A STUDY OF HOUSEHOLD INCOME DETERMINANTS AND INCOME INEQUALITY IN THE TOMINIAN AND KOUTIALA ZONES OF MALI

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ABSTRACT

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According to the UN's Millennium Development Indicators, 57.6% of the rural population in Mali was living below the national poverty line in 2006. To improve on this statistic, it is important to understand the following about communities in rural Mali: 1) the makeup of household incomes, 2) factors associated with higher income levels, and 3) the levels of income inequality in these communities. This thesis used panel household data from the Cercle of Tominian and the Cercle of Koutiala to examine these issues. More specifically, a descriptive statistics analysis of reported household incomes was performed, comparing incomes across zones, years, and income quartiles. This showed that households in both zones were poor with only 8-16% of all households earning more than $1/day per capita. It also showed that households in Koutiala earned considerably more income than households in Tominian and that food crops are the most important income source for households in both zones.

A Heckman two-step model was also estimated to better understand the determinants of income for cropping, livestock, and nonfarm activities. This analysis showed that having a larger household size and living in Tominian zone were associated with lower probabilities of activity participation and/or lower incomes, while wealth and durable goods indicators, easy road access, and having a household head with at least a primary school education had the opposite effect.

Finally, to determine whether certain income activities increase or decrease income inequality levels, regional Gini coefficients were calculated and decomposed. This analysis showed low levels of income inequality with Gini coefficients ranging from 0.37 to 0.42.

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1. BACKGROUND INFORMATION ON MALIAN HOUSEHOLD INCOMES AND MOTIVATION FOR THIS STUDY

Poverty reduction is often a key goal of economic development programming pursued by international development agencies, as well as national governments. This focus on poverty can been seen through international initiatives, such as the United Nation's Millennium Development Goals which aim to halve the proportion of the world's population suffering from extreme poverty (defined as earning less than $1/day) between the years 1990 and 2015. While the world as a whole is on track to meet this goal, much of this success is due to drastic reductions in poverty levels in East Asia. Meanwhile, other regions of the world have seen only modest improvements. For example, during the 1990-2005 time period, sub-Saharan Africa has only seen poverty levels drop from 58% to 51% of the population (United Nations, 2010).

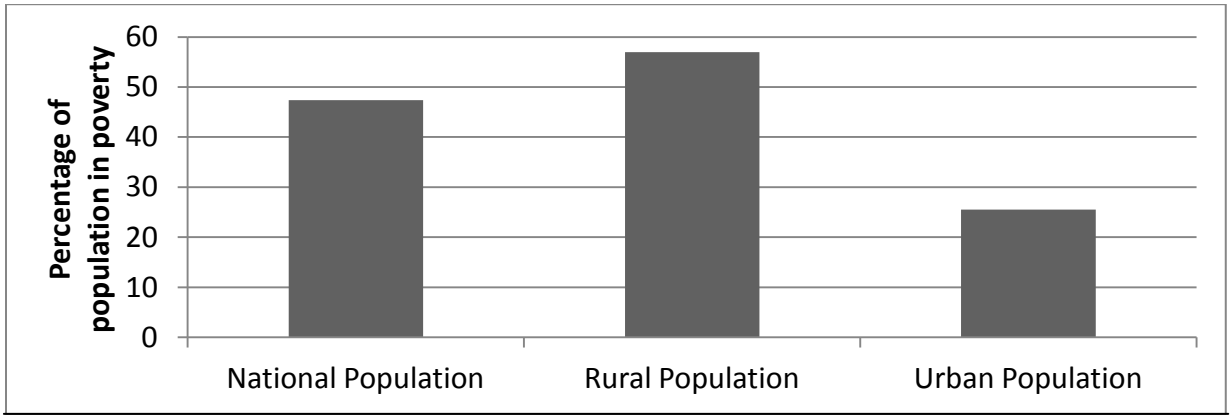
Due to limited successes in sub-Saharan Africa, researchers and policy makers need to consider what types of household livelihood strategies and income activities have the greatest potential to serve as motors of economic growth, reducing poverty while improving income distribution in this region. A better understanding of these parameters should contribute to improved economic development policies and programming in Africa. In particular, information on how livelihood strategies differ between poor and non-poor households, as well as information on whether certain income activities increase or decrease community inequality levels, can be useful to policy makers and international development agencies as they develop new poverty reduction initiatives.

This thesis will examine household livelihood strategies and income inequality, as it relates to poverty, for two rural zones in Mali. Mali is an example of a country that has experienced only modest improvements in poverty levels in recent years. As of 2006, 47% of

Mali's population was living below the national poverty line (The World Bank, 2012c). In addition, Mali is far from meeting the UN Millennium Development Goal of halving poverty by 2015 (The World Bank, 2012b). The United Nations Development Program (2011) currently ranks Mali 175th out of 187 countries on its Human Development Index.

Poverty issues are particularly serious in rural areas of Mali where 67% of the country's population was located as of 2010 (United Nations Population Division, 2012). As of 2006, 57% of Mali's rural population was living below the rural poverty line. In comparison, only 26% of Mali's urban population was living in poverty during the same time period (See Figure 1) (The World Bank, 2012c). In addition, it was estimated in 2010 that the incomes of 80% of Mali's rural population were too low to provide even a basic 2,450 kcal/day diet during the entire year, suggesting that low incomes contribute to food insecurity and malnutrition (Boughton, Staatz, & Dembélé, 2010). Given these statistics, programs and policies that raise rural incomes are urgently needed in Mali.

Figure 1: Poverty Headcount Ratio in Mali at the National, Rural, and Urban Poverty Lines (2006)



Source: Developed by the author using data from World Bank (2012c)

As policy makers and development agencies in Mali work to reduce rural poverty, they need to practice caution and consider all the implications of promoting certain income activities

(agricultural or non-agricultural) as the pathway to poverty reduction. In particular, consideration of which groups will likely reap the majority of benefits from the development of a given sector or income activity is needed before the implementation of policies or programs. For example, a study on poverty in Mozambique found that recent large investments in mining, manufacturing, and utilities megaprojects contributed to overall economic growth for the country but did not significantly reduced poverty levels (Cungara, Fagilde, Garrett, Uaiene, & Headey, 2011). This example shows that while certain economic development projects may generate income in a rural community, the project will only have a poverty-reducing effect if the beneficiaries of the additional income were previously impoverished. If, on the other hand, only wealthier subsections of the population gain additional income, poverty levels will likely remain unchanged and community inequality levels will increase.

Policy makers can also use information on household income sources to identify potential vulnerabilities that may cause a household to fall into poverty or become food insecure. For example, households that earn income solely from rainfed crop agriculture may be more vulnerable to droughts than households with a more diversified income portfolio that includes both farm and nonfarm activities. On the other hand, households that earn a high percentage of their income from nonfarm activities and that generally purchase cereals on the market would be more vulnerable to changes in consumer food prices. As these examples show, understanding household income sources can play an important role in predicting how shocks to a community will likely impact poverty levels and food security.

For these reasons, understanding what types of income activities are practiced by the poor and non-poor subsections of a country's rural population, as well as how certain income

activities either increase or decrease community inequality levels, can help policy makers improve policy and program design.

1.1 Purpose of Study and Research Questions

The purpose of this study is to explore the issues described above as they relate to two rural, agricultural zones in southern Mali. In particular, panel household survey data from the Tominian and Koutiala zones of Mali was analyzed to answer the following questions:

1) What were the income levels and sources reported by households in Koutiala and Tominian during the 2006/07, 2008/09, and 2009/10 cropping years? To what extent did household income portfolios differ across zones, years, and income quartiles?

2) What household and community characteristics were associated with higher levels of income earned by households participating in the following three income categories: crops, livestock, and nonfarm activities?

3) What were the income inequality levels in Koutiala and Tominian during the three cropping seasons? Does income from selected categories (nonfarm activities, transfers, cash crops, food crops, livestock, and other agricultural activities) increase or decrease income inequality in these communities?

To answer the first research question, a descriptive statistics analysis of reported household incomes was performed, comparing incomes across zones, years, and income quartiles. Standard statistical tests were performed. To examine the second research question, a Heckman two-step model was estimated to better understand the determinants of income for cropping, livestock, and nonfarm income. Finally, to answer the third research question on whether or not certain income activities increase or decrease income inequality levels, regional Gini coefficients

were calculated and decomposed using a Gini decomposition method proposed by Lerman and Yitzhaki (1985).

1.2 Previous Studies on Household Incomes in Mali

Two previous studies used household survey data from 1987-88 and 1994-96 from rural Mali to examine household incomes and livelihood patterns (Debrah & Sissoko, 1990; Abdulai & CroleRees, 2001). A third, more recent study interviewed national and local experts to construct livelihood zones for all regions of Mali (Famine Early Warning Systems Network 2010). None of these studies used the Malian household survey data to examined issues relating to income sources and inequality levels.

Debrah and Sissoko (1990) collected data on cash incomes (i.e., no valuation of production produced and consumed at home) by surveying 15 households during the 1987/88 crop season in the Banamba zone (a coarse grain zone not far outside of Mali's capital city, Bamako). They determined that the surveyed households were generally not subsistence farmers but rather were active participants in the local markets. In addition, households in this study were found to have earned, on average, 20% of cash income from crops, 39% from cattle, 32% from small stock, and 9% from nonfarm activities. Debrah and Sissoko also found that cash incomes were used for a variety of purposes. Surveyed households reported that they sold crops to the local market in order to raise cash to purchase grains and animal feed that were not produced by the household. In addition, households reported selling livestock during the "hungry season" (when food stocks are low) to purchase grains and livestock feed, as well as to pay for farm machinery repairs, hired agricultural labor, and to purchase additional livestock. Finally, Debrah

and Sissoko found that incomes from nonfarm activities were often reinvested into the farm to support various livestock and cropping activities.

The study by Abdulai and CroleRees (2001) examined the incomes of 120 households in the Malian cotton basin (the Sikasso and Koutiala *cercles*) during the 1994/95 and 1995/96 growing seasons. This study found that, on average, 70% of total income came from crop production (44% from cotton) while about 30% came from non-cropping activities. In addition, the study found that as total household income rose, the share of income earned from food crops declined, while the share of income earned from non-cropping, cotton, and livestock activities rose. In addition, Abdulai and CroleRees used a conditional fixed effects logit model to identify factors found to affect the probability of a household's participation in cotton, livestock, and nonfarm activities. They determined that variables representing the number of male adults in the household, household landholdings, an interaction term of household size multiplied with landholdings, and value of agricultural equipment were all positively correlated with a higher probability of participation in these three activities. The landholding variable was found to have the largest effect on participation with calculated coefficients ranging from 0.79-0.97, depending on the income source. Finally, they concluded the study by arguing that poorer households in the Malian cotton basin are less diversified than wealthier households because they face barriers to entry into higher-return activities.

Finally, the authors of the Famine Early Warning Systems Network (FEWS NET) study created livelihood profiles for all regions of Mali through a two-step process which included 1) interviewing local, regional and national experts, and 2) organizing a national livelihood profiling conference attended by technical staff from FEWS NET, the United Nations, and local and international nongovernmental organizations (2010). This was the only study identified that

examined household incomes and livelihood strategies in both the Koutiala and Tominian areas of Mali. The FEWS NET study classified the Tominian zone as part of the West and Central Rainfed Millet/Sorghum livelihood zone where households generally participate in rainfed agriculture, as well as sedentary livestock rearing. The FEWS NET study also found that poor households in this zone generally have fewer household members, poorer access to land, agricultural equipment, and formal credit, and generally produce smaller quantities of cash crops than wealthier households.

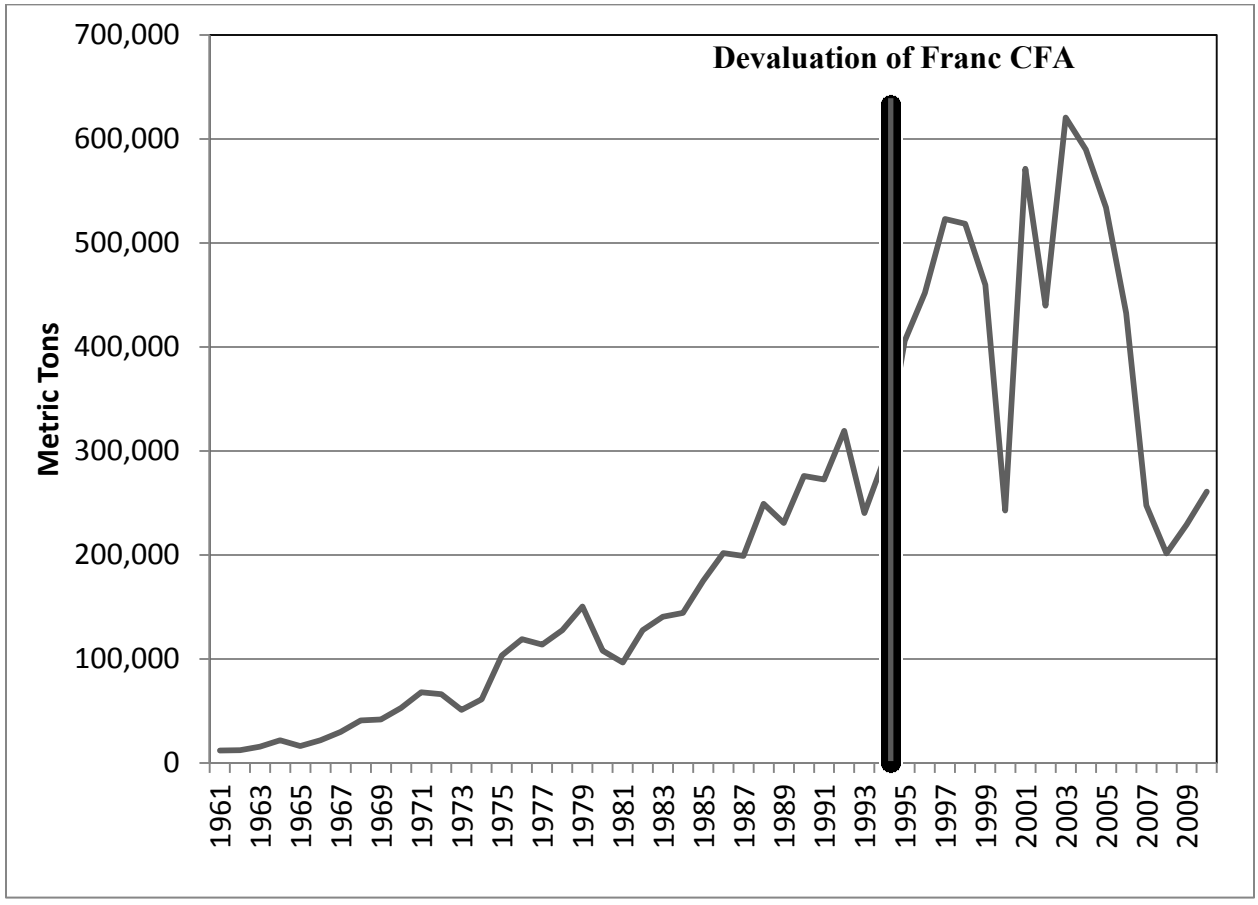
The FEWS NET study placed the Koutiala zone within the sorghum, millet, and cotton livelihood zone. In this zone, households generally have good market access, and agricultural credit and inputs are provided by the *Banque Nationale de Developpement Agricole (BNDA)*. Similar to the Tominian zone, the authors of this study argued that poor households in this region generally have smaller families and landholdings.

1.3 Limitations of the Previous Studies on Malian Household Incomes

While these three studies revealed notable patterns relating to household incomes in Mali, all three studies have their limitations. First, the data from the two studies using household income data was over 15 years old, and Mali has experienced considerable changes since these surveys were conducted. For example, the Abdulai and CroleRees study was conducted the year after Mali's currency, the Franc CFA, was devalued. The devaluation caused exported cotton to become significantly more profitable, resulting in several subsequent booms in the Malian cotton sector. As shown in Figure 2, the devaluation was followed by more variable cotton production levels from year to year, exposing farmers to additional risks not seen before the Franc CFA devaluation. One might expect household income portfolios to change as a result of the currency

devaluation, although such changes might occur over several years as it takes time for households to adjust their fixed assets. Since Abdulai and CroleRees' study was performed in the two years immediately after the devaluation, their study's results may not have fully reflected any income portfolio changes that occurred after this policy change. In addition, recent issues relating to the Malian cotton sector, such as low producer prices, concerns about the privatization of the national cotton company, and institutional inefficiencies within the sector, may cause households to change their income portfolios. As a result, repeating the analysis with more recent data may show different household livelihood strategies than those reported in earlier studies.

Figure 2: Cotton Production Levels in Mali



Source: Developed by author using data from FAOSTAT, a database created and managed by the Food and Agriculture Organization of the United Nation's Statistical Division (2012)

In addition, Abdulai and CroleRees' study used a fixed effects logit model. Fixed effects models cannot show the direct effects of time-invariant factors, such as distance from a market or ethnic group of the household (Wooldridge, 2009). Given this constraint, a re-evaluation of this problem using an econometric model that can take into account time-invariant variables may reveal new information.

A limitation of the Debrah and Sissoko study (1990) is that it only surveyed 15 households and only examined cash incomes. The small sample size makes it difficult to draw conclusions about the community and limits the usefulness of the study for policy purposes. In addition, most economists agree that household income should include both cash and in-kind, non-monetary income (Ellis, 2000a). In developing country situations, examining only cash income has been found to be problematic because a considerable share of household production is intended for home consumption and never enters the market. For this reason, studying only cash income may miss an important component of a given household's livelihood strategy.

Finally, the FEWS NET livelihood profiles study is considerably more recent but a weakness of this study is that it is based primarily on interviews with national and local experts and no household survey data was used. As a result, the quality of this study is highly dependent on how well the experts interviewed understood the local dynamics of each region profiled.

Given the limitations of past studies, further research on household incomes in Mali using more recent data is needed. In particular, understanding household income levels and sources can help policy makers identify potential vulnerabilities that households in a given community face and can help them determine how shocks (such as a drought, changes in commodity prices, etc.) may impact household incomes and food security. In addition, an awareness of household and community characteristics that differentiate higher income-earning households from lower

income-earning households can help policy makers focus their attention on particular issues and policies that could raise incomes for the poor and reduce poverty rates. For example, if it is shown that high income-earners generally have more education or better access to transportation than poorer households, policy makers would perhaps want to focus their attention on improving access to education and transportation for the poor. Finally, understanding whether inequality levels increase or decrease as a result of certain income activities will help policy makers understand if promoting a given income source may actual help the poor and reduce poverty levels, or just increase the incomes of the wealthy sub-sections of the population.

1.4 Structure of Thesis

The issues discussed above will be explored in more depth in the next six chapters of this thesis. Chapter 2 is a literature review on the topic of household livelihood strategies, household income determinants, and income inequality. Chapter 3 presents the data used in this study, as well as income definitions applicable to this analysis. Chapter 4 describes household income levels and the relative importance of different income sources in these two zones of Mali. In Chapter 5, a Heckman two-step econometric model is used to examine the determinants of per capita household income and the extent to which they differ by income type (e.g., crop, livestock, and nonfarm activities). Chapter 6 then uses a Gini decomposition method to better understand the relationship between income sources and income inequality. Finally, Chapter 7 discusses the implications of this study's results, policy recommendations, and suggestions for future research.

