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Analysis of Portfolio Diversification and Risk Management of Livestock Assets in the Borana Pastoral System of Southern Ethiopia

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Analysis of Portfolio Diversification and Risk Management of Livestock Assets in the Borana Pastoral System of Southern Ethiopia

by

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ABSTRACT

Analysis of Portfolio Diversification and Risk Management

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Southern Ethiopia

by

Medhat Ibrahim, Master of Science

Utah State University, 2015

Major Professor: Dr. DeeVon Bailey
Department: Applied Economics

This thesis analyzes the different types of investments and diversification strategies pursued by some of the wealthy pastoralists in the Borana Plateau of southern Ethiopia. Field surveys with 12 influential pastoralists in the region were conducted to obtain data about the different investments they have. The data also identified their risk perception about different potential investments. Returns on the potential investments considered in the study were calculated using a return on assets approach (ROA).

A nonlinear quadratic program was used to estimate five optimal portfolios using a mean-variance (E-V) formulation for minimizing variance. These optimal portfolios were analyzed together with the portfolios actually held by the 12

participants using risk analysis. This included using portfolio analysis, stochastic dominance, and stochastic efficiency, and estimating risk premiums for different investment alternatives. It was found that large investments in camels, savings accounts, and real estate are preferred by very risk-averse producers. A combination of cattle, camels, and savings tended to make up the portfolios of more risk-seeking participants. Sheep and goats, while arguably beneficial during droughts, are high risk, low reward types of assets.

The results from this study closely match the current perception of the 12 panel participants. They ranked the risk associated with cattle as the highest of the investment options considered and for camels as the lowest risk alternative. They also ranked livestock investment with regard to the perceived risk of investments as high compared to savings accounts and real estate. This also supports the movement toward less investment in cattle and more investment in other alternatives such as camels.

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PUBLIC ABSTRACT

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Ethiopia is one of the poorest and most populated countries in the world. It is also one of the largest receivers of foreign aid in the world. The Borana Plateau in the Oromia region is one of the poorest regions in southern Ethiopia. The local population in this region has relied on livestock for their livelihood for many generations. The growing number of humans and livestock on the Borana Plateau has caused the rangeland to be degraded. Coupled with more frequent and severe droughts, this growth can cause the loss of a large number of the livestock in this region from time-to-time. Several scientific and social studies have been conducted regarding how to maintain more sustainable livelihoods on the Borana Plateau in the face of all of these challenges. Most of the social science literature has focused on the poor and how to build their resiliency in the face of poverty and drought.

Research about poor pastoralists is very important. However, it is likely the wealthy pastoralists of the region have the greatest potential to fuel economic activity by their investment decisions.

This thesis focused on an analysis of portfolio diversification and risk management by wealthy pastoralists on the Borana Plateau. The method was to choose 12 important and wealthy pastoralists to survey to obtain data for the analysis. The idea was that wealthy pastoralists have more discretionary income available to invest compared to other local people. They have large-sized cattle herds, which leads to a larger-than-average consumption of the community water and forage resources. Wealthy pastoralists can also provide employment for the local communities for milking and herding activities. Understanding the diversification strategies used by this segment of the pastoralist population also provides some insights about the diversification strategies that are available and the barriers that exist to accessing different forms of investment to allow for diversification. This type of information may help us understand how to aid more general economic development in the Borana Plateau given that investment decisions of the wealthy are relatively important compared to the general population. It is also likely true that the livestock investment decisions by wealthy pastoralists may point to the future configuration of livestock herds on the Borana Plateau.

A nonlinear quadratic program was used to estimate five optimal portfolios using a mean-variance (E-V) formulation for minimizing variance. These optimal portfolios were analyzed together with the portfolios actually held by the 12

participants using risk analysis. This included using portfolio analysis, stochastic dominance, and stochastic efficiency, and estimating risk premiums for different investment alternatives. It was found that large investments in camels, savings accounts, and real estate are preferred by very risk-averse producers. A combination of cattle, camels, and savings tended to make up the portfolios of more risk-seeking participants.

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CHAPTER 1

INTRODUCTION

The first of the eight Millennium Development Goals[1](MDGs) of the United Nations is to eradicate extreme poverty and hunger, with a target to halve the number of people in the world whose income is less than $1 a day and also to halve the number of people who suffer from hunger by 2015 (UN 2013). Some studies have been predicting scenarios that could happen in the near future if widespread hunger continues (Hammond 2000; Runge et al. 2003; Von Braun 2005; Randers 2008; Beddington 2009). The perfect storm scenario suggested by Beddington[2] is a good example. He predicts that by the year 2030, the world will need to be producing 50 percent more food and energy than it is now, as well as 30 percent more water. He goes on to state that there may not be a complete collapse in the system, but major problems will start occurring if not tackled by finding solutions (Beddington 2009).

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[1] The millennium Development Goals (MDGs) are time-bound and quantified targets established by the United Nations in order to address world extreme conditions including income poverty, hunger, disease, lack of adequate shelter, and exclusion- while promoting gender equality, education, and environmental sustainability.

[2] Sir John Beddington, UK government chief scientific advisor and head of the Government Office for Science 2008-2013

As the world population increases, the need for securing food resources increases as well. Food insecurity exists when necessary food stocks are not available to the population and when the population has insufficient access to the food stocks at adequate nutritional levels (Zuberi and Thomas 2012). The Food and Agriculture Organization of the United Nations (FAO) predicts the world's population will increase to 9.1 billion by 2050. Seventy percent of this increase will be in urban areas indicating increased urbanization because only 49 percent of the world's population lives in urban areas today (FAO 2009). Food production must be increased by 70 percent by 2050. It is estimated that there will be a need to increase annual meat production by over 200 million tons. This suggests meat production will reach 470 million tons by 2030 if it is to help meet the protein intake of the projected increased population (FAO 2009).

Sub-Saharan Africa (SSA)

Sub-Saharan Africa (SSA) is the region of the world with the highest prevalence of human malnourishment (FAO, IFAD and WFP 2014). However, SSA's regional gross domestic product (GDP) growth rose by 5.2 percent in 2014 and was expected to increase by 5.4 percent in 2015 (World Bank 2014).

Livestock production is an important economic activity in Africa. There are 250 million Tropical Livestock Units (TLU = 250 kg) of live animal weight in Africa. This number includes cattle, sheep, goats, equines, and camels. Animal production takes place over a vast expanse of Africa on about 30 million km^2 or half of Africa's

total land area (Peden et al. 2006). Sudan and Ethiopia have about third of livestock with another third in Nigeria (Peden et al. 2006).

Total aggregate meat consumption in SSA between 2015 and 2030 is expected to increase by 3.7 percent annually which is a higher rate of increase in meat consumption than in recent years in SSA (3.5 percent) and much higher than the world's expected annual meat consumption growth (1.5 percent) during this period (Bruinsma 2003). While the growth in the demand for meat in SSA projects an opportunity for local livestock producers, significant barriers may prevent the meat industry in SSA from participating fully in this opportunity, or at least as fully as they might if these barriers were not present. For example, the U. S. Geological Survey indicates that drought in the Horn of Africa has become more frequent and severe during the past 20 years (Funk et al. 2012). Severe drought often results in large numbers of livestock either dying or being sold off at greatly depressed (Coppock 1994).

Ethiopia

Ethiopia is one of the countries in SSA (Figure 1). It is a landlocked country located in the Horn of Africa. Ethiopia shares borders with Eritrea to the north, Sudan to the west, Kenya to the south, and Somalia and Djibouti to the east (FAO 2014). Ethiopia has the second largest human population of any country in Africa with about 94 million people (UN 2014). However, Ethiopia is one of the poorest countries in the world with annual per capita income averaging only $470 (UN 2014). Roughly 39 percent of Ethiopians live below the World Bank's poverty line of $1.25 a day

and, as a result, are vulnerable to food insecurity. Also, 82 percent of Ethiopians depend on subsistence agriculture for their livelihoods (USAID 2012). The United States provided approximately $10 billion in economic assistance to Ethiopia between 1951 and 2011 (USAID 2012). At the same time, Ethiopia is also one of the fastest growing economies in SSA with an annual growth in GNP of 10.4 percent experienced between 2009 and 2013 (World Bank 2013). Ethiopia is one of the top livestock producers in Africa and among the top 10 in the world with an impressive 35 million cattle, 11.4 million sheep and 9.6 million goats (Embassy of Ethiopia 2014).

Ethiopia's land area is around 1.1 million km^2 (Federal Ministry of Education 2010). Two thirds of this area could be used for agriculture. The actual cultivated area of Ethiopia is about 16.5 million hectares (22 percent). Smallholder farming represents 96 percent of the cultivated area of Ethiopia while the rest is used for governmental and private commercial farming (Federal Ministry of Education 2010)

The Borana Plateau

The Borana Plateau is an important rangeland area in southern Ethiopia. The pastoralists of the region have relied on cattle for many generations for their livelihoods. The pastoralists of this region have been slow to participate in commercial livestock trade. This lack of trade has been limited by social, economic, ecological, and political factors (Coppock 1994). Other factors that have threatened pastoralist livelihoods in the region specifically, and in Africa in general, are droughts which are increasing in frequency and severity (Coppock 1994). Social, political,

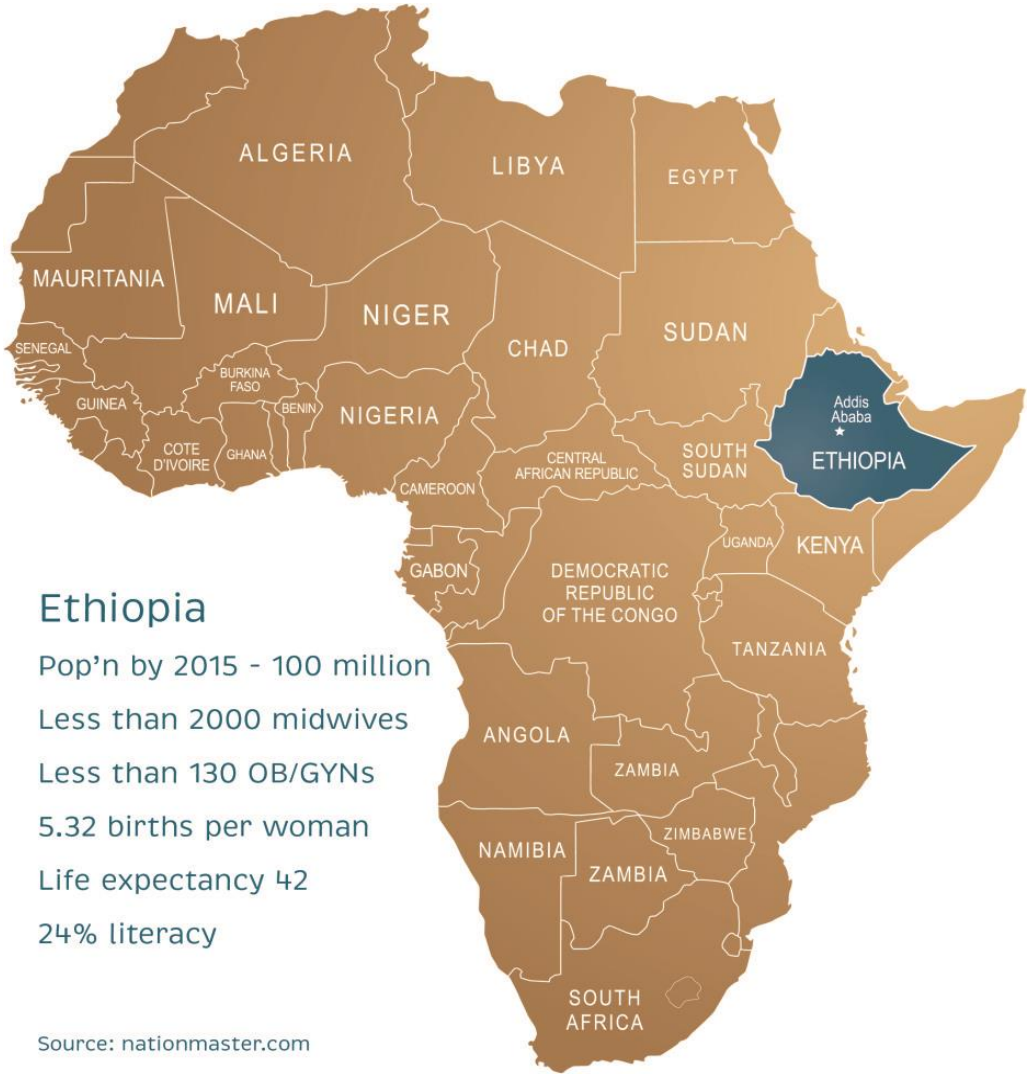

Figure 1. Africa and Ethiopia

Source: http://www.nationmaster.com/country-info/profiles/Ethiopia

economic, and religious conflicts are also factors that threatened their livelihoods (Coppock 1994). Population growth, external interventions, and the loss of pastoral grazing lands are also factors have negative consequences for the Boran pastoralists on the Borana Plateau (Coppock 1994; Swift et al. 2001).

The expanding human and livestock populations of the Borana Plateau have caused the rangeland to be degraded. For example, bush encroachment on the grasslands has reduced grass production and the resulting reduction in ground cover has caused a recent acceleration of gully erosion (Coppock 1994; Coppock et al. 2014). Another factor negatively affecting pastoralists in the Borana Plateau is the loss of grazing lands to cultivation (Desta 1999).

Research Objectives

Because diversification is an essential risk management strategy, this thesis presents an analysis of the diversification strategies pursued by wealthy pastoralists in the Borana Plateau. Wealthy pastoralists were studied because an increasing portion of the wealth in the Borana Plateau is becoming concentrated in the hands of pastoralists owning 50 cows or more (our definition of wealthy in this area). Understanding the diversification strategies used by this segment of the pastoralist population will provide insights about the diversification strategies that are available and the barriers which exist to accessing different forms of investment allowing for diversification. The specific objectives of this research are:

(1) Determine the types of investment strategies and level of diversification used by pastoralists such as cattle, camels, goats, sheep, farming, value-

Figure 2. The Borana Plateau

Source: https://www.google.com/maps/@8.1789002,39.0964242,6z

added agricultural activities, financial assets such as bank accounts, and financial instruments such as certificates of deposit, and real estate investments.

(2) Determine the perceived level of risk for each of these different potential investments; and

(3) Use quadratic programming to determine empirical risk preferences associated with the different portfolios of potential investments,

The analysis presented in this thesis is conducted more than 15 years after a similar analysis undertaken by Desta (1999). However, it provides a deeper assessment of the motivations and characteristics of diversification by pastoralists on the Borana Plateau than was completed by Desta. The result of this research will provide a clearer picture of risk management strategies undertaken by pastoralists on the Borana Plateau which will assist in making recommendations to remove barriers to diversification that may exist. This should provide insights about educational activities that could help pastoralists in their risk management activities.

CHAPTER 2

LITERATURE REVIEW

Investment theory is defined as, "The study of the individual behavior of households and economic organizations in the allocations of their resources to the available investment opportunities" (Merton 1977, p. 1). Merton (1977) divided the individual's investment decision into two parts. The first part is "consumption saving" where the individual decides how much of his wealth to allocate to his current consumption and how much to invest in future consumption. The second part is "portfolio selection" choices where he decides how to allocate his savings among the available investment opportunities.

The gain obtained as a result of holding a certain asset over a period of time is called a "return." For example, the return on a stock can be defined by the dividend paid to shareholders (investors) or by the income of the stock's value. The return on a bond can be defined by the annuities paid to the investors or by the difference between the buying and selling prices (Ionescu 2011). The "rate of return" is often associated with the degree of risk taken. That is, larger rates of return are typically associated with larger risks than smaller rates of return. The risk taken by investors can be divided in two types (Lintner 1965; Sharpe 1964). One is called systematic risk. Systematic risk is caused by economy-wide disturbances affecting all returns. This risk cannot be eliminated using diversification. The other is unsystematic risk. This type of risk is caused by factors not associated with economy-wide conditions.

This risk can be reduced using diversification. Academic and policy research in Africa have usually focused on risk management and diversification related to livestock assets and comparing returns on livestock investments to non-farm investments. Swallow (1994) divided the risks facing pastoralists and agro-pastoralists in Africa into three major risks including environmental risks, property categories, and market risks. Environmental risks include: 1) rain fall variation and its relationship with the quality and quantity of forage and crop production; 2) temperature changes and their effect on the kind of livestock breeds and species; 3) interactions with wildlife; and 4) livestock and crop diseases. Property risks for agro-pastoralists are mainly the risks and threats to their livestock, natural pastures, fallow lands and cropland. The main risks for livestock are: 1) loss due to weather conditions like droughts; 2) livestock diseases; 3) loss due to change in social relations like partnership and sharing agreements; and 4) the lack of security and increasing violence.

Market risks include livestock and input price variability and the availability of inputs and outputs. Risk management and diversification strategies adopted by pastoralist households discussed by Swallow (1994) are: 1) livestock mobility and migration; 2) asset accumulation and depletion; 3) different livestock species and breeds; 4) crop cultivation; 5) waged labor and self-employment; and 6) new livestock production techniques. Swallow (1994) also discussed risk management and diversification strategies used by pastoralist households as being: 1) sharing and

hospitality; 2) group ownership and inheritance; 3) bride-wealth; 4) livestock management arrangements; and 5) rotating credit societies.

Desta (1999) conducted a portfolio analysis for Boran pastoralists and discussed the diversification and risk management of livestock assets in the Borana plateau of southern Ethiopia. He used a bank savings account as a measure of non-pastoral investment. Desta interviewed and used data from 317 pastoralist's households who lived in the range of a 35 km radius from four major towns in the region. The populations in these four cities represented 73 percent of the total population of the study area. Desta's study concluded that diversification using non-pastoral investments and access to finance and marketing are vital factors in sustaining the livelihoods of pastoralists in the region. The results from Desta's stochastic dominance analysis suggested the best investment portfolio option for pastoralists was combining cattle with safe banking while using an improved cattle marketing system.

