Shocks and Household Welfare in Kenya

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Declaration

This thesis is my original work and it has not been presented for a degree in any other university.

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The findings, opinions and recommendations are those of the author, and do not necessarily reflect the views of the institutions and other individuals mentioned here. I also bear responsibility for any errors and omissions.

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List of Abbreviations and Acronyms

AIDS	Acquired Immune Deficiency Syndrome
ASALs	Arid and Semi-Arid Lands
AST	Asset Smoothing Theory
ATMs	Automated Teller Machines
CDF	Constituencies Development Fund
CMH	Complete Market Hypothesis
DALYs	Disability-Adjusted Life Years
ESP	Economic Stimulus Programme
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GEE	Generalized Estimating Equations
HIV	Human Immunodeficiency Virus
ICT	Information Communications Technology
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGAs	Income Generating Activities
IHME	Institute for Health Metrics and Evaluation
ILO	International Labour Organization
KES	Kenya Shillings
KFW	German Development Bank
KIHBS	Kenya Integrated Household Budget Survey
KNBS	Kenya National Bureau of Statistics
LATF	Local Authority Transfer Fund
MCA	Multiple Correspondence Analysis
MPC	Marginal Propensity to Consume
NASSEP	National Sample Survey and Evaluation Programme
NGAAF	National Government Affirmative Action Fund

NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
PEV	Post-Election Violence
PIH	Permanent Income Hypothesis
ROSCAs	Rotating Credit and Savings Association
RVF	Rift Valley Fever
SDGs	Sustainable Development Goals
SDI	Simpson Diversity Index
SSA	Sub-Saharan Africa
UNOCHA	Office for the Coordination of Humanitarian Affairs
USAID	United States Agency for International Development
VER	Vulnerability as Exposure to uninsured Risk
VIF	Variance Inflation Factor

Abstract

The threat of adverse effects of shocks on the welfare of Kenyan households is still a challenge in socio-economic development in the country. Among the sources of vulnerability to shocks is the livelihoods' reliance on agriculture, a sector that is highly prone to recurrent shocks. Vulnerability, especially among rural households is also due to physical isolation from the mainstream national economic activities. The shocks consequently lead to welfare reductions among households, indicating inadequacies in the existing risk management and coping strategies. In the absence of effective coping mechanisms, households cannot effectively smooth consumption, thus likely to experience fluctuations in consumption expenditures and food insecurity. Vulnerable households are also most likely to resort to ineffective coping mechanisms, such as selling of farmland – a recourse likely to reduce the existing resource base, weaken resilience, and increase vulnerability of falling into deeper poverty. In order to address adverse effects of shocks on household welfare, this study assessed; first, the effect of farm income shocks on rural household welfare; secondly, the circumstances and household characteristics that predispose households to engage in distress sales of farmland; thirdly, the dynamism in household vulnerability to shocks by examining the association between the physical infrastructure development in the country and vulnerability to shocks; and finally, the relationship between livelihood diversification and household vulnerability to climate shocks. The study uses household level data contained in the Kenya Integrated Household Budget Surveys collected by the Kenya National Bureau of Statistics in 2005/06 and 2015/16. Results show that consumption spending was lower for rural households that reported farm income shocks compared to those that were not affected, differences were noted when households were disaggregated along agro-ecological zones and non-monetary measures of welfare produced similar results as monetary welfare measures. On the shocks and household characteristics leading to distress sales of farmland, results revealed that age of the household head, loss of both income and assets due to shocks, persistence of shocks and idiosyncrasy of shocks increased the probability of distress sales. In addition, existence of land markets and the acreage of land holdings increased the likelihood of distress sales of farmland. The predisposition for distress sales of farmland reduced for households whose heads had at least tertiary level of education and access to public services such as tarmacked roads. The number of livestock owned reduced the likelihood of distress sales of farmland. On the association between infrastructure growth and vulnerability to shocks, the results revealed that between 2005/06 and 2015/16, there was a reduction in household vulnerability to the general shocks with the reduction being higher for urban households; rural households' vulnerability to food shocks reduced more compared to urban households. Both rural and urban households increased the use of infrastructure-supported ex-post coping strategies such as savings and borrowing to respond to food-security shocks, with the adoption being higher by five percentage points among rural households. Finally, the study found that livelihood diversification had an inverse relationship with household vulnerability to climate shocks. Disaggregating the analysis along income classes and agro-ecological zones showed clearly that livelihood diversification has a role in mitigating the risk of climate shocks in rural Kenya. From the findings, policy suggestions are offered for enhancing the households' resilience to shocks.

Chapter One   Background, Context and Motivation of the Thesis

1.1   Background and Context

The threat of adverse effects of shocks on the welfare of Kenyan households is still a development challenge. In the context of welfare, shocks refer to the events that negatively affect the livelihoods security. This involves, for instance, the fluctuations and unpredictability of livelihoods' support mechanisms (Ullah, 2017) as well as vulnerability to various forms of livelihood risks (Hahn, Riederer and Foster, 2009). For majority of households in Kenya, all components of livelihoods comprising of capabilities, material and social resources and activities required to make a living out of these components, suffer vulnerability to various forms of shocks (Nhung and Thang, 2017). Thus, the term 'shocks' is used in this study to categorize the risks and actualized events that adversely and significantly affect household welfare in quantifiable and unquantifiable losses (Canagarajah, Siegel and Heitzmann, 2002). The quantifiable reduction in welfare is often expressed in consumption reduction, food insecurity and declines in other measures of quality of life. In this thesis, 'household welfare' means the general state and degree of well of households as proxied by household standard of living, health and happiness. According Cropsey (1955), household welfare indicates a 'composite level of gratification of all individual preferences' in the household.

In developing countries, various sources of risk contribute to the observed high frequency of vulnerability to adverse shocks. One of the main sources of vulnerability is over-reliance on subsistence agricultural production, yet subsistence agriculture is highly prone to weather and climate variability. The proportionately higher incidence of infectious diseases in developing countries compared to the industrialized ones contribute to the high frequency of health shocks at the household level. This is due to geographic, demographic and socio-economic factors (Boutayeb, 2010). In the era of open economies and globalization of markets, families in developing countries are also exposed to global macro-economic shocks which for instance contribute to shocks such as price inflation and job losses transmitted to the home country from the international sources (Kiptui, 2008; Musyoki, Pokhariyal and Pundo, 2012). The frequency of shocks and the inadequate response usually deplete the household adaptive capacity which perpetuates poverty and destitution.

The various shocks can be categorized as either idiosyncratic or covariate. Idiosyncratic shocks affect a specific household in isolation and their effect is not simultaneously experienced by other households within the community (Heltberg, Oviedo and Talukdar, 2014). They include health-related shocks; social shocks such as family break up and theft or burglary; economic shocks such as loss of employment at the household level, imprisonment of the productive household members, fire and destruction or damage of household dwelling units. On the other hand, covariate shocks are those that affect many or all households within a community simultaneously (Heltberg, Oviedo and Talukdar, 2014). They are mostly natural and climatic/weather related shocks such as earthquakes, tsunamis, lightning, flooding and droughts. They are also economic shocks such as food price inflation, large fall in the price of agricultural produce and general economic recession that potentially lead to mass employment losses and general economic recession. Household response strategies to shocks are dependent on whether the shock is idiosyncratic or covariate in nature. Thus idiosyncratic shocks affecting only a single household or a few households in the community can be mitigating through borrowing from community members unaffected or rely on other forms of community support mechanism. However, in situations where idiosyncratic shock evolve and become covariate (for example diseases, pests that start with individual household before becoming an epidemic or pandemic), the coping mechanism can evolve along the coping continuum (Devereux, 1993). However, the theoretical postulation of how the nature of shocks influence households coping mechanisms are not necessarily validated by the empirical evidence (see Kenjiro, 2005).

Given the potential vulnerability of Kenyan households to livelihood risks, it is believed that the occurrence of welfare-reducing shocks is prevalent. The documentation of the adverse effects of these shocks is mainly of the covariate shocks such as drought, flooding, manmade disasters, price inflation of essential commodities including food, unemployment, civil strife and ethnic clashes. Kenya's households especially in the rural areas of the arid and semi-arid lands (ASALs) perennially suffer food and water shortages due to recurrent droughts. Major droughts have been reported in 1998-2001, 2003/04, 2006, 2009, 2011, 2016/17 and 2019 (Fitzgibbon, 2012; UN Office for the Coordination of Humanitarian Affairs {UNOCHA}, 2019). The country also experiences destructive flooding in the river-basin areas of Tana River, Kisumu, Narok, Samburu, Turkana, Kilifi, Garissa, Mandera, Siaya, Homa Bay counties as well as in built parts of Nairobi city. Floods with severe adverse effects on household welfare occurred in 1961, 1963/64, 1968,

1977/78, 1982, 1985, 1990, El Niño floods of 1997/1998, 2003 and in 2015 (Kihiu and Laibuni, 2018). The 1997/1998 El Niño rains caused severe flooding, mudslides and disease outbreaks such as Rift Valley Fever (RVF), highland malaria and cholera in different parts of Kenya. The resultant flooding destroyed road, telecommunication and other civil networks, as well as reduced production of staples such as maize, potatoes and beans (Ngecu and Mathu, 1999). Kenya's maize production, for instance, dropped by 20 per cent as a result of the El Nino (Wangia, Wangia, and De Groote, 2002). Other notable disasters that have occurred include terrorism, fire, landslides, transportation accidents and collapsing of buildings (Huho, Mashara and Musyimi, 2016). The other major and prevalent source of shocks among households in Kenya is diseases and illnesses. Malaria, flu, respiratory infections and diarrhea are most prevalent, although HIV/AIDS, lower respiratory infections and diarrhea lead in the causes of mortality (Institute for Health Metrics and Evaluation, {IHME}, 2019). Economic shocks such as inflation are also prevalent. In the recent past, the country has witnessed average annual inflation rates above 10 percent. For example, it was 14.5 percent in 2006, 26.2 percent in 2008 and 14.0 percent in 2011 (World Bank, 2019). These high inflation rates are associated with other shocks such as drought (in 2008 and 2011) and the post-election violence (PEV) of 2007/08.

The general welfare of households in developing economies demonstrably fall due to the impact of various livelihood shocks, indicating inadequacies in the existing risk management and coping strategies (Frankenberg, Smith and Thomas, 2003; Dercon, Hoddinott and Woldehanna, 2005). The capacity to effectively shield household welfare from the adverse effects of shocks is limited by among others, low endowments, high frequency and persistence of shocks, non-existed or limited financial and insurance markets for risk sharing and limited social safety nets (Morduch, 1990; Gao and Mills, 2018; Hidrobo et al., 2018). Cases of welfare reductions due to adverse effects of shocks have been observed among households in Kenya. For example, droughts in Kenya always cause severe food shortages at household level which result to malnutrition, death and disruption of livelihoods, especially in the rural areas where households have limited capacity to maintain their consumption when adversely affected by droughts. As observed in table 1.1, the welfare cost of successive droughts has been increasing over time as indicated by the monetary response required as well as the number of people affected. In addition, 78.3 percent of total disability-adjusted life years (DALYs) – a measure of cost of health loss due to health shocks – are constituted by years of lives lost from premature deaths contributed mainly by HIV/AIDS,

lower respiratory infections, diarrheal diseases, tuberculosis, and malaria (Frings et al., 2018). The 2007/08 PEV led to deaths and displacement of over 1000 and 600,000 people respectively. Dupas and Robinson (2012) found that through market closures, destruction of infrastructure and transport/communication services, destruction of properties and livelihoods, displacement of people, and disruption of social networks, household incomes subsequently decreased, which resulted into large declines in expenditures and in consumption of necessary items such as food. Guibert and Perez-Quiros (2012) found that the disputed election violence had a negative influence on per capita gross domestic product (GDP), with an estimated fall of about 6 percent. A direct consequence of a fall in per capita GDP is reduction in consumption at the household level.

Table 1.1: Occurrence of Droughts in Kenya

Major drought events	GoK and International Humanitarian Aid Received (US$) (Millions)*	Number People Affected (Millions)**
2017	—	4.00
2011	427.4	3.75
2009	423	3.79
2006	197	2.97
2003/2004	219.1	2.23
1998-2001	287.5	2.36

*UNOCHA financial tracking service and GoK figures

** Kenya Food Security Steering Group (GoK)

Source: Adapted from Fitzgibbon (2012) with additions from UNOCHA (2019)

Figure 1.1 below summarizes the cumulative effects of shocks (measured as fluctuations in aggregate consumption) on Kenya's macroeconomic performance (measured as fluctuations in GDP). This relationship is contrasted with that of the USA, chosen here to represent a developed economy that is taken to be more resilient to the effects of shocks. It is clear that Kenya's aggregate consumption growth is comparatively more volatile demonstrating households' inability to smooth consumption over time. In addition, consumption fluctuations in Kenya are observed to have been

bigger and more frequent in the earlier stages of the economy, however, over time, the annual fluctuations have dampened and the frequency reduced. This phenomenon represents the correlation between the stage of country's economic development and the impact of shocks (Loayza et al., 2007). Thus, in the sixties, Kenya's economy was largely agrarian and the households had limited coping mechanisms. As the economy developed over time, economic sectors diversified and financial and commodity markets grew, household labour become more specialized, and technology more improved which resulted into reduction in the frequency of shocks and decline of household vulnerability (Benson and Clay, 1994).
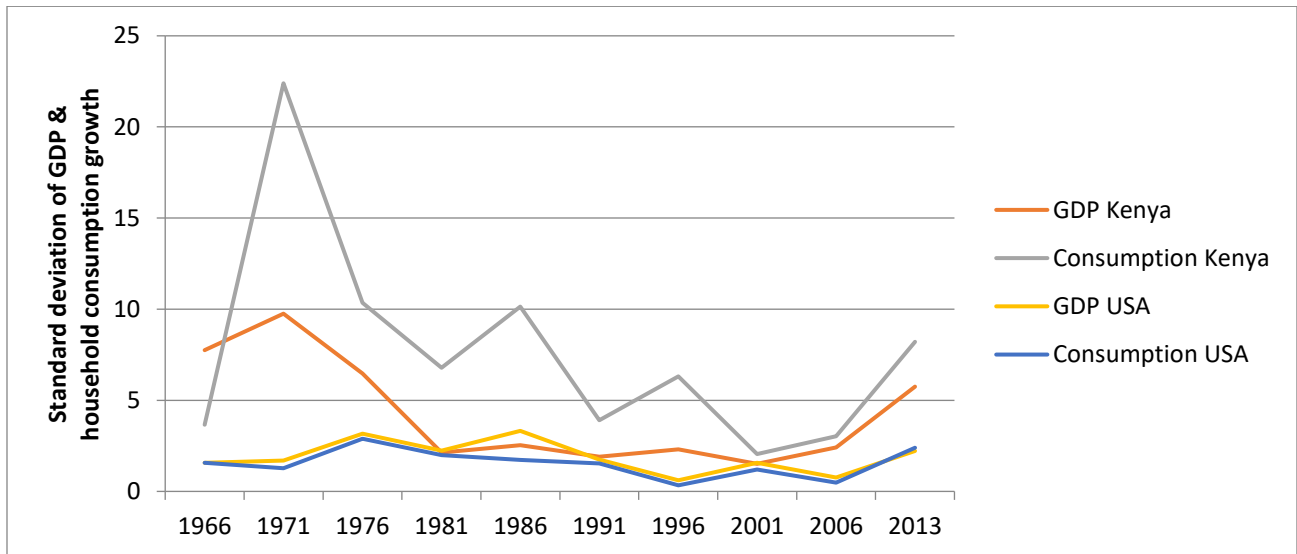
Figure 1.1: Consumption and GDP fluctuations in Kenya and the United States of America (USA), an OECD country (1966–2013)

Source: Author's computation based on data from World Bank (2015)

1.2 Overview of the Study Problem Statement

In Kenya, the high incidence of household vulnerability to a myriad of shocks as well as ineffective risk management systems has necessitated an interest in research which has resulted into a significant body of literature on the nexus between livelihood shocks and household welfare. These studies include assessments of household vulnerability to shocks, effect on consumption stability and the role of assets in consumption smoothing (Christiaensen and Subbarao, 2005; Ndirangu, 2007; Nganou, Parra and Wodon, 2009; Okoba, Dejene and Mallo, 2011) as well as effect of shocks on stress levels as a measure of welfare (Chemin, De Laat and Haushofer, 2013), effect of

shocks on household discount rates for the future and incentives for natural resource conservation (Damon, Zivin and Thirumurthy, 2015). Other studies have explored household decision making regarding the strategies to pursue in response to shocks (McPeak, 2004), while others have examined how transfers have motivated households to seek livelihoods diversification (Barrett, Bezuneh and Aboud, 2001). Plenty of existing literature has explored household response mechanisms, specifically the determinants of various coping strategies (Amendah, Buigut and Mohamed, 2014; Bonfrer and Gustafsson-Wright, 2017) as well as assessment of specific strategies used (Robinson, 2012; Mathenge and Tschirley, 2015).

The existing body of relevant literature has advanced the understanding on the connection between livelihood shocks and household welfare in Kenya. However, given the dynamic nature of sources of shocks and household response mechanisms, knowledge gaps still do exist. For example, Kenyan rural households are located in different agro-ecological zones and this heterogeneity in the physical environment could impact on the nexus between vulnerability to shocks and the response options available to households. Also, knowledge on the extent to which the household physical-environment differences manifest in the welfare losses from adverse effects of shocks is important for informing the design of targeting policies. In addition, despite extensive literature on coping strategies, the focus on the welfare-reducing coping options is still limited. These coping strategies are mostly unpopular as they potentially increase household vulnerability to poverty. For example, distress sales of farmland is unpopular (but not non-existent) among rural households. In developing economies, land supports most of rural livelihoods either directly or indirectly, and therefore its deprivation contributes to poverty (Finan, Sadoulet and De Janvry, 2005). In addition, vulnerability to shocks and coping mechanisms are dynamic. For instance, economic development over time could result into more resilience of livelihoods against adverse effects of shocks, thus reducing vulnerability. On the other hand, the increasing climate and variability could make previously-resilient households vulnerable. Studies focusing on this dynamism, specifically the role of infrastructure development could provide important insights into the nexus between shocks and household welfare. Lastly, rural livelihoods in the country are based mainly on agriculture (FAO, 2018), a sector most prone to production risks such as climatic shocks. Investigating how livelihood diversification within and outside agriculture relates with household vulnerability to climate shocks will enhance understanding of shocks and their influence on household welfare.

Based on the foregoing background, this study explores four themes, all aimed at contributing to the understanding of how shocks impact on the household welfare. First, the effect of farm income shocks on various categories of household consumption expenditures and food security is examined, with the focus on rural families disaggregated along agro-ecological zones. Secondly, the study examines the determinants of the rural households' decision to sell farmland as a coping option. This study contributes to the other works examining choice of welfare-reducing coping strategies such as Robinson and Yeh (2011) who examined use of potentially risky coping strategies among sampled women in western Kenya. The study also explores dynamism in household vulnerability to shocks by examining the association between the physical infrastructure development in the country and household vulnerability to shocks as well as evolution of ex-post response mechanisms, specifically adoption of infrastructure supported risk coping strategies. Finally, the hypothesis that livelihood diversification reduces household vulnerability to climate shocks is tested in the context of rural Kenya. The study uses data collected from all over Kenya. The heterogeneity in the sampled households helps to ameliorate simultaneity problem in the relationship among variables of interest by isolating exogenous influences on household decision making (Quisumbing, 1996). Also, the availability of the dataset in two periods (2005/06 and 2015/16) helps to analyze the time dynamics by pooling the cross-sectional observations.

1.3   Objectives of the Thesis

The overall objective of this thesis is to explore how livelihood shocks impact on the household welfare in Kenya. The study seeks to achieve this objective by pursuing the following four general objectives;

1. Assess the effect of farm income shocks on the welfare of rural households in Kenya, measured by consumption expenditures and food security, as a non-monetary measure of welfare
2. Find out the determinants of distress sales of farmland in rural Kenya
3. Find out whether infrastructural changes in Kenya between 2005/06 and 2015/16 resulted into changes in household vulnerability to shocks as well as changes in ex-post coping strategies

4. Test the hypothesis that among rural households in Kenya, livelihood diversification is negatively related with the vulnerability to climate shocks

1.4   Contribution to the Literature

By pursuing the stated research objectives, this study hopes to contribute to the development economics literature by highlighting insights into the nexus between livelihood shocks and household welfare in the context of developing countries like Kenya. Specifically, this thesis contributes first by highlighting how different categories of essential household expenditures differ among households based on vulnerability to shocks as well as agro-ecological location. It also shows how rural farm income shocks influence non-monetary indicators of welfare. Secondly, given the significance of land in the socioeconomic, political and cultural landscape in Kenya, and given that land issues are contextual, this study contributes to the existing literature on land in the country by providing the perspective of distress sales of farmland due to shocks. Third, this thesis contributes by showing how the growth of physical infrastructure stocks and access levels aids household resilience to livelihood shocks, and finally, highlights how livelihood diversification builds resilience of rural households according to different income classes and agro-ecological locations.

1.5   Shocks and Household Welfare: Theoretical/Conceptual Framework

It is generally known that shocks have adverse effects on household welfare, especially in rural areas. In developing countries, shocks are common and occur persistently, while in the same environment households have limited and ineffective means of coping with the adverse effects of shocks (Gunning, 2013). Consequently, in the absence of interventions, the exposure from shocks leads to welfare reduction and ultimately poverty (Dercon and Hoddinott, 2004). In this context therefore, the connection between shocks and household welfare can be abstracted conceptually. Following Alam and Mahal (2014), a conceptual framework abstracting this relationship is presented in figure 1.2.
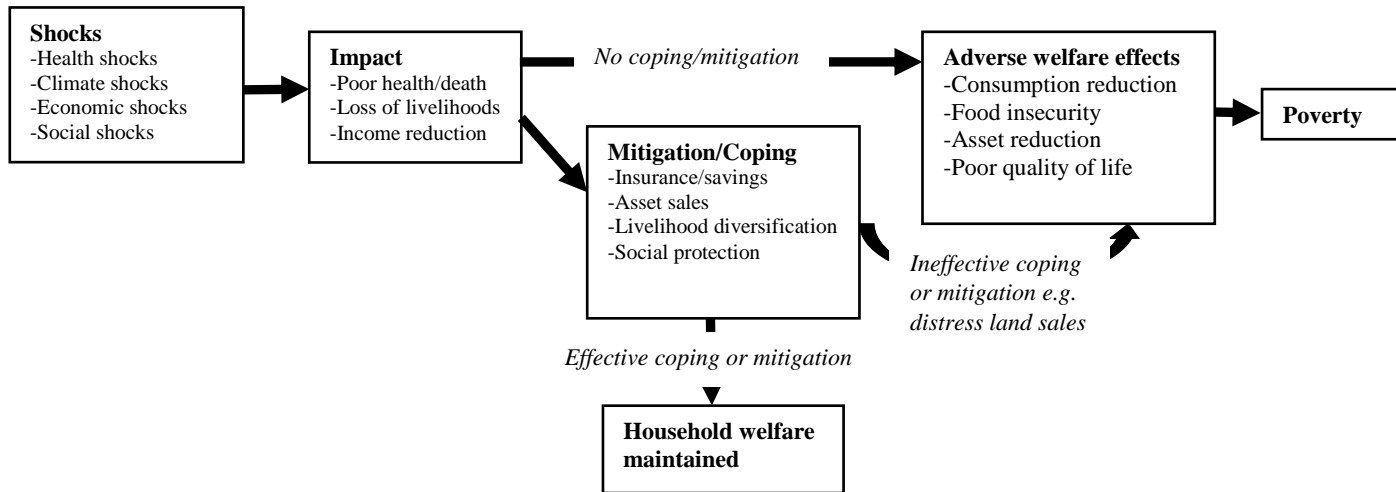
Figure 1.2: Conceptual framework of the effects shocks on household welfare

Source: Adapted from Alam and Mahal (2014)

As demonstrated in figure 1.2, households in developing economies experience shocks from different sources such as diseases and death, climate and weather extremes including natural disasters, economic risks due to changes in the primary macroeconomic variables, and disturbances in the social fabric such as conflict, family break-up and displacements. When shocks hit households, the direct impact depended on the shock and include reduced household income from economic, health shocks and climate shocks, loss of livelihoods due to climate, social and economic shocks, poor health including death due to health shocks (Islam and Maitra, 2012; Akter and Basher, 2014). In most cases, rural households in developing countries have limited capacity for effective coping and mitigation of shocks (Tongruksawattana, Waibel and Schmidt, 2010). Empirical studies indicate of situations where households are unable to cope with shocks, implying a full impact of the shock on the household's welfare (Nikoloski, Christiaensen and Hill, 2018).

However, a significant majority of rural households make an effort to respond to the adverse effects of shocks through strategies such as use of savings, formal and informal insurance, liquidating assets including the productive ones, livelihood diversification, increasing household labour supply including taking children off school for work, social safety nets including public works programmes (Subbarao et al., 2012; Nikoloski, Christiaensen and Hill, 2018). Effective coping with/mitigation of shocks implies that households maintain a smooth consumption path despite the occurrence of shocks. This is the ideal outcome of shock response management, where household welfare is not adversely affected (Gao and Mills, 2018). In situations where households are unable

to mitigate the effects of shocks or the coping mechanisms adopted are ineffective, household welfare is eventually adversely affected. Adverse effects of shocks on household include reduced consumption, food insecurity and other quality of life indicators. Households ultimately slide into poverty when these welfare indicators fall below the accepted levels (Barrett, 2005).

1.6   Data used in the Thesis

This thesis uses two cross-sectional data sets collected by the Kenyan national agency in charge of statistics, the Kenya National Bureau of Statistics (KNBS). The data sets came from the Kenya Integrated Household Budget Surveys (KIHBS) collected in 2005/06 and in 2015/16, which were nationally representative and covering a 12-month period. The 2005/06 and the 2015/16 KIHBS used similar tools and approach in sampling, data collection including the tools used and processing. It was therefore possible for the datasets to be pooled into when where needed in the individual analytical essays. Stata was the statistical software used for analyzing the data in all the analytical chapters.

For the 2005/06 KIHBS, 861 and 482 rural and urban clusters respectively were randomly selected from across the country with the aim of collecting household statistics that were representative at both the national and sub-national levels. The clusters are the primary sampling units as per the National Sample Survey and Evaluation Programme IV (NASSEP IV), which is the sampling frame and contained 1,800 clusters chosen based on the size proportion of the enumeration area created using the 1999 Population and Housing Census (Republic of Kenya, 2007). Ten households were then randomly selected from each of the national tally of 1,343 clusters giving a total sample size of 13,430 households. This nationally representative sample size accordingly comprised of 8,610 rural and 482 urban households. The overall sample size was then reduced to 13,154 after factoring the non-response (which was less than one percent) and data cleaning.

For the 2015/16 KIHBS, the sample was drawn from the national sampling frame based on the fifth edition of the National Sample Survey and Evaluation Programme V (NASSEP V). This sampling frame, containing 5,360 clusters was similarly constructed from the enumeration areas designed in the 2009 Kenya Population and Housing Census. From the 5,300 clusters in the national sample frame, 2,400 were randomly selected constituting 1,412 from rural areas and 988

from the urban centres (Republic of Kenya, 2018). The next stage in the sampling process involved selecting 16 households from each of the 2,400 clusters selected in the first step. Finally, 10 households were randomly selected from the 16 households, producing a final sample size of 24,000 households that participated in the study consisting of 14,120 and 9,880 from rural and urban areas respectively. The final tally of sample size that was used in this study after non-response and data cleaning by KNBS is 21,773 households.

1.7   Effective Policies to Counteract Distress Shocks among Households in Kenya

The adverse effects of household welfare due to livelihood shocks represent a weakness in the household resilience and adaptive capacity to shocks (Mjonono, Ngidi and Hendriks, 2009). Household capacity to effectively respond to shocks is also hampered by the increasing frequency and severity of shocks in developing countries over time (Zseleczky and Yosef, 2014). The frequency, severity and persistence of these shocks ultimately depletes the existing household capacity to respond to shocks. In the absence of proactive policy interventions, the affected households suffer welfare losses and ultimately descent into poverty. Policy interventions that build resilience and adaptive capacity of households to cope with shocks without compromising the present and future productive capacity are therefore the most suitable to counteract the shocks.

Policies for climate change adaptation and mitigation are useful to build the resilience of rural incomes from shocks that have adverse effect on welfare. The other is rural livelihoods policy that focuses on making risk-management markets work for rural households as well as policies on social safety nets. The other policy intervention is rural infrastructure development (roads, bridges, irrigation schemes, water supplies, schools, health centers and fresh produce and livestock markets). Rural infrastructure eases connectivity of rural economies to the mainstream economy and improves rural population's access to basic welfare services (e.g. health, education, security) – which cumulatively build resilience and adaptive capacity to shocks (Barrios, 2008). Building population labour skills and equipping farmers with production knowhow also helps households to effectively cope with shocks. Research has found a positive link between educational attainment and household resilience to shocks (Feeny, 2016). Other relevant policy interventions include

enhancing household holdings of small livestock that are easily liquidated and do not carry significant costs on future productive capacity.

Promoting livelihood diversification in the rural economies is also a policy option that reduces household vulnerability to the asset-depleting effects of shocks (Twine, 2013). Livelihood diversification is enhanced through skilled labour force, enabling infrastructure and commercial networks to support alternative livelihoods. Finally, government and community-led risk management schemes provide effective mitigation of shocks before they overwhelm household response capacities. This policy approach calls for advance preparation for risks and forestalling them before they materialize into shocks (World Bank, 2014). Examples of risk management include nutrition and preventive health care – to forestall health shocks, regular weather updates – to minimize adverse effects of climate and natural disasters, prudent management of the economy – to avert food and agricultural inputs price inflation, and sharing of market information to increase farmer's income hence more adaptive capacity to future shocks (World Bank, 2014).

1.8   Organization of the Thesis

This thesis is structured into four essays that are presented in form of chapters. Essay one is presented in chapter two, and discusses how agricultural income shocks among farming families in rural areas of Kenya affect household expenditures of essential goods and services such as food and education as well as household incidence of food insecurity. The second essay is contained in chapter three, and it examines the determinants of household decision to sell farmland as an ex-post coping option, among the rural families. The third essay is contained in chapter four and it examines the role of the physical infrastructure growth in the country between 2005/06 and 2015/16 in affecting the household vulnerability to shocks as well as in affecting various ex-post coping strategies, especially those that are facilitated by infrastructure such as savings, credit and insurance markets. Chapter five contains the fourth essay which tests the hypothesis that livelihood diversification is associated with reduced vulnerability to climate shocks among rural households in Kenya. Finally, chapter six provides the summary and conclusions drawn from the four essays, as well as presenting the policy recommendations, limitations of the thesis and areas suggested for further study.

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Chapter Two   Effect of Farm Income Shocks on Household Welfare in Rural Kenya

2.1   Introduction

Majority of rural households in developing economies derive their livelihoods from agriculture, a sector that is highly prone to recurrent shocks. In the absence of effective coping mechanisms, these households are usually unable to smooth consumption and are thus likely to experience fluctuations in consumption expenditures which in the extreme cases can plunge households into poverty (Townsend, 1994; Udry, 1995; Günther and Harttgen, 2009). In the advanced economies with efficient risk sharing systems, household consumption has been found to be insensitive to various forms of transitory income shocks (Blundell, Pistaferri and Preston, 2008). However, whether in developed and developing economies, households prefer smooth consumption and have been shown to institute measures to safeguard consumption from income fluctuations (Morduch, 1994; Kochar, 1999; Morduch, 1999). Governments and non-government institutions also implement social safety net programmes to shield vulnerable households from consumption fluctuations (Subbarao et al., 1997; Alderman and Haque, 2006).

Agriculture in developing countries is still prone to the risk of weather, production (pests, storage infestation) and economic (price and related market) shocks. The magnitude of losses due to these shocks is reflected in a Food and Agriculture Organization of the United Nations {FAO}(2017) report that estimated that shocks-prone developing countries lost approximately USD 93 billion in livestock and crops from natural-climatic related shocks between 2005 and 2014. Consequently, these risks and shocks are transmitted to farming households as manifested in welfare indicators such as hunger, malnutrition, depressed consumption and poverty (Webb et al., 2018). One possible transmission mechanism is through the numerous income shocks characteristic in subsistence agriculture in sub-Saharan Africa (McCarthy, Brubaker and De La Fuente, 2016). Rural households in developing countries depended mainly on agriculture and other livelihoods derived from natural resources are likely to experience frequent income shocks (Burke, Gong and Jones, 2015). These shocks are also likely to be short-lived and thus less likely to attract attention of government and other relevant stakeholders. In addition, if the shocks are severe and recurrent – often in varying forms and types –, their camouflaged effects can destabilize household incomes with potential adverse effects on household welfare.

Consumption expenditure is one of the most important component of household accounts, and as reflected in national accounts, it constitutes the largest share of household accounts (Johnson, McKay and Round, 1990). In development discourse, consumption expenditure is used as one of the money metric measures of welfare, together with income. Consumption is usually considered a better indicator of well-being than other indicators such as income, and therefore by extension a better measure of poverty status (Ravallion, 1992). In relation to shocks, consumption spending is especially important as it provides important measure of household ability to sustain a smooth spending path irrespective of income fluctuations. By observing the consumption spending paths over a reference period of time, one can assess household vulnerability to various shocks as well as the household access to consumption smoothing facilities such as financial and insurance markets and informal risk sharing.

While household consumption expenditure represents the aggregate measure of all expenditures and transfers of all goods and services, it can be disaggregated into food and non-food consumption, essential and non-essential consumption, as well as into constituent components such as food, education, health, transport, communication, energy, housing and others. Based on various motivations and other determinants, marked differences exist in the categories and components of household consumption expenditures (Castner and Mabli, 2010; Kamakura and Yuxing Du, 2011). Consequently, household consumption expenditure choices have important implications on the short and long term welfare outcomes such as human development. Since household welfare is complex, non-monetary measures of welfare are also usually considered to enhance understanding and better public policy targeting (Noglo, 2017). In this case, the non-monetary measures have a non-negligible role in complementing the mainstream monetary measures of welfare. The use of non-monetary measures of welfare helps address the recall and reporting biases in self-reported monetary indicators of welfare such as income and consumption expenditure.

2.1.1 The Context of Shocks and Household Welfare in Kenya

About 70 percent of the 74 percent of Kenya's rural population is employed in agriculture and thus depends on income mainly from crop and livestock production as well as farm-based wages (FAO, 2018). This population is prone to livelihood fluctuations caused mainly by negative shocks that perennially affect the agriculture sector in the country. Common shocks include recurring droughts that depress domestic food production, slacken performance of the manufacturing and services

industry, and increase conflict over natural resources (Mbogo, Inganga and Maina, 2015); floods, forest fires and landslides (Obiero and Onyando, 2013; Opere, 2013; Parry et al., 2012); pests and crop and livestock diseases (Pritchett, Thilmany and Johnson, 2005; Rich and Wanyoike, 2010) and economic shocks such as input and output price fluctuations. Agriculture-dependent households also face structural challenges such as inaccessible markets, financing constraints and outdated agricultural production technologies that cumulatively contribute to low and unstable incomes (Salami, Kamara and Brixiova, 2010). Consequently, agriculture-dependent households have lower per-capita incomes and experience more monthly income fluctuations than non-agriculture dependent rural households (Collins, Cojocaru and Zollman, 2015). Indeed, among the rural households, the median standard deviation of monthly per-capita income was higher for agriculture-dependent households by 38 percentage points (ibid).

The occurrence of frequent and unanticipated shocks in household agricultural production reflects the observed annual fluctuations in aggregate output of key food crops in Kenya. Figure 2.1 shows the agricultural output – as measured in monetary value – of maize, wheat, cut flowers, vegetables, pyrethrum and tea. The figures show that the output of the crops produced by mainly the smallholder farmers fluctuates most (see for example maize and vegetables, compared with cut flowers and tea which are produced by established firms in controlled environments and have established value chains for marketing). In addition, an analysis of marketed crop and animal produce (see tables 2.7 and 2.8 in the appendices) by households disaggregated by the counties demonstrates that income from agriculture largely reflects the country's agro-ecological zones. Households in counties in high agricultural-potential zones such as Bomet, Meru, Uasin Gishu and Nyandarua earned more than the households in arid counties (such as Mandera, Marsabit, Turkana, Garissa, Samburu and Wajir) by a factor of 300. On the other hand, counties in the ASALs with zero or negligible earnings from sale of crops reported mean animal sales of above KES. 10,000 in livestock sales. This direct relationship between households' crop and livestock earnings implies that rural livelihoods are still beholden to their surrounding natural environments.
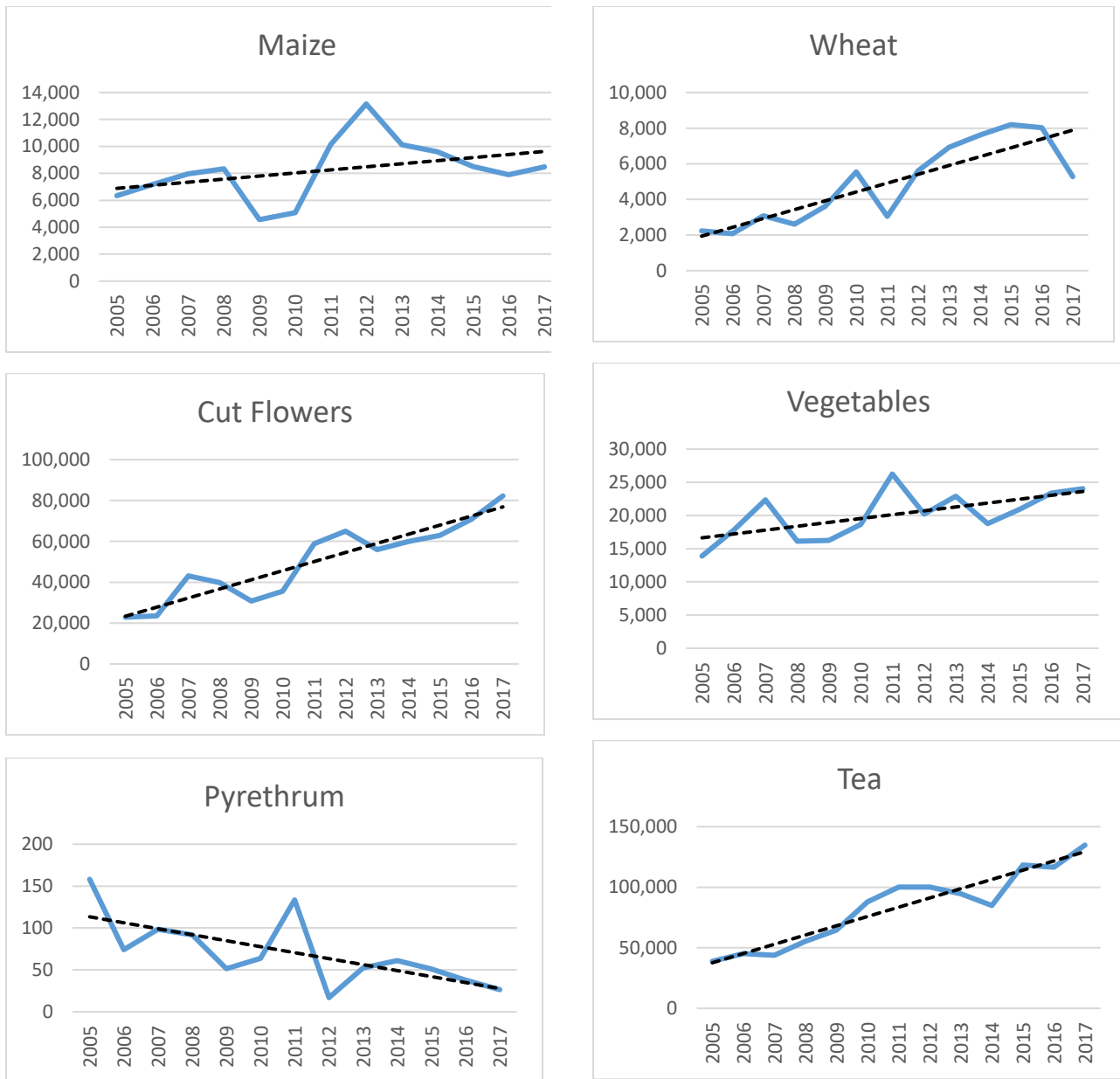
Figure 2.1: Marketed production of various crops produced in Kenya at current prices (KES)

2.1.2 Statement of the Problem

At the aggregate level, the performance of key household welfare indicators such as food and nutrition, health and education tracks the GDP performance in Kenya (Republic of Kenya, various years). At the household level, families that depend on agriculture are most likely to fund their expenditures from agricultural proceeds such as sale of crops, animals and wages derived from providing labour to agricultural-based enterprises. When incomes from these sources fluctuate due to shocks, household expenditures may fluctuate accordingly or remain stable owing to internal and external household interventions put in place to ensure smooth consumption. Due to inadequate coping mechanisms, household incomes and consumption spending in developing economies are likely to fall as a result of shocks (Dercon, Hoddinott and Woldehanna, 2005). There is extensive literature on the relationship between livelihood shocks and household welfare in developing countries (see for example Hoddinott, 2006; Günther and Harttgen, 2009; Kim and Prskawetz, 2010; Baez et al., 2017).

The studies using consumption as a measure of welfare have mainly lumped different categories of consumption expenditures (Christiaensen and Subbarao, 2004; Asiimwe and Mpuga, 2007). Important heterogeneity in the response of different categories of consumption expenditures to income shocks is thus masked and remains unknown. Exploring the variations in household spending in response to income shocks is likely to highlight important implications on household wellbeing and consumption smoothing trade-offs. This analysis is especially more illuminating when household agro-ecological differences are considered, as is the focus of this study. In addition, while the non-monetary perspective of welfare is useful for comprehensive understanding of household wellbeing, the relationship between the non-monetary indicators of rural household welfare and income shocks is scant in the development literature.

In the literature of shocks and household welfare, this study contributes by highlighting how different categories of essential household expenditures differ among households based on vulnerability to shocks as well as agro-ecological location. While a related study in Kenya by Wineman et al. (2017) focuses on the effect of weather shocks on household income and calorie availability as measures of welfare, the current study focuses on household expenditures, specifically going beyond food expenditures to include non-food expenditures in general and education spending in particular, as indicators of household welfare. The other way this study

contributes to the literature on shocks and rural household welfare is through highlighting the relationship between farm income shocks and non-monetary indicators of welfare.

Exploring the variations in household expenditures due to current income shocks has important relevance in understanding underlying causes of rural poverty and devising descriptive policy recommendations.

2.1.3 Research Questions

In the academic literature on welfare effects of income shocks, many empirical questions have been posed regarding the relationship between income shocks and household consumption expenditure patterns. This study extends the existing literature by answering the following questions in the context of rural households in Kenya;

1. What are the effects of farm income shocks on household aggregate, non-food, food and education expenditures?
2. What are the effects of farm income shocks on household indicators of food security?
3. What is the difference in the effect of farm income shocks on consumption expenditures and food security disaggregated into agro-ecological zones?

The hypothesis to be investigated in this study is that shocks leading to agricultural income losses among rural households reduces general household consumption spending including food, nonfood and education expenditures. The experienced farm income shocks also have adverse effect on household food security. The study further hypothesizes that there are differences in how the households are affected along agro-ecological zones.

2.1.4 Objective of the Study

The general objective of this study is to assess the effect of farm income shocks on the welfare of rural households in Kenya. The specific objectives in the context of rural households in Kenya are;

1. Assess the effects of farm income shocks on household aggregate, non-food, food and education expenditures
2. Assess the effects of farm income shocks on household indicators of food security
3. Establish the differences in the effects of farm income shocks on consumption expenditures and food security disaggregated into agro-ecological zones

2.1.5 Significance of the study

Chronic poverty as well as vulnerability of non-poor households slipping into poverty remains a development challenge in Kenya. Among the main causes of poverty in Kenya are shocks that adversely affect household livelihoods. These include farm income shocks, emanating mainly from fluctuations in agricultural output among households engaged in rural peasantry production. Consequently, the incidence of poverty is proportionately higher in the country's marginalized rural areas because of low agricultural output due to climate shocks. Accordingly, studying how these farm income fluctuations affect household spending on various categories of goods and services as well as food security indicators enhances the understanding of the cost of shocks on household welfare. The findings have relevant policy implications on rural poverty, specifically in highlighting the challenges of income variability on essential consumption expenditures for rural households in Kenya. Targeted policies to stabilize rural agricultural household's income from fluctuations as well as to shield essential consumptions from income fluctuations can then be developed to contribute to rural poverty reduction.

