Essays on the Microeconomics of Development in Guatemala

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Dedication

For my darling Elena

Abstract

This dissertation presents results from three studies analyzing the microeconomics of development in Guatemala. Women play a critical role in improving the health and well-being of their children. This is particularly important for countries with high rates of child malnutrition, such as Guatemala. This dissertation first analyzes how women's intra-household bargaining-power impacts their ability to seek information about health and nutrition from a variety of sources. Greater intra-household bargaining power increases women's ability to participate in health information networks. Second, this dissertation finds that women who are more risk averse increase the number of health-information sources that they consult. Finally, among women in this sample, there is no strong relationship between women's risk preferences and the household's ownership of productive assets and diversification of income sources.

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Chapter 1

Introduction

Improving women's health knowledge is of crucial importance throughout the developing world, particularly given that women play a pivotal role in their children's health and nutrition. In rural Guatemala, 69 percent of uneducated mothers' children are severely malnourished. For mothers without any education, overcoming the barrier of illiteracy and acquiring health information are critical first steps to improving the well-being of their children.

Risk preferences and trust in health care providers may determine whom women seek information from regarding health and nutrition. Furthermore, risk preferences may relate to the diversification of income and assets, and in developing countries there are a number of reasons why rural households diversify their income and assets. Income diversification measures are usually directly linked with households' asset stocks, such as livestock or poultry. While risk averse individuals may choose to earn income from a greater number of sources to protect against adverse shocks, such as a poor crop yield in agriculture, it may also be the case that risk averse individuals choose to invest in assets that are less risky.

This dissertation weaves together multiple issues facing poor families in Guatemala. More specifically, it analyzes the role of women's decision-making and preferences as it

relates to participating in health information networks, diversification of health information sources, and the diversification of productive assets and income sources for the household. The following paragraphs summarize how this was done by briefly describing the remaining chapters of this thesis.

Chapter 2 describes the primary data collected by the author in 2014 in Highland Guatemala. It describes the data collected, which consist of data collected using a household survey instrument and an experiment designed to elicit risk preferences. This chapter provides an overview of the key variables used in the empirical analysis, including: measures of women's intra-household bargaining power; information regarding health information networks; health knowledge; relative trust in a doctor or pharmacist; and an experiment to elicit risk preferences. A total of 248 women in 18 randomly chosen villages in the Department of Sololá participated in the household survey.

In Chapter 3, the first dissertation essay investigates the impact of increased women's intra-household bargaining power, one aspect of economic empowerment, on women's participation in both formal and informal health information networks to obtain information about child health and nutrition. This essay further extends the "standard" conceptualization of bargaining power, which reflects one aspect of empowerment, to include a woman's decision-making influence over: household expenditures; agricultural production; decisions on income generated from agricultural production; productive capital and assets; and decisions about credit. The findings suggest that increased women's intra-household bargaining power increases women's participation in both formal and informal health information networks. This increased bargaining power has implications for increasing a woman's capability to participate in informal networks, including family, friends and neighbors, and to improve her social support network. The results also show that an increase in participation in more formal networks of knowledge – such as trained medical professionals, books or brochures – is what leads to more accurate child health knowledge.

In Chapter 4, the second essay in this dissertation analyzes the relationship between: (i) risk aversion and health information-seeking behavior; and (ii) risk aversion and relative trust in a doctor or pharmacist. The analysis in this paper is motivated by a

framework that incorporates risk aversion into women's decision-making as it relates to income and health, and tests this relationship empirically. The results show that risk averse women consult with a greater number of distinct health information sources, thus diversifying where they get their information, but not necessarily by increasing the frequency of getting their information. Risk averse women are also less dependent on their families for child health knowledge. Finally, the greater a woman's knowledge of child health, the less relative trust she has in either a pharmacist or a doctor. Based on these findings, this study discusses mechanisms to better target health information campaigns to improve marginalized women's knowledge of child health.

In Chapter 5, the third dissertation essay focuses on diversification of household assets and income sources. Poor households are more likely to be hurt by income fluctuations and shocks. Diversifying agricultural assets and income sources is a crucial strategy employed by the poor to meet their critical needs, mitigate risks, respond to shocks, and provide a personal safety net. Bardhan and Udry (1999) argue that income diversification is a method for reducing unwanted variance in income, especially in an environment where savings, credit, and insurance markets are inaccessible or inefficient. Agricultural production is a common source of income in rural areas of developing countries, and improving assets related to agriculture may be a means of poverty alleviation. This essay delves into the role of women's risk preferences in influencing their households' asset portfolio and income diversification. While one might expect risk averse individuals to diversify their household's sources of income, the results from this study provide only limited evidence that this is occurring.

Together, the essays in this dissertation shed light on the ways in which poor women make decisions related to health and overall livelihoods. This dissertation contributes to a growing body of research at the intersection of health economics and development economics, presenting research that makes use of original data collected by the author in a remote region of Guatemala.

Chapter 2

Data and Setting

This section describes Highland Guatemala, where the data were collected, as well as the survey instrument and the sample of women who participated in the study. A total of 248 women in 18 randomly chosen villages in the Department of Sololá participated in the household survey. Figure 2.1 shows a map of the sample of households that participated in the study.

Households were randomly chosen within each village to be interviewed. Enumerators asked to speak with the main female decision-maker in each household, and this was the person who responded to the survey questions. The majority of the survey respondents were the main female decision-maker in the household, while nine percent identified themselves as the daughter of the main female decision-maker and six percent as the daughter-in-law. In the case of a daughter or daughter-in-law responding to the survey, they appear to be the main female decision-maker in the household, but did not identify themselves in this role, possibly out of respect for the older generation. The majority (93 percent) of women in the sample live in households that have both male and female principal decision-makers in the household, and it is not uncommon for multiple generations to live in the same household in this region of Guatemala.

In Guatemala, women's involvement in agriculture has increased since the forty-year-long armed conflict ended in 1996. Garrard-Burnett (2000) reports that since

the armed conflict ended women heads of household have branched into commercial agricultural production, a traditionally male-dominated activity. The percent of land area that is dedicated to agriculture has also increased significantly in the past fifty years in Guatemala. In 1961, only 25 percent of land area was used for agriculture, but by 2011 this had increased to 41 percent (World Bank, 2012).

Gender relations strongly favor men in the agricultural sector in Guatemala as men are more likely to specialize in major crops or participate in other significant sources of household income generation (Carter, 2002). Less than 30 percent of married female household heads have land of their own, and they exert less control over the management of their land or the use of income generated from their land than do their single female household head counterparts (Katz, 1995). Even though women are allowed to own land titles by law in Guatemala, they are limited by illiteracy, custom, and ignorance of the law (Garrard-Burnett, 2000). While not many women own land, increasing their control over land management and agricultural production has the potential to improve household welfare.

Challenges extend beyond land ownership and agricultural production in Highland Guatemala, where the mostly Mayan indigenous populations may face challenges regarding the acquisition of health knowledge. Schooley et al. (2009) cites language barriers as limiting Mayan women's access to accurate information about health services and health information. There are over 20 distinct Mayan languages in Guatemala, and it is not uncommon for men and women in rural areas to speak only a Mayan indigenous language and not Spanish, the official national language (Schooley et al., 2009).

Access to health care practitioners is limited in the Highlands of Guatemala, which may lead individuals to seek health information and care from non-professionally trained sources. Goldman and Heuveline (2000) analyze the relationship between child illness and health-seeking behavior using the 1995 Guatemalan Survey of Family Health. They focus on children who became ill with diarrhea or respiratory diseases, and find that families are more likely to seek a health care provider for intestinal symptoms than for respiratory problems, and are more likely to do so when the mother perceives the illness to be serious. They also find that most of the children in the sample receive some

form of treatment and that the health care providers most likely to be consulted are pharmacists, who generally do not have any professional training in Guatemala.

The remainder of this chapter is organized as follows. Section 2.1 describes the households and individuals who participated in the study. Section 2.2 summarizes the questions from the Women's Empowerment in Agriculture Index that are used to calculate women's agricultural bargaining power. Section 2.3 focuses on the different types of productive assets and sources of income for the household. Turning to health, Section 2.4 describes measures of health information networks and Section 2.5 summarizes the measures of health knowledge. Section 2.6 reports the measure of relative trust in health care providers and, finally, Section 2.7 describes the experiment to elicit risk preferences.

2.1 Survey Households

Highland Guatemala is comprised of mostly Mayan indigenous people, many of whom face high levels of poverty and illiteracy. In fact, Guatemala has one of the highest adult illiteracy rates in Latin America at 25 percent,[1] with 31 percent of adult women (aged 15 and older) illiterate[2] (United Nations, 2011; World Bank, 2012). Table 2.1 provides summary statistics for the sample of women interviewed, along with information about their household. The sample of women in this study are mostly Cakchiquel speaking Maya (94 percent), followed by native Spanish speakers (six percent) and one woman who speaks Quiché Maya. Oftentimes, the Mayan dialect is their native language and Spanish is their second language.

The women who participated in this study range in age from 18 to 70 years old, with an average age of 35 years. True to the region, there are high illiteracy rates among the sample; 45 percent of women in the sample are illiterate and 39 percent never attended school. Most of the illiterate women in the sample cannot read or write, but a few can either sign their name or read some things, but not write. On average, women live in

[1] The adult illiteracy rate is from 2010.
[2] The adult women illiteracy rate is from 2009.

households with 7 people, including 3.4 children. The average house has three rooms, electricity, a metal roof, a cement floor, a pit latrine, and drinking water piped into the yard. An index proxying for wealth was created using the characteristics of the dwelling.[3]

2.2 Bargaining Power and the Women's Empowerment in Agriculture Index

Questions from the Women's Empowerment in Agriculture Index (WEAI) were used to measure women's bargaining power within the household.[4] The WEAI was originally designed as a monitoring and evaluation tool for the U.S. Government's Feed the Future Program, but can also be used to measure the extent of women's empowerment in agriculture (Sraboni et al., 2014). In developing the index, Alkire et al. (2013) focus on five dimensions of empowerment: decisions over agricultural production; ownership, access, and decision-making power over productive resources; sole or joint control over income and expenditures; leadership in the community; and the allocation of time dedicated to productive tasks, domestic activities, and leisure.

For the purpose of this study, an index of women's household bargaining power in agriculture is calculated using components of the WEAI. More specifically, the dimensions of empowerment that relate to intra-household bargaining power are used in this study. The sections included in the index of bargaining power used in the analysis are shown in Table 2.2 and include: (A) household decision-making; (B) agricultural

[3]The index was calculated using principal component factor analysis following Filmer and Pritchett (2001). The following sets of dummy variables are included in the index: roof material, floor material, overall household condition, number of rooms, type of toilet, drinking water source, electricity, and type of cooking fuel. The first principal factor has an eigenvalue greater than one, a desirable result, indicating that there is consistency in the underlying relationship between the household characteristics. Further, the factor loadings for all of the variables are positive.

[4]The survey questions from the WEAI used in the calculation of women's bargaining power are provided in Appendix A.

decision-making; (C) access to productive capital; and (D) access to credit.[5] The individual questions were summed within each section and range from zero to one. The questions in the sections on household and agricultural decision-making are scaled responses of the extent to which a woman feels she can provide input into the decision. The questions in the sections on access to productive capital and credit are binary variables indicating whether the woman has either sole or joint decision-making power. There is no distinction made between sole or joint decision-making power because it is ambiguous as to whether one is preferred over the other. It could be the case that being the sole decision-maker is an indicator of more power, but it could also be the case that making a decision jointly is a sign of a positive relationship and mutual empowerment.

Equation (2.1) calculates the women's bargaining power in agriculture, W_i, for each individual, i, used in this study.

$$W_i = \frac{\frac{1}{I^A}\sum_{a=1}^{6} S_a^A + \frac{1}{I^B}\sum_{a=1}^{5}\sum_{j=1}^{2} I^B(S_{aj}^B) + \frac{1}{I^C}\sum_{a=1}^{14}\sum_{j=1}^{2} I^C(S_{aj}^C) + \frac{1}{I^D}\sum_{a=1}^{5}\sum_{j=1}^{2} I^D(S_{aj}^D)}{I[A] + I[B] + I[C] + I[D]} \tag{2.1}$$

First, for each type of asset or activity, there is an indicator variable, I, reflecting if someone in the household reports ownership over or participation in that asset or production. The superscripts denote the section (A, B, C, or D) and a represents the areas within each section. For example, within section (D) access to credit, there are five areas a: non-governmental organizations, informal lenders, formal lenders, friends or relatives, and group-based loans. For each area a, the subscript j represents the individual questions asked about each type of decision (such as input into decisions generally and input into into decisions regarding the income generated) and S simply represents the survey questions. If there is more than one question per area, the survey question, S is denoted with j. Finally, the summation for each section is divided by the

[5]For this index of agricultural bargaining power, the original WEAI section on leadership in the community was excluded because the focus of this paper is on decision-making within the household. In addition, time allocation survey questions of the original WEAI were not collected because they are beyond the scope of this study.

number of assets that the individual responds the household either owns or participates in that area. This will control for the number of assets, areas of production, or sources of credit within the household so that women in households with a larger number of assets do not appear to be more empowered.

For example, if a woman lives in a household that has no access to credit, the last section of the equation, $\frac{1}{I^D}\sum_{a=1}^{5}\sum_{j=1}^{2} I^D(S_{aj}^D)$ will equal zero. This indicates that the woman does not have any empowerment with respect to access to credit because the household isn't even participating in credit markets. The entire equation will be divided by three rather than four since the household only participates in three of the four areas of decisions. However, if a woman lives in a household that has access to two, out of five total, types of credit (formal loans and group-based loans), her answers to the questions, "Who made the decision to borrow?" and "Who makes the decisions about what to do with the money/item borrowed" will be summed. If she participates (either solely or jointly) in both the decision to borrow and use of funds for the group-based loans, but only to the decision to borrow for the formal loans, then $\frac{1}{I^D}\sum_{a=1}^{5}\sum_{j=1}^{2} I^D(S_{aj}^D) = \frac{3}{4}$. When summed over all four sections, this index W_i tells us how empowered a woman is within her household to make decisions regarding the household assets, income generation, agricultural production and credit.

Table 2.2 reports summary statistics for normalized variables included in the calculation of the women's empowerment in agriculture index. This indicates the percent of women who are participating in the decision-making related to each activity. The calculation of women's bargaining power also includes the extent to which women feel that they can make decisions about the items in the sections on household and agricultural decision-making. Each of the four sections are scaled from zero to one, so together they range from zero to four. the majority of women fall between two and three on the four-point scale. Before use in estimations, this women's empowerment variable was normalized to have a mean of zero and standard deviation of one.

2.3 Asset Accumulation, Sources of Income, and Diversification

Women in this study were asked about the different types of income-generating activities for their households. The top panel of Table 2.3 reports summary statistics on the different types of income-generating activities of these women's households. The different types of income sources include: food crop farming, cash crop farming, livestock raising, non-farm economic activity, and wage or salary employment.

The most common source of income in Highland Guatemala is food crop farming, with 76 percent of the sample households participating in this form of income-generation. Fewer households, 45 percent, participate in cash crop farming. Some of these cash crops include high-value nontraditional agricultural export crops, such as broccoli and snow peas, and there is evidence from Hamilton, Asturias, and Tevalan (2001) that women are participating in the cultivation and harvesting of these crops in Guatemala. Katz (1995) finds that women in Guatemala transfer labor time to these traditionally male-dominated nontraditional cash crop activities. In this sample, 70 percent of women (in households that are engaged in cash crop farming) report that they participate in the household decisions related to cash crop farming. Over half (60 percent) of households earn income from wage or salary employment. Least common among this sample is livestock raising, with only 19 percent of households earning income from livestock. Income diversification is calculated as the sum of the number of different income-generating activities for the household.[6] Overall, households with two household decision-makers have 2.4 different sources of income on average, while female-only decision-maker households have 2.1 sources of income. Eleven households (4.4 percent) report no source of income, while 13 (5.2 percent) report having all five sources of income.[7]

The middle panel in Table 2.3 reports summary statistics on the types of productive capital used in the calculation of asset diversification. These assets are mostly

[6] Ideally, the shares of income from each source would be used to calculate an index, such as the Herfindahl or Herfindahl-Simpson concentration indices. Unfortunately, these data do not include information on the shares of income from each source, so this is not possible.

[7] It is possible that the list of income sources used in this survey did not include all of the potential sources and these eleven households earn income from an excluded source, such as remittances.

agricultural in nature and include: agricultural land, non-agricultural land, large livestock, small livestock, poultry, and non-mechanized farm equipment. These assets were recorded in the survey as binary variables that indicate whether the household owns each type of asset. The table also reports information about women's participation in decisions related to each type of asset. Very few households own land, 13 percent own agricultural land and 3 percent own non-agricultural land. Katz (1995) finds that less than 30 percent of married female household heads have land of their own, and that they exert less control over the management of their land or the use of income generated from the land relative to their single female household head counterparts. Further, even though women are allowed to own land titles by law in Guatemala, they are limited by illiteracy, custom, and ignorance of the law (Garrard-Burnett, 2000). A common productive asset in this area of Guatemala is poultry, mainly chickens; 65 percent of households own chickens and 88 percent of women participate in decisions regarding poultry farming. Only 10 percent of households own non-mechanized farm equipment and, in these households, only one-third (33 percent) of women participate in the decision to sell, rent, or purchase equipment. The asset diversification index is the sum of the number of types of productive capital a household owns. On average, households have 2.9 different types of productive assets. Only three households have all six of these assets, while eleven households report having none of these productive assets.

Finally, the bottom panel in Table 2.3 reports other forms of assets not included in the productive asset diversification measure, including: fishing equipment, mechanized farm equipment, on-farm business equipment, a house, small and large consumer durables, cell phones, and means of transportation. Almost half (46 percent) of households have cell phones, while almost no households own mechanized farm equipment. Among the 30 percent of households who own the house they are living in, or some other secondary structure, 57 percent of women report that they participate in the decision to sell, rent, or purchase a house. On average, households have 3.2 different types of other forms of assets.

2.4 Measures of Health Information Networks

The household survey questionnaire contains a series of questions on child health information sources, which are used to identify women's health information networks. Women participating in the study were asked, "How many times in the last year have you received information about child health?" from eleven different sources. The response options were originally on a four-point scale, but were recoded for estimation purposes as an approximate number of times per year.[8] Table 2.4 provides summary statistics on the number of times women obtained new information about child health in the last twelve months from the different sources. On average, women consulted with 7.1 different types of health information sources in the last year; however, women identified consulting an average of only 3.3 different sources more than twice per year.

The empirical results use the total number of sources consulted to represent the amount of women's time dedicated to gathering health knowledge, which was defined as x_k in the model in Chapter 4. These different sources of health knowledge can be aggregated into more general types: written information sources; formally-trained information sources; informal sources, such as social network sources including family, friends, and neighbors; untrained pharmacists; and community health workers. The written sources include books or brochures, magazines, and the internet. Formally-trained sources refer to doctors or nurses. Pharmacists are kept as a separate category since they are not required to have any specific training in Guatemala. Finally, there is a category for a woman's social network, including: family, friends, and neighbors. Table 2.4 shows that community health workers, nurses, and family are the three most common sources of information about child health, while the internet is the least frequent. Formal information sources are likely to be more accurate than social-network-based information sources or the untrained community pharmacists.

[8] The original response options are: (1) never; (2) once or twice in the last year; (3) more than once or twice, but less than once per month; and (4) more than once per month. This was recoded to be the approximate number of times per year: (1) zero; (2) one and a half; (3) seven; and (4) eighteen. Robustness checks show consistency in the results based on both a decrease and an increase in the latter two approximations.

2.5 Measures of Health Knowledge

To measure knowledge of child health and nutrition, each woman in the study answered a series of ten questions in an attempt to measure the accuracy of her child health knowledge. Christiaensen and Alderman (2004) use a mother's ability to judge correctly whether her children's growth status is normal as a proxy for maternal nutritional knowledge. They find considerable gains in reduced child stunting from improving a mother's nutritional knowledge. In Guatemala, where almost half of all children are chronically malnourished (stunted), normal growth status may not be a precise measure of maternal health knowledge. For this study, a health knowledge index is calculated from a linear combination of the ten questions related to knowledge about children's health and nutrition. These questions were developed based on both the literature, particularly Glewwe (1999), and findings from interviewing local health personnel in the Highland area of Guatemala prior to data collection.

For simplicity of understanding during enumeration, the ten questions were converted into true or false statements. These survey items include questions on the best method to reduce diarrhea in children, how to identify whether a child is malnourished, what to do to avoid infection in a wound, how to have safe drinking water, when to introduce solid foods to babies, the risks of smoke in the household, and signs of respiratory infection.[9] Table 2.5 reports summary statistics for the variables included in the calculation of the health knowledge index. Of the ten questions, the total answered correctly ranged from four to ten, with an average of 8.3 questions correct. The table also shows that the survey item most frequently answered correctly was the question regarding the use of vaccinations as the best method for avoiding polio in children. Similarly, over 90 percent of women reported correctly that a lack of growth in height is a sign of child malnutrition, that coughing and a runny nose are signs of a respiratory infection and that smoke in the household is bad for an infant's lungs. These findings are not surprising given that respiratory infections are common in this region and that there have been many public health campaigns recently which installed chimneys to reduce the amount of smoke in homes.

[9]The full list of child health knowledge questions can be found in Appendix B.

2.6 Relative Trust

Trust refers to an individual's belief that others are reliable - a subjective probability assigned by that individual to another person taking an action that benefits her or him (Schechter, 2007). However, an individual's reported trust may not be reflected in his or her behavior (O'Neill, 2002). Research in the area of trust raises important considerations, including the competence of the trustee and the underlying motives of the trustee. The use of advice from a specific source depends on two factors affecting an individual's trust in that source: the previous accuracy of advice from that source and the similarity of values between an individual and that source (Siegrist, Earle, and Gutscher, 2003; Twyman et al., 2008). Siegrist, Gutscher, and Earle (2005) model trust and confidence and find that greater trust and confidence, the latter defined as a conviction that uncertainty is low, reduced perceived risks. Evidence suggests that both risk preferences and trustworthiness are highly correlated with the decision to trust (Eckel and Wilson, 2004; Schechter, 2007). This study focuses on health-information-seeking behaviors and, as such, asked women about their relative trust in health care providers.

The measure of relative trust used in this study was elicited during the household survey. Women were asked to identify who they trust more, a doctor or a pharmacist, in order to capture a measure of relative trust in health care providers. However, a number of women responded to this question by saying they trust neither a doctor nor a pharmacist. The enumerators followed up on this response and those who said that they trust neither said that they trust God, a nurse or midwife, the community health center, or traditional natural medicine. In comparing the relative trust of women in the sample, there is a significant difference between literate and illiterate women. Of those who cannot read or write, 67 percent report that they have relatively more trust in a doctor, compared to 85 percent of literate respondents. Only 12 percent of literate women reported relatively higher trust in a pharmacist, while 22 percent of illiterate women reported greater relative trust in pharmacists. Table 2.6 provides descriptive statistics related to relative trust and shows a statistically significant difference by women's literacy levels in their trust in a doctor or a pharmacist.

2.7 Experimental Measures of Risk Preferences

Women make decisions incorporating their risk preferences, including whether to consult with formally-trained health sources or with non-formal sources such as untrained pharmacists or those in their social network. The empirical evidence that risk preferences matter for decision-making in developing countries has increased dramatically since the seminal papers on eliciting risk through field experiments by Binswanger (1980, 1981). The risk game used in this study to measure choice under uncertainty follows recommendations from Cardenas and Carpenter (2008) for populations lacking literacy and numeracy skills. Dave et al. (2010) offer a method for simplifying the method of Eckel and Grossman (2008a), particularly when participants lack literacy and numeracy skills. Further simplifying the method in Dave et al. (2010), women in this study faced the same chances for receiving a high and a low payoff in each of the gambles. This approach is consistent with Holt and Laury (2002) and the simple risk aversion measure used to elicit preferences in several Latin American countries by Cardenas and Carpenter (2013). The game offers a measurement of women's willingness to take risks by choosing gambles with greater variance in the payoffs.