Little et al. (2001) used field-work observations, individual interviews and focus groups, to gather information about pastoral and non-pastoral income earning activities. They indicated that agriculture and cultivation, if feasible, are good ways for pastoralists to diversify during good climate conditions. If agriculture and cultivation are not feasible, labor wages and trading or business activities represent good ways to diversify Little et al. (2001).

Skilled higher-income waged labor, business and trading activities are also used by the wealthiest pastoralists. Wealthy pastoralists use herd mobility to

diversify in dry areas. Wealthy pastoralists could use dry land cultivation as a source of the cereal used in the livestock feed to reduce the amount needed to be purchased Berhanu et al. (2007).

McPeak and Barrett (2001) talked about strategies to reduce the risk exposure in the arid and semi-arid rangelands of eastern Africa. They listed herd mobility, migration and accumulation, financial savings, livestock marketing, insurance, diversification by non-farm activities, and external assistance from government and charity organizations as ways to reduce risks for pastoralists in the region.

Lybbert et al. (2001) concluded that mortality and calving are very important to herd dynamics during weather and other shocks compared to marketing and social insurance mechanisms. They suggested that maintaining a larger herd size before the shock is the best means to have a reasonable herd size following the shock. The data suggested that a pastoralist household's chances to remain pastoralists for a few years was much less when the heard size dropped to about six head of cattle compared to those pastoralist households with 15-30 head of cattle. This second group represents the hope for the Borana pastoralism against livestock cycles that happen because of shocks like droughts and diseases. Lybbert et al. (2001) also suggest that wealthy pastoralists need means to diversify their assets and to invest in non-pastoral activities.

Coppock et al. (2008) researched the die-offs of cattle in the Borana plateau of southern Ethiopia during droughts and found that cattle "boom-and-bust" cycle is predictable in the in data covering from 1983 to 2005. According to their study, this

finding can be used to encourage pastoralists to diversify and to help plan the activities of the agencies involved in the relief and development efforts for these pastoralists. Coppock et al. (2008) warned about factors like resource degradation, population growth, and rainfall variation which can affect the production system. Their research pointed out that any further efforts and solutions to help the sustainability and the future of pastoralism in the Borana plateau region should focus on capacity building and livelihood diversification.

Tache and Oba (2010) concluded that crop cultivation represents a livelihood diversification strategy against livestock and not a poverty-mitigating strategy. It has been suggested that the lifestyle of the pastoralists in Borana region of southern Ethiopia is changing from pastoralism to agro pastoralism[3] due to poor pasture and livestock productivity, environmental conditions, and population growth (Coppock 1994; Gemtessa et al. 2005). The region is exposed and vulnerable to several risks. These include: 1) climate risks which such as drought, and floods, which lead to harvest failure; 2) policy shocks, such as taxation and migration changes; and 3) livestock illness and death (Dercon 2002). There is also the typical income, price and revenue risks for farm commodities that is faced by these producers (Tomek and Peterson 2001).

[3] Agro pastoralism is combining farming with pure pastoralism to cope with the food insecurity (Coppock 1994; Gemtessa et al. 2005).

The population of the Borana Plateau receives a large amount of the food aid sent from the United States and other countries to Ethiopia (Coppock 1994). Pastoralists in the region are striving to maintain a sustainable livelihoods in the face of all of these challenges. The means or assets needed to develop sustainable livelihoods include: human capital (the health, education and skills of household members); physical capital such as farm machinery; 3) social capital (the groups which they belong to); financial capital (savings, credit, cattle); and natural capital (the natural resources at their disposal such as land and water) (Ellis 1999). In reference to making a living using the different categories of capital, Ellis defines "livelihood" as, "The activities, the assets, and the access that jointly determine the living gained by an individual or household (Ellis 1999, p. 2).

Following the traditional view of how one can reduce risks in markets and production, pastoralists need to diversify their livelihoods to be able to adapt to the risks they face including natural phenomena such as droughts. Improving pastoralists' risk management methods and, as a result, their resiliency to the natural and economic shocks they face is fundamental to helping them continue to maintain their livelihoods in the Borana Plateau. Diversification is a likely strategy for doing this. Diversification could be explained to a farmer by saying, "Do not put all your eggs in one basket." Diversification reflects the voluntary exchange of assets and allocating them across various activities to achieve an optimal balance between the return and the risk exposure given the constraints they face (Barrett et al. 2001).

Ellis listed some of the positive and negative effects of diversification (Ellis 1998). The positive effects result in improving the long-run resilience associated with facing adverse trends and shocks. These positive factors include seasonality (by reducing the adverse effect of labor and consumption smoothing by utilizing labor and generating income in off-peak periods), risk reduction, higher income, asset improvement by putting the asset to a better use, and environmental benefit by investing more resources and dedicating more time to improving the quality of the natural resources. The negative effects of diversification include income distribution resulting in widening the disparities between the classes in a society, farm output – or stagnation on the farm by relying on distant labor, and adverse gender effects where the male labor take advantage of diversification compared to the women (Ellis 1998).

Income diversity is an increasingly-used tool by herders to manage their risk and enhance their economic welfare. Diversification should complement and not compete with the traditional pastoralist risk management methods such as herd mobility and accumulation (increasing the number of stock) (Little 2009). Little (2009) has presented some recommendations to policy makers in eastern and southern Africa to help pastoralists manage their risk using non-pastoral income in rural and urban areas. Some of the non-pastoral activities listed on the policy brief are trade occupations like selling milk, firewood, animals, or any other products. Other suggestions included trade occupations such as employment as a herder, a farm worker or a migrant laborer, establishing a retail shop, engaging in sales and rental of

property, selling wild products like gum, firewood, Arabica or medicinal plants, and farming.

Insurance represents another way for diversifying a rural smallholder's portfolio and potentially reducing the risk caused by factors like climate change. An index-based livestock insurance (IBLS) is a new form of insurance that was introduced in 2010 to protect livestock pastoralists from drought risk (Ellis 1998). The IBLI insurance used in the Borana Plateau is called the Cumulative Deviation of Pasture Availability Index (CZNDVI) which monitors forage conditions using satellite images for two seasons in 12 months (Mude et al. 2009).

Some portfolio selection theories have discussed the rules of diversification of risky assets. Markowitz's (1952) revolutionary "portfolio theory" is one of the most well-known of these theories and discusses the relationship between return, risk, and portfolio diversification. The correlation among asset or security returns affects how much diversification can assist in reducing the risk associated with a certain portfolio. If the returns among different potential assets are perfectly correlated, diversification will not have any effect on the amount of risk the investor faces (Markowitz 1952; Tobin 1958). Markowitz created his theory based on a few assumptions including: 1) investors are rational and risk-averse with a goal to maximize their utility and minimize the risk for any level of expected return; 2) the markets are efficient and investors have access to the needed market information to make rational investment decisions. The main factor assumed to drive investment decisions is assumed to be

the expected or the standard deviation[4] of the returns for different investments from their average or mean return. Rates of return can be estimated using financial models by taking into consideration some factors like exchange rates and inflation. The nominal values of returns need to be changed into real values for the return in order to be measurable and comparable between the different studies (Ionescu 2011).

Foreign Direct Investment in Ethiopia

Inflows of foreign direct investment (FDI) into Africa increased by 4 percent ($57 billion USD) in 2014 compared to 2013. This increase was supported by growing international and intra-African investment flows. These investments include infrastructure and customer-based industries like food, retail, finance, and tourism (UNCTAD 2014). The increase was driven by southern and eastern African sub regions. The FDI flows into southern Africa almost doubled to $13 billion in 2014 compared to 2013, due mainly to infrastructure investments in both South Africa and Mozambique (the gas sector in Mozambique). The FDI also increased by 15 percent in eastern Africa to $6.2 billion in 2014 compared to 2013, led by the investment flows in Ethiopia and Kenya (UNCTAD 2014).

Kenya is becoming one of Africa's most-favored investment hubs with investment flows into the oil and gas exploration, manufacturing and transport sectors (UNCTAD 2014). This world investment report expects the Ethiopian industrial strategy to attract Asian investments to develop Ethiopia's manufacturing base.

[4] Standard deviations will be designated as σ from this point forward.

Growth in both FDI and investment in Ethiopia may provide opportunities for Ethiopians with discretionary money for such investments if they have the necessary understanding and connections to participate in these opportunities.

The Ethiopian government is focusing on large-scale investments in social, infrastructural, and energy projects to achieve its a five-year growth and transformation plan (GTP 2010-2015) with a goal to grow the country's GDP by 11.2 - 14.9 percent annually. The plan also indicates a desire for establishing a more middle class income status by 2025 as a part of its millennium development goals (USTR 2013). This report indicates that Ethiopia needs a large amount of FDI to support its plans. Large investments accompanied by political stability have improved trade conditions for Ethiopia and have led to a positive effect on the country's overall credit status. The same report listed the Ethiopian investments that cannot be offered to foreign investors as banking, insurance, and financial services. Sectors such as telecommunication, power transmission and distribution and postal services are state-owned investments and are also unavailable to foreign investors. The investments limited to Ethiopian nationals include broadcasting, air transport services, import trade, capital goods, and rentals (USTR 2013).

The Ethiopian government has provided both foreign and domestic investors with investment incentives based on performance requirements. For example, an investor engaged in the manufacturing, processing or production of agricultural products is exempt from tax for five years if he or she exports at least 50 percent of their product or supplies at least 75 percent of their product to an exporter as

production inputs. Investors putting money into developing regions like Gambella and Afarare are eligible for an additional one year of tax exemption (USTR 2013).

The G8 countries partnered with Ethiopia to create "New Alliance for Food Security and Nutrition" to achieve Ethiopia's goals as a part of the Africa Agriculture Development Program (CAADP) (FIAN 2014). Ethiopia showed commitment to the G8 program in its Agricultural Growth Program. The partnership goals include creating more private investment in agriculture, achieving sustainable food outcomes, supporting the implementation of Ethiopia's Agriculture Sector Policy Investment Framework (PIF), scaling innovation, reducing the number of poor in Ethiopia by 2.9 million by 2022, and eliminating hunger (FIAN 2014).

In May 2012, six Ethiopian companies and eight international companies signed "letters of intent" to explain their investment in Ethiopia under the new Alliance for Food Security and Nutrition and to support the Ethiopian or "PIF." The names of the Ethiopian companies are: Bank of Abyssinia, Guts Agro Industry, Hilina Enriched Foods, Mullege, Omega Farms, and Zemen Bank. The international companies include: AGCO, Diageo, DuPont , Netafim, SwissRe. Syngenta, United Phosphorous, and Yara International (FIAN 2014).

The Ethiopian Privatization Agency (EPA) was established by the Ethiopian government in 1995 to privatize state-owned enterprises. The EPA office is preparing 43 out of the 113 state-owned enterprises in sectors like, construction, agriculture and agro-industry, manufacturing hotels, trade, transport, and mining to be privatized in the near future (USTR 2013). According to the Ethiopian embassy, Ethiopia has

investment opportunities in modern commercial livestock animal husbandry breeding due to the low output per unit of domestic breeds using the traditional cattle breeding methods. There are also opportunities in production and processing of meat, milk and eggs using ostrich, civet cat, and crocodile farming (USTR 2013).

Although the Ethiopian government tries to encourage trade through different incentives, there are many barriers to trade on both the import and export side within the region and globally. Ethiopia is not yet a member of the World Trade Organization (WTO), which limits trade opportunities between the country and other countries globally. The Ethiopian government has been working on new legislation and policies since they submitted the request to register with the (WTO) in January 2003. Ethiopia does not participate in the free trade area as a part of the Common Market for Eastern and Southern Africa (COMESA), which also limits the trade potential in such areas (USTR 2013),

The Ethiopian government applies high tariffs which reached 17.3 percent in 2012. These tariffs are applied to protect local industries like textile and leather (WTO 2013; USTR 2013). Ethiopia also applied some export bans on cereals in 2009 that are currently in force due to perceived local supply shortages. In 2001, another ban on raw and semi-processed hides and skins was imposed to increase the domestic supply and to encourage the export of these products (USTR 2013). The same report mentions that to place an order an importer needs a letter of credit equal to the value of the order and an import permit. These permits are also difficult to obtain (USTR 2013).

Another barrier listed by the U. S. Trade Representative Office (2013) is that foreign exchange is controlled by the Central Bank of Ethiopia. This makes the local currency (Birr) more difficult to convert to other currencies. This current political regime favors well-connected firms such as the large and state-ruling party firms over smaller and newer firms when it comes to processing payments and capital transaction on a timely basis (USTR 2013).

Intellectual property rights protection is another issue facing foreign investors in Ethiopia. Although Ethiopia is a member of the world Intellectual Property Organization and has an intellectual property office (EIPO), its main focus is on protecting local patents and trademarks versus protecting foreign brands.

Smallholder Family Investments

The International Fund for Agricultural Development (IFAD) of the United Nations realizes the importance of smallholder family farmers to food and nutrition security. According to IFAD (2014), smallholder farmers produce 80 percent of the food in sub-Saharan Africa and parts of Asia and are the largest providers of jobs to the local labor force in these areas. The IFAD invests in smallholder family farmers in different regions of the world and aims to enhance productivity, help smallholder farmers adapt to climate change, build rural infrastructure, empower women, provide access to financial tools and capital, improve smallholders' access to markets, and encourage public-private partnerships (IFAD 2014).

A low level of education is another challenge facing overall development and investment in the rural areas of Ethiopia. Illiteracy limits the opportunities for poor

Ethiopians to benefit from the recent economic growth. Poverty in rural areas and high population growth, combined with unskilled teachers, poor facilities, and limited materials, make the situation even worse (USAID 2012). Ethiopia has started a five-year Education Sector Development Program (ESDP IV) 2010-2015 with the aim to improve access to high quality, sustainable and equitable education at the different levels of education including adult education. Formal and non-formal education increases the efficiency of small business operations, productivity and long-term survivability of businesses (Bekele and Worku 2008).

World Bank researchers used data from the agriculture sample survey known as RICS-AgSS taken for the four largest rural regions in Ethiopia (Oromia, Tigray, SNNP, and Amahara) (Loening. et al. 2009). Data from 14,646 households were included in the analysis which determined the importance of the rural non-farm sector in these locations (Loening et al. 2009). The main findings of the RICS-AgSS survey include: 1) about 25 percent of all households participate in nonfarm enterprises; 2) the main activities of most of the non-farm enterprises in Oromia, Tigray, and SNNP are trade, manufacturing and services compared to the enterprises in the Amahara region which are primarily involved in manufacturing followed by trade; and 3) households headed by women (25 percent of the sample) tend to be more involved in operating these enterprises (47 percent of the enterprises are operated by households that are headed by women).

According to the RICS-AgSS analysis, an increase in the average education of households with a non-farm enterprise from two to five years increases the number of

enterprises in the economy by 15 percent. The research listed the major barriers to non-farm enterprises in these regions beside market access as being financial services and transportation (Loening et al. 2009).

Limited financial resources and access to capital are big challenges to small businesses in Ethiopia. Small businesses need internal finance (savings, retained profit, sales of assets) and external finance instruments like loans and trade credits[5] (Getachew and Sahlu 2013). Small businesses in Ethiopia are often unwilling to apply to banks for loans because they believe they will be rejected due to a lack of needed collateral (Zeru 2010).

Poverty in rural Ethiopia limits the means of transportation of people and goods. Sixty-five percent of the area of Ethiopia is farther than five km away from an all-weather road (Ethiopian Roads Authority 2009). Rural transportation solutions need to be adapted to local social, economic and environmental conditions to be sustainable (Mengesha 2010).

According to the Ethiopia Rural Socioeconomic Survey (ERSS 2013) and the detailed information it provides about the households' on-farm enterprises over the 12-month period preceding the survey, half of the number of households in small towns in Ethiopia are involved in non-farm enterprises. The main activities of these enterprises include selling processed agriculture products like food and local

[5] Trade credits are accounts payable when suppliers lend the products to the small enterprises.

beverages (six percent of the households), services and business from home like shops (six percent of households), and trading on the streets or in a market (five percent of the households). The survey listed other sources of income as transfer/ gifts (from friends and family), pension and investment, rental income, revenue from sales of assets and inheritance (ERSS 2013).

Although the small and medium enterprises (MMMEs) in Ethiopia are a major contributor to the country's economy, the risk of a failing business for these enterprises is also high. In a study conducted with 500 randomly-selected small businesses in five major cities in Ethiopia, it was found that the main reasons businesses fail are lack of finance, lack of education, poor managerial skills, lack of technical skills, and a lack of knowledge about how to retain part of the earnings in to the business (Bekele and Worku 2008). The same study found that the probability of failure of enterprises that are not involved with informal financial institutions known as (IQQUB) was 3.5 time higher than the ones that were.

The strategy of foreign direct investors in Ethiopia has changed to focus more on exports and trade compared with to domestic investors whose strategy is focused on local markets (Lavers 2013). Lavers' study shed light on some of the conflicts between the benefits of FDI at the macro level represented in foreign exchange earnings and the negative impact on micro levels groups like pastoralists and smallholders.

Investment is a critical element in economic growth. While the government of Ethiopia and potential large investor focus in developing parts of the economy that

are likely centered in the more urban areas of the country, investment decisions by local individuals may be an important part of the economy in localized and rural areas within Ethiopia. This particular study focuses on investments and investment diversification for wealthy pastoralists in the Borana Plateau. It demonstrates that pastoralists will diversify assets when they have discretionary income, but that there is a relatively small number of investments in their portfolios. The results demonstrate clearly that risk plays a very important role in portfolio selection and management for wealthy pastoralists. This may help to understand optimum risk management strategies for pastoralists and also provide insight to potential outside investors about the relative risk of different potential investments that exist on the Borana Plateau.