2.2 Literature Review

This section examines the existing literature on the relationship between household income shocks and household consumption. The review starts with the theoretical literature, in which the foundation between income and consumption is explored. Thereafter, related empirical works focusing on households in developing countries are analyzed. Finally, literature gaps are noted and linked to the contribution of the current study.

2.2.1 Theoretical Literature Review

Income and consumption are important indicators of welfare and their both short and long term relationships have been explored comprehensively in theoretical and empirical literature. Pioneering the theory of this relationship include Modigliani and Brumberg (1954) who postulated that household decision making regarding consumption followed needs of different ages and was constrained by their income. This postulate led to the lifecycle theory of consumption. Related to the lifecycle consumption hypothesis is the permanent income hypothesis, developed by Friedman (1957), which premises that household's consumption decision at specific point in time is

dependent on the expected lifetime income and not the income at the point of the specified consumption.

The general upshot of these theories collectively referred to as lifecycle-permanent income hypothesis (PIH) is that short-term income fluctuations does not affect consumption; rather consumption is affected by changes in permanent income. These theories are augmented by considerations of precautionary savings motive that explains how economic agents use savings to smooth consumption over time (Weil, 1993; Carroll, 2001). In addition to PIH, the theory of complete market hypothesis (CMH) has been proposed to explain how economic agents can share risks through insurance and credit markets thus realizing stable consumption paths in the face of income variations, but on condition that these markets worked efficiently (Cochrane, 1991; Mace, 1991; Townsend, 1994; McCarthy, 1995). In reality, full insurance is not perfect as exemplified by Cochrane (1991) to the extent that households are only able to insure against consumption fluctuations caused by idiosyncratic income shocks, but not when shocks are covariate. In the case that households face liquidity constraints or are unable to insure consumption against income shocks, the lifecycle-permanent income hypothesis is empirically rejected (Zeldes, 1989), implying that consumption tracks the income process irrespective of whether the change in income was anticipated or otherwise. To seek yet more theoretical grounding of household behavior in the face of income shocks in low resource countries, Zimmerman and Carter (2003) developed the asset smoothing theory (AST) whose central tenet is that households can either smooth consumption or assets depending on asset levels.

In ideal situations, households have access to functioning markets for insurance, credit and other financial instruments to smooth consumption. In most of the developing economies, these markets are largely weak, incomplete or non-existent thus exposing household consumption paths to variations. In situations of imperfect markets for credit and insurance for example, some households save and dissave as a strategy to smooth consumption profiles in the face of transitory income shocks (Deaton, 1989). The theory of saving differs from the asset smoothing theory in that assets are accumulated and liquidated in the short term with the aim of smoothing consumption, effectively leaving households with relatively small assets holdings, while in asset smoothing theory, the focus is to maintain stable asset levels at the risk of consumption fluctuations (Deaton, 1989; Zimmerman and Carter, 2003). The complete market hypothesis is argued to work

among communities in developing countries due to the practice of community-driven informal insurance system that is supported by geographical proximity of households and socio-cultural and ethnographic homogeneity that reduces challenges of information asymmetry and enforcement of contracts (Morduch, 2004).

The link between income fluctuations and household consumption in developing countries has generated substantial academic and policy interest. Households in developing economies face more widespread and persistent income shocks owing to the fact that their livelihoods are mainly depended on the vagaries of nature (Dercon, 2002; Baez, Kronick and Mason, 2013) and limited infrastructure as well as the spatially-covariant risk and the problems of adverse selection and moral hazard that cumulatively limit the working of formal risk sharing, insurance and credit markets (Rosenzweig, 2001). This has brought forth literature such as the informal systems of risk sharing that is based on drawing upon household and society-wide resources such as social networks (Morduch, 1999; Kumar and Singh, 2012). The argument in this theory is that an efficient communal risk sharing should protect individual household consumption from individual income risks (Morduch, 1999). Since the informal risk sharing mechanisms are weak and inadequate, governments and donors theoretically play the role of redistributing incomes, safeguarding household assets and protecting household consumption from fluctuations through various types of safety net programmes (Subbarao et al., 1997; Alderman and Haque, 2006).

2.2.2 Empirical Literature Review

The empirical testing of the permanent income hypothesis of consumption smoothing in developing countries include the pioneering works by Wolpin (1982) who found that rural households in India attempted to smooth consumption from income shocks caused by weather variability. Other related early empirical studies include Deaton (1990) and Townsend (1994) who found that household consumption was only marginally affected by household income among villagers in rural Côte d'Ivoire and India respectively. However, both studies rejected the hypothesis of full insurance. However, Nguyen, White and Ma (2018) did not find empirical evidence in support of PIH among poor rural households in Vietnam, unlike the CMH and AST which were empirically vouched using the same data sample.

The empirical testing of permanent income hypothesis has also widened scope to incorporate various dimensions in consumption smoothing, specifically how households in low-income environments achieve non-varying consumption process. For instance, Rosenzweig and Wolpin (1993) and Berloffa and Modena (2013) have examined the role of asset endowment in household consumption response to income shocks in rural India and Indonesia respectively. The other commonly studied means of consumption smoothing is the use of communal risk-sharing through informal insurance mechanisms (Udry, 1990; Grimard, 1997; Fafchamps and Lund, 2003). The nature of shocks also determine how household consumption respond, with Kim et al., (2009) finding that a birth in a sample of Indonesian rural households reduced individual consumption in the family. Others such as Bui et al. (2014) found that in Vietnam, natural disasters caused a 7.1 percent decline in per capita expenditures in the affected households compared to the unaffected ones. Nguyen et al. (2020) analyzed panel data in Vietnam and Thailand and found that reported weather shocks had significant and negative effects on rural households' income and consumption.

The existing literature in the developing countries context has found rural households' consumption to be generally vulnerable to livelihood shocks (Christiaensen and Subbarao, 2005; Asiimwe and Mpuga, 2007) while the AST was empirically found to hold in pastoral households in northern Kenya (see McPeak, 2004). Related to the current study is Wineman et al. (2017) who analyzed the effects of weather extremes on rural households' welfare in Kenya, and found that adverse welfare effects of all forms of weather extremes considered. Additionally in Nigeria, Amare et al. (2018) found differential negative impacts of rainfall shocks on consumption of rural households disaggregated alomg wealth and geographical zones. Salvucci and Santos (2020) found that the 2015 flooding in Mozambique caused a 10-17 percent consumption reduction in households affected by the shock compared to those not affected.

There is consensus from the review of literature that households strive to smooth consumption when hit by shocks. However, the extent of this consumption smoothing is influenced by a myriad of factors and circumstances as documented in the literature. In the existing literature on this subject, consumption is mostly lumped together. The contribution of this study is to assess the effect of farm income shocks on components of household consumption spending, specifically disaggregated into food, nonfood and education. The other innovation of the study is the inclusion of the effect of farm income shocks on non-monetary measures of household welfare. Most of the

studies reviewed do not consider the relationship between shocks and non-monetary indicators of household welfare.

2.3   Methodology and Estimation Approach

This section presents the theoretical and empirical foundation for understanding and formulating the problem being investigated as well as strategies used to provide answers to the research questions. An explanation of the type and source of data used is also offered.

2.3.1   Theoretical Framework/Conceptual Framework

As highlighted in the review of literature, household consumption is theoretically expected to be protected from the effects of short-term income fluctuations due to shocks. However, if household response mechanisms to shocks are unable to smooth consumption, consumption and other welfare indicators decline due to the adverse effects of shocks. This is largely the case in rural areas of low-income countries where markets for formal credit and insurance markets are limited. The alternative risk sharing arrangements characterized by informal networks have been empirically found not to provide full insurance (Udry, 1990; Grimard, 1997; Fafchamps and Lund, 2003). In the absence of functioning financial markets and efficient risk-sharing mechanisms, other options available to households include accumulation and liquidation of assets (Paxson, 1992; Rosenzweig and Wolpin, 1993), selling of labour (Kochar, 1999) and relying on both emergency and other livelihood support transfers (Devereux, 2001; Maxwell et al., 2010). Without effective risk management, shocks lead to a reduction in household consumption spending. This relationship is captured simply in the conceptual framework in figure 2.2.
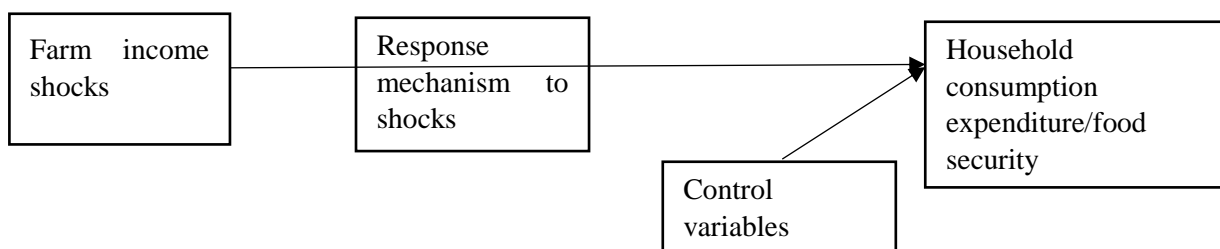
Figure 2.2: Conceptual Framework – Characterizing expenditure response from income shocks

Source: Adapted from Wineman et al. (2017)

As indicated in figure 2.2, agricultural households are exposed to a variety of shocks that potentially lead to fall in household income. Such shocks include droughts, floods, crop and animal diseases and pests. Once these shocks occur, households respond in various ways such as shifting labour from farm to off-farm activities, liquidating assets, relying on social support, cutting down expenditures among others. In other cases, households fail to mitigate against the adverse effects of the shocks and bear the full welfare loss. In addition, the response mechanisms to shocks are not effective in protecting the household welfare. Household welfare, as proxied by consumption expenditure and food security provides the effect of farm income shocks. Other variables influencing household welfare are also included in the conceptual framework.

2.3.2 Estimation Strategy

Following Bui et al. (2014), a standard consumption regression model that relates the household's expenditure with income, a vector of control variables and a dummy variable for the occurrence of farm income shocks, as shown in equation 2.1 is used to estimate the effect of farm income shocks on household consumption expenditures.

$$\ln(C_i) = \alpha_0 + \alpha_1 \ln(Y_i) + \alpha_2 X_i + \alpha_3 D_i + \epsilon_i \qquad (2.1)$$

where $\ln(C_i)$ denotes the natural logarithm of household i's expenditure, $\ln(Y_i)$ is the natural log of household farm income, X_i denotes a vector of household- and community-specific control variables, D is a dummy variable that takes a value of 1 if household i reported being adversely affected by farm income shocks and 0 otherwise, and ϵ_i is the mean zero error term, assumed to be independently and identically distributed (i.i.d). $\alpha_0, \alpha_1, \alpha_3$ and α_4 are the model parameters. The control variables influencing the household expenditures in the context of this study are age, sex, education and employment statuses of the household head; household size clustered in dependency categories and a dummy variable indicating whether the household agricultural production was conducted in a different county from the one of residence.

The dependent variable takes different categories of annual household consumption expenditures. In this estimation, the expenditures considered are aggregate household spending, food, nonfood and education expenditures. The value of own-produced food was included in the computation of household food expenditures. All categories of household expenditure are expressed in logarithms as their level forms were found not be normally distributed and hence likely to yield less-reliable estimation coefficients. Household agricultural income is a major determinant of household

consumption spending. In this model, the variable constitutes of household annual receipts from sale of crops, livestock and livestock products. The variable is also expressed in natural logarithmic form. Age in years of the household head is included in the model as a control variable. According to the lifecycle theory of consumption analyzed in literature, family consumption spending varies along the age of the household head. Related to age is the household dependency status, which is measured in the model by the number of household members in the following age categories: zero to 17 years, 18 to 64 years, and over 65 years. Following Cameron and Worswick (2001), clustering household members along these age categories clarifies where household spending is concentrated as well as dependency levels. Meghir (2004) found that the propensity to consume is affected by household demographic characteristics such as the number and age composition of the household members, which dictate the consumption needs and preferences over time.

The other control variable is the marital status of the household head, considered as a dummy taking the value of one for couples and zero for singles. For ease of model estimation, all unions were categorized as couples while the others not reportedly in any union were classified as single. The sex of the household head is also a control variable, entering the model as a dummy and taking the value of one for males and zero if otherwise. The education status of the household head in the model is clustered based on the highest attainments and include those without formal education, and those with primary, secondary and tertiary level qualifications.

Also included is the employment status of the household head and the various occupations were grouped into waged, small businesses and agriculture, based on the risk of the occupation to farm income shocks. The occupation of household head is categorized as those in waged employment– indicating those with secure and stable sources of income; small business employment – indicating the occasional workers in stable industries, casuals in service industry and others with semi-secure sources of income; and agricultural employment– representing those in primary production such as farmers, livestock keepers and fisher-folks and thus characterized by insecure and fluctuating incomes. Except for the retired household heads receiving regular pension or other sources of regular income, the occupation of the retirees was classified as insecure, because of reduced earnings due to departure from active employment. Household heads with missing information on employment but were seeking work were coded as having insecure incomes.

Income and consumption expenditures are used in regionally deflated prices in order to take care of spatial price variation that is evidently present in Kenya because of undeveloped transport networks especially in the arid and semi-arid regions (Deaton, 2003). Total expenditure is the aggregation of all consumption related expenditures reported by the households and includes food and nonfood expenditures. The variables of expenditures and income were transformed into logarithms in order to minimize the skewness and therefore improve the validity of the estimated coefficients. This relationship between consumption expenditure, income, income shocks and control variables is estimated using a simple linear regression to generate reliable estimates. The estimated model does not suffer from endogeneity since the events contributing to farm income shocks (drought, floods, crop and livestock pests and diseases, fluctuations in farm input and output prices) occur naturally or beyond the control of rural households and therefore are exogenous in the model.

Household food security status was used as the non-monetary measure of household welfare and was regressed on the same variables as the consumption expenditure explained earlier. Households that reported that its members missed meals due to lack of money or other resources (in a period of 12 months) were recorded as food insecure. Therefore, the indicator of food security used has a binary response, taking a value of one if the household reported being food insecure and zero otherwise. Following Agresti (2018), the relationship between income shocks and the latent propensity that a household will report food insecurity or not is formally represented as;

$$y_i^* = \alpha + \beta X_i + \varepsilon \qquad (2.2)$$

where y^* represents the underlying latent propensity that a particular household i will report an instance of food insecurity ($y = 1$). X is a vector of exogenous variables that are thought to influence the underlying latent propensity being measured. α and β are unknown model coefficients, and ε is the unknown error term, assumed to be normally distributed, have zero mean and a variance of σ^2.

The likelihood of success or failure of the observed event (report of food insecurity or not) is represented formally in equation 2.3.

$$y_i = \begin{cases} 1 & if \ y_i^* > \tau \\ 0 & if \ y_i^* \leq \tau \end{cases} \qquad (2.3)$$

where τ is the threshold, once exceeded, y takes a value of one, and zero if otherwise.

Having specified the latent propensity for the outcome, and given that y^* is unobservable, still following Agresti (2018), it therefore follows that the distribution of errors ε is unknown. In order to use the maximum likelihood estimation, this study assumes the standard logistic distribution of errors, formally stated in equation 2.4

$$ln\left(\frac{p_i}{1-p_i}\right) = \sum_{k=0}^{k=n} \beta_k \, x_{ik} \tag{2.4}$$

Consequently, a logistic regression is used for this estimation. In this study, a logistic distribution of errors is assumed since it is believed that the distribution function of household likelihood of reporting food insecurity has more observations appearing at both ends of the distribution function (Klieštik, Kočišová and Mišanková, 2015). This indicates that households are more likely to either report hunger or not, thus the distribution that has 'flatter tails'.

The disaggregation of the sample size based on agro-ecological zones was introduced because the farm income shocks are due to weather-related occurrences such as drought and floods as well as geographically-isolated incidences such as crop and animal diseases and water shortages. This disaggregation therefore helps to isolate the degree of household ability to insulate consumption from income shocks, which by extension demonstrates the state and strength of formal infrastructure for risk sharing (presence of banks, insurance, and credit reference bureaus); as well as strength of social networks. The disaggregation also demonstrates the household vulnerability to shocks along climatic zones, persistence of transitory shocks due to recurring droughts (that depletes household buffer stocks).

Kenya is formally divided into six agro-ecological zones, agro-alpine, high potential, medium potential, semi-arid, arid and very arid (Republic of Kenya, 2012b). In this study, the zones are categorized into two; arid and semi-arid lands (ASALs) and non-ASALs. The sampling framework used in collection of the data for this study weighted the population density and for that reason, the final sample size used in this analysis reflects the population density of the two agro-ecological zones. While the ASALs constitute more than 80 percent of the country's land mass, only about a third of the population reside there (Republic of Kenya, 2017).

On the other hand, disaggregation of consumption expenditures makes it easier to isolate specific changes to household consumption expenditures due to farm income shocks. In addition, the disaggregation helps unmask whether consumption responses to income shocks indicate varying priorities for essential household expenditures analyzed, that is food and education. Cumulatively, all these disaggregation aids the exploration of heterogeneity of livelihoods and vulnerability in Kenyan households.

Table 2.1: Disaggregation of respondents per agro-ecological zones

Agro-ecological zone	Sample size
ASALs	4,618
Non-ASALs	8,474
Number of observations	13,092

In this study, shocks are household accounts of various events that negatively affected welfare in the period of five years prior to data collection. Self-reported shocks are potentially biased, especially for long recall periods and varying subjectivity in determining the severity of shocks. To avoid recall bias, preventive measures were undertaken during collection of the data used for this study. Research assistants probed the respondents to minimize, for instance, recall bias. To minimize social-desirability bias, respondents were also adequately informed on the objectives of the study and thus encouraged to give as correct responses as possible. External validation of the household data was done by comparing with community data collected separately. In addition, self-reported shocks have been found to accurately capture household welfare, producing statistically significant estimates and with the correct sign and magnitude (Ackerman and Sabelhaus, 2012).

In addition, since households were allowed to report multiple shocks, where more than one shock contributed to crop loss per household, the study adopted the most recent one – in order to minimize recall bias and also to synchronize crop loss and household consumption expenditures. Further still, the self-reported instances of crop loss in the different survey areas at the different times was compared with the information from external sources (see for instance https://reliefweb.int/report/kenya/kenya-food-security-outlook-update-august-2014) and there was convergence. Subjectivity in household assessment of the severity of farm income shocks also

found not to be a serious bias after 72 percent of the clusters[1] showed convergence of households' assessment of the severity or non-severity of the shocks. In addition, farm income shocks are mainly covariate, with the likelihood of affecting many households in their wake and therefore not liable to biases associated with idiosyncratic shocks (Nguyen and Nguyen, 2020).

2.3.3 Data Type and Sources

The study uses the 2015/2016 Kenya Integrated Household Budget Survey (KIHBS), conducted in 2,400 randomly selected clusters, comprising 988 rural and 1,412 urban clusters. A random sample of 10 households was selected from each cluster, giving a sample size of 24,000. The KIHBS is nationally representative and covers a wide range of household welfare topics such as education, health, agricultural production, shocks and expenditures. This study focused on respondents living in rural areas (14,120 households) since they draw their incomes mainly from agriculture. However, 24 percent of the households based in urban centres too reported being adversely affected by farm income shocks, but were nevertheless not used in the study. This can however, be attributable to a noted dualism in household livelihoods in developing countries in which urban based households run parallel income generating activities in the rural areas such as growing crops and keeping livestock. After cleaning of the dataset, the sample size remained at 13,092 rural households. Households provided detailed information in modules covering family gender, age and educational attainment, shocks within the past five years, sources of income, consumption expenditures and agricultural holdings and activities. While the household-specific data was obtained from the KIHBS, agro-ecological zoning data came from various publicly-available published reports.

2.4   Estimation, Results and Discussion

In this section, the results of various estimations are presented and discussed, first the summary statistics, then estimation results based on both monetary and non-monetary measures of household welfare.

2.4.1 Descriptive Statistics

Table 2.2 provides key summary statistics of the variables used in this study. Results indicate that farm income shocks are a common phenomenon among rural households in Kenya (in the 5-year

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[1] Cluster is the enumeration area, consisting of 10 households drawn from the same village. Therefore, households within a cluster are expected to be likely homogeneous and face similar agro-climatic conditions.

reporting period, 70 percent of the sampled households reported at least one type of shock that adversely affected household income). The annual household income from agriculture is widely distributed in the sampled households. The aggregate annual household consumption expenditure is greater than the total annual farm income indicating availability of non-farm sources of income among the sampled rural households.

Table 2.2: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max	N
Household experienced farm income shocks (Yes=1)	0.70	-	0	1	8,728
Total annual income (KES)	54,328	145,486	0	4,934,720	6,198
Total annual expenditure (KES)	60,882	73,506	113	6,632,901	13,092
Annual Food expenditure (KES)	39,983	65,318	0	6,612,557	13,092
Annual Nonfood and nondurable expenditure (KES)	12,416	16,593	0	563,890	13,092
Annual Education expenditure (KES)	3,651	9,261	0	324,725	13,092
Household reported hunger last 12 months (1=yes)	0.52		0	1	13,070
Household members aged 0-17 years	3	2	0	16	13,092
Household members aged 18-65 years	2	1	0	11	13,092
Household members aged over 65 years	0.2	0.5	0	3	13,092
Marital status of household head (Couple=1, Single=0)	0.7	-	0	1	13,092
Sex of household head (Male=1)	0.6	-	0	1	13,092
Education of household head	Primary	-	None	Tertiary	9,669

The mean annual food spending is higher than the other subsets of household expenditure, and also the observations show greater dispersion around the mean. The households reporting zero food expenditures are composed of one person aged over 65 years indicating a possibility of complete dependence. Seventy nine percent of the households reporting zero spending on nonfood items were found in Turkana county, which is also the poorest in the country, indicating a possible association between poverty and consumption expenditures. Thirty three percent of sampled rural households had zero education spending. This can be explained by lifecycle of the households, unavailability of private educational facilities, or the expenditures could be met by others outside the household. Within the previous 12 months to the data collection, 52 percent of rural households reported that member(s) missed meals because of lack of money or other resources to obtain food.

This indicates that a significant number of rural households faced food insecurity at the time of the survey. The results also show that household membership is mainly youthful, indicating a case of children dependence on their parents. It was also found that majority of household heads were in some form of marriage, mainly males and with primary level of education.

2.4.2 Effect of Farm Income Shocks on Household Consumption Expenditures

The effect of farm income shocks is estimated on a monetary measure of household welfare, indicated by total household consumption expenditures as well as specific categories of household consumption namely non-food, food and education. As reported in tables 2.3, 2.4 and 2.5, these estimations were done for the whole sample of rural households, and for the households categorized as either located in ASALs and non-ASALs zones. Since the econometric analysis used is appropriate for this relationship, the results can be reported and interpreted.

Table 2.3 reports the results of the estimation seeking to answer the research question on the effect of farm income shocks on household aggregate, non-food, food and education expenditures for all the sampled rural households. The coefficient of income shocks is negative and statistically significant at one percent for the total household expenditure as well as for food and non-food expenditures. This effect is however not significant on the education expenditure. This finding indicates that, holding other factors constant, total consumption spending as well as non-food and food expenditures were lower for rural households that reported farm income shocks, compared to those that were not affected. The spending reduction is however higher for non-food consumption items compared to food items. Before interpreting the effect of farm income shocks on consumption spending, the effect of farm income on consumption spending is explored. Households with higher farm incomes have higher spending on overall consumption goods and services, non-food, food and education. These findings indicate an income effect in the sampled households, thus explaining the observed reduced spending in the households that experience income-reducing shocks (Deaton, 1989). The finding that households facing income shocks have lower consumption expenditures implies rural families in the sampled area are unable to smooth consumption from income fluctuations. Despite this study relying on self-reported measures of farm income shocks, farm income receipts and consumption expenditures, the results are consistent with studies that have used objective measures of shocks and welfare and different

approaches and found adverse effects of income shocks on household welfare (Wineman et al., 2017). The convergence of findings validates the claim that the data used in this study satisfies quality and reliability thresholds.

Table 2.3: Effect of Farm Income Shocks on Household Consumption Expenditure Categories – Whole country

Variable	Expenditure Categories			
	Aggregate	Non-Food	Food	Education
Farm income	0.0915***	0.1203***	0.0758***	0.1252***
	(0.0051)	(0.0092)	(0.0056)	(0.0149)
Farm income shocks (Yes=1)	-0.0697***	-0.1009***	-0.0546***	-0.0287
	(0.0204)	(0.0368)	(0.0217)	(0.0595)
Farm in different county (Yes=1)	0.1045***	0.0557	0.1582***	-0.3169***
	(0.0318)	(0.0554)	(0.0357)	(0.0888)
Age of household head	-0.0159***	-0.0391***	-0.0176***	0.0797***
	(0.0047)	(0.0087)	(0.0051)	(0.0181)
Square of age of household head	0.0001***	0.0003***	0.0002***	-0.0008***
	(0.0000)	(0.0001)	(0.0001)	(0.0002)
Sex of household head (Male=1)	0.0028	-0.1121***	0.1144***	-0.6597***
	(0.0224)	(0.0400)	(0.0254)	(0.0656)
Marital status (Couple=1)	-0.0278	0.0604	-0.0289	0.0496
	(0.0273)	(0.0483)	(0.0319)	(0.0878)
Household size: 0-17 years old	-0.0954***	-0.1152***	-0.0959***	-0.0152
	(0.0047)	(0.0088)	(0.0052)	(0.0149)
Household size: 18-65 years old	-0.0715***	-0.0494***	-0.1331***	0.2272***
	(0.0095)	(0.0173)	(0.0098)	(0.0245)
Household size: Over 65 years old	-0.1310***	-0.1667***	-0.1678***	0.0950
	(0.0331)	(0.0627)	(0.0363)	(0.1007)
Education of household head ('no formal education' is reference category)				
Primary	0.0730***	0.1565***	0.0113	0.2151***
	(0.0195)	(0.0370)	(0.0209)	(0.0553)
Secondary	0.2141***	0.3898***	0.1141***	0.5653***
	(0.0243)	(0.0442)	(0.0260)	(0.0706)
Tertiary	0.4461***	0.8333***	0.2207***	0.5909***
	(0.0502)	(0.0775)	(0.0494)	(0.1576)
Employment of household head ('salaried/waged' is reference category)				
Small business	-0.0122	-0.0374	0.0427	-0.2512***
	(0.0316)	(0.0545)	(0.0337)	(0.0871)
Agriculture	-0.0491*	-0.1632***	0.0290	-0.2560***
	(0.0277)	(0.0484)	(0.0294)	(0.0761)
Intercept	10.903***	9.565***	10.618***	4.736***
	(0.1191)	(0.2186)	(0.1260)	(0.4447)
N	2,913	2,913	2,913	2,349
R^2	0.3126	0.2081	0.2879	0.1983
F-Values	83.37***	55.43***	69.38***	36.29***

Robust standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

The results further indicate that the difference in consumption spending due to farm income shocks is high for non-food expenditures and low for food expenditures in the sampled households. This finding confirms that, compared with other categories of household consumption expenditures, spending on basic food has low income elasticity even in low income countries (Bouis, 1994; Colen et al., 2018). This implies that the sampled rural households seek ways to smooth consumption of food in the event of income shocks, compared to nonfood spending. Consistent with the existing literature (for example Börner et al., 2015; Kazianga and Wahhaj, 2017; Khanal, Mishra and Nedumaran, 2019), Kenyan rural households protect consumption expenditures from income falls through recourse to savings, assets liquidation, borrowing and relying on transfers. In addition, the consumption – spending differences due to income shocks indicates that the sampled household's current income is close to their permanent incomes. The consequence is consumption expenditure frameworks that are sensitive to income fluctuations.

The estimation results with the households disaggregated according to agro-ecological zones are presented in tables 2.4 and 2.5. The results for the households grouped according to agro-ecological zones are consistent with countrywide sample for expenditure categories, except education. Households that reported farm income shocks had statistically significant lower spending compared to those that were not prone to the shocks. Shock-prone households in ASALs reported higher spending differences compared to their counterparts in non-ASALs. The classification of households according to agro-ecological zones reveals that the adverse effect of farm income shocks on household welfare is severer in the ASALs. This is especially so in food expenditures. This imply that climate shocks contribute greatly to the fluctuations in agricultural income among sampled households. In addition, this study finds that spatial factors influence the extent to which rural households suffer welfare loss from agricultural shocks (Christiaensen and Subbarao, 2005; Berchoux et al., 2019).

Table 2.4: Effect of Shocks on Household Consumption Expenditures Categories – ASALs

Variable	Expenditure Categories			
	Aggregate	Non-Food	Food	Education
Farm income	0.0823***	0.0976***	0.0733***	0.0709***
	(0.0088)	(0.0188)	(0.0096)	(0.0268)
Farm income shocks (Yes=1)	-0.1176***	-0.2870***	-0.1044**	0.3389***
	(0.0453)	(0.0829)	(0.0473)	(0.1216)
Farm in different county (Yes=1)	0.2543	0.3167	0.3002	-0.0193
	(0.1719)	(0.2155)	(0.2110)	(0.3437)
Age of household head	-0.0124	-0.0213	-0.0242***	0.0951***
	(0.0091)	(0.0172)	(0.0096)	(0.0329)
Square of age of household head	0.0001	0.0002	0.0002**	-0.0009***
	(0.0001)	(0.0002)	(0.0001)	(0.0003)
Sex of household head (Male=1)	-0.0934**	-0.2702***	0.0652	-0.7789***
	(0.0398)	(0.0735)	(0.0407)	(0.1177)
Marital status (Couple=1)	0.0004	0.0840	-0.0193	0.1366
	(0.0518)	(0.0928)	(0.0566)	(0.1621)
Household size: 0-17 years old	-0.0939***	-0.1028***	-0.0935***	-0.0205
	(0.0090)	(0.0166)	(0.0097)	(0.0244)
Household size: 18-65 years old	-0.0615***	-0.0541	-0.1262***	0.2539***
	(0.0169)	(0.0330)	(0.0182)	(0.0403)
Household size: Over 65 years old	-0.1232	-0.2137**	-0.1262**	-0.0703
	(0.0500)	(0.1079)	(0.0555)	(0.1386)
Education of household head ('no formal education' is reference category)				
Primary	0.1227***	0.3334***	0.0250	0.3333***
	(0.0374)	(0.0733)	(0.0404)	(0.1033)
Secondary	0.3008***	0.6181***	0.1621***	0.5913***
	(0.0481)	(0.0901)	(0.0501)	(0.1329)
Tertiary	0.6243***	1.1415***	0.3434***	1.0056***
	(0.0891)	(0.1689)	(0.1041)	(0.2782)
Employment of household head ('salaried/waged' is reference category)				
Small business	0.0623	0.1467	0.1161*	-0.2799*
	(0.0648)	(0.1172)	(0.0697)	(0.1636)
Agriculture	-0.0028	-0.0717	0.0981*	-0.2292
	(0.0548)	(0.1036)	(0.0579)	(0.1418)
Intercept	10.792***	9.165***	10.698***	4.3708***
	(0.2275)	(0.4369)	(0.2400)	(0.7946)
N	793	793	793	664
R^2	0.3212	0.2209	0.2982	0.2427
F-Values	26.76***	16.91***	22.48***	11.33***

Robust standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

The effect of income shocks on education expenditure produced mixed results. In the countrywide sample, the reduced spending in shock affected households was not statistically significant. In the ASALs, households reporting income shocks had higher spending, while in the non-ASALs, similar households had lower spending. The results in the ASALs sample were investigated deeply

to reveal that while households reporting income shocks had lower absolute education expenditure, their share of education spending to the total consumption spending was higher than households that reported no adverse effects of farm income shocks (t-test statistically significant at one percent). This could imply that rural households in ASALs value education and although they face income fluctuations, spending on education is prioritized. It was further found that households reporting shocks had more household members in school-going age brackets and this could also contribute to the positive relationship between probability of reporting shocks and education spending in the sampled households.

The variable of whether or not a household had a farm in a different county (from their county of residence) was included in the estimation model as a proxy for farm income diversification. This variable's coefficient was significant for total consumption, food and education spending in the models containing countrywide and non-ASALs sample sizes. Consistent with Kemboi, Muendo, and Kiprotich (2020) households with diversified farm holdings had more total consumption and food expenditures compared to those without, implying this type of diversification helps reduce farmer's income fluctuation and thus enhance welfare. However, this spatial diversification was found not to be significant for households in ASALs counties. Since rural farming were diversifying into neighbouring counties (with more or less similar agro-ecological conditions), it is therefore possible that in ASALs, this practice did not insulate households from adverse effects of climate shocks. The country's ASALs are also economically and geographically isolated from the mainstream economy (Republic of Kenya, 2012a), therefore, spatial agricultural diversification is less likely to afford households better income streams. On the other hand, in the countrywide and non-ASALs samples, education expenditure was found to be lower for households that had farms in different counties compared with those that did not. Since seeking farms in different counties is a coping mechanism, it is possible that farms diversifying could be having depressed incomes in the first place and this could be negatively affecting education spending.

Table 2.5: Effect of Shocks on Household Consumption Expenditures Categories – Non-ASALs

Variable	Expenditure Categories			
	Aggregate	**Non-Food**	**Food**	**Education**
Farm income	0.0924***	0.1283***	0.0733***	0.1425***
	(0.0062)	(0.0106)	(0.0068)	(0.0181)
Farm income shocks (Yes=1)	-0.0455**	-0.0496	-0.0268	-0.1169*
	(0.0229)	(0.0410)	(0.0245)	(0.0683)
Farm in different county (Yes=1)	0.0722**	0.0276	0.1195***	-0.3235***
	(0.0324)	(0.0575)	(0.0364)	(0.0936)
Age of household head	-0.0173***	-0.0477***	-0.0155***	0.0799***
	(0.0056)	(0.0101)	(0.0063)	(0.0222)
Square of age of household head	0.0001***	0.0004***	0.0001**	-0.0008***
	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Sex of household head (Male=1)	0.0382	-0.0508	0.1278	-0.6035***
	(0.0275)	(0.0484)	(0.0326)	(0.0805)
Marital status (Couple=1)	-0.0365	0.0556	-0.0289	0.0017
	(0.0325)	(0.0568)	(0.0394)	(0.1053)
Household size: 0-17 years old	-0.0942***	-0.1180***	-0.0949***	-0.0063
	(0.0057)	(0.0104)	(0.0061)	(0.0188)
Household size: 18-65 years old	-0.0746***	-0.0517***	-0.1336***	0.2183***
	(0.0114)	(0.0199)	(0.0117)	(0.0307)
Household size: Over 65 years old	-0.1234***	-0.1378*	-0.1752***	0.2249
	(0.0443)	(0.0768)	(0.0489)	(0.1396)
Education of household head ('no formal education' is reference category)				
Primary	0.0515**	0.0829**	0.0062	0.1652***
	(0.0226)	(0.0420)	(0.0241)	(0.0655)
Secondary	0.1805***	0.3047***	0.0953***	0.5626***
	(0.0279)	(0.0496)	(0.0302)	(0.0833)
Tertiary	0.3832***	0.7251***	0.1796***	0.4587**
	(0.0601)	(0.0879)	(0.0563)	(0.1885)
Employment of household head ('salaried/waged' is reference category)				
Small business	-0.0445	-0.1044*	0.0096	-0.2391**
	(0.0364)	(0.0612)	(0.0387)	(0.1019)
Agriculture	-0.0631**	-0.1945***	0.0078	-0.2550***
	(0.0323)	(0.0544)	(0.0344)	(0.0897)
Intercept	10.9661***	9.7856***	10.6206***	4.7026***
	(0.1400)	(0.2507)	(0.1514)	(0.5432)
N	2,120	2,120	2,120	1,685
R²	0.3072	0.2196	0.2749	0.1941
F-Values	57.19***	41.61***	46.52***	27.07***

Robust standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

The results of the coefficients of the control variables in the models are discussed next. Age of the household head is negatively associated with all consumption spending categories except education in which the relationship was positive. The square of age was introduced to capture the non-linear relationship between age and spending, as confirmed in the results. On the relationship

between gender and consumption spending, households headed by males had reduced spending compared to those headed by females on non-food and education categories. Household headship appeared to influence food expenditures in the countrywide sample, but such relationship could not be sustained when the sample was analyzed separately along agro-ecological zones. The marital status of the household head did not have influence on consumption expenditures. On the other hand, the household size in different age groups had an inverse relationship with consumption spending in mainly all expenditure categories except education in the 18-65 age category, in which the relationship was positive. The spike in education spending for households with members aged 18 could reflect the enhanced household spending in college education. These results are also consistent in all sample categorization. In all expenditure categories for all samples, households with more educated heads had higher expenditures. Reduced spending was noted in households with heads occupied in agriculture compared with those in salaried employment. However, in the ASALs sample, food spending was found to increase in households with unstable occupations compared to those in well-paid and stable employment. This reflects the poverty status in the ASALs where food spending is higher among the poor.

2.4.3 Effect of Farm Income Shocks on Non-Monetary Measures of Household Welfare

In this study, incidence of hunger in the household was used as an indicator of food security. Food security is then adopted as the non-monetary measure of household welfare (Pinstrup-Andersen, 2009). Table 2.6 presents the results of the relationship between farm income shocks and household food security status, as well as the relationship with control variables.

For all categories of samples considered, households that reported being adversely affected by farm income shocks were more likely to report incidences of hunger. Specifically, the probability of reporting hunger was higher for households that were adversely affected by farm income shocks than those not affected by 15 percent, 19 percent and 10 percent respectively in the whole country, ASALs and non-ASALs samples, holding all other variables at their means. As was found in the estimation using consumption expenditures, households in ASALs (compared to those in non-ASALs) have the highest probability of experiencing food insecurity if affected by farm income shocks. This confirms the vulnerability of rural households in marginal lands in coping with agricultural income shocks (Börner et al., 2015). The convergence of the findings using different

measures of household welfare (monetary and nonmonetary) implies that the data used reliable and the estimation approach is reliable, thus rendering the estimates credible for policy recommendations.

Table 2.6: Effect of farm income shocks on household food insecurity – whole country, ASALs and non-ASALs (marginal effects)

Variable	Sampled Area		
	Whole Country	ASALs	Non-ASALs
Farm income	-0.0753***	-0.0715***	-0.0667***
	(0.0065)	(0.0126)	(0.0072)
Farm income shocks (Yes=1)	0.1454***	0.1786***	0.0977***
	(0.0240)	(0.0491)	(0.0263)
Farm in different county (Yes=1)	0.0352	-0.2392	0.1087***
	(0.0373)	(0.1482)	(0.0373)
Age of household head	0.0076	0.0167*	0.0044
	(0.0055)	(0.0101)	(0.0064)
Square of age of household head	-0.0001	-0.0002	7.46e-06
	(0.0001)	(0.0001)	(0.0001)
Sex of household head (Male=1)	0.0015	0.0537	0.0053
	(0.0264)	(0.0447)	(0.0315)
Marital status (Couple=1)	-0.0583*	-0.1070	-0.0515
	(0.0312)	(0.0577)	(0.0360)
Household size: 0-17 years old	0.0451***	0.0321***	0.0458***
	(0.0057)	(0.0099)	(0.0066)
Household size: 18-65 years old	0.0105	-0.0066	0.0097
	(0.0095)	(0.0167)	(0.0111)
Household size: Over 65 years old	-0.0014	0.0131	-0.0471
	(0.0367)	(0.0576)	(0.0455)
Education of household head ('no formal education' is reference category)			
Primary	-0.1330***	-0.1026***	-0.1394***
	(0.0229)	(0.0401)	(0.0266)
Secondary	-0.2193***	-0.2173***	-0.2132***
	(0.0271)	(0.0517)	(0.0310)
Tertiary	-0.3671***	-0.3947***	-0.3465***
	(0.0464)	(0.1082)	(0.0485)
Employment of household head ('salaried/waged' is reference category)			
Small business	0.0372	0.0125	0.0573
	(0.0362)	(0.0715)	(0.0404)
Agriculture	0.0580*	0.0563	0.0484
	(0.0316)	(0.0604)	(0.0354)
N	2,913	793	2,120
Pseudo R^2	0.1113	0.1084	0.1142
LR chi2	447.61***	113.79***	325.83***

Standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

Household food security had the expected relationship with income, indicating that income reduced the incidence of reporting hunger. The coefficient of agricultural farm diversification was not statistically significant except for households in non-ASALs in which it was positive, indicating that the probability of reporting hunger increased by 11 percent for households with farms in different counties, holding all other variables at their means. This implies that the sampled households were using diversification as response mechanism to shocks (Reardon et al., 2007). In this model, the effect of age, gender and marital status of the household head was largely absent. The coefficient of household size was only significant in the 0-17 age group, in which the likelihood of reporting hunger increased with size. This is consistent with literature that in rural sub-Saharan Africa, the number of children was positively related to household food insecurity (Lamidi, 2019). The coefficient of the education achievement of the household head is consistently significant across all the samples, and indicate that households with more educated heads were less likely to report hunger incidences, all other variables held at their means. Finally, the relationship between the occupation of the household head and hunger incidence was found to be largely absent, except in the countrywide sample in which employment in agriculture predisposed households to more likelihood of hunger.

2.5   Summary, Conclusions and Policy Recommendations

2.5.1   Summary and Conclusions

Rural households in Kenya derive large share of their income from agriculture. On the other hand, agricultural production is prone to various shocks such as climate and weather risks, crop and animal pests and diseases, and price and market shocks of inputs and outputs. Accordingly, fluctuations in agricultural incomes of rural households is likely to result to welfare loss, such as consumption. While this connection has been examined in the literature, studies that have used consumption expenditure as a measure of welfare have mainly lumped different categories of consumption expenditures, thus masking important heterogeneity in the household spending categories. In addition, the relationship between farm income shocks and non-monetary measure of welfare is largely scant in the literature. This study sought to fill this identified gap by assessing the effects of farm income shocks on disaggregated household consumption expenditures along agro-ecological zones as well to find the effect of farm income shocks on food security, as a non-

monetary measure of welfare. This study has relevant policy significant as it provides in-depth understanding of welfare vulnerability in rural areas of the country and also come up with targeted policies for stabilizing rural household's incomes from fluctuations.

In order to establish the theoretical and empirical relationship between income and consumption literature on lifecycle – permanent income hypothesis, precautionary savings motive, complete market hypothesis, asset smoothing theory were reviewed which revealed that consumption is theoretically expected to be protected from the effects of current income shocks. However, empirical evidence produced mixed results. The econometric estimation followed two approaches, a linear regression in the case of consumption expenditures and a logistic regression in the case of food security. The 2015/2016 Kenya Integrated Household Budget Survey (KIHBS) data was applied on the econometric models in three samples; countrywide, ASALs and non-ASALs. The results reveal that total consumption spending, non-food and food expenditures were lower for rural households that reported farm income shocks, compared to those that were not affected by the similar shocks. Food expenditures reduced more compared to other expenditure categories. Disaggregation of the data along agro-ecological zones revealed that ASALs households afflicted by shocks reduced their consumption spending more than their counterparts in non-ASALs. The study also found that shock-prone rural households in the ASALs had bigger education share of total consumption spending compared to households not affected by shocks. Logistic regression results using food security as the dependent variable are consistent with the results using consumption expenditures, in that households that reported being adversely affected by farm income shocks were more likely to report incidences of hunger.

2.5.2   Policy Recommendations

This study investigated the effect of agricultural income shocks on household welfare outcomes, using self-reported measures of risk, income, consumption expenditures as well as hunger incidence. The results are consistent with the results in other studies using quantifiable measures of shocks and welfare outcomes (see for example Christiaensen and Subbarao, 2005; Wineman et al., 2017). This finding implies that self-reported measures and indicators can be relied upon to make policy inferences in situations where it is not feasible to access or use observed data household income risks, incomes and consumption indicators. In developing countries, administrative data on welfare measures is largely missing while observation data is expensive to

collect (United Nations, 2005), therefore, survey data becomes the second-best. For example, Kenya has two waves of nationally representative self-reported data on various dimensions of household welfare that can be used to generate policy-relevant research.

Results of this study indicate that rural households in Kenya are still vulnerable to agricultural income fluctuations which predispose them to welfare losses and poverty. This implies that the sources of risk are still present and may increase in the future – for example increased and intense farm income shocks due to changing climate and weather patterns as well as increased incidence of livestock and crop diseases. Policies and programmes for climate change adaptation and mitigation are useful to build the resilience of rural incomes from various shocks that have adverse effect on welfare. The other aspect is on rural livelihoods policy that focuses on making risk-management markets work for rural households. Possible strategies include microcredit schemes, crop and livestock insurance and building physical infrastructural in geographically-isolated rural areas. In addition, policies and existing strategies targeting the poor, such as social safety nets need to be enhanced to protect the livelihoods of the rural poor.

