to track all baseline households residing within mainland Malawi (except those on Likoma Island), including individuals that moved away from the baseline dwellings between 2010 and 2013 that were neither guests nor servants during the baseline survey, and were at least 12 years of age at that time. Individuals that moved away from the baseline household and fulfilled the aforementioned criteria were called split households. For those individuals who split off from their main households between 2010 and 2013, once located, the new household that they formed or joined was included in the 2013 sample. Thus the 2013 sample had a total of 4,000 households that could be traced back to baseline households. Of these 3,104 baseline households, 2,384 did not split while 720 baseline households had split into one or more households. After accounting for 20 baseline households that had disappeared between 2010 and 2013, the overall attrition rate between the two years was 3.78 percent at household level (NSO 2013).

4.5 Data Cleaning

The first step in the analysis was defining a measure of resilience. This process included making sure that data files from 2010 that contained information on food security were merged together with the data files from 2013 containing the same information for the same households. This was necessary in order to measure the change in food security between 2010 and 2013, and thus define a measure of household resilience. After the dependent variable was defined, there was need to get a measure of household baseline characteristics. Thus, I used 2010 data to generate household baseline characteristics. Therefore, although data from both 2010 and 2013 is used to define the dependent variable, all the regressors come from 2010 which is the baseline year. For purposes of this study I only include households for which information is available for both 2010 and 2013, thus split off households are excluded. Although excluding split off households might potentially introduce selection bias, doing so is critical because it enables the analysis of research

to capture changes in household food security between 2010 and 2013 (i.e resilience of households) for the same households.

The 2013 data set had a total of 4,000 households, however, this included split-off households. For purposes of this study, I only keep original households because it ensures that the analysis captures resilience for the same households between 2010 and 2013. Therefore, after split-off households were dropped, only 2,729 households remained from 2013. Of these households, 19 had duplicates (i.e households with same household identification numbers). Because the information was different between the duplicates, all the duplicates were deleted, thus bringing the number of households in the 2013 file to 2691. On the other hand, the 2010 panel had 3246 households. The file that had the food security variables had no duplicates and each household was uniquely identified by a key variable called HHID.

After ensuring that both 2010 and 2013 files containing the food security variable had no duplicates or missing values, the files were merged. This was done using a key variable (i.e HHID) that was present in both files and that uniquely identified the households. After merging, the resulting total number of households was 2,691. This was expected as the merge was done so as to have a one to one match between households in the two years. After merging the files with information on the dependent variable, the next step was to merge files that had information on independent variables. All independent variables were generated from the 2010 data set. This was necessary because I was interested in determining what characteristics households had in 2010 that enabled them to be resilient to shocks, including the devaluation and weather shocks, on the horizon. Before the merge was performed, each data file was checked for duplicates on the household identification number, extreme values, and missing values were also checked. I also ensured that only variables of interest in the file and the household identifying information were

kept in the resulting cleaned data files. After merging all the files from the household survey, the total number of households came to 2666.

4.6 Summary Statistics

Table 4.2 presents summary household-level statistics of all regressors in the resilience logistic model. On average households had five members with the largest household having 19 members. Although it is common to have male headed households in the sample, almost a quarter of the households were headed by a female. The average age of the heads of households is 42 years, and over half of them are literate which means that they are able to read and write English and/or Chichewa. The households are primarily agricultural households: about 83 percent of the households owned or cultivated land. On average, a household owned 2 livestock (e.g. cattle or goats) and 4 poultry. Corn is a very important staple crop to households in Malawi, and on average a household planted 0.42 hectares of corn. The average area of tobacco planted by the households is 0.05 hectares which is very low. Thus very few households planted tobacco despite it being an important cash crop as discussed in Chapter 3.

Agricultural households in Malawi supplement their income through non-agricultural employment (e.g working in the city) and ganyu (i.e farm labor income earned by working on other farms). Thus about 25 percent of the households have access to non-agricultural employment, while 30 percent of the households have access to ganyu income. Very few households (i.e 3 percent) have access to diversified income sources (i.e access to both non-agricultural employment and ganyu income). There is low access to credit among households with only 14 percent having access to credit.

Malawi is divided into three regions: Northern, Central and Southern. Twenty-three percent of the households are located in Northern Region, which has the lowest share of households. The rest of the households, 37 percent and 40 percent are located in Central and Southern regions, respectively.

Table 4.2: Summary statistics of variables

Variable	**Mean**	**Median**	**Min**	**Max**
A. Continuous variables				
Age (years)	42	38	13	110
Household size	5	5	1	19
Proportion_adults	0.6	0.56	0	1
Productive (Farming) assets	1	0	0	32
Number of livestock	2	0	0	146
Number of poultry	4	0	0	67
Corn planted (hectares)	0.42	0.4	0	7
Tobacco planted (hectares)	0.05	0	0	5
Distance to population center (km)	30	30	0.26	93
Distance to ADMARC (km)	8	6	0.08	35
Temperature of wettest quarter (^{o}C)	23	23	20	29
Precipitation of wettest quarter (mm)	676	651	497	1199
B. Discrete Variables				
Gender dummy (1=female)	0.22	0	0	1
Literate dummy (1=yes)	0.69	1	0	1
Land ownership dummy (1=yes)	0.83	1	0	1
Non-agricultural employment dummy (1=yes)	0.25	0	0	1
Ganyu dummy (1=yes)	0.30	0	0	1
Non-agricultural employment *ganyu	0.03	0	0	1
Electricity dummy (1=yes)	0.11	0	0	1
Access to credit dummy (1=yes)	0.14	0	0	1
Northern region dummy (1=yes)	0.23	0	0	1
Central region dummy (1=yes)	0.37	0	0	1
Southern region dummy (1=yes)	0.40	0	0	1
C. Dependent Variables				
Resilience dummy (1=yes)	0.64	1	0	1
Food security 2010 (1=yes)	0.74	1	0	1
Food security 2013 (1=yes)	0.64	1	0	1

The average distance from the household to the nearest Agricultural Development and Marketing Corporation (ADMARC) outlet is about 8 kilometers, while the average distance of the households to the nearest population center with at least 20,000 people is about 30 kilometers. Only 11 percent of the households have access to electricity.