CHAPTER 3

FIELD SURVEY AND RESULTS

The main source of data used in the analysis presented in this study is taken from field interviews with 12 wealthy pastoralists who live around the Yabelo District on the Borana Plateau of southern Ethiopia. In discussions with Dr Layne Coppock and Dr. DeeVon Bailey at Utah State University they highlighted the need to focus on the wealthy pastoralists because of the amount of discretionary income wealthy pastoralists have available to invest (compared to other local people), their large-sized cattle herds (compared to others in the local community), their larger-than-average consumption of the community water and forage resources, and the employment they provided for the local communities for milking and herding activities. Coppock et al. (2014) defined wealthy households in the Harweyu region (a community and area in the same general area as Yabello) as households which own 100 cattle or more together with more than 100 sheep and goats and more than 20 camels.

Davies et al. (2007) listed three reasons relating to the importance of wealth to households. First, wealth raises long-term consumption of the household through the dissaving of the income generated from the return of investments in assets. Second, wealth enables consumption smoothing and the ability to protect households against adverse events such as unemployment, illness or aging (or, in this case, drought). The third reason is that wealth provides finance for the informal sector and can underwrite entrepreneurial activities by using wealth as a collateral for business loans.

The literature about world wealth distribution suggests that the inequality in global wealth is startling and its trend toward increased inequality is not slowing down or decreasing over time (Bourguignon and Morrison 2002; Milanovic 2005, Davies et al. 2007). Davies et al. (2007) found that global household wealth is highly concentrated with the top 10 percent of the world adults owning 71 percent of the world's wealth in 2000. The estimated Gini coefficient for global household wealth is said to now be 0.802 (Davies et al. 2007) compared to the 0.642 estimated by Milanovic (2005). The distribution of world income is somewhat less unequal compared with the world wealth distribution (Davies et al. 2007).

Income and wealth inequality also exists on the Borana Plateau. In their attempt to provide insights into the distribution of total income, cash income and livestock of different livelihood groups in Ethiopia and Kenya, McPeak et al. (2007) plotted the data from their sample from 11 sites in both countries on Lorenz curves. The Lorenz curve was constructed by first sorting the data for total income for survey respondents from the lowest to the highest value (ascending order). Second, the data were then sorted by households based on total household income. Third, they plotted total income of the poorest five percent of the survey respondents. Fourth, they then plotted the total income of the poorest 10 percent of the survey respondents. Fifth, they continued in a similar manner for cash income and livestock. Sixth, the curve was constructed by having the vertical axis represent the share of total income and the horizontal axis representing the share of the population (all respondents). The resulting pattern (curve) represented the cumulative percent of the total income

earned by the share of the population. If a Lorenz curve is a straight line with a 45 degree angle at the origin, there is perfect equality in the sample.[6] The more curved the line is the greater inequality exists in the sample.

McPeak et al. (2006) then calculated the Gini coefficient using the ratio of the size of the area between perfect equality (straight line with a 45 percent angle at the origin) and the actual Lorenz curve over the total area under the line of perfect equality. They found that the three variables exhibited relatively high inequality for their sample. The Gini coefficient for total cash was 0.56,[7] for cash income it was 0.68 and for livestock it was 0.64. They also found that only 8 percent of the total households controlled half of all income and that 4 percent of households had no cash. Livestock showed a similar pattern as the income pattern.

McPeak et al. (2006) also found that access to cash income and ownership of livestock is concentrated in a small share of the total households on the Borana Plateau. They also found that when they divided the survey respondents according to medians, which divided the population into two groups with 50 percent of the sample each, that the lower cash group controlled only 8 percent of cash income while the remaining 92 percent was controlled by the higher cash group. The livestock lower group controlled 11 percent of total livestock while 89 percent of livestock was

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[6] For example, 10 percent of the wealth is held by 10 percent of the population, 20 percent of the wealth by 20 percent ot the population, etc.

7 A Gini coefficient of 0.0 represents perfect equality.

controlled by the higher livestock group. There was a similar pattern within the two higher cash and livestock groups where the top eight percent of the sample controlled 50 percent of the total cash income and 50 percent of the livestock assets, respectively.

These findings clearly demonstrate that discretionary income for investment purposes in the Borana Plateau is concentrated in the hands of relatively few pastoralists. Because discretionary income is an essential component of investing, focusing our survey on the investment decisions made by wealthy pastoralists seems appropriate. The concentration of wealth in the hands of wealthy pastoralists also suggests that the investment decisions of relatively few wealthy pastoralists likely have a very significant impact on local economic development because they are the local people with the most money available to invest. While it is possible that outside investors would also be interested in making investments in the pastoral areas of southern Ethiopia, this study focuses its attention on the investment choices of local, wealthy pastoralists.

Data Collection

The data for this analysis are collected using a similar framework to the agriculture indicators (ABI) used by the World Bank (2012). The ABI framework is taken from the World Bank and IFC Doing business (DB) approach (World Bank 2012). The ABI approach uses a literature search and review combined with data from surveys conducted using a participatory approach to bring all the stakeholders concerned with the research onboard. This results in suggestions for policy reforms

to improve the efficiency and performance of the agribusiness sector in a developing country situation (World Bank 2012).

There were several steps used to collect the data for this analysis including the following:

1. Identifying influential and wealthy pastoralists living in and around Yabelo District on the Borana Plateau through field work performed by Mr. Seyoum Tezera of MARIL PLC in Addis Ababa, Ethiopia and by the Oromia Agricultural Research Institute (OARI).
2. The face-to-face interviews conducted by Mr. Seyoum Tezera of 12 wealthy and influential pastoralists are used to complement and validate data obtained by the literature review. For example, data from the interviews and data from Forrest (2014) and Forrest et al. (2015) were found to be consistent and were merged to calculated returns to different investment.
3. Internal and external expert opinion was used to validate and enhance the quality and acceptability of the data used in the analysis. Internal expert opinion and advice included Dr. D. Layne Coppock, Dr DeeVon Bailey at USU. External opinions and reviews included executives from local banks in the study area and from the Oromia Agricultural Research Institute (OARI).
4. Using the literature review done by the World Bank (2012) previous studies performed in the Borana Plateau and Ethiopia (i.e., Forrest (2014) and Forrest et al. (2015) as a secondary source of data, the analyses was conducted using

stochastic dominance with respect to a function (SDRF) and quadratic programming (QP).

5. It is planned that the findings of this study will be presented to the Ethiopian government for use in future policy considerations as well as to the Borana pastoralists involved in the study.

The Surveys[8]

The surveys were conducted by USU's field representative (Mr. Seyoum Tezera) in the Borana region with 12 pastoralists who are considered important and wealthy members of the Borana community. Those who were interviewed will be referred to as the "Panel." There were almost 50 years separating the youngest and oldest member of the Panel. Five of the Panel indicated that they lost their father at an early age and most of them were raised by their mothers. Five of the Panel indicated that they inherited some livestock from their fathers. However, all the members of the Panel are proud of what they have accomplished and each indicated they have worked from a very young age to build their own herds.

Besides herding livestock, some of the Panel members indicated they had sold firewood, tracked cattle for traders, sold cloth and rented camels to sell salt in order to save and start their own herds. They all agreed that livestock herding requires

[8] These surveys were carried out after receiving clearance from the internal Review Board (IRB) for human subjects at Utah State University. The IRB protocol was #6376.

dedication because traditionally, livestock required travelling with the herd for several kilometers each day to find land to graze as well as water. The Panel members have each worked hard day and night to guard and herd their livestock. Over a period of many years, each member of the Panel has seen their livestock herds hit hard by droughts and other conflicts and disasters that resulted in them losing most of their herds. None of the twelve had received any formal education and only one of them indicated he could read and write. They lamented that not receiving at least minimum education limited their opportunities for economic and personal growth. Each wished they had had some education to make their daily interactions in life easier and better. When asked about the main reasons for having aimed at accumulating large numbers of livestock, the Panel listed providing basic needs like meat and milk for their families, gaining a source of income, and to feel secure.

Livestock Portfolios

The returns on livestock and the other investment portfolios are calculated using a return on assets (ROA) approach based on the survey questionnaire and the data provided by the 12 members of the Panel. The revenues and costs (net income) for livestock portfolio are derived from Forrest (2014) who made estimates of costs and returns for different livestock and cropping activities in the Harweyu community of the Borana Plateau in 2014; an area in the same general region as the 12 members of the Panel.

Cattle[9]

The total number of cattle owned by the 12 members of the Panel was 1120 bulls and 3430 cows (Table 1). The average number of cattle owned per pastoralist is 93 bulls and 286 cows (Table 2). This suggested that each Panel member owned an average of about 93 bulls and 286 cows or 379 cattle in total (Table 2). The value per head was assumed to be $175 USD as reported in Forrest (2014). This gave an average value for the cattle owned by each panel member of about $66,354 USD[10] (Table 2). Total net revenue per head in a normal[11] year was estimated by Forrest 2014) on a per head basis[12] to be about $94 USD per head (Table 3). During drought years, milk

[9] During droughts only 50% of surviving females cattle calve. Also during drought, the cows that are lactating only produce 10% as much milk as during normal rainfall years. During the two year of drought the number of cattle is reduced by 62.5 percent divided into 15.6 percent during the first year and 46.9 percent during the second year. This is based on information from the surveys, Coppock (personal conversation 2015) and Bailey (personal conversation 2015) relating to droughts having less impacts in the first year of a drought than in the second.

[10] Assumes an exchange rate of about 20 Birr per $1 USD (xe.com 2015).

[11] "Normal" was defined by Forrest (2014) as a year with normal rainfall or, in other words, a non-drought year.

[12] Forrest (2014) estimated costs and returns on both per head and per cow basis. Per head basis is what is reported here.

production is assumed to decline by 50 percent and 10 percent fewer of the remaining female cattle had calves (actually lactated) (Forrest et al. 2015). The general form of the equation for calculating livestock returns is as follows:

(1) $RETURN_{it} = ((NUMBER_i(1 - TOTLOSS_{it})(1 + REBUILD_i^{t-6})(1 - MILKLOSS_{it})(1 - LACLOSS_i)(NREVENUE_i)) - ((NUMBER_i)(LOSS_{it})(PRICEHD_i)))/INVEST_i$

where $RETURN_{it}$ represents the return in decimal form for the i^{th} livestock species (I = cattle, camels, goats, and sheep) for the t^{th} year of the simulation (t = 1, 2, 3, . . . , 10. For drought years t = 5, 6). *NUMBER* is the initial number of the i^{th} livestock species. $TOTLOSS_{it}$ is the cumulative percentage of livestock lost in the drought for each livestock species. For example, in YEAR 5 *TOTLOSS* is 0.156 for cattle and in *YEAR 6 it is 0.625* (i.e., the cumulative loss is 62.5 percent over the two-year drought and this is assumed to more severe in Year 2 (0.469) than in Year 1 (0.156)). *REBUILD* is the rebuilding rate for the specified livestock species following the drought in Year 5 and Year 6 and is set to equal zero for t = 1, 2, 3, 4, and 5. Herds are assumed to rebuild at this compounding rate following a drought until the herd reaches the same level as it was prior to the drought. Herds were assumed to be unable to grow beyond this level due to constraints imposed by available grazing and browse resources. $MILKLOSS_{it}$ is the reduction in normal milk production in a drought year (*MILKLOSS* = 0 for t = 1, 2, 3, 4, 7, 8, 9, 10 for species) compared to a normal year by livestock species. *MILKLOSS* is 0.90 for

Table1. Total Number of Livestock Owned by the 12 Panel Members and Per Head Values.

Species	Male Number	Female Number	Value/head [a]	Total Value[b]
Cattle	1120	3430	$175	$796,250
Camels	152	235	$875	$338,625
Sheep	750	1450	$30	$66,000
Goats	750	1450	$30	$66,000

[a] Forrest (2014) estimated costs and returns on both a per head and per cow basis. Per head basis is what is reported here.
[b] Monetary values reported in USD. To convert to Ethiopian Birr, multiply by 20.

Table 2. Average Number of Livestock Owned by Individual Panel Members and the Average Value of Livestock Owned by Individual Panel Members.

Species	Male Number	Female Number	Value/head[a]	Total Value[b]
Cattle	93	286	$175	$66,354
Camels	13	20	$875	$28,219
Sheep	63	121	$30	$5,500
Goats	63	121	$30	$5,500

[a] Forrest (2014) estimated costs and returns on both a per head and per cow basis. Per head basis is what is reported here.
[b] Monetary values reported in USD. To convert to Ethiopian Birr, multiply by 20.

cattle, 0.15 for camels, and 0.25 for sheep and goats in drought years (for t = 5, 6). $LACLOSS_i$ is the percentage of females lactating in a drought year compared to a normal year (in this case *LACLOSS* is 50 percent for cattle and 0 percent for all other livestock species. $NREVENUE_i$ is the net revenue per head reported by Forrest (2014) for the i^{th} livestock species in a normal year. $LOSS_{it}$ is the actual percentage loss for the i^{th} species in a particular year. For example, *LOSS*=0.0156 in Year 5 and 0.469 in Year 6 and is zero, otherwise. $PRICEHD_i$ is the value of livestock species i as reported by Forrest (2014) and $INVEST_i$ is the total value of the initial investment at the beginning of the simulation for the i^{th} livestock species. In non-drought years, *LOSS* = *MILKLOSS* = *LACLOSS* = 0. The mean return and itsσ for *RETURN* for the different livestock species as calculated over a simulated ten-year period was used to simulate a distribution of returns used in the stochastic dominance analysis explained later.

Based on equation (1) total net revenue from milk and livestock sales or consumption [13]in a normal year from cattle would be about $35,788 USD (Table 3). This suggested total investment in cattle herd (investment) of about 54 percent ($35,788/$66,354) during a normal rainfall year (Table 3).

Two successive years of drought would result in approximately 62.5 percent loss of the cattle herd based on average estimates made by the Panel. Based on

[13] Forrest (2014) valued both sales and consumption of livestock products (milk and meat) at the market value to account for the opportunity costs of these products.

Table 3. Average Livestock Complement for the Panel Together with Estimated Revenue and Return on Investment During Normal Year[a] Based on Forrest (2014).

Net Revenue from Livestock	Average number of Livestock [b]	Revenue per normal year per 'head a	Total normal year	normal year return on investment
Cattle	379	$94	$35,788	54%
Camels	32	$205	$6,611	23%
Sheep	183	$5	$944	17%
Goats	183	$13	$2,341	43%

[a] During droughts only 50 percent of surviving females cattle calve. Also during drought, the cows that are lactating only produce 10 percent as much milk as during normal rainfall years. Milk production is reduced by 15 percent for female camels and 25 percent for the surviving female sheep and goats during a drought. (Coppock 1994 and 2014).

[b] During the two year of drought in the simulation, the number of cattle is reduced by 62.5 percent divided into 15.6 percent during the first year and 46.9 percent during the second year; the number of camels is reduced by 4.6 percent in total divided into 1 percent during the first year and 3.6 percent during the second year; the number of goats is reduced by 50 percent in total divided in to 10 percent during the first year and 40 percent during the second year; and the number of sheep is reduced by 59 percent in total divided into 12 percent during the first year and 47 percent during the second year. This is based on information from the surveys, Coppock (personal conversation 2015) and Bailey (personal conversation 2015) relating to droughts having less impacts in the first year of a drought than in the second.

information from Coppock (personal conversation 2015), average returns to the cattle herd were simulated over a 10-year period assuming the first four years were normal rainfall years and provided a return of 54 percent to the investment in cattle (Table 4). The fifth (Year 5) and sixth years (Year 6) were assumed to be drought years with an absolute loss in the cattle herd of 15.6 percent during the first year and 46.9 percent during the second year (see Table 5 for more information on the calculation of returns for livestock).

Camels[14]

The total number of camels owned by the 12 members of the Panel was 152 bulls and 235 cows (Table 1). The average number per pastoralist is 13 bulls and 20 cows (Table 2). This suggested that each Panel member owned an average of 33 bulls and 20 cows, or 53 camels in total (Table 2). The value per head was assumed to be $875 USD as reported in Forrest (2014). This gave an average value for the camels owned by each

[14] During droughts milk production is reduced by 15 percent for female camels and the number of camels is reduced by 4.6 percent divided into 1 percent during the first year and 3.6 percent during the second year. This is based on information from the surveys, Coppock (personal conversation 2015) and Bailey (personal conversation 2015) relating to droughts having less impacts in the first year of a drought than in the second.

Table 4. Estimated Net Returns per Year in Percentage for the 10-Year Simulation.

Year	Cattle	Camels	Goats	Sheep	Savings Account[a]	Real Estate	Maize	Beans
1	54	23	43	17	3	14	240	590
2	54	23	43	17	3	12	240	590
3	54	23	43	17	3	11	240	590
4	54	23	43	17	3	11	240	590
5	-10	19	19	0	4	11	-100	-100
6	-46	15	-24	-42	4	9	-100	-100
7	26[b]	23[c]	27	9	4	13	240	590
8	33	23	35	11	4	11	240	590
9	42	23	43	14	5	9	240	590
10	53	23	43	17	5	10	240	590
Avg.	31	22	31	8	4	11	172	452
Stdev	34	3	21	18	1	2	143	291
CV[d]	108	13	67	237	21	14	83	64

[a] For savings account rates, Year 1 corresponds with actual rates in 2003, Year 2 with 2004, and so forth to Year 10=2013 as reported by Trading Economics (2015).
[b] The compounded annual rebuilding rate for numbers of cattle, sheep and goats following a drought is approximately 27.5 percent (Desta and Coppock 2002)
[c] The compounded annual growth in numbers for camels is approximately 17 percent as reported in Forrest et al. (2015) based on Kaufmann (1998).
[d] CV is coefficient of variation which is ratio of σ to the mean and used in normalization of risk across multiple investments.