Women were given a choice of six cash gambles.[10] Individuals were shown a sheet of paper with six options, each of which show a circle, half of which is colored red (50 percent chance of low payoff) and the other half of which is colored blue (50 percent chance of high payoff). Inside the colored halves of the circle, the payoffs are written in common currency form, such as 10Q, where Q represents the Guatemalan currency, Quetzales ($1 = 7.7 Guatemalan Quetzales). Women were asked to choose one of the six gambles, each of which have equal probabilities of the high and low payoffs occurring. Next, three blue chips and three red chips were placed into a paper bag. The enumerator showed the individual the six chips before placing them in the bag, and then randomly drew one. If the chip drawn was red, the woman received the low payoff and if the blue chip was drawn the woman received the high payoff.

The relationship between the expected return and risk is shown in Figure 2.2. The

[10] Appendix C shows the visual representation of the game shown to women in the sample.

gambles increase in risk as well as in the expected return from Gamble 1 to Gamble 5, at which point the expected return stays constant, but the risk increases, for Gamble 6. In the risk aversion game, risk averse individuals will choose the lower risk, lower return gambles, such as Gamble 1 or Gamble 2. In Gamble 1 there is no risk involved. Both the expected return and the risk gradually increase with each gamble. Gambles 5 and 6 have the highest expected return. Finally, risk loving individuals will choose Gamble 6, which has the same expected return as Gamble 5, but has an increased level of risk.

Table 2.7 summarizes the gamble choices by showing the low and high payoffs associated with each outcome, the expected return, and the standard deviation or risk of each gamble. The low and high payoffs are in quetzales (Q), the currency in Guatemala. The standard deviation of the expected payoff represents a measure of risk. The final column shows the frequency with which each of the options were chosen among the 248 women in the sample. The frequencies show that more than twice as many women chose the riskiest option (27.0 percent) than chose the option with zero risk (12.5 percent). Further, the three riskiest options were chosen much more frequently (69.8 percent) than the three least risky options (30.2 percent). This indicates that most women viewed the increase in the expected return as more valuable than the cost of increased risk, but it is also possible that some women did not fully understand the different gambles.

Figure 2.1: Map of Sample in Sololá, Guatemala

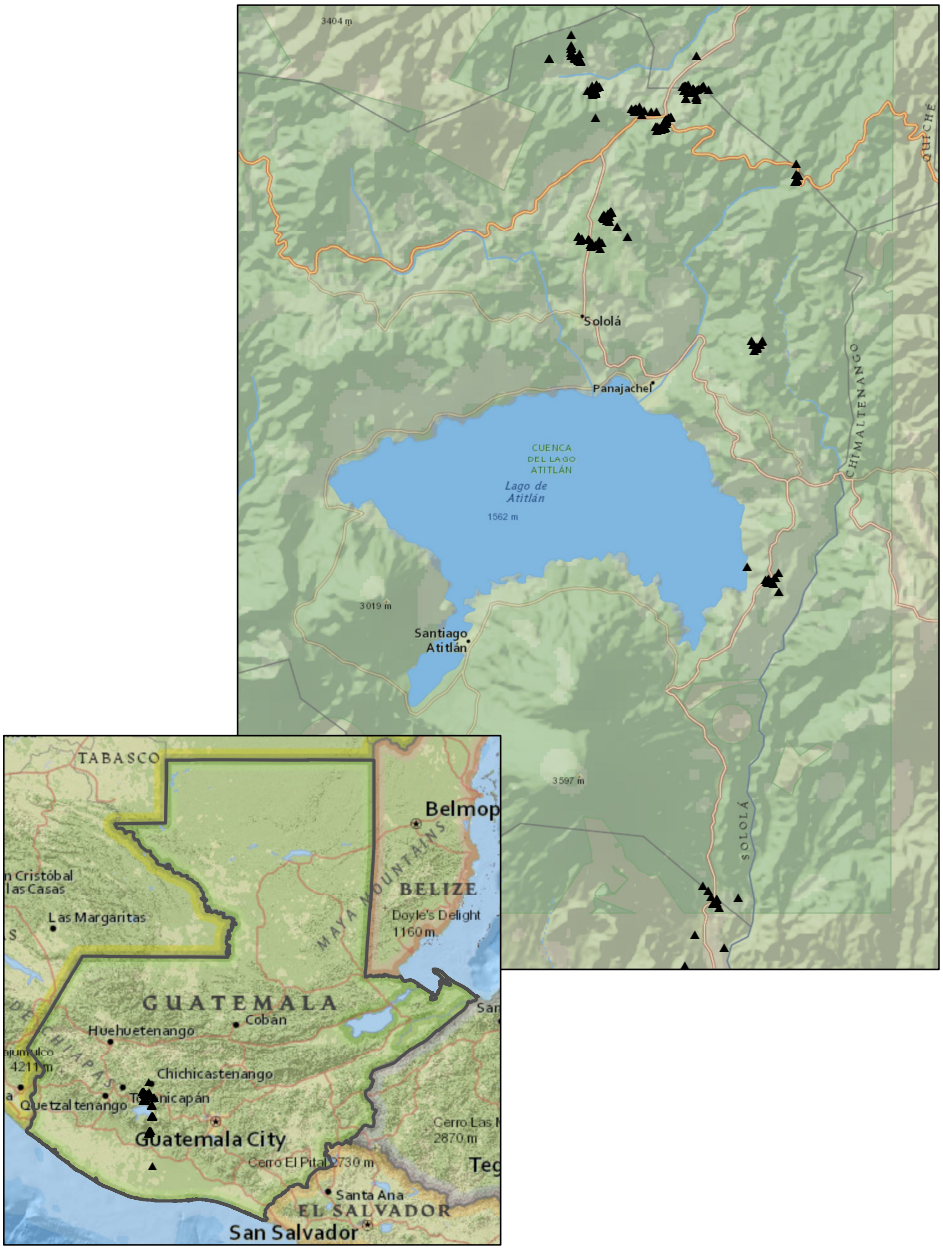

Figure 2.2: Risk and Return of Gamble Choices

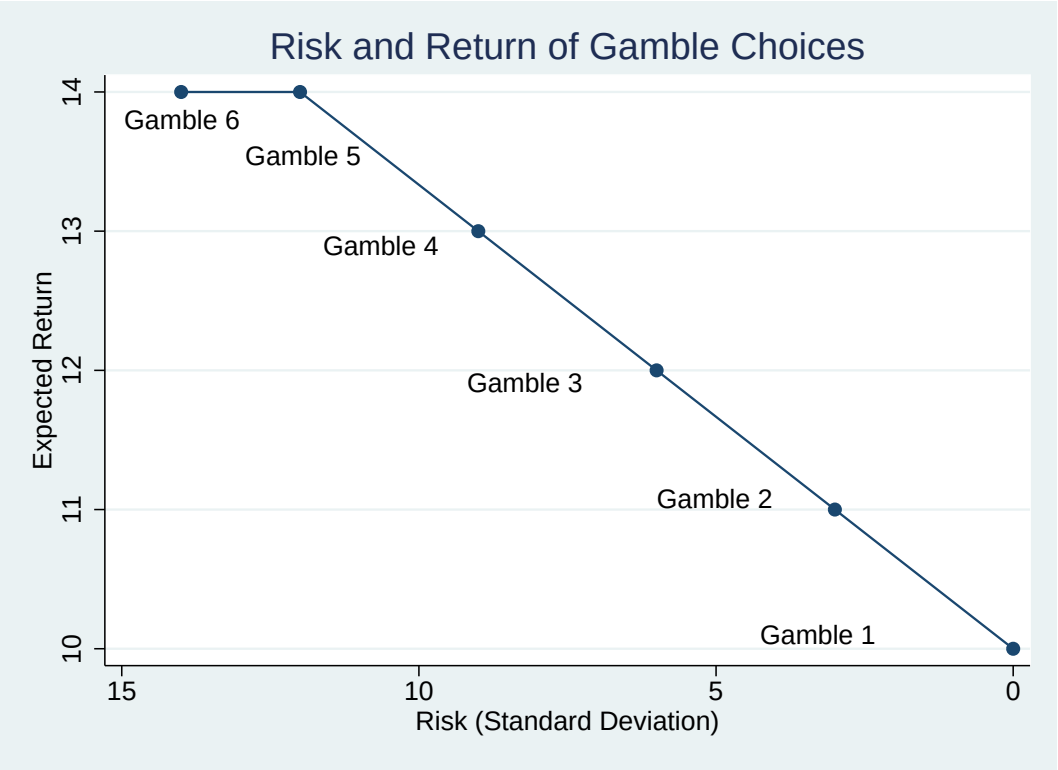

Table 2.1: Summary Statistics

	Mean	**Standard Deviation**
Age	35.04	11.37
Age Gap between Male & Female Household Heads	3.95	5.69
Cakchiquel Language	0.94	0.25
Literate	0.55	0.50
Completed Primary School	0.46	0.50
Completed Secondary School	0.09	0.29
Household Size	6.94	2.87
Number of Children	3.40	2.62
Number of Rooms	2.88	1.44
Electricity	0.94	0.23
Metal Roof	0.84	0.37
Wood Roof	0.04	0.20
Earth Floor	0.35	0.48
Cement Floor	0.55	0.50
Piped Water into House	0.37	0.48
Piped Water into Yard	0.51	0.50
Flush Toilet	0.07	0.25
Pit Latrine	0.71	0.45
Firewood as Cooking Fuel	0.97	0.17
Gas as Cooking Fuel	0.03	0.17

n=248

Table 2.2: Women's Household Decision-Making Summary Statistics

	n	Mean	Mean
A. Household Decision-Making		**Decision**	
(1) Agricultural Production	219	0.52	–
(2) Inputs for Agricultural Production	220	0.52	–
(3) Crop Type	219	0.53	–
(4) Serious Health Problem	246	0.63	–
(5) Wage or Salary Employment	246	0.54	–
(6) Household Expenditures	246	0.65	–
B. Production and Income Generation		**Decision**	**Income Use**
(1) Food Crop Farming	190	0.68	0.69
(2) Cash Crop Farming	110	0.70	0.71
(3) Livestock Raising	47	0.64	0.65
(4) Non-Farm Economic Activities	101	0.76	0.77
(5) Wage and Salary Employment	149	0.71	0.71
C. Access to Productive Capital		**Sell or Rent**	**Buy New**
(1) Agricultural Land	201	0.50	0.52
(2) Large Livestock (oxen, cattle)	41	0.63	0.54
(3) Small Livestock (goats, pigs, sheep)	52	0.69	0.67
(4) Chickens, Ducks, Turkeys, Pigeons	192	0.87	0.88
(5) Fish Pond or Fishing Equipment	8	0.88	0.88
(6) Farm Equipment (non-mechanized)	196	0.33	0.37
(7) Farm Equipment (mechanized)	2	1.00	1.00
(8) Non-farm Business Equipment	5	0.50	0.50
(9) House (and other structures)	245	0.57	0.57
(10) Large Consumer Durables (TV)	131	0.62	0.61
(11) Small Consumer Durables (radio)	157	0.63	0.64
(12) Cell Phone	194	0.64	0.63
(13) Non-Agricultural Land	33	0.64	0.52
(14) Means of Transportation	55	0.38	0.38
D. Access to Credit		**Borrow**	**Loan Use**
(1) Non-Governmental Organization	7	0.71	1.00
(2) Informal lender	5	0.20	0.40
(3) Formal lender	51	0.45	0.63
(4) Friends or relatives	9	0.56	0.78
(5) Group based micro-finance or lending	14	0.64	0.93

Table 2.3: Household Agricultural Assets and Income-Generating Activities and Female Decision-Making

		Mean Household Participation	Mean Female Decision-Making
Income Generation	(1) Food Crop Farming	0.76	0.68
	(2) Cash Crop Farming	0.45	0.70
	(3) Livestock Raising	0.19	0.64
	(4) Non-Farm Economic Activities	0.41	0.76
	(5) Wage and Salary Employment	0.60	0.71
	Average Total Sources of Income	**2.41**	–
Productive Capital	(1) Agricultural Land	0.13	0.50
	(2) Non-Agricultural Land	0.03	0.64
	(3) Large Livestock (oxen, cattle)	0.05	0.63
	(4) Small Livestock (goats, pigs, sheep)	0.14	0.69
	(5) Chickens, Ducks, Turkeys, Pigeons	0.65	0.87
	(6) Farm Equipment (non-mechanized)	0.10	0.33
	Average Total Number of Productive Assets	**2.89**	–
Other Forms of Assets	(1) Fish Pond or Fishing Equipment	0.01	0.88
	(2) Farm Equipment (mechanized)	0.00	1.00
	(3) Non-farm Business Equipment	0.02	0.50
	(4) House (and other structures)	0.30	0.57
	(5) Large Consumer Durables (refrigerator, TV)	0.23	0.62
	(6) Small Consumer Durables (radio)	0.29	0.63
	(7) Cell Phone	0.46	0.64
	(8) Means of Transportation	0.02	0.38
	Average Total Number of Other Assets	**3.24**	–

Table 2.4: Average Annual Number of Consultations of Health Information Sources

Child Health Information Sources	Mean	Standard Deviation
Books or brochures	1.71	4.20
Newspaper or Magazine	1.33	3.72
Internet	0.18	0.93
TV or radio	3.64	6.07
Family	7.52	7.55
Friends	2.78	4.85
Neighbors	4.54	6.19
Pharmacists	2.74	4.83
Community Health Worker	11.51	7.37
Doctor	5.33	6.79
Nurse	12.09	7.28
Summary by Source Type		
Total Annual Visits to All Sources	53.19	27.23
Total Annual Visits to Formally Trained Information Sources	35.61	18.47
Total Annual Visits to Social Network Information Sources	14.84	14.25
Total Annual Visits to Pharmacists	2.74	4.85
Total Number of Sources	7.12	1.79
Number of Sources Consulted More Than Twice Per Year	3.33	1.73

n=248

Table 2.5: Child Health Knowledge Summary Statistics

Child Health Knowledge	**Mean**	**Standard Deviation**
Q1. Diarrhea treatment	0.82	0.38
Q2. Signs child is malnourished	0.95	0.22
Q3. Avoiding infection in a wound	0.65	0.48
Q4. Polio vaccination	0.98	0.13
Q5. Safe drinking water	0.56	0.50
Q6. Introducing solid foods	0.80	0.40
Q7. Signs of respiratory infection	0.94	0.25
Q8. Baby sleeping position	0.82	0.38
Q9. Danger of smoke in house	0.95	0.22
Q10. Complimentary foods for babies	0.83	0.38
Total Answered Correctly	8.31	1.35

n=248

Table 2.6: Relative Trust Summary Statistics

	Illiterate		**Literate**		**Difference**
	n	Mean (s.d.)	n	Mean (s.d.)	χ^2 (p-value)
Relative Trust in Doctor	107	0.67 (0.47)	136	0.86 (0.36)	14.634*** (0.002)
Relative Trust in Pharmacist	107	0.22 (0.41)	136	0.11 (0.33)	10.778** (0.013)
Relative Trust in Neither	107	0.10 (0.31)	136	0.03 (0.17)	6.005 (0.111)

n=243

Table 2.7: Risk Aversion Gamble Choices

Choice (50/50 Gamble)	**Low Payoff**	**High Payoff**	**Expected Return**	**Standard Deviation of Payoff**	**Fraction of Subjects Who Chose (%)**
Gamble 1	10Q	10Q	10Q	0	12.5%
Gamble 2	8Q	14Q	11Q	3	7.6%
Gamble 3	6Q	18Q	12Q	6	10.1%
Gamble 4	4Q	22Q	13Q	9	22.2%
Gamble 5	2Q	26Q	14Q	12	20.6%
Gamble 6	0Q	28Q	14Q	14	27.0%

Chapter 3

Women's Bargaining Power, Participation in Information Networks, and Child Health Knowledge in Highland Guatemala

3.1 Introduction

Lack of literacy skills can severely impede parents' acquisition of information that they can use to improve their children's health, especially if that information is available primarily through written sources. Guatemala has one of the highest adult illiteracy rates in Latin America at 25.2 percent in 2010, with 30.5 percent of adult women (aged 15 and older) illiterate in 2009 (United Nations, 2011; World Bank, 2012). For mothers without any education, the prevalence of child malnutrition in Guatemala is 69.3 percent, significantly higher than the country-wide average of 48 percent (World Bank, 2012). Glewwe (1999) presents evidence that maternal health knowledge is the crucial skill for improving children's nutritional status, and that such knowledge can be acquired

both through formal and informal education channels. Glewwe's results suggest that information networks can be important channels for the acquisition and dissemination of knowledge, including knowledge of child health and nutrition. As such, illiterate populations in Highland Guatemala often depend on knowledge obtained through verbal advice from community health workers, untrained pharmacists, family, neighbors, and others in their social networks. Informal information networks may, however, be sources of misinformation about child health; for example, informal information networks may contribute to mistaken beliefs. When literacy isn't easily addressed due to a lack of programs, there may be other factors that can affect how women gain knowledge verbally through interacting in networks.

This paper investigates the impact of increased women's intra-household bargaining power, one aspect of economic empowerment, on women's participation in both formal and informal health information networks to obtain information about child health and nutrition. In Guatemala, increased women's bargaining power may translate into positive outcomes for the entire household. This research uses primary data collected in the Guatemalan Highlands, including both a household survey as well as questions from the Women's Empowerment in Agriculture Index (WEAI) to measure bargaining power. There are two sets of analyses in this chapter: the first set estimates the impact of a woman's intra-household bargaining power on her participation in information networks, and the second analyzes the relationship between these formal and informal networks and a woman's actual child health knowledge.

A number of studies have analyzed the relationship between women's intra-household bargaining power and various household welfare outcomes. Quisumbing et al. (1995) show that women play a critical role in meeting the nutritional needs of their families through increased budget shares spent on food. Thomas (1997) finds that increasing the share of household income under women's control increases household budget shares spent on health and education, and may lead to the consumption of more nutritious food. This study examines whether women's bargaining power increases their participation in networks that enable them to learn about child health and nutrition and subsequently increase their health and nutrition knowledge. This study contributes to the literature on women's bargaining power in household decision-making by extending the measure

of bargaining power to include decision-making power over: agricultural production decisions; the use of income generated from agricultural production; household productive assets and expenditures; and credit decisions.

Little attention has been given in the existing literature regarding how women's agricultural bargaining power impacts their participation in formal and informal information networks. Involvement in agricultural production and other marketing decisions may indicate that a woman has more freedom of movement in her daily life to interact with people in the marketplace, other farmers, or financial service providers. Another innovation of this study is the development of a measure of women's health comprehension as well as the development of household survey questions to analyze women's use of different types of child health information sources. The findings show that increased women's bargaining power increases their participation in both formal and informal health information networks and that increased women's participation in formal information networks, in particular, is positively related to improved knowledge of child health.

The remainder of this chapter is organized as follows. Section 3.2 discusses the relevant literature on women's intra-household bargaining power, information networks, and child health knowledge. Section 3.3 presents the empirical framework. Section 3.4 presents the estimation results, which are discussed in two parts, one on the impact of women's bargaining power on the participation in information networks and one on the relationship between these information sources and actual child health knowledge. Finally, Section 3.5 discusses the implications of the results of this study and draws conclusions.

3.2 Literature Review

This section briefly reviews the literature relevant to this study, including the literatures on women's bargaining power, on information networks, and on child health knowledge. This research conceptualizes one aspect of women's economic empowerment, intra-household bargaining power, as an individual's ability to make decisions within

the household. Women's intra-household decision-making power is only one aspect of women's empowerment, which also includes confidence, voice, agency, and leadership. According to Kabeer (2001), empowerment is the expanding of people's ability to make strategic life choices, particularly in contexts where this had been denied to them. From interviews conducted in Guatemala, women generally defined empowerment as the capability to make decisions and have equality with men (Alkire et al., 2013). This study analyzes a woman's intra-household decision-making power as it relates to her ability to access both formal and informal information networks that can be used to learn about child health.

Social networks, such as family and friends, are important sources of information for populations with high illiteracy rates, and so they can be used to overcome problems due to incomplete information. Informal information sharing can be central to improving household welfare, particularly when that information directly improves the well-being of children within the household. However, there is also the risk of acquiring misinformation, particularly in places where there are high illiteracy rates, because of the dependence on word-of-mouth for information. Social networks enable someone to overcome barriers, such as imperfect information or access to credit (Cardenas and Carpenter, 2008; Karlan, 2005). This is important for this study because it could be the case that individuals trust their family, friends and neighbors more than they trust medical professionals and, thus, more frequently seek information about child health from non-professionals.

Studies show that women play a critical role in meeting the nutritional needs of their families through access to food and nutrition (Quisumbing et al., 1995; Smith, Ruel, and Ndiaye, 2005). Thomas (1997) finds that increased income under women's control has a causal impact, leading to larger budget shares spent on human capital, health, education, and he suggests that it also led to higher nutritional value in food consumed. Thomas, Contreras, and Frankenberg (2002) analyze both a husband's assets at marriage and his wife's assets at marriage in Indonesia and find that more powerful wives allocate resources towards goods and services in a way that positively impacts child health, after controlling for total household income. While there are many different factors that determine bargaining power within the household, asset ownership has often

been used as a proxy for bargaining power. Friedemann-Sánchez (2006) argues that women's household bargaining strategies rely on several assets: kin networks; labor-related networks; and physical and financial assets. She finds that property ownership in Colombia increases women's intra-household bargaining power by providing women with both leverage in household negotiations and fall-back options. Quisumbing (1994) argues that inherited landholdings are a valid measure of bargaining power. Further, Agarwal (1997) finds that land rights improve women's bargaining power. Deere and Doss (2006) argue that assets increase a woman's empowerment and well-being not only in the household, but in the community and in other public arenas as well. Drawing on research conducted in Bangladesh, Kabeer (2001) evaluates the empowerment potential of access to credit and finds that access to credit appears to impact gender differences in decision-making.

In Highland Guatemala there are a number of constraints regarding the spread of child health knowledge. For illiterate populations, it may be easier to learn about child health from informal sources, such as family, neighbors, or pharmacies, in the community rather than from more formal sources, such as books, magazines, or doctors. Goel et al. (1996) find that retail pharmacies in developing countries are one of the most important sources of information and health advice. Yet, individuals who seek health advice from pharmacies may be receiving inappropriate or inaccurate information since pharmacists are not subject to the same education and training requirements as professional medical staff. There is more likely to be a pharmacy than a medical office based in a remote village, indicating that pharmacy staff may be more integrated into the community (Goel et al., 1996). Kroeger et al. (2001) find that drug advice from pharmacies in Guatemala is more likely to be of poor quality than advice from physicians. Furthermore, individuals may be more likely to treat themselves before seeing a doctor. Analyzing health perceptions in Inner Mongolia, Zhang et al. (2007) find that a significant proportion of community members were misinformed about the transmission of tuberculosis (TB) and results showed that individuals were more likely to treat themselves first before they visited a doctor. The reliance on untrained individuals for information about child health may lead to a lack of accurate knowledge in remote places like highland Guatemala where individuals have more access to informal sources

of information than to formal sources.

This study analyzes the relationship between a woman's intra-household bargaining power and utilization of information networks, both formal and informal, for learning about child health and, secondly, how these different types of sources impact her actual health knowledge. Greenaway et al. (2012) find a strong association between maternal education and the use of health services in Ghana and, further, that health knowledge explains the association between maternal education and the use of health services. Specifically, they find that health knowledge is important for mothers' use of the following services: antenatal care, giving birth with the supervision of a trained medical professional, and child vaccination. Shieh et al. (2009) analyze health literacy and found that the majority of women who participated in their study frequently sought pregnancy health information from family and friends. These informal information networks can be important avenues through which women learn about child health, but may not provide accurate health knowledge in the context of Highland Guatemala.