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Appendices

Table 2.7: Earnings from crop sales per county

County	Mean Earning from Crop Sales (KES)
Bomet	20,186
Meru	16,237
Uasin Gishu	15,935
Narok	15,549
Embu	13,359
Kirinyaga	13,170
Muranga	12,997
Taita Taveta	11,736
Nakuru	11,686
Nyeri	11,359
Migori	10,482
Nandi	10,281
Nyandarua	10,072
Trans Nzoia	9,550
Elgeyo Marakwet	8,298
West Pokot	8,169
Kakamega	6,989
Tharaka Nithi	6,970
Bungoma	6,782
Kericho	6,715
Nyamira	6,527

County	Mean Earning from Crop Sales (KES)
Kisii	6,390
Kiambu	4,438
Machakos	3,980
Baringo	3,473
Kitui	3,103
Homa Bay	2,651
Kajiado	2,411
Lamu	2,370
Kilifi	2,105
Laikipia	2,078
Makueni	1,443
Kwale	1,335
Tana River	1,270
Busia	1,006
Vihiga	895
Siaya	645
Isiolo	495
Kisumu	352
Mandera	194
Marsabit	65
Turkana	25
Garissa	11
Samburu	2
Wajir	-

Table 2.8: Earnings from Livestock sales per county

County	Mean Earning from Livestock Sales (KES)
Kajiado	27,218
Narok	26,070
Wajir	12,483
Kiambu	11,155
West Pokot	10,939
Baringo	9,863
Garissa	9,831
Isiolo	9,528
Marsabit	7,133
Kitui	6,725
Mandera	6,455
Nyandarua	6,230
Samburu	6,148
Makueni	5,756
Tharaka Nithi	5,240
Bomet	5,220
Lamu	5,185
Machakos	5,169
Bungoma	5,050
Elgeyo Marakwet	4,964
Meru	4,928
Nakuru	4,882
Laikipia	4,746
Migori	4,321
Nandi	4,238
Tana River	3,986
Uasin Gishu	3,629
Muranga	3,467
Kericho	3,065
Kakamega	2,901
Kisumu	2,831
Nyamira	2,827
Kirinyaga	2,803
Nyeri	2,791
Kisii	2,709
Homa Bay	2,697
Embu	2,665
Trans Nzoia	2,334
Taita Taveta	2,244
Vihiga	2,212
Kwale	1,688
Siaya	1,641
Busia	1,589
Kilifi	1,068
Turkana	787

Chapter Three   Determinants of Distress Sales of Farmland in Rural Kenya

3.1   Introduction

Households in developing countries continuously face comparatively more welfare-reducing shocks than their counterparts in developed economies. Literature has established higher frequency and prevalence of shocks to households in less developed economies compared to those in developed economies (Loayza et al., 2007). Shocks are also disproportionately prevalent among the poor than the rich due to variety of reasons but principally because of differences in the physical, economic, social and institutional environments of the former versus that of the latter (Morduch, 1994; Bretschger and Vinogradova, 2017). For the majority of rural households in developing countries, sources of livelihoods are less diversified and are mostly depended on the natural environment and therefore highly vulnerable to climate and weather variability (Morduch, 1994). Public goods and services are also limited, a situation that reinforces with the nature of their livelihoods to increase vulnerability to shocks such as diseases, low prices for agricultural outputs as well as high prices of basic manufactured household commodities.

Given the high exposure to shocks and the limited institutional support for maintaining smooth consumption, the risks and eventually shocks facing the rural households have been found to cause considerable welfare loss to the affected households through avenues such as loss of income and other forms of livelihoods, as well as, loss and incapacitation of available human productive capacities through sickness and death (Baulch and Hoddinott, 2000; Pallage and Robe, 2003). Consequently, considerable amount of both theoretical and empirical research has documented various response mechanisms usually adopted by households in low-resource economies in order to deal with the adverse effects of the shocks and pursue relatively smooth consumption.

The response mechanisms take the form of prevention, for instance boiling drinking water to avoid water borne diseases; mitigation, for instance diversifying livelihoods; and coping with the shocks, for example through reducing household expenditure (Alderman and Paxson, 1994; Ludi and Bird, 2007). The coping mechanisms are generally classified as either effective (such as use of savings, insurance, household labour, government and communal support) (Kochar, 1999; Jabeen, Johnson and Allen, 2010) or ineffective (such as removing children from school, selling production assets

such as farmland, delaying or cutting down essential consumption such as health care) (Beegle, Dehejia and Gatti, 2006; Amendah, Buigut and Mohamed, 2014). This means that while the effective coping mechanisms help households to restore its welfare to pre-shock status, ineffective coping mechanisms (which include sale of productive assets such as farmland, reduction of household essential consumption and engaging in risky behaviours such as prostitution) are usually costly and have long term negative consequences on household welfare. Thus, any chosen response strategy either before or after a negative shock may reduce household resource base, weaken its resilience, and increase its vulnerability of falling into deeper poverty.

Selling of farmland is considered among the ineffective ex-post coping strategies because land is the principal factor of production for the rural population in least developed countries, which constitutes 67 percent of the population (World Bank 2019). In addition, over 90 percent of the rural households are engaged in agriculture, and use land for crop farming, livestock production, fishing, forest exploitation and artisanal mining (Anríquez and Stamoulis, 2007). The rural households have higher incidences of poverty compared to urban ones and the poverty is intricately connected to livelihood risks that generate shocks that further adversely affect household welfare (Carter et al., 2007; Dercon, 2009; Günther and Harttgen, 2009).

3.1.1 Household Coping Mechanisms to Shocks in the Kenyan Context

Households in Kenya experience most of the risks that are inherently global as well as those that are specific to developing countries. Indeed, Kenya is among the most shock-prone developing countries (Eckstein, Künzel and Schäfer, 2017). The prevalence of shocks and household vulnerability to welfare losses in developing countries has been attributed mostly to the reliance on agriculture as the main source of livelihoods as well as limited support systems for risk management that bounds household resilience (Morduch, 1995; World Bank, 2013). In Kenya, the major economic activity is driven by agriculture, representing 26 percent of GDP, 40 percent of total employment (constituting 70 percent of rural employment), 65 percent of the exports and 60 percent of foreign exchange earnings (Republic of Kenya, various years). In addition, 98 percent of the agricultural systems are rain-fed and over 75 percent of agricultural output is produced by the smallholder farmers, two aspects that compound to result into high variability in the sector owing to production and climate-induced risks (Republic of Kenya, 2017a). Households engaged

in the sector thus experience a variety of shocks such as production and marketing shocks, effects of global economic recessions and political and civil strife that affect production and marketing. These include droughts and other weather related shocks, crop and livestock disease, agricultural commodity price fluctuations. The shocks to crop production have been estimated to have caused an annual loss to the agricultural GDP of 2 to 4.2 percent (D'Alessandro et al., 2015).

The effects of these shocks usually get compounded since the occurrence and effect of one shock precipitate another. For example, drought reduces food production and supply which results into increased food prices and general price inflation, thus reduced household food consumption and attendant consequences of malnutrition and disease. In addition, rural livelihoods in low resource economies are exposed to multiple risks that cumulatively contribute to higher frequency of realized adverse shocks (Heltberg, Oviedo and Talukdar, 2014). As an example, a household in rural areas in these developing countries will in addition of weather and climate shocks be most exposed to health shocks because of inaccessibility of primary healthcare facilities. Also, because of remoteness and isolation from the mainstream trade and economic networks, such households in rural areas are also hardest hit by price inflation of basic commodities.

Another significant source of risk to household livelihoods in Kenya is the incidence and prevalence of diseases and illnesses. Measured across different periods, malaria has been found the most prevalent illness in Kenya (31 percent), followed by influenza (16.5 percent), headache, respiratory infections and diarrhea, all at 7 percent. HIV/AIDS, lower respiratory infection and diarrheal diseases remain the leading causes of most deaths in the ten year period between 2007 and 2017 (Institute for Health Metrics and Evaluation, {IHME}, 2019). Diseases and death result into loss of income due to forgone labour earnings from productive household members. Household welfare is also adversely affected through diversion of resources for the treatment and management of illnesses (Quintussi et al., 2015; Mwai and Muriithi, 2016). Diseases also have long term effects on household welfare through reduced or lost human capacity due to missed school or work days for convalescence (Chima, Goodman and Mills, 2003). Studies have also shown that disease incidence is higher among the poor households in rural areas compared to their counterparts in urban areas (Achoki et al., 2019).

Natural disasters such as droughts and floods are the other threats to household livelihoods in Kenya. The disasters cause destruction of property, death and disease epidemics, all which

contribute to disruption of livelihoods. Households in rural areas, majority who make living from agriculture and livestock pastoralism, are the most vulnerable. Droughts occur frequently in the more than 80 percent of the country's ASALs while floods commonly affect low lying areas of Budalangi, Nyando, Rachuonyo and Tana River (Kihiu and Laibuni, 2018). Almost 30 cases of major droughts have been reported in the country since 1883 with the frequency and intensity increasing in successive years, while floods are almost perennial, but their frequency peaked in the 1997/1998 El Nino induced rains (Ngecu and Mathu, 1999; Kihiu and Laibuni, 2018).

Another source of shocks emanate from Kenya's open economy policy and the subsequent integration into the global financial system which predisposes households to economic risks that come as a result of exchange rate fluctuations, global economic recessions and financial crises, (Kiptui, 2008; Musyoki, Pokhariyal and Pundo, 2012). Household welfare is adversely affected through increased unemployment due to fall in aggregate demand, instability in the prices of agricultural export commodities such as tea, coffee and horticulture, reduced international tourism and reduction in diaspora remittances. Indeed, exchange rate volatility risks are higher for exporters in low income countries than countries with big economies (Sauer and Bohara, 2001). Given that Kenya is a net importer of important food supplies such as sugar, cooking oils and grains including maize the staple, households are thus more vulnerable to the transmission of world food markets to local prices compared to households in countries such as Uganda which rely most on domestic food sources (Benson, Mugarura and Wanda, 2008; Manitra, Iafrate and Paschali, 2011; International Food Policy Research Institute {IFPR}), 2017). The welfare reduction from food price inflation in the country has been found to be higher among the poor compared to the rich, and especially the rural landless households (Levin and Vimefall, 2015).

A summary of common shocks as reported by respondents in a data collected across the country for a period of 12 months in 2005/2006 and 2015/2016 comprising 13,212 and 21,773 households respectively is provided in table 3.1.

Table 3.1: Distribution and frequency of common shocks affecting households in Kenya

Type of shock	Frequency (%)	
	2005/2006	**2015/2016**
Drought/floods	12.74	16.05
Crop diseases/crop pests	2.43	7.63
Livestock died or stolen	9.74	14.2
Household business failure (non-agricultural)	4.25	4.02
Loss of employment for the salaried	2.99	2.62
End of regular assistance	1.25	1.26
Large fall in sale prices for crops	3.01	2.99
Large rise in prices of food	16.63	13.21
Large rise in agricultural input prices	4.05	2.40
Severe water shortage	5.45	4.45
Chronic/severe illness/accident of household member	12.01	****
Birth in household	1.18	1.19
Death of household head	2.03	2.05
Death of working member	1.02	0.68
Death of other family member	11.28	10.11
Break-up of household	1.31	2.21
Breadwinner jailed	1.07	0.29
Fire	0.91	0.87
Carjacking/robbery/burglary/assault	2.66	3.32
Dwelling damaged/destroyed	0.83	0.60
HIV/AIDS	0.42	0.51
Eviction/conflict/ethnic or clan clashes	****	2.71
Others	2.72	6.62
Total number of shocks reported	25,510	27,534

Source: Author's computation from KIHBS, 2005/2006 and 2015/2016

Between the two study periods, there was increased percentage of households reporting shocks such as crop diseases and pests, loss of livestock to diseases and theft, business failure, loss of employment, household break-up, carjacking, robbery and burglary. The percentage of households reporting the economic shocks such as rise and fall of prices fell between the study periods. Similar reduction was noted for households reporting severe water shortages, death of working member of households, jailing of breadwinners and destruction/damaging of dwellings. Occurrence of droughts/floods, fire, diseases such as HIV/AIDS and deaths of household heads and other family members and end of regular assistance remained constant or changed marginally between the study periods. The 2015/2016 survey did not include responses for diseases, accidents and other malaise and it is believed that this omission is captured in the disproportionately high percentage of 'other' shocks.

Household response to shocks in developing countries takes place in the context of a higher frequency to shocks due to disproportionately higher vulnerability to myriad of shocks occasioned by reliance on primary means of production, poverty and higher exposure to natural calamities. The environment in which households respond to shocks is compounded by weak formal risk sharing systems such as insurance, functioning financial markets, social protection systems and limited access to basic infrastructure that facilitates opportunities for diversified livelihoods. Consequently, households resort to ex ante strategies of adjusting economic activities to less risky but low yield options and ex post strategies such as relying on community and social networks for support, drawing down on savings and liquidating assets, increasing household labour force and participation including taking children off school to work, adjusting household consumption expenditure including reducing essential consumption. Response strategies such as taking children off school, leasing out farmland or even selling it involve significant opportunity cost since they limit household productive capacity and increase vulnerability to future shocks thus perpetuating poverty.

Response strategies among households in Kenya are characteristic of the developing countries. Shocks are prevalent, especially among the poor and rural households and efficient risk sharing systems are limited (Eriksen, Brown and Kelly, 2005; Mworia and Kinyamario, 2008; Smucker and Wisner, 2008). For instance, only 3 percent of commercial banks' lending goes to agriculture, with even smaller fraction going to smallholder farmers (Kenya Bankers Association, 2018); only 3 percent of farmers are aware of agricultural insurance and only 0.4 percent of the farmers were using the insurance (Association of Kenya Insurers, 2016). There is also limited integration of farming households into formal financial infrastructure which limits use of formal credit and savings instruments to smooth out consumption (ibid). While social protection has increased since 2003 owing to the institutionalization of the concept in the policy and legislative agenda and thus expansion of social protection programmes (Republic of Kenya, 2012; Wanyama and McCord, 2017), coverage is still limited in terms of geography and beneficiary categories and the existing social protection programmes have not been successful in aiding households to effectively cope with various livelihood shocks (Del Ninno and Mills, 2015).

In the data on shocks collected in 2005/2006 and 2015/2016 in Kenya, households reported various response mechanisms to cope with the shocks and/or regain their pre-shock welfare status (see table 3.2). The coping strategies are classified into the following categories.

Table 3.2: Household coping strategies to shocks in Kenya

Category of Coping Strategy	2005			2015		
	% of coping mechanisms reported					
	First Choice	**Second Choice**	**Third Choice**	**First Choice**	**Second Choice**	**Third Choice**
Use of savings and sale of assets	42.58	24.97	12.20	32.93	18.09	13.21
Labour coping strategies	15.08	14.54	10.16	9.30	13.63	8.26
Borrowing	3.08	5.33	5.16	2.83	5.72	6.45
Social and institutional support	12.31	21.87	23.08	9.19	18.44	15.55
Reducing consumption expenditure	11.32	25.53	39.49	10.09	32.87	44.18
Did nothing/Spiritual intervention[2]	6.60	5.56	8.58	32.66	9.31	11.44
Others	9.03	2.19	1.33	3.02	1.94	0.91
* of which sale of farmland	0.65	0.62	0.26	0.25	0.31	0.49
Number of response mechanisms	16,237	8,706	3,917	27,122	8,797	2,868

Various responses are ranked according to their importance as perceived by households in terms of coping with the shock or in terms of helping the household regain its former welfare level. In both data collection periods, the use of savings and sale of household assets was the commonly adopted option to respond to shocks. The other popular coping strategies included the use of labour-based coping strategies, relying on family, social and institutional support networks and systems as well as reduction of consumption expenditures. Use of savings and disposing of assets is subsequently being ranked less, while the importance of relying on borrowing and external support increases as a second and a third choice coping options. This implies that households choose coping strategies in a continuum which means that the potential response strategies are not considered on equal basis, but rather on consideration of factors such as discount value, opportunity cost, liquidity (in the case of physical assets), availability nature and persistence of shocks (Devereux, 1993; Quisumbing, 1996; Fafchamps and Lund, 2003; Kenjiro, 2005). Choices that rank high in the first choice option then decrease in the subsequent rankings are those most likely to be chosen first (example is use of savings, sale of assets and increasing labour supply)

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[2] . In 2015, 29 percent of the 'first choice' was to 'do nothing' which is not a credible response since at least some reaction emanating out the effect of the shock is expected

while those that are least in the first choice option and increase in subsequent ranking are the ones at the further end of the continuum (example is reducing consumption, borrowing, seeking help and selling of farmland).

3.1.2   Statement of the Problem

Rural households in developing countries continuously face the risk from livelihood shocks while at the same time operate in an environment where systems for effective risk sharing such as financial and insurance markets are weak or non-existent. In order to cope with the adverse effects of shocks, households are sometimes forced to resort to ineffective coping strategies such as sale of farmland. The households are forced to rely on ineffective coping strategies despite them being undesirable and potentially contributing to worse welfare outcomes in the current and subsequent periods. One such strategy is the sale of farmland, which is ineffective because it limits household future productive capacity and therefore more vulnerability to shocks. This is especially so in rural Kenya, where land is the most important factor of production (Burke et al., 2007). It is therefore in the interest of public policy to understand circumstances leading to distress sales of farmland in order to address the vulnerabilities that can result to rural households losing their farmland due to shocks.

The existing literature does not adequately address the circumstances contributing to households to sell their farmland following shocks, especially in the context of Kenya. For example, World Bank (2013) gives the general reasons why households use coping strategies deemed detrimental to long term household welfare and these include poverty trap, persistence of shocks, information asymmetry, cognitive and behavioural failures, missing markets and public goods, social and economic externalities. Ruben and Masset (2003) explain the circumstances of distress sales of farmland in Nicaragua; Kenjiro (2005) shows how illnesses are most likely to lead to distress land sales in rural Cambodia; and Deininger and Jin (2008) study the effect of shocks on land sales in rural Vietnam. While these studies exist, it is inappropriate to use their findings for policy reference in Kenya because differences in rural land tenure systems, land history, land inheritance regimes, socio-economic differences between the countries and risks to shocks among many other differences.

This study contributes to the literature by providing the perspective of distress sales of farmland in Kenya. Plenty of studies on land in Kenya exist ranging in diversity of themes from land uses

(Serneels and Lambin, 2001; Mundia and Aniya, 2006), land tenure (Haugerud, 1989; Migot-Adholla, Place and Oluoch-Kosura, 1994), land politics (Boone, 2012; Fox 2018; Kweyu et al., 2020), land conflicts (Mackenzie, 1998; Campbell et al., 2000; Yamano and Deininger, 2005), and others. However, literature on distress land sales is scant. The other contribution of this study is the use of pooled cross-sectional data to reflect changes in household socio-economic status over time in relation to coping with shocks. According to Dang and Carletto (2018), pooled cross-sectional data can yield reliable estimates in situations where panel data is unavailable, as is the case in developing countries where it is expensive and technically challenging to collect panel data.

3.1.3 Research Question

Considering the context presented so far in this study and specifically the identified literature gap, the remaining sections lay the theoretical and empirical frameworks and seeks to provide an answer to the following research questions;

1. What are the shocks characteristics that determine household probability of engaging in distress sales of farmland in rural Kenya?
2. What are the household and other general characteristics that determine household likelihood of selling farmland as a coping strategy in rural Kenya?

3.1.4 Objectives of the Study

The general objective of this study is to find out the determinants of distress sales of farmland in rural Kenya. Contributing to the overall understanding of this objective are the following specific objectives;

1. Find out the characteristics of shocks that cause distress sales of farmland in rural Kenya.
2. Assess the household and other general characteristics likely to predispose families into selling farmland as a coping strategy in rural Kenya.

3.1.5 Significance of the study

Given that livelihood shocks continue to adversely affect the welfare of Kenyan households, the findings of this study are significant in informing the policy discourse on effective responses to livelihood risks that potentially protects household welfare in the present without compromising the future. Specifically, the knowledge of the circumstances of choice of costly coping mechanisms will be useful in designing and implementing policies and other remedial interventions that foster

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household resilience from adverse effects of shocks. This, for instance, includes influencing key determinants in order to expand the coping options available to rural households.

In understanding the causes of the welfare-reducing ex-post coping strategies among households, this study also contributes to the current policy focus that emphasizes on shifting from risk management strategies that are ad-hoc and reactive, to those that are planned, active and adopted in the broad context of ensuring sustainable livelihoods (World Bank, 2013). An example of sustainable risk management strategies include enabling vulnerable households to access information on possible sources of risk (e.g. weather updates), promoting formal and informal risk sharing frameworks (e.g. crop and livestock insurance) and providing opportunities for households to diversify their incomes (e.g. road transport networks to increase intra-country trade opportunities) (World Bank, 2013).

3.2 Literature Review

This section reviews both theoretical and empirical literature on household choice of response strategies to livelihood shocks. The section specifically reviews the previous studies that provide the context for understanding the determinants of household ex-post coping strategies. In addition, the review identifies what is already known about the subject and highlight the gap that this study seeks to fill.

3.2.1 Theoretical Literature Review

Households in developing countries experience a variety of shocks emanating from different sources such as climate and weather variability, diseases and accidents, economic factors, social unrest and violence (Maharjan, 2014). Shocks can be classified as either idiosyncratic or covariate depending on the number of affected households in a community (Heltberg, Oviedo and Talukdar, 2014). Idiosyncratic shocks have isolated and non-simultaneous effect on households, while covariate shocks have widespread reach and simultaneous effect (Heltberg, Oviedo and Talukdar, 2014). Given this typology of shocks, microeconomic theory has it that households are better at insuring against idiosyncratic compared to covariate shocks (Günther and Harttgen, 2009). Linking this proposition on the theory of community risk sharing (Fafchamps, 2011), it follows that the impact of idiosyncratic shocks are lower on households than covariate shocks and thus households are least likely to resort to ineffective coping strategies.

The economic loss from shocks is also theorized to influence household's coping capacity (Kochar, 1995). This is related to the notion of 'thresholds of risk' which permit effective coping (Warner and Van der Geest, 2013). The response to shocks, apart from being a function of the shocks, is also a depended on the internal and external attributes of the household affected (Krueger and Perri, 2009). Household's attributes include resources at their disposal (Paumgarten and Shackleton, 2011). On the other hand, household access to resources depend on both intrinsic and extrinsic characteristics such as gender, education level, occupation of the household head, and the household social connections (Curtis, 1986; Udry, 1996). This theoretical framework helps in conceptualizing the understanding of the determinants of distress sales of farmland as a shock response strategy.

Household response strategies to shocks have been classified as either advance management (ex-ante) such as such as livelihood portfolio diversification or risk coping (ex-post) which entails strategies to smooth consumption once risk has materialized and involves borrowing, dissaving, seeking assistance from various support systems and increasing and diversifying labour supply (Alderman and Paxson, 1994; Kochar, 1995; Nyariki and Wiggins, 1999; Park, 2006; Sawada, 2007). Ludi and Bird (2007) argue that risks can be mitigated through strategies such as preventive health practices, migration, water conservation and sound macroeconomic policies. Other studies have argued that household response strategies fall in a continuum and are chosen sequentially (Devereux, 1993; Fafchamps and Lund, 2003). The first choice is insurance (for example drawing down precautionary savings or reliance on social networks). If the household has no insurance or it has been exhausted, they liquidate the accumulated assets such as small livestock and other easily disposable assets. Borrowing is considered next if the household is unable to dispose assets or has exhausted them. In such a shock response continuum, it has been established that options with low economic and social costs are chosen first while those with significant costs are chosen as last resort (Devereux, 1993; Kenjiro, 2005).

3.2.2 Empirical Literature Review

In developing countries, the risk of households' welfare being adversely affected by livelihood shocks is ever-present. Consequently, considerable empirical literature has been generated over time assessing household response to shocks. Response management of adverse shocks operates

in a continuum of choices, starting with risk minimization strategies before shocks have materialized (ex-ante response mechanisms) and ending with measures taken to protect welfare loss after shocks have happened (ex-post response mechanisms) (Devereux, 1993; Adams, Cekan and Sauerborn, 1998; Fafchamps and Lund, 2003). The main empirical works have established that the types and nature of shocks; sources, frequency and intensity of shocks; persistence and severity of shocks; as well as costs and benefits determine the response mechanisms chosen (Cashdan, 1985; Ellis, 1998; Morduch, 1999; Baulch and Hoddinott, 2000; Dercon, 2002; Holzmann, Sherburne-Benz and Tesliuc, 2003; Sawada, 2007).

Regarding response mechanisms to household welfare shocks, various strategies are commonly applied. Alderman and Paxson (1994) propose two general strategies; first, a household can manage risk by responding in advance to reduce the negative effect of shock through strategies such as livelihood portfolio diversification aimed to lessen income variability. The second option is risk coping which entails strategies to smooth consumption once risk has materialized and involves borrowing, dissaving, seeking assistance from various support systems and increasing and diversifying labour supply. This is generally consistent with what other authors refer to as ex ante – mitigation before the event, and ex post – mitigation after the event (Kochar, 1995; Nyariki and Wiggins, 1999; Park, 2006; Sawada, 2007). Another typology of risk management strategies is provided by Ludi and Bird (2007) and has three general categories of prevention, mitigation and coping. According to the authors, prevention entails preventive health practices, migration, water conservation and sound macroeconomic policies. Mitigation and coping strategies are similar to those elaborated by other authors reviewed above.

The choice of sale of farmland could also be understood in the sequential choice of coping options in the event of a shock (Devereux, 1993; Fafchamps and Lund, 2003). In this context, Fafchamps and Lund (2003) contends that the initial choice is insurance in the forms and variants such as precautionary saving, and reliance on social networks. If a household is unable to insure risk, they liquidate the accumulated assets such as small livestock and other easily disposable assets. Borrowing is considered next if the household is unable to dispose assets or has exhausted them. On the other hand, Devereux (1993) argues that households face a choice of options in a coping continuum. Options with low economic and social costs are chosen first while those with significant costs are chosen as last resort (Kenjiro, 2005). The costs associated with selling the

household farmland are that, while the household satisfies current consumption needs, it loses future consumption potential and that loss of productive capacity and resilience to future shocks can precipitate household descent into poverty.

Having reviewed the theoretical context that underpins household welfare risk management and circumstances that lead to choice of various coping mechanism, empirical literature on the covariates affecting choice of response mechanisms is reviewed.

The choice of coping mechanisms is to a large extent determined by the type of shock (Cashdan, 1985; Ellis, 1998; Sawada, 2007). Other determinants are based on the cost-benefit analysis of the coping mechanism, that is, the welfare loss due to the choice vis-à-vis the loss from the adverse effect (Cashdan, 1985; Baulch and Hoddinott, 2000). Additionally, the characteristics of risks such as the sources, correlation, frequency and intensity also inform household response mechanisms and the underlying reasons for the kind of response adopted (Holzmann, Sherburne-Benz and Tesliuc, 2003). In the same breath, Dercon (2002) postulates that specific characteristics of various risks faced which include nature of the shock, that is whether the shock is idiosyncratic or covariate, the frequency and intensity of the shock, also influence household response. Additionally, Morduch (1999) argues that household response mechanism depend on the recurrence and severity of the shock as well as how long its impact continues to affect the household.

Other studies have examined the specific characteristics of land that limit its disposal in order to cope with shocks. In most of rural Africa, the customary land tenure limits formal market transactions (Berge et al., 2014). In Kenya, as in other societies, apart from land forming the backbone of rural livelihoods, its ownership grants households recognition and status in the society (Neale, 1985, as cited in Deininger, Jin and Nagarajan, 2009). Additionally, land transactions are controlled for various reasons such as to limit concentration of land among the rich at the expense of the poor. In Kenya, the official sale of agricultural land is controlled through the land control boards which assess the reasons for sale and validates the consent from the key stakeholders of the selling family (Republic of Kenya, 2017b). The land control boards have the power to guard against irresponsible or extreme distress sales of land. Thus in essence, land is therefore not treated as a 'normal' commodity that can be liquidated in the market to help household respond to various shocks that the household may face.

However, cases exist in which households opt to sell farmland to alleviate adverse welfare effects of shocks. However, they are limited and in most cases chosen as last resort after other 'normal' coping options have been exhausted (Basu, 1986; Sarap, 1995; Deininger, Jin and Nagarajan, 2009; Thebe and Rakotje, 2013; Chitonge et al., 2017). Longhurst (1986) found that in northern Nigeria, drawing down of durable assets such as sale of farmland was only due to extreme events such as famine and not due to seasonal food fluctuations. Sarap (1995) found that among the households in Indian villages, the incidence of selling land increased if the response to the shock required lump sum and inelastic expenditure. Lesorogol (2005) established that in pastoral communities in Kenya, customs discourage private ownership of land as well as land sales in order to maintain pastoralism, which is the main source of livelihood. In addition, a study conducted in Lesotho, Kenya and South Africa, Drimie (2003) found that households were unwilling to sell their land to respond to household welfare threats arising out of effects of HIV/AIDS. According to the author, selling of land constitutes a drastic measure to respond to shocks as such move can potentially make it impossible for the household to benefit from land in the future and to lose family inheritance.

Several empirical studies have established the welfare effects of households that are forced into distress land sales. Swain (2007) found that landless households are less likely to obtain credit due to lack of collateral/security and that land poverty reduces the resilience of households against health-related shocks such as HIV/AIDS (Drimie, 2003). Townsend (1994) found that in Indian villages, landless households could not participate in the informal credit and insurance arrangements. Similarly in India, Morduch (1999) found that household land holding capacity determined its capacity to smooth consumption shocks. In Latin America, López and Valdés (2000) found that landless households had less per capita income compared to similar households with land, validating the notion that landlessness exacerbates poverty. These findings from the literature support the general observation that land is a resource that poor households can leverage to pursue sustainable livelihoods that are resilient from adverse effects of shocks. This include for example using the land to increase food production, collateralizing it for credit access and retaining the land to enhance household's belongingness and social capital in the community that provide social support in the event of adverse shocks. Therefore, liquidating land would seem a remote option for a utility-maximizing household.

The reviewed literature has provided a theoretical understanding of the circumstances and conditions of decision making under the environment of risk and uncertainty, the strategies of risk management including sequencing of the options. The review of empirical evidence further highlighted general determinants of coping mechanisms. Available literature also explain the circumstances under which households resort to selling farmland as a response to shocks. In the context of the literature reviewed, this study aims to test whether the circumstances postulated in the literature apply among households affected by shocks in Kenya. In addition, the study seeks to establish to which self-reported shocks accurately predict the theory of household risk coping using data on self-reported shocks from rural households in Kenya. This is a noted gap in the current literature which this study aims to fill.

While the study seeks to establish the general determinants of household decision to sell farmland as a shock-coping strategy, a special focus is on key possible determinants which include access to credit, the role of land markets, household poverty status, labour markets and institutional support systems. These determinants are highlighted because they can be influenced through policy to enhance household resilience to shocks. For example, where land markets exist, household disposal of land (and acquisition) is expectedly comparatively higher, with the attendant benefits of efficient reallocation of land as a factor of production that increases agricultural productivity (Vranken and Swinnen, 2003; Wineman and Liverpool-Tasie, 2016; Restuccia and Santaeulalia-Llopis, 2017), but also encouraging distress land sales that increase household poverty and reinforce economic and social differentiation among the rural households (Ruben and Masset, 2003)

Credit access in rural households is still relatively low, mainly because of weak formal financial infrastructure and low demand for financial services and this limits household capacity to cope with livelihood shocks (Demirguc-Kunt and Klapper, 2012). Empirical literature has established that deprivation of credit contributes to incidences of distress land sales (Deininger and Jin, 2008). In rural Morocco, Kusunose and Lybbert (2014) found that drought-stricken households without access to formal credit increased renting out of their farmlands compared to those with access. On the other hand, land constrained households were less likely to access credit because of lack of collateral (Saqib, Ahmad and Panezai, 2016; Saqib et al., 2018).

Household poverty determines both household vulnerability and response options in the sense that poor households are more susceptible to shocks and have limited resources and networks to respond to the consumption fluctuations (Fafchamps, 2003). A study of coping strategies for Kenyan agricultural households affected by health-related shocks found no relationship between household poverty and probability of selling farmland (Bonfrer and Gustafsson-Wright, 2017).

Labour markets provide households with an opportunity to diversify their income and this has been demonstrated in Kenya to reduce vulnerability to consumption variance and also provide efficient means of ex post risk coping (Christiaensen and Subbarao, 2005). However, this strategy is not effective in less-diversified economies as evidenced by Jayachandran (2006) in rural India where it was found that agriculture-based labour income for credit-constrained, less mobile poor farmers traces the sector's production fluctuations. This is because households, bereft of other consumption smoothing options, supply labour inelastically leading to a dip in the equilibrium wage (ibid).

The role of governments in provision of public goods and services and redistribution of income determine household coping mechanisms to welfare shocks. World Bank (2013) argues that governments can specifically support the contribution of household risk management by providing public health insurance, reskilling of the public for effective labour participation, provision of safety nets for the vulnerable, building public infrastructure to connect and integrate communities for trade and labour mobility, maintaining law and order, enforcing property rights and prudent macroeconomic management.

3.3   Methodology and Estimation Approach

This section presents the specific theoretical and empirical approaches and procedures used to get the results of this study.

3.3.1 Theoretical Framework/Conceptual Framework

The estimation is based on a conceptual framework showing the postulated determinants of household risk coping mechanism. According to the literature on risk coping, household response to shocks is determined by both the shock and household characteristics (Cashdan, 1985; Ellis, 1998; Dercon, 2002; Sawada, 2007; Modena and Gilbert, 2012). In addition, external factors such as the macroeconomic, societal, political, agro-ecological and cultural factors as well as the

availability of public amenities may also affect the choice of coping strategies (Adams, Cekan and Sauerborn, 1998).

As presented in figure 3.1, the household will choose a coping mechanism depending on the type, nature, frequency and intensity of the shock. For example, while idiosyncratic shocks are easily insurable within the community in which the household exists, this is not the case with covariate shocks. Additionally, household characteristics such as income, assets, access to credit and social support networks determine the capacity of households to respond to shocks. This framework conceptualizes the examination of the determinants of household choice of selling farmland to respond to shocks.
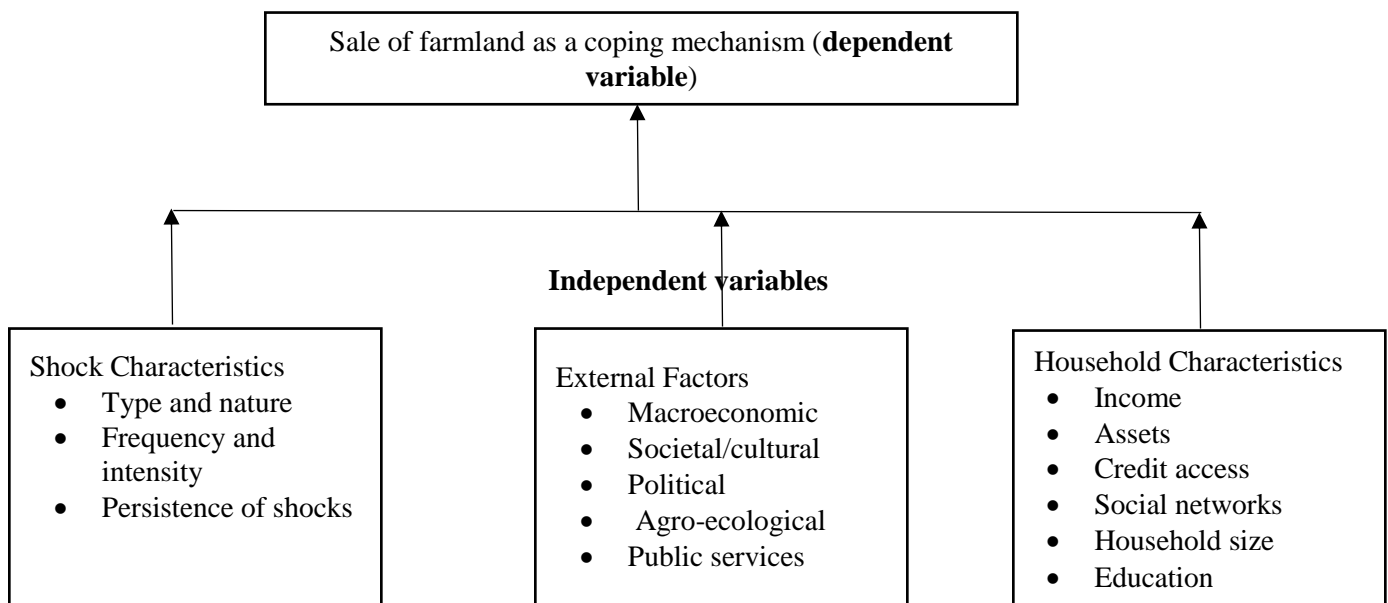
Figure 3.1: Determinants of Household Coping Mechanism to Shocks

Source: Cashdan, 1985; Adams, Cekan and Sauerborn, 1998; Ellis, 1998; Dercon, 2002; Sawada, 2007; Modena and Gilbert, 2012

3.3.2 Study Hypotheses

The empirical analysis is guided by the following hypotheses. After stating them, the empirical and theoretical grounds for the proposed hypotheses are provided;

Hypothesis 1. The likelihood of selling farmland increases in the case of idiosyncratic shocks, in shocks with high material and monetary costs, and in shocks that happened longer ago from the date of data collection.

Hypothesis 2. The likelihood of selling farmland is lower in households with more labour force, and more educated household heads. It is also lower in households with less land holding, and in households with more livestock holding.

Hypothesis 3. The likelihood of selling farmland is lower among households with access to credit facilities and access to physical infrastructural services such as an all-weather roads.

Household response to shocks is usually influenced by a mix of shock and household characteristics, as well as the environment of the household (Cashdan, 1985; Adams, Cekan and Sauerborn, 1998; Ellis, 1998; Dercon, 2002; Sawada, 2007; Modena and Gilbert, 2012).

Shocks are either idiosyncratic (meaning that only one household or few households are affected) or covariate (affect most or all households in the community). Compared to idiosyncratic shocks, covariate shocks have severer effects because of limited sharing of risks and therefore result to detrimental responses such as sale of productive assets (Porter, 2008; Günther and Harttgen, 2009). However, other studies have found that idiosyncratic shocks such as diseases are likely to require emergency and lump sum funding for treatment and therefore result into sale of productive assets, as compared to the effect of covariate shocks such as crop failure (Kenjiro, 2005). Also influencing the coping options is the severity of shocks – which is assessed in the financial and material losses households suffer due to the shocks (Tongruksawattana et al., 2013). Other studies have established that persistent shocks deplete household capacity over time leading to distress sales of productive assets (Devereux, 1993 Ruben and Masset, 2003).

Household characteristics have been found to influence response to shocks. For example, household resource endowment provide buffer against adverse effects of shocks (Yamano and Jayne, 2004; Cooper and Wheeler, 2016). The probability of distress asset sales therefore reduces with the size of resource endowments. Studies also indicate that households tend to sell small assets first (such as goats, sheep, and household items), and prefer to protect productive assets such as ploughing oxen and farmland (Devereux, 1993; Yamano and Jayne, 2004; Hoddinott, 2006). Household labour size is considered an endowment for paid work as a response to shocks (Heltberg

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and Lund, 2009; Davis, 2015; Kim, Lee and Halliday, 2018). Additionally, household education endowment had positive association with effective shock–response strategies and less of the detrimental ones (Rashid, Langworthy and Aradhyula, 2006; Berman, Quinn and Paavola, 2014). Studies have also found the motive of disposing off productive assets increasing after certain age thresholds of household heads unless there is need to inherit the assets to younger household members (Quisumbing, 1996; Browning and Crossley, 2001) while the effect of the gender of household head is mixed (Glewwe and Hall, 1998; Porter, 2012).

Besides the shocks and household characteristics, other factors influencing response to shocks are household agro-ecological, social, political and economic environment. These include access to credit services, which offers alternative opportunities to cope with shocks and therefore limit distress land sales (Deininger and Jin, 2007). Others are land ownership regimes and existence of land markets. Lesorogol (2005) found that in pastoral communities in Kenya, local level norms exist to discourage land sales in order to preserve pastoral enterprises. Although titling of land eases land transaction costs, Haugerud (1989) and Syagga (2011) found that land transactions in Kenya were done informally without the need of formal validation and are not exclusively pegged on title deed status. Access to public services such as tarred roads improves market linkages, setting up of financial infrastructure and more job opportunities, all which offer opportunities for effective coping options (Fan, Nyange and Rao, 2005; Schwarze and Zeller, 2005).

3.3.3 Estimation Strategy

Following the conceptual framework and based on the objective of the study, households affected by shocks can either resort to selling farmland or not. Therefore, the dependent variable takes a binary response. There is also a vector of independent variables, assumed to influence the outcome of the dependent variable. According to Long and Freese (2006), this relationship can be formally expressed as

$$Y_i^* = X_i\beta + \varepsilon_i \tag{3.1}$$

In equation 3.1, Y_i^* is an unobservable variable that takes value ranging $-\infty$ to ∞ . X_i is a vector of independent variables. i points out the specific observation, β represent respective coefficients and ε is random error following $\varepsilon \sim N(0,1)$. The dependent variable takes the value 0 for negative outcome and 1 for a positive outcome. In this study, $Y_i = 1$ if a household sold farmland and $Y_i = 0$ otherwise.

Long and Freese (2006) shows the link between the binary observed variable Y and the continuous unobserved variable Y^* as

$$Y_i = \begin{cases} 1 & if \ Y_i^* > 0 \\ 0 & if \ Y_i^* \leq 0 \end{cases}$$ (3.2)

Long and Freese (2006) explains that Y^* is latent indicating that there unobservable underlying motivations contributing to decisions which are observable. For a binary outcome model with single independent variable, this latency can be formally represented as;

$$Pr(Y = 1 \mid x) = Pr(Y^* > 0 \mid x)$$ (3.3)

Substituting the structural model and rearranging terms,

$$Pr(Y = 1 \mid x) = Pr(\varepsilon > -[\alpha + \beta x] \mid x)$$ (3.4)

Equation 3.4 shows that the probability of the binary outcome is influenced by the distribution of the error term ε. This distribution also influences the econometric estimation strategy for such binary outcome models. Long and Freese (2006) highlights two commonly used distributions of error term ε, both with assumed mean of 0 but one where the error term is assumed to be normal with $Var(\varepsilon) = 1$ and the other where the error term ε is assumed to be distributed logistically with $Var(\varepsilon) = \pi^2/3$, giving rise to a binary probit model and a binary logit model respectively. Borrowing from Long and Freese (2006), the models are presented in equations 3.5 and 3.6 respectively.

Binary probit model

$$\Pr(Y = 1 \mid x) = \int_{-\infty}^{\alpha+\beta x} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) dt$$ (3.5)

Binary logit model

$$\Pr(Y = 1 \mid x) = \frac{\exp(\alpha+\beta x)}{1+\exp(\alpha+\beta x)}$$ (3.6)

This study uses the logistic regression model to estimate the factors that determine whether a household sells its farmland as a coping mechanism. As stated earlier in this chapter, the probability of selling farmland after shocks is rare because rural livelihoods are mainly derived from land. Therefore, the distribution of this occurrence is likely to be skewed. The distribution

function of the estimation model is therefore expected to take a cumulative logistic distribution function because of the fat tails (Horowitz and Savin, 2001). This necessitates the use of logistic regression and not probit regression, which takes a cumulative normal distribution function.

Two logistic regression models are estimated in this study. In the first model, the probability that a shock event resulted in sale of farmland is regressed against explanatory variables such as nature of shocks (idiosyncratic versus covariate), monetary and material loss from the shocks and the period since the shock was reported. This regression will only be carried in households that reported to have resorted in distress sales of farmland. Since households reported a maximum of three shocks that had occurred within a five-year period, it is observed in the data that some shocks resulted into sale of farmland while others did not. Accordingly, the aim of this estimation is to find out the characteristics of shocks that resulted into distress sales of farmland.