Table 5. Values Used in Calculations Depicted in Equation (1).[a]

Variable	Cattle	Camels	Goats	Sheep
NUMBER	379	32	183	183
$TOTLOSS_5$	0.156	0.01	0.10	0.12
$TOTLOSS_6$	0.625	0.046	0.5	0.59
REBUILD[b]	0.275	0.175[c]	0.275	0.275
MILKLOSS[d]	0.9	0.15	0.25	0.25
LACLOSS[d]	0.5	0.00	0.00	0.00
$LOSS_5$	0,156	0.01	0.10	0.12
$LOSS_6$	0.469	0.036	0.40	0.47
NREVENUE[e]	$94.39	$205	$12.77	$5.15
PRICEHD[e]	$175	$875	$30	$30
INVEST	$66,354	$28,219	$5,500	$5,500
Mean over Ten-Year Simulation [f]	31%	22%	31%	8%
Stdev	34%	3%	21%	18%
CV[g]	108%	13%	67%	237%

[a] Monetary values reported in USD. To convert to Ethiopian Birr, multiply by 20.
[b] Based on information reported in Forrest et al. (2015) as well as Desta and Coppock (2002) and Coppock et al. (2008).
[c] Based on Kaufmann (1998) as reported in Forrest et al. (2015).
[d] Information taken from Forrest et al. (2015).
[e] Information taken from Forrest (2014).
[f] The maximum livestock portfolio is due to some of the constraints on growth like grazing and water resources.
[g] Coefficient of Variation.

panel member of about $28,219 USD[15] (Table 2). Total net revenue per head in a normal[16] year was estimated by Forrest (2014) on a per head basis[17] to be about $205 USD per head (Table 3). This suggests total net revenue from milk and livestock sales or consumption[18] in a normal year from camels would be about $6,611 USD (Table 3). During drought years, milk production is reduced by 15 percent for female camels and (Coppock 1994; Coppock et al. 2014). Equation (1) can be used with the information provided in Table 5 to calculate returns for the investment in camels over the 10-year period.

Based on equation (1) and Table 5, it is estimated that the return on the value of the camel herd (investment) would be about 23 percent ($6,611 /$28,219) during a normal rainfall year. Two successive years of drought would result in approximately 4.58 percent loss of the camels herd based on average estimates made by the Panel. Based on a suggestion by Coppock (personal conversation 2015), average returns to the camels herd were calculated over a 10-year period assuming the first four years

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[15] Assumes an exchange rate of about 20 Birr per $1 USD (xe.com 2015).

[16] "Normal" was defined by Forrest (2014) as a year with normal rainfall or, in other words, a non-drought year.

[17] Forrest (2014) estimated costs and returns on both a per head and per camel basis. Per head basis is what is reported here.

[18] Forrest (2014) valued both sales and consumption of livestock products (milk and meat) at the market value to account for the opportunity costs of these products.

were normal rainfall years and provided a return of 23 percent to the investment in camels. The fifth (Year 5) and sixth years (Year 6) were assumed to be drought years with an absolute loss in the Camels herd by 4.6 percent divided into 1 percent during the first year and 3.6 percent during the second year (Table 4).

Sheep[19]

The total number of sheep owned by the 12 members of the Panel was 750 males and 1450 females (Table 1). The average number per pastoralist is 63 males and 121 Females (Table 2). This suggested that each Panel member owned an average of about 63 males and 121 females or 184 sheep in total (Table 2). The value per head was assumed to be $30 USD as reported in Forrest (2014). This gave an average value for the sheep owned by each panel member of about $5,500 USD.[20] Total net revenue per head in a normal[21] year was estimated by Forrest (2014) on a per head

[19] During droughts milk production is reduced by 25 percent for the surviving female sheep. The number of sheep is reduced by 59 percent divided in to 12 percent during the first year and 47 percent during the second year. This is based on information from the surveys, Coppock (personal conversation 2015) and Bailey (personal conversation 2015) relating to droughts having less impacts in the first year of a drought than in the second.

[20] Assumes an exchange rate of about 20 Birr per $1 USD (xe.com 2015).

[21] "Normal" was defined by Forrest (2014) as a year with normal rainfall or, in other words, a non-drought year.

basis[22] to be about $5 USD per head (Table 3). This suggested that total net revenue from milk and livestock sales or consumption[23] in a normal year from sheep would be about $944 USD (Table 3). This suggested a return on the value of the sheep flock (investment) of about 17 percent ($944/$5,500) during a normal rainfall year.

Two successive years of drought would result in approximately 59 percent loss of the sheep flock based on average estimates made by the Panel (Table 4). Based on a suggestion by Coppock (personal conversation 2015), average returns to the sheep flock were calculated over a 10-year period assuming the first four years were normal rainfall years and provided a return of 17 percent to the investment in sheep. The fifth (Year 5) and sixth years (Year 6) were assumed to be drought years with an absolute loss in the sheep flock of 12 percent during the first year and 47 percent during the second year.

During drought years, milk production for sheep was assumed to decline by 25 percent and 0 percent of the remaining female sheep had lambs (actually lactated). As a result, returns for sheep during the drought years were calculated based on equation (1) and the information given in Table 5. These estimated returns are calculated for the 10-year period for sheep and are reported in Table 4.

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[22] Forrest (2014) estimated costs and returns on both per head and per cow basis. Per head basis is what is reported here.

[23] Forrest (2014) valued both sales and consumption of livestock products (milk and meat) at the market value to account for the opportunity costs of these products.

Goats[24]

The total number of goats owned by the 12 members of the Panel was 750 males and 1450 females (Table 1). The average number per pastoralist is 63 males and 121 Females (Table 2). This suggested that each Panel member owned an average of about 63 males and 121 females or 184 goats in total (Table 2). The value per head is assumed to be $30 USD as reported in Forrest (2014). This gives an average value for the goats owned by each panel member of about $5,500 USD (Table 2).[25] Total net revenue per head in a normal[26] year was estimated by Forrest (2014) on a per head basis[27] to be about $13 USD per head for goats (Table 3). This suggested that total

[24] During droughts milk production is reduced 25 percent for the surviving female goats during. The number of goats is reduced by 50 percent divided in to 10 percent during the first year and 40 percent during the second year. This is based on information from the surveys, Coppock (personal conversation 2015) and Bailey (personal conversation 2015) relating to droughts having less impacts in the first year of a drought than in the second.

[25] Assumes an exchange rate of about 20 Birr per $1 USD (xe.com 2015).

[26] "Normal" was defined by Forrest (2014) as a year with normal rainfall or, in other words, a non-drought year.

[27] Forrest (2014) estimated costs and returns on both per head and per cow basis. Per head basis is what is reported here.

net revenue from milk and livestock sales or consumption[28] in a normal year from goats would be about $2,341 USD (Table 3). This suggested a return on the value of the goats herd (investment) of about 43 percent ($2340/$5,500) during a normal rainfall year (Table 4).

Two successive years of drought would result in approximately 50 percent loss of the goat herd based on average estimates made by the Panel (Table 4). Based on a suggestion by Coppock (personal conversation 2015), average returns to the goat herd were calculated over a 10-year period assuming the first four years were normal rainfall years and provided a return of 42.6 percent to the investment in goats (Table 4). The fifth (Year 5) and sixth years (Year 6) were assumed to be drought years with an absolute loss in the goats herd of 10 percent during the first year and 40 percent during the second year. The information provided on Table 5 is applied to calculate returns to the goat herd over the 10-year period and these returns are reported in Table 4.

Crops

The returns on crops are calculated using a return on assets (ROA) approach based on the survey questionnaire and the data provided by the 12 members of the Panel. The revenues and costs (income) for livestock portfolio are derived from

[28] Forrest (2014) valued both sales and consumption of livestock products (milk and meat) at the market value to account for the opportunity costs of these products.

Forrest (2014) conducted in the Harweyu community of the Borana Plateau region compared to the assets held by the 12 members of the panel.

Crops in the survey region are dominated by maize and beans (Coppock et al. 2014) and this matches what the 12 members of the Panel indicated. The total number of hectares (ha.) of cropland farmed by the 12 members of the Panel was 20 ha. This 20 ha. is divided between 15.4 ha. of maize and 4.6 ha. of haricot beans (Table 6). The average amount of cropland farmed per pastoralist is 1.67 ha. (Table 7).

Maize

The price of maize is $ 0.2 USD/kg for the crop and $0.1 USD/kg for maize residue (Forrest 2014). This gave an average value for the maize owned by each panel member of about $647.03 USD (Table 7). The following equation is used to calculate returns for crops:

$$(2)\ RETCROP_{ct} = ((YIELD_c)(CROPPR_{ct}) + RESIDUEVL_{ct} - EXPENSES_{ct})/EXPENSES_{ct}$$

where $RETCROP_{ct}$ was the return on crop investment in decimal form for the c^{th} crop (c = maize, beans) in the t^{th} year. *YIELD* is the per hectare yield, *CROPPR* is the crop price, RESIDUEVL was the value of crop residue, and *EXPENSES* were the expenses reported for these crops by Forrest (2014). For drought years (t = 5, 6), *YIELD* and *RESIDUEVL* were assumed to equal zero. A land charge of 150 Birr ($7.50) per hectare was included in this case that was not included in Forrest (2014). The mean return and itsσ for *RETCROP* for the different crops as calculated over a simulated

ten-year period was used to simulate a distribution of returns used in the stochastic dominance analysis explained later. Using equation (2), an average return on land and management for normal year is about $ 470.43 USD (Table 7) for maize. This suggested an average return on land and management for drought year is about $ -161.74 USD (Table 7).

Two successive years of drought would result in a 100 percent loss of the maize harvest. Based on a suggestion by Coppock (2015), average returns to the maize crop were calculated over a 10-year period assuming the first four years were normal rainfall years and provided a return of 240.23 percent (Table 8). The fifth (Year 5) and sixth years (Year 6) were assumed to be drought years with an absolute loss of the whole crop and residue. Table 9 reports numbers used in the calculations reported in Table 8.

Haricot Beans

The price of Haricot Beans is $ 0.20 USD/kg for the crop and $0.10 USD/kg for haricot beans residue (Forrest 2014). This gave an average value for the haricot beans owned by each panel member of about $348.80 USD (Table 7). This suggested an average return on land and management for normal year is about $295.45/ha. USD (Table 7). This suggested an average return on land and management for drought year is about $48.88 USD (Table 7).

Table 6. Total Crop Land Share and Returns of Cropland Per Member of the Panel.[a]

Crop	Total cropland Ha.	Crop share Ha.[b]	Quantity kg	Price/kg USD	Crop Net value Birr/Ha.[c]	Total Value in Birr	Total Return to Land and Management Normal Year	Total Return to Land and Management in Drought Year
Maize	20	15.375	2000	$0.20	400	7764.38	5645.13	-1940.89
Residue			1125	$0.10	112.5			
Beans		4.625	4000	$0.20	800	4185.63	3545.42	-586.55
Residue			1125	%0.10	112.5			

[a] Monetary values reported in USD. To convert to Ethiopian Birr, multiply by 20.
[b] The crop share of land assuming that about 75 percent of the land is cropped with maize and 25 percent with beans (Tezera 2014).
[c] Based on that reported in Forrest (2014). During drought years no labor cost for harvest is excluded and EXPENSES was reduced by $26.60/ha. in those years (see equation (2). In addition to expenses listed in Forrest (2014) a 150 Birr land rent change was also subtracted from gross revenues. The rental rate was based on an average from rental rates across Ethiopia as reported by the Ethiopian Ministry of Agriculture (2015).

Table 7. Average Share and Returns for Cropland for Each Member of the Panel[a].

Crop	Average cropland ha	Average Land in the Crop/ha[b].	Average Crop value/ha [c].	Average Return on Land and Management for Normal Year	Average Return to Land and Management in Drought Years
Maize	1.67	1.28	$647.03	$470.43	-$161.74
Beans		0.39	$348.80	$295.45	-$48.88

[a] Monetary values reported in USD. To convert to Ethiopian Birr, multiply by 20.
[b] The crop share of land assuming that about 75 percent of the land is cropped with maize and 25 percent with beans (Tezera personal conversation 2014).
[c] Based on that reported in Forrest (2014). During drought years no labor cost for harvest is excluded and EXPENSES was reduced by $26.60/ha. in those years (see equation (2). In addition to expenses listed in Forrest (2014) a 150 Birr land rent change was also subtracted from gross revenues. The rental rate was based on an average from rental rates across Ethiopia as reported by the Ethiopian Ministry of Agriculture (2015).

Table 8. Estimated Net Returns Per Year in (Percentage) for 10-Year Simulation

Year	Maize	Beans
Year 1	240.23	589.88
Year 2	240.23	589.88
Year 3	240.23	589.88
Year 4	240.23	589.88
Year 5	-100.00	-100.00
Year 6	-100.0	-100.00
Year 7	240.23	589.88
Year 8	240.23	589.88
Year 9	240.23	589.88
Year 10	240.23	589.88
Average	172.19	451.90
Stdev	143.45	290.88

Table 9. Values Per Hectare Used in Calculations Depicted in Equation (2).[a]

Variable	Maize	Haricot Beans
YIELD/Ha.	2,000 kg.	4,000 kg
CROPPR	$0.20 kg.	$0.20 kg
RESIDUEVL	$112.50	$112.50
EXPENSES[b]	$152.84	$153.42
Mean Over Ten-Year Simulation	172.19%	451.90%
Σ 143.45%	290.88%	
CV[c]	83.31%	64.37%

[a] Monetary values reported in USD. To convert to Ethiopian Birr, multiply by 20.

[b] *EXPENSES* based on that reported in Forrest (2014). During drought years no labor cost for harvest is included and *EXPENSES* was reduced by $26.60 in those years.
[c] Coefficient of Variation.

Two successive years of drought would result in a 100 percent loss of the haricot bean harvest. Based on a suggestion by Coppock (2015), the average returns to the haricot bean crop are calculated over a 10-year period assuming the first four years are normal rainfall years and provided a return of 589.88 percent (Table 8). The fifth (Year 5) and sixth years (Year 6) were assumed to be drought years with an absolute loss of the whole crop and residue. Table 8 reports estimated returns for haricot beans over a 10-year period based on equation (2) and the information given in Table 9.

Real Estate

Access Capital is an Ethiopian company that creates reports to support investing in Ethiopia. They surveyed three residential real estate brokers in each of 10 residential neighborhoods of Addis Ababa focusing on the sales price and monthly rent for individual homes. They measured returns on real estate by comparing it to the annual rental income derived from a property relative to its purchase price. The yield according to the report varies depending on size of the property and the neighborhood. The rental yield around lower-priced neighborhoods in Addis Ababa ranges from 4 to 5 percent return per year. The report compares the yield in the case of poorer neighborhoods to be similar to that received on saving accounts. Returns of high-priced neighborhoods in Addis Ababa are around 10 percent (Access Capital 2010).

Leamer (2007) and others researched and analyzed the effects of GDP on housing prices. Valadez (2010) investigated the relationship and correlation between house prices indexes (HPI) and the change of GDP in the United States. The results of his research suggested that there is a positive relationship between HPI and GDP. The average of the Ethiopia GDP growth (annual percentage) 2003-2012 is 9.82 percent with a σ of ±4.22 percent. Given that no information was available for returns to real estate investment in the Borana Plateau, it was decided a more reliable measure of return on real estate investment would be changes in Ethiopia's GDP and the information reported in Table 10 is what is used to complete the investment portfolio analysis in this study.

Bank Saving Accounts

In 2011 the average saving deposit rate for public banks in Ethiopia was four percent and for private banks was six percent. The lending rate from public banks was 9.5 percent and private banks was 12.5 percent during this same time period (World Bank 2013). One percent of rural Ethiopian households have bank accounts. Fourteen percent of the adult population in Ethiopia has access to credit. The average loan amount in 2010 in Ethiopia was US$ 170 (World Bank 2013). The saving account earns an interest of 5 percent compounded and calculated basis (Commercial Bank of Ethiopia 2015), according to the National Bank of Ethiopia, The average interest rate between 2003 and 2013 was 3.73 percent with a σ of ±0.79 percent and this is what was used to complete the portfolio analysis in this study.

Risk Perception

In an attempt to measure the perception of risk for different investment options, the 12 panel members were asked to rank their investment options over a period of 10 years from the investment perceived to be the most risky (ranked #1) to the one perceived to be the least risky (ranked #4). To get a general perception of perceived risk in different categories of assets, livestock, banking, property in town, and cultivation were the choices for these rankings provided to the Panel. Perhaps not surprisingly, the Panel ranked livestock investment as the most risky followed by cultivation, banking and real estate (Table 11). The 12 panel members were also asked to rank their perceptions of the relative risk of investing in the different livestock species (cattle, camels, goats, and sheep). They ranked cattle as the riskiest livestock species followed by sheep, goats and camels (Table 12).

The panel members compared their perception of risk of other investments compared to their perceptions of the risk associated with livestock over a period of 10 years. The majority saw banking as less risky than livestock (Table 13). They were equally divided to see real estate as two times less risky and five times less risky than the livestock (Table 13). Cropland came in as being as risky as livestock (Table 13).

Portfolio and Investment Selection

The investment portfolios, based on percentage invested in each of the investment options considered, for the 12 panel members is reported in Table 14. The average share and σ (risk) of each of the investments indicated by the panel members

Table 10. Average and Standard Deviation of GDP Growth Based on Annual Percentage Changes in Ethiopian GDP from 2003-2012.

Average	Stdev
9.82%	4.22%

Table 11. Investment Options Risk Ranking by the 12 Panel Members.

Category	Rank[a]
All livestock species	1
Banking	3
Property in town	4
Cultivation	2

[a] Ranking is over 10 periods (years) with 1 being the riskiest option.

Table 12. Livestock Species Risk Ranking by the 12 Panel Members.

Category	Rank [a]
Cattle	1
Camels	4
Sheep	2
Goats	3

[a] Ranking is over 10 periods (years) with 1 being the riskiest option.

Table 13. Majority of Panel Responses Falling into Each Category for Comparing the Risk of Other Investments to Livestock.

Category	Categories		
	Banking	Real Estate	Cropland
10 X More			
5 X More			
2 X more			
Equal			X
2 X less	X	X	
5 X less		X	
10 X less			

is also reported in Table 14 and will be compared with the results from the optimum portfolio selection and share as determined by the quadratic programing analysis reported later on.