2. LITERATURE REVIEW

In order to better understand the context of this study on household incomes and livelihood strategies in Mali, a literature review is presented. The first section of this literature review discusses income activities commonly found in West Africa, as well as related theories proposed by researchers on household livelihood diversification in developing countries. This section also includes a discussion of factors found to be correlated with agricultural and non-agricultural participation and income levels in various countries throughout the world. The second section of this literature review discusses the relationship between income sources and income inequality.

2.1 Household Income Portfolios and Livelihood Diversification

2.1.1 Common Income Sources

Traditionally it was thought that rural households in developing countries only participated in agriculture, with a focus on cropping activities. However, research from various developing countries has shown that rural households actually participate in a variety of income activities — both on and off the farm.

2.1.1.1 Livestock Income

In addition to crops, one income source common in West Africa is livestock. In much of rural Africa, where there are few financial and banking alternatives, livestock serves as a relatively liquid asset and is often used as a savings mechanism (Dercon, 1998). Livestock can also be culturally significant and can play an important role in local customs, such as in the case of bride payments. A common hypothesis is that households use livestock as a consumption smoothing mechanism, selling off livestock to ensure that consumption levels remain relatively

constant throughout the year when faced with an income shock. However, this idea has been questioned by Fafchamps, Udry, and Czukas (1998) in a study of rural households in Burkina Faso. This study found that households that faced the most significant income losses during a drought reported that their primary motivation for selling livestock was to meet household consumption needs. However, statistical analysis of these households' reported income showed that, at most, livestock sales only made up 30% of the income lost as a result of the drought. Fafchamps et al. argue that although livestock income can help make up a sizable share of lost income due to a drought, it does not make up for all of it, and therefore is unlikely to be the only consumption smoothing mechanism employed by households in Burkina Faso.

A study of household incomes in several countries neighboring Mali, including Burkina Faso and Senegal, used data collected between 1981-1990 to find that households in the Sudanian agroclimatic zone (which would be similar to the climate of Mali's Tominian and Koutiala zones) earned, on average, 5-10 percent of total income from livestock activities. This study also found that the share of income earned from livestock was fairly constant across income quartiles (Reardon et al., 1993).

2.1.1.2 Nonfarm Income

Another common income source is nonfarm activities. Nonfarm income includes income earned from non-agricultural rural wage employment, self-employment activities, land rentals, and domestic and international migration remittances. Nonfarm income has been found to be a significant part of household income and has been estimated to account for approximately 51% of rural income in Asia, 34% in Africa, and 47% in Latin America (Haggblade, Hazell, & Reardon, 2009). In the Sudanian agroclimatic zone of Burkina Faso and Senegal, local nonfarm activities made up on average 20-27% of total income during the 1980s (Reardon et al., 1993).

2.1.1.3 Migration Remittance Income

Within the nonfarm income category, income from migration remittances merits further discussion. In Africa, it has been argued that most household income diversification is not only nonfarm in nature but also non-rural, suggesting that people are moving to urban areas to search for income opportunities (Ellis, 2000a). In addition, there has been evidence to suggest that migration can play an important role in household risk reduction and consumption smoothing. For example, a study of households in rural India found that households commonly send their daughters to other villages or regions to marry. In these agricultural communities, where income risks are often correlated with location, the study argued that this migration spatially diversifies Indian families' risks. During periods of low income, remittance income could be sent between the two locations, smoothing household consumption patterns (Rosenzweig & Stark, 1989).

Several studies have examined the role of migration remittances on household incomes in West Africa. The Reardon et al. study (1993) of the Sudanian zone of Senegal, Niger, and Burkina Faso found that remittance income made up, on average, a small percentage of total income during the 1980s, ranging from 2-3%. Another study of households in northern Mali, where poor climatic conditions cause higher agricultural risk, found that migration is extremely common, and that the remittances received by households in this region often corresponded with agroclimatic shocks and the death of household members (Perakis, 2011). Finally, Gubert, Lassourd, and Mesplé-Somps (2010) estimated that international remittance income reduced national-level poverty rates in Mali by 5-11%.

2.1.2 Relationship between Farm and Nonfarm Activities

The relationship between agricultural and non-agricultural activities/sectors in developing countries has been discussed in previous literature (see, for example, Reardon et al., 1993). In

this literature, three questions are frequently explored: 1) does a vibrant agricultural sector aid in the development of a strong non-agricultural sector or vice versa? 2) Do nonfarm income activities lead to agricultural labor constraints within rural communities? And 3) do households usually reinvest nonfarm income into farming activities?

The rural growth linkage approach is one model created to answer these questions. This approach states that a community's agricultural sector creates forwards and backwards production linkages and expenditure/consumption linkages with the community's nonfarm sector (Ellis, 2000a). For example, if the cocoa industry in Nigeria experiences a boom, there will likely be more demand for inputs, such as fertilizers, pesticides, and herbicides (backward production linkages). In addition, employment opportunities for cocoa traders, transporters, and processors will also increase (forward production linkages). Finally, as cocoa farmers become wealthier, they will likely increase consumption, which will create a multiplier effect throughout the community (expenditure/consumption linkages) (Ellis, 2000a; Delgado, Hopkins, & Kelly, 1998). Attempts have been made to estimate this multiplier effect for various developing countries. For each additional dollar earned on farm, researchers have estimated that an additional $0.30-1.90 is created in the community, depending on the country and research study (Ellis, 2000a; Delgado et al, 1998; Haggblade & Hazell, 1988). These results suggest that improvements in the agricultural sector will lead to additional off-farm opportunities in the community.

One issue examined by Haggblade and Hazell (1988) is whether production or consumption linkages produce greater multiplier effects. They argue that in rural Africa, consumption linkages tend to dominate while production linkages have a much smaller effect. They also argue that improvements in agricultural income should be focused on poorer households, rather than larger landholders, because higher income in the hands of the poor will

have a greater multiplier effect in the community. Larger households, meanwhile, tend to spend more of their money outside of the community and on high priced goods that are not generally produced or sold by poorer subsections of the population.

The rural growth model was explored in the study mentioned earlier by Reardon et al. (1993) of rural incomes in Burkina Faso, Niger, and Senegal using data from the 1980s. This study found that almost all income earned by the surveyed households was either directly related to agriculture or linked via production-side linkages. This study also examined the issue by agroclimatic zones, and found that as one moved farther north into areas with riskier agriculture, the linkages between agricultural and non-agricultural activities became less strong. In particular, for the Sudanian zones of Burkina Faso and Senegal, 85-98% of household incomes on average were from agriculture or directly-linked to agricultural activities.

Past studies have also tried to understand whether or not participation in nonfarm income activities reduces liquidity constraints and leads to more agricultural investments and input expenditures. Studies using household surveys from Vietnam, Bulgaria, and Nigeria found evidence which indicates that the presence of nonfarm income increases household expenditures on agricultural inputs (Hertz, 2009; Oseni & Winters, 2009; Stampini & Davis, 2009). In addition, a study of a Dogon community in Mali found that migration remittances were often used to purchase farm machinery, livestock, and to pay for hired agricultural labor (David, 1995).

Finally, another issue commonly discussed in the literature is whether or not participation in nonfarm activities creates farm labor constraints, leading to a reduction of agricultural productivity. A case study of a Dogon community in Mali found evidence to support this idea (David, 1995). This case study found that the interviewed households stated that migration,

particularly by young adults, to urban areas created a labor gap, making the cultivation of family fields in rural Mali more difficult.

2.1.3 Reasons for Livelihood Diversification

Frank Ellis defines rural livelihood diversification as "the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living" (Ellis, 2000a, p. 15) The following six reasons are often given for why households might diversify their incomes:

2.1.3.1 Risk Reduction

It has been argued that risk averse households prefer lower incomes with lower risk to higher incomes with higher risk. One way in which a risk averse household might reduce risk is through income diversification into activities that are not positively correlated with each other (Ellis, 2000a; Ellis, 2000b; Reardon et al., 2000; Reardon et al., 1992). For example, a Malian household that is currently only growing coarse grains might have the opportunity to diversify into cotton (a cash crop) or send a few household members to Mali's capital, Bamako, to seek employment. Coarse grain production and cotton production levels can be highly correlated. In other words, an agroclimatic shock, such as a drought, would reduce both crops' production levels at the same time. Nonfarm income earned in Bamako, on the other hand, will likely be uncorrelated with coarse grain production. As a result, income diversification through migration may reduce risk more than diversification into cash crops. Finally, researchers have stressed that diversification for risk reduction purposes is considered ex-ante and happens before an income shock, such as a drought, occurs (Ellis, 2000a; Ellis, 2000b; Reardon, Taylor, Stamoulis, Lanjouw, & Balisacan,

2000). Risk reduction strategies differ from coping strategies in response to income shocks, which will be discussed in the next section.

2.1.3.2 Coping after a Shock

Diversification can also be ex-post and occur after an income shock. In this situation, households are forced into other activities for survival purposes because income from one activity is not sufficient to live on (Ellis, 2000a; Ellis, 2000b; Reardon et al. 2006). For example, a study of households in the Lacustre zone in Mali identified migration, livestock sales, and receiving gifts from friends and relatives as coping strategies commonly used in this area (Harrower & Hoddinott, 2005).

2.1.3.3 Seasonality

In most areas of West Africa, agriculture can only occur during a limited period of the year. Consumption, on the other hand, occurs all year long. As a result, households might attempt to smooth consumption by participating in other types of income activities during the months when they are not busy with agriculture (Ellis, 2000a; Ellis, 2000b). For example, Wooten's ethnographic study of the Niamakoroni village, located near Bamako in Mali, found that during the short rainy season, household members were generally too busy with agricultural activities to be active in nonfarm activities. However during the dry season, household members frequently participated in various, local nonfarm activities, such as the collection of forestry items and the production of charcoal and crafts (Wooten, 2003).

2.1.3.4 Credit Market Failures

In many rural areas of developing countries, credit is unavailable. As a result, farmers may struggle to accumulate enough cash to purchase inputs and equipment needed for agricultural activities. One solution to this liquidity constraint is to diversify into other

cash-generating activities (Ellis, 2000a; Ellis, 2000b). As mentioned earlier, research on rural households in Vietnam, Bulgaria, and Nigeria reported that the presence of nonfarm incomes decreases liquidity constraints facing farmers and increases household expenditures on agricultural inputs (Hertz, 2009; Oseni & Winters, 2009; Stampini & Davis, 2009).

2.1.3.5 Asset Strategies

Households may also choose to diversify their income activities to enable them to make investments today that will enable higher incomes tomorrow (Ellis, 2000a; Ellis, 2000b). For example, a study in Senegal found that mothers' participation in off-farm horticulture employment increased their children's primary school enrollment levels (Maertens & Verhofstadt, 2011). This finding suggests that rural household diversification in Senegal has led to educational investments which will likely lead to higher incomes in the future.

2.1.3.6 Returns from Income Activities

A household may diversify its income sources if the returns from other activities are higher than the returns from the household's current activities (Reardon et al., 2000). This reason for diversification is often explored using the household economic model, which compares the returns from the household's current activities with the returns from other potential income sources (Ellis, 2000a).

The reasons for household livelihood diversification described above are often combined into two larger categories labeled "survival" and "choice". If one diversifies for "survival" reasons, the diversification is usually involuntary and may be in response to an income shock, such as a drought, death in the family, etc. This differs from diversification for "choice" reasons which are voluntary (Ellis, 2000a). An example of "choice" driven diversification could be

household diversification into a new sector in order to take advantage of high local demand for a certain product or service.

2.1.4 Determinants of Household Income

Many studies have used household survey data from various regions of the world to examine determinants of household income. A review of these studies reveals several factors commonly found to be correlated with higher income levels and a higher probability of participation in certain income sources:

Education: The importance of education is frequently discussed in past studies. For example, studies from Mexico, Ghana, and Nicaragua found that higher levels of education were associated with an increased probability of participation in nonfarm activities (Yunez-Naude & Taylor, 2001; Abdulai & Delgado, 1999; Corral & Reardon, 2001). In the study of households in Mexico, low levels of education (1-3 years) was associated with a higher probability of participation in staple crop activities (Yunez-Naude & Taylor, 2001) while the Nicaragua study found that primary and secondary school education decreased the probability of farm wage employment (Corral & Reardon, 2001). This suggests that households with no education or very low levels of education are more likely to participate in farm activities because they do not have the skills to participate in other income activities. However, with higher education levels, households generally diversify into nonfarm activities because they have the necessary education to overcome nonfarm entry barriers. One interesting finding from the Mexico study (Yunez-Naude & Taylor, 2001) is that the education level of the household head was found to have no impact on income levels or participation rates for any activity. Education was also found to increase nonfarm

income levels in studies from Peru and Burkina Faso (Escobal, 2001; Wouterse & Taylor, 2008).

Agricultural Assets: Several studies (Wouterse & Taylor, 2008; Yunez-Naude & Taylor, 2001), including one study from Mali (Abdulai & CroleRees, 2001), identified agricultural assets as important factors associated with a higher probability of participation in agricultural-related income sources. Types of agricultural assets found to be positive and statistically significant in these papers include farm size (ha), access to irrigated land, and the value of a household's agricultural equipment.

Local Infrastructure and Market Access: Market access, road access, and the state of local infrastructure were found to be positively correlated with the probability of participating in nonfarm activities in several studies of households living in Burkina Faso, Ghana, and Nicaragua (Wouterse & Taylor, 2008; Corral & Reardon, 2001; Abdulai & Delgado, 1999). However, the Nicaraguan study found the opposite relationship for farm income to be true (i.e. road access was negatively correlated with income from farm activities) (Corral & Reardon, 2001).

Other Household Characteristics: Two studies found that a household member's age was positively correlated with income from non-agricultural activities, at least up until a certain age (Corral & Reardon, 2001; Olale & Hensen, 2012). In addition, the relationship between family size and agricultural income was examined by several studies although the direction of this relationship remains unclear. One study of households in Mexico found that larger family sizes decreased farm income (Yunez-Naude & Taylor, 2001). However, a different study of households in Burkina Faso found that larger family sizes were associated with higher levels of staple crop income (Wouterse & Taylor, 2008). Finally,

access to credit was identified as an important factor relating to both farm and off-farm self-employment income activities (Escobal, 2001).

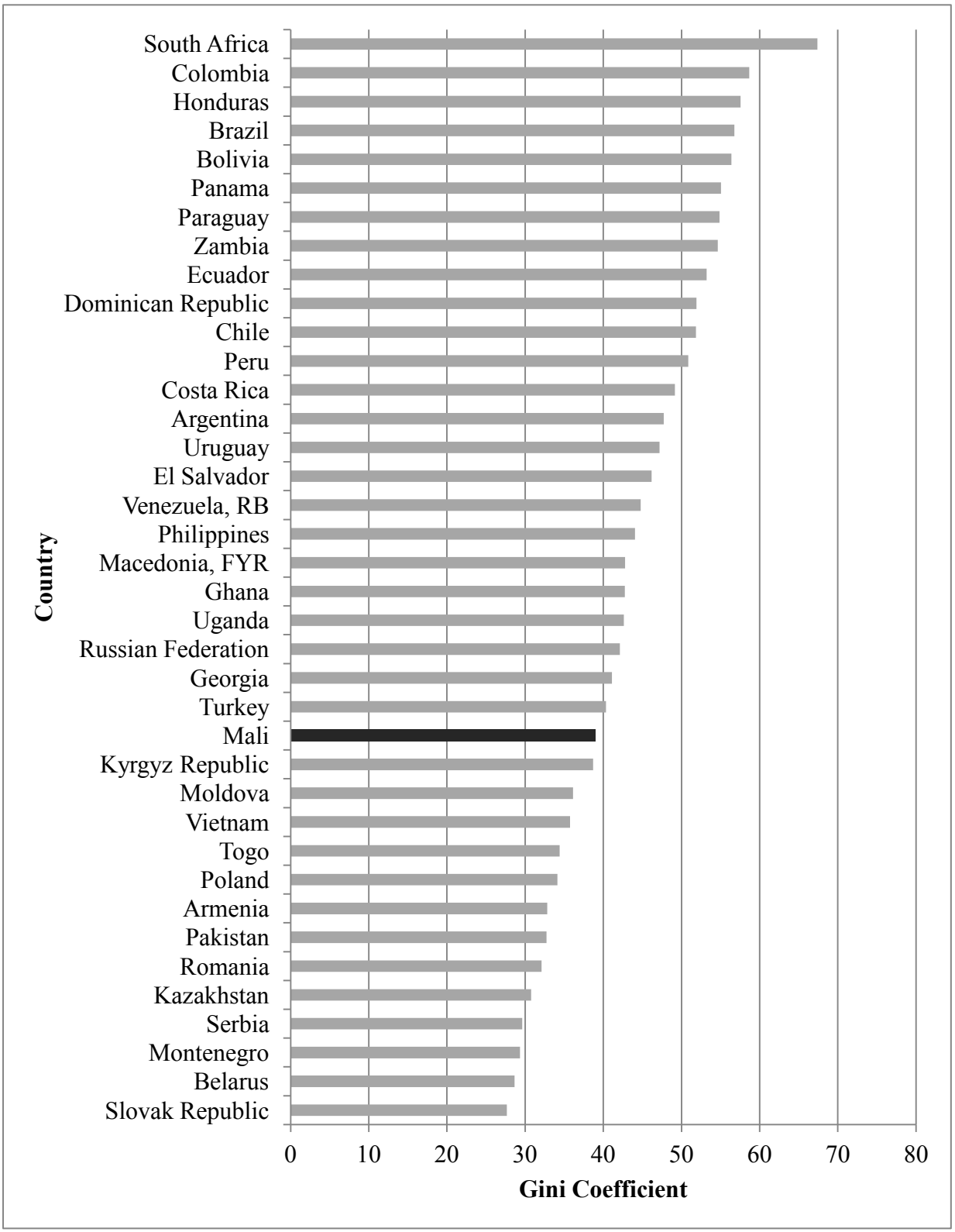
2.2 Income Inequality

In addition to examining household livelihood strategies in Mali, this thesis will also examine income inequality issues. Income inequality can be examined at either the national or local level, and in this next section, literature on inequality at both levels was reviewed. In addition, there is a discussion of the literature relating to how income from certain sources (cash crops, livestock, nonfarm, remittances, etc.) either increases or decreases community income inequality levels.

2.2.1 National-Level Income Inequality

One measure commonly used to determine income inequality levels is the Gini coefficient. The Gini coefficient is based on the Lorenz curve and is normally a value between zero and one. A value of zero represents perfect income equality and a value of one represents perfect inequality (see Chapter 6 for additional information). The World Bank estimated Mali's national Gini coefficient to be 0.39 in 2006. As shown by Figure 3, this value suggests that Mali's income inequality level is similar to the levels found in most countries in Western, Eastern, and Central Africa. It is higher than those found in many countries in East Europe, and lower than those found in many countries in Latin America and Southern Africa (The World Bank, 2012a).