In Malawi most of the agricultural production occurs during the rainy season which is the wettest quarter of the year. Thus production is heavily dependent on the climatic conditions, especially upon the precipitation received. Precipitation during the wettest quarter ranged between 497 to 1199 millimeters, with an average of 676 millimeters. The average temperature during the wettest quarter was 23 degrees Celsius.

Chapter 5: Results

5.1 What Do the Respondents Say?

In 2013, all 4,000 households that where interviewed reported having faced some kind of shock. However, of these, only 3,820 households reported having faced severe shocks that negatively affected the household.

Table 5.1: Severe Shocks affecting households in 2013

Type of shock	Frequency	Percent
Unusually high prices for food	1,238	32.41
Unusually high costs of agricultural inputs	830	21.73
Drought	286	7.49
Serious illness or accident of household member(s)	277	7.25
Irregular rains	226	5.92
Death of other household member(s)	124	3.25
Theft of money/valuables/assets/agriculture	124	3.25
Floods	112	2.93
Unusually low prices for agricultural output	95	2.49
Other specified shock such as lack of employment	72	1.88
Death of income earner(s)	71	1.86
Break-up of household	62	1.62
Loss of employment of previously salaried household members	56	1.47
Conflict/violence	43	1.13
End of regular assistance/aid/ remittances	38	0.99
Reduction in the earnings from household (non-agricultural) business (not due to illness or accident)	37	0.97
Birth in the household	37	0.97
Household (non-agricultural) business failure (not due to illness or accident)	30	0.79
Reduction in the earnings of currently salaried household members (not due to illness or accident)	22	0.58
Unusually high level of livestock disease	20	0.52
Unusually high level of crop pests or disease	18	0.47
Earthquakes	1	0.03
Landslides	1	0.03
Total	3,820	100

Table 5.1 shows the most severe shocks faced by households in 2013. The majority of the households, about 32 percent, reported that unusually high prices for food was the most severe shock that they faced followed by unusually high costs of agricultural inputs and drought that were reported by about 21 percent and 7 percent of the households, respectively as the most severe shocks that they faced.

Table 5.2: General response to shocks faced by households in 2013

Household response to shocks	**Frequency**	**Percent**
Relied on own-savings	1,895	49.74
Did not do anything	653	17.14
Received unconditional help from relatives/friends	286	7.51
Changed dietary patterns involuntarily	210	5.51
Other specified response	126	3.31
Obtained credit	114	2.99
Adult household members who were previously not working had to find work	110	2.89
Engaged in spiritual efforts - prayer, sacrifices, diviner, and consultation	107	2.81
Received unconditional help from government	60	1.57
Sold livestock	50	1.31
Sold durable assets	47	1.23
Sold crop stock	35	0.92
Reduced expenditures on health and/or education	29	0.76
Sold agricultural assets	28	0.73
Received unconditional help from Non-Governmental Organizations (NGO)	27	0.71
Employed household members took on more	18	0.47
Household members migrated	5	0.13
Sold land/building	5	0.13
Sent children to live elsewhere	4	0.1
Intensified fishing	1	0.03
Total	3,810	100

Another 7 percent of the households reported that they faced serious illness or accident of household member(s). Households also reported having experienced irregular rains as a shock that

they faced. This was reported by about 6 percent of the households as one of the most severe shocks that they faced.

When faced with these shocks, households responded in a number of ways to try to regain their former level of welfare. Table 5.2 shows the most important response to shocks that were reported by households in 2013. About 50 percent of the households relied on their own savings in response to the shocks that they faced. Despite households experiencing severe shocks, about 17 percent of the households reported that they did not do anything in response to the shock that they faced while about 8 percent of the households received unconditional help from relatives/friends. Other responses to shocks by households included; changing dietary patterns involuntarily, and obtaining credit.

Table 5.3 shows the responses of households to the top four shocks that they faced in 2013. These shocks include unusually high prices for food, unusually high costs of agricultural inputs, drought as well as serious illness or accident of household member(s). The most common responses across all these shocks by households was to rely on their own savings. The second most common response was to do nothing about the shock, which was true for all the shocks except when a household was faced with a serious illness or accident of a household member. When faced with serious illness or accident of a household member, the second most important response was that households received unconditional help from friends or relatives. The third most common response by households that were faced with drought, unusually high costs of agricultural inputs, and unusually high prices for food was changing dietary patterns. While households whose household member(s) had a serious illness or accident responded by engaging in spiritual efforts such as prayer, sacrifices, divinations, or consultations.