The other model regresses the probability of households selling farmland following shocks against household and other general characteristics such as household size, age, gender and education status of household head; household resource endowment measured in livestock, land, income; and household characteristics such as access to credit, all-weather roads and existence of land markets and formal land ownership status. Choice of the variables used in the study models were selected based on the review of literature on household coping strategies to shocks. In addition, only the variables whose data was available were included in the estimation of the study models. For this estimation, households used came from districts and counties where cases of land sales were reported.

As stated earlier, shocks can be idiosyncratic, meaning that only one household or few households are affected. They can also be covariate importing that they affect most or all households in the community. The variable is measured by the number of households affected by the shock. Sampled households reported the number of households in their community affected by the shock in question. According to literature, compared to idiosyncratic shocks, covariate shocks affect rural households most severely and therefore likely to result to distress land sales (Günther and Harttgen, 2009). Similarly, Porter (2008) found that covariate shocks reduced household consumption but idiosyncratic shocks did not. On the other hand, Kenjiro (2005) found that households in Cambodia resorted to distress land sales when affected by idiosyncratic shocks requiring lump sum amount of money such as illness than when affected by covariate shocks such as crop failure.

The length of the shock, measured by the number of months within the previous five years to the surveys periods (2005/06 and 2015/16 respectively) was introduced into the model to assess the effect of shocks that persist for long with households. The length also measures whether the ongoing development of financial markets including mobile money transfer technology and burgeoning of social protection programmes in the country in the recent years could be offering alternative and effective coping mechanisms to shocks thus discouraging distress land sales. It is postulated that longer lasting shocks have higher likelihood of resulting into distress sales of farmland. It is also expected that shocks that happened longer ago had higher chances of resulting to distress land sales compared to those occurring in the recent past. The model also includes the loss value in both monetary and material assets lost due to the shocks. Empirical studies have supported the logical postulation that the probability of distress land sales is positive with the loss from the shock (Kenjiro, 2005).

Household characteristics in the second estimation model include the labour size, measuring the number of household potential pool of labour that can be put into paid work as a response to shocks (Heltberg and Lund, 2009). Accordingly, it is expected that the household probability of selling farmland reduces with its labour size. Age of the household head is introduced into the model to capture lifecycle effects in the household asset management (Quisumbing, 1996). Lifecycle models of asset accumulation and the motive to smooth consumption by drawing down assets indicate that the age of household may have positive effect on probability of selling farmland, ceteris paribus, but this may tempered with the effect of the motive for intergenerational transfers (Kotlikoff and Summers, 1981; Browning and Crossley, 2001). The expected sign of the age coefficient is thus undiscernible. The square of age variable, is introduced into the model to capture possible non-linear relationship between the household distress land sales decision and the age of the household head. Introduction of the squared value of the age variable also improves the fit of the estimation model used. The sex of the household head is commonly used as a control variable when determining household vulnerability and response options to shocks because of engendering access to and control of assets and resources (Blackden 1999; Jones et al., 2017). Empirical evidence on how sex of household head influences household response to shocks is mixed, with Glewwe and Hall (1998) finding no gender difference in household vulnerability while Porter (2012) finding that sex is a significant control for household vulnerability and response to shocks.

The effect of household head's sex on the household's probability for distress land sales cannot therefore be known beforehand.

Empirical studies have established that household education status determines choice of coping mechanism (Berman, Quinn and Paavola, 2015). Additionally, Rashid, Langworthy and Aradhyula (2006) established that household education status determines income source, diversity and stability and reduces likelihood of choice of ex-post coping choices such as sale of farmland. Thus households with more education will have the least likelihood of engaging in distress land sales. The effect of livestock assets on household probability to sell farmland is postulated to be negative as livestock are considered more liquid, and thus placed earlier than land in the coping continuum. Empirical studies in developing economies where livestock sales are used as coping mechanisms confirm the theoretical postulation (Hänke and Barkmann, 2017; Do, Nguyen and Grote, 2019). However, if various shocks affected the livestock, for example livestock disease or drought, then coping by selling the livestock becomes ineffective in insulating households from distress land sales. Another dimension considers that specific household asset thresholds could motivate households to choose to smooth assets and instead reduce consumption or rely on labour market participation in order to smooth consumption (McPeak, 2004; Nguyen, White and Ma, 2018).

Other factors that are likely to influence household decision to sell land in times of distress are whether the household can access credit. The dataset has a credit module from which household credit-access status can be ascertained. Credit constrained households have been found most likely to resort to distress land sales in the event of shocks (Deininger and Jin, 2008). The model also includes two variables related to land; one capturing whether households have title deed to their lands and the other records whether land markets operate in the community. Titled land is easily exchangeable in the market and potential buyers are guaranteed enforcement of their ownership rights (Alston, Libecap and Schneider, 1996). The household access to public services that may influence response mechanisms to shocks is measured in access to tarmac roads. In 2005/06 data, this is proxied by the percentage of population in particular sample area that reported easily accessing tarmacked and graveled roads while in 2015/16, it is measured by whether the households within a cluster had access to an all-weather road throughout the year. It is expected that higher percentage and positive occurrence of these access attributes results into a negative

effect on the probability of resorting to distress land sales. Access to public services such as tarred roads improves market linkages, setting up of financial infrastructure and more job opportunities, all which offer opportunities for effective coping options (Fan, Nyange and Rao, 2005; Schwarze and Zeller, 2005).

3.3.4 Data Type and Sources

This study uses data from the Kenya Integrated Household Budget Survey (KIHBS), collected by the Central Bureau of Statistics, now Kenya National Bureau of Statistics (KNBS). The collection was done countrywide and for a period of 12 months between 2005 and 2006. Since the data was collected for a period of a year, it covered all the possible seasons. The study was conducted amongst 1,343 randomly selected primary sampling units called clusters, of which 861 were rural and 482 urban. The clusters are obtained from a nationally representative sampling frame known as National Sample Survey and Evaluation Programme IV (NASSEP IV), which is designed to produce representative surveys both at the national and sub-national levels (Republic of Kenya, 2007). In each cluster, a random sample of 10 households was selected with uniform chance in each cluster, giving a sample size of 13,430 households. Of these households, 8,610 were rural based while 4,820 were from urban areas. Out of 25,490 shocks reported by 11,016 households, 231 resulted into sale of farmland.

In the shocks module, households were asked if they were affected severely by shocks in the period of five years to the date of survey. The shocks were ranked in terms of severity and financial loss estimated for those which resulted into lost value. The module additionally provides information on when the shocks occurred and whether the shock was idiosyncratic or covariate. Finally, household coping strategies are provided. The information in the shock module and other modules is thus appropriate for the analysis proposed in this study.

To enrich the analysis, the study also used another KIHBS wave collected in the 2015-2016 period, also covering a 12 month period. The sample for this wave was drawn from the fifth National Sample Survey and Evaluation Programme V (NASSEP V) household sampling frame. Republic of Kenya (2018) reports that sampling was multistage in which 2,400 clusters (consisting of 988 in urban and 1,412 in rural areas) were first sampled from the NASSEP V. In the second stage, 16 households from each of the clusters sampled in stage one were selected, which later, in the third

stage, gave 10 households for the KIHBS, totaling into 24,000 households. The number of households in the 2015/16 dropped from 24,000 to 21,773 after data cleaning. From these households, 27,531 shocks were reported, out of which 108 resulted into sale of farmland as a coping strategy.

The 2005/06 and 2015/16 KIHBS datasets are comparable on variables for household specific information as well as shocks which makes pooling the two cross-sectionals into one dataset feasible. However the pooled cross-sectional dataset lacks key control variables contained in modules that either differ or have not been fully processed and shared to the public. These variables are contained in livestock, agriculture holding and access to public services. In developing countries where panel data is rare, pooled cross-sectional data are second best for analyzing household welfare dynamics (Dang and Carletto, 2018). In addition, pooling confers unique advantages such as isolating effects of specific public policies (Wooldridge, 2010) as well as increasing heterogeneity and degrees of freedom in samples since each cross section draws different observations (Hicks 1994).

3.4   Estimation, Results and Discussion

This section presents results of various data analyses conducted. After the exploratory analysis of the data, a bivariate analysis is conducted for the datasets.

3.4.1   Descriptive Statistics

In order to understand the results better, summary statistics of the key variables used in the models estimation are computed and presented.

Table 3.3: Characteristics of shocks that led to distress sales of farmland

Variables	2005/06			2015/16		
	Mean	Std.Dev.	N	Mean	Std.Dev.	N
Nature of shock (idiosyncratic=1)	0.723	-	231	0.642	-	106
Estimated loss from shock (KES)	55,890	250,549	231	184,646	514,843	79
Months since shock occurred(No)	33.4	17.8	231	31.8	15.49	108

As indicated in table 3.3, 72.3 percent of the shocks reported by households that sold farmland in 2005/06 were idiosyncratic. This is greater than in the whole 2005/06 sample where 56.6 percent

of reported shocks were idiosyncratic. In 2015/16, the fraction of idiosyncratic shocks reported by households that sold farmland reduced, compared to 2005/06. In addition, compared to 2005/06, shocks reported by households that sold farmland in 2015/16 did not last longer (mean period of 31.8 months compared to 33.4 months in 2005/06). Finally, the estimated mean value lost due to the adverse effects of shocks was higher in 2015/16 compared to 2005/06, even after factoring the time value of money. In 2005/06, this value was found to be more for shocks that resulted into distress sales of farmland (KES. 55,890) compared to the whole sample with a mean value loss of KES. 27,098. This was different in the 2015/16 data where all shocks had a mean loss of KES. 480,549 from shocks, which was higher than among the shocks which resulted into distress sales of farmland.

Table 3.4: Characteristics of households (in districts and counties where land was sold)

Variables	2005/06			2015/16		
	Mean	Std.Dev.	N	Mean	Std.Dev.	N
Household labour force	2.6	1.6	10,610	1.8	1.2	13,571
Age of household head	44.5	15.7	10,885	44.8	16.1	13,553
Sex of household head (Male = 1)	0.71	-	10,885	0.67	-	13,571
Land size (acre)	2.2	16.8	6,823			
Title deed (has title =1)	0.39	-	5,427			
Land markets (exist=1)	0.75	-	6,823			
Livestock value (KES)	27,054	101,284	9,671			
Credit (has access=1)	0.29	-	10,596	0.35	-	13,571
Access to all-weather road (% of population with access)	18.7	-	10,894			
All-weather road in cluster (1=yes)				0.73	-	13,552
Used social safety networks to respond to shocks (1=used)	0.48	-	8,971	0.28	-	9,067

The mean number of household members participating in labour was lower in 2015/16 compared to 2005/06 and this reflects the drop in mean household size (by one person) in the period between the two surveys. In the sampled districts, the mean age of rural household heads was marginally higher in 2015/16 while there was an increase in the number of females heading households between the two study periods, indicating a possible ongoing transformation in the Kenyan households possibly related to women empowerment (more women are heading their households compared in 2005/06). Households with access to various credit facilities increased from 29 percent to 35 percent in the samples between the two study periods. This increase indicates a possible increase in the supply and demand for credit in for previously-marginalized households

between 2005/06 and 2015/16. The mean number of households that used social support networks to cope with shocks reduced by almost half between the two study periods. Such as significant reduction in the reliance of social networks could have resulted due to possible measurement errors in the data or could imply an increase over time of alternative options to cope with shocks.

Data on land ownership and markets was only available in the 2005/06 survey because the respective questionnaire modules in 2015/16 KIHBS had not been processed by the time of this study. The available data show only 40 percent of sampled households owning title deeds, as well as show high percentage of households reporting presence of land markets (75 percent) in their communities. This finding indicates the existence of alternative land transactions not necessarily pegged on ownership of title deeds on land.

Distribution of shocks that resulted into sale of farmland

Consistent with literature that sale of productive assets such as farmland is undesirable both at the household and public policy level, both datasets indicate limited disposal of farmland as a coping mechanism. In 2005, the shocks resulted into 231 instances of distress land sales while in 2015 cases of distress land sales were lower at 108.

The analysis provided in table 3.4 indicates that households were more likely to sell their farmlands if affected by health shocks that include diseases and deaths (44 percent and 26 percent in 2005/06 and 2015/16 respectively of the shocks causing sale of farmland were health related). Health shocks such as diseases and accidents may require disproportionately huge financial resources and usually without sufficient lead time to seek help from the informal insurance systems or support from community networks (Kawabata, Xu and Carrin, 2002; Kenjiro, 2005). Other significant drivers of distress land sales were climatic shocks and disasters, mostly drought, floods and severe water shortages as well as agricultural production and marketing shocks – which include fluctuations in agricultural input and output prices, crop and animal diseases. What is categorized as economic are those shocks that reduce household's purchasing power, specifically food price inflation, end of welfare assistance or aid, business failure or job losses. Social shocks refer to those that disrupt the social fabric or are as a result of breakdown of societal norms and include break-up of household, jailing of productive household members, conflict and violence that negatively affect household welfare.

Table 3.5: Distribution of shocks that resulted into sale of farmland

Shock	Number and percentage of occurrence			
	2005/2006		2015/2016	
Health shocks	102	(44%)	28	(26%)
Climatic shocks and disasters	45	(19%)	14	(13%)
Agricultural production and marketing shocks	27	(12%)	24	(22%)
Economic shocks	25	(11%)	13	(12%)
Social shocks	23	(10%)	10	(9%)
Others	9	(4%)	19[3]	(18%)
Total	231		108	

An assessment was done of the data on the districts (2005/06) and counties (2015/16) to determine whether households in pastoralist districts and counties participated in distress land sales. Using the 2005/06 data, it was found that in Thika, Maragua, Lamu, Mombasa, Tana River, Marsabit, Garissa, Wajir, Narok, Samburu, Turkana, Buret and Busia districts, no household participated in distress sales of land. Of these districts, Garissa, Wajir, Narok, Samburu, Turkana and parts of Tana River are inhabited mainly by pastoralists and land is mainly communally held. Using 2015/16 data, the following counties did not report any distress land sales: Mombasa, Kwale, Tana River, Garissa, Mandera, Marsabit, Isiolo, Kitui, Nyandarua, Kirinyaga, Kiambu, Turkana, Trans Nzoia, Nakuru, Vihiga, Siaya, Homa Bay, Nairobi City. Of these areas, Tana River, Garissa, Mandera, Marsabit, Isiolo and Turkana counties are predominantly pastoralist. So while it is plausible that pastoralist households were least likely to sell farmland because of communal land holding, in some other districts/counties where land is not communally held and land markets exist, distress land sales were not reported, but because of other reasons. In addition, cases of land sales were found in households in predominantly pastoralist areas such as Kajiado, Samburu and Narok (in 2015/16).

3.4.2 Bivariate Analysis

After conducting descriptive analysis of the possible determining variables of distress land sales, a bivariate analysis of each predictor variable with the dependent variable was implemented. The analysis was done to determine whether there was a relationship between the dependent variable and the proposed independent variable, separately. A chi square statistic was calculated between the dependent variable and categorical independent variables while a simple linear logistic

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[3] The 2015/16 shocks module did not contain option for disease and illness in the list of shocks. this explains why the category of 'Others' has higher frequency and it is expected that it contains responses on disease and illness.

regression was conducted on the continuous independent variables before testing the explanatory continuous variable and reporting the resulting chi square values. The results are presented in table 3.6.

For the 2005 data, a statistically significant empirical relationship was found between household distress sales of farmland and idiosyncratic shocks, magnitude of financial and asset losses due to shocks, length of time since the occurrence of shocks. Household characteristics found to have significant relationship with likelihood of engaging in distress sales of farmland were varied in the three estimation models, with differences noted in household labour size, education qualification of household head and use of social safety networks as a coping option to shocks. Age of the household head and access to all-weather roads were significant in all three models, while access to credit services was not significant across the three models. In 2005/06 model, existence of land markets was found to be statistically significant.

Table 3.6: Bivariate analysis of the factors associated with the probability of selling farmland as a coping strategy to shocks

Variable	2005/2006	2015/2016	Pooled (2005/06 and 2015/16)
Shock Characteristics			
Nature of shocks (Idiosyncratic, Covariate)	6.408**	3.459*	9.25***
Reduction caused by shock (Income loss, Asset loss, Loss of both, Neither loss)	23.19***	20.58***	42.20***
Financial loss from shock	4.68**	3.56*	7.07***
Number of months since shock occurred	5.38**	12.96***	13.84***
Household Characteristics			
Household labor size	6.00**	2.00	19.85***
Age of household head	13.60***	14.14***	25.49***
Age squared (of household head)	9.49***	14.03***	20.62***
Sex of household head (Male = 1)	0.256	0.837	0.595
Education level of household head (None, Primary, Secondary, Tertiary)	9.67**	2.10	8.17**
Household land holding (acres)	0.02		
Land markets exist (Yes=1)	7.00***		
Household land has title deed (Yes, No)	0.222		
Value of livestock owned by household (KES)	0.01		
Household access to credit (Yes, No)	0.328	0.653	0.306
Proportion of households with access to all-weather road	6.94***		
All-weather road in cluster (1=yes)		3.39*	
Used social safety networks to respond to shocks (1=used)	0.957	8.80***	13.55***
2015/06 (2005/16 is reference year=0)			42.19***

***, **, *: indicate significant at 1%, 5% and 10% respectively.

3.4.3 Regression Diagnostics

Before interpreting results of the listed estimation procedures, each regression model was tested in order to validate the specific assumptions required for unbiased coefficients that can be relied upon to make statistical inferences. First, model specification tests revealed that logistic regression model was best suited for this study's estimation. A statistically significant log likelihood chi square value of the estimated model validates the assumption that the estimated model has a relatively good fit for the data. Collinearity of the independent variables was also ruled out in the model as any seriously collinear variable would have been dropped from the regression estimation. Some predictor variables including household livestock value, land size and percentage distribution of households with access to all-weather roads were found to have wide variations in the observations and were transformed by taking their respective logarithms to correct for the dispersion in observations. Finally, a test of heteroscedasticity following the procedure recommended by Wooldridge (2010) found that the error terms of the independent variables have constant variance. The absence of significant dispersion in the variance of predictor variables could be attributed to the prior transformation into logarithm forms.

3.4.4 Model Estimation Results and Discussion

As indicated earlier, this study seeks to test the hypotheses that specific shock and household characteristics predispose households to participate in distress sales of farmland. Accordingly, two logistic regression models were fitted and the respective estimation results, described in marginal effects, presented in tables 3.7 and 3.8. Marginal effects provide the likelihood of selling farmland given a change in the hypothesized variables, while holding the other independent variables at their means.

Estimation results of how characteristics of shocks influenced household decision to sell farmland are presented in table 3.7. The coefficient of nature of shocks was statistically significant in 2005/06 and pooled data. This indicates that idiosyncratic shocks (such as diseases, accidents, death of breadwinners and loss of employment) were more likely to cause households to sell farmland as a coping mechanism, compared to covariate shocks such as droughts, floods, food price inflation, poor prices of agricultural produce and crop and animal diseases. The coefficients of financial and asset losses due to shocks were found to be statistically significant in both survey periods and pooled data and indicates an increasing probability of distress sales of farmland with

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increasing losses. Also significant across all estimation models is the coefficient of time lapse since the shock occurred and time of reporting, with the probability of distress sales increasing with the length of this time lapse. The coefficient of the nature of shocks (idiosyncratic or covariate) was found not to be significant in the 2015/16 data. Also not significant is the coefficient of the effect of time difference (between the two survey periods) on the probability of households selling farmland after being adversely affected by shocks.

Table 3.7: Shock characteristics influencing household decision to sell farmland as a coping mechanism (marginal effects)

	2005/06	2015/16	Pooled (2005/06 and 2015/16)
Nature of shock (idiosyncratic shocks=1)	0.1094* (0.0571)	0.0517 (0.0827)	0.0931** (0.0466)
Financial loss from the shock	0.0688*** (0.0203)	0.0642*** (0.0242)	0.0680*** (0.0154)
Shock caused reduction in: (income loss is reference category)			
Asset loss	0.0809 (0.0711)	0.1781 (0.1261)	0.1039* (0.0614)
Both asset and income loss	0.1846*** (0.0645)	0.2393*** (0.0845)	0.2017*** (0.0513)
Number of months since shock occurred	0.0029* (0.0015)	0.0058** (0.0027)	0.0036*** (0.0013)
2015/16 (2005/06 is reference period)			-0.0162 (0.0500)
Number of observations (N)	378	177	555
Pseudo R-squared	0.0900	0.1150	0.0956
F-value	46.59***	27.93***	72.67***

Standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

Table 3.8 presents the marginal effects of household characteristics determining household decision to participate in distress sales of farmland. The three estimations produced mixed results. In the 2005/06 model, the decision of households to participate in distress sales of farmland was found to be significantly influenced by the following variables: education (households headed by individuals with tertiary level of education were less likely to participate in distress sales of farmland compared to households headed by those without formal education). The results indicate that the probability of selling increased with household land size and in areas where land markets existed by 2.1 percent, holding all other variables at their respective means. On the other hand, the

probability of distress sales was found to reduce in household livestock wealth as well as in households where majority had access to all-weather roads, holding all other variables at their respective means. The marginal effects of age were almost zero, indicating that age was not a determinant of distress land sales among the sampled households. The coefficient of age was consequently not discussed further or used in policy inference.

The estimation model using 2015/16 data has lesser likelihood in explaining the household characteristics that influence household decision to sell farmland after experiencing shocks. Compared to the 2005/06 model, the 2015/16 model had fewer variables due to unavailability of the comparable data. It was found that households in clusters with access to all-weather road were less likely to sell farmland due to shocks. On the other hand, households that used social safety systems (such as sending children to live with relatives, and other assistance from relatives, government and non-governmental institutions) to respond to shocks were also found to be most likely to participate in distress sales of farmland. Specifically, such households increased their probability of engaging in distress land sales by 0.32 percent, holding all other variables at their respective means. In this model, household characteristics such as labour size; age, gender and education status of household head; and access to credit did not have statistically significant relationship with household decision to sell farmland due to shocks.

A model with pooled 2005/06 and 2015/16 data was also estimated and contained only the variables with comparable data in the two surveys. Estimation results revealed that the probability of selling farmland due to shocks increased with the age of the household head (up to a certain level, then starts decreasing). The probability was also high among households that depended more on social safety nets to deal with shocks. On the other hand, the probability of selling farmland was lower for households headed by those with secondary level of education compared to households headed by those without formal education. Estimating with pooled data also revealed that passage of time (between 2005 and 2016) had a statistically significant effect in reducing the probability of households engaging in distress sales of farmland due to shocks.

Table 3.8: Household and general characteristics influencing decision to sell farmland as a coping mechanism (marginal effects)

	2005/06	2015/16	Pooled (2005/06 and 2015/16)
Household labour size	0.0001	0.0005	0.0002
	(.0015)	(0.0008)	(0.0006)
Age of household head	0.0048***	0.0003	0.0012***
	(0.0015)	(0.0004)	(0.0004)
Age of household head squared	-0.00004***	-8.51e-07	-9.66e-06**
	(0.00002)	(3.70e-06)	(3.78e-06)
Sex of household head (Male=1)	-0.0015	-0.0004	0.0012
	(0.0063)	(0.0023)	(0.0021)
Education of household head ('no formal education' is reference category)			
Primary	-0.0006	-0.0015	-0.0025
	(0.0067)	(0.0024)	(0.0023)
Secondary	0.0019	0.0022	-0.0046*
	(0.0088)	(0.0034)	(0.0026)
Tertiary	-0.0164**	0.0026	-0.0046
	(0.0073)	(0.0040)	(0.0029)
Log of household land size (Acres)	0.0061**		
	(0.0028)		
Land markets exist (Yes=1)	0.0211**		
	(0.0090)		
Land has a title deed (Yes=1)	-0.0020		
	(0.0058)		
Log of household livestock value	-0.0029*		
	(0.0017)		
Household access to credit (Yes=1)	-0.0051	-0.0029	-0.0006
	(0.0057)	(0.0022)	(0.0019)
Log of households with access to all-weather road	-0.0044*		
	(0.0025)		
All-weather road in cluster (1=yes)		-0.0047**	
		(0.0021)	
Used social safety networks to respond to shocks (1=used)	0.0014	0.0036*	0.0032*
	(0.0055)	(0.0021)	(0.0018)
2015/06 (2005/16 is reference year)			-0.0096***
			(0.0019)
Number of observations (N)	2,635	7,508	14,368
Pseudo R-squared	0.0483	0.0275	0.0295
F-value	34.62***	24.07***	69.01***

Standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

Discussion

This study sought to find out the circumstances under which households sold farmland as a response to shocks. Among the households that reported selling farmland, the characteristics of the shocks that led to the actual sale of farmland were assessed. It was found that idiosyncratic shocks were more likely to lead to distress sale of farmland compared to covariate shocks. The finding that household-specific shocks were more likely to be associated with distress land sales indicates a rejection of the efficient risk sharing for idiosyncratic shocks in the sampled communities (Townsend, 1994; Fefchamps and Lund, 2003). This implies that rural communities in the sampled areas have weak risk sharing systems. It could also imply that the idiosyncratic shocks such as illnesses had severe consequences that could not be covered under the existing risk sharing infrastructure. This left households with limited coping options and thus contributed to distress sales of farmland. Such observation are confirmed in the existing literature (see for example Kenjiro, 2005; Heltberg and Lund, 2009).

That the probability of selling farmland increased with the increase in both monetary (or income) and material (or assets) loss from the shocks, indicates that extreme shocks, with huge losses are most likely to lead to destitution since households are forced to liquidate productive assets such as farmland in order to cope. This indicates that intense shocks such as health calamities were more likely to lead to distress land sales, mainly because their mitigation required prompt financial requirements to cater for lump-sum payments needed within short lead times (Kenjiro, 2005; Yilma et al., 2014).

The positive and statistically significant association found between the length of time since a shock was reported and the probability of selling farmland could imply that the shocks lasted longer, or its effects persisted longer after the shocks. The shocks might have severe impact and thus easily remembered by the household. All these situations reasonably explain the positive association with distress sales of farmland. This could be supported by the theory and empirical findings that households chose coping strategies in a continuum – meaning that coping strategies deemed to have high opportunity cost and less liquidity (such as selling farmland) are last in the continuum and are only chosen if the shocks have persisted despite earlier strategies to mitigate their adverse effects (Devereux, 1993; Quisumbing, 1996; Fafchamps and Lund, 2003; Ruben and Masset, 2003; Kenjiro, 2005).

Further assessed were the characteristics of households that sold farmland. For this assessment, the estimation used the sample of households in districts (in 2005/06 KIHBS) and counties (in 2015/16 KIHBS) where cases of land sales were reported. The Kenyan data supports the hypothesis that households with highly educated heads were less likely to sell farmland when hit by shocks. According to Rashid, Langworthy and Aradhyula (2006) as well as Berman, Quinn and Paavola (2015), education – as a measure of human capital – predisposes households to higher, stable and diversified incomes which consequently build resilience to shocks and prevent distress sales of productive assets such as farmland. The finding that distress land sales was higher in households with more acreage is consistent with the basic principle that more endowment increases land supply at the market. However, since these are distress sales, it implies household vulnerability to shocks, and absence of risk sharing markets to mitigate the adverse effects of shocks (Deininger and Jin, 2008). This study finds that existence of land markets aids distress sales of farmland. Land markets operate in most parts of Kenya, except in pastoral communities where land is communally held (Lesorogol, 2005). In jurisdictions where land sales are prohibited, households could rely on non-market coping strategies such as social safety nets and support (Carter et al., 2007). This study's data supports this proposition with the finding that the use of social safety networks was marginally higher in districts and counties where land sales did not exist.

The estimation results further indicate that in the sampled areas, the likelihood of selling farmland reduced with the value of household livestock wealth. Such finding confirms the study's hypothesis and implies that ownership of easy-to-sell assets such as livestock reduces the likelihood of disposing off of productive assets such as farmland which compromises household future livelihoods. The existing literature indicate that households prefer sequencing interventions to shocks according to associated costs of each intervention, and in such regard, selling of farmland is mostly adopted as last resort (Devereux, 1993; Janzen and Carter, 2019). The other significant finding of the study was the inverse relationship between household access to public services such as all-weather roads and the probability of distress land sales in both the estimation models using 2005/06 and 2015/16 KIHBS. This finding validates the theory and empirical studies that access to public services encourages income diversification, increases opportunities for trade and integration of community livelihoods into the mainstream transaction macro-economy which increases household resilience to shocks (Christiaensen and Subbarao, 2005).

The relationship between the use of social support systems for coping with shocks and distress sales of farmland was found to be positive and statistically significant in the models using the 2015/16 and pooled data. This study had hypothesized that availability and use of social support systems reduces the likelihood of distress sales of productive assets. However, the findings of this study indicate that the households likely to be supported by social safety systems were also the most likely to end up disposing off their productive assets such as farmland. This could indicate that the existing structure of social support is not adequate in shielding households from the adverse effects of shocks (Del Ninno and Mills, 2015). However, this does not negate the critical role played by social support systems in helping households protect their assets from adverse effects of shocks (De Janvry et al., 2006).

The passage of time between 2005/06 and 2015/16 was found to have worked to reduce the instances of distress sales of farmland among the rural Kenyan households. The data and estimation results indicate that fewer households in 2015/16 compared to 2005/06 were resorting to selling farmland as a coping option to livelihood shocks. These findings could indicate that the economic growth and development in Kenya in the 10 year period between the surveys had increased effective options for coping with shocks among the rural households. This could be through infrastructure development, growth of social support systems, mobile money transfer systems and reduction in poverty. Indeed, between the two study periods, poverty among Kenyan households reduced from 46.8 percent to 36.1 percent (Awiti et al., 2018).

The study found no significant association between the gender of household head and the probability to engage in distress sales of farmland. It therefore implies that in the Kenyan context, the gender of the household head was inconsequential in the probability of choosing ineffective coping mechanisms to shocks (Glewwe and Hall, 1998). Ownership of title deeds were found not to be statistically significant in influencing household decision to sell farmland to cope with shocks, possibly because land transactions in Kenya such as renting, leasing and buying are done informally without the need of formal validation and are not exclusively pegged on the title deed status (Haugerud, 1989; Syagga, 2011). Although an inverse relationship was found between household access to credit facilities and likelihood of distress sales of farmland, the association was also not statistically significant at 10 percent level of confidence. These findings are contrary to the existing literature that highlights the role of credit facilities in aiding vulnerable households

protect their assets and effectively cope with adverse effects of shocks (Morduch, 1998; Beegle, Dehejia and Gatti, 2006; Guarcello, Mealli and Rosati, 2010; Harvey et al., 2014). The insignificance of the coefficients could therefore be attributed to measurement issues in the data. The coefficient of household labour size was also found not to be statistically significant at 10 percent in all the three estimated models. This finding is contrary to the study's hypothesis that more labour force provide households with opportunities for income diversification which subsequently provides adversely affected households with more effective means of coping with shocks (Christiaensen and Subbarao, 2005). The non-significance of the labour force coefficient could imply that the economies are less diversified and therefore more household labour pool does not provide any advantage as the labour demand in those communities could be inelastic (Jayachandran, 2006).

3.5 Summary, Conclusions and Policy Recommendations

Households in developing countries continuously face variety of risks to their livelihoods which have been found to cause considerable welfare loss. How households cope is important because it can determine whether households are able to restore their welfare to pre-shock status or whether the adverse effects of shocks reduce household resource base, weaken its resilience, and increase vulnerability of falling into deeper poverty.

Households still use ineffective coping mechanisms despite them being undesirable and potentially contributing to worse welfare outcomes in the current and subsequent periods. One such coping mechanism is distress sales of farmland. Selling of farmland potentially reduces household future productive capacity considering that most of rural economic activities are based on the land as the primary factor for production.

This study sought to answer the following questions: What are the shocks and household characteristics that would determine a household, faced with risk(s) to choose disposing off of the available productive assets? This question motivates the objective of this study which is to analyze the determinants of household choice of sale of land as a response mechanism to shocks. There are limited studies on the circumstances that predispose households to adopt selling of farmland as a coping mechanism. This study intends to fill this gap by establishing the determinants of

selling farmland as a coping mechanism using a nationally representative data from Kenya. Analysis of current data showed that shocks are still prevalent among households in the country and the environment not robust for building resilience to the shocks, a situation that contributes to poverty. Detailed literature review was done to identify the gaps in understanding household coping mechanisms and situating the context of this study. A logistic regression model was applied to the data after conducting rigorous diagnostic tests to ensure that the estimated coefficients are reliable for interpretation and policy inference.

Various shocks and household characteristics and the households' social and physical environment were found to determine household probability to resort to distress land sales. Some useful policy recommendations are therefore suggested in this study based on the results. Education was found to reduce the household probability for distress land sales. However, this effect only counted if one had skills that can be traded in the labour market. These findings imply that education in the country should emphasize on skills acquisition that can translate into gainful employment in order to shield households from vagaries of subsistence livelihoods in rural areas as well as under-employment in urban areas.

The finding that the coefficient of access to credit was not statistically significant against compelling evidence from literature on the role of credit in household welfare could indicate that the existing credit system in the country is ineffective in mitigating household vulnerability to shocks. Indeed, most of the available credit facilities in rural areas are the informal savings and borrowing arrangements common in rural areas of the country and less of savings provided by banks, insurance companies and other formal financial mediation and access infrastructure. The informal saving systems are only limited to less severe shocks as the study found that idiosyncratic shocks such as diseases were not insurable using the existing informal insurance and saving schemes and households succumbed to distress land sales when inflicted by them. The policy implication for this is that the government should continue pursuing financial integration of rural households in order to provide them with opportunities to hedge risk through solutions such as health insurance, weather index-based insurance, savings and loan facilities.

The study also found that ownership of livestock was associated with less likelihood of engaging in distress sales of farmland. This finding is consistent with literature that livestock act as a buffer against selling more significant assets such as farmland. The policy implication of this finding is

for the government to provide conducive environment for rural households to engage productively in animal husbandry. Livestock such as goats, sheep and cattle provide critical lifelines to rural households especially those in arid and semi-arid areas. Conducive policy environment for livestock production that need to be pursued include protection of animal diseases and pests, livestock feeds and nutrition, livestock marketing and research and extension services.

Finally, the study found that physical infrastructure facilities such as all-weather roads were significantly associated with lower probability for distress land sales. This finding confirms other empirical works that have demonstrated that public services such as roads enhance livelihood diversification, enhance trade among communities and are precursors to establishment of financial infrastructure such as banks, insurance companies and social amenities such as hospitals and schools. All these facilities compound to lessen the probability of ineffective coping mechanisms such as sale of farmland. Given this finding, it is imperative that public policy should focus on building physical infrastructure as a strategy for reducing vulnerability to shocks for the physically isolated communities in the country.

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Chapter Four   Infrastructure Growth, Household Vulnerability and Response to Shocks in Kenya

4.1   Introduction

Households in the rural areas of developing countries have to deal with the near-constant adverse effects of income shocks that potentially threaten their livelihoods. Because the livelihoods are dependent on the existing natural climatic environment, they are thus most likely prone to shocks emanating from natural calamities such as droughts, floods, earthquakes and landslides; agricultural shocks such as crop diseases and pests, loss of livestock to diseases and theft. In addition, the remoteness of rural settlements from the main infrastructural networks and facilities (for example roads, telephony networks, markets and health facilities) exposes households to shocks such as low prices of agricultural outputs, higher prices for food and other basic commodities and higher incidence of adverse effects of diseases and illnesses (Harvey et al., 2014). Also, because of the inherent weak systems for resilience, subsequent shocks usually compound household vulnerability with the ultimate consequence of expanding and entrenching rural poverty.

Since households prefer smooth consumption across states of nature, they are naturally inclined to use various coping mechanisms to secure stable consumption paths (Deaton, 1992). Also, externally, relatives and friends, donor organizations and governments usually make transfers to the shock-afflicted households out of altruism or due to socially-binding obligations and reciprocity, institutional mandates and constitutional requirements, as in the case of governments. Indeed, empirical evidence point to near-perfect household consumption smoothing in developed economies and a generally lesser consumption variations among households in low-income economies (Paxson, 1993; Dynarski et al., 1997; Kochar, 1999; Godoy et al., 2007). To protect consumption from livelihood shocks ex-post, households use a variety of response mechanisms such as liquidating assets, selling labour, seeking assistance from relatives, friends, institutional well-wishers and government. There are also instances in which consumption reduction or alteration is used as a coping mechanism depending on the nature of shocks experienced (McPeak, 2004; Moniruzzaman, 2019).

Food security shocks refer to the adverse effects and circumstances in livelihoods and systems that contribute to inadequate food consumption at the household level (Maxwell and Slater, 2003).

Shocks most likely to cause food inadequacy at the household level range from the natural-climatic ones such as droughts, floods, crop and livestock diseases and pests to those due to market dynamics and policy environment such as food and agricultural inputs price inflation. Droughts, floods, diseases, pests and farm-input price inflation diminish farm supply of food while food price spikes make it unaffordable at the market. Kenyan households, both in the rural and urban areas constantly face food insecurity due to frequent droughts in the country's ASALs, frequent price inflation of the major staples and persistent below-average domestic food production as well as limited distribution networks between food-surplus and food-deficit zones (Orindi, Nyong and Herrero, 2008; Gathiaka and Muriithi, 2017). In the decade between 2005/06 and 2015/16, the country experienced five droughts ((Mbogo, Inganga and Maina, 2014; Uhe et al., 2018). Food prices for important staples increase in times of drought and a particular spike was noted in the 2008/2009, 2010/11 and 2012 periods (Nzuma, 2013; Kelbert and Chisholm, 2014). Generally, the production and supply shocks have contributed to overall food deficit in the country, with the country relying on exports to bridge the domestic production and consumption variance (Welborn, 2018). The reliance on food importation exposes the country to international food price fluctuations which disproportionately adversely affect the poor households. Evidence indicates that food inadequacy is both a consequence of and contributor to poverty (Cook and Frank, 2008). Resource-constrained households and those with limited purchasing power are most likely to experience food shortages. On the other hand, the malnutrition and poor-health effects of inadequate food diminish the human development potential of food-insecure households, ultimately contributing to poverty.

Physical infrastructure promotes the advancement and betterment of the human welfare through increasing factor productivity; contributing to better social outcomes such as education, health, equality and justice; stimulating further growth through innovation, connecting local and international markets and promoting social ties and growth of social capital (Ndulu, 2006; Stern and Dillman, 2006; Calderón and Servén, 2010). The growth of different components of physical infrastructure such as energy, telecommunications and water and sanitation have been empirically found to have positive impact on per capita gross domestic product (GDP) growth especially in low-income countries with low physical infrastructure stocks (Imran and Niazi, 2011). Historically, African economies have underperformed in the provision of basic public physical infrastructure, with non-contracting of the demand-supply gaps. The reduction in public budget

going to infrastructure development in the 1980s and 1990s significantly contributed to the current supply-demand shortfall and while public investment in the sector has improved starting the decade of 2000s, it is estimated that the continent still needs $130–$170 billion a year to build the necessary stocks of physical infrastructure (African Development Bank, 2018).

Kenya's stock of physical infrastructure increased significantly in the period of the last decade and half owing to sustained increase in public spending on the sector. This expansion in the country's physical assets can be demonstrated by the changes in gross fixed capital formation, which expanded by a factor of five in the period between 2005 and 2015 (Republic of Kenya, various years, a). However, like other developing countries in sub-Saharan Africa (SSA), there still exists major gaps in infrastructure needs that impact negatively on the country's economic growth and the welfare of its citizens. These gaps become clearer when specific dimensions of physical infrastructure are considered. For instance, while the country's electric power per capita consumption increased by 28 percent to 166.7 kilowatt/hours between 2005 and 2014, it is still below the world average that stood at the same period at 3,127.5 kilowatt/hours and SSA countries' average at 480 kilowatt/hours (World Bank, 2019). Regarding road infrastructure, the country has a network of 177,800 kilometres, although only 63,575 km is classified and five percent (9,273 kilometres) paved (Republic of Kenya, 2019c). The roads authority estimates that only 70 percent of the classified roads is in good condition and motorable. Access to piped water is concentrated in urban areas (69.4 percent of households compared to 24.8 percent of rural households) (Republic of Kenya, 2018a). The country has low stocks of irrigation infrastructure that are necessary to support non-rain dependent crop production. In 2011, the total value of imports of commonly used irrigation equipment in the country represented only one percent of the total imports (Mendes and Paglietti, 2015; Republic of Kenya, various years, a). Communications infrastructure contributes significantly to the growth of economies and transformation of human lives. Like other countries in Africa, Kenya has experienced four-fold growth in the information communications technology (ICT) infrastructure, powered largely by mobile telephony and broadband internet connections (Republic of Kenya, various years, a). This has spurned related auxiliary innovations such as mobile-telephone based money transfer services that have also embedded assorted financial services to previously financially-excluded sections of the population.

It is no doubt that the quality of life is significantly depended on the state of local infrastructure. This connection is first through the physical infrastructure contributing to the overall GDP growth through opening of markets, reducing production costs, promoting innovations and technology transfers. Secondly, the public stocks of physical infrastructure increase accessibility to health care, education, arbitration, justice and enforcement of contracts, all which contribute to economic empowerment and poverty alleviation. Cumulatively, these interventions have a positive bearing on the improvement of human development indicators such as health, life expectancy at birth, literacy, equality, happiness and justice (Aschauer, 1990).

While infrastructure access provides the foundations and opportunities for socio-economic and political advancement of human societies, shocks on the other hand, disrupt and hamper this progress. The documented evidence generally aver that livelihood risks due to shocks are predominantly a phenomenon of developing countries and especially rural areas (Heltberg, Oviedo and Talukdar, 2015; De Silva and Kawasaki, 2018). People in these areas are most exposed and vulnerable to commonly occurring health and economic shocks and risks from natural and climatic disasters. The exposure is prevalent due to limited diversification of economic activities, leaving households dependent only on agriculture and other forms of primary production which are prone to droughts, floods, earthquakes, tsunamis and other forms of weather variability (De Silva and Kawasaki, 2018). Rural communities in developing countries lack roads, grid electricity connection, irrigation infrastructure and access to integrated crop and livestock markets. They also do not have access to complementary infrastructural amenities such as formal banking, insurance, health and educational services. Health-related shocks are likely to be widespread because of limited access to both preventive and curative health care services (Dolea, Stormont and Braichet, 2010; Bello et al., 2012). Poor infrastructure in the risk-prone areas of developing countries has been cited as an impediment to reciprocal risk-sharing among households located in different agro-ecological zones especially for covariate shocks such as crop failure (Zimmerman and Carter, 2003). The authors also assert that infrastructure deficiency limits the role of markets in providing relief mainly when prices of available assets such as livestock co-vary with income shortfalls.

Infrastructure development, together with other aspects of economic transformation provides opportunities such as jobs, education, health and poverty reduction that reduces exposure and vulnerability to common livelihood risks and shocks. In addition, for risks and shocks that cannot

be completely eliminated, the opportunities provided by economic transformation can provide alternative and more effective means and mechanisms through households cope with shocks. Indeed, World Bank (2014) highlights key social and economic systems that collaboratively contribute to effective risk management. These systems include government-provided goods and services such as infrastructure that potentially reduces household exposure and vulnerability to shocks. For instance, a community proximity and access to bundles of physical capital such as infrastructural goods and services influence how households cope with livelihood shocks (Berchoux et al., 2019). In Kenya, Jedwab, Kerby and Moradi (2017) shows how colonial infrastructural investments determined the integration or exclusion of communities and regions from the mainstream economic activities. The geographic location exclusion and remoteness is positively correlated with exposure and vulnerability to shocks (De Silva and Kawasaki, 2018). In this functional and integrated role of facilitating the distribution of goods and services, infrastructure has been shown to enable flow of relief services to the distressed communities. For instance, a donor-funded road and rail infrastructure in a southern African country brought significant differences in responding to a drought through aiding better flow of food supplies from surplus local and international markets to the drought-hit communities (Klaesi, 1994). It is however not guaranteed that economic transformation translates into opportunities for risk resilience among the vulnerable sections of the population.

4.1.1 Description of Vulnerability to Livelihood Shocks in Kenya

As is characteristic of many developing economies, households in Kenya have had their welfare adversely affected by various shocks experienced at the household, community, regional and national level. Over the years and across the country, households have suffered welfare loss occasioned by droughts and floods, crop and animal diseases, economic shocks such as food and farming input price inflation, loss of employment, diseases and deaths and shocks caused by social conflict such as ethnic clashes. The magnitude and persistence of these shocks coupled with the household baseline vulnerability and the capacity to cope can precipitate the family decline into poverty.