Figure 3: National Gini Coefficients by Country – 2006



Source: Graph created by author using data from the World Bank (2012a)

2.2.2 Community-Level Income Inequality in Rural Areas

Rural community income inequality levels are most relevant to this study on household livelihood strategies and income inequality in Mali. Some have argued that in Africa, rural communities are generally "poor but equal" (Haggblade & Hazell, 1988). In addition, evidence from certain household surveys supports this statement. For example, a study of several rural communities in Burkina Faso calculated Gini coefficients ranging from 0.25-0.34, which suggests relative equality within these rural communities (Reardon et al., 1992). Using the 2006/07 round of income data from the same data set analyzed for this thesis, Samake et al. (2008) reported Gini coefficients of 0.36 and 0.30 for Tominian and Koutiala, respectively.

2.2.3 The Relationship between Income Sources and Community-Level Inequality

Many studies have examined the relationship between income from certain activities (agriculture, livestock, nonfarm, and migration remittances) and community-level income inequality levels. In this next section, literature relating to this topic is reviewed.

2.2.3.1 Crop Income

By using the rural growth linkage approach discussed earlier, some have argued that if agricultural income improvements are focused on smaller/poorer farmers, agricultural activities can be inequality decreasing for the community (see, for example, Haggblade & Hazell, 1988). The assumption behind this argument is that smaller farmers are more likely to spend their money locally, creating positive production and consumption linkages in the community. These local linkages will create additional nonfarm opportunities for the rural poor and will reduce income inequality levels. The argument also states that if increases in agricultural income are focused on larger farms, community-level inequality will increase. This is due to the fact that

larger farmers will likely demand higher-priced inputs and consumer products that are not produced locally in the community. As a result, the local income multiplier effect will be smaller.

Other researchers who have examined the effect of agricultural incomes on income inequality levels have focused on cash crops. Most of these researchers argued that cash crops are income inequality increasing. For example, a study of Pakistani households found that income from sugar cane, a major cash crop in that country, contributed to income inequality (Adams & He, 1995). In addition, Maxwell and Fernando (1989) argued that cash crops are generally income inequality increasing for several reasons. First, early adopters tend to be from favored groups (e.g. larger farmers, men), and as a result of being early adopters, these groups tend to financially benefit more in the short-run compared to late-adopters. Second, they argue that government policies promoting cash crops tend to benefit larger farmers, augmenting inequality. Finally, Maxwell and Fernando state that a focus on cash crops may lead to land tenure issues within a country. For example, if a household loses access to some or all of its land as a result of a national policy to increase cash crop production, this can be inequality increasing.

In general, studies have found that land access is an important factor when it comes to whether agricultural activities are inequality increasing or decreasing. For example, studies from both Pakistan and Egypt, where land ownership is highly unequal, found that cropping income contributed a sizable share of overall income inequality (35-45%) in both countries (Adams & He, 1995; Adams, 2002). On the other hand, a study of households in three zones of Burkina Faso, where land distribution is relatively equal, found that crop income was inequality decreasing (Reardon & Taylor, 1996). Since land distribution in Mali is likely to be similar to that found in Burkina Faso, I hypothesize that this thesis will find crop income to be inequality decreasing.

2.2.3.2 Nonfarm Income

The relationship between the share of total household income earned from nonfarm activities and total wealth has been found to vary depending on the region of the world. In Latin America and Asia, this relationship is often found to be negative and linear, or U-shaped. In these areas, high labor-capital ratio jobs with low entry barriers are widely available providing the poor with easy access to nonfarm activities. In addition, these areas often have a high number of poor, landless households due to highly unequal land distribution. Since agriculture opportunities are limited for these households, they move into nonfarm activities while wealthier households with land access remain in agriculture. Other characteristics of these regions are that they generally have a strong agricultural sector, high population density, easy market access, and good infrastructure (Reardon et al., 2000).

Unlike Latin America and some parts of Asia, the relationship between the share of household income earned from nonfarm activities and total wealth has been found to be positive and linear in much of Africa. Relatively equal land distribution is common in much of Africa so there are few landless households. In addition, these areas usually only have limited nonfarm employment opportunities with low entry barriers in which poor households can participate. As a result, the poor generally remain in agriculture while the wealthy overcome nonfarm entry barriers and diversify into high-return, nonfarm activities (Reardon et al., 2000).

In their literature review of research from Africa, Latin America, and Asia, Reardon et al. (2000a) argue that there is an important relationship between land access and nonfarm income activities. In particular, they state that "inequality in access to scarce land translates into inequality in non-farm employment opportunities because agricultural cash incomes, use of land as collateral for credit, and the confounding of land wealth and political pull are all determinants

of non-farm business starts" (p. 282). However, land can only be a useful source of collateral if active land markets exist, social norms allow for foreclosure of land, and formal lending sources are available; in Africa, this is often not the case (Atwood, 1990). This is confirmed by evidence from Kenya, where land registration programs have been implemented, yet land is not generally used for collateral (Cotula, Toulmin, & Hess, 2004). No literature on Mali was identified that found land being used as collateral for credit.

Other authors who have tried to determine whether nonfarm income has an inequality increasing or decreasing effect have broken down the nonfarm income categories into more specific sub-categories. For example, Adams and He (1995) found that income from government employment was inequality increasing while income from unskilled labor employment was inequality decreasing. They also concluded that the relationship between self-employment activities and income inequality was unclear. Adams and He state that the higher costs involved with entering government employment cause this activity category to be income inequality increasing while the other categories are not.

2.2.3.3 Livestock Income

Another source of income that might influence community inequality levels is livestock income, although the results from previous studies have been mixed. In Adams and He's study of Pakistani households (1995) and Adams' study of Egyptian households (2002), livestock income was found to have a small income inequality decreasing effect. Reardon and Taylor (1996) found in Burkina Faso that livestock income increased inequality slightly in the Sahelian zone and decreased it slightly in the Guinean zone. A common finding across all of these studies is that livestock income has a very minimal effect on income inequality when compared to other

income sources because 1) livestock income generally makes up a very small share of total income and 2) the correlation between livestock income and total income is small.

2.2.3.4 Migration Remittance Income

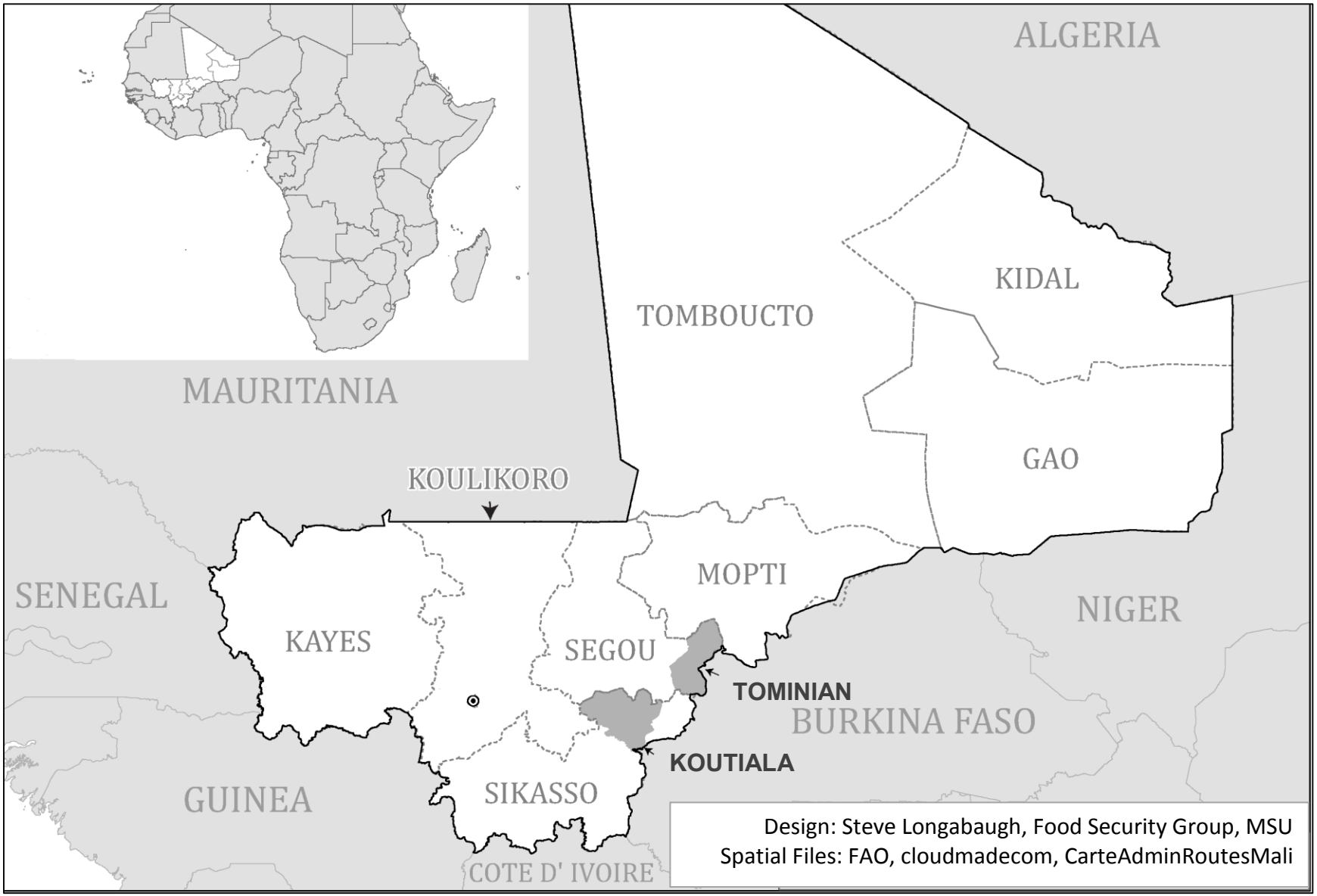
The relationship between migration remittances and income inequality levels has been examined in several previous studies. The Adams and He study (1995) found that internal migration remittances were important to poor households and had an income inequality decreasing effect. However, this study also found that international migration remittances had an income inequality increasing effect. This is due to the fact that international travel, as well as visa applications, is very expensive in Pakistan and therefore, poorer households were less able to find the resources to migrate internationally. Results on the inequality effects of migration remittances in West Africa have been mixed. Reardon and Taylor (1996) reported that remittances had a slight inequality increasing effect on communities. On the other hand, a study in Mali found that international remittances were inequality decreasing (Gubert, Lassourd, & Mesple-Somps, 2010).

3. DATA AND INCOME DEFINITIONS

This analysis used household survey data that was collected in two rainfed agricultural zones of Mali (*Cercle*[1] of Tominian in the Ségou *région* and *Cercle* of Koutiala in the Sikasso *région*) during the 2006/07, 2008/09, and 2009/10 growing seasons. The first year of the survey was funded by the World Bank under its RuralStruc program and was conducted by a consortium formed by IER (*Institut d'Economie Rurale du Mali*), CIRAD (*Centre de Coopération Internationale en Recherche Agronomique pour le Développement)*, and Michigan State University. The purpose of the World Bank's RuralStruc program was to study how seven countries throughout the world (Kenya, Madagascar, Mali, Morocco, Mexico, Nicaragua, and Senegal) responded to recent economic integration and liberalization policies. After the RuralStruc survey was completed in 2006/07, Michigan State University and IER received funding through USAID (US Agency of International Development) and the Bill and Melinda Gates Foundation to follow-up with the same households during the 2008/09 and 2009/10 growing seasons to create a three-year panel data set. The household survey covered numerous topics including household demographics and assets, crop production and sales, livestock income and changes in stock levels, cereal consumption, perceptions of well-being and food security, and nonfarm income.

[1] *Cercle* is a local administrative unit in Mali that is smaller than region. The country of Mali is broken down into 8 *régions* and 49 *cercles*.

Figure 4: Map of the *Cercle* of Tominian in the Ségou *Région* and *Cercle* of Koutiala in the Sikasso *Région*



While both zones selected for this study are rural and are based on rainfed agricultural systems, the Koutiala and Tominian zones differ geographically and economically in several ways. Tominian is located within a traditional coarse grain production zone that has received very limited public investment. The area has faced several severe droughts in the past which is believed to have encouraged some income diversification (such as internal migration) although incomes are still primarily focused on subsistence agriculture (Samake et al., 2008). Important crops produced in the zone include millet, sorghum, peanuts, cowpeas, and fonio[2]. Rainfall averages in the zone are approximately 600-900 mm/year (Murekezi, 2012), placing the zone on the border of the Sudanian and Sahelo-Sudanian agroclimatic zones.

In contrast, the zone of Koutiala is located within Mali's traditional cotton basin and has benefited from extensive public investments (e.g., road infrastructure, agricultural research and extension, farmer literacy training, and cotton ginning capacity). These investments have benefited both cotton and coarse grain production in the Koutiala zone. In addition, the state-owned cotton company (*Compagnie malienne pour le développment des textiles (CMDT)*) has provided cotton farmers with input credit and a guaranteed market. Although this zone has historically done well, low cotton prices and management problems within the CMDT have caused the zone to struggle since 2005 (Samake et al., 2008). Rainfall in the zone is slightly higher than in the Tominian zone (averaging 750-1000 mm/year), placing it in the Sudanian agroclimatic zone (Murekezi, 2012).

The differences in the infrastructure and public investment levels found in these two zones can be partially explained by historic differences in agricultural policies for the cotton and coarse grain industries in Mali. In Koutiala, policies relating to the Malian cotton industry have

[2] Fonio is an annual herbaceous plant that is traditionally grown in West Africa as a cereal (CIRAD, 2012).

greatly impacted the zone. The beginning of many policies relating to the Malian cotton industry can be traced back to the French colonial era. In 1949, France created a cotton monopoly in Mali called the *Compaigne Francaise pour le Developpement des Textiles (CFDT)*. The purpose of this monopoly was to serve as the single buyer of cotton in Mali and ensure that France had easy access to cotton. In 1974 during Mali's post independence era, the CFDT was transformed into the public CMDT (*Compagnie malienne pour le developpement des textiles*) which still exists in Mali today. In more recent years, the CMDT has served as the primary provider of inputs for cotton farmers and the sole purchaser of their cotton production. The CMDT also assisted in the creation of local cotton farmer associations to assist in the distribution of inputs and credit, as well as serving as a vehicle for cotton farmers to organize and defend their rights. Finally, the CMDT has been very active in the economic development of cotton producing areas, through the construction of roads, wells, health centers, schools and through programs such as adult literacy programs (Smale, Diakité, & Keita, 2011).

In contrast, the historical policies for coarse grains, which would greatly impact households in the Tominian zone, have followed a considerably different path from that of the cotton industry despite similar beginnings. In 1964, the government created an official, public, grain marketing agency in Mali called the *Office Malien des Produits Agricoles* (OPAM). Similar to the CMDT for cotton, OPAM was developed to act as a monopoly for grains in Mali. However unlike the CMDT, only 15% of Mali's marketed coarse grains were sold through OPAM and only 3-6 percent of Mali's national coarse grain production ever went through OPAM (Dembélé & Staatz, 2002). In addition to the OPAM, the government created a state rural development program called the *Opérations de développement rural* to assist farmers with improving crop production and marketing. This institution also served as assembly agents

collecting and purchasing coarse grains for OPAM. Due to several difficulties within the industry, the Malian government agreed to start the liberalization process of OPAM Mali in 1981 in exchange for food aid from several international donors. OPAM's monopoly was eliminated and the sector was privatized. Since privatization, course-grain farmers have struggled with reduced access to inputs and new technologies (Staatz, Dioné, & Dembélé, 1989). For example, adoption of new seed varieties has been low and farmers have used only limited amounts of mineral fertilizer (Smale, Diakité, & Keita, 2011).

Another Malian government program, Operation Riz-Segou, which promotes rice production using controlled flooding techniques has also operated in the Tominian zone for many years (Steedman et al., 1976) although there is no indication that the villages included in this study ever produced any significant quantities of rice or were impacted by this program.

Given the different cropping systems and related government policies affecting the Tominian and Koutiala zones, it is hypothesized that the income portfolios of households in each zone will be different. In particular, one might expect that household incomes will be more diversified in the Tominian zone than in Koutiala, with a greater percentage of total income coming from non-cropping activities. In addition, it is hypothesized that total income levels will be higher in Koutiala than in Tominian given the higher levels of public investments, importance of the cotton sector, and better access to agricultural inputs in the Koutiala zone.

Within the Koutiala and Tominian zones, the villages included in the household survey were selected based on certain characteristics (Figure 5). In the Tominian zone, it was thought that households with better market access may be able to cope with the zone's difficult climate and low levels of public investment better than other households. To test this theory, three villages with easy market access and three villages with poor market access were selected to be

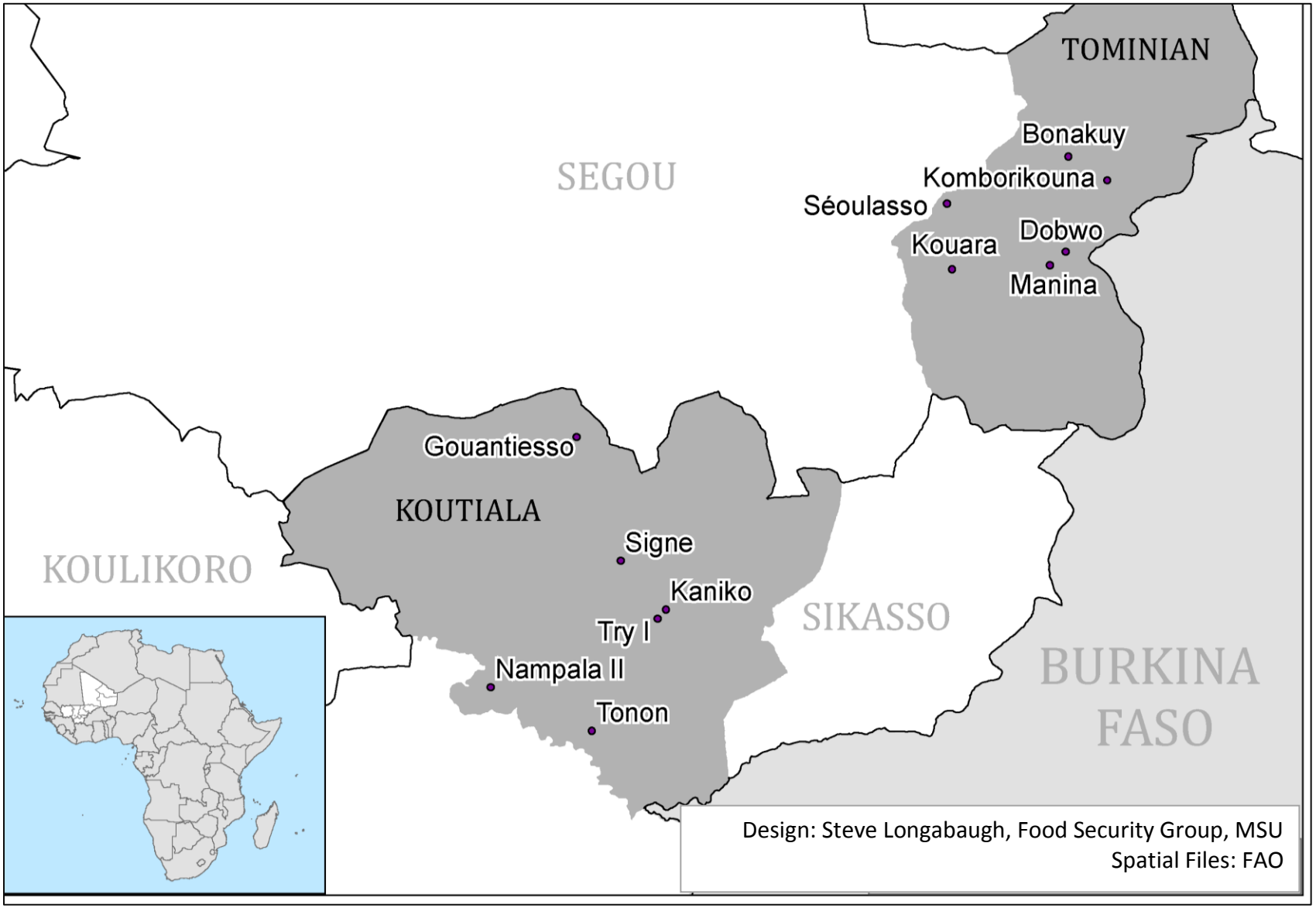
included in the survey. Easy market access was defined as having either 1) access to a good road, 2) a weekly market in the village, or 3) easy access to a neighboring village's market. In the Koutiala zone, the selection of villages was based on market access and land access. Land access was taken into account because it was believed to be a growing constraint for some parts of the zone. To test the latter hypothesis, six villages were selected on a combination of market and land access criteria as follows:

Table 1: Number of Villages in Each Village Selection Criteria Category for the Koutiala Zone

		Land Access	
		Average	**Difficult**
Market Access	**Easy**	1	2
	Difficult	2	1

Source: Samake et al., 2008

Figure 5: Map of Surveyed Villages in Tominian and Koutiala



Limited land availability was defined as having no additional land that could be cleared for agriculture and limited quantities of land in fallow. However, an analysis of the 2006/07 survey data showed that land access did not differ significantly across the villages selected, so only the market access criterion was used in the present study (Samake et al., 2008).