Table 5.3: Selected agricultural shocks and household response

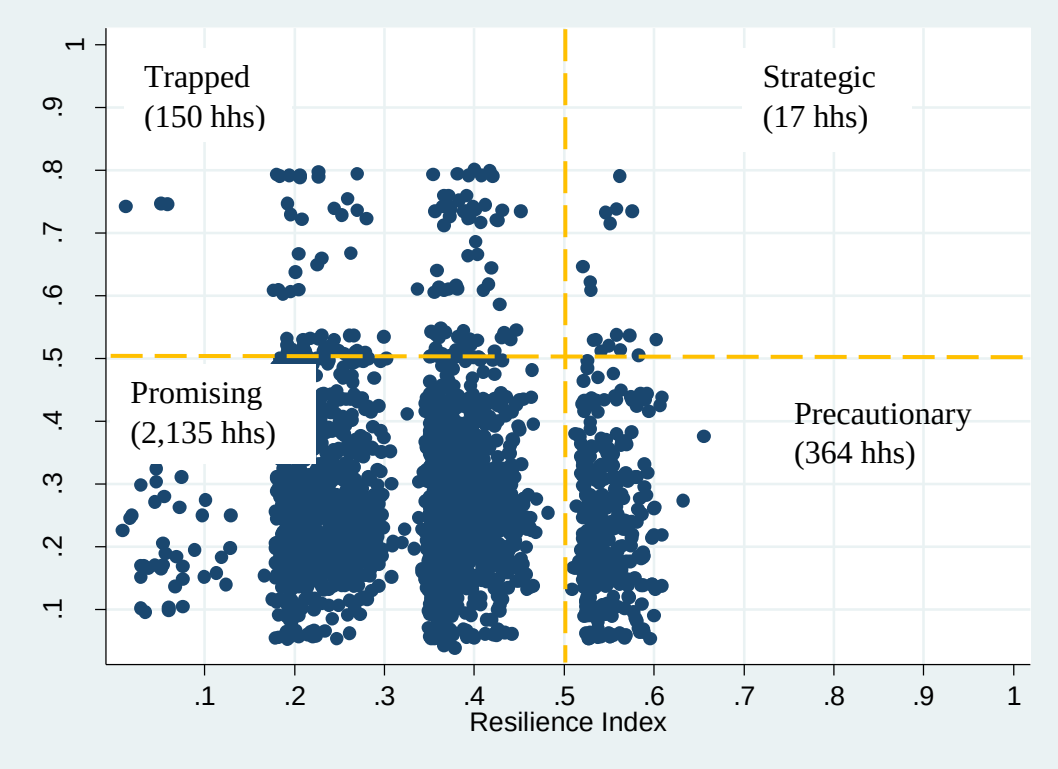
Household response to shock	Shock							
	High food prices		High agric. Input prices		Drought		Serious illness/accident	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Relied on own-savings	658	53	469	56	118	41	132	48
Did not do anything	179	14	150	18	72	25	16	6
Changed dietary patterns involuntarily	93	8	32	4	29	10	4	1
Received unconditional help from relatives/friends	82	7	34	4	10	4	51	18
Other specified response	45	4	14	2	8	3	8	3
Adult household members who were previously not working had to find work	41	3	17	2	10	4	7	2
Obtained credit	29	2	25	3	3	1	13	5
Sold durable assets	19	2	1	0.12	7	2	1	0.36
Sold livestock	16	1	11	1	9	3	5	2
Received unconditional help from NGO /religious institution	14	1	2	0.24	2	1	1	0.36
Received unconditional help from government	13	1	31	4	7	2	3	1
Engaged in spiritual efforts - prayer, sacrifices, diviner	12	1	6	1	7	2	20	7
Employed household members took on more	9	1	4	0.48	0	0	2	1
Reduced expenditures on health and/or education	9	1	9	1	0	0	0	0
Sold crop stock	6	0.49	9	1	1	0.35	4	1
Sold agricultural assets	4	0.32	13	2	1	0.35	7	2
Household members migrated	2	0.16	1	0.12	0	0	0	0
Sent children to live elsewhere	1	0.08	0	0	0	0	1	0.36
Sold land/building	0	0	1	0.12	2	1	0	0
Total	1,232	100	829	100	286	100	275	100

5.2 Household Classification: Vulnerability and Resilience

Using Briguglio's approach, households were classified into four groups depending on their resilience and vulnerability indices. The resilience index is constructed from six resilience building variables and these are: number of productive assets such as farm machinery and farm buildings a household owns, ownership of land, whether the head of the household is literate or not, number of livestock reared, the age of the household head which is a proxy for experience, and access to non-agricultural employment. The variables were selected because literature shows that these variables are important for resilience building, and most of them were statistically significant in some of the econometric analyses. The variables used to construct the resilience index are within the control of the household, thus a household builds or nurtures its resilience through the decisions that it makes. The resilience index takes values between zero and one, and a high index value means that a household has high resilience. On the other hand, a household finds itself in a vulnerable position by factors which are outside its control such as its location, temperature, and precipitation. The vulnerability index was constructed from three variables i.e distance to a population center with at least 20,000 people, distance to an Agricultural Development and Marketing Corporation (ADMARC) outlet, and the annual precipitation. These variables were selected because literature shows that they are important determinants of household vulnerability. The vulnerability index takes values between zero and one, and a high index value means that a household has high inherent vulnerability to shocks.

Figure 5.1 shows the classification of households into four groups depending on their resilience and vulnerability index values.

Figure 5.1: Household Resilience and Household Vulnerability



The results from the classification show that out of 2,666 households, the majority of the households (80 percent) fall into the promising category. This implies that despite them having low levels of vulnerability, there is much they can do to build their resilience. In other words, these households maintain the status quo, thus they are characterized by low levels of vulnerability as well as low levels of resilience. In general, the households in the promising category live in close proximity to areas with a population of more than 20,000 people (i.e the average distance of households to areas with a population of more than 20,000 people is 30 km). This makes it easier for household members of working age to seek and find work opportunities which provide non-farm income to the household. In addition, households in the promising category live in close proximity to Agricultural Development and Marketing Corporation (ADMARC) outlets.

This means they do not have to travel long distances for them to access services that are provided by ADMARC outlets such as markets for their agricultural produce, and warehousing services for storage of agricultural produce that these households produce. These attributes contribute to making households less vulnerable. Yet, the low household vulnerability is accompanied by low levels of resilience building characteristics which include having no or few livestock, and productive assets such as agricultural buildings and machinery. They also report no access to non-agricultural employment and the household heads are younger and illiterate. Thus, although households that fall in the promising category have low levels of vulnerability, their low resilience levels, which are under their control, expose them to adverse exogenous shocks.