Droughts and resulting famine continually affect households mainly in the ASALs of the country, which represent 36 percent of the human population and over 70 percent of livestock (Republic of Kenya, 2018b). The direct consequence of these droughts include loss of livelihoods for

households depended on rain-fed agriculture and subsequent hunger and malnutrition, discontinued school attendance, deterioration of health and ultimately a slip into poverty. In aggregate, these cycles of droughts impact negatively on the national economic welfare, with the GDP contracting by up to two percent in severe cases (Demombynes and Kiringai, 2011). The incidence of poverty is still considerably high in Kenya, despite the poor population dropping from 46.8 percent in 2005/06 to 36.1 in 2015/16, with the poverty being mostly a rural phenomenon and concentrated in the country's ASALs (World Bank, 2018). The state of poverty exacerbates vulnerability to economic shocks such as price inflation of foodstuff and farming inputs, unemployment and business failure due to depressed aggregate economic performance and other unfavourable macro-economic indicators. Between 2012 and 2016, the annual food price inflation in the country averaged about 12.5, approximately double the non-core inflation average of 7.0 percent in the same period (World Bank, 2019). Inadequate physical infrastructure for storing food as well as roads and railway lines for facilitating regional food trade in Kenya have been found to contribute to the vulnerability to food price inflation especially in marginalized rural areas (Emongor, 2014). The other common category of economic shocks is unemployment and its variants including underemployment, and small business failures, which tend to disproportionately affect women, youth, rural dwellers and other marginalized sections of the population.

Kenyan households in both rural and urban areas are also vulnerable to health-related shocks that include diseases, injuries, accidents and deaths of economically productive family members. Vulnerability to health shocks is also related to other triggers of welfare loss such as poverty, inadequate access to basic amenities such as sanitation, malnutrition and risk exposure (Achoki et al., 2019). In Kenya, these shocks have a significant cost as measured by the years of life lost due to premature deaths (Institute for Health Metrics and Evaluation, 2017). In addition, households and by extension, the economy incur both direct costs in the cost of disease treatment as well as indirect cost in the form of labour days lost and school days missed by the sick members and those caregiving. As an example, malaria was estimated to cost households in Kenya both directly and indirectly as high as 28 percent of total household monthly expenditure, which is above the critical threshold cost of 10 percent of equivalent expenditure (Chuma, Okungu and Molyneux, 2010). The reported disease prevalence and mortality rates in the country has significant variations along geographical locations as well as gender, age and socio-economic profiles (World Bank, 2008; Achoki et al., 2019). This reflects differences in population vulnerability to diseases along similar

lines contributed by disease endemicity in different geographical regions, differences in availability of and access to health care facilities, differences in housing conditions and amenities and health outcome differences due to household socio-economic wellbeing.

4.1.2 Review of Evolution of Physical Infrastructure Stocks and Population Access in Kenya between 2005 and 2016

This section reviews the changes in the stocks of physical infrastructure and population access to them between 2005 (at the start of the first KIHBS) and 2016 (at the end of the second KIHBS). Generally, in the period under review, there were notable changes in Kenya's economic, social and political landscape which could have contributed to changes to the country's stocks of physical infrastructure. The increases in the physical infrastructure stocks could also have contributed to the changes in the country's economy, social fabric and the politics. In a snapshot, the GDP growth rate in this period was more than double the rate in the previous equivalent period, the country also experienced a destructive post-election violence, heralded a comprehensive constitutional change since independence and successfully managed a political regime change in 2013. In addition, the country continued its commitment to international calls for action, notably the millennium development goals and sustainable development goals, to advance attainment of social development indicators.

Starting in 2003 and operationally in 2005, the government of Kenya commenced on rebuilding and expanding the road network. In addition to reforming the sector's policy, legal and institutional framework, the government also invested in increasing the length of new and rehabilitated roads. Column two of table 4.1 provides the index of government expenditure on roads between 2005 and 2016, which indicates a steady increase within the reference period. This investment has seen the bitumen road network grow from 8,850 to 14,500 kilometres while the earth/gravel road network increase from 54,360 to 72,500 kilometres between 2005 and 2016. On the other hand, railway transport is less active compared to other transportation infrastructures. The country has been operating the old narrow gauge railway line, with a network of 2,778 kilometres (Republic of Kenya, 2019b). However, in 2013, construction of the standard gauge railway line started with the first phase totaling 472 kilometres connecting the two main cities completed in 2017 (Republic of Kenya, 2019b). In summary, road transport is the dominant mode of transportation accounting for over 80 percent of the of the country's total passenger traffic and 76 percent of the freight

(Republic of Kenya, various years, a). Water, rail and air transport account for the remaining small proportion.

Table 4.1: Some indicators of road infrastructure development in Kenya: 2005-2016

Year	Index of government expenditure on roads (1982 = 100)	Kilometres of bitumen road '000 KM	Kilometres of earth/gravel road '000 KM
2005	62.6	8.85	54.36
2006	201.1		
2007	219.4		
2008	223.8	9.14	54.44
2009	312.9		
2010	265.4		
2011	397.0		
2012	447.3	9.77	53.15
2013	313.9	11.2	52.5
2014	263.4	13.1	63.5
2015	350.3	13.9	65.6
2016	462.8	14.5	72.5

Data Source: Kenya National Bureau of Statistics, Economic Survey-various years

Kenya's land area with irrigation potential amounts to 1.34 million hectares and only 180,503 hectares of this land is officially recorded as irrigated, mainly for rice growing (Republic of Kenya, 2015). There is also unreported, but substantial acreage irrigated for other crops' production. In the absence of other data, this study uses the available data as proxy for tracking the development of irrigation infrastructure in the country within the reference period as presented in table 4.2. The reported decline in irrigated acreage between 2006/07 and 2008/09 could be explained by the overall decline in the country's economic growth as well as the general depreciation of the irrigation infrastructure. Available data on the agricultural irrigated land as a percentage of total agricultural land shows low investment in irrigation infrastructure. Irrigated agriculture provides a long-term solution to the challenges of drought that perennially threatens the country's food security owing to limited potential for rain-fed crop and animal production.

Table 4.2: Officially recorded irrigated crop area (hectares, ha)

Year	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2018/19
Irrigated crop area (ha)	12,501	9,626	9,092	10,072	17,611	21,101	21,872	
Irrigated agricultural land (%)	0.04	0.05	0.04	0.03	0.04			2

Data Source: Kenya National Bureau of Statistics, Economic Survey-various years; World Bank (2019)

Access to improved water and sanitation reduces household morbidity and mortality. Therefore, households with more water infrastructure are less likely to be vulnerable to health-related shocks. The status of water infrastructure in the country over the study's reference period is presented in table 4.3. Water purification infrastructures are installed to ensure that rural households have access to improved water sources. Between 2005/06 and 2015/16, the number of water purification points installed increased by 30 percent. In addition, the number of boreholes drilled yearly by both government and private entities continued to increase. Between 2005/06 and 2015/16, the percentage of sampled households with access to improved drinking water sources rose from 58.9 percent to 72.6 percent (Republic of Kenya, 2018a). However, rural areas had fewer households accessing improved water sources compared to urban centres (61.8 percent and 86 percent respectively). Other studies have also found that access to improved water sources is positively and strongly related to household per capita income and this disparity was found to have increased within the study reference period (World Bank, 2011).

Table 4.3: Number of water purification points and boreholes drilled in Kenya by financial year

Year	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Water Purification Points (No)	186	186	186	192	198	208	209	211	230	234	242
Boreholes Drilled (No)	231	207	170	115	97	95	86	91	376	607	446

Data Source: Kenya National Bureau of Statistics, Economic Survey-various years

Since majority of rural households derive livelihoods from agriculture sector, physical infrastructure to facilitate trading of farm output can enhance the sector's productivity, create

employment, foster exchange economy and ultimately reduce households' vulnerability to livelihood shocks. In addition, functioning rural agricultural markets provide households with opportunities for efficient coping with shocks through accumulation and decumulation of farm produce such as livestock and perennial crops. Data on the development of physical infrastructure for rural markets during the study's reference period is scattered in diverse sources such as records of the defunct Local Authority Transfer Fund (LATF), Kenya Economic Stimulus Programme (ESP), county government budgets and reports from donor projects supporting rural markets linkages and infrastructure growth. Before enactment of the current constitution that scrapped local authorities and 2013 elections that made the local authorities non-operational, development of rural agricultural produce market was being implemented by local authorities funded by the LATF. Although data on the stocks of local markets developed is unavailable, this study uses the total national LATF allocation as proxy for increment of rural markets infrastructure between 2005/06 and 2013/14, when LATF was scrapped, indicated in table 4.4.

Table 4.4: National LATF Allocations (KES, Billion)

Year	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
National LATF Allocations	5	7.5	8.25	9.25	10.4	12.1	15.3	19.4	22.2

Data Source: Kenya National Bureau of Statistics, Economic Survey-various years

The Constituencies Development Fund (CDF), a national transfer to constituencies is also responsible for developing rural market structures. Its national allocation increased fivefold from KES. 7,028,619,994 in 2005/06 to KES. 33,452,350,000 in 2015/16 (Republic of Kenya, 2019a). In 2009, the government initiated construction of fresh produce and grains markets across the country under the Economic Stimulus Programme (ESP) in order to spur exchange economy in the country's rural areas. In addition, county governments have also developed physical infrastructure for rural markets as well as supporting infrastructure such as floodlit lighting and gravelling of roads connecting farms to market centres (Republic of Kenya, various years, b). International development partners have also contributed to the development of rural markets in Kenya. For example, the International Fund for Agricultural Development (IFAD) and the German Development Bank (KFW) funded rural markets and infrastructure projects at a cost of US$ 23.53 million and € 9 million respectively between 2007 and 2017 that have connected over 150,000

rural households to markets and access roads (Republic of Kenya, 2014; International Fund for Agricultural Development, 2018).

Table 4.5: Indicators Stocks and Access of Key Infrastructure Elements in Kenya (2005-2016)

Year	Electric power consumption (kWh per capita)	% of rural population accessing electricity	% of urban population accessing electricity	Mobile cellular subscriptions (per 100 people)	% of population with financial accounts	Private credit bureau coverage (% of adults)	Depth of credit information index (0 = low to 8 = high)
2005	130.2	11.9	57.1	12.8		0.1	
2006	138.0	12.8	58.5	19.8		0.1	
2007	141.7	13.7	59.9	29.8		1.5	
2008	141.2	14.6	61.3	41.6		2.1	
2009	142.1	8.1	65.6	48.1		2.3	
2010	150.3	6.7	58.2	60.4		3.3	
2011	151.1	17.4	65.7	66.1	42.3	4.5	
2012	152.8	18.4	67.1	70.4		4.9	
2013	163.5	19.3	68.6	71.0		4.7	0
2014	166.7	12.6	68.4	73.1	74.7	4.9	0
2015		16.0	78.1	79.8		14.3	7
2016		39.3	77.6			25.8	7

Data Source: World Bank (2019)

Indicators of other relevant physical infrastructure elements in relation to household vulnerability to shocks and shocks-coping mechanisms are provided in table 4.5. The national aggregate electric power consumption (kWh per capita) increased by 28 percent between 2005 and 2014, indicating an increase in the installed national electric power capacity. Between 2005 and 2016, the percentage of rural population accessing the national grid electricity increased by an overall 27.4 percentage points compared to 20.5 percentage points increase among urban population. Supply and access of electricity especially in rural areas promotes productivity of rural production enterprises, encourage diversification of livelihoods and also support growth of financial institutions, education and health facilities, as well as law and order (Kooijman-van Dijk, and

Clancy, 2010; Cook, 2011). Through these channels, electricity therefore contributes to reduction of household vulnerability to livelihood shocks and provide more and better options for coping with shocks.

Between the reference periods, mobile telephone subscriptions moved from 12.8 per 100 people to 79.8 per 100 people. The phenomenal growth is a reflection of general adoption of mobile telephony across the developing countries. Starting 2007, mobile-money services were also introduced in the country to ride on the mobile telephone infrastructure. Mobile telephone infrastructure supports livelihoods through aiding communication markets intelligence, financial services (such as savings, credit and insurance), creating and supporting social networks and generally reducing transaction costs (Sife, Kiondo and Lyimo-Macha, 2010; Jack and Suri, 2014). Table 4.5 also provides national population access of financial services. Population above 15 years with account at financial institutions or mobile-money service providers increased by 32.3 percentage points between 2011 and 2014. Credit reference system, which facilitates lending and growth of credit, also grew significantly between 2005 and 2016.

4.1.3   Statement of the Problem

There is fairly conclusive evidence in the literature asserting that physical infrastructure contributes to economic growth and the resultant human welfare benefits (Ndulu, 2006; Stern and Dillman, 2006; Calderón and Servén, 2010; Imran and Niazi, 2011). Households benefit through channels such as employment opportunities, increased incomes, improved access to education, health and security, and better environmental quality. For the previously excluded communities, infrastructure connectivity and the accompanying positive ripple effects could improve household resilience to various livelihood shocks by reducing exposure and also providing necessary means to anticipate, cope with, resist and recover from shocks.

Other studies acknowledge that the existing livelihood environment (for example, subsistence agriculture in rural areas carried out with rudimentary technology) is the main contributor of household vulnerability to various livelihood shocks (Mogues, 2011; Andersen and Cardona, 2013; Akampumuza and Matsuda, 2017). In addition, other studies link the absence of risk sharing markets (savings, credit and insurance) and high transaction costs to the choice of existing response

and coping mechanisms to shocks among households in less developed countries (Deaton, 1989 and 1992; Ellis, 1998; Dercon, 2002; McPeak, 2004; Dercon, Hoddinott and Woldehanna, 2005). However, less is known about what happens to vulnerability of households to livelihood shocks as the immediate environment transforms over time, for instance, as the rural areas are opened up and connected to urban centres, technologies advance, livelihoods diversify and rely less on the natural environment. Also, less is known about what happens to household response strategies to shocks as markets for risk sharing develop and transaction costs are reduced over time through physical infrastructure growth.

The literature has shown that physical infrastructure promotes and enhances society's socio-economic outcomes (Ndulu, 2006; Stern and Dillman, 2006; Calderón and Servén, 2010; Imran and Niazi, 2011). Other studies elsewhere have found how availability and access to key physical infrastructure help in livelihoods risk management (Zimmerman and Carter, 2003; Dolea, Stormont and Braichet, 2010; Bello et al., 2012). Vulnerability to welfare-reducing shocks is still a problem among Kenyan households in both in rural and urban areas (Orindi, Nyong and Herrero, 2008; Nzuma, 2013; Kelbert and Chisholm, 2014; Mbogo, Inganga and Maina, 2014; Gathiaka and Muriithi, 2017; Uhe et al., 2018). On the other hand, the stocks of physical infrastructure and population access to them grew significantly between 2005 and 2016 in Kenya due to sustained investment in the sector as well as economic, social and political transformations in the country. However, there is considerable differences between the stock and access levels between the rural and urban areas of the country. Based on the literature on the nexus between growth of physical infrastructure and reduction in household vulnerability to shocks, it is expected that the infrastructure growth in Kenya between 2005 and 2016 could have resulted into a reduction in household vulnerability to shocks. This expected change in household vulnerability to shocks due to infrastructural growth in the context of Kenya has not been studied. This study seeks to fill this literature gap.

Among the few studies that explore this connection in is Jack and Suri (2014) who established household welfare gains emanating from reduced transaction costs on household risk sharing at the advent of mobile money transfer system in Kenya. However, Kenya's infrastructural transformation has not been limited to mobile money innovations, instead – like other sub-Saharan countries – the country has also increased its stock of other physical infrastructure especially in

rural areas, translating into growth of percentage of population with access to basic infrastructural goods and services. This study contributes to the existing related literature by examining whether Kenya's infrastructural transformation has contributed to changes in vulnerability of households' livelihoods as well as risk management. This study is motivated by the fact that households suffer welfare loss from the adverse effects of shocks. In addition, they are also likely to use inappropriate coping strategies to shocks such as reducing or cutting down essential consumption such as food, health and education, as well as distress sales of productive assets. In addition, infrastructural investments are costly and there is need to establish if such investments benefit the poor and vulnerable members of the society.

4.1.4 Research Questions

Following a political regime change in Kenya in 2003, the new government launched an economic transformation blue print titled 'Economic Recovery Strategy for Wealth and Employment Creation: 2003 - 2007' that prioritized investments in infrastructure growth as a foundation for economic transformation in the country. The subsequent long term development plan, known as 'Vision 2030' launched in 2008 entrenched the government's commitment to increasing the physical infrastructure stocks in Kenya beyond 2007. Consequently, there has been significant growth in infrastructure stocks and connectivity per capita since then. Using data collected in Kenya in 2005/06 and 2015/16 from nationally-representative sample sizes, this study seeks to answer the general question: did the physical infrastructural stocks and access level changes in Kenya between 2005/06 and 2015/16 result into changes in household vulnerability to shocks as well as changes in ex-post coping strategies? The specific research questions are;

1. What are the differences in household vulnerability to general and food-security shocks in Kenya between 2005/06 and 2015/16?
2. What are the differences in household ex-post coping strategies to food-security shocks in Kenya between 2005/06 and 2015/16?
3. Between 2005/06 and 2015/16, are there differences in vulnerability to shocks and ex-post coping strategies between rural and urban households in Kenya?

4.1.5   Objectives of the Study

In the 14 year period between 2003 and 2016, the Kenya's GDP grew at an average annual rate of 5.2 percent, which is more than double the growth rate of 2.3 percent in an equivalent period between 1989 and 2002. The improved growth in the 2000s is credited to among others, a sustained government spending in new stocks of physical infrastructure as well as rehabilitation of the existing ones. This study hypothesizes that, in the short and long run, the infrastructural transformation in the country since 2003 is related to household vulnerability to livelihood shocks and resultant coping strategies available to the vulnerable populations. This context provides the basis for this study's general objective which is to find out whether infrastructural changes in Kenya between 2005/06 and 2015/16 resulted into changes in household vulnerability to shocks as well as changes in ex-post coping strategies. The specific objectives of the study are;

1. Assess whether household vulnerability to general and food-security shocks in Kenya changed between 2005/06 and 2015/16

2. Assess whether the household ex-post coping strategies to food-security shocks in Kenya changed between 2005/06 and 2015/16

3. Investigate whether there are differences in rural and urban households between 2005/06 and 2015/16 in vulnerability to shocks and ex-post coping strategies

These research objectives as well as research questions guide the execution of the study as reported in the sections that follow. In the next section, a review of relevant theoretical and empirical literature is provided, after which the methodology and estimation strategy are explained. Results are then presented and discussed, before finally concluding and offering policy recommendations.

4.1.6   Relevance of the Study

It is no doubt that physical infrastructure is a prerequisite for economic development. In addition, the state of infrastructure stocks and the connections created by these stocks determine household livelihoods and resilience to shocks (Sallu, Twyman and Stringer, 2010). Studying the connection between infrastructure growth and household vulnerability to shocks assesses the extent to which investments in physical stocks of public capital have yielded welfare gains to the poor, beyond the growth of GDP. By comparing rural and urban households' vulnerability to shocks and coping mechanisms before and after a significant infrastructural transformation, this study illuminates whether the economic growth experienced in the country post 2002 has been pro-poor and broad-

based, such as providing opportunities for the poor rural households to diversify their livelihoods or providing them with more options for coping with shocks.

Findings of this study are also useful in informing national policies on poverty reduction. With 35.6 percent of Kenyans still living below the international poverty line, poverty reduction is still a valid socio-economic and political goal as espoused in national development plans such as Kenya Vision 2030 and the President's Big Four Agenda as well as internationally agreed commitments such as the Sustainable Development Goals (SDGs). Findings of this study specifically address the SDGs' goal number one's target on reducing the vulnerability and building the resilience to shocks among the susceptible sections of the population. In addition, considering that majority of Kenya's poor live in rural areas and are dependent on shock-prone agriculture-based livelihoods, strategies that foster a more inclusive and geographically targeted growth will be most effective in poverty alleviation.

4.1.7   Limitations of the Study

The research questions in this study would have been better investigated and answered using a panel data. However, in its absence, repeated cross-sectionals are used, which is the second best option when compared to the panel data set. Also, the cross-sectional data is only available for two periods, with a gap of ten years. The results would have been richer with more cross-sectional data sets and with shorter time gaps. Finally, measurement errors are common when dealing with self-reported data. However, before the data was used for estimation, it was cleaned and duplicates removed. In addition, outliers were addressed.

4.2   Literature Review

This section provides a review of existing theoretical and empirical literature on livelihood shocks and household coping mechanisms, including the relationship between infrastructure and the vulnerability and resilience to livelihood risks. The review is done in order to position the current study into the existing literature on livelihood shocks and household coping mechanisms.

4.2.1 Theoretical Literature

Risk is a common feature of human livelihoods, and can emanate from numerous sources including natural causes such as earthquakes and droughts, man-made actions such as conflict, policies and accidents, or a combination of both categories of hazards. While risk can be exogenous or endogenous, it is the vulnerability that contributes to occurrences of observable shocks that result into negative welfare outcomes (Abraham and Kumar, 2008). Experiencing a shock therefore manifests a household's vulnerability. In this context, household vulnerability is variable and is determined by covariates such as location, physical, financial, human and social resources, institutional and social support among others (Zhang and Wan, 2006; Abraham and Kumar, 2008). The connection between location and vulnerability works through local variations occasioned by unique set of physical, economic, social and institutional conditions (Eriksen, Brown and Kelly, 2005). These conditions thus converge to cause variability in vulnerability.

In the context of socioeconomic perspective, vulnerability is viewed as a state of the particular system in relation to hazards and risks (Brooks, 2003). Factors such as marginalization, access to physical, financial and social infrastructure, poverty and inequality and others inherent in particular systems coalesce to determine differences in the level of vulnerability between and within geographical entities for a given hazard (Morduch, 1994; Skjeflo, 2013). Vulnerability can also be seen in the context of the sources of exposure; which are conceptually external and internal (Adams, Cekan and Sauerborn, 1998; Chambers, 2006). External triggers of vulnerability refer to the system's given environment and internal sources refer to endowments and endogenous capacity of systems to manage shocks (Schwarz et al., 2011).

Vulnerability, in the sense of exposure to hazards, and risk are dynamic, and their realizations follow certain probabilistic distributions. For example, climatic hazards take a stochastic process, indicating variability in realizations over time (Cai, Judd and Lontzek, 2015). On the other hand, vulnerability of households to various forms of risk and hazards is variable, in the sense that over time, it can remain unchanged, increase or reduce. Baulch and Hoddinott (2000) use poverty as an indicator of vulnerability and demonstrate that within specific time frames, the state of vulnerability fluctuates considerably for the majority of households in developing economies. Depending on the level of household vulnerability, the realization of the mostly exogenous risk results into a hazard, which is classified as a shock if it causes significant welfare loss to the

household (Heitzmann, Canagarajah and Siegel, 2002). Therefore, in relation to shocks, vulnerability will be manifested in the household welfare reduction due to shocks.

The descriptive analysis of the theoretical underpinnings of vulnerability to shocks is also supported by formal theoretical expositions. For example, on dynamism of vulnerability, Brooks (2003) argue that vulnerability can be current or potential and that the future vulnerability is influenced by the current vulnerability and the resultant adaptive capacity after responding to the shock. Indeed, Baulch and Hoddinott (2000) show that future vulnerability is a function of the household's altered stocks of physical, financial and social capital as well as human capital in the form of experience gained in responding to the previous shock. Accordingly, Brooks (2003) define the current level of vulnerability (V_0) as the welfare loss if a shock happens at time $t = 0$, and the potential vulnerability (V_p^t) as the level of exposure at time t in the future. According to the author, this is the exposure after utilization of the current adaptive capacity ($\alpha_0 t$), which reflects the household's potential for maintaining its current welfare trajectory at future time t, based on the prevailing internal and external conditions. Thus, the adaptive capacity acts to reduce vulnerability at time t. In this conceptual framework, potential vulnerability (V_p^t) assessed at the present period ($t = 0$) can be formulated formally as;

$$V_p^t = V_0 - \alpha_0 t \qquad (4.1)$$

To express actual vulnerability at time t (V^t) rather than the potential vulnerability (V_p^t), Brooks (2003) assumes that all of the household's adaptive capacity will be expended in order to maintain welfare upon occurrence of a shock at time t. equation 4.2 represents this expression;

$$V^t = V_0 - \int \alpha dt \qquad (4.2)$$

According to Brooks (2003), the adaptive capacity represented by α in equation 4.2, is dynamic. Thus, the fluctuating adaptive capacity determines household's vulnerability to shocks at different times. This dynamism is brought about by fluctuations over time in the household's physical, economic, social and political environments.

Over a considerable period of time, the various dimensions of the household's environment undergo a transformation. For instance, economic units undergo dynamic changes on many fronts such as economic development, physical advancements of both natural and manmade environments as well as social, cultural and political revolutions (Alence, 2004; Kaya, 2010;

Söderberg Kovacs and Hatz, 2016). In an economic system, these components are interconnected and influence each other in significant ways (World Bank, 2006). For example, democratization of country's political regime could result into positive per capita GDP growth, which can be invested in human capital development that results into socio-cultural transformation and multiplier effects on economic development (Becker, 1962; Acemoglu et al., 2019). A natural consequence of the transformation of the economy or its constituent components are the possible changes in household welfare indicators both in the short and long run (see this concept as applied by Nicita {2004} on household welfare changes due to trade liberalization). Growth in an economy's stocks of physical infrastructure is theoretically expected to result into specific household welfare outcomes through transmission mechanisms such as increased economic productivity, enhanced trade and commerce, innovation and reduction of transaction costs for risk sharing (Jack and Suri, 2014). Specifically, in areas with low base of physical infrastructure endowments, adding the stocks results to increasing returns with tangible transformations in the physical and social environments that, for example, impacts on the health of populations and the resultant worker's productivity (Agénor, 2010). The author goes on to argue that healthy populations expect long lives and this expectation reduces the 'preference for the present', and are thus more likely to build savings that consequently stimulate further rounds of capital formation and economic growth (Agénor, 2010 p. 933).

Physical infrastructure has unique characteristics that influence its impact on household welfare outcomes. World Bank (1994) and Agenor (2010) identifies two: first, accumulation of an absolute critical mass of infrastructure stocks and secondly, networking of necessary and complementary components of infrastructure to produce positive externalities. On the other hand, the welfare outcomes brought about by infrastructure projects are manifested in household utility gains through for example, accessibility of services (Klytchnikova and Lokshin, 2009). The household utility gain is empirically measurable.

Literature on shocks in less developed economies has focused on theorizing the causes of vulnerability and the dynamics of coping mechanisms. For example, the observed pervasiveness of livelihood variability in many rural communities in developing economies has been theorized to be due to high dependence on agriculture whose income is seasonal and the sector's productivity prone to natural hazards and market fluctuations (Gill and Gerard, 1991; Jensen, 2000). Also, the

financial and insurance markets for sharing risk that is due to livelihood variability are mostly missing, incomplete or ineffective in the context of these communities (Binswanger, 1986; Besley, 1994). In the developing economies, efficient operation of markets are also hindered by high transaction costs (Leff, 1984; Norton, 1992). Therefore, alternative risk management and consumption smoothing mechanisms are pursued, either ex-ante, ex-post or combination of both. These include asset accumulation as buffer stocks and for enhanced agricultural production (Deaton, 1989; Rosenzweig and Wolpin, 1993), reliance on labour markets and other forms of livelihood diversification as strategies for ex-ante and ex-post risk management (Kochar, 1999; Barrett, Reardon and Webb, 2001).

The review of theories of livelihood risks, vulnerability and shocks provides the necessary framework for understanding household vulnerability to shocks in the Kenyan context. The literature also postulate the possible mechanisms of household response to shocks as a natural consequence of risk management. On the other hand, the review of economic transformation over time, especially infrastructure growth in the reference period is incorporated in this study to provide a basis for evaluating the dynamics of vulnerability to shocks and ex-post risk-management options in a changing physical, economic and socio-cultural environments in which households find themselves in.

4.2.2 Empirical Literature Review

Academic literature is full of studies on the subject of the relationship between adverse shocks and welfare. Shocks are undesirable because they cause both private and social costs. For example, Hoddinott and Kinsey (2001) have established empirically that children born during severe droughts and other major systemic shocks have life-long sub-optimal health and income consequences (Hoddinott and Kinsey, 2001). Income shocks have also been found to influence the risk of armed conflict in Africa (Fjelde, 2015). In order to effectively address some of the negative outcomes of shocks, policy makers need to understand the causes, including understanding household vulnerability and response strategies.

The aspect of vulnerability of household welfare to shocks has been studied empirically before and following different approaches. One of the approach is creating a vulnerability index using elements such as exposure, sensitivity and adaptive capacity. The constructed index, that measures different levels of vulnerability, is then regressed on household characteristics. Lokonon (2018)

used this approach to study vulnerability of farming households to climate-based shocks in the Niger basin of Benin using cross-sectional data. The study found that over half of the respondents were vulnerable to the shocks and that the vulnerability was influenced significantly by various household characteristics such as gender and education attainment of the household head as well as access to infrastructure-supported agricultural extension services. Mainali and Pricope (2018) also used an index-based approach to assess household vulnerability to drought in rural Nepal. The components of the index included socio-demographic characteristics, livelihood strategies, social capital, main sources of food, access to infrastructure services such as water and healthcare facilities, household disease incidence, and the topography and climatic condition of household geographical location. Household score on this index was used to rank it in a vulnerability continuum.

In other studies, vulnerability is described as the exposure to uninsured risk, abbreviated as VER. This risk can be quantified as consumption loss or variance, or described from self-assessments of vulnerability. Senapati (2019) measured vulnerability as consumption loss and used cross-sectional data in a rural Indian district to find that vulnerability was influenced by household livelihood options, household characteristics such as education, household size and information access. Kurosaki (2006) on the other hand measured vulnerability as consumption variance in two periods and assessed how incidence of adverse and positive effects (negative and positive shocks) affected the variance, while moderating for household characteristics such as demographics, income sources, land ownership, and education status of household head. This approach was also applied by Dercon, Hoddinott and Woldehanna, (2005) on a two-period panel in Ethiopia with regressors being the observable household characteristics, social networks, incidence of shocks and the lasting effect as well as persistence of the shocks.

In other instances, the VER approach can also be defined by self-reported assessments of household welfare against certain metric to produce a binary outcome. The relationship of the bounded response variable and the independent variables is then estimated via the probit and logit regressions. Vulnerability studies using this approach include Schwarz et al. (2011) who used a multivariate probit model to assess the vulnerability of households deriving livelihoods mainly from fishing in remote rural areas of Solomon Islands. Dhanaraj (2016) used a logistic regression on a longitudinal dataset comprising three-period panels to assess household vulnerability to health

shocks in India as a function of household head intrinsic characteristics (e.g. age, gender, education level and occupation status), socio-economic characteristics of the household (e.g. wealth quartile group, caste, religion, household dependency ratios) and access to public insurance scheme. Lokosang, Ramroop and Hendriks (2011), using data for post-conflict South Sudan classified household food-shocks vulnerability in three categories and assessed the probability of being in the vulnerability categories using ordinal logistic regression model on a set of predictor variables such as household characteristics, asset ownership, wealth index quintiles, food sources, livelihood sources and the incidence of food-security shocks.

Considering the pervasiveness of livelihood risks and shocks in developing countries and the general inadequacy of credit, insurance and other financial markets as well as presence of significant transaction costs, it is expected that the matter of household response mechanisms to these shocks, both ex-ante and ex-post has been widely studied, both theoretically and empirically. These studies have been motivated by the need to understand various aspects of household response mechanisms to inform policy action. Aspects of shocks-response mechanisms include the drivers of household choice of response strategies, effectiveness of various response strategies in restoring household welfare, and the cost of specific response strategies adopted in long-term welfare outcomes.

Review of common ways in which households respond to shocks include the use of community-based informal insurance mechanisms to smooth consumption (Townsend 1994 and 1995). Especially in the case of idiosyncratic shocks, households can rely on networks with unaffected community members to regain welfare loss (Ligon 2002). Other households respond to livelihood shocks using ineffective mechanisms such as sending children to work and consequently reducing their school attendance (Beegle, Dehejia and Gatti, 2006). Households also protect consumption fluctuations from idiosyncratic agricultural shocks through increasing labour supplied to off-farm employment (Kochar, 1999; Rose, 2001). Other studies have also examined the drivers of choice of response strategy instituted when adversely affected by shock. One of the drivers is the critical asset level by which households determine whether to smooth consumption by drawing down assets or to suffer consumption reduction rather than allow asset holdings to fall below the critical threshold. Empirical works on this include Carter and Lybbert (2012) in Burkina Faso, Mogues (2011) in Ethiopia and McPeak (2004) in northern Kenya where it was found that assets shocks

led to decreased sale of livestock. When faced with shocks, decisions of the coping options are also considered in the context of the response strategy for the long term welfare outcomes since some response strategies may compromise the future adaptive capacity (Devereux, 1993; Azadi et al., 2018). Tran (2015) demonstrates using data from Vietnam that long-term and sustainable post-shock recovery is dependent on the choice of coping strategy adopted.

The literature has also documented empirical works on the outcome of physical infrastructure on key economic indicators, mostly GDP level and growth rates (Sanchez-Robles, 1998; Calderón and Servén, 2010; Banerjee, Duflo and Qian, 2012). Infrastructure growth has been linked to poverty reduction through facilitating migration of people in search of better economic opportunities in the provinces of South Africa (Cross, Mngadi and Mbhele, 1998). In Rwanda, Lenz et al. (2010) found that the large scale grid-electrification programme in the country had some weak but significant impact on key indicators of poverty such as household income, health outcomes and education performance. In India, access to electricity was found to be positively associated with education and health attainments only in rural areas, possibly because these areas had lower baseline access levels of 53 percent of households compared 93 percent of households in urban areas (Ahmad, Mathai and Parayil, 2014). Still on infrastructure, Mushtaq and Bruneau (2019) demonstrates how information communication technology (ICT) has led to poverty reduction by providing credit and enhancing access to other financial services especially to the hitherto-unbanked populations in the rural areas. The authors demonstrate this connection by empirically estimating a panel data set of 62 countries for the years between and including 2001 and 2012.

Specific empirical studies related to the objectives of the current research include Perz et al. (2013) who assessed the impact of a paved road project to open up previously remote communities to the mainstream regional infrastructure networks in southwestern region of Amazon basin. The study found that the road project led to loss of livelihood diversity and exposed the affected households to greater vulnerability to external shocks emanating of the new connections. The study avers that the inverse relationship between connectivity and livelihood diversification resulted because the affected households had limited education to take advantage of the off-farm livelihood diversification opportunities brought by the new infrastructure. Also related is Meng et al. (2012) assessment of the changes in healthcare and health insurance and outcomes in catastrophic health

expenses using nationally representative three waves of cross-sectional data in China. The changes across time were compared separately for rural and urban households and along stated geographical regions. A basic analysis of the changes revealed that compared to urban areas, rural areas registered bigger increases in physical access to health services, access to various dimensions of healthcare services and increased use of health insurance. However, vulnerability to health shocks (indicated by catastrophic health expenses) increased in 2003-2008 period then dropped in 2008-2011 period.

The effect of infrastructure changes on household risk sharing as a response to livelihood shocks is examined by Jack and Suri (2014) based on access to mobile money transfer and consumption smoothing in Kenya. The authors hypothesize that mobile money transfer system reduced transaction costs of risk sharing among relatives and friends scattered across the country. This could explain the 27 percentage points' increase between data collection periods of 2008 and 2010. Most important, users of the service were able to smooth consumption while consumption for non-users fell by seven percent. Using panel data from Tanzania, Riley (2018) examined the impact of mobile money services on consumption after rainfall shock for users and non-users of mobile money services. The results show that users of mobile money services were able to smooth consumption through remittances from networks outside the shock-affected village and to some extent shared the remittances with non-users in the same village. On the other hand, consumption declined for non-users in villages with users and villages without any user, but the decline in the former was lesser than for the latter. Munyegera and Matsumoto (2016) also use panel data to investigate how access to mobile money services impacts household consumption smoothing in rural Uganda. They find out that, because mobile money transfer service reduces transaction costs, adoption of mobile money services helps household increase consumption, possibly because such households are more likely to receive remittances, also receive them more frequently and in higher amounts relative to their counterparts without access to mobile money transfer services.

This review of empirical literature can be concluded by highlighting that the subject of shocks and coping strategies has received wide and deep empirical investigations. These empirical studies have assessed vulnerability to various livelihood shocks using diverse measures. The studies have also estimated the socio-economic cost of shocks. In addition, many studies have investigated various aspects of ex-ante and ex-post household response mechanisms. This review has identified

an emerging strand of literature focusing on how household vulnerability to shocks and coping strategies are responding to new developments such as those brought by infrastructure. The empirical studies reviewed (for example Jack and Suri, 2014, Munyegera and Matsumoto, 2016; Riley 2018) have limited their investigations on only information communication technology and the effect of the resultant reduction of transaction costs on household welfare. These studies have also not shown explicitly the evolution of vulnerability as well as coping strategies, but have concentrated their evaluations on control and treated groups' outcomes. Other studies have focused separately on electricity access, road connections and financial infrastructure. There are still gaps on empirical studies that consider infrastructure as a bundle of benefits that include electricity connections, information communication technology, irrigation, water and sanitation, roads and markets. The existing studies have also not considered the evolution of vulnerability and response strategies to shocks over time disaggregated along rural and urban households. The current study seeks to contribute to the existing literature on shocks and response strategies by attempting to fill in these gaps in empirical literature.

4.3   Methodology

This section discusses the methodological approach used in analyzing the variability and dynamics of household vulnerability to shocks and the resultant response mechanisms to secure household welfare. First, the theoretical framework on the hypothetical underpinnings of household vulnerability to shocks and risk management is presented. Presented subsequently is the analytical framework for assessing variability in risk vulnerability and the dynamics of coping mechanisms.

4.3.1   Theoretical Framework

This study presents two inter-related conceptual and theoretical frameworks; first, to enable assessment of household vulnerability to shocks and a second one to evaluate the role of infrastructure in the evolution of household response mechanism to food-security shocks across two reference periods.

4.3.1.1 Household Vulnerability to Shocks
The concept of vulnerability has diverse epistemology that is dictated by the realm in which it is being investigated. In the domain of social welfare and livelihoods, which is the focus of this study, vulnerability measures household exposure, sensitivity and resilience to livelihood shocks inferred

in the household intrinsic and extrinsic capacities (Adger, 2006). Exposure to shocks manifests in how variations in household environments explain the nature of shocks experienced, the extent and time span of vulnerability (Adger, 2006). Sensitivity measures the susceptibility or the extent to which households suffer welfare loss depending on its livelihood entrenchment in the shock-causing stress (Adger, 2006). Household sensitivity to shocks is also determined by its inherent poverty level (measured, for example, by number and value of assets) and the extent of livelihood diversification (Devereux, 2001). In the case of food-security shocks, livelihood diversity could imply household sources of food. Resilience refers to the capacity of household welfare to withstand negative shocks over a sufficient period of time (Barrett and Constas, 2014). In other words, this means that welfare measures of resilient households will be insulated from adverse effects of shocks. Using the example of food security, Alinovi, Mane and Romano (2009) present resilience as a latent variable composed of household characteristics such as income, assets and access to publicly-provided services and various forms of social safety nets. These household characteristics can be generalized to broader categories of livelihood shocks. The nature of shocks and the category of households susceptible to specific risks posed by the shocks is also considered when assessing the typology of household vulnerability (Von Braun, (Ed.)., 1992). The nature of shocks refers to the classification based on the primary triggers and include natural hazards, economic shocks such as food price fluctuations and diseases (Sawada, 2007; Heltberg, Talukdar and Oviedo, 2013).

The livelihood risks facing households in most of developing countries are highly variable across time due to a variety of triggers, such as the intrinsic vulnerability to natural climatic conditions (Ravallion, 1988). Over time, the sources of vulnerability change as well as changes in the elements of the household external environment such as technology and physical infrastructure. In addition, also liable to change are the specific household characteristics such as household size, education qualification of household head and intra-household relationships. This indicates that vulnerability is a dynamic concept, and for the purpose of this study it will be measured by the probability that a household will report an adverse welfare effect due to a shock. Sarris and Karfakis (2007) represent the welfare reduction as a household consumption (c_h) reduction below a certain known and agreed standard (z), and go on to formally state the vulnerability as a function of the probability that household welfare will fall beyond this stated standard (see equation 4.3);

$$V_{ht} = Pr(c_{h,t+1} \leq z) \tag{4.3}$$

As indicated, welfare is indicated in this study by the household self-reported welfare reduction due to adverse effects of shock, measured as a binary outcome taking one if the result is positive and zero otherwise. Self-reported shocks have been found to accurately capture household welfare, producing statistically significant estimates and with the correct sign and magnitude (Ackerman and Sabelhaus, 2012). The authors conclude that self-reported shocks are indeed exogenous and thus reliable in explaining household behavior (ibid).

Guided by the theoretical background explained above, a regression model in equation 4.4 is built in which a household self-reported measure of adverse effects of shocks represents vulnerability against an array of independent variables that contribute to the state of vulnerability. For econometric estimation purpose, the equation is specified as;

$$\text{Pr}(GenShock_i) = \alpha_0 + \alpha_1 HCI_i + \alpha_2 Consn_i + \alpha_3 Loc_i + \mu_i \tag{4.4}$$

where $\text{Pr}(GenShock_i)$ is the probability that a household reports being adversely affected by a shock event, HCI_i represents household characteristics, $Consn_i$ represents total household annual expenditure, Loc_i represents household location, μ_i is the error term, and α_0, α_1, α_2, α_3 are estimation coefficients.

Equation 4.5 is therefore used to estimate the probability of households reporting vulnerability to food-security shocks against independent variables as in equation 4.4. However, for the food security shocks, the major source of household food ($\alpha_3 Source_i$) is included in the analysis because it determines the sensitivity to shocks, which influences household vulnerability.

$$\text{Pr}(FoodShock_i) = \alpha_0 + \alpha_1 HCI_i + \alpha_2 Consn_i + \alpha_3 Source_i + \alpha_4 Loc_i + \mu_i \tag{4.5}$$

4.3.1.2 Household Choice of Coping Strategy to Shocks

This study also seeks to estimate the probability of households to use infrastructure-supported ex-post coping strategies when adversely affected by shocks that significantly contribute to food insecurity. The choice of coping strategy is influenced by the shock and household characteristics as well as the environment the household finds itself in (Modena and Gilbert, 2012). The environment includes the availability of public amenities (such as infrastructure) affect the choice of coping strategies (Adams, Cekan and Sauerborn, 1998). Based on this literature, the probability

that a household will use the infrastructure-supported coping strategies will be dependent on both the shocks characteristics, household characteristics and the environment as shown in equation 4.6.

$$\Pr(Coping_i) = \alpha_0 + \alpha_1 SH_i + \alpha_2 HH_i + \alpha_3 EN_i + \mu_i \qquad (4.6)$$

where $\Pr(Coping_i)$ is the probability that a household reports using a specific coping mechanism to shocks, SH_i represents shock characteristics, HH_i represents household characteristics, EN_i represents the household i's environment, μ_i is the error term, and α_0, α_1, α_2, α_3 are estimation coefficients.

4.3.1.3 Evolution of Vulnerability and Ex-Post Coping Mechanisms to Food-Security Shocks

A second and related objective of this study is to assess whether the physical infrastructure development in Kenya between 2005/06 and 2015/16 could have influenced the household vulnerability to shocks as well as the choice of ex-post coping mechanisms between the two periods. Conceptually, it is postulated that physical infrastructure stocks offer households more options for efficient coping with the livelihood shocks. For instance, roads connect locations to the mainstream economy and spur growth of financial institutions that facilitate credit and insurance markets for risk sharing. Another example is electricity connection that promotes new industries and subsequently jobs that provide households with opportunities for using labour-based coping options and opportunities for household income diversification. This study hypothesizes that the observed economic transformation in the country between the two study periods has changed the household exposure and sensitivity to various categories of shocks such as those related to food-security. It also hypothesized that in the same period, there was increased adoption of infrastructure-supported ex-post coping strategies to food-security shocks.

This hypothesized change between 2005/06 and 2015/16 is theoretically modelled as a case of structural breaks. It is assumed that there is a single structural break and therefore, comparing pre-break and post-break data, it is possible to have model parameters that change over the two periods. Specifically, the increment in the stocks of physical infrastructure and the associated connectivity is perceived to be a unique event that changes the model parameters under investigation. Following Wooldridge (2010), introducing the period (time) dummy into the three models being estimated captures the structural break. Assessing the effect of physical infrastructure transformation on

household vulnerability and coping mechanisms to shocks in the two data collection periods amounts to testing the null hypothesis that the regression coefficient on the time dummy variable remain constant against an alternative hypothesis that the coefficient changes over time (Zeileis et al., 2003). As identified in the literature, the factors affecting household vulnerability and choice of household coping strategies to shocks include household socio-economic characteristics, physical assets as well as availability and access to agricultural markets, components of infrastructure and information, all of which are subject to vary across time (Wetterberg, 2007; Asfaw, et el., 2019). Household coping mechanism is therefore an inferred decision made in this context.