Once the villages were selected, researchers constructed a list of family farms in each village with assistance from each village's head, taking care to include family farms from all sections – geographical and social – found in the village. Once this list was created, 25-30 family farmers were randomly drawn from each village's list to be surveyed (Samake et al., 2008).

The survey was conducted slightly differently during the three years of the study. During the first year (2006/07), the household head was the primary person interviewed. The survey also required at least one woman to respond to questions about women's incomes for a separate questionnaire. Finally, married men who headed smaller nuclear households within the larger farm unit were also interviewed. During the 2008/09 survey year, the data collection changed slightly and only the household head was interviewed. Given the large size of families and the yearlong recall of income, there is evidence that perhaps only interviewing the household head led to the under-reporting of household incomes. In addition, there was concern about respondent fatigue due to the long nature of the survey. As a result, the third year of the survey (2009/10) was changed in several major ways. First, the survey was split into two separate interviews with the first interview covering primarily information relating to agricultural production during the rainy season, and the second interview covering livestock income, nonfarm income, and agricultural production during the dry season. In addition, during the third round, efforts were made to interview all household members who earned nonfarm income and all respondents were

asked to recall incomes earned during both the 2009/10 and 2008/09 years to compensate for the under-reporting of income during the second round of the survey.

The strengths of this household survey are (1) that a relatively large number of households in several different zones were interviewed, and (2) that the survey questionnaires covered a wide range of topics (household demographics and assets, crop production and sales, livestock income and changes in stock levels, cereal consumption, and nonfarm income), which allows for the development of econometric models that cannot be constructed with smaller data sets. A weakness of the survey data is that the one-year recall of earned income and the interviewing of only certain household members each year may have led to the under-reporting of income. A second weakness is that much of the income data was collected at the household level and therefore total individual income levels could not be determined. This prevented any major analysis of the gender component of total income within households. For a brief analysis of certain types of women's incomes using data from this household survey, please refer to "Nonfarm Income in the Tominian, Macina, and Koutiala Zones of Mali" by Lazarus and Kelly (2012). Finally, a third weakness of the survey is that it does not include significant information on household expenditures.

It has been argued that given the difficult nature of collecting income data in developing countries and since large variations are typically from year to year with income data, expenditure data can more effectively represent a household's long-term income potential than a direct income measure can (McGlinchy, 2006). However, using expenditure data as a proxy for income has its own limitations. First, expenditure data can only be used to measure total income levels. It cannot be used for detailed analyses of individual income sources. In addition, it requires intensive data collection, such as weekly or monthly interviews with households, which can be

expensive. Since an analysis of individual income sources is an important component of this paper, the lack of expenditure data is not a major problem.

During the 2006/07 cropping year, 151 family farms (or extended household units) were surveyed in Tominian and 153 family farms were surveyed in Koutiala. Attrition rates for the following years were low. During the 2008/09 year, 149 farms were interviewed in Tominian and 150 were interviewed in Koutiala. Finally, during the 2009/10 year, 151 farms were surveyed in Tominian and 150 farms were surveyed in Koutiala.

3.1 Definition of Household

One should note that unlike in the United States, the extended family farm unit in Mali is generally made up of several smaller, nuclear household units that share in the responsibilities of the family farm under the direction of the extended household head. The multiple, nuclear households join together and work as one unit in cropping activities and share the same residency, food produced on collective fields, and some of the farm's income and assets. However, these smaller households are also semi-autonomous in that the members of the smaller household units can also pursue their own income-earning activities and consumption strategies separate from the larger farm (Samake et al., 2008). When the term "household" is used in this thesis, it is in reference to the family farm, unless it is otherwise specified.

3.2 Definitions of Income and Income Categories

As noted in Chapter 1, most economists believe that in the context of developing countries, household income should include both cash and in-kind, non-monetary income. Non-monetary income should be included because in many cases, household production is intended

for home consumption and never enters the market (Ellis, 2000a). In this paper, all efforts were made to take into account both cash and non-cash forms of income—the latter including crop, livestock, and non-agricultural production that was consumed by the household, as well as changes in animal stocks. Net crop income was calculated as the sum of total crop sales plus the value of any unsold production (valued at the average sale price received by the household for sold production or if the household did not sell the crop, the average sale price at the village level) minus the costs of production (including both cash and in-kind inputs but excluding family labor costs). For livestock income, net household income was calculated as the sum of total livestock and livestock product sales plus the value of changes in stocks (resulting from livestock consumption, births, deaths, gifts, etc. and valued used village or zone livestock prices). Finally nonfarm income was calculated by taking gross nonfarm income and subtracting any input costs. Given the limitations of the survey and issues relating to missing sale, revenue, and input cost data, the net incomes used in this report are only rough approximations in some cases.

Once the household survey data was collected, incomes were categorized into six household income categories: cash crops, food crops, livestock, other agricultural activities, other nonfarm activities, and transfers. Detailed definitions of these categories can be found in Table 2. Data on income from land and capital rentals was not collected for all rounds of the survey, and therefore was excluded from this analysis. Since previous studies have found that the income from land rentals made up a small and unimportant share of total income in the zones of Tominian and Koutiala (Abdulai & CroleRees, 2001; Samake et al., 2008), it was assumed that the results of this analysis are unlikely to be significantly different if information on these income sources had been included.

Table 2: Income Category Definitions

Income Category	Definition
Cash Crops	Net income from cotton, peanuts, and fonio
Food Crops	Net income from all crops except cotton, peanuts, fonio. Income from tree crops was included.[3]
Livestock	Net income (including the valuation of changes in stocks and home consumption) from the purchase and sale of animals and animal products, including eggs, milk, hides, and leather.
Agricultural Wages	Income earned from agricultural wage work on other farms, as well as income from agricultural machinery rentals and custom hire.
Non-Agricultural Wages	Wage income earned from non-agricultural activities
Other Nonfarm Activities	Net income from the transformation of agricultural products, forestry and other primary sector activities, artisan and commerce activities, and self-employment. Income from shea nuts and butter was included in this category.
Transfers	Income from public and private transfers including food aid, gifts, and short/long term migration remittances

3.3 Basic Characteristics of the Surveyed Households

Basic descriptive statistics of household demographics provide information about the typical household interviewed for this study. As Table 3 shows, the average farm size ranged from 6.71 ha in Tominian to 13.8 ha in Koutiala. Farm size per capita was also larger in the Koutiala zone than in the Tominian zone (0.99 ha/capita versus 0.69 ha/capita, respectively). Household size also varied across zones with an average of 12 persons per household in Tominian and 15 in Koutiala. Ninety-nine percent of household heads were male in both zones. The average age of a household head was 54 in Koutiala and 56 in Tominian. Household heads

[3] In regions of Mali with irrigation agriculture, such as the Office du Niger, onions are an important cash crop. However, very few households reported income from onions in the Tominian and Koutiala zones, and the reported incomes from onion production by households who grew this crop were very low. As a result, this study assumes that onions are grown primarily as a food crop in Tominian and Koutiala zones. Therefore, this income source has been placed in the food crop category.

reported very limited education levels: only 24% of household heads in Tominian and 15% of heads in Koutiala had attended at least one year of school. Finally, the majority of households in Koutiala were net sellers of cereals (61%) while only 10% were net sellers in Tominian. The null hypothesis that the two zones' means were the same was tested for all variables that were not dummy variables, and in all cases, t-tests indicate that the null hypothesis could be rejected at the 5% significance level or better.

Table 3: Descriptive Statistics on Household Demographical Information

	Tominian			Koutiala			Significance of T-Test[2]
	Mean	**Stand. Dev.**	**% of Total**	**Mean**	**Stand. Dev.**	**% of Total**	
Household Head Attended at Least One Year of Formal Schooling[1]	-	-	24	-	-	15	-
Total Number of Present Household Members	11.73	6.70	-	15.42	7.60	-	0.000
Age of Household Head	56.04	15.19	-	54.17	13.38	-	0.050
Household Was a Net Seller of Cereals[1]	-	-	10	-	-	61	-
Farm Land Owned (Ha)	6.71	5.09	-	13.80	9.27	-	0.000
Farm Land Owned Per Capita (Ha)	0.69	0.58		0.99	0.70		0.000
Household Head is Female[1]	-	-	1	-	-	1	
Dependency Ratio[3]	1.02	0.62	-	1.19	0.65	-	0.000
Number of Smaller, Nuclear Households Living on the Farm	2.31	1.21	-	2.15	1.07	-	0.034

Source: Survey data

[1]Represents a dummy variable

[2]Null hypothesis for T-test: Tominian and Koutiala's means are the same

[3]The dependency ratio is defined as the ratio of the number of present inactive household members (such as children or the elderly) to the number of present active household members.

3.4 External Events in the Koutiala and Tominian Zones that may have Impacted Household Income Portfolios

To better understand household livelihood practices in Koutiala and Tominian during the 2006/07, 2008/09, and 2009/10 cropping years, one must understand external events having occurred during these three cropping years that may have impacted household incomes in each zone. In the Tominian zone, rainfall levels were low during the 2009/10 cropping year (452 mm of precipitation in 2009/10 compared to a range of 557-732 mm of annual precipitation during the 2006 to 2009 years. In addition, the global food crisis that began in 2007 and continued into 2008 led to higher cereal prices in the zone. Since most households in this zone are net cereal purchasers, these high cereal prices likely put pressure on households to acquire more cash income to cover consumption needs. Finally, farmers in this zone generally did not receive support from government programs to purchase agricultural inputs during these three years (Lazarus & Kelly, 2012).

In the Koutiala zone, several issues relating to the cotton sector may have impacted household incomes during the survey period. First, there were concerns that the national cotton company, CDMT, might be privatized although no official efforts towards privatization were made. In addition, farmers received payment for their 2007 cotton production several months late (November 2008), which was well after the 2008 cotton planting season had begun in June 2008. This angered farmers and lead to a boycott of cotton production in the zone (Lazarus & Kelly, 2012). This boycott can be seen in the data set used for this paper. Between the 2006/07 and 2008/09 cropping years, the number of cotton producing households dropped 44% (Murekezi, 2012). Finally, subsidized fertilizer was made available to cotton and maize farmers in the Koutiala zone during the 2009/10 cropping year (Lazarus & Kelly, 2012).

4. HOUSEHOLD INCOME PROFILES FOR TOMINIAN AND KOUTIALA

4.1 Methodology

In order to better understand the income levels and sources reported by households in Koutiala and Tominian during the 2006/07, 2008/09, and 2009/10 cropping seasons, a descriptive analysis was performed. For this analysis, average per capita income levels were compared across the two zones as well as across the three years of data. T-tests and F-tests were used to determine whether incomes are similar across the zones and years. To take into account inflation, the nominal 2006/07 and 2008/09 incomes were adjusted to real income (based on 2010 Franc CFA) using GDP deflators for Mali, as reported by the World Bank.

Income levels, participation levels, and the share of income earned from various income categories (cash crops, food crops, livestock, agricultural wages, non-agricultural wages, transfers, and other nonfarm activities) were also examined for all three cropping seasons. For the 2006/07 season, the costs of production were not disaggregated by crop in the survey questionnaire so net incomes from cash and food crops could not be separated. Therefore, the analysis was performed on total crop income for all three years. To better understand how income activities differ between the poor and non-poor households, the share of total income earned from each income category was also analyzed across income and landholding quartiles, as well as between households living below and above the $1/day poverty line. The determination of households living above and below the $1/day/capita poverty line was made by converting household incomes (reported in Franc CFA) into international dollars using a purchasing price parity approach. A detailed explanation of this methodology can be found in Appendix A.

4.2 Average Total per Capita Income Levels

During the 2006/07, 2008/09, and 2009/10 cropping seasons, average annual real per capita incomes ranged from 35,932 to 52,379 Franc CFA in Tominian and from 77,023 to 84,881 Franc CFA in Koutiala. As shown in Table 4 by the 5%, 25%, 75%, and 95% percentile columns, the difference in income levels between high income earners and low income earners was relatively large. In addition, the median income levels were consistently lower than the mean values, suggesting that the inclusion of a few households with very high incomes increased the mean income values.

Both mean and median incomes declined across the three periods of data for Tominian. This finding is confirmed by an F-test that rejected the null hypothesis that incomes in Tominian were stable across all three years of survey data. In Koutiala, the median income levels also decline over the three survey rounds although mean incomes levels do not show this pattern. An F-test on this zone could not reject the null hypothesis that income levels were stable across the three survey years.

Table 4: Total per Capita Household Income by Zone and Year

Zone	*Year*	*Mean*	*5th percentile*	*25th percentile*	*Median*	*75th percentile*	*95th percentile*	*Signif.**
		(real FCFA/capita using 2010 as the base year)						
Tominian	'06/07	52,379	9,993	25,778	42,476	62,171	114,078	0.005
	'08/09	51,922	9,655	24,290	38,026	67,551	133,316	
	'09/10	35,932	7,742	15,586	24,625	43,269	97,453	
Koutiala	'06/07	84,881	20,816	51,878	74,135	110,711	169,103	0.771
	'08/09	77,023	21,327	45,200	68,207	94,826	160,158	
	'09/10	81,267	21,817	45,573	59,970	85,873	149,942	

Source: Survey data

*Probability that null hypothesis could be rejected (significance column) was determined by running an F-test through SPSS' one-way Anova command to compare annual mean values in each zone.

4.3 Household Income by Source

To better understand household income portfolios and livelihood strategies for the 2006/07, 2008/09 and 2009/10 cropping seasons, individual income sources (cash crops, food crops, cash and food crops combined, livestock, agricultural wages, non-agricultural wages, transfers, and other nonfarm activities)[4] were also examined. Table 5 shows average real per capita income by source in Tominian and Koutiala amongst all surveyed households (including households that reported zero income for a particular category). By studying average income amongst all surveyed households, we gain an understanding of the importance of various income sources at the community/zone level. The analysis of all surveyed households showed that across the two zones, households in Koutiala consistently earned on average higher incomes than households in Tominian in almost all income categories. These regional differences were found to be statistically significant at the 5% level during one or more cropping seasons for cash crops, food crops, livestock income, agricultural wages, and other nonfarm activities. The only income category where Tominian households consistently earned more than households in Koutiala was non-agricultural wages. This finding was statistically significant at the 5% level for the 2008/09 cropping season (Appendix C).

[4] 2006/07 household income from cropping activities could not be disaggregated into income from cash and food crops. As a result, crop income for this survey year is presented in the category "cash and food crops combined."

Table 5: Average per Capita Income Levels by Income Source among all Surveyed Households

	Tominian			**Koutiala**		
	06/07	**08/09**	**09/10**	**06/07**	**08/09**	**09/10**
	(FCFA/capita)*					
Cash Crops		7,740	5,154		12,798	12,539
Food Crops		20,985	16,637		42,924	37,714
Cash and Food Combined	30,856	28,725	21,792	60,485	55,723	50,254
Livestock	-386	3,306	2,210	9,471	6,103	4,864
Ag Wages	213	1,753	156	575	572	789
Non-Ag Wages	1,065	4,288	2,496	660	1,625	1,035
Transfers	9,123	6,162	4,194	2,052	3,538	14,507
Other Nonfarm	11,512	7,688	5,084	11,645	9,462	10,257

Source: Survey data
*Reported in real values using 2010 as the base year.

An analysis of the 2008/09 and 2009/10 cropping years showed that food crops were the most important source of income in both zones, with average incomes from this source ranging from 16,637-20,985 Franc CFA in Tominian to 37,714-42,924 Franc CFA in Koutiala. In addition, the large difference in total per capita income mentioned earlier between Koutiala and Tominian appeared to be primarily due to differences in income earned from food crops.

Average per capita income earned from cash crops was considerably lower than income earned from food crops and ranged from 7,740 Franc CFA in 2008/09 to 5,154 Franc CFA in 2009/10 for Tominian and 12,798 in 2008/09 to 12,539 Franc CFA in 2009/10 for Koutiala. In addition, the difference in income levels between the two zones was found to be less large for cash crops compared to food crops (ranging from 5,058-7,385 for cash crops versus 21,077-21,939 for food crops, depending on the year). This suggests that, for the survey years, cotton income in Koutiala does not, on its own, account for the large income differences between Tominian and Koutiala.

F-tests and t-tests were also performed to determine whether per capita income levels, including all surveyed households, were relatively stable or unstable across the three survey years (Appendix B). For the two years where cropping income could be separated into cash and food crop incomes (2008/09 and 2009/10), t-tests indicated that the null hypothesis that incomes during the two years were the same could be rejected for cash crop income in Tominian. However, the null hypothesis could not be rejected for food crops in both zones and cash crop income in Koutiala. When cash and food crop incomes were combined and data from all three crop seasons were included, f-tests showed that the null hypothesis that the cropping incomes were stable could be rejected at the 5% level for both zones. Finally, F-tests showed that this null hypothesis could be rejected for livestock income, non-agricultural wage income, and other

nonfarm income for the Tominian zone. In the Koutiala zone, F-tests failed to reject this null hypothesis for all non-cropping income sources.

The income level data was also analyzed including only households that participated in each income activity (Table 6). This analysis showed the importance of each income source for those households that participate in the activity. As one would expect, when households reporting zero income from a given income source were removed, the mean income levels increase for almost all income activities, cropping seasons, and zones. The only exception is for food crops were average incomes remain unchanged because all surveyed households reported income from this activity.

After removing the households reporting zero income, non-agricultural wage income is still found to be higher in the Tominian zone compared to the Koutiala zone while income from cash crops, food crops, and livestock were found to be consistently higher in the Koutiala zone. Results for agricultural wage, other nonfarm, and transfer income do not show that incomes from these three sources were consistently higher in one zone during all three years cropping seasons.