The second group of households are those that are trapped. They are classified this way because they have high levels of vulnerability and low levels of resilience. These are the most vulnerable households to shocks. Results show that out of the 2,666 households, about 150 of the households are trapped. These can be thought of as the worst case scenario given their low levels of resilience and high inherent vulnerability. In general, households that fall in the trapped category are located far from areas with a population of more than 20,000 people (i.e the average distance of households to areas with a population of more than 20,000 people is 58 km). This makes it difficult for household members of working age to seek and find work opportunities which provide non-farm income to the household. In addition, households in the trapped category are located far from Agricultural Development and Marketing Corporation (ADMARC) outlets. This means they have to travel long distances for them to access the services that are provided by ADMARC outlets such as markets for their agricultural products, and warehousing services for storage of agricultural commodities that are produced by these households. These attributes contribute to households having high vulnerability levels.

The high vulnerability indices of households that fall in the trapped category is coupled with low levels of resilience building capacity which include having no or few livestock, and having no or few productive assets (i.e agricultural buildings and machinery). They also have no access to non-agricultural employment and the household heads are younger and illiterate. Thus, although they have similar levels of resilience as the households in the promising category, they have higher levels of vulnerability.

The third group of households are those that despite being highly vulnerable have nurtured and/or developed their resilience. These types of households are classified as strategic. The results show that there are only 17 households out of 2,666 that fall in the strategic category. In general, the households in the strategic category live far from areas with a population of more than 20,000 people (i.e the average distance of households to areas with a population of more than 20,000 people is 54 km). This means that the households primarily live in rural areas which makes it difficult for them seek and access work opportunities and thus have to travel long distances to access these opportunities. In addition, households in the strategic category live far from Agricultural Development and Marketing Corporation (ADMARC) outlets. This means they have to travel long distance for them to access the services that are provided by ADMARC outlets such as markets for their agricultural products, and warehousing services for storage of their agricultural commodities. These attributes contribute to high levels of household vulnerability.

However, despite having high vulnerability levels, households that fall in the strategic category have nurtured and/developed their resilience by rearing more livestock which may act as a cash reserve buffer against shocks. They also own more productive assets such as agricultural buildings and machinery which make their farming operations efficient. In addition, they have access to non-agricultural employment, and the household heads are older and literate. Thus,

although they have higher levels of vulnerability than the households in the promising category, they have nurtured and/or developed their resilience which makes them strategic.

The last group of households are those that have been classified as being precautionary. They are classified this way because although they have low levels of vulnerability, they have also nurtured and/or developed their resilience capabilities. These are the best case scenario and the results from the classification show that there are 364 out of 2,666 households that fall in the precautionary category. In general, households that fall in the precautionary category live in close proximity to areas with a population of more than 20,000 people (i.e the average distance of households from the population center is 23 km). This makes it easier for household members of working age to seek and find work opportunities which provide non-farm income to the household.

In addition, households in the precautionary category live in close proximity to Agricultural Development and Marketing Corporation (ADMARC) outlets. This means they do not have to travel long distances for them to access services that are provided by ADMARC outlets such as markets for their agricultural produce, and warehousing services for storage of agricultural products that these households produce. These attributes contribute to making households less vulnerable. Despite having low levels of vulnerability, these households have nurtured and/or developed their resilience by rearing more livestock which may act as a cash reserve buffer against shocks. They also own more productive assets such as agricultural buildings and machinery which are used on their farm enterprises. In addition, they have access to non-agricultural employment, and the household heads are older and literate. Thus, although they have similar vulnerability levels as the households in the promising category, they have nurtured and/or developed their resilience which makes them better off.

From this classification, one can see that the majority of the households have not built their resilience and, although they are promising for the future, these households, appear to be trapped in a traditional status quo. These households are stuck doing what they do in Malawi. Thus, although these households have varying levels of vulnerability, low levels of resilience make it difficult for them to bounce back and/or adapt when they are faced with exogenous shocks.

5.3 Econometric Results

To establish the factors that determine food security in 2010 and 2013, I run two logistic models in Table 5.4. The logistic models are estimated separately for 2010 and 2013 using cross-sectional data for the respective years in order to ascertain how the factors that affect food security compare between the two years. Columns two and three show results for Model 1 which measures the factors that affected food security in 2010. The dependent variable is equal to 1 if a household was food secure in 2010 and 0 otherwise (i.e food security was generated from the question "in the last 7 days, did you worry that your household would not have enough food"). The fourth and fifth columns show the results for Model 2 which also measures the factors that affect food security, but for the year 2013. In Model 2, the dependent variables is equal to 1 if the household was food secure in 2013, and 0 otherwise.

Factors that significantly affected food security in 2010 are literacy, household size, area of corn planted, number of livestock and poultry reared, ownership of land, access to electricity, the region in which a household is located, access to credit, access to ganyu income, and temperature during the wettest quarter of the year. Compared to households with illiterate household heads, those with literate household heads were more likely to be food secure in 2010.

Table 5.4: Food security logistic results

Variable	Model 1: 2010 Food Security		Model 2: 2013 Food Security	
	Coef.	P value	Coef.	P value
Age (years)	0.006	0.71	0.024	0.16
Age squared	-0.0002	0.35	-0.0003	0.099
Gender dummy (1=female)	-0.187	0.12	-0.327	0.003
Household size	-0.098	0.00	-0.113	0.00
Proportion_adults	0.187	0.48	0.122	0.63
Literate dummy (1=yes)	0.327	0.003	0.376	0.00
Productive (Farming) assets	0.064	0.28	0.234	0.00
Land ownership dummy (1=yes)	0.30	0.06	0.418	0.003
Number of livestock	0.032	0.08	0.045	0.02
Number of poultry	0.024	0.004	0.018	0.01
Corn planted (hectares)	0.44	0.002	0.247	0.07
Tobacco planted (hectares)	0.195	0.6	0.124	0.77
Non-agricultural employment dummy (1=yes)	0.051	0.73	-0.009	0.94
Ganyu dummy (1=yes)	-0.80	0.00	-0.793	0.00
Non-agricultural employment *ganyu	-0.423	0.12	0.18	0.53
Electricity dummy (1=yes)	0.925	0.00	1.171	0.00
Access to credit dummy (1=yes)	-0.239	0.06	-0.134	0.21
Distance to population center (km)	-0.007	0.006	-0.001	0.65
Distance to ADMARC (km)	0.003	0.7	-0.001	0.86
Temperature of wettest quarter (^oC)	-0.122	0.00	-0.054	0.06
Precipitation of wettest quarter (mm)	-0.0007	0.17	0.00006	0.91
Region Dummies, base=Southern				
Northern region dummy (1=yes)	0.172	0.23	0.02	0.88
Central region dummy (1=yes)	0.315	0.02	-0.094	0.42
_cons	4.289	0.00	1.21	0.15
Sample size	2666		2666	