3.3 Empirical Framework

Women with greater intra-household bargaining power may have greater ability to participate in information networks, both formal and informal. The measurements of bargaining power in this study include decision-making over household expenditures, agricultural production, income generated from agricultural production, productive capital and assets, and credit. Increasing a woman's decision-making power over these areas can increase the amount of interaction she has with people outside of her household and in her community. Involvement in agricultural production decisions may indicate that a woman has more mobility in her daily life to interact with people in the marketplace, other farmers, or financial service providers. Since some agricultural decisions are made on location in the market or while purchasing agricultural inputs, increased bargaining power over agricultural decisions could indicate increased interactions within the community. Increasing women's decision-making abilities may thus lead to increased

mobility and thus an increased ability to seek information about child health. For example, a woman who is going to the market to sell produce or to purchase fertilizer may be able to stop by the community health center on her way home to ask a question about child health, whereas a woman who is relatively more confined to the household may not be able to make a trip to the community health center to ask a question.

In addition to limitations based on a woman's day-to-day mobility within the community, there may be language or literacy constraints that inhibit learning about child health from more formal sources, such as doctors or books. Informal information networks can be important sources of knowledge for women in remote locations, such as Highland Guatemala. This essay distinguishes between formal and informal networks, the latter of which consists of women's daily interactions with family, friends and neighbors. One reason for making this distinction is contextual in that indigenous women have historically been excluded from participation in social, economic, and political processes in this region of Guatemala. There are barriers to participation in formal networks and formal associations for these women, including literacy, ethnicity, and language barriers. Individual-level inter-personal relationships, however, are relatively inclusive. If there are instances in which a husband is uncomfortable with his wife participating in an association or visiting a medical professional, that woman may still have the opportunity to interact with other women, such as family, friends and neighbors, while performing her daily activities. Situated in between formal and informal sources are pharmacists. Some pharmacists in Guatemala have enough training to be considered a formal source of health information, but since there are no strict guidelines, this varies by the individual. Furthermore, pharmacists are often located in small storefronts near the market, where visits may be frequent and informal. As a result, pharmacists are kept as a separate category during the analysis rather than being included in either the formal or informal categories.

The estimations in this study address two main analysis questions. The first part of the analysis focuses on how a woman's bargaining power may affect her access to information networks, and it distinguishes between formal and informal sources. Secondly, this study analyzes whether these information sources affect women's knowledge about child health. The estimation strategy uses a combination of fixed effects at the community

level and instrumental variables to control for the endogeneity of bargaining power.

To analyze the relationship between a woman's household bargaining power and the frequency with which she participates in information networks to learn about child health, the empirical model in Equation (3.3.1) includes women's bargaining power, W_i, as the variable of interest and the frequency of access to information sources, I_i, as the dependent variable. This model controls for unobserved community-level variables that may influence the availability of information sources by using community fixed effects, f_c. The estimation equation of interest is:

$$I_i = \beta_0 + \beta_1 \mathbf{X_i} + \beta_2 \mathbf{X_h} + \beta_3 W_i + f_c + \epsilon_i \tag{3.3.1}$$

The dependent variable, I_i, is the frequency with which a woman sought information from the different sources in the past twelve months. There are four variations of this variable, one including all sources, one including only the informal sources, one including only the formal sources, and, finally, one including only pharmacists. The explanatory variables include a vector of individual variables related to the woman, $\mathbf{X}_i$, including age, number of children and education. In addition, there is a vector of household level variables, $\mathbf{X}_h$, which includes the size of the household and a wealth index created from data on household assets.

The error term in the equation, ϵ_i, contains unobservable variables that influence the frequency of access to information sources to learn about child health. It could be that the unobserved variables in the error term are correlated with a woman's decision-making power. For example, some households may have strong preferences for both women's rights and learning about child health, which will affect the measures of both the information sources and a woman's bargaining power. Therefore, women's decision-making power may be endogenous, (i.e. $E(\epsilon_i|\mathbf{X_h}, \mathbf{X_i}, f_c, W_i \neq 0)$ where $\mathbf{X}_h$ is a vector of household variables and $\mathbf{X}_i$ is a vector of individual variables), which would lead to biased estimates. Endogeneity poses a challenge to estimating equation (3.3.1), but it can be addressed by using instrumental variable (IV) estimation.

Women's decision-making power has been proxied by a variety of variables in the literature, including: control over income; work status; the difference in age at marriage between men and women; education levels; women's age at the time of marriage; and assets at the time of marriage (Quisumbing and Maluccio, 2003; Park, 2007; Namoro and Roushdy, 2009; Thomas, Contreras, and Frankenberg, 2002; Haddad et al., 1997). To address the issue of endogeneity of bargaining power in this study, the absolute differences in ages between the female and male principal decision-makers in the household is used as an instrument to account for the endogeneity of bargaining power. Since some of the survey respondents identified themselves as the daughter or daughter-in-law of the principal female decision-maker of household, the age gap could not calculated.[1] The absolute age difference ranges from zero to forty years, with an average of four years. The larger the absolute difference in ages between the male and female principal decision-makers in the household, the less bargaining power the woman may have. It is generally the case that women are younger than men in the sample and the larger this difference, the greater the difference in life experience and decision-making power the women may have. Additionally, the difference in ages was decided at the time of marriage and may impact current bargaining power levels, but does not directly impact a woman's current ability to participate in information sources to learn about child health beyond its effect via bargaining power. The first stage estimates in Table 3.1 show that the age gap has significant explanatory power for bargaining power ($F = 7.88$).

Instrumental variables (two stage least squares) estimation is used to estimate the relationship. The second stage equation is shown in equation (3.3.1) and the first stage equation is:

$$W_i = \beta_{W0} + \beta_{W1} X_i + \beta_{W2} X_h + \beta_{W3} Z_i + f_c + \epsilon_{Wi} \tag{3.3.2}$$

where Z_i is the age gap.

[1] The daughters of the head of household rarely had a husband living in the household with them as it is customarily the case that a woman moves in with her in-laws at the time of marriage in this region of Guatemala. The daughters-in-law answered the household roster from the perspective of the principal female decision-maker, oftentimes their mothers-in-law, and therefore their husbands were not always clearly identified. For consistency, both these groups of women were excluded from the age gap calculation. Furthermore, women living in households with only a single female were excluded from the IV models since no age gap could be calculated.

Turning to the second analysis question, equation (3.3.3) estimates the relationship between the frequency with which women utilized information sources in the past 12 months and their knowledge of child health.

$$K_i = \beta_{K0} + \beta_{K1} X_i + \beta_{K2} X_h + \beta_{K3} I_i + f_c + \epsilon_{Ki} \tag{3.3.3}$$

In equation (3.3.3) the dependent variable is a woman's child health knowledge, K_i, and the coefficient of interest is β_{K3}, the coefficient for information sources, I_i. The other explanatory variables include a vector of individual variables related to the woman, $\mathbf{X}_i$, including age, number of children and education. In addition, there is a vector of household level variables, $\mathbf{X}_h$, which includes the size of the household and a wealth index. Finally, the estimation controls for community fixed effects, f_c, and includes an error term, ϵ_{Ki}.

Four different specifications are estimated: one with only formal information sources, one with only informal information sources, one with both formal and informal information sources, and one with pharmacists. Women may consult with formal health information sources or pharmacists more frequently if they have less healthy children and, therefore, may actually have more knowledge about child health and nutrition (or less, if an untrained pharmacist is providing inaccurate information). This phenomena would lead to omitted variable bias since the healthiness of the children is unobserved in this sample. The healthiness of children is presumably positively correlated to knowledge of child health and, therefore, OLS estimation will overstate the effect of information sources on knowledge. Further, there may be something in the error term that is correlated with women's use of information sources. It is possible the findings may be biased due to this endogeneity, although it is unclear in which direction, and thus the findings should be interpreted cautiously.

3.4 Results

The findings from the estimations are divided into two sub-sections. The first focuses on the estimates of the relationship between a woman's intra-household bargaining power and her participation in information networks. The second discusses estimates of the impact of these formal and informal information networks on a woman's actual child health knowledge.

3.4.1 Women's Bargaining Power and Access to Information

Table 3.1 presents ordinary least squares (OLS) and IV estimates of the relationship between bargaining power and formal or informal sources, both of which control for community fixed effects. The first specification estimates the impact of a woman's bargaining power on her access to information about child health and nutrition from all sources, including formal sources, and informal sources. The second specification estimates the impact of a woman's bargaining power on her participation in informal networks, including neighbors, friends and family, for obtaining information about child health. The third specification estimates the impact of bargaining power on more formal networks for obtaining knowledge about child health, such as information from community health workers and doctors. Finally, the first stage results from the two-stage least squares estimation are included in the last column.

The OLS findings in the first specification suggest that increased bargaining power raises a woman's access to both formal and informal forms of information about child health. When formal sources, informal sources and pharmacists are combined, the OLS estimates show that a one standard deviation increase in a woman's bargaining power translates into seeking information about child health from all three types of sources 149 more times per year across all sources. The average total number of times women consulted all ten sources per year is 53.2, so this represents a large increase in information-seeking. This result highlights the importance of women's intra-household bargaining power in enhancing her ability to form relationships outside of the household and seek information about child health. The IV estimates are twice as large as the

those from OLS, but not statistically significant, possibly due to the lack of strength of age gap as an instrument.

Focusing on informal networks, the second specification finds a significant relationship between bargaining power and informal sources of child health information. The OLS estimates indicate that a one standard deviation increase in women's bargaining power leads to 74 more interactions per year with informal networks specifically to learn about child health. The IV estimate is similar, but is not statistically significant. This represents a very large increase. These more casual forms of information networks, such as neighbors, friends and family, can provide a social benefit in addition to the sharing of information about child health. These informal networks may provide a multitude of social benefits, such as increasing a woman's support networks, her self-confidence, and ability to talk to others when she needs help or advice. Therefore, this increase in her ability to gather information about child health from those in her social networks may provide additional benefits and spillovers beyond learning about child health.

Turning to formal sources of information about child health, the OLS results indicate that increasing a woman's bargaining power also has a significant impact on her participation in more formal information networks. The results from the OLS estimation suggest that increasing a woman's bargaining power by one standard deviation increases her seeking of information about child health from formal sources by 63.2 more times per year. The average number of times women consult with formal sources regarding child health per year is 35.6, across all formal sources. In this region of Guatemala, parents are more likely to visit with formal health care providers when presented with a serious illness, rather than for more routine visits. One might assume that both the male and female principal decision-makers are likely to be in agreement about seeking health information from medical professionals if there are seriously ill children in the household. In this scenario, women are less likely to need to use their bargaining power within the household to be able to access information about child health since serious health problems are more likely to warrant mutually agreed upon solicitation of health advice.

For both informal and formal sources, the coefficient on bargaining power is statistically

significant in the OLS estimation, but loses significance with IV estimation mainly due to large standard errors caused by "weak" IVs. There may be something in the error term of equation (4.1) that has a positive impact on women's participation in information sources, such as a household's general egalitarian social values, that is positively correlated with women's bargaining power. Due to this positive correlation between the error term, ϵ, and the coefficient on bargaining power, OLS will overestimate β_3. If there is no measurement error, weak instruments lead to bias in the same direction as OLS, the estimates should be considered upper bounds (Bound, Jaeger, and Baker, 1995). However, bargaining power is a difficult to measure concept and so it is likely measured with error. Measurement error would lead to an underestimation of the impact. It is difficult to determine whether measurement error or endogeneity are causing larger bias in the OLS estimates, and since these biases are in opposite directions it is unclear whether the estimates of β_3 are underestimates or overestimates. The IV estimates are very imprecise with large confidence intervals, leading to no significant estimates. When OLS estimates are significant, it may be endogeneity causing this significance. However, this endogeneity is not strong enough to affect all estimates. Therefore, while not a very precise measure of magnitude, we can learn something from the OLS estimates about which health information sources matter more than others.

Turning to other explanatory variables, the models show that the more children a woman has, the less frequently she will use informal information sources. This finding was statistically significant in both the OLS and IV models and, intuitively, the more children a woman has the less time she has to visit those in her informal network to learn about child health. The greater the number of adults in the household, the more frequently women are able to seek information about child health from both formal and informal sources.[2] It is unsurprising that the larger the household size, the greater frequency with which a woman is able to seek health information from informal sources, which includes family itself, because more adults in the household means there is less need to go outside of the household to obtain information.

Table 3.2 shows estimates of the relationship between a woman's bargaining power and

[2]The estimate on the coefficient for household size is significantly positive in all of the models except for the IV estimates of formal sources.

her participation in formal health information sources, disaggregated further by the type of source. The table shows the findings separately for consulting with community health workers, doctors, and nurses for health information. In the IV models, the table shows a significantly positive relationship between a woman's intra-household bargaining power and consulting with doctors and nurses, but not for community health workers. However, the IV results for doctors and nurses are implausibly high. This finding is consistent with the prediction that less empowered women may face constraints from their spouses in visiting more formal health care providers, such as a doctors and nurses. As women increase their autonomy, they are increasingly able to visit formal health care facilities to consult with doctors and nurses regarding child health. It is unsurprising that there is no significant relationship with community health workers since they are most likely to visit the household, so there is no need for a woman to use her bargaining power to leave the home to gather information from this source.

The next set of results, presented in Table 3.3 focuses on other forms of formal information, namely written and audio format. Given the high levels of illiteracy in the sample, it is unsurprising that there are no strong relationships in these results. There is a significant positive relationship between women's bargaining power and learning about child health and nutrition from the TV or radio, as presented in the OLS model.

Table 3.4 shows the results estimating the relationship between bargaining power and learning about child health from informal sources, such as family, friends, and neighbors, and from the pharmacist. The OLS results show a positive relationship between a woman's intra-household bargaining power and learning about child health from family, friends, neighbors, and the pharmacy.

3.4.2 Access to Information and Child Health Knowledge

Table 3.5 presents the results from the estimation of the impact of a woman's participation in formal and informal information sources on her knowledge of child health. The two outcome variables in these estimates are dichotomous variables measuring whether: (1) The woman answered all ten questions on child health correctly (a perfect score);

and (2) The woman either answered nine or ten of the questions correctly (almost perfect score). One-fifth (19 percent) of women received a perfect score, while over half (52 percent) had an almost perfect or perfect score. The regression estimates whether seeking information from formal or informal sources is (conditionally) correlated with attaining a perfect score on the child health questions.

The models estimated in Table 3.5 should be interpreted cautiously because of concerns regarding endogeneity, but they are suggestive of the impact of information sources on child health knowledge. The results from this analysis show there is a significantly positive relationship between formal information sources and child health knowledge, but not for informal sources. This result suggests that women receive more accurate information about child health from formal sources, such as medical professionals, than from their family, friends and neighbors, which may well be plausible. The results in Column 1 show that a one standard deviation increase in seeking information from formal information sources is associated with an increase in the probability of getting a perfect child health knowledge score by 0.2 percent. Column 2 shows that magazines positively increase the probability of getting a perfect score, while consulting with friends negatively impacts the probability of a perfect score. Even though pharmacists are not required to have specific training in Guatemala, the results in Column 3 suggest that consulting with a pharmacist increases the probability of getting an almost perfect score on the child health questionnaire.

Turning to other explanatory variables, the models show a significant relationship between education levels and knowledge of child health. As one might suspect, completing secondary school has a positive correlation with the frequency with which women participate in formal and informal information sources to learn about child health. This finding is important because it shows the positive relationship between women's education and child health knowledge. While the literature has shown that increasing women's education levels has positive impacts for child health, this result shows that one of the mechanisms through which this happens is directly through her knowledge of child health.

3.5 Discussion and Conclusion

This study presents evidence that increased women's bargaining power within the household increases their ability to participate in health information networks among women in Highland Guatemala. It then finds a positive correlation between formal health information networks and actual child health knowledge, but not between informal health information networks and child health knowledge. Many development efforts target women by increasing their generation of, and control over, income, but the narrow focus and limited conceptualization of women's role by these initiatives leaves room for more detailed analysis on the role of women in improving child health and nutrition. This study has implications for several important topics in international development, including cash transfer programs and women's empowerment initiatives, which are at the forefront of the agenda of development practitioners, policymakers, and researchers. Closing the gender gap in ownership and control over productive assets is an important goal; the United Nations Millennium Declaration in 2000 states that promoting gender equality and women's empowerment is one of the Millennium Development Goals and continues to be a cross-cutting goal in the Sustainable Development Goals. This study contributes to this discussion by offering a more nuanced analysis of household decision-making as it relates to women's ability to participate in information networks and learn about child health.

Accurate information on child health and nutrition alone may not increase child health status; poverty, income constraints, and food security also play important roles. While long-term policies should focus on poverty alleviation and increasing education levels and literacy rates, this study provides evidence that increased women's bargaining power impacts their ability to participate in health information networks. This paper conceptualizes bargaining power as one aspect of empowerment, but extends the measure of bargaining power to include a woman's decision-making power over household expenditures and assets, agricultural production, income generated from agricultural production, productive capital and assets, and credit. The use of components of the Women's Empowerment in Agriculture Index allows for a more comprehensive conceptualization of bargaining power while recognizing that a woman's autonomy to make

decisions is affected by other social norms, such as the expectations of her husband or of other individuals. This study has implications for a woman's ability to exercise her autonomy in participating in informal networks, which can also increase her ability to give and receive support. Robeyns (2003) conceptualizes this capability of participating in support networks as an important method of assessing gender equality. These informal networks may not be a good source of accurate information regarding child health, but they serve many other important roles in women's lives.

While the mainstream, income-centered approach to development tends to focus on human capital as it relates to increased productivity or income generation, this research focuses on the individual capabilities of a woman to participate in information networks to deepen her health knowledge. The findings suggest that increased women's bargaining power increases their ability to participate in both formal and informal information networks and that these formal information networks, in particular, are related to improved child health knowledge. In Highland Guatemala, women's lack of education and low levels of literacy are huge obstacles when it comes to learning about child health and could further lead to the spread of misinformation. Improving women's education and literacy are clear policy recommendations for improving child health and nutrition, but they are long-term, expensive investments. The empirical results from this study suggest that in the short-term, development policy makers should increase the presence or availability of formal health information sources to increase women's knowledge of child health.

Table 3.1: OLS and IV Estimation with Community Fixed Effects of Relationship between Bargaining Power and Participating in Health Information Networks

	All Sources OLS	All Sources IV	Informal Sources OLS	Informal Sources IV	Formal Sources OLS	Formal Sources IV	First Stage Results
Age of Respondent	-0.155	-0.192	-0.005	-0.078	-0.073	-0.001	-0.000
	(0.223)	(0.253)	(0.105)	(0.130)	(0.124)	(0.176)	(0.000)
No. of Children	-3.218*	-1.828	-1.262*	-1.343	-1.655	0.225	0.002
	(1.624)	(2.167)	(0.674)	(1.116)	(1.429)	(1.511)	(0.005)
Primary Education	-1.528	-2.732	-2.199	-2.449	1.526	0.852	0.013*
	(4.596)	(6.110)	(2.708)	(3.148)	(3.200)	(4.260)	(0.007)
Secondary Education	6.787	2.937	0.718	2.517	6.214	1.381	0.019
	(10.454)	(11.765)	(3.335)	(6.061)	(7.587)	(8.203)	(0.014)
Household Size	4.023***	3.862*	0.763	1.082	2.599**	1.606	-0.003
	(1.330)	(2.224)	(0.620)	(1.146)	(1.076)	(1.551)	(0.005)
Wealth Index	-1.302	-0.225	-0.054	0.375	-1.203	-0.494	0.002
	(2.070)	(2.910)	(1.281)	(1.499)	(1.023)	(2.029)	(0.005)
Bargaining Power	149.291***	333.193	74.017***	81.794	63.205**	228.957	
	(28.001)	(203.231)	(19.082)	(104.698)	(24.882)	(141.700)	
Age Gap							0.001**
							(0.001)
Constant	-32.600*	-124.149	-21.936*	-24.258	-6.991	-90.577	0.513***
	(15.472)	(103.698)	(11.233)	(53.422)	(11.474)	(72.302)	(0.020)
Observations	223	176	223	176	223	176	176
R-squared	0.104		0.088		0.072		0.083
F-stat (all regressors)	8.85	–	7.69	–	9.35	–	2.92
F-stat (excluded instrument)	–	–	–	–	–	–	7.88
Wald χ^2	–	692.41	–	220.27	–	621.53	–
Number of Communities	18	16	18	16	18	16	
Wu-Hausman	–	0.107	–	0.132	–	0.242	–

Cluster-robust standard errors in parentheses, clustered at community-level. *** p<0.01, ** p<0.05, * p<0.1
Instrument: Age gap

Table 3.2: OLS and IV Estimation with Community Fixed Effects of Relationship between Bargaining Power and Formal Health Information Source

	Community Health Worker OLS	Community Health Worker IV	Doctor OLS	Doctor IV	Nurse OLS	Nurse IV
Age of Respondent	0.048	0.046	-0.031	0.013	-0.053	-0.035
	(0.052)	(0.064)	(0.048)	(0.076)	(0.041)	(0.066)
No. of Children	-0.597	-0.046	0.038	0.299	-0.210	0.052
	(0.401)	(0.546)	(0.448)	(0.649)	(0.352)	(0.565)
Primary Education	1.143	1.879	-0.612	-1.449	0.034	-0.796
	(1.045)	(1.539)	(1.599)	(1.830)	(1.173)	(1.592)
Secondary Education	1.461	2.256	4.279**	2.357	-1.611	-5.152*
	(1.909)	(2.963)	(1.930)	(3.524)	(1.830)	(3.066)
Household Size	0.877***	0.608	0.267	0.286	0.446	0.421
	(0.241)	(0.560)	(0.365)	(0.666)	(0.302)	(0.579)
Wealth Index	-0.979**	-1.484**	0.995	1.490*	-1.326***	-0.908
	(0.419)	(0.733)	(0.590)	(0.871)	(0.439)	(0.758)
Bargaining Power	2.636	3.872	13.950	113.652*	31.321***	97.037*
	(9.824)	(51.189)	(10.063)	(60.872)	(6.697)	(52.954)
Constant	3.749	2.924	-2.596	-54.349*	-3.948	-37.512
	(5.809)	(26.119)	(4.403)	(31.060)	(3.361)	(27.019)
Observations	223	176	223	176	223	176
R-squared	0.055		0.084		0.096	
F-stat	1.65	-	2.59	-	3.00	-
Wald χ^2	-	508.0	-	77.42	-	505.96
Number of Communities	18	16	18	16	18	16
Wu-Hausman	–	1.295	–	3.792	–	0.025

Cluster-robust standard errors in parentheses, clustered at community-level. *** p<0.01, ** p<0.05, * p<0.1
Instrument: Age gap

Table 3.3: OLS and IV Estimation with Community Fixed Effects of Relationship between Bargaining Power and Written and Audio Health Information Sources

	Books and Brochures OLS	Books and Brochures IV	Magazines OLS	Magazines IV	TV or Radio OLS	TV or Radio IV
Age of Respondent	-0.031	-0.042	-0.017	-0.025	0.010	0.042
	(0.031)	(0.043)	(0.030)	(0.037)	(0.054)	(0.057)
No. of Children	-0.081	0.270	-0.294	-0.133	-0.511**	-0.218
	(0.311)	(0.369)	(0.234)	(0.319)	(0.239)	(0.485)
Primary Education	0.670	0.177	0.221	0.461	0.070	0.580
	(0.683)	(1.042)	(0.546)	(0.900)	(1.465)	(1.369)
Secondary Education	0.889	0.244	1.625	1.575	-0.428	0.101
	(1.197)	(2.006)	(1.797)	(1.732)	(3.128)	(2.635)
Household Size	0.177	0.007	0.305	0.219	0.527*	0.065
	(0.262)	(0.379)	(0.202)	(0.327)	(0.259)	(0.498)
Wealth Index	-0.353	-0.101	0.380*	0.347	0.081	0.161
	(0.381)	(0.496)	(0.200)	(0.428)	(0.282)	(0.652)
Bargaining Power	1.935	27.906	-1.061	-6.153	14.424*	-7.357
	(6.791)	(34.657)	(4.185)	(29.919)	(7.555)	(45.519)
Constant	0.570	-11.578	1.129	4.107	-5.895	5.831
	(4.097)	(17.684)	(1.601)	(15.266)	(4.301)	(23.226)
Observations	223	176	223	176	223	176
R-squared	0.021		0.042		0.027	
F-stat	0.62	–	1.25	–	0.77	–
Wald χ^2	–	31.24	–	27.05	–	64.27
Number of Communities	18	16	18	16	18	16
Wu-Hausman	–	1.59	–	0.010	–	0.230