Cattle are the Panel's largest investment (average of 35 percent of the total portfolio with a σ of ±16.90 percent). The average share of real estate is 22.16 percent with a σ of ±17.55 percent. Camel's average share is 12.89 percent with a σ of ±8.85 percent. Bank accounts average share is 12.89 percent with a σ of ±8.85 percent. The average share for sheep is 3.81 with a σ of ±2.09 percent. Maize's average share is 0.14 percent with a σ of ±0.1 percent and at the investment share for beans was the smallest of the options considered at an average share of 0.04 percent and a standard of 0.03 percent. When one considers the average of investment in livestock (summing investment across cattle, camels, goats, and sheep), one can see that the Panel maintains approximately two-thirds of its assets in livestock investments, on the average. Real estate is far-and-away the most popular investment after livestock based on the average proportion of the total portfolio invested in real estate (Table 14). Many of the Panel members indicated that their real estate investments are related primarily to housing for family members. Bank accounts are not heavily preferred and crops, which have a high variability of returns, are also not overly preferred by the Panel. These results suggest a fairly sophisticated understanding of risks and returns to different investments. This statement is based on the fact that investment flows not simply to the least risky assets to avoid risk, such as bank accounts, but is also spread across livestock species and real estate.

The following chapter presents an analysis of the data related in the various investments chosen by the Panel members. The purpose of the analysis is to determine the "optimality" of the investment choices of the Panel in terms of risk and risk preferences. This type of analysis is appropriate given the different investment choices displayed across members of the Panel. It also aids researchers in understanding the diversification strategies of wealthy pastoralists which may assist in the understanding of how to encourage portfolio diversification on the Borana Plateau. It may also aid in helping to delineate policy strategies for encouraging investment that will lead to locally-led economic development on the Borana Plateau.

Table 14. Estimated Share of Total Portfolio in (Percentage) for Each Investment Category for Each Panel Participant Together with Average and Standard Deviation for the Entire Panel.

Participant	Bank Account	Cattle	Camels	Goats	Sheep	Real Estate	Maize	Beans
P1	20.00	67.67	8.46	0.87	0.87	2.08	0.04	0.01
P2	9.09	43.94	27.46	7.53	7.53	4.08	0.27	0.09
P3	4.76	36.77	18.39	6.30	6.30	27.32	0.11	0.04
P4	16.67	20.26	0.00	3.47	3.47	55.79	0.25	0.08
P5	0.00	31.38	52.30	3.59	3.59	8.97	0.13	0.04
P6	16.67	19.06	23.82	3.27	3.27	33.76	0.12	0.04
P7	16.67	28.88	36.10	4.95	4.95	8.46	0.00	0.00
P8	9.09	18.66	18.66	3.20	3.20	46.92	0.19	0.06
P9	9.09	52.42	26.21	3.00	3.00	5.99	0.22	0.07
P10	9.09	38.33	23.96	4.93	4.93	18.69	0.06	0.02
P11	34.43	11.97	20.52	0.00	0.00	32.83	0.25	0.00
P12	9.09	53.91	6.74	4.62	4.62	21.02	0.00	0.00
Average	12.89%	35.27%	21.88%	3.81%	3.81%	22.16%	0.14%	0.04%
Stdev	8.85%	16.90%	13.81%	2.09%	2.09%	17.55%	0.10%	0.03%

CHAPTER 4

RISK ANALYSIS AND RESULTS

The analysis used in this study relying on methods taking into account rates of return, risks associated with returns, and risk bearing preferences for different decision makers. The methods applied are well-known and frequently used in these types of analyses. The innovation in this study lies in the data obtained from the Panel and the insights that can be gained using the data in the analyses. These insights will help in understanding the investment opportunities, choices, and risks facing wealthy pastoralists on the Borana Plateau. The investment choices of wealthy pastoralists have the potential to significantly influence economic development in the study area. As a result, the understanding the motivations and choices of these pastoralists in their investment choices is important to everyone living in the study area.

Risk Analysis Based on Survey Reponses

The analysis relies on estimated empirical (observed) distributions on returns to eight investment choices (Table 4).[29] Four of these choices are related to livestock (cattle, camels, goats, and sheep), two to non-agricultural investments (real estate and bank savings accounts), and two are related to crop investment (maize and beans).

[29] See also equations (1) and (2) for how the empirical distributions reported in Table 4 were estimated.

Having empirical distributions provides an avenue for risk analysis through the use of simulation. Essentially, one can incorporate uncertainty into the analysis by assuming a distribution of returns (in this case an empirical distribution) and then "simulating" many possible outcomes (returns) that might result between the extremes indicated by the empirical distribution. This assumes, of course, that all possible returns or outcomes are represented by the empirical distribution. While this qualifies the interpretation of the results of the analysis because it is possible for more extreme events to happen than indicated by the Panel participants, it avoids assuming some type of theoretical distributions (e.g., normal distribution) that may or may not actually fit the reality of investment returns in the study area.

Risk analysis requires that the distribution of returns to different investments must be accompanied by assumptions for the utility functions of decision makers who make portfolio choices among different possible investments. Decision makers are assumed to maximize their utility based on their utility function (Norstad 2011). Because the utility function incorporates the influence of wealth as well as its trade-offs with risk (uncertainty), maximizing utility allows for the identification of "optimal" portfolio selection based on these trade-offs. In this study we employ the negative exponential utility function as the basis for portfolio selection for wealthy pastoralists (Norstad 2011). The negative exponential utility function may be represented as follows:

(3) $U(w) = -e^{-\rho w}$

where w represents either consumption or wealth and ρ is degree of risk preference of the decision maker. If $\rho = 0$ then the decision maker is said to be "risk neutral." If $\rho > 0$ the decision maker is said to be "risk averse," and if $\rho < 0$ the decision maker is said to be "risk preferring" or "risk seeking" (Moss 2010). The level of risk preference is important because it drives the "shape" of the utility function and the decision maker's choice based on risk. Specifically, this can be shown by the relative "curve" of the utility function that can be determine by the ratio of the first and second derivatives of the utility function.

(4) $U'(w) = -\rho e^{-\rho w}$

(5) $U''(w) = -\rho^2 e^{-w}$

The ratio of the first and second derivative of provides the "relative" risk preference of the decision maker and is called the Arrow-Pratt absolute risk aversion coefficient (RAC). It is calculated as follows:

(6) $RAC = -\left[\frac{-\rho^2 e^{-w}}{-\rho e^{-\rho w}}\right] = \rho$

Equation (6) demonstrates that for the negative exponential utility function that the RAC is identified by a single number ρ that can also be referred to as a constant absolute risk aversion coefficient or CARA as a result. The analysis will present preferred investment portfolios over a range of values for the RAC. This allows for understanding how risk preference influences the investment choices that are made by wealthy pastoralists and also can provide information for how choices might vary as the level of risk associated with different investments changes.

Stochastic Dominance Analysis

Given there are many different investment combinations that could go into the portfolios of wealthy pastoralists, a method or methods needs to be applied to decide which of these risky choices should not be considered (are not in the "efficient set" of alternatives). Stochastic dominance with respect to a function (SDRF) (Meyer 1977a and b) has been frequently used to make pair-wise comparisons among different investment alternatives to determine an efficient set. Hadar and Russell (1969) provide definitions for first and second degree stochastic dominance. First degree stochastic dominance (FSD) is defined as follows:

> The probability function g is said to be at least as large as f in the sense of FSD if and only if $G(X) \leq F(X)$ for all x in the set of real numbers. Where G and F represent the cdfs of f and g, respectively. The function g is said to be larger than f in the sense of FSD if and only if the above inequality bolds strictly fo at least one x.

In other words, this definition indicates that if two cdfs (G and F) are graphed and compared, that if G is FSD over F if it lies completely (no cross-overs) to the left of F. The definition provided for second-degree stochastic dominance (SSD) by Hadar and Russell (1969) is the following:

> The probability function g is said to be at least as large as f in the sense of SSD if and only if $\int_a^x G(t)dt \leq \int_a^x F(t)dt$ for all x as an element of the real numbers set. The function g is said to be larger than f in the sense of SSD if and only if the above inequality holds strictly for at least one x (p. 289).

In other words, SSD refers to SSD being defined over a set area of two cdfs where G lies to the left of F. Computer programs can be used to test for FSD and SSD. The one employed in this analysis is in Simetar (Richardson et al. 2006). The analysis

presented in this thesis identifies efficient sets for different potential strategies and different potential portfolios for wealthy pastoralists on the Borana Plateau.

Stochastic Efficiency Analysis

While SDRF has been used extensively, researchers have also sought for an analytical method to compare groups of risky choice simultaneously rather than in a pair-wise fashion such as is done in SDRF. Stochastic efficiency with respect to a function (SERF) has been proposed as a method to do this and identify the smallest possible efficient set (Hardaker et al. 2004). Hardaker et al. (2004) propose ordering risky alternatives over a range of values for the RAC based on the "certainty equivalent" calculated at each value of the RAC. They propose the following equation:

$$(7)\ U\big(w,r(w)\big) = \int U\big(w,r(w)\big)dF(w) = \sum_{i=1}^{m} U(w_i,r(w)))P(w_i) \qquad r_i(w) \leq r(w) \leq r_2(w)$$

where U is the decision maker's utility function, w is wealth, r in the decision makers RAC, F is the cdf of the returns for the risky alternative, and P is the probability of return (or pay-off) i. The second term of equation (7) is continuous case and the third term is the discrete case approximation of the utility of return i given that there are m possible returns. The r_1 and r_2 values represent a range of possible RAC with r_1 representing a lower bound of the range and r_2 an upper bound. The r(w) value would be a generalized term representing a value for the RAC between r_1 and r_2. The following steps are then used (Hardaker et al. 2004, p. 257):

1. Select points on each CDF for a finite set of values of w.
2. Convert each of these w values to its utility using the selected for of utility function and the selected value of the risk aversion coefficient.
3. Multiply each finite utility by its associated probability to calculate a weighted average of the utilities of outcomes.

This yields values in terms of the level of utility. Taking the inverse of the utility function yields the "certainty equivalent" or CE. This can be represented as follows:

(8) $CE\big(w, r(w)\big) = U^{-1}(w, r(w))$

The CE represents the value of a "sure" return (investment) that yields the same utility as expected return of a risky alternative (Hardaker et al. 2004; Helmberger and Chavas 1996). In other words, what would the value of a sure return need to be to make a decision maker indifferent between the risky investment and the sure investment? The difference between the expected return for a risky investment and the CE is something called the "risk premium" or RP. In other works an expected return for a risky investment E(w) = CE + RP. The RP represents the amount of money a decision maker would be willing to pay (WTP) to avoid the risky investment if a sure investment is available. Based on this discussion and equation (8), the CE and RP depend on the risk of an investment, the decision maker's utility function, and the decision maker's RAC. For example, if the expected return on a risky investment is $30 and the potential investor would be indifferent between the risky investment ($30) and another sure investment returning $20, the CE would be $20 and the RP would be $10.

The SERF analysis presented in this thesis depicts the CEs and RPs for the different investments and portfolios of investments for wealthy pastoralists on the

Borana Plateau. A negative exponential utility function is assumed in the analysis and the SERF is conducted over a range of RACs representing from risk averse to risk seeking decision makers. Consequently, the RAC is defined over a range similar range. Following a modified method for determining the RAC as suggested by (McCarl and Bessler 1989; Richardson 2006). The RAC was calculated as:

(9) $RAC = \pm \frac{5}{StDev.}$

Nonlinear Programming Analysis

A nonlinear programming (NLP) model is used to create optimum portfolios based on the eight different investment choices considered for wealthy pastoralists and five different sets of restrictions (Hazell and Norton 1986; Hardaker et al. 2004). NLP assumes wealthy pastoralists are risk averse and will only choose an investment with a higher expected return if the variance of the investment is also greater compared to another investment. The NLP model is chosen to rank the investment choices according to the risk and return without using a utility function (Hardaker et al. 2004; Mapp et al. 1979; Manos and Kistopanidis 1986). Nonlinear programming is a process that allows a decision maker to optimize (maximize or minimize) an objective function subject to a number of constraints that are nonlinear. A generic notation for a non-linear programing is shown as follows (Bradley et al. 1977, p. 410):

Minimize

(10) $f\ (x_1, x_2, \dots, x_n)$,

subject to:

$$(11)\ g_1(x_1, x_2, \dots, x_n) \leq b_1,$$

$$\vdots \qquad\qquad \vdots$$

$$g_m(x_1, x_2, \dots, x_n) \leq b_m,$$

where the constraint functions $g_1$through g_m are given and do not need to be linear. The total for investment shares must sum to one. The NLP is optimized assuming that the variance of returns is minimized for five separate investment portfolios defined by the constraints placed on maximum investments in an single investment option. For this study, the five separate scenarios considered for the NLP are the following (see Table 15):

(a) Unrestricted (PUR) – a portfolio with no restriction on how much of the pastoralists total assets could be invested in any one of the eight investments choice.

(b) 2nd Data (P2D) – Survey data. This portfolio option uses limits suggested by Dr. Coppock (personal communication 2015) as resource constraints. For example, full utilization of grass and grazing constraints requires a complements of cattle, camels, and small ruminants. Information on carrying capacities for different livestock species in Harweyu were provided in Forrest et al. (2015). The proportions of the livestock species represented at carrying capacity for Harweyu were used as the constraints on the proportions of the different livestock species that could be part of the portfolio.

(c) Survey Max (PSM) - This portfolio option uses the maximum level of investment by a single one of the 12 Panel members as the maximum amount any of the 12 Panel members could invest in a single one of the eight investment choices.

(d) Equal (PE) - This portfolio option assumes equal proportions of total assets are invested across the investment options considered.

(e) Max Diversity (PMD) - this profile option uses a recommendation by most financial authorities that no more than 20 percent should be invested in any single investment category to avoid unnecessary amounts of risk.

A description of the constraints for each of the five investment strategies described above, the variance-covariance matrix used in the NLP model, and the optimal portfolios associated with each strategy are provided in Tables 15, 16, and 17, respectively. The optimum investment portfolios identified for each of the five investment strategies (restriction sets) are used later in the analysis as a basis for determining how the different constraints affect investment behavior and place limits on the ability to adjust investments in the face of risk.

Simulation Analysis

The basis for the simulation begins with developing the cumulative density functions (cdfs) for the different investment alternatives for the 10 years described in Table 4 (Table 18). Correlated uniform standard deviates (CUSD) are developed to conduct the simulation by randomly drawing 500 uniform standard deviates from a U

Table 15. Synopsis of Constraints in the Nonlinear Programming Model Imposed for Five Separate Strategies.

	Maximum Investment in (percentage)						
Strategy[a]	**Cattle**	**Camels**	**Goats**	**Sheep**	**Crops**	**Savings**	**Real Estate**
PUR	100	100	100	100	100	100	100
P2D	63	27	5	5	5	50	50
PSM	68	52	8	8	>1	34	56
PE	14	14	14	14	14	14	14
PMD	20	20	20	20	20	20	20

[a] PUR = no restrictions on amount of portfolio in each investment option. P2D = total investment in each option limited by resources available. PSM = total investment in each option constrained to be no larger than the largest percentage invested by an individual member of the panel in that option. PE = investments constrained to be equal across all investment options. PMD = investments constrained to be no more than 20 percent of total portfolio in any single investment option.

Table 16. Variance-Covariance Matrix Associated With the Nonlinear Programming Model Used in the Analysis.

	Cattle	**Camels**	**Goats**	**Sheep**	**Savings**	**Real Estate**	**Maize**	**Beans**
Cattle	0.1037	0.0084	0.0620	0.0530	-0.0006	0.0022	0.4040	0.8193
Camels	0.0084	0.0007	0.0052	0.0045	-0.0000	0.0002	0.0350	0.0710
Goats	0.0620	0.0052	0.0400	0.0346	-0.0002	0.0013	0.2295	0.4653
Sheep	0.0530	0.0045	0.0346	0.0304	-0.0002	0.0013	0.1961	0.3976
Savings	-0.0006	-0.0000	-0.0002	-0.0002	0.0001	-0.0001	-0.0014	-0.0028
Real Estate	0.0022	0.0002	0.0013	0.0013	(0.0001)	0.0002	0.0083	0.0168
Maize	0.4040	0.0350	0.2295	0.1961	(0.0014)	0.0083	1.8521	3.7555
Beans	0.8193	0.0710	0.4653	0.3976	(0.0028)	0.0168	3.7555	7.6149

Table 17. Report of Optimum Portfolios[a] Determined by Nonlinear Programming Model Based on Five Different Sets of Restrictions[a] for the Panel Members in the Survey.

Restrictions[c]	Summary of Optimum Portfolio in (percentage)								Objective Function Values	
	Cattle	Camels	Goats	Sheep	Savings	Real Estate	Maize	Beans	Variance	Avg. Return	CV
PUR	0%	0%	0%	0%	69%	31%	0%	0%		0.0000	6%
P2D	0%	27%	0%	3%	50%	20%	0%	0%		0.0002	10%
PSM	0%	10%	0%	0%	34%	56%	0%	0%		0.0001	10%
PE	14%	14%	14%	14%	14%	14%	14%	0%		0.0839	40%
PMD	0%	20%	20%	20%	20%	20%	0%	0%		0.0066	15%
Min	*0%*	*0%*	*0%*	*0%*	*14%*	*14%*	*0%*	*0%*			
Mean	*3%*	*14%*	*7%*	*8%*	*38%*	*28%*	*3%*	*0%*			
Max	*14%*	*27%*	*20%*	*20%*	*69%*	*56%*	*14%*	*0%*			

[a] See Table 4 for cdf of returns assumed for each of the investment options. Table 14 reports the estimated proportions of each investment option held in the portfolio of the different Panel members.
[b] Restrictions defined in Table 15.
[c] PUR = no restrictions on amount of portfolio in each investment option. P2D = total investment in each option limited by resources available. PSM = total investment in each option constrained to be no larger than the largest percentage invested by an individual member of the panel in that option. PE = investments constrained to be equal across all investment options. PMD = investments constrained to be no more than 20 percent of total portfolio in any single investment option.