Households that planted larger areas of corn were more likely to be food secure in 2010. The more livestock (i.e cattle, goats) a household reared, the more likely it was to be food secure in 2010. This result was also true for the number of poultry (i.e chickens and ducks) reared. In addition,

households that owned land were more likely to be food secure in 2010 compared to households that did not own land.

Households with more members were less likely to be food secure in 2010. Compared to households that were located in the Southern region of Malawi, households located in the Central region were more likely to be food secure in 2010. On the other hand, households that are located far from a population center with at least 20,000 people were less likely to be food secure in 2010. A surprising result is that households that had access to credit, were less likely to be food secure in 2010, compared to those that did not have access to credit. This result is inconsistent with the findings of Mutabazi et al. (2015) who found a positive relationship between household resilience and access to credit in Tanzania. Furthermore, households that had access to ganyu income were less likely to be food secure in 2010, compared to those that did not have access to ganyu income.

Factors that significantly affected household food security in 2013 are age squared, gender of the household head, household size, literacy, number of productive assets owned, land ownership, quantity of livestock reared, quantity of poultry reared, area of corn planted, access to ganyu income, access to electricity, and temperature during the wettest quarter of the year. Compared to male headed households, female headed households were less likely to be food secure in 2013. Households with more members were less likely to be food secure in 2013. Households with literate household heads were more likely to be food secure in 2013 compared to households with illiterate household heads. The more productive assets (i.e agricultural machinery and buildings) a household had, the more likely it was to be food secure in 2013.

The results also show that the more livestock and poultry a household reared, the more likely it was to be food secure in 2013. In addition, the larger the area of corn a household planted,

the more likely it was to be food secure in 2013. Households that had access to electricity were more likely to be food secure in 2013 compared to households that had no access to electricity. Higher temperatures during the wettest quarter of the year were associated with household food insecurity in 2013. Lastly, households that worked on other people's farms (i.e had access to ganyu income) were less likely to be food secure in 2013, compared to those that did not have access to ganyu income.

Whether a household was food secure or not was determined by similar factors between 2010 and 2013. Having a household head that is literate, owning land, having access to electricity, rearing more livestock and poultry as well as growing more corn were associated with household food security in both 2010 and 2013. Factors that were negatively associated with household food security in both 2010 and 2013 are household size, access to ganyu income, and temperature during the wettest quarter of the year. While gender of the household head and having more productive assets (i.e machines and buildings) were determinants of food security in 2013, they were not important factors in 2010. Conversely, the region where a household was located and distance between a household and a population center with at least of 20,000 people were determinants of food security in 2010 but not in 2013. Although age itself is not statistically significant, age squared is statistically significant with a negative coefficient. This means that there is a non-linear relationship between the age of the household head and food security. However, this result is only true for the year 2013.

So from these two models for two different years the key drivers of food security, in a statistical sense are household size, access to ganyu income, temperature during the wettest quarter of the year, gender of the household head, quantity of productive assets, number of livestock and poultry a household owns, area of corn planted, the region where a household is located, access to

electricity, and distance between a household and an area with a population center with 20,000 people or more.

Table 5.5: Hypothesized and predicted signs for 2010 and 2013 Food Security Logit Models

Variable	Hypothesized sign	Estimated sign	
		2010	2013
Age	+/-	+	+
Age squared	+/-	-	-
Gender dummy (1=female)	+/-	-	-
Household size	-	-	-
Proportion of adults	+	+	+
Literate dummy (1=yes)	+	+	+
Productive (farming) assets	+	+	+
Land ownership dummy (1=yes)	+	+	+
Number of livestock	+	+	+
Number of poultry	+	+	+
Corn planted (hectares)	+	+	+
Tobacco planted (hectares)	+	+	+
Non-agricultural employment dummy	+	+	-
Ganyu dummy (1=yes)	+	-	-
Non-agricultural employment*ganyu	+	-	+
Distance to population center (km)	-	-	-
Distance to ADMARC (km)	-	+	-
Temperature of wettest quarter (^{o}C)	+/-	-	-
Precipitation of wettest quarter (mm)	+/-	-	+
Electricity dummy	+	+	+
Access to credit dummy	+	-	-
Region dummies, base=Southern			
Northern region dummy	+/-	+	+
Central Region dummy	+/-	+	-

Table 5.5 shows the hypothesized and predicted signs for the 2010 and 2013 food security logistic regression models to give an overview of the findings from running the two separate models.

To determine the effect of household baseline characteristics on household resilience to exogenous shocks, I run two logistic models where I explore the effects of resilience building and vulnerability variables on household resilience to exogenous shocks (Table 5.6).