Cluster-robust standard errors in parentheses, clustered at community-level. *** p<0.01, ** p<0.05, * p<0.1
Instrument: Age gap (F=7.88)

Table 3.4: OLS and IV Estimation with Community Fixed Effects of Relationship between Bargaining Power and Informal Health Source and Pharmacy

	Family OLS	Family IV	Friends OLS	Friends IV	Neighbors OLS	Neighbors IV	Pharmacy OLS	Pharmacy IV
Age of Respondent	0.095	0.088	-0.071**	-0.067	-0.029	-0.099*	-0.077***	-0.113***
	(0.071)	(0.071)	(0.025)	(0.047)	(0.037)	(0.059)	(0.016)	(0.043)
No. of Children	-0.695*	-0.590	-0.080	0.098	-0.488	-0.851*	-0.301	-0.710*
	(0.349)	(0.606)	(0.164)	(0.404)	(0.352)	(0.507)	(0.316)	(0.370)
Primary Education	0.953	0.074	-1.892**	-1.214	-1.260	-1.309	-0.856	-1.134
	(1.432)	(1.708)	(0.655)	(1.138)	(1.030)	(1.430)	(0.678)	(1.042)
Secondary Education	1.864	3.962	-0.818	0.322	-0.327	-1.768	-0.145	-0.960
	(2.482)	(3.289)	(1.382)	(2.192)	(1.834)	(2.754)	(1.155)	(2.007)
Household Size	0.246	0.285	0.108	-0.120	0.409	0.916*	0.662**	1.174***
	(0.278)	(0.622)	(0.180)	(0.414)	(0.327)	(0.521)	(0.297)	(0.379)
Wealth Index	-1.018	-0.800	0.912***	0.886	0.053	0.290	-0.046	-0.106
	(0.784)	(0.813)	(0.225)	(0.542)	(0.528)	(0.681)	(0.640)	(0.496)
Bargaining Power	26.532**	84.814	20.919***	-15.314	26.565***	12.295	12.070**	22.442
	(11.650)	(56.819)	(4.760)	(37.860)	(7.252)	(47.567)	(4.961)	(34.663)
Constant	-9.035	-38.217	-4.836	14.041	-8.066*	-0.082	-3.672	-9.314
	(5.996)	(28.992)	(2.857)	(19.318)	(4.445)	(24.271)	(3.381)	(17.687)
Observations	223	176	223	176	223	176	223	176
R-squared	0.094		0.104		0.055		0.073	
F-stat	6.83	-	9.17	-	2.77	-	59.78	-
Wald χ^2	-	185.68	-	64.82	-	116.85	-	77.66
Number of Communities	18	16	18	16	18	16	18	16
Wu-Hausman	–	0.174	–	1.068	–	0.229	–	0.992

Cluster-robust standard errors in parentheses, clustered at community-level. *** p<0.01, ** p<0.05, * p<0.1
Instrument: Age gap

Table 3.5: Linear Probability Estimation Results on the Determinants of a Perfect (or Almost) Score on the Child Health Knowledge Questionnaire

	Perfect Score	Perfect Score	Almost Perfect Score	Almost Perfect Score
Age of Respondent	0.004	0.003	0.005	0.005
	(0.003)	(0.003)	(0.004)	(0.004)
No. of Children	-0.012	-0.007	0.024	0.032
	(0.025)	(0.027)	(0.022)	(0.024)
Primary Education	0.005	-0.008	0.041	0.034
	(0.036)	(0.038)	(0.068)	(0.069)
Secondary Education	0.245*	0.220*	0.008	-0.016
	(0.117)	(0.111)	(0.149)	(0.148)
Household Size	-0.005	-0.008	-0.033	-0.038
	(0.024)	(0.026)	(0.020)	(0.022)
Wealth Index	-0.013	-0.009	0.017	0.013
	(0.033)	(0.034)	(0.036)	(0.031)
Book or Brochure		-0.001		-0.012*
		(0.007)		(0.006)
Magazine		0.011**		0.021***
		(0.005)		(0.004)
TV or Radio		0.002		0.003
		(0.005)		(0.005)
Community Health Worker		-0.000		0.001
		(0.004)		(0.007)
Doctor		0.004		0.001
		(0.004)		(0.006)
Nurse		0.001		0.001
		(0.005)		(0.005)
Family		0.002		0.004
		(0.004)		(0.006)
Friends		-0.015***		-0.006
		(0.005)		(0.009)
Neighbors		0.007		0.002
		(0.006)		(0.007)
Pharmacy	-0.001	-0.002	0.010**	0.009*
	(0.004)	(0.004)	(0.004)	(0.005)
Informal Information Sources	-0.001		0.001	
	(0.002)		(0.002)	
Formal Information Sources	0.002**		0.002	
	(0.001)		(0.001)	
Constant	0.053	0.094	0.364**	0.402***
	(0.137)	(0.131)	(0.136)	(0.127)
Observations	248	248	248	248
R-squared	0.051	0.084	0.029	0.060
F-Stat	8.03	21.90	10.48	126.21
Number of Communities	18	18	18	18

Cluster-robust standard errors in parentheses, clustered at community-level.
*** p<0.01, ** p<0.05, * p<0.1
Instrument: Age gap

Chapter 4

Risk Aversion and Diversification of Health Information Sources: Evidence from the Guatemalan Highlands

4.1 Introduction

Improving women's health knowledge is particularly important for rural populations, such as the indigenous Mayan people of Guatemala, who are marginalized by geography, literacy, and language. This paper addresses the question of how risk preferences and trust affect health-information-seeking behaviors among women in Highland Guatemala. Among mothers without any education in Guatemala, the prevalence of malnourished children is 69 percent, significantly higher than the country-wide average of 48 percent and the overall average of 13 percent for the Latin American and Caribbean region (World Bank, 2012). Women play a critical role in meeting the nutritional and health needs of their families, and health and nutritional inputs in the first few years of life significantly improve a child's educational outcomes (Martorell et al., 2010; Quisumbing

et al., 1995; Thomas, 1997). A number of studies have found evidence that maternal education and health knowledge, and the use of health services, improve children's nutrition and health status (Fitzsimons et al., 2014; Glewwe, 1999; Greenaway et al., 2012; Shieh et al., 2009).

There are a number of constraints to improving the health knowledge of women in developing countries, including illiteracy, language and cultural barriers, and access to health care professionals (Goldman and Heuveline, 2000; Schooley et al., 2009). For illiterate populations, it may be less intimidating to learn about child health from those in their social network or from the local pharmacist rather than consulting formally-trained medical professionals (Zhang et al., 2007). Goel et al. (1996) find that retail pharmacies in developing countries are one of the most important sources of health advice because they may be more integrated into the community than health professionals, who may not reside in the community. However, advice from pharmacists in Guatemala is likely to be of poorer quality than advice from physicians because pharmacists have much lower education and training requirements (Kroeger et al., 2001). Risk preferences and trust in health care providers may further determine whom women seek information from regarding health and nutrition, particularly in the context of Guatemala, where there are 0.93 physicians per 1,000 people and the majority of whom live in the capital city (World Bank, 2012). This dearth of formally-trained medical professionals may influence women's relative trust in doctors as compared to community-based, but untrained, pharmacists.

The purpose of this chapter is to analyze, among women in remote regions of Guatemala, the relationship between: (i) risk aversion and health information-seeking behavior; and (ii) risk aversion and relative trust in a doctor or pharmacist. To conceptualize this relationship, this study provides a theoretical framework that predicts how risk preferences affect the time women allocate towards learning about child health by consulting different health information sources. Using original data collected in the Guatemalan Highlands, including an experiment to elicit risk preferences, this study estimates the relationship between women's preferences towards risk and their health-information-seeking behaviors. The findings show a significant relationship in which greater risk aversion causes women to consult a greater number of health information sources, thus

gathering information from a broader set of sources, to diversify where they learn about child health. However, risk averse women do not necessarily seek information more frequently. Building on this finding, this study also considers the role that education and health literacy play in determining women's relative trust in doctors versus pharmacists. The greater a woman's knowledge about child health, the less relative trust she has in either a doctor or a pharmacist; this possibly indicates that women with greater health literacy are better able to recognize when receiving inaccurate or inappropriate advice.

This study builds on a growing body of work that uses field experiments to elicit risk preferences (Binswanger, 1980, 1981; Cardenas and Carpenter, 2013, 2004; Dave et al., 2010; Eckel and Grossman, 2008b; Holt and Laury, 2002). From the literature, it is clear that decisions involving trust and social capital may also be governed by other decision-making characteristics such as risk preferences (Schechter, 2007). Holt and Laury (2002) analyze risk aversion and incentive effects and find that individuals become distinctly more risk averse when the payoffs are paid in cash versus hypothetical situations where there is no cash payoff. This study uses cash gambles to elicit risk preferences. Moreover, there is evidence to suggest that experimental results can predict real world decisions (Fehr, Goette, and Zehnder, 2007; Liu and Huang, 2013; Schechter, 2007). Kerwin (2012) provides findings related to risk preferences and health decision-making and finds evidence of non-monotonic relationships and risky health behaviors in Malawi.

This study contributes to an important area of research in economics at the intersection of development and health. First, this study extends the framework that Liu and Huang (2013) use to analyze how risk preferences affect decisions related to income and health by using an expected-utility framework. The framework identifies key trade-offs between income-generating activities and health-improving activities inherent in women's daily decision-making, including the role played by preferences towards risk. The model demonstrates how risk preferences may affect a woman's optimal health seeking behavior if both her income and her child's health are part of the utility function, but the direction of the impact depends on the weight a woman places on health and income in her utility function. Second, this study expands our understanding of how risk preferences are related to women's health knowledge by presenting evidence that risk aversion positively affects the number of health sources a woman consults to learn

about child health and nutrition. The results suggest that risk averse women are more likely to participate in a form of portfolio diversification in their gathering of health information.

The remainder of this chapter proceeds as follows. Section 4.2 provides a framework for studying how risk preferences are incorporated into women's allocation of time towards income generation and improving health knowledge. Section 4.3 describes the empirical strategy for estimating the relationship between risk preferences and health information seeking behavior. Section 4.4 presents the results and Section 4.5 discusses the implications of the findings and concludes with a discussion of policy recommendations.

4.2 Conceptual Framework

This section provides a simple framework to demonstrate how preferences toward risk may affect women's decision-making in both the income and health domains. This framework may be used to analyze the acquisition of information regarding child health for a utility maximizing individual who makes decisions related to both consumption and health. The framework used in this study follows closely that of Liu and Huang (2013) in that it includes both income and health in the utility framework, but modifies their framework to analyze choice under uncertainty using a standard expected-utility specification that incorporates weights on utility obtained from health and from income. This conceptual framework demonstrates how risk preferences may affect a woman's optimal health information seeking behavior when both her income and her child's health are included in the utility function. The basic framework starts with health and income in an expected utility framework and then considers how risk preferences might impact the optimal time that a woman dedicates towards income-generation and improving her health knowledge.

4.2.1 The Basic Framework

Suppose that an individual woman has a utility function that is an increasing function of income (Y) and of the health stock of her children (H). For simplicity, assume as well that the utility function is additively separable: $U = U(H, Y) = U^H(H) + U^Y(Y)$, where superscripts H and Y denote health and income, respectively. Income Y includes only non-health consumption; all spending on health increases utility only be increasing H. Assume an interior solution and well-behaved utility functions that are strictly concave: $U^{H'}(H) > 0$ and $U^{H''}(H) < 0$, and $U^{Y'}(Y) > 0$ and $U^{Y''}(Y) < 0$. With respect to health, the relationship is concave in that initial increases in spending time or money on health increase utility greatly, but individuals who are already fairly healthy do not experience large increases to their utility from improving health (i.e. there are diminishing returns to resources devoted to health). The concavity of health in a utility function is consistent with the literature (Dercon and Krishnan, 2000; Foster, 1995).

Suppose that there are two possible outcomes that a woman faces for her children's health: good health (H_g) and bad health (H_b). Similarly, there are only two outcomes for income: a good (high) amount of income (Y_g) and bad (low) amount of income (Y_b).[1] The good (g) outcomes are always larger than the bad (b) outcomes: $H_g > H_b$ and $Y_g > Y_b$. Expected utility, $E[U] = E[U(H, Y)]$, can now be written as:

$$E[U] = E[U^H] + E[U^Y] = p_g^H U(H_g) + (1 - p_g^H)U(H_b) + p_g^Y U(Y_g) + (1 - p_g^Y)U(Y_b) \quad (4.2.1)$$

where p_g^H and p_g^Y are the corresponding probabilities of H_g and Y_g, respectively.

For simplicity, assume that women can spend their time either picking coffee or seeking out new information regarding child health.[2] This time constraint is built into the probabilities of the good and bad outcomes in that a woman is constrained in the amount of time she can feasibly dedicate to coffee cultivation or gathering health knowledge,

[1] In reality, both health and income states are continuous; this simplification is made for expositional convenience.

[2] While it is possible that women who are cultivating coffee in the company of other women are able to discuss child health, in which case these two activities are not mutually exclusive, for simplicity in the model they are assumed to be mutually exclusive.

which affects the probabilities of both good income outcomes and good health outcomes.

More specifically, women allocate their total time, normalized to equal one, to one of two activities – either generating income (x_c) or gathering health knowledge (x_k) – so that: $x_k = 1 - x_c$. Women focus their income generating activities on agricultural production, in particular coffee cultivation.[3] Suppose that the probability of a good income outcome, p_g^Y, depends only on the woman's time allocation, so that $p_g^Y = p_g^Y(x_k)$. The more time a woman spends in the mountains cultivating coffee, the greater the probability of a good income or, conversely, the more time a woman spends gathering health knowledge, the lower the probability of a good income, $\frac{\partial p_g^Y}{\partial x_k} < 0$. Similarly, the probability of a good health outcome, p_g^H, depends only on the time allocated to seeking health knowledge, x_k, so that $p_g^H = p_g^H(x_k)$. The more time a woman spends seeking new information about child health, the higher the probability that her children have good health, $\frac{\partial p_g^H}{\partial x_k} > 0$.

The optimal time to allocate toward improving her health knowledge depends on the marginal utility of the (expected) gain in child health status, $\frac{\partial U^H}{\partial x_k}$, and the marginal utility of the (expected) lower income $\frac{\partial U^Y}{\partial x_k}$. To see how risk aversion affects women's decisions to allocate their time between seeking health information and cultivating coffee, assume that the $U^H(H)$ and $U^Y(Y)$ functions have the constant relative risk aversion functional form: $U^H(H) = \frac{H^{1-\gamma}}{1-\gamma}$ and $U^Y(Y) = \frac{Y^{1-\gamma}}{1-\gamma}$. Risk neutral preferences are represented by $\gamma = 0$, risk aversion by $\gamma > 0$, and risk 'loving' by $\gamma < 0$.[4] Furthermore, women may differ in the weights they place on income and health, so that $U = (1-\alpha)U^H(H) + \alpha U^Y(Y)$, where $0 \leq \alpha \leq 1$. The larger the weight (α) on income, the more a woman prefers a high income relative to good health for her children. Equation (4.2.2) shows the woman's expected utility.

[3] Coffee cultivation is a seasonal activity, but for simplicity this seasonality is not taken into consideration in the model. Other common income generating activities in this region include weaving and "petty trading".

[4] When $\gamma = 1$, the natural logarithm is used.

$$E[U(H,Y)] = (1-\alpha)\left(\underbrace{p_g^H * \frac{H_g^{(1-\gamma)}}{1-\gamma}}_{\text{Utility from good children's health}} + \overbrace{(1-p_g^H) * \frac{H_b^{(1-\gamma)}}{1-\gamma}}^{\text{Utility from poor children's health}}\right)$$

$$+\alpha\left(\underbrace{p_g^Y * \frac{Y_g^{(1-\gamma)}}{1-\gamma}}_{\text{Utility from good coffee yield}} + \overbrace{(1-p_g^Y) * \frac{Y_b^{(1-\gamma)}}{1-\gamma}}^{\text{Utility from poor coffee yield}}\right) \quad (4.2.2)$$

The optimal amount of time spent cultivating coffee in the mountains, x_c^*, depends on the risk aversion parameter γ, in addition to H_g, H_b, Y_g, and Y_b. This model can be used to predict the impact of preferences towards risk on the optimal time spent gathering health information and cultivating coffee. These predictions depend on the relative weights women place on income and health (that is, on α) and on the risk aversion parameter, γ. The following subsection shows these implications of the model.

4.2.2 Comparative Statics

This subsection considers the impact of changes in risk preferences on the optimal time a utility-maximizing woman spends gathering health knowledge to increase the probability of a good health outcome for her family. Consider the first order condition for Equation (4.2.2) with respect to x_k, and assume an interior solution:

$$\frac{\partial EU}{\partial x_k} = \frac{(1-\alpha)}{(1-\gamma)}\frac{\partial p_g^H}{\partial x_k}\left[H_g^{(1-\gamma)} - H_b^{(1-\gamma)}\right] + \frac{\alpha}{(1-\gamma)}\frac{\partial p_g^Y}{\partial x_k}\left[Y_g^{(1-\gamma)} - Y_b^{(1-\gamma)}\right] = 0 \quad (4.2.3)$$

The second order condition is negative under the assumption of utility maximization.[5]

$$\frac{(1-\alpha)}{(1-\gamma)}\frac{\partial^2 p_g^H}{\partial x_k^{*2}}\left[H_g^{(1-\gamma)}-H_b^{(1-\gamma)}\right]+\frac{\alpha}{(1-\gamma)}\frac{\partial^2 p_g^Y}{\partial x_k^{*2}}\left[Y_g^{(1-\gamma)}-Y_b^{(1-\gamma)}\right]<0 \tag{4.2.4}$$

Next, consider the effect that risk aversion has on the optimal time gathering health knowledge using the implicit function theorem to derive the optimal time dedicated to health information seeking. Equation (4.2.5) totally differentiates the first order condition in Equation (4.2.3) with respect to risk preferences, γ, and x_k at the optimal time dedicated to health information-seeking:

$$(1-\alpha)\left(\frac{\partial^2 p_g^H}{\partial x_k^{*2}}\left[\frac{H_g^{(1-\gamma)}}{1-\gamma}-\frac{H_b^{(1-\gamma)}}{1-\gamma}\right]dx_k^*\right)$$

$$-(1-\alpha)\left(\frac{\partial p_g^H}{\partial x_k}\left[\frac{H_g^{(1-\gamma)}}{(1-\gamma)^2}-\ln(H_g)\frac{H_g^{(1-\gamma)}}{1-\gamma}+\frac{H_b^{(1-\gamma)}}{(1-\gamma)^2}-\ln(H_b)\frac{H_b^{(1-\gamma)}}{1-\gamma}\right]d\gamma\right)+$$

$$\alpha\left(\frac{\partial^2 p_g^Y}{\partial x_k^{*2}}\left[\frac{Y_g^{(1-\gamma)}}{1-\gamma}-\frac{Y_b^{(1-\gamma)}}{1-\gamma}\right]dx_k^*\right)$$

$$-\alpha\left(\frac{\partial p_g^Y}{\partial x_k}\left[\frac{Y_g^{(1-\gamma)}}{(1-\gamma)^2}-\ln(Y_g)\frac{Y_g^{(1-\gamma)}}{1-\gamma}+\frac{Y_b^{(1-\gamma)}}{(1-\gamma)^2}-\ln(Y_b)\frac{Y_b^{(1-\gamma)}}{1-\gamma}\right]d\gamma\right)=0 \tag{4.2.5}$$

Rearranging terms yields the following expression for the impact of a change in γ on x_k^*:

$$\frac{dx_k^*}{d\gamma}=\frac{\frac{(1-\alpha)}{(1-\gamma)}\frac{\partial p_g^H}{\partial x_k}\left[\ln(H_g)H_g^{(1-\gamma)}-\ln(H_b)H_b^{(1-\gamma)}\right]+\frac{\alpha}{(1-\gamma)}\frac{\partial p_g^Y}{\partial x_k}\left[\ln(Y_g)Y_g^{(1-\gamma)}-\ln(Y_b)Y_b^{(1-\gamma)}\right]}{\frac{(1-\alpha)}{(1-\gamma)}\frac{\partial^2 p_g^H}{\partial x_k^{*2}}\left[H_g^{(1-\gamma)}-H_b^{(1-\gamma)}\right]+\frac{\alpha}{(1-\gamma)}\frac{\partial^2 p_g^Y}{\partial x_k^{*2}}\left[Y_g^{(1-\gamma)}-Y_b^{(1-\gamma)}\right]} \tag{4.2.6}$$

[5] Under the assumption of an interior solution. A sufficient, but not necessary condition is that: $\frac{\partial^2 p_g^H}{\partial x_k^{*2}}<0$ and $\frac{\partial^2 p_g^Y}{\partial x_k^{*2}}<0$.

The expected sign of $\frac{\partial x_k^*}{\partial \gamma}$ depends on the components in the numerator. The denominator is the second order condition shown in Equation (4.2.4), which is negative from the assumptions of an interior solution. The first term in the numerator, $\frac{(1-\alpha)}{(1-\gamma)}\frac{\partial p_g^H}{\partial x_k}\left[\ln(H_g)H_g^{(1-\gamma)} - \ln(H_b)H_b^{(1-\gamma)}\right]$, is non-negative because $\frac{\partial p_g^H}{\partial x_k} \geq 0$. The sign of the second term in the numerator, $\frac{\alpha}{(1-\gamma)}\frac{\partial p_g^Y}{\partial x_k}\left[\ln(Y_g)Y_g^{(1-\gamma)} - \ln(Y_b)Y_b^{(1-\gamma)}\right]$, is non-positive because $\frac{\partial p_g^Y}{\partial x_k} \leq 0$. Overall, the sign of the numerator depends on: (1) the relative magnitudes of the impact of time spent seeking health information on the probability of good health outcomes ($\frac{\partial p_g^H}{\partial x_k}$) or good income outcomes ($\frac{\partial p_g^Y}{\partial x_k}$) ; (2) the (relative) weights a woman places on income (α) and health ($1-\alpha$); and (3) the values of Y_g, Y_b, H_g, and H_b.

Consider first the relative magnitudes of time dedicated towards seeking health information on the probability of good health outcomes or good income outcomes. If the time spent seeking health information has a greater (positive) impact on the probability of a good health outcome than it does on the (negative) impact on the probability of a good income outcome, i.e. $\frac{\partial p_g^H}{\partial x_k} > \frac{\partial p_g^Y}{\partial x_k}$, then $\frac{\partial x_k^*}{\partial \gamma}$ is more likely to be positive. This tells us that the impact of risk aversion on the optimal time dedicated towards health-information-seeking is positive when time dedicated to gathering health information has a greater impact on the positive probability of a good health outcome than on reducing the probability of a good income outcome.

Next, consider the relative weights a woman places on income (α) and health ($1-\alpha$). Assuming risk aversion ($\gamma > 0$), then as a woman places greater emphasis on health, i.e. ($1-\alpha$) gets bigger, then $\frac{\partial x_k^*}{\partial \gamma}$ is more likely to be positive. In this case, the woman is averse to risks in both income and health, but placing more weight on health. Therefore, her risk aversion is more likely to lead to increased time dedicated towards seeking health information, rather than coffee cultivation.

Finally, consider the relative values of Y_g, Y_b, H_g, and H_b. If there is more variance in health, in the sense that $|H_g - H_b| > |Y_g - Y_b|$ is likely to be positive. In this case, the impact of risk aversion on the optimal time seeking health information is more likely to be positive, $\frac{\partial x_k^*}{\partial \gamma} > 0$. This is intuitive in that risk averse women are interested in reducing the amount of variance in their health outcomes and income outcomes. If there

is a larger difference between a good and bad health outcome, then a risk averse woman is interested in reducing this variance.