Table 18. Cumulative Distribution Functions[a] (CDFs) Used in the Simulation and Risk Analysis.[b]

Cumulative Probability	Cattle	Camels	Goats	Sheep	Savings Account[a]	Real Estate	Maize	Beans
0.0	-46.00	15.00	-24.00	-42.00	3.00	8.65	-100.01	-100.01
0.11	-46.00	15.00	-24.00	-42.00	3.00	8.65	-100.00	-100.00
0.22	-10.00	19.00	19.00	0.00	3.00	8.80	-100.00	-100.00
0.33	25.79	23.43	27.19	8.77	3.00	10.49	240.23	589.88
0.44	32.88	23.43	34.71	11.23	3.00	10.79	240.23	589.88
0.55	41.92	23.43	42.56	14.36	4.00	10.83	240.23	589.88
0.66	53.45	23.43	42.56	17.17	4.00	11.18	240.23	589.88
0.77	53.93	23.43	42.56	17.17	4.00	11.46	240.23	589.88
0.88	53.93	23.43	42.56	17.17	4.00	11.82	240.23	589.88
1.0	53.93	23.43	42.56	17.17	5.00	12.55	240.23	589.88

[a] Cumulative Distribution Functions (CDFs) is defined as the probability that a variate, X, takes on a value less than or equal to a number X (Weisstein 2015).
[b] See Table 4 and equations (1) and (2) for additional information.

Table 19. Estimated Net Returns in (Percentage) Per Year for the 10-Year Simulation Reported in Percentages.

Year	Cattle	Camels	Goats	Sheep	Savings Account[a]	Real Estate	Maize	Beans
1	54	23	43	17	3	14	240	590
2	54	23	43	17	3	12	240	590
3	54	23	43	17	3	11	240	590
4	54	23	43	17	3	11	240	590
5	-10	19	19	0	4	11	-100	-100
6	-46	15	-24	-42	4	9	-100	-100
7	26[b]	23[c]	27	9	4	13	240	590
8	33	23	35	11	4	11	240	590
9	42	23	43	14	5	9	240	590
10	53	23	43	17	5	10	240	590
Avg.	*31*	*22*	*31*	*8*	4	11	172	452
Stdev	*34*	*3*	*21*	*18*	1	2	143	291
CV[d]	*108*	*13*	*67*	*237*	21	14	83	64

[a] For savings account rates Year 1 corresponds with actual rates for 2003, Year 2 with 2004, and so forth to Year 10=2013 as reported by Trading Economics (2015).
[b] The compounded annual rebuilding rate for numbers of cattle, sheep and goats following a drought is approximately 27.5 percent (Desta and Coppock 2002)
[c] The compounded annual growth in numbers for camels is approximately 17 percent as reported in Forrest et al. (2015) based on Kaufmann (1998).
[d] CV is coefficient of variation which is ratio of σ to the mean and used in normalization of risk across multiple investments.

Table 20. Linear Correlation Matrix Used to Correlate Uniform Standard Deviates in the Simulation Analysis.

	Cattle	Camels	Sheep	Goats	Savings	Real Estate	Maize	Beans
Cattle	1	0.95	0.96	0.94	-0.24	0.47	0.92	0.92
Camels	0.95	1	0.95	0.96	-0.13	0.50	0.94	0.94
Sheep	0.96	0.95	1	0.99	-0.15	0.44	0.84	0.84
Goats	0.94	0.96	0.99	1	-0.16	0.51	0.83	0.83
Savings	-0.24	-0.13	-0.15	-0.16	1	-0.61	-0.13	-0.13
Real Estate	0.47	0.50	0.44	0.51	-0.61	1	0.42	0.42
Maize	0.92	0.94	0.84	0.83	-0.13	0.42	1	1.00
Beans	0.92	0.94	0.84	0.83	-0.13	0.42	1.00	1

Table 21. Descriptive Statistics for Correlated Random Returns Used in the Risk Analysis Based on 500 Random Draws Reported in Percentages.

Statistic	Cattle	Camels	Goats	Sheep	Savings Account	Real Estate	Maize	Beans
Mean	33.04	22.26	31.90	8.57	3.82	11.01	175.67	470.51
StDev	30.00	2.53	18.92	15.98	0.68	1.34	127.16	246.40
CV[a]	90.81	11.38	59.30	186.32	17.89	12.14	72.39	52.37
Min	-46.00	15.00	-24.00	-42.00	3.00	8.65	-100.01	-100.01
Max	53.94	23.43	42.56	17.17	5.00	13.57	240.25	589.93

[a]CV is coefficient of variation which is ratio of σ to the mean and used in normalization of risk across multiple investments.

(0,1) distribution and then correlating them using the correlation matrix (Tables 19 and 20). The CUSD are then used to simulate correlated random returns from the cdfs 500 times (Table 18). Table 21 provides statistical information for the 500 random draws of correlated returns. The information in Table 21 can be compared to that reported in Table 19 to verify that the distribution of the random returns matches that for the empirical distribution relatively well.

The random returns described in Table 21 were weighted in each of the 500 random draws by the estimated actual portfolio held by each participant in the Panel (Table 14). This resulted in a weighted total return for each participant for each of the 500 random draws. Alternatively, weights obtained from the NLP analysis (Table 17) were also applied to the simulated returns as a comparison between the randomly generated returns based on the participants' current portfolios and the five portfolios (strategies) used in the NLP. Descriptive statistics for each participant weighted by their current portfolios are reported (Table 22) as well as results for portfolios weighted by the strategies analyzed in the NLP analysis (Table 23).

The results demonstrate clearly that the Panel members do not organize their portfolio of investments to minimize risk. The NLP analysis assumes that, within the constraints imposed on the model that the decision maker will seek to minimize risk based on the variance-covariance among different investment alternatives. However, the descriptive statistics for the NLP strategies allowing the most freedom to select investment options for scenarios PUR, P2D, and PSM tended to make heavy investments in in bank accounts and real estate beside investing in livestock .Such

strategies, while greatly reducing risk as measured by the coefficient of variation (CV) on returns for these strategies, also offered relatively low expected (average) returns compared to the portfolio currently held by the Panel participants (compare CV's in Table 22 to those for PUR, P2D, and PSM in Table 23). Participants clearly tend to spread investments primarily across livestock species with smaller amounts of investments being made in savings accounts and real estate (Table 14) than suggested by the NLP analysis (Table 17). The asset spreading NLP strategies (PE and PMD) are clearly more akin to the strategies actually pursued by Panel participants (Table 14) and reflect average returns and risk (CVs) similar to the portfolios actually held by participants (compare CVs in Tables 22 and 23). Based on this one must conclude that the Panel participants pursue a portfolio diversification strategy that essentially mirrors some type of asset-spreading approach to managing their risk. However, the percentages of the portfolio tend to be heavily oriented toward livestock (Table 14) rather than being evenly spread among all available investment options. This may reflect culture or the resource base of the Panel members.

Stochastic Dominance Results

Table 24 reports the efficient sets for the stochastic dominance analysis for both the NLP strategies and the actual portfolios held by the Panel participants. The focus of the information reported in Table 24 is on risk-averse decision makers based

Table 22. Descriptive Statistics for Each Panel Participant Based on Existing Portfolio Weighted Returns for 500 Random Draws Reported in Percentages.

Statistic	P1[a]	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Mean	25.73	25.39	22.37	15.72	24.88	17.67	17.78	21.15	26.10	22.60	13.89	23.84
StDev	20.32	13.53	11.29	6.23	9.66	5.88	5.76	8.91	15.85	11.69	3.64	16.30
CV[b]	78.98	53.29	50.47	39.61	38.81	33.26	32.40	42.13	60.72	51.73	26.22	68.37
Min	-28.68	-13.13	-9.80	-2.98	-4.22	-0.46	0.14	-5.44	-17.71	-10.77	2.17	-20.75
Max	40.43	36.77	32.31	22.34	33.11	23.58	23.93	28.83	38.33	32.39	17.85	36.63

[a] P1 = Participant 1, P2 = Participant 2, etc.

[b]CV is coefficient of variation which is ratio of σ to the mean and used in normalization of risk across multiple investments.

Table 23. Descriptive Statistics for Portfolio Strategies for Returns Weighted According to the Nonlinear Programming Analysis. Based on 500 Random Draws and Reported in Percentages.

Statistic	PUR[a]	P2D	PSM	PE	PMD
Mean	6.04	10.34	9.64	40.90	15.51
StDev	0.63	0.92	0.81	19.18	4.93
CV	10.41	8.90	8.44	46.89	31.75
Min	4.74	6.29	7.32	-13.77	-6.81
Max	7.65	12.04	11.58	56.41	20.35

[a] PUR = no restrictions on amount of portfolio in each investment option. P2D = total investment in each option limited by resources available. PSM = total investment in each option constrained to be no larger than the largest percentage invested by an individual member of the panel in that option. PE = investments constrained to be equal across all investment options. PMD = investments constrained to be no more than 20 percent of total portfolio in any single investment option.

on the frequent assumption that agricultural producers are risk-averse. The results reported in Table 24 suggest that risk-averse producers tend not to prefer cattle as their largest single investment. This is true given that the four most preferred actual portfolios for risk-seeking participants (P1, P9, P12, and P2) also have the largest proportions of their investments in cattle of the 12 Panel participants. This suggests that participants with relatively large investments in cattle tend to prefer more risk than those with larger investments in camels and other "safer" forms of investment. The four preferred portfolios for risk-averse decision makers (P7, P6, P11, and P5) focus on investing in camels and other relatively safe investments such as real estate, but cattle also remain a significant part of the investment portfolio (average proportion of portfolio for P7, P6, P11, and P5 is slightly less than 23 percent). Cattle offer a positive and relatively large return in eight out of 10 years based on their empirical cdf (Table 18). So, they appear to remain an important part of the investment mix for risk-averse producers. This may also reflect the complementarity of camels and cattle in the grazing system where cattle primarily eat grass and camels primarily eat browse. As a result, having both species results in utilization of a broader spectrum of rangeland feed than one of the species alone (Forrest et al 2015).

The dominant risk-averse strategies (P7, P6, P11, and P5) support the notion that the Panel participants follow a risk-spreading investment strategy. This suggests that the most risk-averse Panel participants still see benefit in investment in relatively

Table 24. Efficient Sets for Risk Adverse Decision Makers Identified by the Stochastic Dominance Analysis.

Efficient Set for Actual Portfolios[a]		**Efficient Set for Hypothetical Portfolios Identified by NLP[b]**	
P7	Most Preferred	P2D	Most Preferred
P6	2nd Most Preferred	PSM	2nd Most Preferred
P11	3rd Most Preferred	PMD	3rd Most Preferred
P5	4th Most Preferred	PUR	4th Most Preferred
P4	5th Most Preferred	PE	Least Preferred
P8	6th Most Preferred		
P3	7th Most Preferred		
P10	8th Most Preferred		
P2	9th Most Preferred		
P9	10th Most Preferred		
P12	11th Most Preferred		
P1	12th Most Preferred		

[a] See Table 14 for portfolios of individual Panel participants.
[b] See footnotes to Table 15 for description of the NLP Portfolio constrains. Table 17 provides information on the portfolio determined for each of these strategies.
[c] P1 = portfolio actually help by Participant 1, etc.

risky assets such as cattle as being an important component of the overall investment strategy. However, cattle are clearly not preferred to camels by risk-averse decision makers.

This finding is potentially important. It suggest that the current environment relating to livestock production risks on the Borana Plateau favors a continued move to more camels and fewer cattle. However, there may be constraints on how much more the camel population can expand. Forrest et al. (2015) suggest that camels alone are unable to support the human population on the Borana Plateau. These results suggest that incentives exist for risk-averse pastoralists to continue to move away from cattle and toward more camels. This trend is likely to continue without drought mitigation strategies that support cattle grazing, such as bush clearing (Forrest et al. 2015).

As was generally expected, the NLP strategies that are preferred by risk-averse decision makers favored minimizing the variance of returns such as was done in P2D, PSM, and PMD (Table 24) rather than diversification across investment options (PE, PUR). Clearly these pastoralists understand the tradeoffs exist between expected average returns and risks because they appear to follow primarily risk-spreading diversification strategies (Table 14). They are willing to accept some additional risk if the expected payoffs are high enough. This is exhibited by the fact that P2D, PSM, and PMD avoided placing cattle in the portfolio in favor of camels (Table 24). This departs from the strategy actually followed by the Panel

participants, but supports the pressure for more camels to reduce risk as indicated by the most efficient sets identified for risk-averse decision makers (Table 24).

Results of the Stochastic Efficiency Analysis

The SERF analysis closely reflects the one provided by the stochastic dominance analysis. Figure 3 shows that the actual portfolio held by P1 is the most preferred portfolio for risk-seeking decision makers. Table 25 reports the inputted risk premiums that are implied by the results depicted in Figure 3. The analysis demonstrates that the efficient set for the different portfolios remains constant at all levels for a risk-seeking decision maker. Figure 4 and Table 26 present the SERF analysis and implied risk premium, respectively, for the five portfolio selected by the NLP.[30]

While the SERF results are important visually, they offer little new information not contained in the stochastic dominance analysis. In either case, pastoralists will prefer to place most of their assets in livestock, particularly cattle and secondarily camels, and then diversity into one or two less risky investment options. The results presented by Forrest et al. (2015) demonstrated the importance of cattle to the livestock, and indeed, the economic system existing on the Borana Plateau. This analysis also demonstrates the critical central role that cattle play in this system not only in providing food consumption products (primarily milk), but also as a critical part of the risk management strategies pursued by pastoralists. As was suggested in

[30] For purposes of comparison, see rankings of portfolios by E-V in Tables 27 and 28.

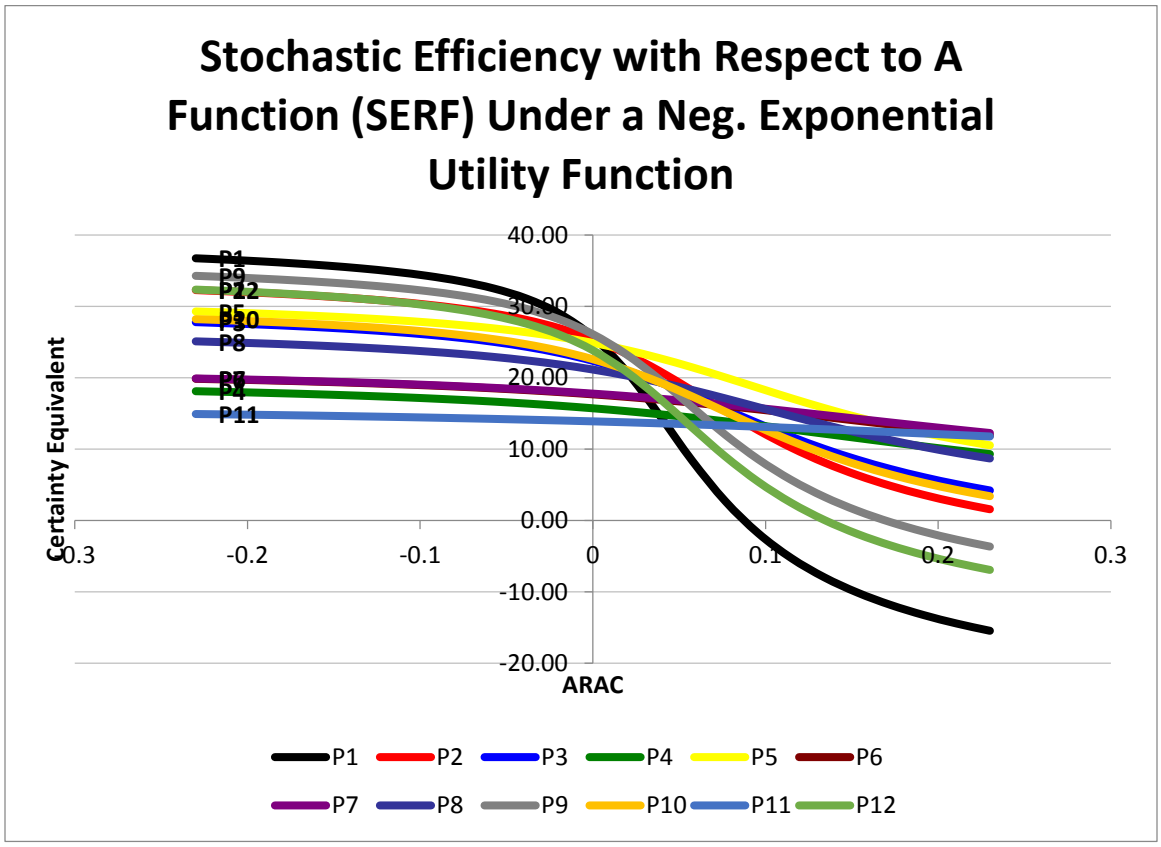

Figure 3. SERF chart depicting risk premiums for different actual portfolios based on risk preference.

Table 25. Implied Risk Premiums for Actual Portfolios Compared to the Actual Portfolio Held by P1 Based on Risk Preferences.

Statistic	P1[a]	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Mean	-	4.55	2.91	(1.30)	6.30	0.75	0.90	2.97	3.62	2.87	(2.49)	1.10
StDev	-	9.32	12.19	17.65	14.09	17.94	18.04	14.96	6.23	11.69	19.48	5.65

[a] P1 = Participant 1, P2 = Participant 2, etc.