Table 5.6: Factors affecting household resilience

Variable	Model 3: Resilience (main model)		Model 4: Resilience with gender interaction	
	Coef.	P value	Coef.	P value
Age (years)	0.02	0.19	0.018	0.24
Age squared	-0.0002	0.17	-0.0002	0.21
Gender dummy (1=female)	-0.39	0.00	-0.109	0.46
Household size	-0.083	0.001	-0.085	0.001
Proportion_adults	0.211	0.38	0.192	0.43
Literate dummy (1=yes)	0.34	0.001	0.338	0.001
Productive (Farming) assets	0.113	0.04	0.112	0.04
Land ownership dummy (1=yes)	0.392	0.007	0.345	0.02
Number of livestock	0.034	0.04	0.031	0.07
Number of poultry	0.016	0.03	0.016	0.03
Corn planted (hectares)	0.429	0.001	0.713	0.00
Tobacco planted (hectares)	0.942	0.01	0.707	0.06
Non-agricultural employment dummy (1=yes)	0.092	0.47	0.100	0.43
Ganyu dummy (1=yes)	-0.383	0.00	-0.365	0.00
Non-agricultural income *ganyu	0.082	0.76	0.073	0.78
Electricity dummy (1=yes)	1.506	0.00	1.514	0.00
Access to credit dummy (1=yes)	0.047	0.70	0.038	0.76
Distance to population center (km)	-0.002	0.46	-0.002	0.42
Distance to ADMARC (km)	-0.004	0.56	-0.005	0.54
Temperature of wettest quarter (^{o}C)	-0.042	0.14	-0.04	0.16
Precipitation of wettest quarter (mm)	-0.0004	0.39	-0.0004	0.44
Region Dummies, base=Southern				
Northern region dummy (1=yes)	-0.05	0.71	-0.04	0.76
Central region dummy (1=yes)	-0.158	0.18	-0.16	0.18
Gender dummy*corn area planted	-	-	-0.822	0.001
Gender dummy*tobacco area planted	-	-	3.478	0.10
_cons	0.943	0.26	0.883	0.29
Sample size	2666		2666	

Columns two and three show results for Model 3, the main model while columns four and five show results for Model 4. Both Models 3 and 4 measure the effect of household baseline characteristics on household resilience to exogenous shocks. However, in order to test whether there is a difference between female and male managed corn and tobacco plots, I include

interactions variables between gender of the household head and the area of corn planted as well as gender of the household head and the area of tobacco planted in Model 4. The dependent variable is equal to 1 if the household is food secure in both 2010 and 2013 or if it is food insecure in 2010 but food secure in 2013. On the other hand, if a household is food insecure in both 2010 and 2013 or if it is food secure in 2010 but insecure in 2013, then the outcome variable is equal to 0. Thus it is a measure of the change in household food security before and after households were faced with exogenous shocks.

The results from Model 3 indicate that households that have access to electricity, own land, have more productive assets, and reared more livestock and poultry are more likely to be resilient against shocks between 2010 and 2013. Furthermore, households that plant more hectares of corn and tobacco, and have a household head who is literate are more likely to be resilient. On the other hand, households with female heads, are large in size and have access to ganyu income are less likely to be resilient. As expected, the results in Model 4 are similar to those in model 3 except for gender which is statistically insignificant on its own but is statistically significant when interacted with the area of corn planted. This may be suggesting that there are differences in corn area planted to fostering resilience depending on if the area is managed by a man or a woman.

Most of the results in Model 3 and 4 are consistent with literature. Compared to households that have no access to electricity, households that have access to electricity are more likely to be resilient. This result highlights the importance of infrastructure for reducing household vulnerability to exogenous shocks. Because electricity is needed in livestock production such as milking and storage of milk and beef, households that have access to electricity are more likely to engage in these farming activities which contribute to household income diversification. In addition, households that have access to electricity are wealthier, live closer to roads, and the

availability of electricity may produce additional health (e.g. potable water) and educational (e.g. night light for studying). This result is consistent with the finding of Seo (2010) who found a positive effect of electricity on profit of mixed and livestock only farms in Africa.

Furthermore, households that own land are more likely to be resilient against exogenous shocks compared to those that do not own land. This may be because households that own land are more likely to invest in technology that enhance the productivity of the land. This result is consistent with the finding by Mutabazi et al. (2015) who also found a positive effect of land ownership on the resilience of farming households in Tanzania.

Households that own more productive assets such as machinery and buildings are more likely to be resilient. Machinery and building can be used in farm production which enhances the efficiency of farming operations. In addition, assets also act as a financial reserve buffer against shocks and may play a role in consumption smoothing. This result is consistent with the findings from Zimbabwe by Hoddinott 2006 who found that households draw on their assets when faced with exogenous shocks.

The more livestock and poultry a household has, the more likely it is to be resilient to exogenous shocks. This result shows that large animals (i.e beef, goats) and small animals (i.e chickens, ducks) alike are important for household resilience. Agricultural households use livestock and poultry as an asset reserve buffer against shocks. Thus agricultural households may sell livestock or poultry when they need money. In addition, poultry and livestock can be a source of protein for the household. The result that households that rear livestock and poultry are more likely to be resilient are consistent with the findings from Zimbabwe by Hoddinott (2006) who

found that when faced with shocks households sold their livestock, thus livestock acted as a buffer against shocks.

Corn is a staple crop in Malawi and is thus important for food security. Therefore the finding that households that grow more corn are more likely to be resilient sheds more light on the importance of the crop, both for food security as well as an important determinant of household resilience. This may be because households that plant more corn are able to meet their food security needs as well as sell excess corn in the market to generate additional income.

Similarly, households that grow more tobacco are more likely to be resilient. As discussed in Chapter 3, tobacco is an important cash crop in Malawi. Therefore, households that plant more hectares of tobacco have access to this extra income. This provides the farming family access to diversified income sources which may be important for coping when faced with a shock as noted by Ellis (2000). Tobacco serves as a proxy for higher value crops and their contribution to resilience.