4.3 Empirical Strategy

This section describes the empirical strategy to estimate the relationships between risk preferences and health information seeking behavior. The estimations test the relationship between risk aversion and time allocated toward health information seeking from the framework in Section 4.2. The two main objectives are to provide insights for Guatemalan women on the relationships between: (i) risk aversion and health information seeking behavior; and (ii) risk aversion and relative trust in a doctor or pharmacist. The data allow one to further explore these relationships by analyzing whether risk preferences relate to a woman's actual child health knowledge, one of the mechanisms that might be related to relative trust in health care providers.

Equation (4.3.1) shows the regression equation for estimating the relationship between risk aversion, γ, and the outcomes of interest, y_i^k, measures of health information-seeking.

$$y_i^k = \beta_0 + \beta_1 \mathbf{X}_i + \beta_2 \mathbf{X}_h + \beta_3 \gamma + f_c + \epsilon_i \tag{4.3.1}$$

The health information sources represented by y_i include: the total number of distinct sources consulted to learn about child health, formally-trained health information sources, pharmacists, community health workers, and sources within one's social network. Health information seeking is reported in three ways: first, the total number of sources; second, an overall measure of whether women visited that source; and third, the frequency of visits for each type of source.

The coefficient of interest is β_3, the coefficient on the measure of risk aversion, γ. As explained in Chapter 2, this measure of risk aversion comes from the gamble given to each woman during data collection. More precisely, risk aversion is represented by a

dichotomous variable equal to one if a woman chooses the option with zero risk present (no variation in payoff). Each of the regressions were also estimated using dummy variables for each of the risk preference options (two through six, excluding the first option) to account more flexibly for the variation of risk preference choice. However, a joint equality of means test of significance did not reject that the coefficients for choices two through six are equal, so the simpler specification is used to reduce the number of parameters to be estimated. The estimations control for individual level variables for the woman, represented by the vector $\mathbf{X}_i$, as well as a vector of household characteristics, $\mathbf{X}_h$. The individual characteristics include age, literacy, education, and number of children, and the household characteristics include a wealth index and the ratio of literate members to adults in the household. Furthermore, the regression includes community fixed effects denoted by (f_c) to increase the precision of the estimates because there are likely to be unobserved community specific factors that influence both a woman's child health knowledge and the frequency with which she seeks new health information. For example, communities that are closer to the city center may have more availability of health professionals. Finally, the error term (ϵ_i) is clustered at the community level, using the wild bootstrap (Cameron and Miller, 2015) method to account for the small number of clusters.

The next set of regressions analyzes whether risk averse individuals are more likely to have better overall knowledge of children's health, presumably due to spending more time to acquire that knowledge. The dependent variable in this case represents a measure of a woman's knowledge about child health and nutrition, or her child health knowledge. The final set of analyses focuses on the relationship between risk preferences and relative trust in a doctor, pharmacist, or neither. Estimates from each of these relationships are reported with and without community fixed effects. Equation (4.3.2) shows the multinomial logit regression equation for estimating the relationship between risk aversion, γ, and knowledge of child health, K_i, and the outcome y_i^t, a measure of relative trust in either a doctor or a pharmacist.

$$y_i^t = \beta_0 + \beta_1 \mathbf{X}_i + \beta_2 \mathbf{X}_h + \beta_3 \gamma + \beta_4 K_i + f_c + \epsilon_i \tag{4.3.2}$$

There are a number of empirical limitations to consider when estimating the relationships outlined above, and when interpreting the results, including the relatively small sample size and concerns related to endogeneity. The sample in this study includes 248 women from Highland Guatemala. This small sample size constrains the analysis, particularly when using fixed effects at the community level for the 18 villages in the study.

There are several potential sources of endogeneity, which may lead to bias in the estimates. The first concern is reverse causality. This study estimates the impact of risk preferences on health information-seeking behaviors, but it may also be the case that health seeking behaviors have an impact on risk preferences. However, this impact is likely to be small in magnitude since individual risk preferences may not vary greatly over time, although there is no evidence for this. Secondly, the use of community fixed effects increases the precision of the estimates given unobserved heterogeneity at the community level. There may, however, still be unobserved characteristics of individual women that are difficult to measure, and thus, not included in the data, and are correlated with the measure of risk aversion. There may be something in the error term, such as innate confidence, that impacts the frequency of health information seeking a woman participates in that is positively correlated with her measure of risk aversion. Speculating on this relationship, it may be the case that innate confidence might lead to women not consulting with different health sources because they believe they know enough about child health already. In this case, confidence would positively impact risk preferences, but lead to a negative correlation between γ and ϵ_i, resulting in an overall underestimation of the true impact.

Another concern is that there may be some measurement error present in the indicator of risk preferences. In the standard case of a continuous explanatory variable, random measurement error would lead to attenuation bias and an underestimation of the true impact. In the case of a binary variable, the measurement error is a classification error and is correlated with the true value (Cameron and Trivedi, 2010). For the measure of risk aversion in this paper, where 1 is equal to risk aversion and 0 otherwise, one may suspect that responses of 1 were measured as a 0 due to misclassification. Given the relatively few women who chose the risk averse gamble, it is likely that the true

response for more women was the risk averse option, but that there was measurement error in their responses. This measurement error is, therefore, correlated with the true unobserved value. Even when measurement error is correlated with the true value, error resulting from misclassification with a binary variable often biases the estimator downward (Aigner, 1973; Hausman, 2001). There is no plausible instrument within the data to correct for either endogeneity or measurement error. Considering this, it is likely that the direction of bias due to endogeneity and measurement error results in underestimation of the true impacts.

4.4 Results and Discussion

This section presents the key findings. The first estimates analyze the relationship between risk preferences and where women seek information about child health, including the total number of sources, and the numbers of formally-trained health sources, pharmacists, community health workers, and social network sources. This relates directly to the framework from Section 4.2 in that it examines the relationship between risk aversion, γ, and health information gathering, x_k. The next set of estimates extends these results to include the frequency with which women consult each type of health information source. Building on these findings, the analysis on whether risk preferences are related to a woman's actual child health knowledge is discussed. Finally, results on the relationship between risk preferences and relative trust in a doctor or pharmacist are presented.

Table 4.1 begins by presenting estimates of the impact of risk preferences on the number of sources that a woman uses when seeking child health information. The findings suggest that a risk averse woman is more likely to consult with a greater number of distinct health information sources. This finding sheds light on the framework by suggesting that a risk averse woman would be willing to shift time from coffee cultivation to gathering health knowledge, but this may be occurring for several reasons. It may be the case that the impact of risk aversion on the optimal time dedicated towards health-information-seeking is positive because the time dedicated to gathering health

information has a greater impact on the positive probability of a good health outcome than on reducing the probability of a good income outcome, $\frac{\partial p_g^H}{\partial x_k} > \frac{\partial p_g^Y}{\partial x_k}$. Another consideration is that it may be the case that there is more variance in health, in the sense that $|H_g - H_b| > |Y_g - Y_b|$. In this case, the impact of risk aversion on the optimal time seeking health information is likely to be positive, $\frac{\partial x_k^*}{\partial \gamma} > 0$, and women will shift time from coffee cultivation to gathering health information.

To further understand this finding, one can consider the different types of health information sources available to women in this region of Guatemala.[6] It could be the case that formal sources of health information, such as doctors, may be less known to women in remote villages because they are available less often than locally-based pharmacists or community health workers. Usually, doctors are not based in the villages but instead visit one day per week or per month. Other health care providers, such as community health workers or untrained pharmacists, may have a daily presence in the community and so may be more trusted sources of information. For some women, visiting a doctor may be considered relatively risky for a number of reasons, such as differences between beliefs in traditional medicine and in modern medicine, lack of community or language connections, and perceptions about visiting a doctor or the clinic. However, the results in of Table 4.1 show that risk averse women actually consult with a greater number of formally-trained health sources, such as doctors or nurses. Table 4.2 further disaggregates these findings to show the difference between nurses and doctors and suggests that the significant impact on formally-trained health sources is driven by visiting with nurses, who are most often women in this context. The other findings in Table 4.1 show no significant relationship between risk preferences and obtaining information about child health from written sources, untrained pharmacists, or community health workers.

The findings in Table 4.1 show that there are a number of other significant factors related to where a woman seeks information about child health. First, wealth is positively related to consulting a greater number of sources. This finding could indicate the

[6]The table shows estimates for written sources, formally trained sources, pharmacists, and community health worker. Also included in the summation of the total number of sources are the social network (friends, family, neighbors) and TV or radio. Findings related to the social network sources are presented in Table 4.4.

greater mobility and access to health care providers afforded by wealth. Unsurprisingly, the findings show that a woman's education level is significantly positively related to her learning about child health from written sources.

Table 4.3 presents estimates of the impact of preferences towards risk on the *frequency* of visits to different sources of child health information. Above, the results showed that risk averse women are more likely to consult a greater number of distinct sources, but Table 4.3 indicates that they are not likely to visit these sources more frequently than non-risk averse women. The findings do suggest that risk averse women consult written sources of child health information less frequently, a somewhat puzzling finding. Furthermore, there are significant negative relationships between age and literacy and the frequency of obtaining information about child health from formally-trained sources. Finally, the lower the ratio of literate household members to total adults in the household, the more frequently a woman gathers information from a community health worker. In this region of Guatemala, community health workers tend to conduct home visits in addition to having a presence in the community center's office. This finding suggests that community health workers are appropriately targeting women in the village who are either illiterate themselves or live in households with a greater ratio of illiterate to literate adults.

Turning to non-trained sources of health information, Table 4.4 shows the estimates of the relationship between risk preferences and gathering child health knowledge from one's social network. There is no significant relationship between risk aversion and the seeking of health information from family, friends or neighbors. Wealthier women are more likely to consult with both friends and neighbors regarding child health information, however, this finding is no longer significant with the addition of community fixed effects.

Table 4.5 shows estimates of the relationship between risk preferences and the frequency with which women gather child health knowledge from their social network. The regression in column (1) shows a marginally significantly negative relationship between risk aversion and the frequency of health information sought from family members, but this relationship is no longer significant when community fixed effects are added to the

regression. The findings show that women with lower (higher) levels of literacy are more (less) dependent on child health knowledge from their friends. Wealth has a significantly positive relationship with seeking health information from friends. Further, consulting with family may also depend on the number of literate family members within the household. Women who have fewer literate members compared to total adults in the household rely on their family significantly more frequently for information regarding child health. This may provide some evidence that illiterate women are further marginalized from health information by living in households with a greater number of illiterate family members.

Table 4.6 shows the relationship between risk aversion and diversification of health information sources, after controlling for the number of times women gather information. The findings show that conditional on the number of times women get information, the risk averse women will gather information from a more diverse set of sources. While risk averse women are not necessarily gathering information more frequently, they are choosing to get information from a broader set of sources.

The findings can be further explored with the data collected to examine whether risk averse women, who consult a greater number of health information sources, also have greater child health knowledge. Table 4.7 shows estimates analyzing the relationship between risk preferences and child health knowledge. Since 52 percent of the sample got either a perfect score or an almost perfect score (9 out of 10 questions correct) on the child health questionnaire, columns (3) and (4) analyze the relationship between risk preferences and getting a perfect (or almost perfect) score on the child health questions. All estimates show no significant relationship between risk preferences and actual child health knowledge.

Finally, Table 4.8 shows estimates from a multinomial logit regression of the relationship between risk preferences and relative trust in a doctor, pharmacist or neither.[7] The estimates show no evidence of a direct relationship between risk preferences and relative trust in a doctor or pharmacist. The lack of a significant relationship between

[7]Trust in neither a doctor nor a pharmacist was used as the frame of reference (base category) in the multinomial logit regression.

risk preferences and relative trust might imply that the mechanism through which risk preferences impact relative trust in medical professionals is through the impact on gathering health information from a variety of different sources. Women who already have greater child health knowledge are less likely to trust a doctor and less likely to trust a pharmacist. This relative lack of trust in either a doctor or a pharmacist by women with greater knowledge themselves about child health may indicate that they are able to correctly judge whether the information they receive is incorrect or inappropriate. Another possible explanation may be that women with greater confidence in their own knowledge may have less exposure to doctors and pharmacists (since they may deem it unnecessary to visit the clinic), resulting in fewer opportunities to develop trust in these sources of child health knowledge.

All together, the findings show a significant relationship between risk aversion and diversification of health information sources, but not necessarily more frequently, among women in Highland Guatemala. This finding provides insight into the framework from Section 4.2 and may indicate that women with greater risk aversion are more willing to shift the amount of time they dedicate to income-generating activities, such as coffee cultivation, and gathering health information. This reallocation of time depends on a number of factors, including: (1) the relative magnitudes of the impact of time spent seeking health information on the probability of good health outcomes ($\frac{\partial p_g^H}{\partial x_k}$) or good income outcomes ($\frac{\partial p_g^Y}{\partial x_k}$) ; (2) the (relative) weights a woman places on income (α) and health ($1-\alpha$); and (3) the values of Y_g, Y_b, H_g, and H_b. Further, educated women are more likely to learn about child health from formally-trained sources, particularly nurses. In addition to education, wealth is significantly related to the total number of distinct health information sources consulted. Further, the greater the knowledge a woman already has about child health, the less relative trust she has in either a pharmacist or a doctor.

4.5 Conclusion

The purpose of this chapter is to analyze, for women in remote regions of Guatemala, the relationship between: (i) risk aversion and health information-seeking behavior; and (ii) risk aversion and relative trust in a doctor or pharmacist. This paper uses primary data collected in Highland Guatemala to estimate these relationships. Providing insight into the framework discussed in Section 4.2, the results show that risk averse women gather health information from a broader set of sources. Further, risk averse women are less likely to be dependent on family members for child health knowledge. And for those women with greater knowledge of child health, they are less likely to have relative trust in either a doctor or a pharmacist. Other interesting relationships emerged from the data, as well. A woman's education, literacy and wealth is significantly related to where she learns about child health. Women in households with lower ratios of literate members to adults in the household are more reliant on their family for health information, but are also more likely to be visited by community health workers.

One of the contributions of this study is to extend the model by Liu and Huang (2013) to conceptualize how risk preferences predict decision-making related to time allocated towards income-generating activities and health information-seeking. This conceptual contribution provides a simple framework for thinking through how individuals make decisions when facing stringent time constraints. The framework in this study extends the application of the model used in Liu and Huang (2013) to empirically test how risk aversion may relate to health seeking behaviors and how this depends on the relative weights a woman places on health and income.

Indigenous women living in Highland Guatemala rely on those in their social networks, such as family, friends and neighbors, for a variety of information, including health information. There is empirical evidence of learning and positive spillovers in social networks (Bandiera et al., 2009; Duflo and Saez, 2003; Foster and Rosenzweig, 1995). Social learning is a process by which individuals learn by observing the behavior of others within their social network, overcoming information asymmetries. For the case of Guatemala, these social networks can be trusted sources of health information for

populations with high illiteracy rates. Informal information sharing can be central to improving household welfare, particularly when that information can directly improve the health of members of the household, including children. However, there is also the risk of the spread of misinformation when that information doesn't come from a trained medical professional, particularly in places where there are high illiteracy rates, because of the dependence on word-of-mouth for information. This study investigates how women in Highland Guatemala use available health resources, such as community health workers and medical professionals, and their social networks, to gather information about child health. These social networks may enable someone to overcome imperfect information problems, where trust and trustworthiness are key components (Cardenas and Carpenter, 2008; Karlan, 2005).

For health interventions, the results from this study identify a need for stricter training requirements for pharmacists to increase women's perceptions about and trust in their abilities. Women with greater knowledge about child health have lower relative trust in pharmacists or doctors. With respect to pharmacists, this may possibly indicate that they recognize that untrained pharmacists may give inaccurate or inappropriate advice. Policy interventions can address this lack of relative trust in health care professionals, particularly pharmacists, in this region by expanding the educational and training requirements of pharmacists in Guatemala. In this study, one of the most common sources of child health information for women is the community health worker, so expanding their presence in remote villages and providing them with more training may be a pathway for improving women's health knowledge. Finally, the results imply that barriers exist to learning about child health for illiterate women in Highland Guatemala, who are marginalized in a number of respects.

There are also some important limitations of this study. First, and foremost, there are concerns related to the endogeneity of women's risk preferences as it relates to her participation in health information networks and relative trust in health professionals. The direction of causality is difficult to disentangle and, as a result, the findings should be interpreted cautiously. However, this study provides a conservative estimate of how risk aversion is positively related to greater health information-seeking among women in rural Guatemala. A second limitation is that this study relies on self-reported health

behaviors. Women's recollections of the number of times they have sought information may not be accurate and could conceivably bias the results. Finally, a limitation in both the conceptual framework and empirically is that the findings assume that women in this setting are able to independently choose how much health information to seek and that women act based on this knowledge. In reality, women in the sample are limited in the number of opportunities for engagement with medical professionals and limited by time constraints to discuss child health and nutrition.

Table 4.1: Regression Estimates of the Relationship between Risk Preferences and Where Women Learn about Child Health

	Total Number of Sources		Written Sources		Sources with Formal Training		Pharmacists		Community Health Worker	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Risk Aversion	0.536***	0.411*	0.081	0.050	0.055*	0.065*	0.064	0.085	0.011	0.012
	(0.189)	(0.211)	(0.073)	(0.079)	(0.030)	(0.035)	(0.118)	(0.119)	(0.015)	(0.013)
Age of	-0.009	-0.010	0.001	-0.003	-0.000	0.001	-0.005	-0.007*	-0.003***	-0.002
Respondent	(0.012)	(0.014)	(0.004)	(0.003)	(0.001)	(0.001)	(0.003)	(0.003)	(0.001)	(0.001)
Literacy of	0.014	-0.028	-0.007	-0.037	0.010	0.019	0.006	-0.003	0.002	0.004
Respondent	(0.099)	(0.099)	(0.028)	(0.027)	(0.018)	(0.020)	(0.026)	(0.026)	(0.010)	(0.010)
Highest Education	0.236**	0.175	0.100***	0.107**	0.005	-0.009	-0.071**	-0.064*	0.002	-0.001
of Respondent	(0.098)	(0.130)	(0.033)	(0.044)	(0.020)	(0.024)	(0.035)	(0.035)	(0.009)	(0.010)
No. of Children	-0.103	-0.086	-0.012	-0.008	-0.016	-0.017*	0.008	0.004	0.004	0.002
	(0.070)	(0.071)	(0.012)	(0.013)	(0.010)	(0.009)	(0.028)	(0.026)	(0.006)	(0.005)
Wealth Index	0.319***	0.274**	0.052	0.077**	-0.030*	-0.037**	0.058**	0.060**	0.000	-0.003
	(0.087)	(0.096)	(0.039)	(0.033)	(0.015)	(0.016)	(0.026)	(0.025)	(0.007)	(0.008)
Ratio of Literate	0.493**	0.393*	0.034	0.012	0.054*	0.046*	0.076	0.098	-0.005	-0.004
Adults in HH	(0.201)	(0.213)	(0.074)	(0.072)	(0.028)	(0.025)	(0.078)	(0.083)	(0.015)	(0.011)
Constant	6.439***	6.845***	0.271	0.466***	0.887***	0.866***	0.766***	0.823***	1.044***	1.015***
	(0.669)	(0.616)	(0.169)	(0.094)	(0.087)	(0.079)	(0.164)	(0.179)	(0.029)	(0.035)
Observations	248	248	248	248	248	248	248	248	248	248
R-squared	0.126	0.062	0.093	0.097	0.046	0.063	0.048	0.056	0.036	0.014
Community Fixed Effects?	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Number of Communities		18		18		18		18		18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for a small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.2: Regression Estimates of the Relationship between Risk Preferences and Seeking Child Health Information from Doctors or Nurses

	Visits a Doctor		Frequency of Doctor Visits		Visits a Nurse		Frequency of Nurse Visits	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Risk Aversion	0.141	0.114	0.223	0.089	0.081*	0.092*	0.056	0.318
	(0.086)	(0.088)	(0.868)	(0.891)	(0.043)	(0.047)	(1.632)	(1.740)
Age of Respondent	-0.001	0.001	-0.054	-0.080*	-0.003**	-0.001	-0.093*	-0.037
	(0.001)	(0.001)	(0.042)	(0.044)	(0.001)	(0.001)	(0.054)	(0.046)
Literacy of Respondent	-0.019	-0.027	-0.951***	-1.078**	0.006	0.017	-0.423	0.233
	(0.030)	(0.025)	(0.323)	(0.409)	(0.018)	(0.021)	(0.437)	(0.491)
Highest Education Respondent	0.033	0.036	1.261***	1.162*	0.002	-0.018	0.598	-0.328
	(0.022)	(0.023)	(0.454)	(0.558)	(0.020)	(0.025)	(0.615)	(0.704)
No. of Children	-0.024	-0.029*	-0.225	-0.166	-0.015	-0.017	0.165	0.015
	(0.016)	(0.016)	(0.183)	(0.192)	(0.012)	(0.011)	(0.350)	(0.321)
Wealth Index	0.037*	0.047	1.317**	1.257**	-0.029*	-0.043**	-0.721	-1.399***
	(0.022)	(0.028)	(0.519)	(0.577)	(0.017)	(0.018)	(0.555)	(0.459)
Ratio of Literate Members to Adults in HH	0.063*	0.040	1.533	1.275	0.062*	0.054*	-0.189	0.078
	(0.033)	(0.033)	(0.943)	(0.961)	(0.035)	(0.031)	(1.046)	(0.926)
Constant	0.760***	0.778***	5.616**	7.255***	0.961***	0.933***	14.949***	13.216***
	(0.129)	(0.099)	(2.320)	(2.318)	(0.057)	(0.042)	(3.292)	(2.492)
Observations	247	247	247	247	247	247	247	247
R-squared	0.038	0.040	0.104	0.075	0.051	0.061	0.033	0.040
Number of Communities		18		18		18		18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for a small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.3: Regression Estimates of the Relationship between Risk Preferences and Frequency of Seeking Child Health Information from Different Sources

	Total Number of Sources		Written Sources		Sources with Formal Training		Pharmacists		Community Health Worker	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Risk Aversion	-4.217	-3.252	-0.575*	-0.655**	0.139	0.204	1.400	1.564	-1.235	-0.735
	(4.288)	(4.165)	(0.313)	(0.304)	(1.032)	(1.107)	(1.078)	(1.155)	(1.338)	(1.227)
Age of Respondent	-0.126	-0.049	-0.000	-0.014	-0.074*	-0.058	-0.042***	-0.068***	0.038	0.088*
	(0.187)	(0.175)	(0.011)	(0.015)	(0.039)	(0.039)	(0.016)	(0.012)	(0.060)	(0.051)
Literacy of Respondent	-2.138*	-1.147	-0.084	-0.103	-0.687**	-0.422	-0.418	-0.291	0.418	0.806*
	(1.108)	(1.248)	(0.111)	(0.138)	(0.339)	(0.420)	(0.267)	(0.244)	(0.375)	(0.446)
Highest Education of Respondent	2.538	1.738	0.343*	0.305	0.930*	0.417	0.351	0.086	0.195	-0.059
	(1.870)	(2.142)	(0.165)	(0.241)	(0.492)	(0.590)	(0.420)	(0.445)	(0.559)	(0.572)
No. of Children	0.821	0.438	-0.026	0.011	-0.030	-0.075	0.148	0.285	0.969***	0.764*
	(0.917)	(0.938)	(0.037)	(0.048)	(0.224)	(0.208)	(0.311)	(0.333)	(0.357)	(0.384)
Wealth Index	-0.156	-1.313	0.097	0.091	0.298	-0.071	0.207	0.063	-0.698**	-0.959**
	(1.545)	(1.681)	(0.150)	(0.131)	(0.365)	(0.361)	(0.567)	(0.591)	(0.325)	(0.411)
Ratio of Literate Adults in HH	-4.466	-3.303	-0.118	-0.188	0.672	0.677	0.051	-0.080	-3.105***	-2.567*
	(3.351)	(3.295)	(0.165)	(0.146)	(0.883)	(0.837)	(0.727)	(0.744)	(1.121)	(1.217)
Constant	48.185***	43.948***	0.757	1.246**	10.282***	10.235***	3.874***	4.696***	10.172***	7.708***
	(8.048)	(8.317)	(0.636)	(0.460)	(2.163)	(1.943)	(1.294)	(0.902)	(2.463)	(2.520)
Observations	248	248	248	248	248	248	248	248	248	248
R-squared	0.032	0.017	0.046	0.043	0.060	0.020	0.033	0.049	0.043	0.047
Community Fixed Effects?	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Number of Communities		18		18		18		18		18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for a small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.4: Regression Estimates of the Relationship between Risk Preferences and Seeking Information from Social Networks