Table 6: Average per Capita Income Levels for only Households that Participated in a Given Activity

	Tominian			Koutiala		
	06/07	**08/09**	**09/10**	**06/07**	**08/09**	**09/10**
	(FCFA/capita)*					
Cash Crops		9,399	6,380		16,693	14,386
Food Crops		21,123	16,637		42,924	37,714
Cash and Food Combined	30,856	28,914	21,792	60,485	55,723	50,254
Livestock	-503	3,747	2,567	9,925	6,270	5,216
Ag Wages	5,473	12,191	840	2,254	1,996	2,247
Non-Ag Wages	32,803	29,823	26,922	16,838	10,599	8,506
Transfers	16,528	8,729	5,864	4,617	5,769	20,448
Other Nonfarm	13,637	12,126	9,842	12,459	11,634	12,341

Source: Survey data

*Reported in real values using 2010 as the base year

Table 7 presents household participation levels for each income source. Since the household survey was focused on rural agricultural households, it is not surprising to find that almost all surveyed households in both zones grew food crops. In addition, the majority of households earned incomes from cash crops, livestock, transfers, and other nonfarm activities during most or all years of the survey. Agricultural and non-agricultural wage work had the lowest participation rates. Given the low average per capita income levels reported by households participating in agricultural wage activities, it is not surprising that participation rates for this activity were found to be low. However, those households that participated in non-agricultural wage work generally reported high income levels so the low participation rates suggest that entry barriers are preventing some households from participating in this lucrative income source.

Table 7: Activity Participation Rates

	Tominian			**Koutiala**		
	06/07	**08/09**	**09/10**	**06/07**	**08/09**	**09/10**
Cash Crops	-	82%	81%	-	77%	87%
Food Crops	-	99%	100%	-	100%	100%
Cash and Food Combined	100%	100%	100%	100%	100%	100%
Livestock	77%	88%	86%	95%	97%	93%
Ag Wages	4%	14%	19%	25%	29%	35%
Non-Ag Wages	3%	14%	9%	4%	15%	12%
Transfers	55%	71%	72%	44%	61%	71%
Other Nonfarm	84%	63%	52%	93%	81%	83%

Source: Survey data

Table 8 shows the average share of total household income earned from various income activities during the three cropping seasons. This analysis showed that food crop income made up the majority of household income for both the Tominian and Koutiala zones, confirming the findings discussed earlier. Other smaller but notable income sources include cash crops, transfers,

and other nonfarm activities. F-tests showed that the null hypothesis that the share of total income earned from each income activity was the same across the three cropping seasons could not be rejected at the 5% level for any income source or zone except for transfer income for Koutiala and other nonfarm income in Tominian (Appendix D). However, t-tests comparing income levels across zones showed that Tominian households earned a statistically significant higher share of their total income from transfers all three years and higher income from other nonfarm activities in 2006/07. Households in Koutiala, on the other hand, earned statistically significantly higher share of their income from food crops in 2008/09 (Appendix E).

Given the focus on cotton in the Koutiala zone, one might have expected to find cash crops representing a larger share of total income than is shown by this analysis. In fact for 2008/09 and 2009/10, if all off-farm income sources (agricultural wages, non-agricultural wages, transfers, and other nonfarm) were combined into one larger off-farm income category, this analysis showed that the average share of total income earned from off-farm activities was actually higher than the share of total income earned from cash crops in both zones. However, this finding may be due to the 2008 cotton boycott in Koutiala and may not hold true during a typical production year. Since the crop income from 2006/07 could not be disaggregated into separate cash and food crop income categories, it is difficult to say what percentage of household income came from cash crops during this year prior to the cotton boycott.

Table 8: Average Share of Household Income by Source

	Tominian			Koutiala		
	2006/07	**2008/09**	**2009/10**	**2006/07**	**2008/09**	**2009/10**
Cash Crops	-	15%	14%	-	14%	16%
Food Crops	-	49%	53%	-	59%	57%
Cash and Food Crops Combined	62%	64%	67%	73%	73%	73%
Livestock	0%	4%	2%	8%	6%	5%
Ag Wages	0%	1%	1%	1%	1%	1%
Non-Ag Wages	1%	4%	3%	1%	2%	1%
Transfers	16%	12%	13%	2%	5%	6%
Other Nonfarm	21%	15%	13%	15%	13%	14%

Source: Survey Data

4.4 Distribution of Income Across Household Types

4.4.1 Distribution of Income across Income Quartiles

Tables 9, 10, and 11 show that in Tominian, households in higher income quartiles generally earned a lower share of their total income from food crops and a higher share of their total income from non-agricultural wage activities. These tables also show that in the Koutiala zone, higher income earners generally received a higher share of total income from cash crop (most likely cotton) and livestock activities, and a lower share from agricultural wages. These results were all confirmed to be statistically significant at the 10% level or better using F-tests for at least two out of the three years of survey data.

Table 9: Average Share of Household Income by Source and Income Quartile (2006/07 Cropping Season)

	Tominian					Koutiala				
Quartile	**1st**	**2nd**	**3rd**	**4th**	**Signif ***	**1st**	**2nd**	**3rd**	**4th**	**Signif ***
Crops	70%	63%	63%	52%	0.785	77%	73%	75%	68%	0.738
Livestock[a]	-5%	-2%	-1%	6%	0.950	-3%	9%	10%	15%	0.114
Ag Wages	0%	1%	1%	0%	0.328	2%	1%	0%	0%	0.045
Non-Ag Wages	0%	1%	0%	4%	0.091	0%	2%	1%	0%	0.327
Transfers	16%	15%	18%	13%	0.881	2%	2%	3%	3%	0.935
Other Nonfarm	19%	22%	19%	24%	0.769	21%	12%	11%	14%	0.077

Source: Survey data

*Probability that null hypothesis could be rejected (indicated by the significance column) was determined by running an F-test through SPSS' one-way Anova command.

[a] In some cases, the average share of household income earned from livestock activities was negative, which signifies that households were making livestock investments.

Table 10: Average Share of Household Income by Source and Income Quartile (2008/09 Cropping Season)

	Tominian					Koutiala				
Quartile	**1st**	**2nd**	**3rd**	**4th**	**Signif ***	**1st**	**2nd**	**3rd**	**4th**	**Signif ***
Cash Crops	14%	14%	20%	12%	0.134	8%	14%	15%	21%	0.059
Food Crops	60%	53%	43%	38%	0.008	67%	59%	55%	55%	0.164
Livestock[a]	-3%	3%	9%	8%	0.280	0%	6%	10%	7%	0.088
Ag Wages	1%	0%	0%	2%	0.455	3%	1%	1%	0%	0.026
Non-Ag Wages	0	1%	2%	14%	0.000	2%	2%	2%	2%	0.999
Transfers	14%	13%	10%	10%	0.669	7%	3%	3%	4%	0.195
Other Nonfarm	15%	15%	16%	16%	0.985	14%	15%	13%	10%	0.645

Source: Survey data

*Probability that null hypothesis could be rejected (indicated by the significance column) was determined by running an F-test through SPSS' one-way Anova command.

[a] In some cases, the average share of household income earned from livestock activities was negative, which signifies that households were making livestock investments.

Table 11: Average Share of Household Income by Source and Income Quartile (2009/10 Cropping Season)

	Tominian					Koutiala				
Quartile	**1st**	**2nd**	**3rd**	**4th**	**Signif ***	**1st**	**2nd**	**3rd**	**4th**	**Signif ***
Cash Crops	11%	15%	13%	17%	0.359	10%	16%	17%	22%	0.014
Food Crops	69%	57%	49%	39%	0.000	63%	62%	60%	42%	0.000
Livestock[a]	-10%	5%	4%	10%	0.004	2%	5%	3%	11%	0.003
Ag Wages	1%	1%	1%	0%	0.243	3%	1%	1%	0%	0.008
Non-Ag Wages	0%	2%	2%	9%	0.011	1%	1%	0%	3%	0.123
Transfers	17%	12%	18%	6%	0.033	8%	3%	6%	5%	0.383
Other Nonfarm	12%	8%	13%	20%	0.064	14%	12%	12%	16%	0.558

Source: Survey data

*Probability that null hypothesis could be rejected (indicated by the significance column) was determined by running an F-test through SPSS' one-way Anova command.

[a] In some cases, the average share of household income earned from livestock activities was negative, which signifies that households were making livestock investments.

4.4.2 Distribution of Income Across Landholding Quartiles

An analysis of the average share of household income earned from various income activities broken down by landholding quartiles (Tables 12, 13, and 14) showed that the share of income earned from agricultural wages declined as landholdings increased (statistically significant at the 10% level in Tominian for the 2006/07 and 2009/10 cropping years and in Koutiala for the 2008/09 cropping year). This may suggest that households with higher landholdings require more labor to farm the additional land and therefore, cannot spare household members to go work on other farms in the community. Another possible explanation of this result is that households with higher landholdings are able to produce more food on-farm

and therefore, do not need household members to work on other farms in order to earn money to cover food production shortfalls. For the 2009/10 cropping year, the share of income from transfers also declined as landholdings increased (statistically significant in Tominian at 0.002 and in Koutiala at 0.009) for likely the same reasons as described above. The share of total income from transfers, which was mostly made up of short-term and long-term remittance income, was found to be higher across all landholding quartiles in Tominian as compared to Koutiala. This may be due partially to stark differences in average farm size between the two zones. For example in 2009/10, farms in Tominian averaged 5.73 ha while farms in Koutiala averaged 14.12 ha.

Table 12: Average Share of Household Income by Source and Land Quartile (2006/07 Cropping Season)

	Tominian					**Koutiala**				
Quartile	**1st**	**2nd**	**3rd**	**4th**	**Signif ***	**1st**	**2nd**	**3rd**	**4th**	**Signif ***
Crops	62%	69%	58%	60%	0.926	66%	85%	72%	70%	0.146
Livestock[a]	-6%	-9%	3%	9%	0.787	11%	-2%	12%	11%	0.200
Ag Wages	2%	0%	0%	0%	0.044	2%	2%	0%	1%	0.175
Non-Ag Wages	0%	0%	3%	2%	0.266	1%	0%	1%	0%	0.729
Transfers	17%	18%	15%	12%	0.760	3%	3%	2%	2%	0.671
Other Nonfarm	25%	22%	20%	17%	0.536	17%	12%	13%	17%	0.556

Source: Survey data

*Probability that null hypothesis could be rejected (indicated by the significance column) was determined by running an F-test through SPSS' one-way Anova command.

[a] In some cases, the average share of household income earned from livestock activities was negative, which signifies that households were making livestock investments.

Table 13: Average Share of Household Income by Source and Land Quartile (2008/09 Cropping Season)

	Tominian					Koutiala				
Quartile	**1st**	**2nd**	**3rd**	**4th**	**Signif ***	**1st**	**2nd**	**3rd**	**4th**	**Signif ***
Cash Crops	12%	16%	17%	16%	0.502	10%	10%	19%	18%	0.120
Food Crops	46%	50%	48%	50%	0.928	64%	59%	59%	54%	0.530
Livestock[a]	3%	2%	7%	5%	0.882	1%	9%	6%	6%	0.338
Ag Wages	0%	2%	0%	1%	0.518	2%	1%	1%	1%	0.097
Non-Ag Wages	2%	7%	2%	6%	0.217	0%	4%	2%	3%	0.216
Transfers	16%	12%	12%	8%	0.327	4%	6%	5%	3%	0.360
Other Nonfarm	21%	13%	14%	14%	0.188	18%	11%	8%	15%	0.049

Source: Survey data

*Probability that null hypothesis could be rejected (indicated by the significance column) was determined by running an F-test through SPSS' one-way Anova command.

[a] In some cases, the average share of household income earned from livestock activities was negative, which signifies that households were making livestock investments.

Table 14: Average Share of Household Income by Source and Landholding Quartile[1] (2009/10 Cropping Season)

	Tominian					Koutiala				
Quartile	**1st**	**2nd**	**3rd**	**4th**	**Signif ***	**1st**	**2nd**	**3rd**	**4th**	**Signif ***
Cash Crops	6%	11%	16%	21%	0.000	11%	16%	18%	19%	0.207
Food Crops	51%	53%	54%	55%	0.951	55%	61%	57%	54%	0.536
Livestock[a]	3%	6%	1%	-1%	0.645	4%	7%	3%	7%	0.264
Ag Wages	2%	0%	1%	0%	0.002	2%	2%	1%	0%	0.175
Non-Ag Wages	3%	1%	4%	5%	0.413	2%	0%	1%	2%	0.462
Transfers	25%	15%	9%	8%	0.002	10%	2%	4%	6%	0.009
Other Nonfarm	9%	14%	16%	12%	0.516	15%	12%	16%	11%	0.352

Source: Survey data

*Probability that null hypothesis could be rejected (indicated by the significance column) was determined by running an F-test through SPSS' one-way Anova command.

[a] In some cases, the average share of household income earned from livestock activities was negative, which signifies that households were making livestock investments.

4.4.3 Distribution of Income Between Households Above and Below the $1/Day/Capita Poverty Line

Tables 15, 16, and 17 show the average share of total income earned from various income sources with households divided by whether they earned over a dollar a day per capita, calculated using a purchasing price parity approach described in Appendix A. While t-tests suggested that for certain income sources during certain years, the percentages were statistically different when comparing households earning above and below the $1 poverty line, there was little consistency in the findings when compared across all three rounds of survey data. Therefore, no major conclusions were drawn from this analysis.

Table 15: Average Share of 2006/07 Income Earned by Source and by Household Poverty Status (2010 International Dollars)

	Less $1/Day	Over $1/Day	Significance (two tailed)
Crops	68%	64%	0.618
Livestock	2%	13%	0.293
Ag Wages	1%	0%	0.238
Non-Ag Wages	1%	1%	0.800
Other Nonfarm	18%	18%	0.970
Transfers	10%	5%	0.080
Total # HH	257	50	

Source: Survey data

Table 16: Average Share of 2008/09 Income Earned by Source and by Household Poverty Status (2010 International Dollars)

	Less $1/Day	Over $1/Day	Significance (two tailed)
Cash Crops	14%	17%	0.426
Food Crops	55%	47%	0.101
Livestock	5%	7%	0.534
Ag Wages	1%	2%	0.290
Non-Ag Wages	3%	7%	0.020
Other Nonfarm	14%	12%	0.482
Transfers	8%	8%	0.941
Total # HH	260	43	

Source: Survey data

Table 17: Average Share of 2009/10 Income Earned by Source and by Household Poverty Status (2010 International Dollars)

	Less $1/Day	Over $1/Day	Significance (two tailed)
Cash Crops	14%	20%	0.086
Food Crops	56%	38%	0.001
Livestock	3%	12%	0.036
Ag Wages	1%	1%	0.508
Non-Ag Wages	2%	2%	0.946
Other Nonfarm	10%	9%	0.880
Transfers	13%	18%	0.150
Total # HH	276	23	

Source: Survey data

4.5 Discussion of the Descriptive Statistics Analysis of Household Income Portfolios in the Tominian and Koutiala Zones

In conclusion, the descriptive statistics presented above relating to the three cropping years studied in this thesis showed that per capita income levels in both the Tominian and Koutiala zones were low and were highly dependent on crop income (particularly food crop income). Despite a strong focus on the cotton sector in Koutiala, income from cash crops was found to be considerably smaller than income from food crops for households in this zone for both survey rounds where cash and food crop incomes could be separated (2008/09 and 2009/10). In addition, cash crop income was only a slightly larger share of total household income than nonfarm income for these two years. This result may be due to the 2008 cotton boycott so further research using data from a typical cropping year is needed to confirm or refute this finding.

Another finding from this analysis is that per capita incomes in Koutiala were about 1.5-2 times larger than per capita incomes in Tominian. In addition, this difference appeared to be primarily due to differences in the levels of food crop income between the two zones. Larger

farm sizes and access to agricultural credit and inputs in Koutiala may partially explain this finding.

These descriptive statistics also showed that wealthier households in Tominian and Koutiala generally had different income portfolios than poorer households. As households in both zones become wealthier, the share of income from food crops generally declined, suggesting that wealthier households were moving away from subsistence agriculture to other income activities. In Koutiala, wealthier households often earned a higher share of their income from cash crops and livestock activities as compared to poorer households. In Tominian, wealthier households tended to earn a larger share of income from non-agricultural wage activities. Despite high income levels for non-agricultural wage activities, participation rates were found to be low for this activity. This suggests that entry barriers were preventing poorer households from participating in this income source. These issues are explored in more detail in the next chapter of this paper.

5 DETERMINANTS OF HOUSEHOLD INCOME

5.1 Methodology

To better understand factors associated with higher levels of household income, an econometric model of household income determinants was developed. For the econometric model section of this thesis, data on household income per capita was combined into three larger categories: cropping income (includes income from both food and cash crop activities), livestock income, and nonfarm income (includes income from agricultural wages, non-agricultural wages, and other nonfarm activities). For this analysis, nonfarm income did not include income from transfers, such as migration remittance income, because the focus of this analysis was on locally-earned income. Attempts were made to model transfer income separately but the model presented later in this chapter did not fit the transfer income data well. It is possible that transfer income is less impacted by the characteristics of the transfer-receiving household and is more influenced by factors not covered by this household survey, such as individual characteristics of the migrant or the household's domestic and international social networks. Additional research on transfer income is needed to confirm this hypothesis and is beyond the scoop of this study.

The determinants of household income model used in this analysis needed to address two issues relating to the Malian household survey data set: 1) the panel or longitudinal nature of the data, and 2) potential selectivity bias.

Panel Data

Data sets that have multiple observations for the same individual, household, country, etc. over a given period of time are considered panel data set (Wooldridge, 2010). An issue with panel data is that the observations are not necessarily independently distributed. Factors that impact a given individual/household/country/etc. in one year will likely impact observations in

other years as well. These factors are shown by the variable *c* in Wooldridge's basic panel data set model (2010):

$$Y_{it}=B_0+x_{it}\beta+c+u_{it}$$

More precisely, the variable *c* represents omitted explanatory factors that impact Y_t but are constant overtime. It is also referred to as the unobserved effect (Wooldridge, 2010). For example, in an econometric model of household income determinants, *c* might represent household members' intelligence, ability, or drive to succeed. While these factors may be important to the model, it is difficult to collect quantitative data to measure these factors and thus, these factors are usually omitted. In cases where the unobserved effect (*c*) is correlated with any of the explanatory variables, such as when unobserved ability and intelligence are correlated with an observed variable like education level, a pooled OLS model will result in inconsistent and biased results (Wooldridge, 2010).

One solution to this problem is to eliminate the time constant, unobserved effect using a differencing econometric model such as a fixed effects model (Wooldridge, 2010). A fixed effects model was used in Abdulai and CroleRees' study of factors affecting the probability of participation in cotton, livestock activities, and nonfarm activities (2001). One constraint of a fixed effects model is that while it solves the unobserved effect problem, it also drops out all time-invariant explanatory variables in the model. In the case of modeling household income determinants, it seems probable that time-invariant variables, such as location or road access, could be important factors in household income. For this reason, a fixed effects model was not used in this thesis.

Another econometric model commonly used by researchers working with panel data sets is called the random effects model. Unlike the fixed effects model, this model can include time-

invariant explanatory variables. However, a random effects model requires the assumption that there is zero correlation between any explanatory variable and the unobserved effect, *c* (Wooldridge, 2010). In the case of household income determinants, it seems difficult to assume that there exists zero correlation between these variables. For example, an explanatory variable like education level is likely correlated with unobserved variables, such as ability or intelligence. For this reason, a random effects model was not ideal for this analysis.