Large households and those that are headed by females are less likely to be resilient. The first result, regarding household size may be because having a large household means having more mouths to feed which may constrain the resources of the household. The result that female headed households are less likely to be resilient may be an indication that there exists a gender gap in Malawi. Thus I include interaction variables between gender and area of corn and tobacco planted, in Model 4 to help explain the negative coefficient on gender of household heads. Results show that gender itself has no statistically significant effect on household resilience. However, I find that compared to male headed household that grow more corn, households with female heads that grow more corn are less likely to be resilient. This result is consistent with the finding from Malawi

by Kilic et al. (2014) that shows that female managed plots are on average less productive than male managed plots.

The result that households that have access to ganyu income are less likely to be resilient compared to households that have no access to ganyu income is somewhat puzzling and inconsistent with the findings by Daressa et al. (2009) and Ellis (2000) who show the importance of having diversified income sources of which ganyu income is a part. However, this result may be suggesting that households that work on other people's farms may not be able to generate enough income on their own farms to sustain themselves and thus have to work on other people's farms in order to supplement their income. This may explain why households with access to ganyu income are less likely to be resilient compared to those that have no access to ganyu income.

In Malawi, most of the agricultural production is done during the rainy season which is the wettest quarter of the year. Results indicate that having higher temperatures during the wettest quarter of the year has a negative effect on household resilience. This may be because higher temperatures during the growing season may affect plant development thus negatively affecting the harvest. In addition, higher temperatures, when coupled with high humidity may be associated with a high prevalence of animal and crop diseases. Furthermore, most of the agriculture in Malawi is rain-fed, hence suitable climatic conditions are needed to have a good harvest.

To interpret the effect of a unit change of the household baseline characteristics on the likelihood of a household being resilient in the Malawian context, I compute the marginal effects for variables in Model 3 (Table 5.6). Starting with baseline characteristics that have a significant negative effect on household resilience, we see that an increase in household size by one member decreases the likelihood of household resilience by 2 percent. A one degree increase in temperature during the wettest quarter of the year decreases the likelihood of household resilience by 1 percent.

Table 5.7: Marginal Effects for variables in Model 3

Variable	Marginal effect
Age (years)	0.0006
Gender dummy (1=female)	-0.09
Household size	-0.02
Literate dummy (1=yes)	0.08
Productive (Farming) assets	0.02
Land ownership dummy (1=yes)	0.09
Number of livestock	0.01
Number of poultry	0.003
Corn planted (hectares)	0.10
Tobacco planted (hectares)	0.21
Non-agricultural income dummy (1=yes)	0.22
Ganyu dummy (1=yes)	0.06
Electricity dummy (1=yes)	0.34
Access to credit dummy (1=yes)	0.01
Distance to population center (KMs)	0.0004
Distance to ADMARC (KMs)	-0.001
Temperature of wettest quarter (^{o}C)	-0.01
Precipitation of wettest quarter (mm)	0.0001
Region Dummies, base=Southern	
Northern region dummy (1=yes)	-0.01
Central region dummy (1=yes)	-0.04

Furthermore, compared to households with male heads, female headed households are 9 percent less likely to be resilient.

For baseline household characteristics that positively affect household resilience we see that households that have electricity are 34 percent more likely to be resilient compared to those that do not have electricity. The large marginal effect of electricity on household resilience shows how important infrastructure is to households. In general, households that have electricity are wealthier and closer to roads. Compared to households with heads that are not literate, households with literate household heads are 8 percent more likely to be resilient. This result may be indicative of the importance of being able to read and write in order to take advantage of the opportunities

that are available in the market such as leveraging high producer prices, timing of planting season, etc. The results also show that having one more cow or goat increases the likely of household resilience by 1 percent, while having one more chicken increases household resilience by 0.3 percent. This result shows that having more cows, goats, and chickens enhance household resilience to exogenous shocks.

The results also show that households that own land are 9 percent more likely to be resilient compared to those that do not own land. Increasing the area of corn planted by 1 hectare increases household resilience by 10 percent, while increasing the area of tobacco planted by one hectare increases household resilience by 21 percent. This result shows that growing corn and tobacco are important for household resilience because of the importance of corn and tobacco as a staple crop and cash crop, respectively. In addition, the large marginal effect of tobacco (i.e 21 percent) may indicate the importance of having diversified household income sources such as that obtained from selling tobacco or other higher value crops.

The key findings from this research are that most of the households are promising, meaning that they have low inherent vulnerability and low resilience capacity levels. Diversification is also important for household resilience. Household diversification can be in terms of having more livestock and poultry as well as growing more hectares of corn and tobacco. In addition, having more assets and having access to infrastructure such as electricity plays a role in terms of maintaining household food security in Malawi.

5.4 Robustness checks

Table 5.8 shows in-sample predictions for Model 3.

Table 5.8: In-sample model predictions

		Actual		
		Y=0	Y=1	Total
Predicted	Y=0	253	211	464
	Y=1	711	1,491	2,202
	Total	964	1,702	2,666

The results indicate that 26 percent of households that fall in the non-resilient category are correctly specified, while 88 percent of the households that fall in the resilient category are correctly specified. Therefore, the model is much stronger at predicting resilient households compared to non-resilient households. Overall the model correctly predicts 65 percent of resilient and non-resilient households.

In addition to in-sample predictions, I check to ensure that there are no omitted variables and that the model is correctly specified by performing a linktest. The results from this test show that the model is correctly specified and that there are no omitted variables (results of the linktest are shown in Table A2 in Appendix A). Furthermore, I also try different specifications for the main model (i.e Model 3) to see how robust the results are. I do this by adding and dropping variables in the model. The results from these robustness checks show that the results are robust to the specification of the model (alternative model specification results are included in Table A1 of Appendix A).