The nature of infrastructural transformation in the country in the period under review was not specific to certain locations or sections of the population, rather it was a general phenomenon affecting the whole economy. For example, the commonly used and popular mobile money transfer system, MPESA was non-existent in the whole country before 2007. Its introduction covered the whole country and all socio-economic classes, as long as one had a mobile telephone connection. The data for this study does not therefore have distinct control and treatment groups because it is assumed that all the study subjects received the treatment. Based on this, the evaluation of the impact of the infrastructural difference on household vulnerability to shocks and coping mechanisms cannot be implemented using the standard difference-in-difference procedures. However, because rural areas had lower baseline levels of physical infrastructure stocks and population access, it is postulated that the effect of this intervention on household vulnerability and change in ex-post coping strategies to shocks will be higher among rural households compared to those in urban areas.

4.3.2 Study Hypotheses

Based on the literature reviewed, this study hypothesizes that the observed economic transformation in the country between 2005/06 and 2015/ has changed the household exposure and sensitivity to general and food-security shocks. It also hypothesizes that in the same period, households increased the adoption of infrastructure-supported ex-post coping strategies to food-security shocks.

4.3.3 Estimation Model Specification

All the three estimation models (equations 4.4, 4.5 and 4.6) have dependent variables (y) that have a binary outcome. Therefore, a regression will be conducted on a latent variable y^*

$$y_i^* = X_i\beta + \varepsilon_i \tag{4.7}$$

in which y_i^* measures the latency of household i vulnerability to shocks or probability of using infrastructure-aided coping strategies; is a $(k \times n)$ vector of observed non-random explanatory variables, assuming n sample size; β is a $(k \times 1)$ vector of unknown parameters and ε_i is the random error term, and in this case it is assumed to be normally distributed with zero mean and a variance of one (Long and Freese, 2006; Ncube et al., 2016). By stating that the outcome variable is latent, it indicates that it is unobserved. However, what can be observed is either success or failure of an event that corresponds to the unobserved.

The observed dependent variable (y) is binary, taking a value of one for positive outcome (that is, household reports adverse effects on welfare due to shocks/ household reports using infrastructure-aided coping strategies) and a value of zero for a negative outcome (household reports welfare not being adversely affected by shocks/ household reports not using infrastructure-aided coping strategies). To enable the estimation of y given the unobserved y^*, a measurement equation following Long and Freese (2006) is presented in equation 4.9 showing the link between the two variables

$$Y_i = \begin{cases} 1 & if\ Y_i^* > 0 \\ 0 & if\ Y_i^* \leq 0 \end{cases} \tag{4.8}$$

Equation 4.9 indicates that where the latent variable y^* is positive, the observed y will be one, and also y will respectively take the value of zero in the case where y^* is negative (Long and Freese, 2006).

The decision is modelled based on the observed choices of coping mechanisms using the logistic regression model. Logistic regression is used because the model function is assumed to take a cumulative logistic distribution. Therefore, according to Agresti (2018), the dependent variable in each estimation model depends on the values of explanatory variables $\pi(x)$ represented in vector. The logarithm of the odds for the cumulative logistic distribution are presented as;

$$logit[\pi(x)] = log\left[\frac{\pi(x)}{1-\pi(x)}\right] = \alpha + \beta x \tag{4.9}$$

As explained by Agresti (2018), if the value of x is quantitative, equation 4.10 implies that $\pi(x)$ takes an S-shaped distribution. The econometric estimation of the choice of specific coping strategy will be guided by equation 4.10. To capture the evolution of time in the household decision of coping strategy, the time element (year dummy) will be introduced into equation 4.10.

4.3.4 Description of Variables used in the Study

This study investigates two related questions on household vulnerability to shocks and the choice of ex-post coping mechanisms in response to food-security related shocks. Variables used to describe and estimate vulnerability to livelihood shocks and the ex-post coping strategies to food-security shocks were inferred from the review of literature. Only the variables in which data is available are used in the study. In addition, some variables are only used to describe the context of the study and are not included in the empirical estimation models.

In this study, shocks refer to events and experiences that were reported in the two survey periods as having severely affected the household welfare negatively, leading to both quantifiable and unquantifiable welfare loss. They vary in categories such as; natural climatic shocks, health shocks, economic shocks, social shocks and those due to social conflicts. In both data collection periods, households ranked a maximum of three shocks in terms of severity on the welfare. This is a dummy variable taking a value of one if households reported shocks and zero otherwise. In the estimation of household vulnerability to shocks, the household reports of these events are used as the dependent variable with two possible values of 'adversely affected' or 'not adversely affected'. In the estimation of ex-post coping mechanisms, shocks are used as an explanatory variable to the observed household choice of shock-coping strategies.

Household size refers to the number of people in a household, which is typically a housing unit with all the members having a common living arrangement such as partaking of meals and common reference point of authority within the unit, with that individual being the household head (Beaman and Dillon, 2012). In this study, the household size is further categorized into the membership in three age categories; those between zero and 17 years, those between 18 and 64 years, and those over 65 years. Household size and age composition influence important parameters of vulnerability such as household income, consumption and labour decisions as well as the general poverty (Wright, 1994; Lanjouw and Ravallion, 1995; Brandolini and D'Alessio, 2001). Specifically, it has been established in the literature that large family sizes especially in the

dependency ages (young children and household members with advanced ages) increases likelihood of vulnerability to livelihood shocks (Olayemi, 2012).

The gender of the household head refers to the sex (male or female) of the person deemed the most responsible for the household at the time of survey. Development research in low-income economies reveal that the sex of household heads determines access to economic opportunities and resources, with female-headed households being relatively more disadvantaged (Kishor and Neitzel, 1996; Pashapa and Rivett, 2017). This is especially so considering that the main contribution of female-headship is widowhood, itself a source of vulnerability as it predisposes such households to loss of economic opportunities and resources contingent on marriage such as access to productive assets (e.g. land, credit), as well as social status and protection (Van de Walle, 2013; Beegle et al., 2016). This study hypothesizes that vulnerability to the general and food-security shocks is higher for female-headed households compared to those with male leadership. In addition, it is proposed *a priori* that household coping success to shocks is also gender-dependent, with female headship scoring poorly, consistent with the findings of Klasen, Lechtenfeld and Povel (2015).

The age of the household head influences household vulnerability through various channels. First is through lifecycle shocks such as death of household heads and terminal disease burden which on average tend to increase as the age of household heads advance. Other shocks such as family break-up and births are related with the household stage in lifecycle and could precipitate vulnerability triggers such as single-headed households, diseases such as HIV, dependency and also reduced household production capacity. Second, triggers of vulnerability to shocks such as poverty usually trace the human lifecycle (Pankhurst, 2009, February). Also, coping opportunities such as livelihood diversification and participation in paid labour are more available to households with members in the productive age (Barrientos, Gorman and Heslop, 2003). In the low-income economies, livelihood strategies (such as subsistence farming and waged employment) pursued by the household heads determine the overall household vulnerability to shocks and capacities for effective response to retain the mean household welfare (De Sherbinin et al., 2008).

The education variable represents the status of accumulated human capital which is hypothesized to have a negative effect on probability of a household being vulnerable to shocks. This connection works through skills and knowledge acquisition for advanced economic production and

sociocultural and political organization, more informed risk perception and disaster preparedness and better adaptation including the pyscho-social health post the effects of shocks (Frankenberg et al., 2013; Muttarak and Lutz, 2014). The employment status of the household head, just like education reflects the idiosyncratic characteristics determining household vulnerability to shocks and ability to cope. Households whose livelihoods are depended mainly on agriculture and natural resources are most adversely affected by shocks because of reliance on rain-fed crop and animal production which is susceptible to climatic and weather-related fluctuations. In addition, the livelihood status of the head determines whether the household resides in rural or urban areas which consequently affects vulnerability to location-specific shocks and the latent capacity to respond to the adverse effects of the shocks. Thus, compared to households with stable and secure sources of income, smallholder agricultural households are expected to be more likely to report both the general and food-shortage shocks and also less likely to rely on infrastructure-supported ex-post coping mechanisms.

The household access to the national grid-supplied electricity as well as access to piped water system are included in the study as proxy variables for physical infrastructure stocks across the sampled areas and in different times of data collection. Rural households' access to formal financial markets for risk sharing of shocks through savings, credit and insurance depends on the availability of the physical bank branches, electricity for running automated teller machines (ATMs), road connections for supporting the operations of the financial systems including communication infrastructure for information sharing and awareness creation on available financial products and services (Sarma and Pais, 2011). In general, the growth, cost and adoption of formal financial markets and systems for sharing livelihood risks hinges upon a system-wide and country's noticeable advancements in the physical infrastructure stocks (Beck and De La Torre, 2006). Based on the preceding propositions, this study hypothesizes that populations with physical access to formal financial services and the supporting infrastructure for knowledge and awareness are more likely to use them to mitigate against adverse effects of shocks than the physically excluded populations. In addition, the study hypothesizes that there is a significant increase in the use of formal financial services and other infrastructure-aided ex-post coping mechanism between the two periods of data collection (2005/06 and 2015/16) owing to the country's increase in the stocks of physical infrastructure. The access to piped water used in this

study refers to potable water for drinking, which is normally used for other domestic functions such as cooking and washing.

The monetary value of household total annual consumption expenditure and an index of the quality of the main house are included in the study as proxy measures of the household wellbeing. Consumption expenditure describes actual and imputed spending on all food and non-food items (excluding rent) reported by the respondents in varying recall periods. The expenditures are computed in regionally-deflated prices to account for the spatial differences in prices in the various parts of the country where the data was collected. In addition, all the reported recalled-expenses are subsequently approximated to reflect an annual expenditure. Both data collection periods lasted twelve months in order to capture all the seasonal variations in expenditures (International Labour Organization {ILO}, 2003). As an indicator of household welfare, consumption expenditures therefore has negative relationship with vulnerability (Morduch, 1994; Santos et al., 2011). Using the Multiple Correspondence Analysis (MCA), an index of the quality (in terms of physical structure) of the household's main dwelling unit was computed based on the house's roofing, walling and flooring materials used. The quality of housing has been used as a social economic indicator of poverty, and accordingly, the quality index is *a priori* expected to have a negative relationship with vulnerability but a positive relationship with the effective ex-post coping strategies such as formal risk sharing (Zainal et al., 2012).

Access to credit, either from formal or informal sources provides households with ex-post strategies to smooth consumption in the event of adverse shocks. In the context of this study, credit refers to any borrowings for any source that was accessible by the household for consumption smoothing or investment. In the data used in this study, access to credit refers to whether any household member borrowed cash, goods or services from either formal or informal sources. Thus, access to credit is an indicator variable with the value of one if the household borrowed and zero otherwise. The conditions governing the borrowings such as collateral requirements, amounts borrowed and the purpose of the loans were not reported. This study hypothesizes that households that are able to access credit are also most likely to resort to related ex-post coping strategies that are based on risk-sharing and utilization of the existing formal and informal financial infrastructure to smooth consumption (DeLoach and Smith-Lin, 2018)). It is expected that the physical infrastructure growth in Kenya between 2005/06 and 2015/16 has resulted into increased

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opportunities for both formal and informal credit through expansion of physical and virtual financial outlets, mobile telephony platform credit services, and information communication and technology spread that has increased financial literacy including awareness for forming and joining rotating credit and savings association (ROSCAs). However, the continued existence of localized informal credit services could indicate that infrastructure growth therefore, has an inconclusive effect on adoption of borrowing and savings as an ex-post coping strategy.

The 2015/16 dataset contains information about household access to formal insurance and mobile-money enabled telephone devices. Households with access to one category of formal financial services are more likely to have access to the other, thus, those with formal insurance are likely to have access to other formal financial products and services such as savings and credit (Zeller and Sharma, 2000). Access to insurance was therefore postulated to increase the probability of adoption of savings and borrowings as an ex-post strategy to smooth consumption after adverse effects of shocks. Access to formal financial services in general insulates households from food consumption fluctuations through facilitation of savings and drawing from them in times of need, accessing credit and receiving payouts upon materialization of risks covered in the insurance contract (Zeller and Sharma, 2000). Ownership of mobile telephones enabled with money transfer system is considered in the study because it has been credited for lowering the transaction costs of risk sharing (Jack and Suri, 2014). Therefore, with the growth of mobile telephony infrastructure in the country, households in distress can communicate and receive assistance in form of loans and grants from relatives and other social networks scattered in vast geographical space.

Year is the time-period indicator and is included in the pooled regression models to account for the variable changes over the two time periods. It is therefore an indicator variable taking the value of one for the 2015/16 cross-section and zero for the 2005/06 cross-section. In addition, the year dummy is also interacted with specific independent variables of interest to assess possible changes in the variable effects in the 2015/16 period compared to the previous period. Assuming that the effect of all other explanatory variables is constant across the time periods, the effect of the physical infrastructure stocks changes over time (represented by the year dummy) is expected to be associated with a reduction in vulnerability to the general shocks and especially food security shocks and an increase in household reliance on savings and borrowings to deal with food security

shocks ex post. Thus, the coefficient of year dummy is expected to be negative in the vulnerability estimation (equation 4.8) and positive for the ex-post coping strategies model (equation 4.10).

4.3.5   Source and Type of Data

This study uses two cross-sectional data sets collected by the Kenyan national agency in charge of statistics, the Kenya National Bureau of Statistics (KNBS). The data sets came from the Kenya Integrated Household Budget Surveys (KIHBS) collected in 2005/06 and in 2015/16, which were nationally representative and covering a 12-month period. The 2005/06 and the 2015/16 KIHBS used similar tools and approach in sampling, data collection including the tools used and processing. There are however a few differences in the 2015/16 survey that included addition of questionnaire modules (for example, inclusion of household justice and information and communication technology use modules). The similarity in the surveys therefore makes pooling the two cross-sectionals into one dataset feasible. At the time of writing this report, data contained in livestock, agriculture holding and access to public services modules had not been fully processed and released to the public. Therefore, analysis in this study was limited to the available data. In developing countries where panel data are rare, pooled cross-sectional data are second best for analyzing household welfare dynamics (Dang and Carletto, 2018). In addition, pooling confers unique advantages such as isolating effects of specific public policies (Wooldridge, 2010) as well as increasing heterogeneity and degrees of freedom in samples since each cross section draws different observations (Hicks,1994).

Data collection for the 2005/06 KIHBS commenced in May 2005 and was completed in April 2006 by the then Central Bureau of Statistics before it was replaced by the now semi-autonomous KNBS through the Statistics Act of 2006. To build up the sample, 861 and 482 rural and urban clusters respectively were randomly selected from across the country with the aim of collecting household statistics that were representative at both the national and sub-national levels. The clusters are the primary sampling units as per the National Sample Survey and Evaluation Programme IV (NASSEP IV), which is the sampling frame and contained 1,800 clusters chosen based on the size proportion of the enumeration area created using the 1999 Population and Housing Census (Republic of Kenya, 2007). Ten households were then randomly selected from each of the national tally of 1,343 clusters giving a total sample size of 13,430 households. This nationally

representative sample size accordingly comprised of 8,610 rural and 482 urban households. The overall sample size was then reduced to 13,154 after factoring the non-response (which was less than one percent) and data cleaning. The final tally of households used in this study therefore comprises of 8,447 rural and 4,707 urban households.

In the 2015/16 KIHBS, data collection started in September 2015 and ended in August 2016. The sample used in this study was similarly drawn from the national sampling frame based on the fifth edition of the National Sample Survey and Evaluation Programme V (NASSEP V). This sampling frame, containing 5,360 clusters was similarly constructed from the enumeration areas designed in the 2009 Kenya Population and Housing Census. From the 5,300 clusters in the national sample frame, 2,400 were randomly selected constituting 1,412 from rural areas and 988 from the urban centres (Republic of Kenya, 2018a). The next stage in the sampling process involved selecting 16 households from each of the 2,400 clusters selected in the first step. Finally, 10 households were randomly selected from the 16 households, producing a final sample size of 24,000 households that participated in the study consisting of 14,120 and 9,880 from rural and urban areas respectively. The final tally of sample size that was used in this study after non-response and data cleaning by KNBS is 21,773 households, consisting of 13,092 and 8,681 from rural and urban areas respectively.

Both KIHBS had detailed questionnaire modules to capture shocks experienced by the sampled households as well as coping responses. Households responded a maximum of three shocks drawn from a list of different types that can possibly affect household welfare adversely. These included food security, economic, health-related and social conflict shocks. in addition, the households ranked the shocks in terms of severity, estimated the resultant monetary and material loss, stated the nature of shocks (idiosyncratic or covariate), estimated the time the shocks occurred and listed (a maximum of three) the various response strategies used to cope and/or regain the welfare lost. In addition, the questionnaire contained other modules with relevant data used in this study. In general, the data is appropriate for the objectives of this study, specifically to assess changes in household welfare over time since it tracks socio-economic profiles of all categories of households using key indicators such as consumption expenditures, housing quality, household size and composition, access to basic services and vulnerability to welfare shocks and the accompanying response strategies.

4.4 Results and Discussion

This section presents the descriptive statistics of the variables used in the study as well as the estimation results of the household vulnerability to the general and food-security related shocks. Also presented are estimation results of household ex-post coping strategies to food shocks and the role of physical infrastructure growth in the evolution of coping strategies in the period between 2005/06 and 2015/16.

4.4.1 Descriptive Statistics

Summary statistics of variables used in the estimation of the hypothesized relationships in the study are provided in table 4.6, for the two cross-sectional datasets. Other variables such as access to electricity and piped water, monetary value of the loss from the shocks, nature of shocks (whether idiosyncratic or covariate), number of shocks reported by households are not included in the estimation models but are used to describe the context of the study.

In the 2005/06 sample, the mean number of household members were 5.1 and a standard deviation of 2.8. In the 2015/16 sample, the mean number of household members reduced to 4.3 and a standard deviation of 2.5. The mean household size observed in the two datasets are consistent with the global development forums' findings showing African countries family sizes averaging 5 persons (United Nations, 2017). During the ten year difference of data collection, there was also a notable decrease in the mean household size in the sampled households, reflecting the global trends in the fall of fertility, improved health and longevity, increasing urbanization trends and increasing cultural tolerance to single-parenthood (United Nations, 2017). The dispersion of the average household's size from the mean is also lower in 2015/16 confirming that the sampled families are consistent with the global trends in household size. Disaggregation of household size into three different age categories reveals that the average size of household members in the 0-17 years and 18-64 years age categories fell between the two study periods but stayed the same for those members in the 65 and more year's category.

Table 4.6: Descriptive Statistics

Variables	2005/06					2015/16				
	Mean	Std. Dev	Min	Max	N	Mean	Std. Dev	Min	Max	N
Household size	5.1	2.8	1	29	13,154	4.3	2.5	1	28	21,773
Number of household members between ages:										
0 and 17	2.5	2.1	0	18	13,150	2.2	2.0	0	16	21,767
18 and 64	2.4	1.4	0	16	13,150	1.9	1.1	0	11	21,767
Over 65	0.2	0.4	0	5	13,150	0.2	0.4	0	3	21,767
Sex of household head (Male=1)	0.7	-	0	1	13,141	0.7	-	0	1	21,767
Age of household head (years)	44.3	15.2	15	97	13,141	44.7	16.1	12	100	21,767
Education of household head	Primary	-	None	Tertiary	9,840	Primary	-	None	Tertiary	17,303
Location	0.6	-	0	1	13,154	0.6	-	0	1	21,773
Electricity	0.16	-	0	1	12,939	0.34	-	0	1	21,666
Access to piped water	0.32	-	0	1	12,939	0.36	-	0	1	21,734
Access to mobile money platform	_____	_____	_____	_____	_____	0.85	-	0	1	21,767
Household total annual consumption expenditure (KES)	144,126.8	235,623.1	1162.86	6,649,316	13,102	79,501.1	88,474	112.7	6,632,901	21,773
Estimated loss from shock one (KES)	39,332	200,781	0	9,999,999	10,976	954,856.2	9.52e+07	0	1.00e+10	11,032
Estimated loss from shock two (KES)	18,534	69,077	0	2,000,000	5,288	38,674.2	158,164.3	0	5,400,000	7,144
Estimated loss from shock three (KES)	18,127	56,780	0	1,500,000	3,936	35,935.3	136,405.8	0	5,000,000	4,672
Nature of shock one (1=idiosyncratic)	0.64	-	0	1	10,976	0.61	-	0	1	13,624
Nature of shock two (1=idiosyncratic)	0.52	-	0	1	5,288	0.54	-	0	1	8,406
Nature of shock three (1=idiosyncratic)	0.50	-	0	1	3,936	0.50	-	0	1	5,292
Number of shocks reported	1.93	1.14	0	3	13,154	1.26	1.19	0	3	21,773
Credit access	0.29	-	0	1	12,787	0.32	-	0	1	21,773

Source: Author's computation from KIHBS, 2005/06 and KIHBS, 2015/16

The statistics reveal that most sampled households in the two datasets were headed by male gender at 70 percent. The mean age of the household head rose from 44.3 years in 2005/06 to 44.7 years in 2015/16, while the spread of the average age of households' head from their respective means

rose from 15.2 to 16.1 years. This increase in the standard deviation of the household heads' age is reflected in the minimum age of 12 and the maximum age of 100 recorded in the 2015/16 sample. A further analysis of the descriptive statistics reveals that households headed by persons below 18 years were more likely to be located in the counties officially regarded as marginalized. These households are also most likely to be female-headed, indicating the consequences of early pregnancies, which perpetuate household poverty and vulnerability to livelihood shocks.

In both cross-sectionals, 60 percent of the respondents were from rural areas and the rest from urban centres. This confirms consistency in the sampling of respondents in both KIHBS, which makes the datasets comparable for the use of tracking changes in household welfare across time. In this study, location is measured as a dummy variable taking the value of one for households in rural areas and zero for households in urban areas. Location of the household is commonly used in empirical studies as a control variable in estimating household vulnerability to shocks and ex-post coping strategies. Depending on their nature and type, shocks are normally specific to physical location and therefore, and therefore both vulnerability and use of ex-post coping strategies chosen will depend on whether the household is located in rural or urban areas. For instance, households in rural areas are more likely to report being affected by drought because of dependence on rain-fed agriculture as well as being more vulnerable to diseases because of limited preventive health and curative care facilities in rural areas of Kenya. The infrastructure for coping with shocks such as insurance and credit markets and financial institutions for facilitating savings are also limited in rural areas.

Variables related to the level of physical infrastructure stocks and household access in the sampled households between 2005/06 and 2015/16 include access to electricity, access to piped water and ownership of mobile money transfer-enabled platforms. In the 2005/06 KIHBS, 16 percent of the sampled households had access to the national grid electricity connection. The electricity access more than doubled in 2015/16 KIHBS, although the number of non-missing values (representing households who responded) increased by 40 percent. Disaggregating the households by location shows that mean access in the rural areas rose from three percent in 2005/06 to 17 percent in 2015/16 while mean access by urban households rose from 41 percent to 60 percent in the same period. Compared to grid electricity, data on access to piped water show less changes over the study periods, but with a higher baseline access in 2005/06 at 32 percent of the sampled households

and increasing to 36 percent of the sampled households in 2015/16. Disaggregating the access based on household location reveals that the sampled rural families with piped drinking water access rose from 16 percent to 23 percent in 2015/16 while urban households with access dropped from 62 percent to 55 percent of the sampled households. This means that the four percent increase the national access was driven by expansion of water infrastructure in rural areas mostly due to the localized small-piped water schemes controlled in a quasi-private system that promotes incentivized management and overall sustainability. The decline in water access in urban areas could be due to the sampling framework that included more unserved urban households or due to a higher rate of formation of urban households compared to the rate of provision of physical infrastructure services such as water and sewerage.

Mobile phone-based money transfer service was launched in Kenya in 2007 and has grown tenfold since then, translating into a national access of 73 percent by 2017, more than double the sub Saharan countries average of 35 percent (Moody's, 2018). Among the sampled households, those with the mobile money account were at 85 percent. This platform reduces transaction cost and time by allowing users to deposit, transfer, buy goods and services and pay bills, and withdraw money through the mobile telephone in real time. The reduction of transaction costs is important especially for rural households where many breadwinners travel to urban centres to fend for their families. Sending money to relatives before the advent of mobile money transfers was through friends and other relatives, bus drivers, the postal corporation, and through the few bank branches in rural areas, which was risky and costly.

In both periods of data collection, households were asked to report shocks that led to welfare reduction. Households reported a maximum of three shocks ranked in terms of severity but the listing in the questionnaire was not entirely based on severity. However, an analysis revealed for instance that the monetary loss from shocks was higher for the shocks listed first and reduced accordingly. In addition, idiosyncratic shocks were the ones mostly listed on top of the list (however, 57 percent of the reported shocks were idiosyncratic in nature). The existence of this pattern in the two datasets reveals that the data collected through recalling of shocks accurately approximates the actual adverse events that affected household welfare within the recall period. The consistency of household responses confirms that the self-reported data on shocks is valid for use in this study and the estimated coefficients are reliable for policy inference. Given the lack of

data to compute a composite vulnerability (to shocks) index that can be used to quantify household vulnerability to a set of risks, self-reported measures were therefore used and are known to produce reliable estimates (see for example Nguyen, 2019).

Table 4.7: Frequency Distribution of the Shocks

	2005/06 (%)		2015/16 (%)	
Shock	**Rural**	**Urban**	**Rural**	**Urban**
No was shock reported	12	25	32	44
Drought/floods	18	4	13	4
Crop diseases/crop pests	2	1	6	3
Livestock died or stolen	10	3	11	5
Household business failure (non-agricultural)	2	6	2	3
Loss of employment for the salaried	2	6	1	3
End of regular assistance	1	1	1	1
Large fall in sale prices for crops	2	1	2	1
Large rise in prices of food	8	12	6	10
Large rise in agricultural input prices	2	1	1	1
Severe water shortage	3	2	2	2
Chronic/severe illness/accident of household member	12	10		
Birth in household	1	1	1	1
Deaths in the household	18	19	10	9
Break-up of household	1	2	1	2
Breadwinner jailed	1	1	0	0
Fire	1	1	1	1
Carjacking/robbery/burglary/assault	1	4	2	4
Dwelling damaged/destroyed	1	0	0	0
HIV/AIDS	0	0	0	0
Eviction/conflict/ethnic or clan clashes			2	2
Others	2	3	6	4
Sample size	8,447	4,707	13,092	8,681

Source: Author's computation from KIHBS, 2005/06 and KIHBS, 2015/16

Table 4.7 provides a comparison of households that reported at least one welfare-reducing shock in the five year period preceding the surveys in 2005/06 and 2015/16. The comparison is done according to the location of the household, which, as per theory is a key determinant of household vulnerability to various shocks. First, vulnerability to shocks appear to be a rural problem. In both data collection periods, higher percentage (25 percent and 44 percent in 2005/06 and 2015/16 respectively) of urban households reported being not adversely affected by welfare-reducing shocks compared to rural households. This is compared to only 12 percent and 32 percent in 2005/06 and 2015/16 respectively of rural households that reported not being adversely affected by shocks.

Similarly, other shocks that were predominantly reported by rural households compared to urban households in both survey periods include droughts and floods, crop diseases and pests, loss of livestock through diseases and theft, fall in the price of agricultural produce and destruction of dwellings. Additionally in 2005/06, a higher percentage of rural households reported being negatively affected by price increases of agricultural inputs, severe water shortages and severe/chronic diseases, illnesses and injuries. To check the reliability of the self-reported shocks, the survey responses in different survey areas at the different times was compared with the information from external sources (see for instance https://reliefweb.int/report/kenya/kenya-food-security-update-february-2006) and https://reliefweb.int/report/kenya/kenya-food-security-outlook-update-august-2014), and there was convergence. Comparison of the reported events was also done with the country's weather and climate agency, the Kenya Meteorological Department.

4.4.1.1 Total Shocks Reported

Since households reported multiple shocks, the study assesses the frequency of all shocks reported by households according to the location of households that reported them.

Table 4.8: Frequency Distribution of all Shocks Reported

	2005/06 (%)		2015/16 (%)	
Shock	**Rural**	**Urban**	**Rural**	**Urban**
Drought/floods	16	6	20	9
Crop diseases/crop pests	3	2	9	5
Livestock died or stolen	12	5	17	10
Household business failure (non-agricultural)	3	7	3	6
Loss of employment for the salaried	2	6	2	5
End of regular assistance	1	1	1	1
Large fall in sale prices for crops	4	2	3	3
Large rise in prices of food	15	20	11	17
Large rise in agricultural input prices	5	2	3	2
Severe water shortage	6	5	4	5
Chronic/severe illness/accident of household member	12	12		
Birth in household	1	1	1	2
Deaths in the household	13	18	12	14
Break-up of household	1	2	2	3
Breadwinner jailed	1	1	0	0
Fire	1	1	1	1
Carjacking/robbery/burglary/assault	2	5	2	6
Dwelling damaged/destroyed	1	1	1	1
HIV/AIDS	0	1	0	1
Eviction/conflict/ethnic or clan clashes			3	3
Others	2	3	6	6
Number of shocks reported	17,752	7,654	18,347	9,187

Source: Author's computation from KIHBS, 2005/06 and KIHBS, 2015/16

4.4.1.2 Regression Diagnostics

This study makes use of consumption expenditures for households spread across different regions in the country, including specific urban and rural location differences. There is also time differences of the expenditures between 2005/06 and 2015/16 study periods. In order to make the nominal household expenditures comparable across the different geographical regions and the two survey periods, appropriate regional and time price deflators are used. Geographic deflators for the different zones where data was collected from was provided and the values already deflated. The adjustment of the relevant values to cater the time difference was done following Thompson (2009). Assuming that the 2005/06 period is represented by 2006 while the 2015/16 period is represented by 2016, the values in the 2005/06 survey are expressed in 2016 prices as;

$$2006 \ value \ in \ 2016 \ prices = 2006 \ value \ \times \ \left(\frac{Index \ number \ for \ 2016}{Index \ number \ for \ 2006}\right) \qquad (4.10)$$

The data used in this study was collected by the KNBS and the sampled clusters were drawn from the NASSEP framework. The sampling of the clusters was random and nationally representative. Sampling of the households from the clusters was also random. Sampling bias is ruled out for the sampled households and thus the results of the study can be independently attributed to the phenomenon being investigated. Also, the necessary cleaning, including addressing duplicates, missing and illogical observations was undertaken in both samples. Outliers were identified and examined further to determine whether it was due to measurement error before deciding to correct the incorrectly reported observation, capping the data to exclude the outliers, or dropping the observations altogether.

The disturbance term in all the models being estimated in this study is assumed to be normally distributed and so the p-values of the estimated coefficients are reliable for significant testing. This is due to the fact that the sample sizes used in this study are sufficiently large, and therefore according to the central limit theorem, the disturbance term follows a distribution that approaches normality (Baltagi, 2008). Also tested was the appropriateness of logistic regression to model the postulated relationships in the study. Tests also revealed that in all the models estimated, there were no serious collinearity among the independent variables.

4.4.2 Analysis of Household Vulnerability to Shocks

The preliminary analysis of this study's data shows a significant variability in household vulnerability to shocks. In 2005/06 and 2015/16 study periods, 17 percent (sample size = 13,154)

and 37 percent (sample size = 21,773) of households respectively, reported having not been adversely affected by a shock within the recall period. This indicates that within the population and in different data collection periods, household vulnerability to various shocks varied based on specific factors. This section assesses the various household-specific and external attributes determining or influencing household vulnerability to livelihood risks, manifested through realization of shocks. Estimation results of the determinants of household vulnerability to the general welfare shocks are presented in table 4.9 separate for 2005/06 and 2015/16 data study periods and for the pooled cross-sections. The pooled cross-sections has the time variable (year dummy) to assess the extent to which household vulnerability to the general livelihood shocks has changed between the two study periods.

For average households, the probability of being adversely affected by shocks reduced by 2.5 and 4.1 percentage points in 2005/06 and 2015/16 respectively for a one point increase in the index of housing quality, holding all other variables at means. Likewise, for the pooled cross-sectional data, a one point increase in the housing quality index reduces the probability of reporting vulnerability to shocks by 3.5 percentage points. The MCA index scores increase with the quality of housing, thus households with higher MCA index scores are presumed to have better quality houses and therefore better welfare. The estimated coefficients are statistically significant at one percent for the different cross-sectionals and pooled datasets, indicating that housing quality, as a measure of household welfare is significantly associated with the probability of vulnerability to various livelihood shocks. The difference in the magnitude of housing quality index coefficient in 2005/06 and 2015/16 reveals a growing importance of household wealth in reducing vulnerability shocks. This implies that in the Kenyan context, as households improve their economic statuses, they are therefore better suited to institute ex-ante response mechanisms to retain welfare even in the face of livelihood shocks (Andersen and Cardona, 2013).

The estimated association between the household total consumption expenditures, also included in the model as an indicator of household economic status, and the probability of reporting being adversely affected by a shock is not consistent in the two study periods. On average, a percentage increase in household consumption expenditures led to a reduction in the probability of reporting vulnerability to shocks by 1.5 percentage points in 2005/06 but using the 2015/16 cross-section, a similar increase in consumption expenditures resulted into a 4.8 percentage points increase in the

probability of reporting adverse effects of shocks, holding all other variables at their respective means. Povel (2015) also found that income was positively related to the probability of exposure to shocks for rural households in rural Thailand. With the pooled dataset, a one percent increase in household consumption is associated with a 1.6 percent increase in the probability of reporting shocks. As a measure of household welfare, total household consumption expenditure increases the wellbeing, ceteris paribus. Households with higher spending are associated with more assets and diverse livelihoods which translates into more resilience and lower vulnerability to shocks. This *a priori* hypothesis is consistent with the estimation results using the 2005/06 dataset, but has opposite relationship with the 2015/16 and the pooled datasets. The positive relationship found in these results could be due to the fact the shocks reported are not directly related to the household economic status such as deaths or social and inter-ethnic group conflict. The unexpected result could also indicate that the reported household expenditures includes transfers, which does not reflect the true economic status of the household.

In all datasets, the coefficient of location is positive and statistically significant. For average households, the predicted probability of reporting vulnerability to all categories of shocks is 1.8, 4.6 and 4.0 percentage points higher in rural than in urban areas respectively for 2005/06, 2015/16 and pooled datasets. The results indicate that the households in rural areas were on average more likely to report vulnerability to all categories of shocks. Given that the majority of the reported shocks were climatic, weather and agricultural related, it is plausible to expect that households in rural areas would be more vulnerable because their livelihoods depend mostly on agriculture and other natural resources. In addition, households in rural are likely to suffer more from economic shocks such as food price inflation because of limited livelihood diversification (Ellis, 1998).

The association of other household-specific characteristics with the vulnerability to shocks reveals that female-headed households are more likely to report vulnerability compared to those headed by the males in all the regression equations. This indicates that in the context of the sampled households, as in a study in Uganda (Akampumuza and Matsuda, 2017), the gender of the household head influenced household vulnerability to shocks. The results also show that in the three models estimated, the probability of reporting shocks increased with the age of household head. The positive relationship between age and household vulnerability can be construed to

indicate that on average, the household resilience capacity to shocks declines with age, which is consistent with the standard life-cycle theory.

Table 4.9: Analysis of household vulnerability to all categories of shocks (marginal effects)

	2005/06	2015/16	Pooled cross-section 2005/06 and 2015/16
Housing quality index	-0.0255***	-0.0406***	-0.0353***
	(0.0057)	(0.0058)	(0.0043)
Log of total household annual expenditure	-0.0153**	0.0477***	0.0162***
	(0.0064)	(0.0078)	(0.0050)
Location (Rural = 1)	0.0181*	0.0462***	0.0396***
	(0.0101)	(0.0090)	(0.0121)
Sex of household head (Male = 1)	-0.0376***	-0.0548***	-0.0484***
	(0.0094)	(0.0091)	(0.0068)
Age of household head	0.0046**	0.0049**	0.0045***
	(0.0019)	(0.0020)	(0.0015)
Age squared of household head	0.0000*	0.0000	0.0000*
	(0.0000)	(0.0000)	(0.0000)
Household size: 0-17 years old	0.0170***	0.0277***	0.0216***
	(0.0023)	(0.0026)	(0.0018)
Household size: 18-64 years old	0.0090**	0.0119**	0.0069**
	(0.0035)	(0.0043)	(0.0029)
Household size: 65 and more years old	0.0189	0.0274	0.0194
	(0.0170)	(0.0185)	(0.0135)
Education of household head ('no formal education' is reference category)			
Primary	-0.0179*	0.0025	-0.0045
	(0.0099)	(0.0100)	(0.0074)
Secondary	-0.0194*	-0.0142	-0.0156*
	(0.0109)	(0.0115)	(0.0084)
Tertiary	-0.0538***	-0.0493**	-0.0525***
	(0.0185)	(0.0175)	(0.0133)
Employment of household head ('Salaried/waged' is reference category)			
Small business	0.0256**	0.0214*	0.0245***
	(0.0103)	(0.0110)	(0.0082)
Agriculture	0.0090	0.0817***	0.0584***
	(0.0112)	(0.0109)	(0.0082)
Year dummy (2015 = 1)	_____	_____	-0.1996***
			(0.0094)
Location dummy interacted with Year dummy	_____	_____	-0.0060
			(0.0131)

Standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

Household size was disaggregated based on dependency, and categorized into zero to 17 years and over 65 years as the non-working group and 18 to 64 years being the working age group. Upon estimation, it was found that household sizes in the zero to 17 year and 18 to 64 year categories

increased the probability of reporting vulnerability to shocks. The magnitude of the association was however higher and more significant for the zero to 17 year category. The coefficient of the over 65-years category was not statistically significant at 10 percent. The positive association between the size of nonworking age group and vulnerability to shocks is expected according to literature (see for example Dercon, Hoddinott and Woldehanna, 2005; Andersen and Cardona, 2013). The 'unexpected' positive relationship between the size of working age group and the vulnerability to shocks could imply that vulnerability to the shocks being considered is an increasing function of household size irrespective of the age-group categorization.

Households whose heads have more education achievement compared to those without any formal education had lower probability of reporting vulnerability to all categories of shocks. The association of education achievement on vulnerability to shocks is explicitly significant in all education rungs in the 2005/06 but it is only significant in tertiary level 2015/16. There is a notable difference between 2005/06 and 2015/16 in the level at which education achievement rungs become significantly associated with the probability of reporting shocks. The non-significance of primary and secondary education levels in 2015/16 compared to 2005/06 could imply an evolution over time in the dynamics of labour markets and the aggregate education achievement levels in Kenya. The relationship of employment status of the household head with the household vulnerability to shocks is as expected from theory. In general, compared to households whose heads are in stable, formal and salaried employment, those whose heads work in unpredictable and low paying businesses as well as peasant farming and related agricultural enterprises are more likely to report adverse effects of shocks. Since employment represents the livelihood source, sectors such as agriculture are most depended on natural environment and therefore more vulnerable to climate-related shocks as well as economic shocks such as farm-input price inflation.

The estimation model with the pooled data set contained a variable of time effect between 2005/06 and 2015/16. This is the variable measuring the evolution of household vulnerability to shocks across the reference period. The results show a statistically significant difference in the household probability of reporting vulnerability to shocks between the two reference periods. Specifically, holding all other factors constant, as the reference period changes from 2005/06 to 2015/16, the probability of an average household reporting vulnerability to a shock reduces by 20 percentage points, holding all other variables at their means. The results are consistent when estimated

separately for rural and urban households. The probability of reporting shocks reduces as the reference period changes from 2005/06 to 2015/16 for both households, but the magnitude is higher by five percentage points for urban households. The similar effect of time passage on both rural and urban households' probability of reporting shocks explains the non-significance of the coefficient of interaction between location and time. This shows in effect that there are no statistically significant differences between rural and urban households' vulnerability to shocks in 2005/06 and 2015/16. These findings indicate an increase in both rural and urban households' resilience at the same reference period when physical infrastructure stocks and access levels also increased in both rural and urban areas.

4.4.3   Analysis of Household Vulnerability to Food Security Shocks

An analysis of household vulnerability specifically to food security shocks is provided in this section. These are the shocks that directly and adversely affect household's ability to access food and thus make them food-insecure. In this study, they include droughts, floods, crop diseases and pests, death or theft of livestock, inflation of food and farming inputs prices and severe water shortages. Food security shocks are prevalent and have significant ramifications on household welfare and in general on the country's human capital development. Malnutrition is ranked first (both in 2007 and 2017 studies) as the risk factor driving most deaths and disability in Kenya (Institute for Health Metrics and Evaluation, 2017). In this study's sample, out of the 10,978 households reporting shocks in 2005/06 study, 73 percent reported food-security related shocks. In 2015/16, 70 percent reported similar shocks out of 13,706 households.

The estimation results of household vulnerability to food-security shocks are presented in table 4.10. The results indicate that, in general and holding all other variables at their means, there were no statistically significant changes in household vulnerability to food-security shocks between 2005/06 and 2015/16. However, the coefficient of the interaction of time and location of household was found to be statistically significant at one percent. Compared to urban households, the rural households' probability of reporting vulnerability to food-security shocks reduced by four percentage points in 2015/16 sample compared to 2005/06 sample. These findings are consistent with the study's hypothesis that rural households' vulnerability to food-security shocks reduced due to increases in the stocks of physical infrastructure in the country between 2005/06 and

2015/16. However, since by design this is an observational study and not a randomized controlled experiment, it is not possible to infer that the reduction in household vulnerability to food-security shocks was caused only by the increase in physical infrastructure stocks within the reference period. The results are therefore interpreted to mean that a statistically significant association was established, which could be could be attributed to infrastructure growth, but other possible explanations cannot be ruled out (Ramsey and Schafer, 2012).

The estimation produced statistically significant coefficients for the model's control variables. Coefficients of variables measuring household wellbeing, housing quality index and total household consumption expenditure were statistically significant and as expected, negatively associated with the probability of reporting a food-security shock. The probability of reporting a food-security shock was likely to be positively associated with households residing in rural areas than those in urban areas. Male heads of households were more likely to report food-security shocks than female heads, unlike in the general shocks model where it was found that female-headed households were more vulnerable than male-headed households. Other empirical studies have found that female-headed households are more likely to be food insecure compared to the male –headed ones (Jacobs, 2010; Felker-Kantor and Wood, 2012; Kassie, Ndiritu, and Stage, 2014) while others such as Mallick and Rafi (2010) found no statistically significant effect of household's gender on household food security. Vulnerability to food-security shocks was found to increase for households headed by individuals working in the less stable and unpredictable jobs compared to those in regular and salaried employment. The coefficient of age was found to be statistically insignificant from zero in all the models.

Household size in all age categories was found to be positively associated with the probability of reporting food shocks, except for the over 65-years category for the 2015/16 cohort. These results could indicate that many of households' adult members cannot find work, meaning that dependency rate increased with household size. Dependency is positively related to household food-security vulnerability. The model included household main source of food as per a theoretical claim that vulnerability to food-security shocks is associated with the sources of food (Moltedo et al., 2014). Food sources was found not to have statistical significance for the 2005/06 data set.