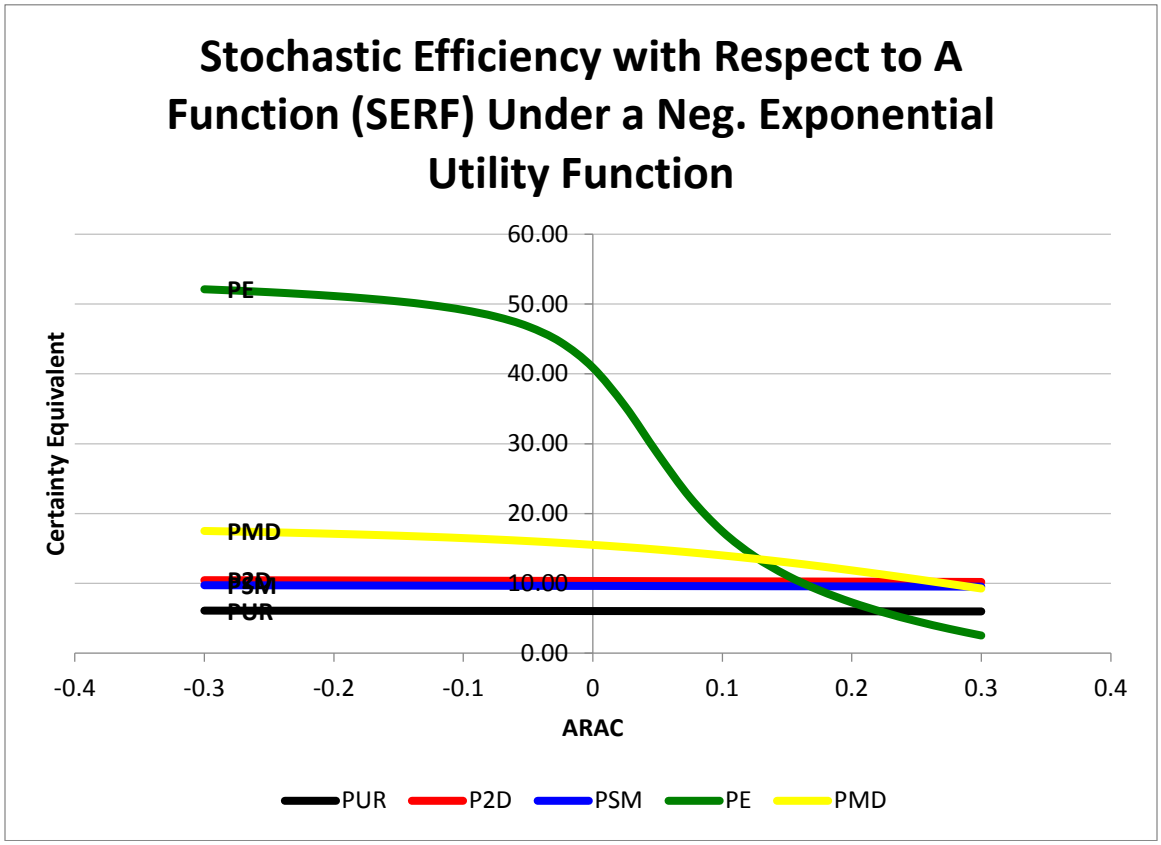

Figure 4. SERF chart depicting risk premiums for different NLP portfolios based on risk preference.

Table 26. Implied Risk Premiums for Actual Portfolios Compared to PUR Based on Risk Preferences.

Statistic	PUR[a]	P2D	PSM	PE	PMD
Mean	-	1.3	3.6	26	8.66
StDev	-	0.04	0.02	19.6	2.5

[a] PUR = no restrictions on amount of portfolio in each investment option. P2D = total investment in each option limited by resources available. PSM = total investment in each option constrained to be no larger than the largest percentage invested by an individual member of the panel in that option. PE = investments constrained to be equal across all investment options. PMD = investments constrained to be no more than 20 percent of total portfolio in any single investment option.

Table 27. Ranking of 12 Panel Participants Using Mean Return and CV.

Participant[a]	Mean Return		CV	
	Value	Rank[b]	Value	Rank[c]
P1	25.73	2	78.98	12
P2	25.39	3	53.29	9
P3	22.37	7	50.47	7
P4	15.72	11	39.61	5
P5	24.88	4	38.81	4
P6	17.67	10	33.26	3
P7	17.78	9	32.40	2
P8	21.15	8	42.13	6
P9	26.10	1	60.72	10
P10	22.60	6	51.73	8
P11	13.89	12	26.22	1
P12	23.84	5	68.37	11

[a] P1 = Participant 1, P2 = Participant 2, etc.

[b] The mean returns are ranked with 1 being the participant with the highest return and 12 is the participant with the lowest return.

c CV is ranked with 1 being the participant with the lowest risk and 12 is the participant with the highest risk.

Table 28. Ranking of Five NLP Portfolios by Mean Return and CV.

Model[a]	Mean Return Value	Rank[b]	CV Value	Rank[c]
PUR	6.04	5	10.41	3
P2D	10.34	3	8.90	2
PSM	9.64	4	8.44	1
PE	40.90	1	46.89	5
PMD	15.51	2	31.75	4

[a] PUR = no restrictions on amount of portfolio in each investment option. P2D = total investment in each option limited by resources available. PSM = total investment in each option constrained to be no larger than the largest percentage invested by an individual member of the panel in that option. PE = investments constrained to be equal across all investment options. PMD = investments constrained to be no more than 20 percent of total portfolio in any single investment option.

[b] The mean returns are ranked with 1 being the portfolio with the highest return and 5 is the portfolio with the lowest return.

c CV is ranked with 1 being the portfolio with the lowest risk and 5 is the portfolio with the highest risk.

Forrest et al., camels can play a role in risk management in the Borana Plateau, but this role is expected to remain a secondary one to cattle in this system.

The results also suggest that efforts that have been made to encourage pastoralists to diversify into non-agricultural assets such as bank accounts and real estate (Desta 1999) are well founded. However, these alternative investments should be seen as complementary to livestock production, especially cattle production.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

The need for securing more food resources as the world population increases has become a main concern for governments and NGOs around the world especially in planning future sustainable polices and aid projects. Sub-Saharan African countries and especially Ethiopia have been a focus of many aid projects for many years. Livestock production has been an important economic and social livelihood activity in this region.

Pastoralism in Ethiopia and on the Borana Plateau in the south has been a way of life for many generations. Many factors such as droughts and degradation and reduction of rangeland because of the increasing human and livestock population affected the livelihood of pastoralists in this region.

There has been a need for better risk management strategies for pastoralists in this region to diversify their investment portfolio. It is important to understand the nature of risk for pastoralist investment portfolios and how pastoralists perceive risk when making investment choices. The purpose of study was to provide insights toward understanding investment opportunities, choices, and the risk pastoralists are facing. The data were collected from field interviews of 12 influential and wealthy pastoralists in the Yabelo District of the Borana Plateau. The wealthy pastoralist's Panel was chosen because the relatively large amount of discretionary income they

can invest compared to most people in the Borana Plateau and their large-sized herds which consume more water and forage resources than the small herds owned by the rest of the community. Wealthy pastoralists also provide employment for local communities through milking and herding their livestock.

The main investment options that members of the panel are currently investing are divided in to livestock sector (cattle, camels, sheep and goats), nonagricultural sector investments (bank saving accounts and real estate) and cropping represented here by maize and haricot beans. The returns on those investments were calculated using a return on assets (ROA) approach based on the responses to a survey questionnaire provided to the Panel and secondary data taken from previous research. Average returns for the investment options were estimated/calculated over a 10-year period assuming the first four years were normal-rainfall years with livestock herds at full capacity followed by two years of drought and then four herd rebuilding years with normal rainfall.

The analytical methods used in this thesis used the rates of return on the different types of investments, risk associated with those returns and risk bearing preferences for different decisions makers. Nonlinear programming analysis was used to create optimum portfolios based on the assumption that decision makers minimize risk at every given rate of return through the selection of investment alternatives that do so. Stochastic dominance analysis was used to determine the most efficient investment when compared to one another, and stochastic efficiency analysis was used to compare investment strategies to identify whether the investment

strategies being pursued by the Panel participants reflected risk-averse or risk – seeking behaviors.

The 12 panel members are entrepreneurs who have limited education and who worked hard from a young age to grow their herds. Identifying opportunities and ways to measure the importance of education in helping and supporting pastoralists make appropriate investments would be a good contribution to the literature, but is not tested in this study. Some of the Panel members inherited the herds and others started their own .They all had to suffer through local conflicts and natural disasters like droughts and they lost large numbers of their herds during this hard time. The age of the Panel members ranged from 50 to 98 years old. They accumulated their livestock herds to provide meat and milk needs for their families, as a source of income and as a source of social feeling of security.

The Panel participants appear to understand the tradeoffs between expected average returns and risk because they clearly pursue building diversified portfolios that have larger than expected rates of return and larger variances than simply putting their money into bank savings accounts (essentially a guaranteed investment). The Panel participants still invest heavily livestock investments (cattle, camel, goat and sheep) instead of evenly distributing their portfolio among the different investments. However, very risk-averse Panel members tend to invest more in camels than in cattle. As a result, risk-averse producers tend to avoid cattle as their largest single investment comparing with the risk seeking producers who invested large proportions of their portfolios in cattle. Risk-averse producers also tended to combine livestock

investments (especially camels) with safer investments options such as saving bank accounts and real estate. Cattle remain an important part of the overall investment strategy even with risk-averse producers.

Risk-averse producers favor camels over cattle and this suggests that the current environment in the Borana plateau favors a continued moves towards camels instead of cattle. The results also support the efforts that have been made to encourage pastoralist to diversify into alternative investments such as non-agriculture assets (real estate and saving accounts). More research is needed for a better understanding of how to determine how much the camel population can increased while side-by-side with cattle to support the human population during droughts.

The results from this study closely match the current perception of the 12 Panel participants. They ranked the risk associated with cattle as the highest and for camels as the lowest for investments in livestock. They also ranked livestock investment with regard to the perceived risk of investments as the highest compared to savings accounts and real estate. This also supports the movement toward less investment in cattle and more investment in other alternatives.

The results are consistent with the notion that more diversification results in lower risks for pastoralists, or at least provides an avenue for reducing risks if pastoralists choose to use them. This conclusion matches that of Desta (1999) who suggested that the best investment portfolio option for pastoralists was combining cattle with safe banking. The results reported here also support the idea that bank accounts can reduce pastoralists' risk. However, other relatively safe investments,

such as real estate or camels, offer higher returns than saving accounts for pastoralists seeking to reduce their risks.

REFERENCES

Access Capital Research. May 2010. Sector Report—Real Estate. Available online at *http://www.ethioconstruction.net/sites/default/files/Law/Files/Sector%20Report--Real%20Estate.pdf.*

Africa and Ethiopia Map. Available online at *http://www.nationmaster.com/country-info/profiles/Ethiopia*

Barrett, Christopher B., Thomas Reardon, and Patrick Webb. 2001. "*Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications.*" Food policy 26, no. 4: 315-331.

Beddington, John. 2009. "*Food, energy, water and the climate: a perfect storm of global events.*" In Lecture to Sustainable Development UK 09 Conference, vol. 19..

Bekele, Eshetu, and Zeleke Worku. 2008. "*Factors that affect the long-term survival of micro, small and medium enterprises in Ethiopia*." *South African Journal of Economics* 76, no. 3: 548-568.

Berhanu, Wassie, David Colman, and Bichaka Fayissa. 2007. "*Diversification and livelihood sustainability in a semi-arid environment: A case study from southern Ethiopia.*" *Journal of Development Studies* 43, no. 5: 871-889.

Bourguignon, François, and Christian Morrisson. "Inequality among world citizens: 1820-1992." *American economic review* (2002): 727-744.

Borana Plateau map. Available online at *https://www.google.com/maps/@8.1789002,39.0964242,6z*

Bradley, Stephen P., Arnoldo C. Hax, and Thomas L. Magnanti. "*Applied mathematical programming"*. Reading, MA: Addison-Wesley, 1977.

Bruinsma, Jelle. 2003. "*World agriculture: towards 2015/2030. An FAO perspective"*. Earthscan Publications Ltd,.

Commercial Bank of Ethiopia. 2015. Found online at *http://www.combanketh.et/DomesticBanking/Deposits/SavingsAccount.aspx.*

Coppock, D. L., G. Gebru, S. Mesele, and S. Desta. 2008. *"Are Drought-Related Crashes in Pastoral Cattle Herds Predictable? More Evidence of Equilibrium Dynamics from Southern Ethiopian Rangelands."* Page 1090 in Multifunctional Grasslands in a Changing World, volume II, Edited by the

Organizing Committee of the 2008 International Grasslands Congress/International Rangelands Congress (IGC/IRC). Guagdong People's Publishing House, Beijing. pp. 1,154.

Coppock, David Layne, ed. 1994. *The Borana Plateau of Southern Ethiopia: Synthesis of pastoral research, development, and change*, 1980-91. No. 5. ILRI (aka ILCA and ILRAD).

Coppock, David Layne, Getachew Gebru, Solomon Desta, Sintayehu Mesele, and Seyoum Tezerra. 2008.*"Are Cattle Die-Offs Predictable on the Borana Plateau?"*.

Coppock, David Layne, Seyoum Tezera, Bedasa Eba, Jaldessa Doyo, Demisachew Tadele, Derege Teshome, Nizam Husein, and Meiso Guru. 2014.*"Sustainable Pastoralism on the Borana Plateau: An Innovation Systems Approach."*.

Davies, James B., Anthony Shorrocks, Susanna Sandstrom, and Edward N. Wolff. 2007. *"The world distribution of household wealth."* Center for Global, International and Regional Studies.

Davies, James B., Anthony Shorrocks, Susanna Sandstrom, and Edward N. Wolff. 2007. *"The world distribution of household wealth."* Center for Global, International and Regional Studies .

Department of State: *2014 Investment Climate Statement Ethiopia* June 2014 Cheryl Monticello, Commercial Officer, MonticelloCD@state.gov, 011 130 6588. Abdulkader Hussen, Commercial Specialist, HussenAM@state.gov, 011 130 6177.U.S. Embassy, PO Box 1014, Addis Ababa Ethiopia.

Dercon, Stefan. 2002. *"Income risk, coping strategies, and safety nets."* The World Bank Research Observer 17, no. 2: 141-166.

Desta, S. and D. L. Coppock.2002. *"Cattle Population Dynamics in the Southern Ethiopian Rangelands, 1980-97."* Journal of Range Management, 55: 439-451.

Desta, Solomon, and D. Layne Coppock. 2002. *"Cattle population dynamics in the southern Ethiopian rangelands, 1980-97."* Journal of Range Management: 439-451.

Desta, Solomon. 1999. *"Diversification of livestock assets for risk management in the Borana pastoral system of southern Ethiopia."* PhD diss., Utah State University. Department of Rangeland Resources.

Ellis, Frank. 1998. *"Household strategies and rural livelihood diversification."* The journal of development studies 35, no. 1: 1-38.

Ellis, Frank. 1999. "*Rural livelihood diversity in developing countries: evidence and policy implications."* London: Overseas Development Institute.

Embassy of The Federal Democratic Republic of Ethiopia investment opportunities 2014

Ethiopia Interest Rate 2003-2012. Available online at *http://www.tradingeconomics.com/ethiopia/interest-rate.*

Ethiopia Rural Socioeconomic Survey. May 7th, 2013. (ERSS) Survey Report. Central Statistical Agency & the World Bank.

Ethiopian Ministry of Agriculture, 2015, land lease information. Found online at *http://www.moa.gov.et/land-leased.*

Ethiopian Road Authority. 2009. Revised Universal Rural Road Access Program, Addis Ababa.

FAO. 2013. Ethiopia overview *http://www.fao.org/countryprofiles/index/en/?iso3=eth.*

FAO, 2009 How to feed the world in 2050 report (FAO). Found online at : *http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf*

FAO, IFAD and WFP. 2014. *The State of Food Insecurity in the World 2014. Strengthening the enabling environment for food security and nutrition*. Rome, FAO. Found online at http://www.fao.org/3/a-i4030e.pdf

Federal Ministry of Education, August 2010. Addis Ababa, Ethiopia, Education Sector Development Program IV (ESDP IV) 2010/2011 – 2014/2015. Program Action Plan.

FIAN G8 Cooperation framework to support The *"G8 new alliance for food security and nutrition in Africa"* Editors: Editors: Roman Herre, Philip Seufert, Yifang Slot-Tang, Denisse Cordova, Flavio Valente, Laura Michéle. February 21014 .Available online at *http://www.fian.org/fileadmin/media/publications/2014_G8NewAlliance_screen.pdf*

Forrest, B. 2014. *"Analysis of Building Resiliency in an Ethiopian Pastoral System: Mitigating the Effect of Population and Climate Change on Food Insecurity"*.

MS thesis. Department of Applied Economics, Utah State University, Logan, Utah.

Forrest, Brigham W., D. Layne Coppock, DeeVon Bailey, and Ruby A. Ward. February 2015. *"Economic Analysis of Land and Livestock Management Interventions to Improve Resiliency of a Pastoral Community in Southern Ethiopia."* Journal paper 8670, Utah Agricultural Experiment Station and Department of Applied Economics, Utah State University, Logan, Utah.

Funk, Chris, Jim Rowland, Gary Eilerts, Emebet Kebebe, Nigist Biru, Libby White, and Gideon Galu. 2012. "A climate trend analysis of Ethiopia." *US Geological Survey, Fact Sheet* 3053.

Gemtessa, Kejela, Bezabih Emana, and Waktole Tiki. 2005.*"Livelihood Diversification in Borana: Pastoral Communities of Ethiopia–Prospects and Challenges."* Unpublished report by WABEKBON Consult, Ethiopia .

Getachew, Dereje, and Tesfatsion Sahlu. 2013."*Determinants of Trade Credit Use by Private Traders in Ethiopia: Case of Mekelle City, Tigray Regional State.*" Research Journal of Finance and Accounting 4, no. 10: 1-7.

Hadar, Josef, and William R. Russell. 1969. *"Rules for ordering uncertain prospects."* The American Economic Review: 25-34.

Hammond, Geoffrey P. 2000. "Energy, environment and sustainable development: a UK perspective." *Process Safety and Environmental Protection* 78, no. 4: 304-323.

Hardaker, J. Brian, James W. Richardson, Gudbrand Lien, and Keith D. Schumann. 2004. *"Stochastic efficiency analysis with risk aversion bounds: a simplified approach."* Australian Journal of Agricultural and Resource Economics 48, no. 2 (2004): 253-270.

Hazell, Peter BR, and Roger D. Norton. 1986. *"Mathematical programming for economic analysis in agriculture."* New York: Macmillan.