Chapter 6: Conclusions

Households in developing countries are continually being faced with exogenous shocks that usually have negative impacts on their livelihoods. Thus there has been a lot of interest in the development community to come up with ways of ensuring that households are not only able to anticipate the shocks, but that they are also able to cope with and/or adapt to the negative effects of exogenous shocks. This approach lends itself to resilience thinking. The current paper speaks to this issue by analyzing the effects of household baseline characteristics on the resilience of households to economic and weather shocks. I study household resilience in the context of 2,666 households in Malawi who experienced devaluation of currency and flood shocks between 2010 and 2013. Households were defined as resilient based on their ability to maintain household food security after they were faced with exogenous shocks or if they were able to move from being food insecure to food security after being faced with the exogenous shocks. In other words, households were defined as being resilient if they were able to cope with and/or adapt to the negative effects of the exogenous shocks during this period. The effect of baseline household characteristics on the resilience of households was analyzed using a logistic regression model.

I also classify households into four categories based on their inherent vulnerability and nurtured resilience using the approach developed by Briguglio et al. (2009). To the best of my knowledge, this has not been done before for households in a low income nation. Households fell into the promising category if they had low levels of vulnerability as well as low levels of nurtured resilience. Trapped households were those that had high levels of inherent vulnerability but did not build and/or nurture their resilience. Households that fell in the trapped category are the most vulnerable to the negative effects of exogenous shocks. Households that despite having high levels of inherent vulnerability had taken time to build and/or nurture their resilience so that they were

able to withstand and/or bounce back from the negative effects of exogenous shocks fell into the strategic category. The last group of households were classified as precautionary. This is because in addition to having no or low inherent vulnerability, they have nurtured and/or build their resilience.

The key findings from this research are that most of the households are promising, meaning that they have low inherent vulnerability and have not built and/or nurture their resilience. They are promising households because there is much they can do to build their resilience capacity. Furthermore, diversification is important for household resilience. Household diversification can be in terms of having more livestock and poultry as well as growing more hectares of corn and tobacco. In addition, having more assets plays a role in maintaining household resilience, while having access to infrastructure such as electricity plays a role in reducing the vulnerability of Malawian households to exogenous shocks.

Several immediate implications can be drawn from these results. First, these results show that having access to electricity is important for household resilience. However, only 11 percent of the households have access to electricity in this Malawi data set. This underscores the importance of investing in infrastructure that increases access to electricity to households. Second, this study shows that planting more tobacco increases the resilience of households to exogenous shocks. However, currently few farmers include tobacco in their crop mix, and for those that do plant tobacco they plant an average of 0.05 hectares which is small. Thus there is need to come up with programs that encourage farmers to include high value cash crops in their crop mix or increase the hectares of these crops planted. In addition, opportunities should be provided for households to diversify their income sources.

The findings of this paper have important implications on future resilience research. First there is need to design a study for only resilience and vulnerability analysis. Second, explore more in-depth the reasons for low resilience capacity or "stuckness" of most of the households in this sample. Third, analyze government programs that may or may not encourage households to remain in the promising category. Finally, explore non-farm employment opportunities that will relieve population pressures on limited arable land base.

Appendix A: Map of Malawi and Robustness Checks

Figure A1: Map of Malawi

Source: 2015-2016 Malawi Demographic and Health Survey Report

Table A1: Robustness checks for Model 3

Variable	Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value
Age (years)	0.022	0.16	0.025	0.11	0.020	0.19	0.021	0.17
Age squared	0.000	0.15	0.000	0.11	0.000	0.16	0.000	0.16
Gender dummy (1=female)	-0.397	0.00	-0.396	0.00	-0.409	0.00	-0.396	0.00
Household size	-0.079	0.00	-0.077	0.00	-0.079	0.00	-0.081	0.00
Proportion_adults	0.227	0.35	0.217	0.37	0.225	0.35	0.234	0.33
Literate dummy (1=yes)	0.344	0.00	0.334	0.00	0.345	0.00	0.337	0.00
Productive (Farming) assets			0.131	0.02	0.130	0.02	0.162	0.00
Land ownership dummy (1=yes)	0.397	0.01	0.548	0.00	0.398	0.01	0.397	0.01
Number of livestock	0.049	0.00	0.039	0.02	0.036	0.03		
Number of birds	0.018	0.01	0.017	0.02	0.016	0.02	0.016	0.03
Maize planted (hectares)	0.455	0.00			0.455	0.00	0.449	0.00
Tobacco planted (hectares)	1.047	0.01	1.019	0.01			0.979	0.01
Non-agricultural employment dummy (1=yes)	0.072	0.57	0.088	0.49	0.071	0.57	0.087	0.49
Ganyu dummy (1=yes)	-0.392	0.00	-0.382	0.00	-0.395	0.00	-0.392	0.00
Ganyu *non-agricultural employment	0.103	0.70	0.058	0.83	0.080	0.76	0.085	0.75
Electricity dummy (1=yes)	1.506	0.00	1.485	0.00	1.498	0.00	1.501	0.00
Access to credit dummy (1=yes)	0.046	0.71	0.045	0.72	0.054	0.67	0.043	0.73
Distance to population center (km)	-0.001	0.59	-0.001	0.54	-0.001	0.62	-0.002	0.41
Distance to ADMARC (km)	-0.005	0.49	-0.004	0.58	-0.004	0.58	-0.004	0.59
temperature of wettest quarter (^{o}C)	-0.042	0.14	-0.050	0.07	-0.048	0.08	-0.036	0.19
Precipitation of wettest quarter (mm)	0.000	0.39	-0.001	0.25	-0.001	0.30	0.000	0.43
Region Dummies, base=Southern								
Northern region (1=yes)	-0.017	0.90	-0.118	0.37	-0.068	0.61	-0.046	0.73
Central region (1=yes)	-0.142	0.23	-0.180	0.13	-0.159	0.18	-0.150	0.20
Cons	0.887	0.28	1.113	0.18	1.143	0.17	0.758	0.36
Sample size	2666		2666		2666		2666	

Table A2: Linktest results for Model 3

Resilience dummy, 1=yes	Coef.	P value
_hat	1.027	0.00
_hatsq	-0.019	0.78
_cons	-0.001	0.98

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