Table 4.10: Estimation of household vulnerability to food security shocks (marginal effects)

	2005/06	2015/16	**Pooled cross-section 2005/06 and 2015/16**
Housing quality index	-0.0228*** (0.0078)	-0.0508*** (0.0069)	-0.0377*** (0.0051)
Log of total household annual expenditure	-0.0212** (0.0094)	-0.0185** (0.0093)	-0.0251*** (0.0060)
Location (Rural = 1)	0.0987*** (0.0140)	0.0290** (0.0108)	0.0805*** (0.0121)
Sex of household head (Male = 1)	0.0378*** (0.0123)	0.0256** (0.0105)	0.0316*** (0.0080)
Age of household head	0.0022 (0.0027)	-0.0001 (0.0024)	0.0008 (0.0018)
Age squared of household head	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Household size: 0-17 years old	0.0147*** (0.0030)	0.0142*** (0.0030)	0.0146*** (0.0021)
Household size: 18-64 years old	0.0146*** (0.0047)	0.0289*** (0.0052)	0.0211*** (0.0034)
Household size: 65 and more years old	0.0390* (0.0223)	0.0349 (0.0212)	0.0350** (0.0153)
Household main source of food ('Purchased' is the reference category)			
Own-produced	0.0013 (0.0191)	0.0404*** (0.0126)	0.0313*** (0.0104)
Gifts	0.0066 (0.0389)	0.0842** (0.0301)	0.0517** (0.0239)
Own-stocks	0.0409 (0.0335)	0.0182 (0.0350)	0.0284 (0.0243)
Education of household head ('no formal education' is reference category)			
Primary	0.0137 (0.0135)	0.0145 (0.0121)	0.0152* (0.0090)
Secondary	0.0113 (0.0154)	0.0513*** (0.0137)	0.0365*** (0.0102)
Tertiary	-0.0454* (0.0270)	0.0727*** (0.0202)	0.0287* (0.0161)
Employment of household head ('Salaried/waged' is reference category)			
Small business	0.0538*** (0.0153)	0.0235* (0.0138)	0.0377*** (0.0102)
Agriculture	-0.0077 (0.0151)	0.0285** (0.0134)	0.0112 (0.0099)
Year dummy (2015/16 = 1)	_____	_____	-0.0129 (0.0110)
Location dummy interacted with Year dummy	_____	_____	-0.0443*** (0.0143)

Standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

However, in the 2015/16 and pooled data sets, results show that compared to the households depending on mainly purchased foods, households producing own foods and depending on own stocks were more likely to report being adversely affected by food-security shocks. In 2005/06 data set, education had the expected negative relationship with the probability of reporting food-security shocks. however, in the 2015/16 and the pooled data sets, results indicate that households headed by heads with higher education levels, compared to the heads with no formal education, had higher probability of reporting being adversely affected by shocks that result into food insecurity. These findings could imply that households with lower education achievements were more likely to engage in less risky-but lower returns food production ventures (Morduch, 1990; Dercon, 2002).

4.4.4 Household ex-post coping strategies to shocks

When hit by shocks, households adopt a variety of ex-post coping strategies. Presented in table 4.11 below are the reported measures undertaken by the affected households to insulate themselves from the effects of shocks ex post. Households ranked up to three strategies in terms of importance in responding to the adverse effects of shocks. In this study, only the first choice is used for the analysis. Coping mechanisms which are households' first choice represent 57 percent in the 2005/06 sample and 70 percent in the 2015/16 sample. The ex-post coping strategies for the general shocks and for food-security shocks are assessed for the two study periods. To ensure comparability of the two data sets, the response 'did nothing' reported for 7,990 responses in the 2015/16 data set was expunged.

The popular household response to shocks was spending cash savings in both the data collection periods and for both the general and food shocks. Between the two data collection periods, the percentage of households using this strategy to cope with general shocks and food-security shocks increased by 8.93 and 9.23 points respectively. Between 2005/06 and 2015/16, households reduced the use of the following ex-post coping strategies when adversely affected by the general shocks: selling of animals, working more and longer hours, spiritual help and prayers, selling household assets such as tools and furniture, receiving help from government and local non-governmental organizations. During the same period and for all shocks, households increased the use of cash savings, working away from home for long periods, receiving assistance from international non-

governmental organizations (NGOs), receiving help from family and friends, reducing food consumption and reducing non-food expenditures.

Table 4.11: Coping strategies for all categories of shocks

Coping Mechanism	2005/06 percentage	2015/16 percentage	2005/06 percentage	2015/16 percentage
	All Shocks		Food-security shocks	
Spent cash savings	26.11	35.04	25.33	34.57
Sent children to live with relatives	0.86	0.5	0.79	0.36
Sold assets (tools, furniture, etc.)	1.56	0.91	1.44	0.7
Sold farmland	0.58	0.35	0.49	0.27
Rented out farmland	0.63	0.35	0.64	0.32
Sold animals	10.19	7.84	10.48	8.63
Sold more crops	1.8	2.1	1.9	2.2
Worked more, worked longer hours	10.7	8.78	11.48	9.57
Other household members who were not working went to work	0.93	0.45	0.94	0.33
Started a new business	1.97	1.87	1.64	1.72
Removed children from school to work	0.21	0.16	0.19	0.13
Went elsewhere to find work for more than a month	1.37	1.89	1.13	1.54
Borrowed money from relatives	2.66	2.79	2.34	2.42
Borrowed money from money lender	0.46	0.57	0.39	0.38
Borrowed money from institutions (e.g. banks)	0.5	0.64	0.41	0.51
Received help from religious institutions	0.62	0.78	0.6	0.58
Received help from local NGO	0.79	0.11	0.96	0.1
Received help from international NGO	0.39	1.17	0.48	1.14
Received help from government	2.11	1.46	2.46	1.56
Received help from family/friends	8.34	8.99	7.26	7.11
Reduced food consumption	6.84	8.41	8.15	10.37
Consumed lower cost, but less preferred foods	2.62	2.99	3.1	3.52
Reduced non-food expenditures	2.34	2.86	2.63	3.49
Spiritual help- prayers, sacrifices	7	4.72	6.04	3.87
Other coping strategies not listed	8.44	4.28	8.72	4.59
Sample size	25,220	19,227	20,238	15,150

Source: Author's computation from KIHBS, 2005/06 and 2015/16

The other response mechanisms had negligible change between the study periods. For food-security related shocks, responses based on using cash savings, receipt of assistance from international NGOs, and reduction of food and non-food expenditures increased between 2005/06

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and 2015/16. Selling of household durable assets such as tools and furniture, selling animals, selling household labour, and receiving help from government and local NGOs as well as spiritual intervention reduced between the two study periods. The other coping strategies did not have significant differences between the two study periods. In addition, only in the following ex-post coping strategies were the percentage of responses different between the general shocks and food-security shocks: starting a new business, borrowing money from relatives, and receiving help from family and friends. Specifically, the mean percentage of responses in the two datasets was significantly higher for these coping mechanisms.

4.4.5 The Role of Infrastructure Growth in the Evolution of Ex-Post Coping Strategies to Food-Security Shocks in Kenya

This section gives the estimation results of households' probability of using infrastructure-supported ex-post coping strategies when adversely affected by shocks that significantly contribute to food insecurity. Infrastructure-supported ex-post coping strategies include use of financial savings, formal credit facilities and borrowing from relatives and friends. For the use of these coping strategies to achieve the critical mass, key infrastructure facilities such as financial institutions, credit reference bureaus and information communication technology have to be available. In addition, financial institutions such as banks and insurance companies thrive in an environment supported by other infrastructure services and stocks such as roads, electricity and other auxiliary services such as security and information and communication technologies. These coping strategies constitute a risk management system through which households respond to consumption fluctuations through saving and borrowing. These strategies are regarded more effective in stabilizing household welfare from the adverse effects of shocks and do not compromise ability to cope with future shocks, as is likely to be the case with strategies such as distress sales of productive assets and taking children off school to go work (Alpízar, 2007). In table 4.12, results are presented separately for the two time periods and then for the pooled cross-sections with year dummy included to account for the country's infrastructure changes between 2005/06 and 2015/16.

Table 4.12: Estimation of household probability to use infrastructure-supported ex-post coping strategies to food security shocks (marginal effects)

	2005/06	**2015/16**	**Pooled cross-section 2005/06 and 2015/16**
Reported food shocks (Yes = 1)	0.0666*** (0.0129)	0.0539*** (0.0129)	0.0613*** (0.0091)
Housing quality index	0.0177** (0.0086)	0.0104 (0.0090)	0.0177*** (0.0061)
Log of total household annual expenditure	0.0663*** (0.0105)	0.0685*** (0.0124)	0.0600*** (0.0072)
Location (Rural = 1)	0.0024 (0.0158)	0.0234* (0.0142)	-0.0224 (0.0138)
Sex of household head (Male = 1)	0.0161 (0.0139)	0.0456*** (0.0136)	0.0292*** (0.0097)
Age of household head	0.0026 (0.0030)	0.0053* (0.0031)	0.0045** (0.0021)
Age squared of household head	0.0000 (0.0000)	-0.0001*** (0.0000)	0.0000* (0.0000)
Household size: 0-17 years old	-0.0035 (0.0032)	-0.0013 (0.0037)	-0.0002 (0.0024)
Household size: 18-64 years old	-0.0032 (0.0050)	0.0167** (0.0065)	0.0023 (0.0038)
Household size: 65 and more years old	-0.0290 (0.0234)	0.0449* (0.0270)	0.0040 (0.0175)
Reported access to credit (Yes = 1)	0.0372*** (0.0122)	-0.0164 (0.0125)	0.0114 (0.0087)
Access to formal insurance (Yes = 1)	_____	0.0322* (0.0166)	_____
Access to mobile money transfer platform (Yes = 1)	_____	0.0625** (0.0229)	_____
Education of household head ('no formal education' is reference category)			
Primary	0.0507*** (0.0146)	0.0051 (0.0151)	0.0295** (0.0104)
Secondary	0.0453** (0.0168)	0.0130 (0.0179)	0.0343** (0.0122)
Tertiary	0.0185 (0.0293)	0.0188 (0.0291)	0.0258 (0.0203)
Employment of household head ('Salaried/waged' is reference category)			
Small business	0.0035 (0.0171)	-0.0154 (0.0186)	-0.0099 (0.0123)
Agriculture	-0.0596*** (0.0166)	0.0134 (0.0180)	-0.0289** (0.0120)
Year dummy (2015/16 = 1)	_____	_____	0.0367** (0.0139)
Location dummy interacted with Year dummy	_____	_____	0.0506*** (0.0173)

Standard errors are in brackets. ***, **, *: significant at 1%, 5% and 10% respectively

This study hypothesized that changes in the country's stocks of physical infrastructure and population access between 2005/06 and 2015/16 has contributed to increased household use of infrastructure-supported ex-post coping strategies. To determine if there was an increased reliance on these coping strategies, a pooled cross-section regression was instituted. Results show that the coefficient of time period dummy was statistically significant at five percent level of significance. Specifically, the probability of a household using infrastructure supported coping strategies increased by 3.7 percentage points as the reference period changes from 2005/06 to 2015/16, holding all other variables at their means. The results indicate that when affected by food-security shocks, households were in 2015/16 than in 2005/06 more likely to use financial savings, formal credit facilities and borrowing from relatives and friends as ex-post coping strategies. This could mean that in 2015/16, the physical infrastructure supporting these coping options were accessible to more households and that there was increased use among the households. In the absence of a randomized-controlled experiment, it is not possible to attribute the changes in the use infrastructure-supported ex-post coping strategies exclusively to the country's infrastructure transformation between the reference periods.

To assess robustness of the claim that adoption of these specific coping strategies are attributable to infrastructure growth, a comparison was done of the changes in their use across the reference period and between the rural and urban households when faced by general food-security shocks. Separate estimation results indicate that passage of time was associated with increased probability of using the infrastructure-supported coping strategies in both rural and urban households. This is plausible given that infrastructure growth in the country during the reference period was not limited to rural areas. While the status of the rural-urban gaps in basic physical infrastructure stocks and access between 2005/06 and 2015/16 could not be determined in the scope of this study, it is assumed to exist on almost all key indicators. However, infrastructure stocks and access levels grew between the reference periods in both rural and urban areas. For example, mobile telephone connections and money transfers were negligible in both areas at the baseline (2005/06) but the access was relatively higher in urban areas in 2015/16. In order to capture both the level and trend effects, a variable interacting household location and year dummy was introduced in the estimation model. The coefficient of the interaction term shows that the probability of using infrastructure-supported coping strategies increased by five percentage points more for the rural households

facing food-security shocks than the urban households facing similar shocks in 2015/16 compared to 2005/06, holding all other variables at their means.

The results reveal greater changes in the adoption of infrastructure-supported coping strategies in the sampled rural households compared to urban households. This revelation strengthens the claim that the infrastructure growth between 2005/06 and 2015/16 contributed to the observed evolution of household ex-post coping strategies. This is because, given that rural areas had lower baseline infrastructure stocks and access levels than urban areas, it is therefore possible that any infrastructure growth in the intervening period (new roads, new electricity connections, new bank branches, mobile telephone subscription and money transfer services) should result to higher changes in the group with lower baseline figures (rural households) than in the group who already had higher baseline infrastructure stocks and access (urban households).

The estimation results of the coefficients of other variables in the model show that households that reported food-security shocks were more likely to use savings and borrowing coping strategies compared to those that reported other shocks. The results are consistent in the estimation of 2005/06, 2015/16 and pooled regression models. These results indicate that drawing off of cash savings and accessing short-term credit are more effective in addressing volatility in production of prices of household food than for dealing with other types of shocks such as household diseases, death or social conflicts. Housing quality index and consumption expenditures both measure household wellbeing. Their coefficients in the models indicate that households with higher absolute incomes were more likely to use savings and borrowings to respond to food-security shocks compared to relatively poor households. the non-significance of the housing-quality index coefficient in 2015/16 compared to 2005/06 could indicate an overall standardization in the materials being used for housing roofing, flooring and walling across the country in the ten year period between 2005/06 and 2015/16 to the extent that this quality index is no longer a proxy for household wellbeing in 2015/16 than it was in 2005/06.

In 2005/06 and the pooled cross-section models, the location of household did not matter in the use of savings and borrowing as ex-post coping strategies. However, in the 2015/16 cohort, rural households were more likely to use these coping strategies compared to urban households to respond to food-security shocks. In 2015/16, one example of these coping strategies was transfer of money (credit or transfers) via the mobile money platform. Studies including Jack and Suri

(2014) have established a general pattern of mobile money transactions originating in urban areas and terminating in rural areas. This pattern of transfers and the reported higher frequency of food-security shocks in rural areas compared to urban areas could explain the positive coefficient in the location variable. In the 2005/06 data, the sex of the household head has no effect on household decision to use infrastructure-supported coping strategies. However, in 2015/16 and the pooled data, results show that households headed by men are most likely to use savings and borrowings to smooth consumption after food-security shocks. In addition, the use of these coping strategies increases with the age of household head and the relationship is weakly non-linear in the 2015/16 data and weakly linear in the pooled data.

The coefficients of different categories of household sizes were mostly insignificant except in the 2015/16 cohort where the probability of using these coping mechanisms increased as households members in the 18-64 years and over 65 years categories increased. Households that reported being able to access various types of formal and informal credit were also found to be most likely to use savings and borrowing as coping strategies. However, this relationship was only significant in the 2005/06 data. Similarly, in 2015/16 cohort where data on insurance and mobile money transfer system was available, results show that households accessing these services were also most likely to use savings and borrowing to smooth food shocks. These results are expected since access to one form of financial service (e.g. insurance) indicates presence of an underlying infrastructure that supports access to savings and credit services.

The coefficient on education was not statistically significant in the 2015/16 data set. However, in the 2005/06 and the pooled data sets, the results are consistent with other empirical works that the probability of using infrastructure-supported coping strategies increased with the level of education (Berman, Quinn and Paavola, 2015; Fungácová and Weill, 2015; Zins and Weill, 2016). Like in the case of education, the coefficients of occupation category of household heads were not statistically significant at 10 percent for the 2015/16. However, in the 2005/06 and pooled data sets, results show that, compared to households headed individuals with salaried and stable employment, households headed by individuals in agricultural and peasantry employment were less likely to resort to use of infrastructure-supported ex-post coping strategies.

4.5 Summary, Conclusions and Policy Recommendations

4.5.1 Summary and Conclusions

This study set to establish whether the changes in physical infrastructure stocks and population access levels in Kenya between 2005/06 and 2015/16 had an association with changes in the household vulnerability to the general and food-security shocks as well as the ex-post coping strategies adopted to ensure smooth household welfare. In order to ascertain the role of physical infrastructure on household shocks' vulnerability and resultant ex-post coping strategies, this study specifically disaggregated rural and urban samples in addition to the time differences because of the apparent differences in the stocks physical infrastructure and population access levels between the rural and urban areas, especially in a developing country like Kenya. Food-security shocks are specifically highlighted in the study because they are most prevalent especially among rural households and low-income earners in urban areas. In addition, food insecurity causes malnutrition and poor health which diminish the human development potential.

Physical infrastructure contributes to opening of markets, reduction of production, accessibility to healthcare, education, and other amenities that cumulatively reduce household exposure and vulnerability to livelihood risks and shocks. In addition, infrastructural goods and services including financial mediation services and communication networks provide opportunities for risk sharing and other effective means and mechanisms through which households cope with shocks. Kenya's stock of physical infrastructure increased significantly in the period following a political regime change in 2003, which has contributed to significant growth in physical stocks and population access rates. Empirical studies have largely been missing, specifically in the Kenyan context, on the links between physical infrastructure progress and household vulnerability to shocks and ex-post coping strategies across time and between geographical locations.

After reviewing both theoretical and empirical literature as well as presenting the empirical estimation strategy on linkages between the state of physical infrastructure and vulnerability as well as coping strategies to shocks, this study found significant changes in household vulnerability and ex-post coping strategies across the two reference periods and between rural and urban sampled households. First, the results reveal a statistically significant reduction in household vulnerability to the general shocks between 2005/06 and 2015/16, with the reduction being higher for urban households by five percentage points in relation to the reduction in rural households.

secondly, although generally there was no observed change in household vulnerability to food-security shocks in the reference period, disaggregating the households by geographical location reveals that rural households' vulnerability dropped by four percentage points compared to urban households between 2005/06 and 2015/16. Lastly, the study found that between 2005/06 and 2015/16, both rural and urban households increased their use of infrastructure-supported ex-post coping strategies such as savings and borrowing to respond to food-security shocks. The magnitude of this adoption was higher by five percentage points among rural households compared to the urban households between the reference periods. The study concludes that there is a plausible association between physical infrastructure changes and household vulnerability and coping strategies to shocks across time and in different geographical locations. Specifically, the magnitude of reduction in vulnerability to shocks and the increase in effective ex-post coping strategies is greater for rural households than for urban households.

4.5.2   Policy Recommendations

The findings of this study though not generated through a randomized controlled trial process, were nevertheless produced from a nationally-representative samples and used time passage – an exogenous variable- to assess changes in household vulnerability and coping response to livelihood shocks. Accordingly and based on these grounds, important policy recommendations can be deduced. First, policy interventions to reduce vulnerability to livelihood shocks should consider that vulnerability is a dynamic aspect across time and space. Livelihood shocks vulnerability-reduction policies should for instance be cognizant of the differences in the extent and time dynamics of vulnerability in rural and urban households separately as well as areas of commonality. In addition, such policies should consider that household vulnerability is not a stable phenomenon and that there is need for constant monitoring of the population at risk to ensure effective policy interventions are implemented.

Secondly, relevant stakeholders should incorporate development of physical infrastructure as an important strategy for reducing vulnerability especially in the country's marginalized areas. This could for instance involve using among other sources, the constitutionally-provided Equalization Fund, which constitutes 0.1 percent of GDP allocated to the marginalized areas for providing basic infrastructure services such to provide basic services including water, roads, health facilities and electricity. In addition, the county governments and other funds meant for rural areas development

including the Constituencies Development Fund (CDF) and the National Government Affirmative Action Fund (NGAAF) should prioritize rural infrastructure development as it provides potent option for reducing household vulnerability to livelihood shocks as well as providing options for effective ex-post coping strategies to shocks that cannot be managed ex-ante.

Third, the development of infrastructure stocks need to be implemented as a bundle of inter-related elements to create bigger impact in vulnerability reduction and building of household resilience to shocks. For example, rural electrification should be complemented with motorable roads, agricultural produce market centres, functional education and health infrastructures as well as promotion of establishment of financial institutions. Provision of physical infrastructure especially for financial inclusion need to be supplemented with necessary soft infrastructure such as regulation of financial institutions offering savings, credit and insurance services to rural populations, education of the population about credit management and promoting credit reference bureaus in areas to assess credit worthiness of potential borrowers and information sharing. Further interventions could include advancing rural economies productivity by creating markets for agricultural produce through use of the growing mobile phone infrastructure to create digital platforms to help smallholder farmers market their produce. However, this can only function effectively with working road transport infrastructure, cold storage facilities and other infrastructure to enhance growth of e-commerce in the rural areas.

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Chapter Five   Livelihood Diversification and Household Vulnerability to Climate Shocks in Rural Kenya

5.1   Introduction

Rural households in low-income economies usually pursue multiple income-generating activities rather than specialize in a single occupation (Ellis, 1998; Barrett, Reardon and Webb, 2001). Activities pursued include those in the agriculture sector and those not depended on agriculture. Within the agricultural sector, pursuing of multiple production activities for instance involves planting different crops, rearing different livestock, as well as combining growing of crops and rearing of livestock. In addition, rural households also engage in other agriculture-related or unrelated income generating activities such as wage employment and self-employed activities including merchandise shops, transportation, storage and petty trading. Income from the non-farm activities accounts for 35 percent to 50 percent of household income in developing countries (World Bank, 2017). In other cases, rural households maximize welfare by leveraging the spatial differences to optimize welfare returns (Ellis, 1998). This includes growing crops in different locations, migrating livestock in search of greener pastures and migration of household members to urban centres to seek for non-farm employment. This process in which rural households build diverse portfolio of income generating activities as well as social support networks for the purpose of safeguarding and enhancing welfare constitutes the essence of livelihood diversification (Ellis, 1998).

Household participation in diverse portfolio of income generating activities is motivated mainly by the 'pull' and 'push' factors (Ellis, 1998; Asfaw et al., 2015; Nagler and Naudé, 2017). Motives of livelihood diversification are classified as due to 'pull factors' if households are attracted by the opportunities available in their environment to increase incomes and enhance welfare through pursuing a diverse portfolio of income generating activities (IGAs). Livelihood diversification due to pull factors is common with the resource-endowed households since this category of diversification has higher entry requirements in terms of various capacities and endowments (Asfaw et al., 2015). Examples of such capacities and endowments are income, assets, location and proximity to important sources of livelihoods, education and social networks. Usually, wealth accumulation is the main goal in this type of livelihood diversification. Other households may adopt diversification as a response to various welfare-reducing shocks. Risk management,

therefore becomes the external stimuli that push households to expand their portfolio of livelihood support systems. As a risk-management strategy, households could use livelihood diversification ex-ante or ex-post. Households institute these strategies in order to smooth income from shocks (Baez, Kronick and Mason, 2013).

Irrespective of the motive, it is plain to see that livelihood diversification is generally beneficial to households through a variety of avenues. For instance, household income increases from the supplementary activities added to the portfolio. In addition, households benefit from production knowledge and skills-transfer gained in wage employment either within the community or through the migrating household members. In the sphere of risk management, livelihood diversification has been found to benefit households via smooth consumption profiles in the presence of income fluctuations due to shocks and seasonality (OECD, 2007). Considering the frequency of shocks in rural livelihoods in low-resource economies, diversification is therefore an important strategy for stabilizing and smoothing consumption from the associated frequent and costly income fluctuations due to shocks.

Studies have highlighted the role of diversification in managing rural livelihood risks in poor countries (Valdivia, Dunn and Jetté, 1996; Bryceson, 1999; Ellis, 2000a, Neudert et al., 2015). Since, in part, diversification entails pursuing a portfolio of unrelated livelihood options with low correlated returns, a perturbation in one source of livelihood need not result into a fall in household consumption because the other income streams are assumed to be unaffected by the same shock. For instance, studies have found specific cases indicating that households with more diversified livelihoods report higher levels and more stable food consumption paths (Block and Webb, 2001) while at the same time finding that diversified livelihood systems to have more resilience to stresses and shocks (De Haan, 2012). Livelihood diversification as a risk management strategy is commonly due to push factors and mostly works for poor households seeking survival from income fluctuations. Essentially, livelihood diversification works as a risk management strategy because it provides a variety of livelihood options, reduces exposure as well as builds a buffer that protects household welfare from the adverse effects of system perturbations (Marschke and Berkes, 2006).

5.1.1 Context of household livelihood diversification and vulnerability to shocks in Kenya

Kenyan households pursue a variety of livelihoods within all sectors of the economy, but mainly concentrated in agriculture, manufacturing, building and construction, trading and services (Republic of Kenya, 2019). This reflects the diversification in the country's economy in terms of sectoral contributions to the GDP and wage employment. According to the Republic of Kenya (2019), the highest contributing sectors to the GDP and employment respectively were agriculture and natural resources (35 percent and 12.7 percent), manufacturing (7.7 percent and 11.1 percent), building and construction (5.4 percent and 6.2 percent), and trading and services (14.7 percent and 16.9 percent). The extent to which households generate livelihoods from these sectors depends on the specific sector's performance, level of human skills, entry and exit conditions and government policies. Accordingly, Kenyan households are likely to pursue a mixture of livelihoods from one or more of these sectors either concurrently, temporally or spatially (Nelson et al., 2016). Specific national policies and programmes have been implemented to enhance livelihood opportunities in all productive sectors of the economy.

Livelihood diversification among Kenyan households also vary according to physical location (rural or urban, and according to agro-ecological zones), income and assets level, household education attainment levels, gender of household head, life-cycle of the productive household members, infrastructure and institutional support such as markets and extension services (McCord et al., 2015). For instance, depending on its agro-ecological zone, a typical rural household could mix crop growing with livestock keeping, exclusively rear livestock (such as pastoralists) or exclusively grow crops, operate shops and related merchandise trade, receive various forms of labour and investment incomes as well as assortment of transfers (Mathenge and Tschirley, 2015). Even pastoralists, known previously to derive livelihoods exclusively from livestock have over time ventured into other economic activities as the effects of population growth, declining resources and environmental degradation caused the returns from pastoralism to dwindle (Bollig, 2016). For example, an examination of household livelihoods in Turkana county found the households, previously predominantly pastoralist, then with varied income sources courtesy of the increasing urbanization, establishment of irrigation infrastructure and formal employment created by the county government (Food Economy Group, 2016). Exploiting the resources within the immediate natural environment was also found a common livelihood diversification strategy

especially among rural families through activities such as charcoal burning, collecting wild fruits and fishing (Ndegwa et al., 2016).

On the other hand, households in both rural and urban areas of the country are vulnerable to a plethora of welfare-reducing shocks. For example, drought is a frequent phenomenon in arid and semi-arid lands (ASALs), which cover over 80 percent of the country's land mass and are home to 20 percent of the country's population (Republic of Kenya, 2012). Other climate-related shocks such as floods and landslides are widespread in all the agro-ecological zones of the country. In addition, diseases are prevalent across the country's physical locations and socio-economic classes, with a high disease burden as measured by the disability adjusted life years (DALYs) contributed by communicable, maternal, neonatal, nutritional diseases, non-communicable diseases and injuries (Achoki et al., 2019). The other prevalent shock is persistent food-price inflation that leads to food inaccessibility for the millions of vulnerable Kenyans, especially those who depend significantly on food markets. This is undesirable because a fall in household food consumption translates into a poor state of the general welfare which impacts negatively on human development and quality of life (Crawford and Thorbecke, 1980).

5.1.2 Statement of the Problem

As shown in the contextual analysis, rural Kenyan households, as in most of developing countries, pursue diversified livelihoods and are also perennially vulnerable to welfare-reducing shocks. In the realm of development economics and poverty reduction, livelihood diversification has been advanced as a viable strategy to counter the welfare-reducing effects of livelihood shocks through the provision of alternative livelihoods, and building of resilience and future adaptive capacity to shocks (Valdivia, Dunn and Jetté, 1996; Bryceson, 1999; Ellis, 2000a; Block and Webb, 2001; Marschke and Berkes, 2006; De Haan, 2012; Neudert et al., 2015). In the literature, it has been demonstrated how various forms of livelihood diversification helps ameliorate and even shield vulnerable households from the adverse effects of livelihood shocks (De Haan, 2012; Akhtar et al., 2019; Birthal and Hazrana, 2019). In the Kenyan context, similar studies have shown the association between various aspects of livelihood diversification and vulnerability to shocks (Dorsey, 1999; McCord et al., 2015; Quandt, Neufeldt and McCabe, 2017). These studies are however based on location-specific sample sizes and are therefore not representative of the heterogeneity in Kenyan rural households. Other studies such as Christiaensen and Subbarao (2005) and Mathenge and Tschirley (2015) used nationally representative sample sizes to show

the effect of household off-farm labour diversification on vulnerability to climate and health shocks. However, rural livelihood diversification has other dimensions beyond alternative uses of household labour and which may have potential influence on household vulnerability to livelihood shocks. The current study contributes to the existing literature by analyzing two waves of nationally representative data to assess the association between a comprehensive measure of rural livelihoods diversification and vulnerability to climate shocks in Kenya. The assessment of the association is also enriched by considering the household heterogeneity in agro-ecological zones and income levels.

5.1.3 Research Questions
In the vulnerability and poverty literature, diversification of livelihoods is routinely touted as a valid policy instrument for addressing household vulnerability to livelihood shocks and also as a catalyst in poverty reduction. However, this relationship is tempered by a number of considerations such as the nature and context of diversification, the context of livelihoods and household vulnerability among other possible covariates. Against such background, this study poses a research question; what is the relationship between livelihood diversification and vulnerability to climate shocks in rural Kenyan households? Specifically, the research seeks to answer this question: what is the relationship between livelihood diversification and vulnerability to climate shocks for rural households in different income cadres and agro-ecological zones? Addressing the research question along such disaggregation controls for the expected confounding effect of income and agro-climatic conditions in this relationship (Asfaw et al., 2019). For example, households in the higher income quantiles will not necessarily be affected by drought irrespective of the level of diversification while poor households will nonetheless be adversely affected by climate shocks despite their level of livelihood diversification. Similarly, households in ASALs must content with drought and its effects irrespective of their levels of livelihood diversification.

5.1.4 Objectives of the Study
In accordance with the research questions being explored, the general objective guiding this study is to test the hypothesis that among rural households in Kenya, livelihood diversification is negatively related with the vulnerability to climate shocks. To understand this relationship further among the rural households in the country, a specific objective is also explored; to assess the relationship between livelihood diversification and vulnerability to climate shocks along income cadres and agro-ecological zones. In addition to these objectives, the findings from the assessments

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provide a basis for making policy recommendations on improving the livelihoods of rural households in Kenya.

5.1.5 Relevance of the Study

Rural livelihoods in most of the developing economies are vulnerable to a variety of welfare reducing shocks (Pelletier et al., 2016). Although many interventions have been instituted to build livelihood resilience, the ongoing change in the climate and weather patterns brings forth new threats such as crop pests and diseases, livestock diseases, more prolonged droughts and unprecedented flooding (Mbow et al., 2019). Diversification of livelihoods promises a viable strategy for building the resilience of the fragile livelihoods, especially those in rural areas of developing countries (Hurlbert et al., 2019). Studying the linkage between livelihood diversification and vulnerability to climate shocks is therefore useful as it informs strategies to build livelihood resilience, reduce poverty and ultimately foster sustainable livelihoods in the face of climate change.

With Kenya's rain-fed agriculture-dependent and climate-sensitive tourism economy, vulnerability of livelihoods is an important development concern (USAID, 2018). Consequently, the country has made commitments towards improving the livelihoods of households vulnerable to climate-related shocks. These commitments are contained in various national and international policy documents such as Kenya Vision 2030, Third Medium Term Plan 2018 – 2022, President's Big Four Agenda, Sustainable Development Goals and the African Union Agenda 2063. Findings of this study contributes to the existing policy discourse and recommendations for building the resilience of the poor and vulnerable households from adverse effects of climate shocks.

5.1.6 Limitations of the Study

In the computation of livelihood diversification index, relevant indicators of diversification were mined from questionnaire modules on household demographics, production activities and income sources as there was no direct data for determining livelihood diversification at the household level. This approach may result in inexact measures of household livelihood diversification index, and ultimately affect the correlation coefficients estimated. However, sensitivity analyses were conducted that found that such possible inaccuracies did not fundamentally affect the results based on the *a priori* expectations. In addition, some variables used in the study have recall data, which in some instances is potentially inaccurate in their measurement. However, during data collection,

responses requiring recall were probed to ascertain their accuracy, reported shocks were cross-validated through using market and community questionnaires and focus group discussions to minimize the measurement errors emanating from recalling of responses (Republic of Kenya, 2007, 2018). Finally, a few differences were observed in the questionnaires in the two surveys. Such differences leads to differences in measurements as well as non-comparability of study variables across the two data sets. In addition, data on crop and livestock farming in the 2015/16 KIHBS had not been processed by the time of the study. This affected the quality of analysis and limited the inferences that could be done within the study's scope.

5.2   Literature Review

The role of livelihood diversification in household welfare outcomes is theoretically hinged upon the standard portfolio theory of risk and return as applied in finance. The essence of the theory is that economic agents are motivated to hold portfolios that maximize expected returns for given risk, as measured by its variance (Markowitz, 1959). In this perspective, diversification can be regarded as an economic undertaking whose optimal value can be determined through marginal analysis of costs and benefits (Statman, 2004). Accordingly, households will seek a diverse portfolio of income generating activities if the marginal benefits of doing so exceeds the marginal costs (Statman, 2004). Costs of diversification according to Statman (2004) are those related to transacting or holding into the activities, while the benefit is the reduction of risk, as measured by the standard deviation of portfolio returns. This theory can be used to explain household livelihood management, specifically the diversification of rural livelihood options. For these households, the portfolio problem arises because the households are supposed to allocate its scarce resources (time, money, skills) among competing alternatives which have uncertain outcomes (McEntire, 1984).

The relationship between livelihood diversification and household vulnerability to shocks emanates theoretically from the established motives of holding a diverse portfolio for the purpose of risk management. Barrett, Reardon and Webb (2001) argue that there is a natural predisposition for livelihood diversification among rural households of developing economies. This arises first because the rural subsistence production ubiquitous in such economies has seasonal variations and therefore specialization would not result into the desired smooth consumption across seasons. Secondly, diversification can be explained by the incomplete and missing markets for important

factors of rural production such as land, labour, credit and insurance. Another disposition for diversification is that it offers a means of ex-post coping with income shocks. Finally, diversification thrives in such settings because of existence of economies of scope – in which, unlike economies of scale where concentration of production units results into greater output, more returns are obtained if production units are applied into multiple activities.

Regarding the relationship between diversification and household welfare' vulnerability to risk, there is a valid theoretical affirmation in the literature. Diversification is found to be relevant along the risk management continuum (Ellis, 2000b; Barrett, Reardon and Webb, 2001). It manages risk ex-ante through its role as an anticipatory precaution to forestall income and consumption variability, while it can be used ex-post as a reactionary response to stabilize welfare upon the realization of risk (Ellis, 2000b). According to Scoones (1998), vulnerability to climate-related hazards is conceptualized as being system-specific and as a function of exposure (nature and degree of riskiness), sensitivity (extent and degree of susceptibility to shocks), and adaptive capacity (extent of adjustment to system-normal).

Assuming decision making in the utility-maximizing framework, the inherent heterogeneity in livelihood diversification can be explained by the differences in preferences and circumstances of the households (Curcuru et al., 2010). Although referring to the portfolio choice of financial assets, Curcuru et al. (2010) avers that household-specific circumstances such as endemic risks, demographics, information asymmetries and transaction costs contribute mostly to the heterogeneity. In addition, under the framework of utility maximization, diversification implies a process of maximizing welfare given a set of resource constrains. This theoretic framework also explains the pull and push motives of diversification (Barrett, Reardon and Webb, 2001). The sustainable livelihoods approach due to Scoones (1998) focusing on the household capabilities and resources also helps explain the resultant heterogeneity in rural livelihoods and the subsequent effect on the relationship between diversification and vulnerability to shocks.

In the literature of livelihood diversification in low-resource economies, various empirical studies have examined the relationship between livelihood diversification and vulnerability to risks. Some studies have found that shocks trigger diversification, in which case the latter is a reactionary response to adverse effect of shocks (Abraha, 2007; Mutenje et al., 2010; Asfaw et al., 2015; Kubik and Maurel, 2016). Other set of studies found that livelihood diversification enhances ex-ante

adaptive capacity of households from adverse effects of shocks (Asfaw, Pallante and Palma, 2018). In other cases, no relationship was found between portfolio diversification and vulnerability to shocks (Kowalski et al., 2016; Dedehouanou and McPeak, 2020). Such findings have been attributed to the underlying characteristics of livelihood diversification (such as portfolios being pro-cyclical or the intensity and severity of shocks). This study adds to the existing empirical works in Kenya such as Christiaensen and Subbarao (2005), Opiyo, Wasonga and Nyangito (2014) and Amwata, Nyariki, and Musimba (2016) on household vulnerability to climate-related shocks; McCord et al. (2015) on the finding that households diversify not solely for food security but also due to other reasons such as tradition or peer imitation; Lay, Mahmoud and M'Mukaria (2008), Olale and Henson (2013) and Romeo et al., (2016) on the effect of livelihood diversification on various aspects of household welfare such as nutrition, poverty and income distribution. The current study uses a nationally representative sample size to assess the relationship between livelihood diversification and welfare vulnerability but does not specify *a priori* the relationship between diversification and vulnerability to shocks as is the case with Mathenge and Tschirley (2015) who studied the effect of climate shocks on the labour market diversification in Kenya.

5.3   Methodology and Estimation Approach

This section presents the approach and framework used in estimating the relationship between livelihood diversification and vulnerability to climate shocks.

5.3.1 Theoretical Framework

The relationship between livelihood diversification and vulnerability to climate shocks is modelled under the broad theme of precautionary risk management. Since the primary motive of risk management is to ensure smooth consumption across different states, it is therefore expected that vulnerability to shocks is inversely related with the level and extent of livelihood diversification (Rampini and Viswanathan, 2016). Essentially, increasing the options in the portfolio of livelihood options leads to reduced risk in welfare fluctuations (Statman, 2004). In the context of this study and assuming incomplete markets as well as risk-averse households, diversification is considered as an insurance against welfare fluctuations brought by climate-related shocks (Rampini and Viswanathan, 2016). Livelihood diversification limits the negative impacts of climate shocks on household welfare by steadying incomes across different states. In rural areas where livelihoods

are mostly depended on agriculture, climate shocks contribute significantly to household income fluctuations. Livelihood diversification therefore creates buffers that make livelihoods less sensitive to adverse effects of climate shocks. Risks and opportunities for livelihood diversification differ across different categories of households, thus bringing a variation in this postulated relationship (Seaman et al., 2014).

5.3.2 Estimation Strategy

The relationship between livelihood diversification and vulnerability to climate shocks postulated in this study is estimated through correlation analysis. The premised relationship between the two has yielded the testable hypothesis that households with more diversified livelihoods are associated with fewer incidences of vulnerability to adverse effects of climate shocks. The postulated association is conditioned by the inclusion of agro-ecological zones and income classes of the samples, which are considered as important covariates with potential influence on the hypothesized relationship (Asfaw et al., 2019).

Climate shocks are assumed to be independent and identically distributed (iid). These shocks are classified as covariate in nature, implying that their occurrence is non-discriminant of all households in the targeted physical location. However, the extent to which household welfare is adversely impacted by the shocks differs among the affected households on account of various factors such as the levels and extent of livelihood diversification. In this case, livelihood diversification can be seen as a response to climate shocks or alternatively, the extent to which households are vulnerable to shocks could be due to the level/extent of livelihood diversification (Paavola, 2008; Asfaw, Pallante and Palma, 2018). This situation is partly contributed by findings in the literature indicating that livelihood diversification is used as both an ex-ante risk management and ex-post coping strategy (Asfaw et al., 2019, Birthal and Hazrana, 2019).

Since it is possible that both variables can alternately be designated as explanatory as well as response variables, a regression analysis relating one variable as a function of the other could not be carried out in the scope of the data available. Instead, a correlation analysis describing the linear association between livelihood diversification and vulnerability to climate shocks was implemented. The correlation results, indicating the strength and direction of the relationship is adequate to answer the study's research questions (see Mayer-Schönberger and Cukier, 2013). Since data on livelihood diversification and vulnerability to climate shocks was obtained from

randomly selected samples of the population, inferences based on the findings of the correlation analysis are valid (Ramsey and Schafer, 2012).

5.3.2.1 Computation of Livelihood Diversification Index

Rural households in Kenya, like in other developing countries, draw their livelihoods mainly from agriculture and other natural resource endowments such as fishing, hunting and gathering. Non-agricultural sources of livelihood such as waged labour and trade are also available and their access depends on specific household and regional characteristics such as educational achievement, skills set and proximity to transport corridors or commercial nodes. To the extent of available data, computing of the livelihood diversification index for this study factored in all the possible sources of livelihood support of the sampled households.

In the general perspective, rural livelihoods diversification consists of crop diversification, farm sector diversification (mixed farming), labour force diversification, income diversification, as well as social and institutional support networks (Ellis, 1998; Mehta, 2009). Crop diversification loosely translates into growing a mixture of different crops with varying characteristics in one or different fields. For livestock keepers, diversification involves rearing a variety of breeds. These production diversification strategies help farmers maximize on weather and climate variability and generally reduces vulnerability of household production systems to climate shocks (Lin, 2011; Megersa et al., 2014). Mixed farming involves combining crop and livestock production. The crop-livestock integration insulates smallholder farm households from climate-induced welfare reductions through avenues such as provision of alternative livelihoods (Altieri et al., 2015). Livelihood diversification also involves participation of household members in waged and salaried labour and employment either in agricultural or non-agricultural sectors (Ellis, 1998). Education provides opportunities for non-farm employment, which provides reliable and perhaps more income to the household (Barrett, Reardon and Webb, 2001; Block and Webb, 2001). Also, education, as a proxy for technical efficiency improves the productivity of the farming sector, hence boosting household incomes (Paltasingh and Goyari, 2018). Kochar (1999) has demonstrated that household labour market participation compensates for the welfare reduction due to climate shocks. Household labour force and education endowment are used in this study to measure the potential of household labour force diversification. Other non-farm income sources such as profit from business, investment income such as rent, savings, interest, dividend and pension; as well as other regular transfers also constitute important avenues of rural livelihoods

diversification (Mehta, 2009). The contribution of social and institutional support networks into rural livelihood diversification were not considered in this study because of lack of relevant data.

After identifying the components of household livelihood diversification, their measurements are explained. Measuring the components of livelihood diversification at the household level assumes that the household optimizes allocation of its resources to the various livelihood generating sources, given its resource constraints (Mehta, 2009). This proposition ignores the intra-household dynamics inherent in households. The measure of crop and livestock diversification was mainly the author's and was guided by the choice of Simpsons Diversity Index (SDI), chosen to compute the overall livelihood diversification index due to the data limitations in this study (Smith and Grassle, 1977). Empirical application of this diversification index computation has been adopted (see for example Mutenje et al., 2010; Evers, 2014; McLaughlin et al., 2014).

Based on the theoretical and empirical guide discussed, crop diversification is measured in this study by aggregating all the crop types grown as well as the different and separate pieces of land in which the crops are grown. To assess the extent of crop diversification, an index was first created combining a measure of income earning from crop sales and a measure of the type of crops grown (whether food or cash crops). To get an index measure of crop sales, the number of crops grown was multiplied by a correlation coefficient of crop sales and number of crops grown. An index measure of crop type grown (food or cash crops) was calculated as follows: since cash crops earn more than food crops, they were given a weight of one, while food crops a weight of zero. The weights were cumulated per household then multiplied with a correlation coefficient of crop sales and the aggregate crop-type weights. The two indices (sales from crops and types of crops grown) were aggregated to measure the extent of crop diversification. Following SDI, livestock diversity was measured by the number of types of livestock owned by the household. A household was considered to have more livestock diversification if it had more different types of livestock, and less livestock diversification if it had few types.

On the other hand, household participation in non-agricultural income-generating enterprises was measured by the number of such enterprises as shops, grain milling machines, rural furniture making, tailoring, water vending among others. Measurement per household was as follows: zero for no enterprise, one for one enterprise, 1.2 for two enterprises, 1.3 for three and 1.4 for four. Regarding other sources of income, households with such streams as rent, savings, interest,

dividends and pensions were given a weight of one, and a zero to those that did not have such streams. Labour force diversification was measured by two indicators; aggregation of household members employed for pay either within or outside the household, and a measure of education attainment in the household. Levels of education qualification attained were weighted as follows: no formal schooling was weighted zero, primary level got a weight of one, secondary got 1.5, diploma level got 2, and finally graduate and post-graduate getting a weight of 3. The total household education achievement was measured by the aggregation of individual members' attainment times the respective weights.