	Family		Friends		Neighbors		Social Network	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Risk Aversion	-0.012	-0.012	0.002	-0.030	0.061	0.049	-0.022	-0.023
	(0.036)	(0.035)	(0.052)	(0.058)	(0.056)	(0.058)	(0.021)	(0.022)
Age of Respondent	0.000	0.002**	0.000	-0.001	-0.003*	-0.002	0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)
Literacy of	0.016	0.020	0.001	-0.024	-0.004	-0.013	-0.004	-0.004
Respondent	(0.011)	(0.012)	(0.034)	(0.036)	(0.022)	(0.023)	(0.004)	(0.004)
Highest Education	-0.005	-0.018	0.015	0.030	-0.008	-0.005	0.007	0.006
of Respondent	(0.016)	(0.017)	(0.023)	(0.032)	(0.033)	(0.036)	(0.007)	(0.005)
No. of Children	-0.001	-0.006	-0.020	-0.020	-0.018	-0.027	0.003	0.001
	(0.018)	(0.016)	(0.026)	(0.029)	(0.015)	(0.016)	(0.003)	(0.002)
Wealth Index	-0.003	-0.015	0.065***	0.060	0.043**	0.036	0.009	0.008
	(0.017)	(0.015)	(0.024)	(0.035)	(0.018)	(0.024)	(0.009)	(0.007)
Ratio of Literate	-0.005	-0.001	0.129*	0.115	0.082**	0.080*	-0.002	-0.000
Adults in HH	(0.042)	(0.043)	(0.077)	(0.084)	(0.038)	(0.039)	(0.004)	(0.004)
Constant	0.925***	0.888***	0.579***	0.674***	0.945***	0.964***	0.952***	0.938***
	(0.045)	(0.034)	(0.190)	(0.175)	(0.132)	(0.146)	(0.048)	(0.046)
Observations	248	248	248	248	248	248	248	248
R-squared	0.008	0.024	0.054	0.038	0.037	0.025	0.024	0.031
Community Fixed Effects?	No	Yes	No	Yes	No	Yes	No	Yes
Number of Communities		18		18		18		18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for a small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.5: Regression Estimates of the Relationship between Risk Preferences and Frequency of Seeking Information from Social Networks

	Family		Friends		Neighbors		Social Network	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Risk Aversion	-2.820*	-2.302	-0.633	-0.886	-0.477	-0.419	-3.930	-3.607
	(1.626)	(1.672)	(0.616)	(0.569)	(1.188)	(1.244)	(2.793)	(2.721)
Age of Respondent	0.066	0.111	-0.041	-0.061*	-0.074*	-0.049	-0.048	0.001
	(0.068)	(0.066)	(0.031)	(0.034)	(0.040)	(0.042)	(0.112)	(0.110)
Literacy of	-0.060	0.297	-0.727***	-0.874***	-0.589	-0.576	-1.376	-1.153
Respondent	(0.538)	(0.597)	(0.204)	(0.263)	(0.519)	(0.560)	(1.064)	(1.252)
Highest Education	0.619	0.421	0.128	0.352	-0.032	0.211	0.714	0.985
of Respondent	(0.493)	(0.597)	(0.240)	(0.412)	(0.555)	(0.658)	(0.910)	(1.123)
No. of Children	0.038	-0.135	-0.135	-0.152	-0.172	-0.310	-0.270	-0.597
	(0.255)	(0.229)	(0.091)	(0.116)	(0.143)	(0.194)	(0.356)	(0.373)
Wealth Index	-1.072	-1.380*	0.795***	0.853***	0.218	0.092	-0.059	-0.434
	(0.677)	(0.717)	(0.219)	(0.219)	(0.468)	(0.498)	(1.130)	(1.165)
Ratio of Literate	-1.972**	-1.451*	-0.244	-0.074	0.249	0.380	-1.966	-1.145
Adults in HH	(0.899)	(0.704)	(0.506)	(0.484)	(0.493)	(0.468)	(1.273)	(1.148)
Constant	7.260**	4.896	6.791***	7.248***	9.053***	7.924***	23.104***	20.068***
	(2.912)	(3.098)	(1.662)	(1.688)	(2.109)	(2.540)	(4.538)	(5.233)
Observations	248	248	248	248	248	248	248	248
R-squared	0.065	0.080	0.059	0.064	0.020	0.016	0.037	0.033
Community Fixed Effects?	No	Yes	No	Yes	No	Yes	No	Yes
Number of Communities		18		18		18		18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for a small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.6: Regression Estimates of the Relationship between Risk Preferences and and Diversity of Health Information Sources

	Total Number of Sources (1)	Total Number of Sources (2)
Risk Aversion	0.641***	0.503**
	(0.199)	(0.206)
Total Frequency of Visits to All Sources	0.025***	0.028***
	(0.009)	(0.009)
Age of Respondent	-0.006	-0.009
	(0.015)	(0.018)
Literacy of Respondent	0.068	0.005
	(0.104)	(0.107)
Highest Education Respondent	0.173	0.126
	(0.126)	(0.143)
No. of Children	-0.124	-0.098
	(0.077)	(0.077)
Wealth Index	0.323***	0.311***
	(0.077)	(0.095)
Ratio of Literate Members to Adults in HH	0.605**	0.487*
	(0.248)	(0.258)
Constant	5.238***	5.597***
	(0.783)	(0.814)
Observations	247	247
Community Fixed Effects?	No	Yes
R-squared	0.206	0.173
Number of Communities		18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for a small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.7: Regression Estimates of Relationship between Risk Preferences and Child Health Knowledge

	Actual Knowledge		Perfect (or Almost Perfect) Score	
	(1)	(2)	(3)	(4)
Risk Aversion	-0.300	-0.240	-0.146	-0.126
	(0.290)	(0.271)	(0.103)	(0.102)
Age of Respondent	0.008	0.010	0.002	0.003
	(0.009)	(0.010)	(0.004)	(0.004)
Literacy of Respondent	-0.017	0.008	-0.012	0.006
	(0.094)	(0.107)	(0.031)	(0.033)
Highest Education of Respondent	0.131	0.033	0.025	-0.011
	(0.105)	(0.117)	(0.044)	(0.046)
No. of Children	-0.032	-0.031	0.001	0.003
	(0.063)	(0.036)	(0.021)	(0.020)
Wealth Index	0.077	-0.023	0.049	0.008
	(0.142)	(0.124)	(0.046)	(0.041)
Ratio of Literate Adults in HH	0.111	0.098	-0.011	-0.031
	(0.197)	(0.168)	(0.075)	(0.078)
Constant	7.792***	7.858***	0.451**	0.456**
	(0.571)	(0.504)	(0.201)	(0.189)
Observations	248	248	248	248
R-squared	0.026	0.012	0.023	0.015
Community Fixed Effects?	No	Yes	No	Yes
Number of Communities		18		18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for a small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 4.8: Multinomial Logit Regression Estimates of Relationship between Risk Preferences and Relative Trust in a Doctor or Pharmacist

	Relative Trust in Pharmacist (1)	Relative Trust in Dr. (2)
Risk Aversion	0.244	0.513
	(1.269)	(1.215)
Age of Respondent	0.038	0.026
	(0.034)	(0.031)
Literacy of Respondent	0.142	0.297
	(0.390)	(0.343)
Highest Education of Respondent	0.445	0.487
	(0.516)	(0.442)
No. of Children	-0.078	-0.143
	(0.228)	(0.205)
Wealth Index	-0.304	-0.077
	(0.344)	(0.288)
Perfect (or Almost) Child Health Knowledge	-3.068***	-2.637**
	(1.085)	(1.051)
Ratio of Literate Adults in HH	-0.116	0.252
	(0.795)	(0.731)
Constant	1.212	2.169
	(2.156)	(1.999)
Observations	248	248

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for a small for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Chapter 5

Risk Aversion, Agricultural Assets and Income Diversification

5.1 Introduction

Poor households in developing countries are more likely than other households in those countries to be hurt by income fluctuations and shocks. Diversifying agricultural assets and income sources is a crucial strategy employed by the poor to meet their critical needs, mitigate risks, respond to shocks, and provide a personal safety net. Bardhan and Udry (1999) argue that income diversification is a method for reducing unwanted variance in income, especially in an environment where savings, credit, and insurance markets are inaccessible or inefficient. Agricultural production is a common source of income in rural areas of developing countries, and increasing assets related to agriculture may be a means of poverty alleviation. This paper delves into the role of women and how their individual risk preferences influence their households' asset portfolio and income diversification.

This purpose of this chapter is to analyze how women's risk preferences relate to their participation in various types of agricultural activities, ownership of agricultural assets,

and income diversification. This relationship is motivated by a framework to consider this relationship between risk and portfolio choice of assets and income activities, based on the model of Rosenzweig and Binswanger (1993). The empirical analysis in this study draws on data collected by the author in the Guatemalan Highlands, including an experiment to elicit risk preferences. To answer the question of how women's risk preferences relate to assets, income sources and diversification, the empirical model controls for unobserved community-level variables that may influence the availability of assets and options for income-generation through the use of community fixed effects. Furthermore, the empirical model incorporates a control for women's decision-making over household assets and household income sources. To do this, women's intra-household decision-making is interacted with risk preferences to determine whether there are any differential impacts based on women's intra-household decision-making abilities. While one might expect risk preferences to have a relationship with diversification of assets and income sources, this study presents evidence from Guatemala suggesting there is not a strong connection between the two.

Livelihoods refer to the opportunity set afforded an individual or household as a result of their asset endowment and their allocation of these assets across various activities to generate income or other benefits (Barrett and Reardon, 2000; Barrett et al., 2005). Diversification of income and assets is common in developing countries, and there are a number of reasons that rural households diversify their income and assets. Income diversification measures are usually directly linked to household asset stocks, such as livestock or poultry. While risk averse individuals may choose to earn income from a greater number of sources in order to protect against adverse shocks, such as a poor crop yield in agriculture, it may also be the case that risk averse individuals do not invest in a greater number of distinct productive assets, but instead choose to invest in assets that are less risky.

There is evidence that income diversification contributes to higher income and food consumption, and to greater stability of income over time (Bowser, Nelson et al., 2012; Reardon, Delgado, and Matlon, 1992). However, there are a number of constraints to increasing assets and diversifying income sources. For example, Bowser, Nelson et al. (2012) find that land tenure increases the set of income generating activities and

increases the asset portfolio among low-income communities in Brazil. Abdulai and CroleRees (2001) study income diversification in Southern Mali and find that poorer households have fewer opportunities in non-cropping activities, such as livestock rearing and non-farm work, and suggest there are significant capital entry constraints to portfolio diversification. Turning to the role of women, Jacoby (1991) estimates the gendered productivity in agriculture in the Peruvian Sierra and finds evidence that women specialize in livestock production. Women's role in livestock raising and agricultural production may further increase the food security and nutritional status of children within the household (Haddad et al., 1997; Quisumbing et al., 1995). While there is growing evidence on women's role in agriculture, this study contributes to the existing literature by providing information on women's risk preferences and how this impacts households' agricultural assets and income diversification. Improving our understanding of income diversification and constraints to women is especially important for identifying effective means of targeting programs for improving the asset holdings of the poor.

The remainder of this chapter proceeds as follows. Section 5.2 provides a framework for studying how risk preferences relate to portfolio diversification regarding assets and income sources. Section 5.3 describes the empirical strategy for estimating the relationship between risk preferences and ownership of agricultural assets and participation in multiple income-generation activities. Section 5.4 presents the results, and Section 5.5 discusses the implications of the findings.

5.2 Conceptual Framework

This section provides a simple framework of income diversification to demonstrate the relationship between risk preferences and asset accumulation. Women who are risk averse may be more likely to diversify their household's income-generating activities and agricultural assets. Risk averse individuals may encourage the household to earn income from a greater number of sources to protect against adverse shocks, such as a poor crop yield in agriculture. For instance, a household with risk averse individuals may prefer to earn income from both farming and wage employment so that in the

case there is a poor crop yield, they have another source of income for the household. Furthermore, risk averse individuals may accumulate either a greater number of distinct productive assets, or choose to invest in assets that are less risky. For example, it may be the case that households with risk averse individuals prefer to purchase land rather than livestock as a more secure form of investment.

The framework presented in this section comes directly from Rosenzweig and Binswanger (1993) to explore the relationship between risk and portfolio choice of assets and income activities. Consider an individual, such as a farmer in Highland Guatemala, with total asset holdings (wealth) W who chooses the allocation of different assets prior to the realization of a random risky outcome (ω) – such as weather or some other shock impacting wealth – to maximize her expected utility of consumption.[1] In this region of Guatemala, most households are farmers and the largest risk they face is related to weather. For simplicity, assume that ω does not vary by type of asset, but is a risk facing all assets. Assume that (expected) utility, denoted by U, is a function of the mean (μ_c) and the standard deviation (σ_c) of consumption:

$$U = V(\mu_c, \sigma_c), \quad V_\mu > 0, \quad V_\sigma < 0 \tag{5.2.1}$$

The quasi-concavity of Equation (5.2.1) is sufficient to guarantee convexity of preferences, so that $V_{\mu\mu} < 0$ and $V_{\mu\mu}V_{\sigma\sigma} - V_{\sigma\mu}^2 \geq 0$ (Meyer, 1987). The individual influences the mean and standard deviation through the choices of productive assets and income sources. Rosenzweig and Binswanger (1993) assume that there exists a profit function with constant returns to scale in the investment inputs and normalize, arbitrarily and without loss of generality, by the n^{th} productive asset. The mean and standard deviation of farm profits, μ_Π and σ_Π, are determined by the household's investments and the mean and standard deviation of the risky outcome (ω) as follows:

$$\mu_\Pi = W f(\tilde{\alpha_i})\mu_\omega, \qquad f_{\alpha\alpha} < 0 \tag{5.2.2}$$

$$\sigma_\Pi = W\Gamma(\tilde{\alpha_i})\sigma_\omega, \qquad \Gamma_{\alpha\alpha} < 0 \tag{5.2.3}$$

where W is household wealth, $\tilde{\alpha_i}$ is the portfolio investment vector indicating the value

[1] In Rosenzweig and Binswanger (1993) ω refers strictly to weather risk.

share of the i^{th} investment input in total wealth. The term $\Gamma(\tilde{\alpha_i})$ takes a vector of the variance of asset choice and turns it into a scalar while $f(\tilde{\alpha_i})$ takes a vector of the mean of assets and converts it to a scalar. Equations (5.2.2) and (5.2.3) show the profits per unit of wealth. Assuming there is one source of stochastic variability in profits for simplicity, Γ measures the riskiness of the asset portfolio. The mean of consumption is given by the mean of profits:

$$\mu_c = \mu_\Pi \tag{5.2.4}$$

Next, in order to map the standard deviation of profits to that of consumption, credit market constraints are considered. Assuming individuals have (very) limited access to credit and (very) limited ability to borrow on capital markets, then:

$$\sigma_c = \kappa(W)\sigma_\Pi \tag{5.2.5}$$

with $0 < \kappa(W) \leq 1$ and $\kappa'(W) < 0$. Equation (5.2.5) expresses the relationship between the variability in consumption and profits as influenced by wealth; wealthier individuals are better able to reduce the variance in their consumption. If individuals have no access to credit markets, then the variation in their consumption is equal to the variation in profits: $\sigma_c = \sigma_\Pi$. At the other extreme, if individuals are perfectly insured against risk, then there is no variation in their consumption: $\sigma_c = 0$.

The individual now chooses her portfolio investments, $\tilde{\alpha_i}$, which then determines the mean and standard deviation of consumption, μ_c and σ_c, to maximize her utility. The individual is constrained by the mean and standard deviation of profits (μ_Π and σ_Π), which are functions of μ_ω and σ_ω.

The first-order conditions give:[2]

$$V_\mu f_{\alpha_i} = -V_\sigma \Gamma_{\alpha_i} \sigma_\omega \kappa, \quad i = 1, ..., n-1 \tag{5.2.6}$$

where $f_{\alpha_i} = f_i - f_n$ and $\Gamma_{\alpha_i} = \Gamma_i - \Gamma_n$, with f_j and Γ_j the marginal contributions of the j^{th} productive asset to the mean and standard deviation, respectively (Rosenzweig and Binswanger, 1993). From Equation (5.2.6), risk averse individuals, whose marginal

[2]See Appendix 5.6 for details.

contributions to each productive asset vary in their profitability ($\Gamma_{\alpha_i} \neq 0$), will realize lower average profits than if they had maximized expected profits as long as their incomes as not perfectly insured ($0 < \kappa \leq 1$) since $-V_\sigma \Gamma_{\alpha_i} \sigma_\omega \kappa$ cannot be equal to zero. The motivating concept from this framework and the subsequent empirical framework stems from this idea that there is an interwoven relationship between risk preferences, assets, and income-generating activities. The empirical framework will test whether individuals who are more risk averse choose asset portfolios that reduce the expected variance of profits.

5.3 Empirical Strategy

To analyze the relationship between women's risk preferences and the household's diversification of either assets and income sources, the regression equations in Equations (5.3.1) and (5.3.2) are used. The two measures of diversification used in this study are simply the distinct number of assets owned by, or income sources of, the household. Two alternate measures of diversification are calculated by dividing the summations of the number of assets or income sources by the wealth index, to show diversification per unit of wealth. This equation includes women's risk preferences, γ_{ic}, as the variable of interest and diversification of assets, D_{ic}^A, and income, D_{ic}^Y, as the dependent variables in each of the specifications. This model controls for unobserved community-level variables that may influence the availability of assets and options for income-generation by using community fixed effects, f_c. Furthermore, women's decision-making over assets (A) within the household, W_{icA}, is interacted with risk preferences, γ_{ic}, to test whether the risk preferences of women with more intra-household bargaining has a greater impact on the households' choice of assets.

$$D_{ic}^A = \alpha_0 + \alpha_1 X_{ic} + \alpha_2 \gamma_{ic} + \alpha_3 W_{icA} + \alpha_4 (\gamma_{ic} * W_{icA}) + f_c + \epsilon_{icD^A} \tag{5.3.1}$$

$$D_{ic}^Y = \phi_0 + \phi_1 X_{ic} + \phi_2 \gamma_{ic} + \phi_3 W_{icY} + \phi_4 (\gamma_{ic} * W_{icY}) + f_c + \epsilon_{icD^Y} \tag{5.3.2}$$

The dependent variables, D_{ic}^A and D_{ic}^Y, are the measures of asset or income diversification, respectively. The explanatory variables include a vector of individual variables

related to the woman, $\mathbf{X}_{ic}$, including age, number of children, education, and husband's education level. The regression includes a variable measuring a woman's risk preferences (γ_{ic}), both as a separate variable and interacted with women's decision-making power, community fixed effects (f_c), and an error term for each (ϵ_{icD^A} and ϵ_{icD^Y}).

The next set of estimates analyzes the relationship between women's risk preferences and asset accumulation, the regression equation in Equation (5.3.3) includes women's risk preferences, γ_{ic}, as the variable of interest and the different agricultural assets, A_{ic}, as the dependent variable. This model controls for unobserved community-level variables that may influence the availability of assets and options for income-generation by using community fixed effects, f_c. Similar to the models above, women's decision-making over assets (A) within the household, W_{icA}, is interacted with risk preferences, γ_{ic}. The equation to be estimated is:

$$A_{ic} = \beta_0 + \beta_1 X_{ic} + \beta_2 \gamma_{ic} + \beta_3 W_{icA} + \beta_4 (\gamma_{ic} * W_{icA}) + f_c + \epsilon_{icA} \tag{5.3.3}$$

The dependent variable, A_{ic}, are dummy variables that indicate the different types of productive assets owned by the household.[3] The productive assets include the ownership of: large livestock; small livestock; poultry; agricultural land; non-agricultural land; and non-mechanized farm equipment. The explanatory variables include a vector of individual-level variables related to the woman, $\mathbf{X}_{ic}$, including age, number of children, education, and husband's education. The variable measuring a woman's risk preferences (γ_{ic}) is used in separate regressions in two distinct specifications: first, as a dummy variable indicating risk averse preferences (one signifies choosing the option devoid of risk and zero otherwise, indicating any form of risk tolerance) and, in a second regression, as a series of dummy variables representing risk options two through six. Finally, the regression includes an error term (ϵ_{icA}).

The purpose of this estimation is to analyze whether risk preferences relate to the different types of assets, possibly indicating that some assets are thought to represent lower or higher levels of risk. It could be the case that larger livestock are a riskier

[3] Appendix 5.6 shows the results using the seemingly unrelated regression (SUR) estimation method to test between and within columns for the joint significance of risk.

form of asset relative to owning chickens since they represent a more consolidated form of wealth and if several goats or a cow died, it would represent a larger shock to the household than if a chicken died. Similarly, large livestock may be more risky than small livestock. With respect to land, non-agricultural land may be less risky that agricultural land since land used for agricultural purposes faces risks associated with rainfall and weather. Non-mechanized farm equipment may include a range of items, from shovels to push rototillers. The riskiness of this equipment may depend on the size of the item, with smaller items more susceptible to theft, but larger items more valuable.

Finally, a similar analysis is conducted, but focusing on the relationship between women's risk preferences and household income sources. The regression equation in Equation (5.3.4) includes women's risk preferences, γ_{ic}, as the variable of interest and the different sources of income, Y_{ic}, as the dependent variable. These income sources include food crop farming, cash crop farming, livestock raising, non-farm economic activity, and wage and salary employment. This model controls for unobserved community-level variables that may influence the availability of assets and options for income-generation by using community fixed effects, f_c, and includes an error term (ϵ_{icY}). Women's decision-making over income (Y) sources within the household, W_{icY}, is interacted with risk preferences, γ_{ic}.

This analysis will show the relationship between risk preferences and various sources of income, with the potential of suggesting whether there are some sources of income that coincide with lower or higher levels of risk. For example, cash crop farming is a riskier agricultural activity since it is more dependent on prices from the international market. While farmers may be able to increase their profits from making the switch from subsistence farming to cash crop farming, there is also greater risk involved. Relative to wage or salary employment, which may be the least risky income source, earning income from livestock or either subsistence or cash crop farming may be risky. Finally, earning income from non-farm economy activities is most commonly small stores in this region of Guatemala. While there may not be much risk involved, income from these stores is dependent on local demand. The estimation equation of interest is:

$$Y_{ic} = \delta_0 + \delta_1 X_{ic} + \delta_2 \gamma_{ic} + \delta_3 W_{icY} + \delta_4 (\gamma_{ic} * W_{icY}) + f_c + \epsilon_{icY} \tag{5.3.4}$$

The purpose of this study is to estimate an association between risk preferences and household assets, income sources, and diversification of these assets and income sources. One potential source of endogeneity is reverse causality, in which the choice of assets and income source has an impact on risk preferences. It may be the case that women in households with fewer assets, or wealth, or different types of assets are more risk averse. However, there is mixed evidence as to whether poor people are more risk averse or than wealthier people (Binswanger, 1980; Brunnermeier and Nagel, 2008; Cardenas and Carpenter, 2008; Holt and Laury, 2002; Schechter, 2007). It is possible that the diversification of income sources or assets may impact risk preferences. Risk preferences in this study are elicited during an experiment that is measuring choice under uncertainty. Gollier and Pratt (1996) study the concept of background risk and finds that the individual who faces more background risk will choose the less risky gamble. This is problematic for the analysis in this study because individuals who have more diversified income sources may be willing to choose a riskier gamble. Therefore, this potential reverse causality may introduce bias into the estimates of the impact of risk preferences on assets and income sources.