Given the constraints of both random effects and fixed effects models, this econometric analysis used a correlated random effects (CRE) model, also referred to as the Mundlak-Chamberlain device. Proposed by Mundlak (1978) and Chamberlain (1984), this is a random effects model that includes an additional vector $\bar{x_t}$. The vector $\bar{x_t}$ represents the average values of each time-variant explanatory variable across the time period covered by the panel data set. A correlated random effects model can therefore be written as follows[5]:

$$Y_{it}=B_0+x_{it}\beta+c_i+u_{it}$$

where:

$$c_i=\alpha_0+\delta\bar{x_i}+\varphi_i, \quad \varphi_i|x_i\sim N(0,\sigma_\varphi^2)$$

The benefit of a correlated random effects model is that it combines several positive aspects of both the fixed effects and random effects models. It allows for time-invariant factors, such as location and road access, to be included in the analysis like a random effects model. In addition, it also solves the unobserved heterogeneity issues associated with the unobserved effect, *c,* like a fixed-effect model (Ricker-Gilbert, 2011).

[5] The generic presentation of the correlated random effects model presented here is a slight variation of the model presented by Muyanga, Jayne, & Burke (2010).

Potential Selection Bias

In addition to issues relating to panel data, the econometric model needed to address any potential selection bias present in the data. As the last chapter showed, not all households participated in livestock or nonfarm income activities, and the decision to participate in these income activities was not likely random. This raised concerns that the subset of the population that earned income from one of these two activities may have been different from the general population in some way which allowed them to earn higher returns or have a comparative advantage in the activity. If this type of selectivity bias was present in a data set and the econometric model was not corrected to take selectivity bias into account, the model's coefficients could be biased (Lanjouw, 2001; Yunez-Naude & Taylor, 2001).

To resolve this problem, several authors have used Heckman two-step models (also known as a Heckit model) to evaluate the determinants of nonfarm income (see, for example, Berdegue, Ramirez, & Reardon, 2001; Lanjouw, 2001). A Heckman model has two stages. First, a probit regression is performed to determine the factors affecting the yes/no decision to participate in a given activity. From the probit model, an adjustment factor correcting for selectivity bias, called an inverse mills ratio, is calculated. The inverse mills ratio is then included in the second stage of the analysis where typically an OLS regression of the factors affecting income levels is performed. Mathematically, the Heckman two-step model can be written as:

$$Y_i = Bx_i + Dw_i + u_i$$

where Y_i is only observed if $Z_i=1$ in the following probit regression:

$$Z_i = Ev_i + u_i$$

In this model, Y_i represents the dependent variable (household income in our case), X_i and V_i represent vectors of explanatory variables, and W_i represents the inverse mills ratio. If the OLS regression finds the inverse mills ratio to be significant, then selectivity bias is present in the model.

The econometric model presented in this thesis combined a Heckman two-step model and a correlated random effects model. To do this, a probit analysis of factors impacting activity participation was first performed for each year and from this information, each year's inverse mills ratio (IMR) was calculated. Then, all of the inverse mills ratios were included in a correlated random effects model for the second stage of the model. The vector $\overline{x_t}$ representing the average values of the time-variant explanatory variables were only included in the second stage of the model. Tables 18 and 19 present the explanatory variables, as well as abbreviations and descriptive statistics for each variable used in this econometric model.

Table 18: Abbreviations for Explanatory Variables Included in the Determinants of Household Income Model

Abbreviation	**Definition**
DEPEND	Dependency Ratio[6]
AGE	Age of Household Head
POP	Number of People in Household
FEMALE	Female Household Head Dummy
CE_EDU_1_6	Household Head Has 1-6 Years of Education
CE_EDU_7+	Household Head Has 7+ Years of Education
EDU_MAX_1_6	Most Educated Person (14 yrs. old +) has 1-6 Years of Education
EDU_MAX_7+	Most Educated Person (14 yrs. Old +) has 7+ Years of Education
FARM_SIZE	Land Owned (Ha)
EASY_ACCESS	Easy Road Access Dummy
TOMINIAN	Tominian Regional Dummy
ROOMS	Number of Rooms In Household Head's Home (proxy for wealth) in 2006/07
MOTO	Household owns a Motorcycle or Motorbike Dummy
CART	Household owns an Animal Cart Dummy
MOVED_LATE	Household Moved To Village After the Village's Creation (proxy for poor access to land)
DIVIDED	Parent's Farm Was Divided (proxy for land access constraints)

[6] The dependency ratio is defined as the ratio of the number of present inactive household members (such as children and the elderly) to the number of present active household members.

Table 19: Descriptive Statistics of Independent Variables Included In The Determinants of Household Income Model

	ZONES COMBINED			TOMINIAN			KOUTIALA		
Factors	**Mean**	**Stand. Dev.**	**Valid %**	**Mean**	**Stand. Dev.**	**Valid %**	**Mean**	**Stand. Dev.**	**Valid %**
DEPEND	1.10	0.64	-	1.02	0.62	-	1.19	0.65	-
AGE	55.11	14.34	-	56.04	15.19	-	54.17	13.38	-
POP	13.56	7.39	-	11.73	6.70	-	15.42	7.60	-
FEMALE	-	-	0.8 %	-	-	0.9 %	-	-	0.7 %
CE_EDU_1_6	-	-	16 %	-	-	19 %	-	-	13 %
CE_EDU_7+	-	-	4 %	-	-	6 %	-	-	3 %
EDU_MAX_1_6	-	-	29 %	-	-	25 %	-	-	33 %
EDU_MAX_7+	-	-	37 %	-		44 %	-	-	30 %
FARM_SIZE	10.23	8.26		6.71	5.09	-	13.80	9.27	-
EASY_ACCESS	-	-	47 %	-	-	44 %	-	-	49 %
TOMINIAN	-	-	50 %	-	-	100 %	-	-	0 %
ROOMS	1.75	0.90		1.52	0.72	-	2.00	1.00	-
MOTO	-	-	44 %	-	-	36 %	-	-	52 %
CART	-	-	74 %	-	-	67 %	-	-	82 %
MOVED_LATE	-	-	10 %	-	-	0 %	-	-	20 %
DIVIDED	-	-	41 %	-	-	36 %	-	-	46 %

Source: Survey data

It is possible that some of the explanatory variables, particularly those relating to durable goods and wealth, such as the animal cart and motorcycle ownership variables could be endogenous in one or more of the econometric models. This is particularly true for the models representing income sources that made up a greater share of total income, such as cropping and nonfarm income. Endogeneity may occur if, for example, rather than ownership of a motorcycle or animal cart leading to higher income levels, higher income levels actually cause households to purchase animal carts or motorcycles.. Any explanatory variable representing household wealth could also be a source of endogeneity. In this analysis, wealth was proxied by the number of rooms reported to be in the household head's home in 2007 as it was thought to be less vulnerable to endogeneity issues compared to other wealth indicators. Since access to transportation and household wealth seem like factors that could be correlated with higher income levels, the motorcycle, animal cart, and number of rooms variables were left in the model and no efforts were made to correct for endogeneity[7]. However, if endogeneity existed in the models, the predicted coefficients may be biased and inconsistent.

One benefit of a Heckman two-step model is that the set of variables used to explain the yes/no decision to participate in each income activity does not need to be the same as the set of variables that are used to explain differences in income levels among households that participate in the activity. With Heckman two-step models, there should generally be one or more explanatory variables in the probit analysis that are not included in the second stage of the model to reduce the model's standard errors. The selection of these excluded variables should be based

[7] Lagging these variables was tried in an effort to reduce endogeneity within the models but did not yield better or considerably different results (i.e. the signs on coefficients and significance levels were very similar). Given that this did not significantly change the results, the econometric models presented in this thesis do not include lagged variables nor are any other attempts made to correct for endogeneity.

on the following: (1) the variables need to impact a household's participation decision, and (2) the variables should not affect income levels once a household decides to participate in the activity. If variables are not excluded from the second stage and the explanatory variables in both stages are the same, the inverse mills ratio will be highly correlated with the explanatory variables in the second stage. In this case, the model would still be a best linear unbiased estimator (BLUE) but the model's standard errors would be high. An examination of other studies that have used Heckman two-step models to study determinants of household incomes shows that the explanatory variables chosen to be excluded from the second stage have varied greatly, suggesting that there is not a consensus among researchers on the best explanatory variables to exclude. This lack of consensus is likely due to the fact that it is difficult to find variables within household survey data sets that only impact the yes/no decision to participate in an income activity without impacting income levels. For this analysis, a dummy variable indicating whether or not the farm of the household head's parents was divided up among their children was selected to be omitted from the second stage. The reason that the division of the parents' farm might be important for the yes/no activity participation decision is that if the farm is divided among many children, access to farm land becomes more constraining. Therefore, the children may have an incentive to move into other income activities. Based on the econometric models presented in previous studies, the exclusion of other explanatory variables was also tried but did not yield better or considerably different results (i.e. the signs on coefficients and significance levels were very similar).

Three dummy variables representing female-headed households, households with a head who had more than 7 years of education, and households that had moved to their village after the village's creation were omitted from the first step of the Heckman model (the probit analysis)

and were only included in the second stage. These variables were excluded from the probit analysis because they were found to perfectly predict activity participation due to the small number of households where the explanatory variable was equal to one. The omission of these variables is acceptable in a Heckman model as the set of variables used to explain the yes/no decision to participate in each income activity does not need to be the same as the set of variables that are used to explain differences in income levels among households that participate in the activity

As noted in Chapter 4, income levels were significantly higher in the zone of Koutiala than in the zone of Tominian. Despite these differences, incomes from both zones were pooled together for this econometric analysis in order to increase the total number of household observations. To take into account differences in income levels between the two zones, a dummy variable indicating one for households living in Tominian and zero otherwise was included in the model. Interacting regional dummy variables with other explanatory variables was also tried but did not yield significantly different results. As a result, no regional interaction terms were included in the model presented in this thesis.

5.2 Factors Correlated with a Higher Probability of Participation and Higher Income Levels Earned from Livestock, Nonfarm, and Cropping Income Activities

Factors correlated with a higher probability of participation, as well as factors correlated with higher levels of per capita income, were examined for three common income sources: livestock income, nonfarm income, and crop income. In all of the models, the inverse mills ratios were found to be statistically insignificant at the 5% level (one inverse mills ratio was significant at the 10% level for nonfarm income). This suggests limited to no selectivity bias present in the

models meaning that a regular correlated random effects model that does not correct for selectivity bias could also be used. For comparison purposes, results from both a model that corrected for selectivity bias and one that does not are presented in this paper.

The R^2 and pseudo R^2 values reported below were found to be relatively low and varied from 0.073-0.393, depending on the specific model. That said, tests on the null hypothesis that all coefficients were equal to zero (ex. the likelihood ratio chi-square test and the wald chi-square statistic*)* could be rejected at the 0.001 significance level or better for all of the econometric models.

5.2.1 Livestock Income

The results from a probit regression of factors impacting participation in livestock income activities showed that larger farm sizes (measured in hectares) and owning an animal cart or motorcycle were correlated with a higher probability of participating in livestock income activities (Table 20). For these three variables, owning a animal cart or motorcycle had the greatest effect (increasing the probability of participation by 0.09% and 0.026%, respectively) while an additional hectare of farmland has a considerably smaller effect (only increasing the probability by 0.005%). This model also showed that living in the Tominian zone and older household heads were correlated with a lower likelihood of participating in livestock income, with living in Tominian decreasing the probability by 0.034% and older household heads decreasing the probability by 0.001%. The model also showed that the cropping year 2008/09 was correlated with a greater likelihood of participation in livestock activities.

Table 20: Determinants of Participation in Livestock Activities

Factors	dF/dx[a]	Standard error	Z-value[c]
	All Three Cropping Seasons Pooled[b]		
DEPEND	-0.010	0.094	-1.49
AGE	-0.001	0.005	-3.40
POP	0.002	0.014	1.90
CE_EDU_1_6	-0.008	0.191	-0.51
EDU_MAX_1_6	-0.005	0.174	-0.37
EDU_MAX_7+	0.002	0.179	0.18
FARM_SIZE	0.005	0.020	3.22
EASY_ACCESS	-0.003	0.155	-0.27
TOMINIAN	-0.034	0.182	-2.56
ROOMS	-0.003	0.100	-0.45
MOTO	0.026	0.181	2.03
CART	0.090	0.149	5.59
DIVIDED	-0.016	0.147	-1.44
2009	0.034	0.175	3.10
2010	0.016	0.163	1.41
# of Observations			901
Chi^2 Likelihood			175.44
Prob > chi^2			0.000
Log Likelihood			-211.499
Pseudo R^2			0.293

Source: Survey data

[a]dF/dx represents the change in the probability of participation due to a one unit increase in the explanatory variable

[b]Calculated using dprobit in STATA

[c]Z-value indicates statistical significance: >1.645 = 10% significance level, >1.96 = 5% significance level, >2.576 = 1% significance level

The second stage of the Heckman two-step model showed factors associated with higher levels of livestock income. Table 21 showed that a higher dependency ratio (a higher ratio of inactive, dependant household members to every active household member), owning at least one motorcycle or motorbike, and moving to the village sometime after the village's creation were correlated with higher levels of livestock income. Meanwhile, living in the Tominian zone and having a larger household size were correlated with lower income levels.

The magnitude of the effect of each of these variables on livestock income varied. A one unit increase in the dependency ratio, or owning a motorcycle or moving to the village after the village's creation all increased per capita livestock incomes by somewhat similar levels, ranging from 3,599 F CFA to 4,160 F CFA. Living in the Tominian zone also had a relatively large effect, decreasing income levels by 2,906 F CFA. Meanwhile, the household size variable had the smallest, statistically significant effect, with each additional person only decreasing per capita income by 731 F CFA.

Table 21: Determinants of per Capita Livestock Income Levels

Dependent Variable: Livestock income/capita (FCFA)	**CRE results corrected for selectivity bias**			**CRE results with no selectivity bias correction**		
Factors	Coef.	Standard Errors	Z-value[b]	Coef.	Standard Error	Z-value[b]
DEPEND	4,021	2,066	1.95	3,867	2,042	1.89
AGE	251	159	1.58	242	159	1.53
POP	-731	287	-2.55	-714	284	-2.51
FEMALE	2,501	19,007	0.13	2,362	18,955	0.12
CE_EDU_1_6	-4,601	10,211	-0.45	-3,977	10,187	-0.39
CE_EDU_7+	7,094	18,331	0.39	8,620	18,237	0.47
EDU_MAX_1_6	1,556	2,133	0.73	1,513	2,131	0.71
EDU_MAX_7+	4,451	2,896	1.54	4,254	2,882	1.48
FARM_SIZE	74	128	0.58	79	126	0.63
EASY_ACCESS	-1,919	1,213	-1.58	-1,889	1,204	-1.57
TOMINIAN	-2,906	1,416	-2.05	-3,143	1,360	-2.31
ROOMS	-427	614	-0.70	-396	611	-0.65
MOTO	4,160	2,245	1.85	4,247	2,223	1.91
CART	-3,141	3,134	-1.00	-2,842	3,050	-0.93
MOVED_LATE	3,599	1,886	1.91	3,591	1,882	1.91
2009	-288	1,524	-0.19	633	1,264	0.50
2010	-734	1,646	-0.45	98	1,338	0.07
CONSTANT	7,970	3,571	2.23	7,200	3,421	2.10
IMR[a] (2006/07)	-4,618	4,875	-0.95			
IMR[a] (2008/09)	1,246	6,060	0.21			
IMR[a] (2009/10)	139	5,408	0.03			
# Observations	808			808		
Wald-Chi^2 Statistic	60.57			59.53		
Prob > chi^2	0.001			0.00		
Overall R^2	0.075			0.073		

Source: Survey data

[a] The abbreviation IMR stands for the inverse mills ratio

[b] Z-value indicates statistical significance: >1.645 = 10% significance level, >1.96 = 5% significance level, >2.576 = 1% significance level

5.2.2 Nonfarm Income

Living in the Tominian zone, having an older head of household, and the 2008/09 and 2009/10 cropping season variables were found to be negatively correlated with the probability of participating in nonfarm activities (Table 22). Meanwhile easy market access and having a head of household with 1-6 years of formal education was found to be correlated with a higher probability of participating in nonfarm income activities.

As for the magnitude of the effects of these variables on the probability of activity participation, living in a village with easy market access had a relatively large positive effect (increasing the probability by 0.067%), while the dummy variables representing living in Tominian zone, 2008/09 cropping year, and the 2009/10 cropping year all had relatively large negative effects, ranging from -0.141% to 0.173%.

Table 22: Determinants of Participation in Nonfarm Activities

Dependent Variable: Participation in Nonfarm Activities (Yes =1, No=0)	dF/dx[a]	Standard Error	Z-value[c]
	All Three Cropping Seasons Pooled[b]		
DEPEND	-0.002	0.081	-0.10
AGE	-0.002	0.004	-2.18
POP	-0.002	0.009	-0.97
CE_EDU_1_6	0.062	0.159	1.72
EDU_MAX_1_6	0.008	0.131	0.25
EDU_MAX_7+	0.052	0.136	1.59
FARM_SIZE	0.003	0.010	1.43
EASY_ACCESS	0.067	0.114	2.39
TOMINIAN	-0.141	0.128	-4.46
ROOMS	0.017	0.070	0.96
MOTO	-0.019	0.121	-0.63
CART	0.026	0.129	0.78
DIVIDED	0.042	0.112	1.52
2009	-0.166	0.133	-4.59
2010	-0.173	0.134	-4.73
# of Observations			901
Chi^2 Likelihood			107.78
Prob > chi^2			0.000
Log Likelihood			-392.501
Pseudo R^2			0.121

Source: Survey data

[a] dF/dx represents the change in the probability of participation due to a one unit increase in the explanatory variable

[b] Calculated using dprobit in STATA

[c] Z-value indicates statistical significance: >1.645 = 10% significance level, >1.96 = 5% significance level, >2.576 = 1% significance level

For the second stage of the Heckman two-step model, a larger number of people within the household and moving into a community after the village was created were correlated with lower per capita income levels (Table 23). On the other hand, easy road access, the 2008/09 and 2009/10 cropping seasons, living in Tominian and more rooms in the household head's home (a proxy for wealth) were found to be correlated with higher income levels.

When one considers the magnitude of the effects of these statistically significant variables, household size had the smallest effect with one additional person decreasing income by 929 F CFA. Meanwhile, the 2008/09 and 2009/10 dummy variables had the greatest effect, increasing incomes by 6,088 to 6,480 F CFA.

Note that the inverse mills ratios were only found to be significant at the 10% level or better for the 2009/10 cropping year. For both other years, the inverse mills ratios were insignificant, suggesting no selectivity bias.