Helmberger, Peter G., Jean-Paul Chavas. 1996. *The Economics of Agricultural Prices*. Prentice Hall: Upper Saddle River, NJ. .

Hogg, Richard. 1996. *"Government policy and pastoralism: Some critical issues."* In Conference on pastoralism in Ethiopia: Full papers.

Ionescu, Luminiţa. 2011. "The financial crisis as a failure of corporate governance."*Economics, Management, and Financial Markets* 2: 827-832.

Investing in smallholder family farmers for the future we want International Fund for Agricultural Development. 2014. Governing council .Via Paolo di Dono, 44 - 00142 Rome, Italy.

Kaufmann, B. 1998 *"Analysis of Pastoral Camel Husbandry in Northern Kenya*." Weikersheim, Germany:Margraf Verlag.

Lavers, Tom. 2013. "*The role of foreign investment in Ethiopia's smallholder agricultural development strategy."*.

Leamer, Edward E. 2007.*"Housing is the business cycle."* No. w13428. National Bureau of Economic Research.

Lintner, John. 1965. "The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets." *The review of economics and statistics*: 13-37.

Little, Peter D., Kevin Smith, Barbara A. Cellarius, D. Layne Coppock, and Christopher Barrett. 2001. *"Avoiding disaster: diversification and risk management among East African herders."* Development and Change 32, no. 3: 401-433.

Little, Peter. 2009. "Hidden value on the hoof: cross-border livestock trade in Eastern Africa." *Policy Brief* 2.

Loening, Josef, and Laketch Mikael Imru. *"Ethiopia: diversifying the rural economy. An assessment of the investment climate for small and informal enterprises."*

Lybbert, Travis, Christopher Barrett, Solomon Desta, and D. Layne Coppock. 2009. *"Pastoral risk and wealth-differentiated herd accumulation in southern Ethiopia."* USAID, Utah State University, International Livestock Research Institute, and the Rockefeller Foundation (2001).

Manos, Basil D., and George I. Kitsopanidis. 1986. *"A quadratic programming model for farm planning of a region in central Macedonia."* Interfaces 16, no. 4: 2-12.

Mapp, Harry P., Michael L. Hardin, Odell L. Walker, and Tillak Persaud. 1979 *"Analysis of risk management strategies for agricultural producers."* American Journal of Agricultural Economics: 1071-1077.

Markowitz, Harry. *"Portfolio selection."* The journal of finance 7, no. 1 (1952): 77-91.

McCarl, Bruce A., and David A. Bessler. 1989. "Estimating an upper bound on the pratt risk aversion coefficient when the utility function is unknown*." *Australian Journal of Agricultural Economics* 33, no. 1: 56-63.

McPeak, John G., and Christopher B. Barrett. 2001. *"Differential risk exposure and stochastic poverty traps among East African pastoralists."* American Journal of Agricultural Economics: 674-679.

McPeak, John G., and Peter D. Little. 2006 *"Pastoral livestock marketing in Eastern Africa: research and policy challenges."* Intermediate Technology Publications Ltd.

McPeak, John G., Peter D. Little, and Cheryl R. Doss. 2011. *"Risk and social change in an African rural economy: livelihoods in pastoralist communities."* Vol. 7. Routledge.

Mengesha, Teferra. 23 – 25 November 2010. *"Emancipating the Rural Population from Isolation. Intermediate Means of Transport (IMTs) The Case of Ethiopia in Sub-Saharan Africa."* A Paper Presenting at the 1st AFCAP Practitioners Conference.. Addis Ababa.. W.T Consult PLC.

Merton, Robert C. 1977"On the microeconomic theory of investment under uncertainty."

Meyer, Jack. 1977a. *"Choice among distributions."* Journal of Economic Theory 14, no. 2: 326-336.

Meyer, Jack. 1977b *"Second degree stochastic dominance with respect to a function."* International Economic Review: 477-487.

Milanovic, Branko. 2005 "Worlds apart." *Measuring International and Global Inequality, Princeton and Oxford: Princeton University Press, 227p* .

Moss, Charles B. October 5, 2010. "Utility Functions, Risk Aversion Coefficients and Transformations:
Lecture XVIII." Available online at *http://ricardo.ifas.ufl.edu/aeb6182.risk/Slides18-2010.pdf.* 2015.

Mude, Andrew, Christopher B. Barrett, Michael R. Carter, Sommarat Chantarat, Munenobu Ikegami, and John G. McPeak. 2009*"Index based livestock*

insurance for northern Kenya's arid and semi-arid lands: the Marsabit pilot." SSRN 1844758.

Norstad, John. 1999. *"An introduction to utility theory."* Unpublished manuscript at http://homepage. mac. com/j. norstad .

Peden, D., A. Freeman, A. Astatke, A. Notenbaert, W. Ayalneh, and I. Baltenweck. 2006. *"Investment options for integrated water-livestock-crop production in sub-Saharan Africa."* ILRI Work. Pap).

Privatization and the Public Enterprises Supervising Authority (PPESA). Available online at *http://www.ppesa.gov.et/*.

Randers, Jorgen. 2008. "Global collapse—Fact or fiction? " Futures 40, no. 10: 853-864

Richardson, James W. 2006. *"Simulation for applied risk management."* Department of Agricultural Economics, Agricultural and Food policy center, Texas A&M University.

Runge, C. Ford, Benjamin Senauer, Philip G. Pardey, and Mark W. Rosegrant. 2003. *Ending hunger in our lifetime: food security and globalization*. Intl Food Policy Res Inst,.

Sharpe, William F. 1964. "Capital asset prices: A theory of market equilibrium under conditions of risk*." *The journal of finance* 19, no. 3: 425-442.

Swallow, Brent M. 1994 *"The role of mobility within the risk management strategies of pastoralists and agro-pastoralists."* London: International Institute for Environment and Development.

Swift, Jeremy, Kate Hamilton, S. Devereux, and S. Maxwell. 2001 *"Household food and livelihood security."* Food security in sub-saharan Africa : 67-92.

Tache, Boku, and Gufu Oba. 2010. *"Is poverty driving Borana herders in Southern Ethiopia to crop cultivation?"* Human ecology 38, no. 5: 639-649.

The state of food insecurity in the world, the multiple dimensions of food security report 2013. FAO Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat 2011. World Population Prospects: The 2008 Revision, *http://esa.un.org/unpp*

Tobin, James. 1958*"Liquidity preference as behavior towards risk."* The review of economic studies: 65-86.

Tomek, William G., and Hikaru Hanawa Peterson. 2001.*"Risk management in agricultural markets: a review."* Journal of Futures Markets 21, no. 10: 953-985.

UNCTAD, World Investment Report 2014*" Investing In the SDGS: An Action Plan"*. United Nations Publication Sales No. E.14.II.D.1 ISBN 978-92-1-112873-4 eISBN 978-92-1-056696-4

United Nations Millennium Development Goals (MDGs), fact sheet (1). "n.d*."Available online at http://www.un.org/millenniumgoals/pdf/Goal_1_fs.pdf*.

USAID, Ethiopia, Country Development Cooperation Strategy 2011 – 2015 Accelerating the Transformation toward Prosperity PUBLIC VERSION: March 2012.

USTR, Office the United States trade representative, Executive office of the president, Ethiopia report 2013 *http://www.ustr.gov/sites/default/files/Ethiopia_0.pdf.*

Valadez, Ray M. 2010."The housing bubble and the GDP: a correlation perspective. "Journal of Case Research in Business & Economics 3: 1-18.

Von Braun, Joachim. 2005. *The world food situation: an overview*. International food policy research institute (IFPRI).

World Bank, 2014, Africa's Pulse An analysis of issues shaping Africa's economic future April 2014 volume 9. Found online at http://www.worldbank.org/content/dam/Worldbank/document/Africa/Report/Africas-Pulse-brochure_Vol9.pdf.

Weisstein, Eric W. "Distribution Function." From MathWorld--A Wolfram Web Resource. http://mathworld.wolfram.com/DistributionFunction.html

World Bank data base Ethiopia overview. "n.d." Available online at http://www.worldbank.org/en/country/ethiopia/overview.

World Bank, databank, http://databank.worldbank.org/data/views/reports/tableview.aspx.

World Bank. 2010. Ethiopia - Protecting the most vulnerable. IDA at work. Washington, DC: World Bank Group. Available online at

http://documents.worldbank.org/curated/en/2010/09/20372040/ethiopia-protecting-most-vulnerable.

World Bank. 2012. Agribusiness indicators - Ethiopia. Washington, DC: World Bank. Available online at http://documents.worldbank.org/curated/en/2012/04/16374742/agribusiness-indicators-ethiopia.

World Bank. 2013. Ethiopia - Second Phase of General Education Quality Improvement Project. Washington DC; World Bank. Available online *athttp://documents.worldbank.org/curated/en/2013/10/18499496/ethiopia-second-phase-general-education-quality-improvement-project.*

WTO, World Trade Organization, 2012, found online at *http://stat.wto.org/TariffProfiles/ET_e.htm*

Zuberi, Tukufu, and Kevin JA Thomas. 2012. *Demographic projections, the environment and food security in Sub-Saharan Africa*. No. 2012-001.

Zeru, Fetene. 2010. "*Access to Finance and Its Challenge for Small Business Enterprises*." Case of Addis Ababa City Study conducted in partial fulfilment of the MSc in accounting and finance. Submitted to Addis Ababa University, School of Business and Public Administration, Department of Accounting and Finance.

APPENDIX

Survey questions

PASTORAL WEALTH AND ALTERNATIVE INVESTMENT INTERVIEW

1. You have been selected for this interview because you are regarded as an important member of the Borana community who has great wealth. Please describe your life since you were a young boy. What are the most important reasons why you have become so wealthy and successful?

2. How old are you now? Where do you live? How long have you lived in the Borana region?

3. How many wives and children have you had? Where do your wives and children live?

4. Have any of your children received formal or informal education? If "yes" list them by name, the level completed and what they are doing now. Expand table if needed (*if "no," skip to #5*).

ID Number	Gender	Formal Level?	Informal Level?	What is the child's age, and what is he/she doing now?

5. Have any of your wives received formal or informal education? If "yes," list them by name, the level completed, and what they are doing now. Expand table if needed. *(If "no," skip to #6*).

ID Number	Formal Level?	Informal Level?	What is the wife doing now?

6. Have you ever received formal or informal education? If "yes," please specify formal or informal and indicate level(s) completed. (*If "no," note below and skip to the next question*.)

7. Can you read or write? If "yes," please specify the level for each. If "no," is this a problem for you? Please explain.

8. You are known for having large numbers of livestock. Why do you want to accumulate large numbers of livestock? (multiple reasons are fine – try to rank in terms of importance.)

9. Do you own different species of livestock? (Examples: cattle, camels, sheep, goats, horses, donkeys, mules). Answer "yes" or "no."

10. If you own more than one species of livestock, explain why. In other words, what are the advantages and disadvantages for each species?

11. What are the specific benefits to you of having large numbers of livestock?

12. What are the specific problems for you when having large numbers of livestock?

13. Who did the herding and milking work for your animals 15 years ago?

14. Who does the herding and milking work for your animals today?

15. If there has been a change in the types of people who contribute labor for your herds over the past 15 years, explain why. If there has been no change, also explain why.

16. In Borana culture, the wealthy herd owners used to give milk and calves to the poor people in return for the labor of the poor people who herded and milked animals owned by the wealthy. This process could help the poor re-build their herds over time. Did you or your father engage in this practice years ago—yes or no? Do you engage in this practice today—yes or no? If this practice has changed, please explain when it began to change, and why.

17. What is your opinion of poor people in Borana today? Why do you think they are poor? Are they able today to build-up their herds to become wealthy, or not?

18. Besides livestock, do <u>you own</u> any of the following?

(a) Huts (where people live in an olla)
i. Number and locations

(b) Houses (where people can live)
i. Number, locations, sizes, values in Birr (and specify partial ownership)

(c) Small shop (duka; market outlet), butchery, tea shop, etc.
i. Number, locations, sizes, values in Birr (and specify partial ownership)

(d) Hotels
i. Number, locations, sizes, values in Birr (and specify partial ownership)

(e) Other roofed buildings (storage facilities, slaughter facilities, etc.)
i. Number, locations, sizes, values in Birr (and specify partial ownership)

(f) Livestock holding-grounds or feedlots
i. Number, locations, sizes, values in Birr (and specify partial ownership)

(g) Motor vehicles (lorries, cars, buses, motorcycles)
i. Type, number, locations, value in Birr (and specify partial ownership)

(h) Other physical assets not yet mentioned
i. Type, number, locations, value in Birr (and specify partial ownership)

19. Please describe any businesses you are involved with.

Name or Description of Business	Location of Business	How Old is this Business (years)?

(expand table if necessary)

20. Do you control cropland? If yes, how many hectares total do you control, and for how many years? *(if "no," then skip to question #26)*

21. If you answered "yes" for the previous question, what types of crops do you typically grow *(list in order of importance, on average over the past 5 years)*?

22. For the top three crops that you grow, please specify what percent of the grain yield, when averaged over the past 5 years, is: (a) Consumed by your family members; (b) donated for free to other people in the local community; or (c) sold on the market.

Crop Name	%Consumed	%Donated	%Sold	Total
				100%
				100%
				100%

23. For the same three crops, please note the frequency of crop failures when little or no grain is produced.

Crop Name	Fails 1 in 2 years	1 in 3 years	1 in 4 years	1 in 5 years	1 in 7 years	1 in 8 years	1 in 9 years	1 in 10 years	Other (years)

24. Do <u>you</u> also use your cropland (or fenced cropland area) for kalo? If "yes," give the size (hectares) for each kalo in the cropland areas you control, and note if the grazing use is "private" (for your animals only) or if it is open to the community. *(If "no," skip to question #26)* Expand table if necessary.

Kalo name (or other identifier)	Kalo size (hectares)	Private Use Only?	Mixed Private and Community Use?	Community Use Only?	Leased to Traders or Others?

25. Briefly explain how and when the kalo in question #24 are used.

26. Do you have access to kalo that are not placed within your cropland areas? If "yes," please fill the table below. *(If "no," skip to question #28)* expand table if necessary.

Kalo name (or other identifier)	Kalo size (hectares)	Private Use Only?	Mixed Private and Community Use?	Community Use Only?	Leased to Traders or Others?

27. Briefly explain how and when the kalo in question #26 are used.

28. Do you use banking services? *(if "yes" specify the services, if "no" go to #30)*

29. If you keep money in a bank (from above), for how many years have you done this? Why? Where did you get the idea? What type of account(s) do you have?

30. Assume you have 100 units of investment in total. Please specify how the units are distributed across the categories below

Units:	Livestock	Banking	Property in town	Cultivation	kalo	Business	Your children	Your wives	Total
									100

31. Assume you have 100 units of investment for livestock below. Please specify how the units are distributed across the various species.

Units:	Cattle	Camels	Sheep	Goats	Donkeys	Horses/Mules	Total
							100

32. Assume <u>you</u> have 100 units of investment for property below. Please specify how the units are distributed across the various categories

	Huts	Houses	Small Business Facilities (dukas, etc)	Hotels	Other roofed buildings	Holding Grounds, Feed lots, etc.	Motor Vehicles	Total
Units:								100

33. Assume <u>you</u> have 100 units of investment for business activities below. Please specify the major categories of business* and how the units are distributed *(see answers for question #19)*

					Total
Units:					100

*[*categories might include shop-keeping, mining, trading (specify types of goods), natural resource extraction, other…]*

34. How many livestock does a <u>wealthy, influential man like you own</u> in this current year?

Species	**Males**	**Females**	**Species**	**Males**	**Females**
Cattle			Goats		
Camels			Donkeys		
Sheep			Horses		
Mules					

35. Of the animals specified in #34, what number (out of 100) will die in a 2-year drought?

Cattle	Camels	Sheep	Goats	Donkeys	Horses/Mules

36. How many animals are typically sold from a wealthy man's herds in the types of years shown below?

Type of Year	Cattle	Camels	Sheep	Goats	Donkeys	Horses/Mules
Average Rainfall Year						
First Drought Year						
Second Drought Year						

37. Compare your herd composition between today and 15 years ago, on average:

Today			15 Years Ago		
Species	%Adult Females	%Adult Males	Species	%Adult Females	%Adult Males
Cattle			Cattle		
Camels			Camels		
Sheep			Sheep		
Goats			Goats		

38. Has there been a change in herd composition as shown in question #37? If "yes," explain why.

39. In Borana traditional society, milk from the cow was almost evenly shared (50:50) between the calf and the people who lived or worked for a wealthy household such as yours. Has this split in milk allocation changed today? If yes (it has changed), does the calf get more milk or less milk today in your household? Explain any reasons for the change.

40. Risk includes the chance for a herd to grow as well as the chance for a herd to have losses. Rank the livestock species in terms of their overall level of risk for you over a 10-year period. The number "1" indicates the most risky species while the number "4" is the least risky species. If two livestock species have the same risk, give them the same rank.

Category	Rank
Cattle	
Camels	
Sheep	
Goats	

41. Using the same method as in #38, please rank the following investment options in terms of their overall level of risk for you over the past 10 years. The number "1" indicates the most risky while the number "6" is the least risky. For two categories of the same risk, give them the same rank. If any categories cannot be ranked, leave them out of the exercise.

Category	Rank
All livestock species together	
Banking	
Property	
Cultivation	
Business	
Your children	

42. Specify the investment risk for categories below <u>when compared with cattle</u> over the past 10 years.

Category	Categories					
	Banking	Property	Cropland	Kalo	Business	Your Children
10x More						
5x More						
2x More						
Equal						
2x Less						
5x Less						
10x Less						

43. If <u>you</u> are invested in non-pastoral options (like a home in town, hotel, business, vehicles, etc.), where did you get the idea to do this? Please explain. If you are not invested in non-pastoral options, please explain why not.

44. What investments are <u>you</u> most interested in making that you are not already involved with? What most limits <u>you</u> from making these new investments? Please explain.