The measure of risk preferences used in this study was experimentally elicited and is prone to measurement error. It could be that women participating in the risk game did not understand how the game worked or did not choose the risk game that accurately reflects their risk preferences because of this misunderstanding. The presence of random measurement error in the risk preferences variable would lead to attenuation bias, that is an underestimation of the true impact.

The models may not control well for unobserved heterogeneity between respondents given that there are many individual characteristics that are unobserved. Further, this unobserved heterogeneity could lead to biased estimates. These unobserved characteristics are captured in the error term. The models do, however, control for factors that are common among individuals within each community through the inclusion of community fixed effects. Given these potential problems, the estimates in this chapter should be interpreted with caution, and in particular they may be biased estimates of the causal impact of risk aversion on asset and income diversification.

The Appendix Tables include a number of robustness checks for the findings. The Appendix Tables in Section 5.6 provide the same analysis estimated using seemingly unrelated regression estimation method to test for the joint significance of risk both within and between columns and the Appendix Tables in Section 5.7 exclude observations of the women who chose the riskiest option. It is possible that those who chose the risk-loving option did not understand the game, so this set of results analyzes the relationships excluding these individuals. The results in these two sets of appendix tables support the findings from the "main" results.

5.4 Results and Discussion

This section presents the key findings of the estimates of the relationship between risk preferences and agricultural assets, income sources, and diversification of these assets and income sources. The first set of estimates, reported in Tables 5.1, 5.2, and 5.3, analyze the relationship between risk preferences and agricultural assets. The next set of estimates, reported in Tables 5.4, 5.5, and 5.6, show the relationship between risk preferences and participation in different income-generating activities. Finally, Tables 5.7 and 5.8 show the results estimating the relationship between risk preferences and asset diversification and income diversification, respectively.

Table 5.1 begins by presenting estimates of the impact of risk aversion on the probability of the household owning different agricultural assets, including large livestock, small livestock, poultry farming, agricultural land, non-agricultural land, and non-mechanized farm equipment. The measure of risk aversion used in this table is a dichotomous variable indicating a willingness to tolerate at least some risk. One might expect that different forms of agricultural assets are riskier than others and that risk averse individuals may prefer to hold their wealth in the form of lower risk assets. For example, large livestock may be riskier than small livestock because it represents a consolidation of wealth and the death of a cow would impose a larger negative shock to the household than the death of a rabbit. That said, the findings suggest that there is no significant relationship between risk aversion and asset ownership after controlling for fixed effects

at the community level. Turning to the covariate variables, the findings show that the husband's education level is negatively related to owning small livestock and that households with more children are more likely to own both small and large livestock, as well as chickens, ducks, turkeys, or pigeons. The results also show that age is positively related to land ownership, both agricultural and non-agricultural, as well as farm equipment.

Table 5.2 reports findings from a similar analysis, but uses risk choices two through six, instead of risk aversion, to analyze the impact of risk preferences on asset ownership. The results with respect to husband's education, age, and number of children are of similar in significance and direction as those in Table 5.1. With respect to risk, when women chose the fourth option (compared to the option with zero risk involved), their household is more likely to own large livestock, poultry, agricultural land, and non-agricultural land. This finding may suggest there is some risk involved in agricultural production and households with women who tolerate some risk may be more likely to own agricultural assets. However, this finding disappears after dropping the risk 'loving' observations and, therefore, shouldn't be taken very seriously. Furthermore, there is a significant relationship between risk preferences and non-agricultural land; households of women who chose options with more risk (risk choices four and six) are more likely to own non-agricultural land, while those who chose a low risk option (choice two) are less likely to own non-agricultural land. However, the significance on these coefficients may simply be reflective of multiple hypothesis testing. Altogether, this suggests that there is little evidence that tolerating some risk is related to owning non-agricultural land. Extending this analysis, Table 5.3 conditions the findings on women's decision-making power within the household regarding assets, but suggests no significantly different results.

The findings in Table 5.4 now turn to the estimates of the impact of risk aversion on participation in different types of income-generating activities, including food crop farming, cash crop farming, livestock raising, non-farm economic activity, and wage and salary employment. Risk averse individuals may choose to earn income from sources that are considered more secure, or that require fewer gambles. For instance, in comparing food crop farming to cash crop farming, food or subsistence farming is the status quo in Highland Guatemala and, therefore, could be considered less risky than transitioning

a plot to grow cash crops. Making the transition to cash crops requires learning new farming techniques and also exposes a farmer to potentially greater volatility in prices from the international market. Earning income from agriculture more generally is riskier than earning income from wage or salary employment since it depends on the annual yields and market prices. However, there are often education and literacy requirements for securing employment in wage or salaried positions. The results in Table 5.4 show that a household where the main female decision-maker is risk averse is more likely to participate in non-farm economic activity, which could include small to medium enterprises, such as owning a local store. Furthermore, households with older women making decisions are more likely to participate in food crop farming. Since food or subsistence crop farming is the traditional activity in this region of Guatemala, this second finding is unsurprising, and may suggest a reluctance among the older generation for transitioning to new types of income-generation. Households with a greater number of children are more likely to participate in livestock raising. This finding is plausible since children can contribute to the work of caring for livestock. Finally, a woman's literacy level is a positively related to participation in both non-farm economic activity and wage and salary employment.

Table 5.5 reports findings on a similar analysis of the impact of risk preferences on participation in income-generating activities, but uses risk preference options two through six instead of the dichotomous measure of risk aversion. The findings suggest that women who chose risk option two, compared to the option with zero risk, are more likely to participate in non-farm economic activity. Again, this significance may simply be the result of multiple hypothesis testing. The results with respect to age, the number of children, and literacy are of similar in significance and direction as those in Table 5.4. The results in this table also suggest a positive relationship between a husband's education level and participation in wage and salary employment, which is intuitive since this type of employment often has educational and literacy requirements.

Expanding these results, Table 5.6 shows estimate of the relationship between risk aversion and income sources, now adding the interaction term of risk aversion and women's decision-making ability regarding income-generation within the household. The findings

show a significantly positive impact of risk aversion on participation in cash crop farming. However, for women who are more involved in household decision-making regarding income-generation, the impact of risk aversion on cash crop farming is smaller.[4]

Turning to asset diversification, Table 5.7 shows the analysis of the impact of risk preferences on agricultural asset diversification. It is possible that risk averse individuals choose to spread their wealth into a more diverse portfolio of assets. This analysis first estimates the association between risk preferences and the total number of assets within the household and then considers the number of assets per unit of wealth. There doesn't appear to be a clear relationship between risk preferences and asset diversification (total number of assets or assets per wealth), although there is minimal evidence that choosing risk option four is significantly positively associated with asset diversification. The size of the coefficient on this fourth risk option choice is larger in magnitude in Columns (4) and (5) as compared to the coefficient once the number of assets controls for wealth (Column (7)). However, this loses significance after dropping the risk 'loving' observations. Focusing on the control variables, women's decision-making power over household assets does not appear to have any significant impact, but both age and number of children are positively related to the number of assets in the household, while the husband's education level is negatively related to assets in six of the seven specifications.

Lastly, Table 5.8 considers income diversification by showing the results from analyzing the relationship between risk preferences and income diversification, both in total number of income sources and income sources per unit of wealth. It is plausible that risk averse individuals choose to earn income from more stable sources, thus reducing the variance in their household's income. There is some evidence in Columns (4), (5) and (7) of a significantly negative relationship with risk tolerance (choosing risk options three and/or six) and income diversification, before and after controlling for level of wealth.

[4] $CC = ID + 4.93RA - 4.96 * ID * RA$ where CC = Cash Crop Farming, ID = Income Decision-Making, and RA = Risk Aversion. To see the impact of an increase in risk aversion on the decision to participate in cash crop farming, take $\frac{\partial CC}{\partial RA} = 4.93 - 4.96 * ID$. With $ID > 0$, the effect of risk aversion on cash crop farming is smaller for women with more decision-making power. The mean value of ID is 0.99. Therefore, on average there is no impact of risk aversion on cash crop farming. However, if women have no decision-making power within the household, the impact of women's risk aversion on cash crop farming is positive. In this scenario, women's risk aversion is not considered in the household decision to participate in the relatively risky activity of cash crop farming.

While this may suggest that households of women who tolerate some risk are less likely to diversify the number of different sources of income, the evidence is limited and difficult to interpret. Moreover, women's decision-making ability over income sources is significantly positively related to income diversification within the household, as shown in Column (3). While not the focus of this paper, this latter finding may suggest that women play an important role in the household's decisions regarding income-generation.

Overall, there are two main themes resulting from this analysis: one related to the role of risk aversion in asset ownership and another related to income-generation within the household. While one might expect that different forms of agricultural assets are riskier than others and that risk averse individuals may prefer to hold their wealth in the form of lower risk items, the findings suggest there is only limited evidence of a significant relationship between risk tolerance and asset ownership, including large livestock, poultry, agricultural land, and non-agricultural land. While there is some evidence of a significantly negative relationship between risk tolerance (choosing risk options three and/or six) and income diversification, before and after controlling for level of wealth, these could simply reflect multiple hypothesis testing. It is possible that this may suggest that households of women who tolerate some risk are less likely to diversify the number of different sources of income, the evidence is very limited.

5.5 Conclusion

The purpose of this study is to analyze the relationship between women's risk preferences and the household's agricultural assets and income diversification. The findings from this study, implying that risk preferences do not have a strong relationship with household assets or income sources, which may indicate that households are making asset and income decisions based on factors other than risk. This finding is consistent with Barrett, Reardon, and Webb (2001), who recognize that many studies seeking to understand the reasons for rural income diversification focus on a single explanation, such as risk management, and fail to consider other reasons, such as liquidity constraints. Further, Alderman and Paxson (1992) discuss how portfolio diversification to limit the

amount of risk in income is likely to vary greatly across households and also partly depends on the household's ability to smooth consumption through the use of credit markets.

While not the focus of this paper, there is some evidence related to women's role in decision-making regarding household assets and income sources. The results show that a household where the main female decision-maker is risk averse is more likely to participate in non-farm economic activity, which could include small to medium enterprises. Moreover, women's decision-making ability over income sources is significantly positively related to income diversification within the household. This finding is consistent with that of Meinzen-Dick et al. (2011) and Peterman et al. (2011) demonstrating the importance of considering women's role in household decision-making, particularly as it relates to agricultural production. Furthermore, households with older women making decisions are more likely to participate in food crop farming.

This paper considers the relationship between risk preferences and agricultural assets and income diversification using data collected by the author in Highland Guatemala. The evidence presented in this study contributes to a growing literature on the relationship between risk preferences and portfolio diversification. There is a rather weak link between risk aversion and asset diversification or income source diversification for this sample of women in Highland Guatemala. Further investigation is needed to determine the factors that lead a household to diversify their assets and income sources in Highland Guatemala.

Table 5.1: Community Fixed Effects Linear Probability Regression Estimates of the Relationship between Risk Aversion and Agricultural Assets

	Large Livestock (1)	Small Livestock (2)	Poultry Farming (3)	Agricultural Land (4)	Non-Agricultural Land (5)	Non-Mechanized Farm Equipment (6)
Age of Respondent	0.003	0.001	0.003	0.005**	0.006***	0.007***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)
Literacy of Respondent	0.031	0.022	0.024	-0.017	0.024	-0.024
	(0.021)	(0.016)	(0.014)	(0.020)	(0.016)	(0.016)
No. of Children	0.037***	0.032*	0.021*	0.009	-0.012	0.001
	(0.010)	(0.016)	(0.012)	(0.010)	(0.007)	(0.010)
Husband's Education Level	-0.007	-0.052**	-0.008	-0.007	0.004	-0.012
	(0.013)	(0.022)	(0.015)	(0.022)	(0.012)	(0.017)
Risk Aversion	-0.037	-0.034	-0.042	-0.042	-0.067	0.044
	(0.034)	(0.078)	(0.050)	(0.059)	(0.039)	(0.079)
Constant	-0.126	0.117	0.557***	0.676***	-0.106**	0.644***
	(0.169)	(0.108)	(0.133)	(0.122)	(0.038)	(0.101)
Observations	243	244	244	244	244	244
R-squared	0.077	0.080	0.028	0.046	0.040	0.068
Number of Communities	18	18	18	18	18	18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 5.2: Community Fixed Effects Linear Probability Regression Estimates of the Relationship between Risk Preferences 2-6 and Agricultural Assets

	Large Livestock (1)	Small Livestock (2)	Poultry Farming (3)	Agricultural Land (4)	Non-Agricultural Land (5)	Non-Mechanized Farm Equipment (6)
Age of Respondent	0.003	0.001	0.003	0.005**	0.006***	0.007***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)
Literacy of Respondent	0.031	0.020	0.022	-0.018	0.025	-0.025
	(0.021)	(0.015)	(0.015)	(0.021)	(0.015)	(0.015)
No. of Children	0.038***	0.033*	0.022*	0.011	-0.010	0.002
	(0.009)	(0.016)	(0.012)	(0.010)	(0.007)	(0.011)
Husband's Education Level	-0.010	-0.057**	-0.011	-0.008	0.009	-0.013
	(0.013)	(0.023)	(0.015)	(0.022)	(0.012)	(0.017)
Risk #2	0.072	0.110	0.040	0.013	-0.101*	-0.082
	(0.070)	(0.113)	(0.105)	(0.070)	(0.051)	(0.090)
Risk #3	0.047	0.098	-0.025	-0.056	0.021	-0.045
	(0.073)	(0.121)	(0.071)	(0.091)	(0.072)	(0.102)
Risk #4	0.062*	0.070	0.132**	0.101*	0.119**	0.023
	(0.031)	(0.104)	(0.057)	(0.052)	(0.051)	(0.077)
Risk #5	0.095	0.063	0.064	0.120	0.065	-0.010
	(0.057)	(0.104)	(0.066)	(0.076)	(0.068)	(0.085)
Risk #6	-0.031	-0.053	-0.019	-0.020	0.090*	-0.108
	(0.053)	(0.069)	(0.071)	(0.089)	(0.048)	(0.102)
Constant	-0.163	0.092	0.520***	0.625***	-0.191***	0.684***
	(0.165)	(0.096)	(0.150)	(0.155)	(0.065)	(0.120)
Observations	243	244	244	244	244	244
R-squared	0.093	0.101	0.050	0.073	0.067	0.084
F-test for Joint Significance of Risk	1.44	2.49	1.41	1.75	18.85	0.93
Number of Communities	18	18	18	18	18	18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 5.3: Community Fixed Effects Linear Probability Regression Estimates of the Relationship between Risk and Assets, Conditional on Women's Decision-Making Power

	Large Livestock (1)	Small Livestock (2)	Poultry Farming (3)	Agricultural Land (4)	Non-Agricultural Land (5)	Non-Mechanized Farm Equipment (6)
Age of Respondent	0.003	0.001	0.003	0.007***	0.005**	0.006***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.001)
Literacy of Respondent	0.031	0.022	0.023*	-0.023	-0.016	0.024
	(0.020)	(0.015)	(0.012)	(0.016)	(0.020)	(0.016)
No. of Children	0.037***	0.032*	0.022*	0.000	0.009	-0.012
	(0.010)	(0.015)	(0.011)	(0.009)	(0.010)	(0.007)
Husband's Education Level	-0.006	-0.054**	-0.015	-0.010	-0.007	0.008
	(0.014)	(0.021)	(0.015)	(0.017)	(0.023)	(0.011)
Asset Decision-Making	-0.063	-0.005	0.534	-0.181	-0.104	-0.164
	(0.191)	(0.482)	(0.339)	(0.299)	(0.279)	(0.225)
Interaction of Asset Decision-Making and Risk Aversion	0.022	0.562	-0.082	0.313	0.576	-0.442
	(0.512)	(0.601)	(0.708)	(0.667)	(0.759)	(0.587)
Risk Aversion	-0.053	-0.429	0.021	-0.178	-0.448	0.242
	(0.368)	(0.424)	(0.515)	(0.449)	(0.534)	(0.437)
Constant	-0.082	0.119	0.191	0.768***	0.746***	0.006
	(0.215)	(0.298)	(0.290)	(0.210)	(0.210)	(0.159)
Observations	243	244	244	244	244	244
R-squared	0.077	0.083	0.046	0.070	0.049	0.046
Number of Communities	18	18	18	18	18	18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 5.4: Community Fixed Effects Linear Probability Regression Estimates of the Relationship between Risk Aversion and Income-Generating Activity

	Food Crop Farming (1)	Cash Crop Farming (2)	Livestock Raising (3)	Non-Farm Economic Activity (4)	Wage and Salary Employment (5)
Age of Respondent	0.003**	0.003	0.002	0.001	-0.002
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
Literacy of Respondent	-0.023	0.022	0.011	0.099***	0.053*
	(0.023)	(0.028)	(0.022)	(0.025)	(0.028)
No. of Children	0.002	0.004	0.040***	0.015	0.011
	(0.014)	(0.010)	(0.013)	(0.015)	(0.012)
Husband's Education Level	0.004	-0.001	0.005	-0.003	0.042
	(0.023)	(0.021)	(0.025)	(0.018)	(0.024)
Risk Aversion	-0.013	0.043	-0.010	0.152*	-0.010
	(0.071)	(0.090)	(0.063)	(0.082)	(0.074)
Constant	0.703***	0.284	-0.053	0.031	0.411***
	(0.128)	(0.208)	(0.145)	(0.212)	(0.121)
Observations	244	244	244	244	244
R-squared	0.023	0.005	0.076	0.077	0.059
Number of Communities	18	18	18	18	18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 5.5: Community Fixed Effects Linear Probability Regression Estimates of the Relationship between Risk Preferences 2-6 and Income-Generating Activity

	Food Crop Farming (1)	Cash Crop Farming (2)	Livestock Raising (3)	Non-Farm Economic Activity (4)	Wage and Salary Employment (5)
Age of Respondent	0.004**	0.003	0.002	0.002	-0.002
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
Literacy of Respondent	-0.022	0.024	0.009	0.102***	0.053*
	(0.024)	(0.030)	(0.022)	(0.028)	(0.030)
No. of Children	0.004	0.005	0.041***	0.017	0.012
	(0.015)	(0.010)	(0.012)	(0.015)	(0.012)
Husband's Education Level	0.002	-0.002	0.002	0.001	0.044*
	(0.024)	(0.019)	(0.024)	(0.019)	(0.025)
Risk #2	0.034	-0.011	0.028	-0.311**	-0.105
	(0.063)	(0.161)	(0.093)	(0.130)	(0.141)
Risk #3	-0.041	-0.194	0.055	-0.150	-0.009
	(0.102)	(0.136)	(0.088)	(0.108)	(0.108)
Risk #4	-0.010	-0.116	0.076	-0.151	0.070
	(0.093)	(0.116)	(0.060)	(0.117)	(0.089)
Risk #5	0.131	0.096	0.019	-0.073	0.009
	(0.077)	(0.129)	(0.081)	(0.062)	(0.099)
Risk #6	-0.043	-0.051	-0.064	-0.169	0.003
	(0.088)	(0.079)	(0.076)	(0.108)	(0.091)
Constant	0.674***	0.307	-0.057	0.149	0.390**
	(0.176)	(0.210)	(0.113)	(0.190)	(0.137)
Observations	244	244	244	244	244
R-squared	0.050	0.038	0.095	0.090	0.067
F-stat for Joint Significance of Risk	4.03	6.59	2.57	1.21	1.03
Number of Communities	18	18	18	18	18

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 5.6: Community Fixed Effects Linear Probability Regression Estimates of the Relationship between Risk and Income Sources, Conditional on Women's Decision-Making Power

	Food Crop Farming (1)	Cash Crop Farming (2)	Livestock Raising (3)	Non-Farm Economic Activity (4)	Wage and Salary Employment (5)
Age of Respondent	0.003	0.003	0.002	0.001	-0.002
	(0.002)	(0.004)	(0.002)	(0.003)	(0.003)
Literacy of Respondent	-0.043*	0.013	0.009	0.096***	0.044
	(0.021)	(0.026)	(0.022)	(0.029)	(0.030)
No. of Children	-0.002	0.004	0.042***	0.014	0.007
	(0.013)	(0.010)	(0.014)	(0.015)	(0.012)
Husband's Education Level	0.001	-0.005	0.002	-0.008	0.041
	(0.024)	(0.021)	(0.026)	(0.019)	(0.024)
Income Decision-Making	1.022	1.786	0.756*	0.690	0.942
	(0.752)	(1.241)	(0.380)	(0.659)	(0.786)
Interaction of Income Decision-Making and Risk Aversion	1.032	-4.962**	1.840	3.024	3.398
	(3.476)	(2.172)	(1.323)	(2.291)	(2.755)
Risk Aversion	-1.071	4.943**	-1.837	-2.859	-3.403
	(3.413)	(2.159)	(1.280)	(2.232)	(2.698)
Constant	-0.179	-1.437	-0.795	-0.618	-0.460
	(0.769)	(1.246)	(0.498)	(0.574)	(0.771)
Observations	234	234	234	234	234
Number of Communities	18	18	18	18	18
R-squared	0.047	0.018	0.084	0.076	0.062
F-stat for Joint Significance of Interaction Term and Risk Aversion	0.09	5.23	2.00	1.69	1.56

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1

Table 5.7: Regression Estimates of the Relationship between Risk and Asset Diversification

Dependent variables: Total Number of Household Assets (Columns 1-5) and Assets per Unit of Wealth (Columns 6-7)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Age of Respondent	0.026***	0.025***	0.025***	0.027***	0.025***	0.003***	0.003***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.001)	(0.001)
Literacy of Respondent	0.046	0.062	0.063	0.050	0.056	0.004	0.004
	(0.058)	(0.038)	(0.037)	(0.059)	(0.041)	(0.005)	(0.005)
No. of Children	0.107***	0.088***	0.088***	0.111***	0.094***	0.009***	0.010***
	(0.028)	(0.024)	(0.023)	(0.028)	(0.021)	(0.003)	(0.002)
Husband's Education Level	-0.073	-0.081*	-0.084**	-0.082*	-0.089**	-0.009*	-0.010**
	(0.049)	(0.043)	(0.037)	(0.048)	(0.040)	(0.005)	(0.004)
Risk #2				-0.058	0.050		0.010
				(0.365)	(0.303)		(0.034)
Risk #3				-0.132	0.039		0.005
				(0.250)	(0.233)		(0.025)
Risk #4				0.383*	0.506**		0.053**
				(0.226)	(0.196)		(0.020)
Risk #5				0.278	0.389		0.041
				(0.235)	(0.281)		(0.029)
Risk #6				-0.206	-0.142		-0.018
				(0.216)	(0.253)		(0.026)
Risk Aversion	-0.080	-0.176	-0.831			-0.018	
	(0.177)	(0.204)	(1.526)			(0.021)	
Asset Decision-Making			0.035				
			(1.081)				
Interaction of Asset Decision			0.931				
-Making and Risk Aversion			(2.136)				
Constant	1.661***	1.752***	1.726*	1.552***	1.559***	0.187***	0.168***
	(0.387)	(0.262)	(0.942)	(0.405)	(0.426)	(0.027)	(0.042)
Observations	244	244	244	244	244	244	244
R-squared	0.125	0.102	0.103	0.161	0.146	0.095	0.138
F-stat for Joint Significance of Risk	–	–	–	2.49	2.01	–	2.08
Community Fixed Effects?	No	Yes	Yes	No	Yes	Yes	Yes

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1. Community fixed effects based on 18 communities.