Table 23: Determinants of per Capita Nonfarm Income (Excluding Transfers)

Dependent Variable: Nonfarm income/capita (FCFA)	**CRE results corrected for selectivity bias**			**CRE results with no selectivity bias correction**		
	Coef.	Standard Errors	Z-value[b]	Coef.	Standard Errors	Z-value[b]
DEPEND	-3,301	2,234	-1.48	-3,461	2,220	-1.56
AGE	-136	196	-0.70	-129	193	-0.67
POP	-929	342	-2.71	-939	342	-2.75
FEMALE	-739	21,791	-0.03	-561	21,830	-0.03
CE_EDU_1_6	6,264	10,556	0.59	8,257	10,502	0.79
CE_EDU_7+	1,866	21,171	0.09	-32	21,04	-0.00
EDU_MAX_1_6	-713	2,625	-0.27	-957	2,613	-0.37
EDU_MAX_7+	-5,772	3,629	-1.59	-5,267	3,625	-1.45
FARM_SIZE	-12	154	-0.08	26	151	0.17
EASY_ACCESS	3,912	1,708	2.29	4,521	1,632	2.77
TOMINIAN	3,913	2,207	1.77	1,990	1,842	1.08
ROOMS	1,725	819	2.11	1,774	810	2.19
MOTO	4,265	2,904	1.47	3,786	2,890	1.31
CART	-563	3,600	-0.16	-477	3,602	-0.13
MOVED_LATE	-5,204	2,696	-1.93	-5,281	2,689	-1.96
2009	6,480	2,805	2.31	4,031	1,523	2.65
2010	6,088	2,870	2.12	2,438	1,584	1.54
CONSTANT	5,613	4,690	1.20	6,583	4,543	1.45
IMR[a] (2006/07)	-1,452	10,017	-0.14			
IMR[a] (2008/09)	-7,246	6,437	-1.13			
IMR[a] (2009/10)	-10,294	5,967	-1.73			
# Observations	724			724		
Wald-Chi^2 Statistic	122.83			119.41		
Prob > chi^2	0.000			0.000		
Overall R^2	0.167			0.163		

Source: Survey data

[a] The abbreviation IMR stands for the inverse mills ratio

[b] Z-value indicates statistical significance: >1.645 = 10% significance level, >1.96 = 5% significance level, >2.576 = 1% significance level

5.2.3 Crop Income

For cropping income, a Heckman two-step model was not used because nearly 100% of households reported participating in cropping activities during all three years. As a result, selectivity bias could not be present and a correlated random effects model could be used without any adjustments.

This correlated random effects model showed that household heads who had 1-6 years of education and larger farm size were correlated with higher per capita income levels (Table 24). The household head education variable, in particular, had a relatively large effect on income levels, increasing per capita income by 22,568 F CFA. Meanwhile, living in the Tominian zone, having a higher number of people in the household, and 2008/09 cropping year were correlated with lower income levels. Of these variable, living in Tominian had the largest negative effect, decreasing per capita incomes by 20,120 F CFA

Table 24: Determinants of per Capita Cropping Income Levels

Dependent Variable: Cropping income/capita (FCFA)	**CRE results with no selectivity bias correction**		
	Coef.	Standard Errors	Z-value[b]
DEPEND	2,968	2,382	1.25
AGE	-240	192	-1.25
POP	-1,635	393	-4.16
FEMALE	-17,011	27,706	-0.61
CE_EDU_1_6	22,568	12,801	1.76
CE_EDU_7+	1,423	25,768	0.06
EDU_MAX_1_6	-2,665	2,887	-0.92
EDU_MAX_7+	-4,948	3,903	-1.27
FARM_SIZE	910	178	5.12
EASY_ACCESS	-1,276	2,396	-0.53
TOMINIAN	-20,120	2,711	-7.42
ROOMS	2,033	1,242	1.64
MOTO	2,462	3,067	0.80
CART	-600	4,049	-0.15
MOVED_LATE	-569	3,865	-0.15
2009	4,396	1,713	2.57
2010	961	1,778	0.54
CONSTANT	43,997	6,661	6.60
# Observations	901		
Wald-Chi^2 Statistic	393.21		
Prob > chi^2	0.000		
Overall R^2	0.393		

Source: Survey data

[a] The abbreviation IMR stands for the inverse mills ratio

[b] Z-value indicates statistical significance: >1.645 = 10% significance level, >1.96 = 5% significance level, >2.576 = 1% significance level

5.3 Discussion of the Results from the Econometric Analysis of Household Income Determinants in the Tominian and Koutiala Zones

The results of these econometric models of household income determinants reveal several important findings. First, having a larger household size was correlated with lower levels of per capita livestock, nonfarm, and crop income. While the magnitude of this effect was generally relatively small, this suggests that households in Tominian and Koutiala were facing diminishing returns to additional labor. For cropping income, this finding might also be due to increasing land constraints as households become larger. Given that Mali's annual population growth rate and fertility rate are high (3.0% and 6.3 total births per woman in 2010, respectively) (World Bank, 2012c), the results of this analysis suggest that policies and public health initiatives that reduce the size of families could increase income and reduce rural poverty levels.

Living in the Tominian zone was also found to be correlated with a lower probability of participating in livestock and nonfarm activities as well as considerably lower income levels among those who participated in livestock and crop incomes. However among households participating in nonfarm income activities, living in Tominian was weakly correlated with higher nonfarm incomes. One possible explanation for this finding may be that households in Tominian faced entry barriers that were restricting participation in non-cropping activities. Entry barriers to nonfarm income activities would vary depending on the activity but might include lack of access to credit, capital, technical skills, or social networks needed for a nonfarm activity. Efforts to reduce entry barriers into these activities could increase their participation rates. In addition, access to agricultural inputs, research, and extension is more constrained in Tominian than in

Koutiala because the CMDT provides these services in Koutiala. A lack of these types of assistance in Tominian could partially explain the lower crop income levels.

In general, wealth and the durable goods indicators were found to be positively correlated with livestock participation and income levels, as well as nonfarm income levels, although they were not found to be significant in crop income. This result suggests that as households become wealthier, they may be better able to diversify their income portfolios by moving into livestock and nonfarm activities. However, as noted earlier in this paper, the direction of the relationship between the durable goods and income levels is not clear. As a result, it is possible that endogeneity existed in the model and that the models' coefficients were biased and inconsistent.

Interestingly, easy road access was found to be significant only in the nonfarm income model, suggesting that it is positively correlated with higher nonfarm income levels and higher nonfarm income participation rates. However, easy road access was not found to be correlated with livestock or crop income levels. This finding suggests that building roads and bridges to connect rural communities to local and regional markets, as well as improving the condition of road infrastructure (ex. repairing washed out roads after the rainy season) in rural areas could increase nonfarm incomes and reduce poverty levels.

The only education variable that was found to be significant was the household head's primary school attendance, which had a positive impact on cropping income levels and nonfarm income participation levels. The results were particularly large for cropping income, where primary school attendance increased per capita income by 22,568 F CFA. One possible explanation for this result is that some exposure to primary school education may improve the household head's access to information on both farm and nonfarm practices and techniques, credit, and market information, which can increase agricultural production levels, improve

marketing skills, and help households overcome barriers to nonfarm activities. None of the variables relating to the education levels of other household members were significant. This may be due to the fact that family structures in Mali are hierarchical and as a result, the household head may make most decisions on the household's choice of income activities.

The results from this analysis are somewhat similar to those reported in previous studies. For example, the result that easy access to roads is important for nonfarm activities was also reported by a study from Nicaragua (Corral & Reardon, 2001). In addition, larger family sizes were found to be negatively correlated with farm income in a study from Mexico (Yunez-Naude & Taylor, 2001) and increased levels of rural poverty in Nigeria (Anyanwu, 2005). The Mexican study reported that low levels of education were positively correlated with cropping activities, which is similar to the results reported in this thesis. However that study did not find that the education level of the household head mattered, which differs from the results found for Tominian and Koutiala in this analysis. This variation could be explained by differences in the family structure between rural households in Mali and those in Mexico.

6. COMMUNITY INCOME INEQUALITY AND INCOME SOURCES

6.1 Methodology

This thesis has so far examined household income levels found in the Tominian and Koutiala zones of Mali, as well as factors associated with higher participation rates and income levels for crop, livestock, and nonfarm activities. However, attention should also be paid to who benefits the most from the income earned from each income source. For example, if nonfarm incomes rise but only the wealthy are participating in nonfarm activities, community inequality levels will increase and poverty levels will not decline. For this reason, this chapter will examine how income from various income sources impacts community inequality levels.

To study inequality, one needs to decide on an appropriate income inequality index. Past research has proposed various indices for measuring income inequality. According to the literature, an ideal income inequality measure will have the following features (Adams & He, 1995):

1) *Pigou-Dalton transfer sensitivity*: If income is transferred from a poorer individual to a wealthier individual, the income inequality measure should increase.

2) *Symmetry:* If two individuals switch incomes with each other, the income measure should remain unchanged.

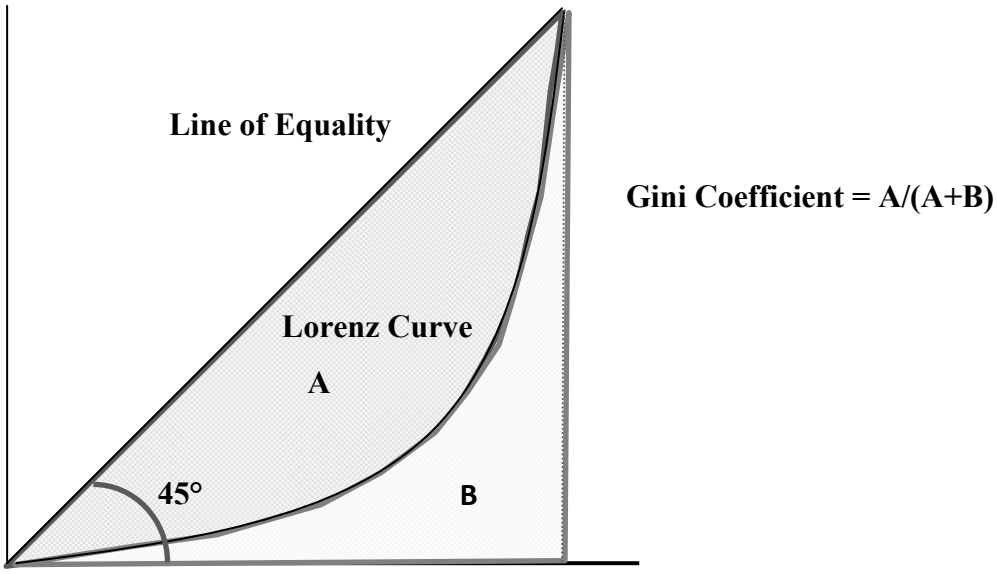
3) *Mean Independence:* If all people in the community have their income increased by the same proportional level, the income inequality measure should remain unchanged.

4) *Population homogeneity:* If the population size increases but the distribution of income does not change within the population, the income inequality measure should remain unchanged.

5) *Decomposability:* The income inequality measure should have the ability of being broken down so one can determine what types of income increase or decrease inequality.

The Gini coefficient, based on the Lorenz curve, is one type of income inequality index that meets all five of these requirements (Adams & He, 1995) and for this reason, it is the income inequality measurement used in this thesis. According to the Food and Agriculture Organization of the United Nations (FAO), the Lorenz curve "relates the cumulative proportion of income to the cumulative proportion of individuals" (Bellù, 2005, p. 2). If there is zero inequality in the community, then the Lorenz curve will be identical to a 45 degree line and the Gini coefficient will be zero. As income inequality increases, the Lorenz curve stretches farther and farther away from the 45 degree line, and the Gini coefficient becomes larger. Mathematically, the Gini coefficient is the ratio of the area between the line of equality and the Lorenz curve divided by the total area under the 45 degree line. In Figure 6, the Gini coefficient is equal to A/(A+B) (The World Bank, 2011).

Figure 6: The Gini Coefficient



Source: Adapted by author from a figure in World Bank (2011)

If all household incomes included in an analysis are positive, the Gini coefficient will take a value between 0 and 1. However, Gini coefficients can also handle negative incomes (Wodon & Yitzhaki, 2001). If negative values exist, the Gini coefficient may be greater than one. While this does not indicate perfect inequality, it is an acceptable finding that was commonly reported in previous studies (see, for example, Pyatt, Chen, & Fei, 1980; Lopéz-Feldman, Mora, & Taylor, 2007; Mishra, El-Osta, & Gillespie, 2009; Lerman & Yitzhaki, 1985).

The three rounds of household survey data from Mali contain one case where total income was reported to be below zero. As a result, the regional Gini coefficients were calculated twice, with and without this one household included. To determine whether differences in the Gini coefficients between the two zones are statistically significant, standard errors and 95% confidence intervals were calculated through bootstrapping using the STATA command *ineqerr*.

Bootstrapping is a resampling method that is frequently used to calculate standard errors of an estimate, $\hat{\theta}$. To bootstrap, a random drawing of *n* observations from the overall population is performed *p* times with replacement. For each drawing, the estimate $\hat{\theta}^{(a)}$ is calculated where a=1, 2, 3, … , p and then the sample standard errors are estimated using the following equation[8]:

$$\text{bootstrapped standard errors } (\hat{\theta}) = \left[(p-1)^{-1} \sum_{a=1}^{p} (\hat{\theta}^{(a)} - \bar{\hat{\theta}})^2 \right]^{\frac{1}{2}}$$

In addition, this study decomposed the Gini coefficients to determine how incomes from various income categories (cash crops, food crops, livestock, agricultural wages, non-agricultural wages, transfers, and other nonfarm activities) contributed to overall income inequality in the two zones. To decompose the Gini coefficients, the method proposed by Lerman and Yitzhaki

[8] The general equations and description of basic bootstrapping is based on information from Wooldridge, 2009.

(1985) was used. Lerman and Yitzhaki state that the Gini coefficient can be written as the following:

$$G = \sum_{k=1}^{K} S_k G_k R_k$$

In this equation, S_k represents the share of total income earned from a given activity, G_k represents the Gini coefficient of income inequality within each income category, and R_k represents the Gini correlation between income from a given activity and total income. R_k can be calculated through the following equation:

$$R_k = \frac{\text{cov}[Y_k, F(Y)]}{\text{cov}[Y_k, F(Y_k)]}$$

In this equation, Y_k represents income from a given activity and $F(Y)$ and $F(Y_k)$ represent the cumulative distributions of total income and income from the given income category, respectively. Once these two equations are calculated, the percentage change in the Gini coefficient associated with a 1% increase in income from a given activity can be calculated with the following equation:

$$\% \text{ Change} = \frac{S_k G_k R_k}{G} - S_k$$

The Gini coefficient decomposition was performed using the *descogini* command in the STATA statistical software. Confidence intervals and standard errors were calculated by bootstrapping for the percentage change in the Gini coefficient associated with a 1% increase in income earned from a given activity.

When interpreting the Gini decomposition results, several issues should be noted. First, this Gini decomposition method can suggest income sources that are income inequality

increasing or decreasing, but it does not show how income portfolios may have been different in the absence of a given income source. For example, a Gini decomposition analysis might suggest that a given income source (Income Source A) is income inequality increasing. However if in the absence of Income Source A, poor households participate in a different income activity with lower earnings (Income Source B), the households are worse off and community inequality may be higher. Therefore, despite the findings from the Gini decomposition analysis that Income Source A is inequality increasing, it may be a better income source for the community than its alternatives. A second limitation of this Gini decomposition method is that it cannot identify factors that cause an income source to be inequality increasing or decreasing (Reardon et al., 2000). Thus, the analysis presented during the next several pages of this thesis may propose hypotheses on why a given income source is inequality increasing or decreasing although further research using more complex methods would be needed to confirm these hypotheses.

6.2 Results

For the three survey years included in this analysis (2006/07, 2008/09, and 2009/10), the regional Gini coefficients of household incomes ranged from 0.409-0.422 for Tominian and 0.373-0.4 for Koutiala (Table 25, Table 26 and Table 27). These values are slightly larger than the regional Gini coefficients calculated by Reardon et al. (1992) for areas in Burkina Faso with agroclimatic zones similar to Tominian and Koutiala using data from the early 1980s. By excluding the one household with negative total income, standard errors and 95% confidence intervals could be calculated for the two coefficients using bootstrapping. The confidence intervals were found to overlap, suggesting that the Gini coefficients in Tominian and Koutiala may not be statistically different from each other.

Table 25: Gini Coefficients for Koutiala and Tominian (2006/07)

Zone	Gini Coefficients	Gini Coefficients
Tominian	0.410	0.392 (0.020) 95% CI: 0.359-0.435
Koutiala	0.373	0.366 (0.018) 95% CI: 0.333-0.404

Table 26: Gini Coefficients for Koutiala and Tominian (2008/09)

Zone	Gini Coefficients	Gini Coefficients
Tominian	0.409	0.409 (0.021) 95% CI: 0.370-0.455
Koutiala	0.391	0.390 (0.024) 95% CI: 0.350-0.442

Table 27: Gini Coefficients for Koutiala and Tominian (2009/10)

Zone	Gini Coefficients	Gini Coefficients
Tominian	0.422	0.401 (0.016) 95% CI: 0.368-0.432
Koutiala	0.400	0.400 (0.022) 95% CI: 0.359-0.444

Source: Survey data
() reports standard error, calculated through bootstrapping using STATA command *ineqerr,* 1,000 repetitions performed
95% CI: stands for 95% Confidence Intervals, also calculated through STATA's *ineqerr* command

The Gini coefficients for both zones were also decomposed by income source (Tables 28-33). In both zones, this showed that food crop income was generally income inequality decreasing while livestock income was inequality increasing. Given that food crops made up a significant share of total income (as shown by S_k) and income inequality within this income

source was low (G_k), the magnitude of the impact that food crop income had on income inequality was relatively great. However, the inequality increasing effect of livestock income was smaller because 1) livestock incomes made up a relatively small share of total income (S_k) and 2) the large number of negative livestock incomes (signifying livestock investments) resulted in a Gini coefficient that is greater than one. As a result, the income inequality effects of livestock income showed by the Gini decomposition analysis may have been overstated and thus appear to be larger than they may have actually been in reality. Another notable finding from the Gini decomposition analysis is that in Tominian, non-agricultural wages were found to be inequality increasing in both 2008/09 and 2009/10. In Koutiala, agricultural wages were found to be income inequality decreasing in all three years and cash crops were inequality increasing for the last two cropping years. All of these results were found to be statistically significant at the 1% level through bootstrapping.