Livelihoods diversification index is computed using approaches such as income shares from the activities pursued or using Margalef index (Asfaw et al., 2015; Lay, Mahmood and M'mukaria, 2008; Davis et al., 2010). In the absence of suitable data to follow such approaches in the computation of the index, an alternative approach, Simpson Diversity Index (SDI), was used. As a measure of livelihood diversity, SDI considers the number of livelihood options present to a household as well as the relative abundance of each option (Mutenje et al., 2010). The SDI is calculated as

$$SDI = 1 - \sum_{i=1}^{n} W_i^2 \qquad (5.1)$$

where, $W_i = \frac{x_i}{\sum x_i}$ \qquad\qquad\qquad (5.2)

x is the ith component of livelihood diversification and w is the proportionate measure of ith component in the total measure of livelihood diversification (Singh, Kumar and Singh, 2006). The calculated SDI ranges between zero and one, where zero represents no livelihood diversification while one represents infinite livelihood diversification.

5.3.2.2   Measure of Vulnerability to Climate Shocks

In the context of this study, climate shocks refer to the unexpected climatic, environmental, natural or weather-related events that adversely affect the welfare of households. These include droughts, floods, earthquakes, hurricanes and tsunamis, and strong winds. The climate shocks used in this study are drought and floods. Climate shocks by their nature manifest indiscriminately to almost all households within a community in which they occur. However, the extent to which occurrence of shocks translates into vulnerability depends on the specific household degree of exposure,

sensitivity to the shock and the adaptive capacity (Adger, 2006). In this study, a household is categorized as vulnerable if it reported as having been severely affected negatively by drought and/or floods within a period of five years up to the time of data collection. Vulnerability to climate shocks is therefore a binary response variable, taking a value of one if a household reported that was affected by climate shocks and zero if otherwise. Available data from other sources apart from the survey used for this study was assessed to find out if the household self-reported climate shocks are valid and reliable. Climate and weather data from Kenya Meteorological Department and these sampled online sources confirm validity and reliability of the self-reported shocks. See for instance https://reliefweb.int/report/kenya/kenya-food-security-update-february-2006) and https://reliefweb.int/report/kenya/kenya-food-security-outlook-update-august-2014). In addition, self-reported shocks have been found to be reliable indicators of vulnerability and have used in other studies and produced reliable results (see for example Ackerman and Sabelhaus, 2012; Nguyen, 2019).

5.3.3 Data Type and Sources

The study used two waves of household survey data collected in 2005/06 and 2015/16. The data was obtained from the Kenya Integrated Household Budget Surveys (KIHBS), which was administered by the national official statistics body, the Kenya National Bureau of Statistics (KNBS). Both surveys covered a period of twelve months in each data-collection period. Data was collected from 1,343 and 2,400 randomly selected sampling clusters in 2005/06 and 2015/16 respectively. In both periods, the clusters were generated from a nationally representative sampling frame known as National Sample Survey and Evaluation Programme (NASSEP). These sampling frames are normally used by KNBS to conduct household surveys in the country and comprise of randomly-sampled clusters drawn from enumeration areas of the censuses carried out in 1999 and 2009 (Republic of Kenya, 2007, 2018). From the 1,343 clusters used in the 2005/06 KIHBS, 861 were rural and 482 urban. The 2015/16 KIHBS had 988 urban and 1,412 rural clusters sampled.

The sampling ended with the selection of 10 households per the cluster sampled earlier, ultimately giving the total sample size in each wave accordingly. Only rural households were considered in this study because their livelihoods, derived mainly from agriculture, are most vulnerable to climate shocks. After an elaborate data cleaning process by both the KNBS and the author, samples of 8,487 and 13,092 households in 2005/06 and 2015/16 respectively were used for analysis in this

study. Sampled households with reported form of livelihood diversification among rural households were 8,483 and 12,217 in 2005/06 and 2015/16 respectively. On the other hand, 2,808 and 4,018 (representing 36 percent and 31 percent) in 2005/06 and 2015/16 respectively of rural households reported being adversely affected by climate shocks.

5.4   Estimation, Results and Discussion

This section presents the characteristics of the data used, followed by findings of the postulated relationships between livelihood diversification and vulnerability to climate shocks. In addition, the section discusses the results obtained in the context of literature on livelihood diversification and vulnerability.

5.4.1   Descriptive Statistics

The descriptive properties of the variables used in this study are presented in table 5.1. The mean value of livelihood diversification index in 2005/06 sample was 0.617 while it was 0.323 in 2015/16 sample, indicating a significant difference in the two periods (p-value of 0.000). The differences arise first because fewer variables were used in the computation of the index in 2015/16 compared with the 2005/06 sample. For 2015/16 KIHBS, data contained in the agriculture (holding and output) and livestock modules had not been processed by the time of doing this study. Differences in the two datasets are also attributable to differences in the variables and measures used in the computation of livelihood diversification index. For example, there are differences in the values used for coding in the education variable. However, despite these differences, both are measures of livelihood diversification for rural households with higher values indicating more diversified livelihoods. The mean number of rural households which reported adverse effects of climate shocks on their welfare was lower in 2015/16 compared with 2005/06 (p-value of 0.000). A statistically significant difference is also present in the household educational achievement index, with the measure being high in 2015/16.

Table 5.1: Descriptive Statistics

Variables	2005/06					2015/16				
	Mean	**Std. Dev**	**Min**	**Max**	**N**	**Mean**	**Std. Dev**	**Min**	**Max**	**N**
Diversification index	0.617	0.171	0	0.828	8,483	0.323	0.260	0	0.75	12,217
Affected by drought/ floods (yes=1)	0.363	-	0	1	7,742	0.307	-	0	1	13,092
Variables contributing to livelihood diversification index:										
Active labour size	2.780	1.518	0	16	8,484					
Education index	1.429	1.774	0	15.5	8,484	1.562	0.650	0	3.5	12,058
Number of farming plots	1.23	0.936	0	11	7,968					
Mixed cropping index	0.158	0.118	0.038	0.953	6,597					
Domestic animals type number	2.519	1.982	0	12	7,951					
Off-farm enterprises index	0.216	0.418	0	1.4	8,338					
Access to other income	0.101	0.302	0	1	8,324					
Household has nonfarm labour (yes=1)						0.575	-	0	1	13,092
No. of non-farm IGAs						0.195	0.447	0	4	13,092
No. of investment income sources						0.054	0.259	0	3	13,092

Source: Author's computation from KIHBS, 2005/06 and KIHBS, 2015/16

5.4.2 Diagnostic Tests

Before analyzing the relationship between livelihood diversification and vulnerability to climate shocks, various tests were conducted to assess the validity of the measures used to represent this postulated relationship. First, development economics literature indicate that rural households pursue more diversified livelihoods than their rural counterparts given that they face more risks in their livelihoods (Ellis, 1998; Ellis, 2000a). Livelihood diversification indices for rural and urban households were compared to test whether the computed measure of diversification follow these dictates.
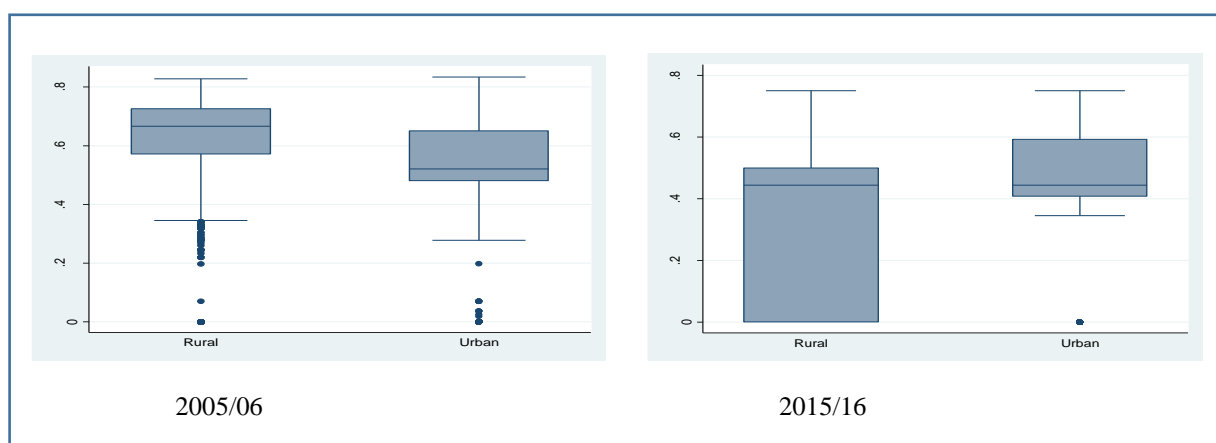
Figure 5.1: Levels and Extent of Livelihood Diversification in Rural and Urban Households

Figure 5.1 shows box plots indicating comparisons of levels of livelihood diversification between rural and urban households in 2005/06 and 2015/16. In line with literature, rural households exhibit higher level of livelihood diversification in the case of 2005/06 data. However, the finding is opposite in the case of 2015/16 data. This unexpected finding is likely because the 2015/16 measure of diversification was computed from variables that are predominantly the livelihoods of urban households such as non-farm labour force, non-farm income generating activities and investment income sources such as savings, pension, rent income, bonds and equity. As previously indicated, the 2015/16 diversification index did not contain measures of agricultural activities which is the mainstay of rural livelihoods and the basis for portfolio diversification. On the other hand, the measure of diversification used in the 2005/06 data incorporated variables fairly balanced between rural and urban livelihoods.

As expected, the data in both waves demonstrate that rural households are most likely to suffer welfare losses from climate shocks (represented here by drought and floods). In 2005/06, 36 percent of rural households compared to 12 percent of urban households reported welfare losses from climate shocks. In 2015/16, 31 percent of rural households compared to 12 percent of urban households reported welfare losses from climate shocks. Because climate shocks reduce agricultural production and productivity, rural households are more likely to suffer welfare losses because their livelihoods are predominantly agriculture-supported. This data can be used to validly demonstrate associations between vulnerability to climate shocks and livelihood diversification since preliminary analysis shows higher incidences of diversification in more risky livelihoods. Accordingly, urban households are excluded from further analysis of the relationship between diversification and vulnerability to climate shocks.

The two variables (livelihood diversification and vulnerability to shocks) were separately examined in order to determine the appropriate methodological approach for estimating the association between them. First, since vulnerability to climate shocks is a categorical variable, analytical methods for relating categorical and continuous variables are therefore pursued in this study. These variables were also tested for normality and homogeneity of variance. Results (see table 5.2) show that livelihood diversification index does not follow normal distribution in both data collection periods. Normality tests are not done on vulnerability to climate shocks since its value takes a binary response. However, since the sample sizes in both data sets are not small, the two-sample t-test can still produce reliable results even with the violation of the assumption of normally – distributed populations (Kwak and Kim, 2017).

Table 5.2: Test of Normality of Livelihood Diversification Index

	N	W	V	z	Prob>z
Diversification index (2005/06)	8,483	0.73523	1143.070	18.766	0.00000
Diversification index (2015/16)	12,217	0.88027	707.949	17.660	0.00000

5.4.3 Assessment of the Association between Livelihood Diversification and Vulnerability to Climate Shocks

The main hypothesis being tested in this study is that households with more diversified livelihoods are associated with fewer incidences of vulnerability to adverse effects of climate shocks. First, the hypothesis is tested by comparing the mean values of livelihood diversification index across the households that reported vulnerability to climate shocks and those that did not. It is expected *a priori* that households with higher livelihood diversification index were less likely to be vulnerable to climate shocks such as drought and floods. The results of the mean comparisons for the two data sets under different categorizations are presented in tables 5.3 and 5.4. The independent sample t-tests comparing the means of households vulnerable to climate shocks with those not vulnerable were conducted and reported separately for 2005/06 and 2015/16.

In both 2005/06 and 2015/16, results indicate a lower mean value of livelihood diversification index for rural households that reported loss in welfare due to climate shocks compared to those that reported no adverse effects. The difference in both periods is statistically significant at 5 percent level of significance. These findings support the hypothesis postulated in this study that more diversified livelihoods are associated with less vulnerability to climate shocks (Ellis, 1998).

This study used a different approach, that is, comparison of means to find an inverse relationship between diversification and vulnerability to climate shocks. Christiaensen and Subbarao (2005) and Amwata, Nyariki, and Musimba (2016), using different approaches, found a similar relation between livelihood diversification and vulnerability to livelihood shocks.

Table 5.3: Mean livelihood diversification index of vulnerable and non-vulnerable households: 2005/06

	Not Vulnerable			Vulnerable				
Household category	N	Mean	Std Dev	N	Mean	Std Dev	Diff(mean)	t-value
All rural	4,933	0.634	0.156	2,808	0.602	0.172	0.033	8.502***
Poor rural	1,994	0.617	0.167	1,611	0.566	0.192	0.050	8.388***
Non-poor rural	2,939	0.646	0.146	1,197	0.649	0.127	-0.003	-0.633
Rural ASALs	792	0.573	0.189	1,428	0.551	0.202	0.022	2.458**
Rural non-ASALs	4,141	0.646	0.146	1,380	0.654	0.112	-0.008	-1.819*

***, **, *: significant at 1%, 5% and 10% respectively

Table 5.4: Mean livelihood diversification index of vulnerable and non-vulnerable households: 2015/16

	Not Vulnerable			Vulnerable				
Household category	N	Mean	Std Dev	N	Mean	Std Dev	Diff(mean)	t-value
All rural	8,519	0.339	0.254	3,698	0.287	0.268	0.052	10.161***
Poor rural	2,729	0.304	0.257	1,623	0.248	0.264	0.056	6.827***
Non-poor rural	5,790	0.356	0.251	2,075	0.318	0.267	0.038	5.781***
Rural ASALs	2,258	0.310	0.268	1,781	0.270	0.268	0.041	4.775***
Rural non-ASALs	6,261	0.349	0.248	1,917	0.304	0.267	0.046	6.923***

***, **, *: significant at 1%, 5% and 10% respectively

The rural samples were disaggregated to control for the effect of income and climatic differences on the relationship between livelihood diversification and vulnerability to climate shocks. Households with monthly per adult equivalent total expenditure of KES. 1,562.18 and below are classified below the national absolute poverty line. In addition, households were classified into two agro-ecological zones (AEZ), that is, those from arid and semi-arid lands (ASALs) and those from the non-ASAL zones suitable for agricultural production. The district from where the household is sampled from was the lowest unit of AEZ classification in 2005/06 while the county was the reference in the 2015/16 dataset. Interpretation of results should consider the view that the classification of households into AEZ based on districts and counties is greatly generalized since there are cases of districts and counties in Kenya with different agro-climatic conditions and it is possible that the sampled households from same district or county do not share similar AEZ characteristics.

For the households below the poverty line, those reporting welfare losses due to climate shocks had a statistically significant lower level of livelihood diversification index compared with the households that reported not being adversely affected in both survey periods. However, while a similar pattern was observed for the households above the poverty line in the case of 2015/16 data, no statistically significant difference in mean livelihood diversification index was observed using the 2005/06 data. These findings indicate that livelihood diversification index was persistently lower among the households that reported welfare losses from climate shocks, despite the household wealth. This finding confirms that household income and wealth levels moderate the relationship between livelihood diversification and vulnerability to climate shocks (Block and Webb, 2001). The exception observed in the 2005/06 of non-difference in livelihood diversification levels in both the vulnerable and non-vulnerable households implies that other factors apart from income levels contribute to vulnerability to climate shocks.

A similar pattern was observed when households were grouped according to the AEZs. In the ASALs, vulnerable households had lesser diverse livelihoods in both survey periods, although the difference was lower in 2005/06. For households in non-ASAL zones, a similar pattern as in ASALs was observed in 2015/16 data, while the 2005/06 data shows the vulnerable households having more diverse livelihoods. It is important to note that this finding is only statistically significant at 10 percent level of significant, indicating a high likelihood of attributing it to chance. However, if the marginal statistical significance in the difference of means of diversification is upheld, it is plausible to argue that the observed vulnerability could emanate from specific climate shocks in non-ASAL areas such as landslides, flooding and weather-induced diseases such as tea frosts. The comparison of means of the sampled households therefore indicates that agro-ecological location of household influences household response to climate shocks (Asfaw et al., 2019).

The study's hypothesis that more diversified livelihoods are associated with less vulnerability to climate shocks is further tested by conducting a correlation analysis between the two variables. As indicated earlier in this study, correlation analysis is implemented without considering which variable was independent or dependent. This approach is especially appealing for this study since it was established that the two variables have a bidirectional relationship. Accordingly, a point-biserial correlation analysis is implemented between livelihood diversification index (a continuous

variable) and household vulnerability to climate shocks (a binary variable). Implementing point-biserial correlation analysis requires the continuous variable to be normally distributed and have constant variance (Feir-Walsh and Toothaker, 1974). However, when the sample size is sufficiently large and randomly selected, as is the case with the samples used in this study, the central limit theorem indicates that violation of these normality and homogeneity of variance assumption do not bias the results (Kwak and Kim, 2017). Therefore, parametric tests such as point-biserial correlation analysis can be used for hypothesis testing of the association between livelihood diversification and vulnerability to climate shocks.

Table 5.5: Point biserial correlation coefficient between livelihood diversification and vulnerability to climate shocks 2005/06

Household category	Point-biserial correlation coefficient	t-value	P>|t|	N
All rural	-0.0962	-8.5017	0.0001	7,741
Poor rural	-0.1384	-8.3872	0.0001	3,605
Non-poor rural	0.0098	0.6326	0.5270	4,136
Rural ASALs	-0.0521	-2.4572	0.0141	2,220
Rural non-ASALs	0.0245	1.8187	0.0690	5,521

Table 5.6: Point biserial correlation coefficient between livelihood diversification and vulnerability to climate shocks 2015/16

Household category	Point-biserial correlation coefficient	t-value	P>|t|	N
All rural	-0.0915	-10.1608	0.0001	12,217
Poor rural	-0.1029	-6.8262	0.0001	4,352
Non-poor rural	-0.0650	-5.7802	0.0001	7,865
Rural ASALs	-0.0749	-4.7748	0.0001	4,039
Rural non-ASALs	-0.0763	-6.9221	0.0001	8,178

Table 5.5 provides the direction and magnitude of the association between livelihood diversification index and vulnerability to climate shocks using the 2005/06 data. As expected from theory (Ellis, 1998), there is an inverse relationship between livelihood diversification and vulnerability to climate shocks for all sampled households and the rural households below the poverty line. Correlation coefficients of approximately -0.1 and statistically significant at one percent level of significance are observed, indicating that a weak relationship exists between the two variables. This implies that although the association is weak, it is not out of chance. Perhaps livelihood diversification in rural areas of Kenya is not adequate to shield households from adverse effects of climate shocks. In addition, the limitations in the data earlier highlighted, including the

measurement of vulnerability to climate shocks could be clouding up the actual strength of the association.

For non-poor households (those above the poverty line), livelihood diversification did not appear to have a statistically significant association with the vulnerability to climate shocks. This finding confirms that accounting for household income status is important in determining the actual relationship between livelihood diversification and vulnerability to climate shocks (Martin, Lorenzen and Bunnefeld, 2013). Specifically, the results show that unlike the case of poor households, vulnerability to climate shocks is not associated with the level of livelihood diversification among the rich households. For the poor on the other hand, keeping a diverse portfolio of income generating activities was associated with less likelihood of reporting adverse effects of climate shocks.

Distinctive results were observed when the influence of households' agro-ecological conditions was considered. The 2005/06 data indicate that more livelihood diversification was associated with less vulnerability to climate shocks, although the coefficient was lower and weaker in terms of statistical significance, as compared with the aggregated sample of all rural households. On the other hand, among the households in agro-ecological zones of high agricultural potential, livelihood diversification was associated with more vulnerability to climate shocks, although the association is weak (correlation coefficient of 0.02) and statistically significance only if the level of significance is expanded to 10 percent. This implies that the direct relationship between livelihood diversification and vulnerability to climate shocks for households in high potential areas is mainly due to chance and could not be interpreted further. Since the incidences of climate shocks are higher in ASALs than in high potential areas, it is expected that households in these areas will most likely pursue diverse livelihoods for welfare risk mitigation rather than for wealth accumulation, which is expected to be the main driver of diversification in high potential zones. Therefore, while the mean levels of livelihood diversification are lesser in ASALs' households than in their counterparts in agricultural productive areas (partly due to comparatively fewer opportunities for diversification), such diversification is most likely associated with lesser vulnerability to climate shocks. Correlation results validate this presumption in the case of 2005/06 data. The observed variation in the results due to the household's agro-ecological location provides an intuitive understanding of household vulnerability to climate shocks. This finding adds to the

existing literature on the nexus of climate vulnerability and livelihood diversification (Panthi et al., 2016; Asfaw et al., 2019).

Results using the 2015/16 data (presented in table 5.6) reveal an inverse and statistically significant relationship between livelihood diversification and vulnerability to climate shocks, a finding that supports the hypothesis postulated in this study. The relationship is stronger for the aggregated rural sample and for the households below the poverty line. Significant differences in the hypothesized relationship are noted when households are disaggregated along income status, and less significance when disaggregation is along agro-ecological zones. The results based on the 2015/16 data should be interpreted with caution considering that data on farming and livestock were not included in the computation of livelihood diversification index. This omission likely affects the results given that farming and livestock rearing constitute a significant contribution in the livelihoods of rural households in Kenya.

5.4.4 Sensitivity Analysis

Before drawing conclusions and making policy recommendations based on this study findings, sensitivity analyses were carried out to assess the robustness of the results generated. According to Thabane et al. (2013), sensitivity analysis assesses changes in the results due to the effect of outliers, missing data, different definitions of outcomes, methods of analysis, and assumptions on variable distributions. To assess the effect of outliers on the findings, correlation results were assessed by varying the percentage of left-leaning observations excluded in the analysis (the distribution of livelihood diversification index is skewed to the left). Results using 2005/06 were largely unchanged when about 7 percent of the left-leaning observations was excluded, but changed when 31 percent of outlying observations were omitted from analysis. Also observed was the change in results when 28 percent of outlying observations were excluded in the 2015/16 data. The impact on results due to change of methods of analysis was assessed by conducting a regression analysis instead of correlation analysis to define the relationship between livelihood diversification and vulnerability to climate shocks. As indicated earlier, the relationship between these two variables is bidirectional and therefore, regression analysis need to be supported by assumptions on the direction of the relationship. In both 2005/06 and 2015/16, similar results as in correlation analysis (direction of relationship and p-value) were obtained using regression analysis

on assumption of either direction in the relationship between vulnerability to climate shocks and the extent of livelihood diversification.

Analyses using non-parametric methods to test the differences in the mean values of livelihood diversification index between climate-shock affected and unaffected households were conducted to assess the impact of the assumptions on variable distributions. A non-parametric test, Wilcoxon–Mann–Whitney test produced results similar (in terms of p-values) to those produced by the parametric t-test for both the 2005/06 and 2015/16 data. Another assumption made in this study was that rural households were the most vulnerable to climate shocks because their livelihoods depended mainly on agriculture. Accordingly, urban households were not included in the analysis. In this section, it was tested whether the study's results would change if urban households were included in the analysis. The t-test results in the combined sample were found to be different from those in the sample containing only the rural households. Results of the correlation analysis in the sample containing both rural and urban households were different from the sample containing only the rural households. In addition, t-tests and correlation analyses were conducted for urban households separately and distinct results obtained, especially with the 2005/06 data. Generally, the 2005/06 data had more robust results than the 2015/16 data as demonstrated by the sensitivity analyses.

Correlation analyses were also conducted between livelihood diversification index and other shocks reported by the sampled rural households (see results in table 5.7). Relating livelihood diversification with other shocks helps assess whether the study's strategy of estimating relationship between livelihood diversification and climate shocks is valid with other shocks. The 2005/06 data was used for this exercise because it has the necessary modules that comprehensively capture diverse rural livelihoods. Credible patterns can be observed from the results, with the overall implication that the estimation approach used produces a fairly valid results. Association between livelihood diversification and food-price inflation shocks was found to be closely similar to the association between livelihood diversification and climate shocks. This similarity is expected because climate shocks and food-price inflation shocks are related in the sense that occurrence of climate shocks such as drought and floods reduce food supply which effectively raises food prices. The other shocks with similar relationship with livelihood diversification as

climate shocks are severe water shortage (drought causes the shortage), and livestock death or theft (climate shocks cause pasture shortage hence livestock deaths).

Table 5.7: Correlation coefficients between livelihood diversification index and other reported shocks: 2005/06

Shock	Point-biserial correlation coefficients (p-values are in brackets)				
	All rural	Poor rural	Non-poor rural	Rural ASALs	Rural non-ASALs
Drought and floods (climate shocks)	-0.0962 (0.000)	-0.1384 (0.000)	0.0098 (0.527)	-0.0521 (0.014)	0.0245 (0.069)
Crop diseases or crop pests	0.0548 (0.000)	0.0352 (0.0348)	0.0661 (0.0001)	0.0805 (0.0001)	0.0389 (0.0039)
Livestock death or theft	-0.1048 (0.0001)	-0.1571 (0.0001)	-0.0030 (0.8476)	-0.2583 (0.0001)	0.0538 (0.0001)
Business failure (non-agricultural)	0.0518 (0.0001)	0.0436 (0.0088)	0.0445 (0.0042)	0.0278 (0.1902)	0.0344 (0.0105)
Loss of salaried employment	0.0163 (0.1508)	0.0298 (0.0739)	-0.0083 (0.5936)	0.0370 (0.0817)	-0.0082 (0.5440)
End of regular assistance or transfers	-0.0864 (0.0001)	-0.1224 (0.0001)	-0.0265 (0.0880)	-0.1461 (0.0001)	-0.0151 (0.2610)
Large fall in sale prices for crops	0.1072 (0.0001)	0.1000 (0.0001)	0.1072 (0.0001)	0.0567 (0.0075)	0.0929 (0.0001)
Large rise in price of food	-0.0696 (0.0001)	-0.0443 (0.0079)	-0.0945 (0.0001)	-0.0199 (0.3497)	-0.0651 (0.0001)
Large rise in agricultural input prices	0.1322 (0.0001)	0.1251 (0.0001)	0.1293 (0.0001)	0.0866 (0.0001)	0.1124 (0.0001)
Severe water shortage	-0.0853 (0.0001)	-0.1103 (0.0001)	-0.0263 (0.0914)	-0.0374 (0.0782)	-0.0069 (0.6093)
Chronic/severe illness or accident	0.0498 (0.0001)	0.0654 (0.0001)	0.0220 (0.1572)	0.0417 (0.0493)	-0.0033 (0.8072)
Birth in the household	-0.0011 (0.9239)	-0.0086 (0.6054)	0.0155 (0.3189)	-0.0013 (0.9510)	-0.0036 (0.7908)
Death in the household	0.0839 (0.0001)	0.1106 (0.0001)	0.0411 (0.0082)	0.1093 (0.0001)	0.0139 (0.3020)
Breakup of the household	-0.0379 (0.0009)	-0.0207 (0.2144)	-0.0622 (0.0001)	-0.0187 (0.3775)	-0.0492 (0.0003)
Member jailed	0.0128 (0.2615)	0.0180 (0.2799)	0.0066 (0.6722)	0.0158 (0.4566)	-0.0014 (0.9157)
Fire	0.0233 (0.0403)	0.0470 (0.0047)	-0.0012 (0.9407)	0.0474 (0.0254)	0.0077 (0.5655)
Carjacking/ robbery/ burglary/ assault	0.0502 (0.0001)	0.0553 (0.0009)	0.0333 (0.0323)	0.0742 (0.0005)	0.0258 (0.0557)
Dwelling damaged, destroyed	-0.0148 (0.1937)	-0.0141 (0.3958)	-0.0074 (0.6324)	-0.0215 (0.3111)	-0.0086 (0.5223)
HIV/AIDS	-0.0029 (0.7991)	0.0137 (0.4100)	-0.0252 (0.1047)	0.0268 (0.2072)	-0.0243 (0.0705)
Other unspecified shocks	0.0140 (0.2191)	0.0110 (0.5085)	0.0144 (0.3549)	0.0165 (0.4372)	0.0155 (0.2485)

On the other hand, other shocks, as expected, have a relationship with livelihood diversification that is opposite the relationship that livelihood diversification has with climate shocks. Such relationship is that involving shocks like non-agricultural business failure, large fall in sale prices for crops, and large rise in agricultural input prices. Households reporting adverse effects of such shocks are most likely to have higher levels of livelihood diversification compared to those not reporting being adversely affected. In addition, as expected, other shocks were found not to have statistically significant association with livelihood diversification. These include birth in the household, incarceration of a household member, destruction of dwellings and suffering of illnesses such as HIV/AIDS. Other shocks such as chronic and severe illness or accidents, death in the household and loss of salaried employment had relationships with livelihood diversification that could not be explained.

5.5   Summary, Conclusions and Policy Recommendations

5.5.1   Summary and Conclusions

Households in rural areas, including those in Kenya tend to pursue diversified livelihoods, motivated either by the opportunity to enhance household welfare or as a risk-management strategy. Despite the motive, diversification of livelihoods is expected to result into non-reduction of household welfare. Using two waves of nationally-representative data, this study examined the relationship between livelihood diversification and vulnerability to climate shocks among rural households in Kenya. Relevant literature were reviewed to contextualize the study within the existing body of literature and to provide theoretical and empirical basis for hypothesis testing. In both datasets, results support the study's hypothesis that households with higher livelihood diversification index were less likely to be vulnerable to climate shocks. Detailed analysis of the linkages between livelihood diversification and vulnerability to shocks found variations in the results across income classes and agro-ecological zones. The 2015/16 dataset had missing data on key variables used in computing livelihood diversification index, and this could have contributed to some of the differences in results between 2005/06 and 2015/16 datasets. Sensitivity analyses were conducted to address some of limitations identified in the data and model assumptions.

This study found that livelihood diversification has an inverse relationship with household vulnerability to climate shocks. This indicates that the more diversified livelihoods are associated with less vulnerability to adverse effects of climate shocks. This relationship was found to be valid even when the direction was not known *a priori*. Results of the analysis on the data disaggregated along income classes and agro-ecological zones indicates that diversification of livelihoods mitigate the risk of climate shocks among rural households in Kenya. In addition, disaggregating the results based on income classes and agro-ecological zones addresses the confounding effects of income status and weather and climatic conditions in the relationship between livelihood diversification and vulnerability to climate shocks. Finally, the results of the sensitivity analyses provide evidence to support validity of these findings.

5.5.2   Policy Recommendations

Based on the findings of this study, recommendations on the policy space for creating and enhancing resilient rural livelihoods in Kenya are offered. The general policy implication is that promoting a diverse portfolio of income generating activities and assets is an important strategy for ensuring stable and resilient rural livelihoods, especially those that can withstand adverse effects of various livelihood shocks. The government can achieve this through equipping vulnerable households with the skills and providing them with opportunities to diversify their livelihoods. Specific interventions include promoting education and health to build human capital as well as building physical infrastructure to enhance commerce and growth of exchange economy. With the appropriate human and physical capital in place, households can adjust their livelihoods contingent on the unfolding environment either to manage risks or maximize returns (Warren, 2002). In the arid and semi-arid areas of the country, diversification can be promoted through innovations along the existing livelihoods such as value addition in livestock products, livestock feeds (e.g. hay and fodder making) and marketing opportunities for livestock products.

Additionally, in line with the principles of Sustainable Development Goals, economic growth and development policies for rural areas should be designed with the objective of relieving pressure on natural resources which subsequently reduces the frequency and incidences of climate shocks. The government and development partners need to initiate programmes that involve the vulnerable communities to fashion livelihood strategies along building resilience to the adverse impacts of climate shocks. The disaggregation of households according to income cadres and agro-ecological

zones has resulted into specific results that can be adopted in designing site-specific and income class-specific policy interventions to build resilience against climate shocks. Finally, with the expected increases in global warming and associated climate and weather variations, the government should intensify interventions to ensure that households in different agro-ecological zones and income levels have secure livelihoods. This can be done through local research centres as well as institutions of higher learning. For instance, Kenya Agricultural and Livestock Research Organization and other livelihoods research institutions should refocus their mandates into creating solutions for livelihood diversification along the existing livelihoods.

5.5.3   Areas of Further Research

The changing of climate and weather patterns will potentially have adverse effects on people's livelihoods. This study sought to examine the association between rural livelihoods diversification and vulnerability to climate shocks. However, there are other shocks emanating from the changing climate such as disease epidemics and explosion of disease-causing vectors and pathogens. For instance, the world witnessed a global pandemic caused by a novel coronavirus, which has wreaked havoc on people's livelihoods. A study on the relationship between livelihood diversification and the effect of coronavirus pandemic would yield useful insights into this general theme of livelihoods resilience to shocks. Other possible further research in this theme could explore the connection between the households and the macro-economy in regard to livelihood diversification and the aggregate economic performance. The research could explore how livelihood diversification at the household level contributes to the aggregate level of diversification and the implication on the performance of macroeconomic indicators such as inflation, terms of trade, employment and the gross domestic product (GDP) growth.

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Chapter Six Summary, Conclusions and Policy Implications

6.1 Summary, Conclusions and Policy Implications

There is extensive existing literature on the relationship between livelihood shocks and household welfare in Kenya. However, gaps exist in the literature as well as matters of policy relevance that necessitate continued academic investigations. Kenyan households continue to experience shocks from climate and natural disasters, food price inflation, diseases and illnesses, and social unrest. To a significant fraction of households, especially in rural areas, these shocks contribute to welfare loss, and ultimately poverty. The households suffer welfare losses because of limited or weak capacity to effectively respond to the shocks.

In the nexus between livelihood shocks and household welfare in the context of developing countries like Kenya, this thesis contributed by first highlighting how different categories of essential household expenditures differ among households based on vulnerability to shocks as well as agro-ecological location. The thesis also contributed by showing how rural farm income shocks influence non-monetary indicators of welfare. Secondly, given the significance of land in the socioeconomic, political and cultural landscape in Kenya, and given that land issues are contextual, this study contributed to the existing literature on land in the country by providing the perspective of distress sales of farmland due to shocks. Third, this thesis contributed by showing how the growth of physical infrastructure stocks and access levels aids household resilience to livelihood shocks, and finally, the thesis contributed by highlighting how livelihood diversification builds resilience of rural households according to different income classes and agro-ecological locations. The gaps identified in the literature include the effect of shocks on household welfare measured in disaggregated consumption expenditures and food insecurity along the agro-ecological heterogeneity, determinants of distress sales of farmland as a coping strategy, the role of infrastructure growth on household vulnerability to shocks and coping ability and finally the association between livelihood diversification and vulnerability to climate shocks.

Based on the identified literature gaps, this thesis sought to explore how livelihood shocks impact on the household welfare in Kenya by assessing the effect of farm income shocks on the welfare of rural households, measured by consumption expenditures and food security; establishing the determinants of distress sales of farmland; assessing the role of infrastructural changes in Kenya

between 2005/06 and 2015/16 in household vulnerability and coping to shocks; and finally testing the hypothesis that there was a negative relationship between livelihood diversification and vulnerability to climate shocks among rural households.

6.1.1 Effect of Farm Income Shocks on Household Welfare in Rural Kenya

This study sought to fill the gap on the effect of shocks on household welfare measured in disaggregated consumption expenditures and food insecurity along the agro-ecological heterogeneity by assessing the effects of farm income shocks on disaggregated household consumption expenditures along agro-ecological zones as well to find the effect of farm income shocks on food security, as a non-monetary measure of welfare. This study has relevant policy significant as it provides in-depth understanding of welfare vulnerability in rural areas of the country and also come up with targeted policies for stabilizing rural household's incomes from fluctuations.

The results revealed that total consumption spending, non-food and food expenditures were lower for rural households that reported farm income shocks, compared to those that were not affected by the similar shocks. Food expenditures reduced more compared to other expenditure categories. Disaggregation of the data along agro-ecological zones revealed that ASALs households afflicted by shocks reduced their consumption spending more than their counterparts in non-ASALs. The study also found that shock-prone rural households in the ASALs had bigger education share of total consumption spending compared to households not affected by shocks. Logistic regression results using food security as the dependent variable are consistent with the results using consumption expenditures, in that households that reported being adversely affected by farm income shocks were more likely to report incidences of hunger.

From the findings of this study, it is apparent that seasonal fluctuations in agricultural families' incomes still has adverse effects on household consumption expenditure profiles in Kenya; with serious consequences on human development potential. Accordingly, the government should consider intensifying measures to insulate vulnerable households' welfare from effects of transitory income shocks as part of the ongoing poverty reduction strategies. Secondly, the noted heterogeneity in household vulnerability to shocks should be considered in policy formulation and implementation in order to guarantee proper targeting of the development interventions. Ignoring these population and subpopulation differences often leads to inappropriate policy interventions

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(Barrett, Smith and Box, 2001). Third, the findings support the public policy interventions that enhance the quality and reliability of public provision of education and health services, since the results indicated a significantly lower private financing of education and health in rural areas of Kenya.

The estimation approach used in this study implies that self-reported measures and indicators can be relied upon to make policy inferences in situations where it is not feasible to access or use observed data household income risks, incomes and consumption indicators. In developing countries, administrative data on welfare measures is largely missing while observation data is expensive to collect (United Nations, 2005). In addition, policies for climate change adaptation and mitigation are useful to build the resilience of rural incomes from various shocks that have adverse effect on welfare. The other aspect is on rural livelihoods policy that focuses on making risk-management markets work for rural households. While these policy implications are recommended based on the Kenyan data, they are still applicable to other developing countries especially in sub-Saharan Africa.

6.1.2 Determinants of Distress Sales of Farmland in Rural Kenya

This study addressed the gap that while a lot literature on land in Kenya is available, the determinants of distress sales of farmland due to shocks is unknown. The study provided information for filling the gap by analyzing the determinants of household choice of sale of land as a response mechanism to shocks. Various shocks and household characteristics and the households' social and physical environment were found to determine household probability to resort to distress land sales. Education was found to reduce the household probability for distress land sales. The study found that access to credit did not prevent households from distress selling of farmland, indicating possibly that the existing credit system in the country is ineffective in mitigating household vulnerability to shocks. The study also found that ownership of livestock was associated with less likelihood of engaging in distress sales of farmland, confirming that livestock provide buffer against selling more significant assets such as farmland. Finally, the study found that physical infrastructure facilities such as all-weather roads were significantly associated with lower probability for distress land sales, confirming that public services such as roads enhance livelihood diversification, enhance trade among communities and are precursors to establishment

of financial infrastructure such as banks, insurance companies and social amenities such as hospitals and schools.

The policy implication of the results of this study include that there is need for education in the country to emphasize on skills acquisition that can translate into gainful employment in order to shield households from vagaries of subsistence livelihoods in rural areas as well as under-employment in urban areas. Secondly, the government should continue pursuing financial integration of rural households in order to provide them with opportunities to hedge risk through solutions such as health insurance, weather index-based insurance, savings and loan facilities. Thirdly, there is need for government to provide conducive environment for rural households to engage productively in animal husbandry such as protection of animal diseases and pests, livestock feeds and nutrition, livestock marketing and research and extension services. Finally, it is imperative that public policy should focus on building physical infrastructure as a strategy for reducing vulnerability to shocks for the physically isolated communities in the country.

6.1.3   Infrastructure Growth, Household Vulnerability and Response to Shocks in Kenya

This study sought to analyze whether the infrastructure growth in Kenya between 2005 and 2016 resulted into a reduction in household vulnerability to shocks as well as adoption of infrastructure-aided coping strategies. The study specifically disaggregated rural and urban samples in addition to the time differences because of the apparent differences in the stocks physical infrastructure and population access levels between the rural and urban areas.

The study found significant changes in household vulnerability and ex-post coping strategies across the two reference periods and between rural and urban sampled households. First, the results reveal a statistically significant reduction in household vulnerability to the general shocks between 2005/06 and 2015/16, with the reduction being higher for urban households by five percentage points in relation to the reduction in rural households. secondly, although generally there was no observed change in household vulnerability to food-security shocks in the reference period, disaggregating the households by geographical location reveals that rural households' vulnerability dropped by four percentage points compared to urban households between 2005/06

and 2015/16. Lastly, the study found that between 2005/06 and 2015/16, both rural and urban households increased their use of infrastructure-supported ex-post coping strategies such as savings and borrowing to respond to food-security shocks. The magnitude of this adoption was higher by five percentage points among rural households compared to the urban households between the reference periods. The study concludes that there is a plausible association between physical infrastructure changes and household vulnerability and coping strategies to shocks across time and in different geographical locations. Specifically, the magnitude of reduction in vulnerability to shocks and the increase in effective ex-post coping strategies is greater for rural households than for urban households.

Policy suggestions offered based on the findings of this study are; first, policy interventions to reduce vulnerability to livelihood shocks should consider that vulnerability is a dynamic aspect across time and space. Specifically, policies should consider that household vulnerability is not a stable phenomenon and that there is need for constant monitoring of the population at risk to ensure effective policy interventions are implemented. Secondly, development of physical infrastructure should be highlighted as an important strategy for reducing vulnerability especially in the country's marginalized areas. Finally, the development of infrastructure stocks need to be implemented as a bundle of inter-related elements to create bigger impact in vulnerability reduction and building of household resilience to shocks.

6.1.4 Livelihood Diversification and Household Vulnerability to Climate Shocks in Rural Kenya

This study examined the relationship between livelihood diversification and vulnerability to climate shocks among rural households in Kenya. Specifically the study tested the hypothesis that among rural households in Kenya, livelihood diversification is negatively related with the vulnerability to climate shocks. This study found that livelihood diversification has an inverse relationship with household vulnerability to climate shocks. This indicates that the more diversified livelihoods are associated with less vulnerability to adverse effects of climate shocks. This relationship was found to be valid even when the direction was not known a priori. Results of the analysis on the data disaggregated along income classes and agro-ecological zones indicates that diversification of livelihoods mitigate the risk of climate shocks among rural households in

Kenya. In addition, disaggregating the results based on income classes and agro-ecological zones addresses the confounding effects of income status and weather and climatic conditions in the relationship between livelihood diversification and vulnerability to climate shocks. The results of the sensitivity analyses provided evidence to support validity of the study's findings.

The general policy implication from the findings of this study is that promoting a diverse portfolio of income generating activities and assets is an important strategy for ensuring stable and resilient rural livelihoods from adverse effects of climate change. Policies are needed to promote education and health to build human capital as well as building physical infrastructure to enhance commerce and growth of exchange economy. In the arid and semi-arid areas of the country, diversification can be promoted through innovations along the existing livelihoods such as value addition in livestock products, livestock feeds and marketing opportunities for livestock products. Other suggested policies are relieving pressure on natural resources which subsequently reduces the frequency and incidences of climate shocks.

6.2. Limitations of this Study and Areas of Further Research

This study has some limitations arising out of the way it was formulated and executed. While measures were instituted to minimize the effects of these shortcomings, it is however important to consider the limitations as one interprets the study's findings. First, this study used data obtained from a household survey that required respondents to provide recalled information. These household surveys have inherent measurement errors that affect the estimation of important variables (Kasprzyk, 2005; Fisher, Reimer and Carr, 2010). In the data used, inconsistencies were noted in the household reports of income and some categories of expenditures. However, this was minimized by excluding outliers in the observations, which on the other hand affects the estimated coefficients. Second, the incidence of livelihood shocks used in this study are self-reported. Self-assessed measures of a phenomenon, especially the incidence of vulnerability, can result into response and recall biases (Rosenman, Tennekoon and Hill, 2011). To overcome the bias due to self-assessment of risk, household responses were compared with data from external sources on the incidence of the household-reported shocks. The incidence of covariate shocks was also assessed at cluster level in order to validate the individual-household responses. Nonetheless, self-

reported shocks data can still be used to carry out valid empirical estimations that inform policy on risk and household welfare (Heltberg, Oviedo and Talukdar, 2014).

The carrying out of this research has led to emergence of related research issues that are suggested here for further examination. First, a study on the effect of farm income shocks on household consumption expenditures using longitudinal data is recommended as it will provide insights and ground for comparing with studies using pooled cross-sectional data. The use of longitudinal data could also be applied to the chapters estimating determinants of distress sales of farmland and the one on role of infrastructure development on household vulnerability to shocks and coping abilities. Second, the study on the determinants of distress land sales in rural Kenya did not consider the role of communal support and social capital in household decision making due to lack of relevant data. Since literature has established that these variables generally determine household coping options to adverse risks, a specific empirical examination of how they affect the probability of liquidating productive assets such as farmland would add to the existing body of knowledge (Bernier and Meinzen-Dick, 2014; Karanja et al., 2016). In addition, with relevant data that separately assigns control and treatment effects, future studies are recommended that can isolate robustly the causal effects of physical infrastructure development on household vulnerability to shocks. This could be conducted with use of an infrastructure index that can be computed using appropriate data. Such a study would enhance the understanding on various policy interventions to increase household resilience to livelihood shocks in Kenya. Also recommended are studies estimating relationship between livelihood diversification and vulnerability to various livelihood shocks using different measures of vulnerability.

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