Table 28: Gini Decomposition of Household Incomes in Koutiala (2006/07)

Income Source	S_K[1]	G_K[2]	R_K[3]	Share	% Change
Crops (Food and Cash)	0.705	0.379	0.909	0.651	-0.054*
Livestock	0.112	0.908	0.621	0.170	0.057***
Ag Wages	0.006	0.886	-0.162	-0.002	-0.008***
Non-Ag Wages	0.008	0.969	0.197	0.004	-0.004
Transfers	0.023	0.825	0.309	0.016	-0.007
Other Nonfarm	0.147	0.638	0.648	0.163	0.016

Source: Survey data

*, **, *** signify 10%, 5%, and 1% statistical significance, respectively; significance determined using bootstrapping with 1,000 repetitions

[1] S_k represents the share of income from a given activity in total income

[2] G_k represents the Gini coefficient of income inequality within each income category

[3] R_k represents the Gini correlation between income from a given activity and total income

Table 29: Gini Decomposition of Household Incomes in Koutiala (2008/09)

Income Source	S_K[1]	G_K[2]	R_K[3]	Share	% Change
Cash Crops	0.183	0.707	0.741	0.245	0.063***
Food Crops	0.537	0.399	0.841	0.461	-0.076***
Livestock	0.088	1.024	0.551	0.127	0.039
Ag Wages	0.007	0.874	-0.016	-0.000	-0.007***
Non-Ag Wages	0.022	0.922	0.391	0.020	-0.002
Transfers	0.035	0.718	0.233	0.015	-0.020***
Other Nonfarm	0.129	0.662	0.600	0.131	0.002

Source: Survey data

*, **, *** signify 10%, 5%, and 1% statistical significance, respectively; significance determined using bootstrapping with 1,000 repetitions

[1] S_k represents the share of income from a given activity in total income

[2] G_k represents the Gini coefficient of income inequality within each income category

[3] R_k represents the Gini correlation between income from a given activity and total income

Table 30: Gini Decomposition of Household Incomes in Koutiala (2009/10)

Income Source	S_K[1]	G_K[2]	R_K[3]	Share	% Change
Cash Crops	0.186	0.650	0.751	0.226	0.041*
Food Crops	0.498	0.346	0.854	0.367	-0.131***
Livestock	0.081	1.044	0.613	0.130	0.049**
Ag Wages	0.009	0.854	0.116	0.002	-0.007*
Non-Ag Wages	0.016	0.945	0.543	0.020	0.004
Transfers	0.068	0.817	0.697	0.097	0.029
Other Nonfarm	0.143	0.677	0.656	0.158	0.015

Source: Survey data

*, **, *** signify 10%, 5%, and 1% statistical significance, respectively; significance determined using bootstrapping with 1,000 repetitions

[1] S_k represents the share of income from a given activity in total income

[2] G_k represents the Gini coefficient of income inequality within each income category

[3] R_k represents the Gini correlation between income from a given activity and total income

Table 31: Gini Decomposition of Household Incomes in Tominian (2006/07)

Income Source	S_K[1]	G_K[2]	R_K[3]	Share	% Change
Crops (Food and Cash)	0.593	0.392	0.793	0.450	-0.144***
Livestock	-0.003	-30.914	0.604	0.155	0.159***
Ag Wages	0.003	0.973	0.043	0.000	-0.003
Non-Ag Wages	0.020	0.977	0.674	0.033	0.012
Transfers	0.159	0.747	0.492	0.142	-0.017
Other Nonfarm	0.228	0.619	0.639	0.220	-0.008

Source: Survey data

*, **, *** signify 10%, 5%, and 1% statistical significance, respectively; significance determined using bootstrapping with 1,000 repetitions

[1] S_k represents the share of income from a given activity in total income

[2] G_k represents the Gini coefficient of income inequality within each income category

[3] R_k represents the Gini correlation between income from a given activity and total income

Table 32: Gini Decomposition of Household Incomes in Tominian (2008/09)

Income Source	S_K[1]	G_K[2]	R_K[3]	Share	% Change
Cash Crops	0.152	0.593	0.654	0.144	-0.008
Food Crops	0.406	0.422	0.693	0.290	-0.116***
Livestock	0.086	1.142	0.608	0.146	0.060***
Ag Wages	0.016	0.979	0.822	0.031	0.015
Non-Ag Wages	0.071	0.920	0.739	0.118	0.047***
Transfers	0.120	0.769	0.555	0.125	0.005
Other Nonfarm	0.149	0.682	0.588	0.146	-0.003

Source: Survey data

*, **, *** signify 10%, 5%, and 1% statistical significance, respectively; significance determined using bootstrapping with 1,000 repetitions

[1] S_k represents the share of income from a given activity in total income

[2] G_k represents the Gini coefficient of income inequality within each income category

[3] R_k represents the Gini correlation between income from a given activity and total income

Table 33: Gini Decomposition of Household Incomes in Tominian (2009/10)

Income Source	S_K[1]	G_K[2]	R_K[3]	Share	% Change
Cash Crops	0.144	0.603	0.630	0.130	-0.015
Food Crops	0.462	0.406	0.711	0.315	-0.147***
Livestock	0.051	2.242	0.584	0.159	0.108***
Ag Wages	0.005	0.916	0.204	0.002	-0.003
Non-Ag Wages	0.060	0.957	0.804	0.110	0.049***
Transfers	0.130	0.774	0.490	0.116	-0.013
Other Nonfarm	0.148	0.768	0.626	0.168	0.020

Source: Survey data

*, **, *** signify 10%, 5%, and 1% statistical significance, respectively; significance determined using bootstrapping with 1,000 repetitions

[1] S_k represents the share of income from a given activity in total income

[2] G_k represents the Gini coefficient of income inequality within each income category

[3] R_k represents the Gini correlation between income from a given activity and total income

6.3 Discussion of the Gini Decomposition Results

This analysis of Gini coefficients shows that income inequality rates in the Tominian and Koutiala zones of Mali were relatively low (0.373-0.422) and comparable to Mali's national 2006 Gini coefficient of 0.39 reported by the World Bank (World Bank, 2012a). The Gini decomposition analysis also shows some interesting findings that policy makers should consider when making decisions on economic development projects in these two zones. First, food crop income was inequality decreasing. Given that almost all surveyed households reported income from food crops (suggesting low entry barriers) and that this income source has an income inequality decreasing effect, policies and programs that increase food crop income levels may decrease poverty and reduce community inequality levels. This could include projects that increase food crop production levels, such as improving farmers' access to inputs, credit, agricultural extension programs, or new technology. In addition, programs that help farmers make higher profits or better market their food crop production would also have a positive effect on inequality levels. This might include improving market information systems or supporting rural farmer cooperatives, which might help farmers strengthen their bargaining power with traders, make more informed market decisions, reduce input and transaction costs, and gain access to credit.

Since the cotton sector receives considerable attention by policy makers, the finding that cash crop income in the Koutiala zone was inequality increasing should be noted. This suggests that while projects focused on improving the zone's cotton sector may increase income levels, those who primarily benefit from these projects may be some of the wealthier subsections of the population.

Finally in the Tominian zone, non-agricultural wages were found to be income inequality increasing. This information, plus the finding from Chapter 4 that participation in this income source was limited despite high incomes in this sector, suggests that poorer households had difficulty gaining access to this income source. As a result, if policies are put into place that increase non-agricultural wage incomes in rural Mali, it seems likely that only the wealthier subsections of the population will benefit unless the issues of access and entry barriers are addressed.

7. CONCLUSIONS

The purpose of this study was to understand household income sources and levels, as well as how certain income activities either increased or decreased community inequality levels in two zones of rural Mali. The first zone, Tominian, is located within Mali's traditional course grain production zone, has received little public investment, and has been struggling economically in recent years. The other zone, Koutiala, is located in Mali's cotton basin, and has traditionally received considerable public investment, particularly relating to the cotton sector.

The results of this study show that households in both zones were very poor with only 8-16% of all surveyed households earning more than $1/day per capita during each of the three cropping years. Households in the Koutiala zone were found to have earned about 1.5-2 times the income of households in Tominian during all survey rounds.

Overall, this study shows that food crops were the most important income source for all households in the Tominian and Koutiala zones. In addition, this study showed that participation rates for food cropping activity were found to be high (nearly 100%) and that this income source was inequality decreasing. Given the importance of this income source and the low entry barriers for this activity, policy makers should focus policies and programs on increasing production, marketing, and sales of food crops. Examples of such programs might include programs that improve farmers' access to agricultural inputs, agricultural extension programs, better storage techniques, or market price information systems.

The econometric model of determinants of crop income presented in this thesis showed that household heads with some primary school education earned higher levels of crop income than household heads with no primary school education or more advanced levels of education at the secondary school level or beyond. This suggests that policies that encourage greater primary

school attendance could be effective in raising rural incomes. The econometric model showed that larger households generally earned less crop income, which is consistent with the findings of other similar studies on incomes and poverty (see, for example, Yunez-Naude & Taylor, 2001 or Anyanwu, 2005). This suggests that households are facing diminishing returns to additional labor. As a result, programs that help promote family planning in rural areas of Mali might be beneficial.

Nonfarm income, particularly income from self-employment, commerce, artisan, primary sector activities, and transformation of agricultural products, was found to be a smaller but still sizable share of total income. Although the income inequality effects of nonfarm income activities was inconclusive for all nonfarm income sources except non-agricultural wages, it seems that promoting nonfarm income activities through policy initiatives, such as training programs, improved access to non-agricultural credit, or assistance for the development of artisan cooperatives, could reduce poverty. Based on the results of the econometric model, improving road access in rural areas (i.e. building, repairing, and maintaining roads and bridges to connect rural communities to local and regional markets) and reducing family sizes may positively impact nonfarm income levels.

That said, it should be noted that not all nonfarm income activities are the same. In Tominian, non-agricultural wage activities were found to be income inequality increasing. Given the high levels of income earned from these activities but low activity participation rates, entry barriers may be an obstacle preventing many poor households from engaging in non-agricultural wage activities. Entry barriers to nonfarm income activities in general would vary depending on the activity but might include lack of access to credit, capital, technical skills, or social networks needed for a nonfarm activity. Research to identify these barriers and projects aimed at helping

the poor overcome these constraints could be beneficial. However, without such programs, the promotion of non-agricultural wage activities will likely just increase the incomes of the wealthy subsections of the population, increasing inequality and have little direct impact on poverty levels.

Livestock income was found to make up only a small share of total income for the poor and middle-class subsections of the surveyed households, despite a relatively high participation rate. In addition, this income source was found to be slightly income inequality increasing. This suggests that while many households participate in livestock activities, only the wealthy are able to amass enough animals to earn significant income from this source. Focusing policies on other income areas will likely have a larger impact on reducing poverty.

Finally, it should be noted that despite great attention given to the cotton sector,, cash crop income in Koutiala was found to be a considerably smaller share of total income than food crops and was only a slightly larger share than the share of total income earned from nonfarm activities. In addition, evidence shows that cash crops in Koutiala were inequality increasing and that wealthier households earned a larger share of income from cash crops than poorer households. However, before moving policies away from the cotton sector, additional research is needed. First, the cropping years included in this study may not be particularly representative of a normal cotton production year in Koutiala. In particular, due to the late 2007 cotton production payments, many farmers in the zone boycotted cotton in 2008 (Lazarus & Kelly, 2012). As a result, the inequality increasing effect of cotton found in this analysis may mean that wealthier farmers were less likely to abandon cotton production during difficult times for the sector. Also, one should consider that cotton may have a positive, indirect impact on food crop production that is not picked up by this analysis. For example, extra fertilizer provided by the CMDT for cotton

production is often used on cereal crops in the Malian cotton basin (Staatz, Dioné, & Dembélé, 1989). Therefore, further research on the effects of cotton income on poverty levels and inequality in Mali should be performed

7.1 Limitations of this Study

Despite the information learned from this analysis of household incomes, there are several limitations to this study. First, the income data was collected through annual field interviews and required household members to recall all income earned during the previous year. Given that incomes in Mali are rarely salaried and low levels of literacy limit financial record keeping, one year recall data can be inaccurate. Survey collection methods that interview households weekly or monthly about their income levels may result in more accurate income data.

Second, this household survey only included households active in agriculture. As a result, it is possible that some households in the community that are solely involved in nonfarm activities were omitted from the study.

Finally according to the results of the study very few households earned more than a $1/day per capita. While this is possible, this statistic also suggests that there was perhaps under-reporting of household incomes. The under-estimating of income could have several causes. First, not all income-earning household members were interviewed during data collection. As a result, interviewed household members were asked to estimate incomes for household members not present during the interview. Given the large family sizes in Mali, interviewed household members may not have known the exact income levels of other members of their household, leading to under-estimation of household income. In addition, income levels can be sensitive

information that some households may have been hesitant to accurately reveal to survey enumerators.

7.2 Future Research

In addition to the study limitations mentioned above that could be further researched, the results of this study suggest several research areas that could be explored with additional household survey data from Mali. First, additional research on the effect of cotton income on income inequality using data from a typical cotton production year is needed to confirm or refute the finding that cotton is income inequality increasing. Second, the Gini decomposition method used in this thesis cannot identify factors that may contribute to an income source being inequality increasing or decreasing. While this study offers hypotheses on why a given income source may be inequality increasing or decreasing, further research using more complex methods would be needed to confirm these hypotheses. Finally, further research on transfer and remittance incomes could help researchers and policy makers gain a better understanding of the income dynamics in the Tominian zone, where transfer income makes up a sizable share of total income among poorer households.

APPENDICES

Appendix A: Method for Calculating Households Living Above and Below the $1/day Poverty Line

A common poverty line used by international development organizations is based on whether or not household income earnings exceed a $1/day. In order to determine what percentage of the surveyed households fell above or below this threshold, total household incomes reported for Tominian and Koutiala were converted into international dollars using a purchasing price parity approach.

Converting currencies using a purchasing price parity approach is not the same as converting currencies using official exchange rates. In the case of Mali in 2010, the average official exchange rate was 495.28 Franc CFA/1 US dollar (World Bank, 2012d). This compares to the private consumption purchasing price parity conversion factor which was 301.4 Franc CFA per international dollar (equivalent to the purchasing power of one US dollar) in 2010 (World Bank, 2012e). The purchasing price parity approach converts one country's currency into another currency at the rate in which one could buy the same amount of goods in each country. For example, a very simplified purchasing price parity index used by *The Economist* magazine, called the "Big Mac" index, compares the prices of hamburgers sold at MacDonald's in various countries throughout the world. More complex purchasing price party indices, such as those presented by the World Bank, usually compare prices from various countries using a basket of consumer goods. For most purposes, the purchasing price parity approach is believed to be a better indicator of overall well-being than official exchange rates (Callen, 2007). In addition, the United Nations uses this approach in its calculations of households living above and below the $1/day/capita poverty line (United Nations Statistical Division, 2012b). For these reasons, a purchasing price parity approach was used in this thesis.

This appendix briefly covers the three steps used to determine a household's location relative to the $1/day poverty line using a purchasing price parity approach. These steps are:

1) To match the methodology used by the United Nations, the World Bank's purchasing price conversion factor for private consumption from 2010 was used (301.4 Franc CFA per international dollar).
2) In order to convert the reported household incomes into international dollars, the incomes had to be divided by this conversion factor. For example, if a household of 10 people reported earning 1,155,115 Franc CFA in 2010, then the household's annual earnings in international dollars was:

$$\frac{1{,}155{,}115 \text{ Franc CFA}}{\frac{301.4 \text{ Franc CFA}}{1 \text{ International \$}}} = 3{,}832.5 \text{ international \$}$$

3) To determine the household's per capita earnings per day, the international dollars were divided by the number of people present in the household and the number of days in one year. For example, using the household described in Step 2:

$$\frac{\frac{3{,}832 \text{ international \$}}{10 \text{ people}}}{365 \text{ days}} = \$1.05 \text{ per capita per day}$$

This shows that our example household was living above the $1/day poverty line in 2010.

Appendix B / Table 34: Real per Capita Income from Various Sources, Including F-Tests to Determine Statistical Significance of the Income Differences found between Survey Years (in 2010 Franc CFA)

	Tominian				Koutiala			
	2006/07	**2008/09**	**2009/10**	**Signif. (two-tailed)**	**2006/07**	**2008/09**	**2009/10**	**Signif. (two-tailed)**
Cash Crops[1]	-	7,740	5,154	0.009	-	12,798	12,539	0.903
Food Crops[1]	-	20,985	16,637	0.055	-	42,924	37,714	0.084
Food and Cash Crops Combined	30,856	28,725	21,792	0.005	60,485	55,723	50,254	0.036
Livestock	-386	3,306	2,210	0.010	9,471	6,103	4,864	0.071
Ag Wages	213	1,753	156	0.351	5,751	572	789	0.437
Non-Ag Wages	1,065	4,288	2,496	0.041	660	1,625	1,035	0.225
Transfers	9,123	6,162	4,194	0.063	2,052	3,538	14,507	0.343
Other Nonfarm	1,152	7,688	5,084	0.000	11,645	9,462	10,257	0.459

Source: Survey data

[1]Represents a t-test

Appendix C / Table 35: Real per Capita Income from Various Sources, Including T-Tests to Determine Statistical Significance of the Income Differences found between Zones (in 2010 Franc CFA)

	2006/07 Cropping Season			2008/09 Cropping Season			2009/10 Cropping Season		
	Tominian	**Koutiala**	**Signif. (2-tailed)**	**Tominian**	**Koutiala**	**Signif. (2-tailed)**	**Tominian**	**Koutiala**	**Signif. (2-tailed)**
Cash Crops	-	-	-	7,740	12,798	0.090	5,154	12,539	0.000
Food Crops	-	-	-	20,985	42,924	0.000	16,637	37,714	0.000
Crops (Food and Cash Combined)	30,856	60,485	0.000	-	-	-	-	-	-
Livestock	-386	9,471	0.000	3,306	6,103	0.051	2,210	4,864	0.042
Ag Wages	213	575	0.042	1,753	572	0.445	156	789	0.000
Non-Ag Wages	1,065	660	0.527	4,288	1,625	0.034	2,496	1,035	0.140
Transfers	9,123	2,052	0.001	6,162	3,538	0.095	4,194	14,507	0.366
Other Nonfarm	11,512	11,645	0.940	7,688	9,462	0.200	5,084	10,257	0.001

Source: Survey data

Appendix D / Table 36: Average Share of Household Income from Various Sources, Including F-Tests to Determine Statistical Significance of the Income Differences Found Between Survey Years

	Tominian				Koutiala			
	2006/07	**2008/09**	**2009/10**	**Signif. (two-tailed)**	**2006/07**	**2008/09**	**2009/10**	**Signif. (two-tailed)**
Cash Crops[1]	-	15%	14%	0.452	-	14%	16%	0.457
Food Crops[1]	-	49%	53%	0.168	-	59%	57%	0.376
Crops (Food and Cash)	62%	64%	67%	0.666	73%	73%	73%	0.965
Livestock	0%	4%	2%	0.766	8%	6%	5%	0.670
Ag Wages	0%	1%	1%	0.707	1%	1%	1%	0.605
Non-Ag Wages	1%	4%	3%	0.055	1%	2%	1%	0.196
Transfers	16%	12%	13%	0.278	2%	5%	6%	0.003
Other Nonfarm	21%	15%	13%	0.004	15%	13%	14%	0.618

Source: Survey data

[1]Represents a t-test

Appendix E / Table 37: Average Share of Household Income from Various Sources, Including T- Tests to Determine Statistical Significance of the Income Differences found between Zones

	2006/07			2008/09			2009/10		
	Tominian	**Koutiala**	**Signif. (two-tailed)**	**Tominian**	**Koutiala**	**Signif. (two-tailed)**	**Tominian**	**Koutiala**	**Signif. (two-tailed)**
Cash Crops				15%	14%	0.744	14%	16%	0.209
Food Crops				49%	59%	0.002	53%	57%	0.277
Crops Combined	62%	73%	0.099						
Livestock	0%	8%	0.295	4%	6%	0.576	2%	5%	0.224
Ag Wages	0%	1%	0.133	1%	1%	0.311	1%	1%	0.057
Non-Ag Wages	1%	1%	0.608	4%	2%	0.071	3%	1%	0.078
Transfers	16%	2%	0.000	12%	5%	0.000	13%	6%	0.000
Other Nonfarm	21%	15%	0.015	15%	13%	0.211	13%	14%	0.812

Source: Survey data

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