Table 5.8: Regression Estimates of the Relationship between Risk and Income Diversification

Dependent Variables: Total Number of Household Income Sources (Columns 1-5) and Income Sources per Unit of Wealth (Columns 6-7)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Age of Respondent	0.013	0.007	0.007	0.014	0.008	0.001	0.001
	(0.009)	(0.008)	(0.008)	(0.009)	(0.008)	(0.001)	(0.001)
Literacy of Respondent	0.126*	0.162*	0.119	0.131*	0.167*	0.014	0.015
	(0.066)	(0.087)	(0.088)	(0.067)	(0.093)	(0.009)	(0.010)
No. of Children	0.058**	0.072*	0.065*	0.061**	0.079**	0.008**	0.008**
	(0.028)	(0.036)	(0.036)	(0.028)	(0.036)	(0.003)	(0.004)
Husband's Education Level	0.037	0.048	0.032	0.034	0.047	0.004	0.004
	(0.052)	(0.060)	(0.065)	(0.052)	(0.057)	(0.006)	(0.006)
Risk #2				-0.425	-0.365		-0.037
				(0.369)	(0.302)		(0.031)
Risk #3				-0.485*	-0.339*		-0.038*
				(0.279)	(0.186)		(0.020)
Risk #4				-0.181	-0.131		-0.017
				(0.266)	(0.250)		(0.026)
Risk #5				0.008	0.183		0.018
				(0.261)	(0.200)		(0.021)
Risk #6				-0.402	-0.323*		-0.043**
				(0.253)	(0.153)		(0.015)
Risk Aversion	0.259	0.162	-4.227			0.021	
	(0.215)	(0.131)	(4.735)			(0.012)	
Income Decision-Making			5.196***				
			(1.765)				
Interaction of Income Decision -Making and Risk Aversion			4.332				
			(4.768)				
Constant	1.336***	1.376**	-3.489*	1.544***	1.464**	0.148**	0.162***
	(0.447)	(0.571)	(1.851)	(0.462)	(0.570)	(0.053)	(0.053)
Observations	244	244	234	244	244	244	244
R-squared	0.036	0.050	0.061	0.055	0.077	0.042	0.074
F-stat for Joint Significance of Risk	–	–	–	1.23	3.25	–	3.05
Community Fixed Effects?	No	Yes	Yes	No	Yes	Yes	Yes

Cluster-robust standard errors in parentheses, clustered at community-level using the Cameron and Miller (2015) wild bootstrap method for small number of clusters. *** p<0.01, ** p<0.05, * p<0.1. Community fixed effects based on 18 communities.

5.6 Seemingly Unrelated Regression (SUR) Results

Table 5.6.1: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk Aversion and Agricultural Assets

	Large Livestock (1)	Small Livestock (2)	Poultry Farming (3)	Agricultural Land (4)	Non-Agricultural Land (5)	Non-Mechanized Farm Equipment (6)
Age of Respondent	0.006**	0.001	0.005*	0.004*	0.006***	0.004
	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
Literacy of Respondent	0.028	0.018	0.018	-0.017	0.029*	-0.029
	(0.019)	(0.020)	(0.021)	(0.020)	(0.017)	(0.021)
No. of Children	0.027***	0.035***	0.033***	0.015	-0.008	0.006
	(0.009)	(0.010)	(0.010)	(0.010)	(0.008)	(0.010)
Husband's Education Level	-0.014	-0.040**	-0.020	0.000	0.004	-0.003
	(0.016)	(0.017)	(0.017)	(0.016)	(0.014)	(0.017)
Risk Aversion	-0.034	-0.008	-0.035	-0.011	-0.036	0.044
	(0.070)	(0.076)	(0.077)	(0.073)	(0.064)	(0.076)
Constant	-0.170	0.077	0.508***	0.661***	-0.136	0.724***
	(0.128)	(0.138)	(0.141)	(0.134)	(0.117)	(0.140)
Observations	243	243	243	243	243	243
R-squared	0.067	0.075	0.067	0.045	0.036	0.040

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Breusch-Pagan Test of Independence: $\chi^2 = 136.04$

Test of Joint Significance of Risk Aversion Across Columns (1) through (6): $\chi^2 = 1.43$

Table 5.6.2: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk Preferences 2-6 and Agricultural Assets

	Large Livestock (1)	Small Livestock (2)	Poultry Farming (3)	Agricultural Land (4)	Non-Agricultural Land (5)	Non-Mechanized Farm Equipment (6)	Joint Significance χ^2 (7)
Age of Respondent	0.006**	0.002	0.005*	0.005*	0.006***	0.004	
	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	
Literacy of Respondent	0.028	0.018	0.018	-0.017	0.029*	-0.028	
	(0.019)	(0.020)	(0.021)	(0.020)	(0.017)	(0.021)	
No. of Children	0.027***	0.035***	0.034***	0.015*	-0.007	0.007	
	(0.009)	(0.010)	(0.010)	(0.009)	(0.008)	(0.010)	
Husband's Education Level	-0.017	-0.045***	-0.022	-0.002	0.009	-0.005	
	(0.016)	(0.017)	(0.017)	(0.016)	(0.014)	(0.017)	
Risk #2	0.072	0.079	-0.011	-0.008	-0.109	-0.080	2.71
	(0.106)	(0.114)	(0.116)	(0.111)	(0.097)	(0.116)	
Risk #3	0.061	0.037	-0.054	-0.107	-0.017	-0.052	1.67
	(0.098)	(0.105)	(0.107)	(0.102)	(0.089)	(0.107)	
Risk #4	0.066	0.044	0.122	0.068	0.080	0.003	1.49
	(0.081)	(0.088)	(0.089)	(0.085)	(0.074)	(0.089)	
Risk #5	0.057	0.053	0.077	0.081	0.026	-0.010	1.59
	(0.083)	(0.089)	(0.091)	(0.086)	(0.075)	(0.091)	
Risk #6	-0.030	-0.084	-0.022	-0.039	0.066	-0.097	3.35
	(0.079)	(0.085)	(0.086)	(0.082)	(0.072)	(0.086)	
Constant	-0.201	0.072	0.467***	0.643***	-0.184	0.763***	
	(0.137)	(0.148)	(0.150)	(0.143)	(0.125)	(0.151)	
Observations	243	243	243	243	243	243	
R-squared	0.079	0.095	0.090	0.070	0.058	0.049	
F-stat for Joint Significance of Risk	2.98	5.50	6.06	6.50	5.77	2.45	

Breusch-Pagan Test of Independence: $\chi^2 = 131.72$. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5.6.3: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk and Assets, Conditional on Women's Decision-Making Power

	Large Livestock (1)	Small Livestock (2)	Poultry Farming (3)	Agricultural Land (4)	Non-Agricultural Land (5)	Non-Mechanized Farm Equipment (6)
Age of Respondent	0.006**	0.001	0.005*	0.004*	0.006***	0.004
	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
Literacy of Respondent	0.029	0.018	0.017	-0.017	0.028	-0.029
	(0.019)	(0.020)	(0.021)	(0.020)	(0.017)	(0.021)
No. of Children	0.027***	0.035***	0.033***	0.015	-0.009	0.006
	(0.009)	(0.010)	(0.010)	(0.010)	(0.008)	(0.010)
Husband's Education Level	-0.011	-0.043**	-0.028	-0.003	0.009	-0.006
	(0.016)	(0.017)	(0.018)	(0.017)	(0.015)	(0.018)
Asset Decision-Making	-0.269	0.123	0.493*	0.145	-0.105	0.174
	(0.249)	(0.270)	(0.273)	(0.262)	(0.228)	(0.273)
Interaction of Asset Decision-Making	0.340	0.221	-0.105	0.136	-0.828	-0.058
and Risk Aversion	(0.637)	(0.690)	(0.699)	(0.669)	(0.582)	(0.698)
Risk Aversion	-0.275	-0.162	0.044	-0.105	0.541	0.087
	(0.451)	(0.489)	(0.495)	(0.474)	(0.413)	(0.495)
Constant	0.014	-0.008	0.168	0.561**	-0.061	0.604***
	(0.213)	(0.231)	(0.234)	(0.224)	(0.195)	(0.234)
Observations	243	243	243	243	243	243
R-squared	0.072	0.076	0.081	0.047	0.048	0.041

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Breusch-Pagan Test of Independence: $\chi^2 = 136.74$

Test of Joint Significance of Risk Aversion Across Columns (1) through (6): $\chi^2 = 2.48$

Table 5.6.4: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk Aversion and Income-Generating Activity

	Food Crop Farming (1)	Cash Crop Farming (2)	Livestock Raising (3)	Non-Farm Economic Activity (4)	Wage and Salary Employment (5)
Age of Respondent	0.005*	0.005*	0.005**	0.001	-0.003
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Literacy of Respondent	-0.025	0.014	0.010	0.099***	0.027
	(0.021)	(0.026)	(0.020)	(0.024)	(0.025)
No. of Children	0.008	-0.005	0.034***	0.012	0.009
	(0.010)	(0.012)	(0.009)	(0.012)	(0.012)
Husband's Education Level	0.004	-0.008	-0.002	-0.001	0.044**
	(0.018)	(0.021)	(0.016)	(0.020)	(0.021)
Risk Aversion	0.037	0.070	0.016	0.153*	-0.017
	(0.079)	(0.095)	(0.072)	(0.090)	(0.092)
Constant	0.634***	0.254	-0.130	0.052	0.526***
	(0.145)	(0.174)	(0.132)	(0.165)	(0.168)
Observations	244	244	244	244	244
R-squared	0.040	0.015	0.077	0.087	0.045

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Breusch-Pagan Test of Independence: $\chi^2 = 75.26$

Test of Joint Significance of Risk Aversion Across Columns (1) through (6): $\chi^2 = 4.49$

Table 5.6.5: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk Preferences 2-6 and Income-Generating Activity

	Food Crop Farming (1)	Cash Crop Farming (2)	Livestock Raising (3)	Non-Farm Economic Activity (4)	Wage and Salary Employment (5)	Joint Significance χ^2 (6)
Age of Respondent	0.005*	0.006*	0.005**	0.001	-0.003	
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	
Literacy of Respondent	-0.023	0.015	0.010	0.102***	0.027	
	(0.021)	(0.025)	(0.019)	(0.024)	(0.025)	
No. of Children	0.008	-0.005	0.034***	0.014	0.010	
	(0.010)	(0.012)	(0.009)	(0.012)	(0.012)	
Husband's Education Level	0.001	-0.010	-0.006	0.003	0.044**	
	(0.018)	(0.021)	(0.016)	(0.020)	(0.021)	
Risk #2	-0.002	-0.031	0.001	-0.324**	-0.069	4.00
	(0.121)	(0.144)	(0.110)	(0.137)	(0.140)	
Risk #3	-0.104	-0.229*	0.038	-0.152	-0.038	4.22
	(0.111)	(0.133)	(0.101)	(0.127)	(0.129)	
Risk #4	-0.060	-0.129	0.060	-0.159	0.107	4.17
	(0.092)	(0.110)	(0.084)	(0.105)	(0.107)	
Risk #5	0.064	0.051	-0.032	-0.078	0.002	4.02
	(0.093)	(0.112)	(0.085)	(0.107)	(0.109)	
Risk #6	-0.080	-0.067	-0.091	-0.161	-0.003	4.05
	(0.089)	(0.107)	(0.081)	(0.102)	(0.104)	
Constant	0.659***	0.310*	-0.108	0.177	0.506***	
	(0.155)	(0.186)	(0.142)	(0.177)	(0.181)	
Observations	244	244	244	244	244	
R-squared	0.058	0.040	0.097	0.101	0.056	
F-stat for Joint Significance of Risk	4.89	5.91	6.20	3.13	3.53	

Breusch-Pagan Test of Independence: $\chi^2 = 63.80$. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5.6.6: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk and Income Sources, Conditional on Women's Decision-Making Power

	Food Crop Farming (1)	Cash Crop Farming (2)	Livestock Raising (3)	Non-Farm Economic Activity (4)	Wage and Salary Employment (5)
Age of Respondent	0.004*	0.006*	0.005**	0.001	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Literacy of Respondent	-0.040*	0.006	0.007	0.095***	0.017
	(0.021)	(0.027)	(0.021)	(0.026)	(0.026)
No. of Children	0.003	-0.006	0.034***	0.011	0.005
	(0.010)	(0.013)	(0.010)	(0.012)	(0.012)
Husband's Education Level	-0.003	-0.013	-0.005	-0.005	0.039*
	(0.017)	(0.022)	(0.017)	(0.021)	(0.021)
Income Decision-Making	1.041	1.584	0.576	0.988	0.547
	(0.828)	(1.056)	(0.818)	(1.013)	(1.011)
Interaction of Income Decision-Making and Risk Aversion	0.544	-6.757	1.930	2.690	3.894
	(3.626)	(4.627)	(3.585)	(4.435)	(4.431)
Risk Aversion	-0.548	6.742	-1.906	-2.533	-3.909
	(3.596)	(4.588)	(3.555)	(4.398)	(4.393)
Constant	-0.276	-1.275	-0.685	-0.880	0.086
	(0.828)	(1.056)	(0.818)	(1.013)	(1.011)
Observations	234	234	234	234	234
R-squared	0.060	0.031	0.081	0.090	0.047

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Breusch-Pagan Test of Independence: $\chi^2 = 63.91$

Test of Joint Significance of Risk Aversion Across Columns (1) through (5): $\chi^2 = 4.87$

5.7 Regression Results without Risk-Loving Observations

Table 5.7.1: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk Preferences 2-5 and Agricultural Assets

	Large Livestock (1)	Small Livestock (2)	Poultry Farming (3)	Agricultural Land (4)	Non-Agricultural Land (5)	Non-Mechanized Farm Equipment (6)	Joint Significance χ^2 (7)
Age of Respondent	0.007**	0.001	0.006**	0.002	0.004	0.002	
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	
Literacy of Respondent	0.023	0.002	0.025	-0.002	0.020	-0.018	
	(0.023)	(0.025)	(0.023)	(0.022)	(0.019)	(0.024)	
No. of Children	0.021*	0.028**	0.033***	0.013	-0.007	0.006	
	(0.012)	(0.013)	(0.012)	(0.012)	(0.010)	(0.012)	
Husband's Education Level	-0.017	-0.050**	-0.019	-0.009	-0.003	0.010	
	(0.020)	(0.021)	(0.020)	(0.019)	(0.016)	(0.020)	
Risk #2	0.081	0.097	-0.015	-0.013	-0.096	-0.101	2.86
	(0.112)	(0.122)	(0.114)	(0.109)	(0.094)	(0.115)	
Risk #3	0.062	0.041	-0.054	-0.106	-0.015	-0.050	1.74
	(0.102)	(0.112)	(0.104)	(0.100)	(0.086)	(0.105)	
Risk #4	0.069	0.050	0.120	0.064	0.085	-0.002	1.52
	(0.085)	(0.093)	(0.087)	(0.083)	(0.071)	(0.087)	
Risk #5	0.061	0.058	0.077	0.075	0.027	-0.017	1.64
	(0.086)	(0.094)	(0.088)	(0.084)	(0.073)	(0.089)	
Constant	-0.222	0.174	0.401**	0.703***	-0.058	0.773***	
	(0.167)	(0.183)	(0.170)	(0.164)	(0.141)	(0.172)	
Observations	177	177	177	177	177	177	
R-squared	0.069	0.070	0.097	0.043	0.045	0.021	
F-stat for Joint Significance of Risk	0.04	0.22	4.30	4.75	5.01	1.01	

Breusch-Pagan Test of Independence: $\chi^2 = 85.69$. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5.7.2: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk Preferences 2-5 and Income-Generating Activity

	Food Crop Farming (1)	Cash Crop Farming (2)	Livestock Raising (3)	Non-Farm Economic Activity (4)	Wage and Salary Employment (5)	Joint Significance χ^2 (6)
Age of Respondent	0.003	0.008**	0.008**	0.003	-0.002	
	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)	
Literacy of Respondent	-0.015	0.005	0.015	0.081***	0.024	
	(0.024)	(0.029)	(0.024)	(0.029)	(0.028)	
No. of Children	0.009	-0.011	0.032***	0.014	0.012	
	(0.013)	(0.015)	(0.012)	(0.015)	(0.015)	
Husband's Education Level	0.004	-0.001	-0.009	-0.001	0.074***	
	(0.021)	(0.025)	(0.020)	(0.025)	(0.024)	
Risk #2	-0.012	-0.026	0.007	-0.305**	-0.094	3.76
	(0.120)	(0.144)	(0.116)	(0.142)	(0.138)	
Risk #3	-0.103	-0.227*	0.036	-0.153	-0.037	3.25
	(0.109)	(0.131)	(0.106)	(0.130)	(0.127)	
Risk #4	-0.063	-0.126	0.059	-0.152	0.103	5.54
	(0.091)	(0.109)	(0.088)	(0.108)	(0.105)	
Risk #5	0.060	0.056	-0.029	-0.070	0.001	1.23
	(0.092)	(0.111)	(0.089)	(0.109)	(0.107)	
Constant	0.689***	0.270	-0.196	0.166	0.416**	
	(0.178)	(0.214)	(0.173)	(0.211)	(0.206)	
Observations	178	178	178	178	178	
R-squared	0.039	0.061	0.095	0.066	0.084	
F-stat for Joint Significance of Risk	3.61	6.67	1.38	3.29	3.27	

Breusch-Pagan Test of Independence: $\chi^2 = 56.84$. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5.7.3: Seemingly Unrelated Regression (SUR) Estimates of the Relationship between Risk Preferences 2-5 and Asset and Income Diversification

	Asset Diversification (1)	Asset Diversification (2)	Income Diversification (3)	Income Diversification (4)	Joint Significance χ^2 (5)
Age of Respondent	0.022**	0.022**	0.019*	0.018*	
	(0.009)	(0.009)	(0.009)	(0.010)	
Literacy of Respondent	0.049	0.049	0.105	0.105	
	(0.068)	(0.069)	(0.072)	(0.073)	
No. of Children	0.089**	0.089**	0.051	0.051	
	(0.035)	(0.036)	(0.038)	(0.038)	
Husband's Education Level	-0.093	-0.093	0.060	0.060	
	(0.057)	(0.058)	(0.060)	(0.061)	
Risk #2	0.204		-0.198		2.44
	(0.226)		(0.238)		
Risk #3	0.202		-0.200		2.45
	(0.225)		(0.237)		
Risk #4	0.215		-0.188		2.49
	(0.223)		(0.236)		
Risk #5	0.215		-0.187		2.46
	(0.223)		(0.236)		
Risk Aversion		-0.212		0.191	2.45
		(0.225)		(0.237)	
Constant	1.797***	2.010***	1.419***	1.230**	
	(0.494)	(0.479)	(0.522)	(0.506)	
Observations	178	178	178	178	
R-squared	0.105	0.104	0.040	0.039	
F-stat of Joint Significance of Risk	0.15	–	0.14	–	

Breusch-Pagan Test of Independence: $\chi^2 = 447.986$. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.8 Conceptual Framework Derivations

Individuals choose $\tilde{\alpha_i}, \mu_c, \sigma_c$ to solve the following maximization problem:

$$\max \quad V(\mu_c, \sigma_c) \tag{5.8.1}$$

Subject to:

$$\mu_\Pi = W f(\tilde{\alpha_i}) \mu_\omega \tag{5.8.2}$$
$$\sigma_\Pi = W \Gamma(\tilde{\alpha_i}) \sigma_\omega \tag{5.8.3}$$
$$\mu_c = \mu_\Pi \tag{5.8.4}$$
$$\sigma_c = \kappa(W) \sigma_\Pi \tag{5.8.5}$$
$$\tag{5.8.6}$$

Combining the constraints gives:

$$\mu_c = W f(\tilde{\alpha_i}) \mu_\omega \tag{5.8.7}$$
$$\sigma_c = W \Gamma(\tilde{\alpha_i}) \sigma_\omega \kappa(W) \tag{5.8.8}$$

Solving for W and re-arranging gives:

$$\mu_c \kappa(W) \Gamma(\tilde{\alpha_i}) \sigma_\omega = \sigma_c f(\tilde{\alpha_i}) \mu_\omega \tag{5.8.9}$$

The associated Lagrange equation is:

$$\mathcal{L}(\mu_c, \sigma_c, \tilde{\alpha_i}, \lambda_1) = V(\mu_c, \sigma_c) + \lambda_1 \big(\sigma_c f(\tilde{\alpha_i}) \mu_\omega - \mu_c \kappa(W) \Gamma(\tilde{\alpha_i}) \sigma_\omega \big) \tag{5.8.10}$$

The first order conditions follow:

$$\frac{\partial \mathcal{L}}{\partial \mu_c} = V_\mu - \lambda_1 \kappa(W)\Gamma(\tilde{\alpha}_i)\sigma_\omega = 0 \tag{5.8.11}$$

$$\frac{\partial \mathcal{L}}{\partial \sigma_c} = V_\sigma + \lambda_1 f(\tilde{\alpha}_i)\mu_\omega = 0 \tag{5.8.12}$$

$$\frac{\partial \mathcal{L}}{\partial \tilde{\alpha}_i} = \lambda_1 \sigma_c f_{\alpha_i}\mu_\omega - \lambda_1 \mu_c \kappa(W)\Gamma_{\alpha_i}\sigma_\omega = 0 \tag{5.8.13}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_1} = \left(\sigma_c f(\tilde{\alpha}_i)\mu_\omega - \mu_c \kappa(W)\Gamma(\tilde{\alpha}_i)\sigma_\omega\right) = 0 \tag{5.8.14}$$

This system of equations gives[5]:

$$V_\mu f_{\alpha_i} = -V_\sigma \kappa(W)\Gamma_{\alpha_i}\sigma_\omega \tag{5.8.15}$$

[5]Under the assumption that μ_ω is normalized to one.

Chapter 6

Conclusion

In this dissertation I have explored the role of women's decision-making and preferences in Guatemala. Improving women's health knowledge is of crucial importance throughout the developing world, particularly given that women play a pivotal role in their children's health and nutrition. This is particularly important for a country with high rates of child malnutrition, such as Guatemala. This dissertation presented results from three studies analyzing the microeconomics of development in Guatemala.

In the first essay, I investigated the impact of increased women's intra-household bargaining power, one aspect of economic empowerment, on women's participation in both formal and informal health information networks to obtain information about child health and nutrition. While the findings are only suggestive due to estimation problems, they may suggest that increased women's intra-household bargaining power increases women's participation in both formal and informal health information networks. The results also show that an increase in participation in more formal networks of knowledge – such as trained medical professionals, books or brochures – is what leads to more accurate child health knowledge.

In the second essay, I examined the relationship between: (i) risk aversion and health information-seeking behavior; and (ii) risk aversion and relative trust in a doctor or pharmacist. The results show that risk averse women consult with a greater number of

distinct health information sources, thus diversifying where they get the information, but not necessarily increasing the frequency of getting their information. Risk averse women are also less dependent on their families for child health knowledge. Finally, the greater a woman's knowledge of child health, the less relative trust she has in either a pharmacist or a doctor.

In the third essay, I focused on the role of risk preferences in household asset and income diversification. Poor households are more likely to be hurt by income fluctuations and shocks. Diversifying agricultural assets and income sources is a crucial strategy employed by the poor to meet their critical needs, mitigate risks, respond to shocks, and provide a personal safety net. This paper delved into the role of women's risk preferences in influencing their households' asset portfolio and income diversification. While one might expect risk averse individuals to diversify their household's sources of income, the results from this study suggest only limited evidence that this is occurring.

Overall, women play a critical role in their households. This dissertation provides evidence that improving women's intra-household decision-making power improves their ability to participate in health information networks. Furthermore, women who are risk averse may be more likely to diversify the sources of health information they consult, but not necessarily seek information more frequently than do other women. Finally, this dissertation turned to the impact of women's risk preferences on their households' asset portfolio and income source diversification. No strong relationship is found between choice under uncertainty and household asset and income diversification among the sample of women in this study. Altogether, this dissertation contributes to a growing body of research on the microeconomics of health and development in a developing country setting.

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Appendix A

Women's Empowerment in Agriculture Index

This appendix summarizes the sections of the Women's Empowerment in Agriculture Index (WEAI) included in the agricultural bargaining power index used in this study. Table A.0.1 summarizes the different sections used to measure women's empowerment in agriculture.

Section A contains the six areas of household decision-making that are included in this index. This section includes decisions over agricultural production, inputs into agricultural production, types of crops, serious health problems,[1] wage employment, and small household expenditures. For each of these six areas, the same question is asked, regarding whether they are either solely, jointly, or not at all involved in the decision-making process for each area. Following this question, women are asked the extent to which they feel they can participate in the decision (small, medium, or high).

Section B contains five areas of production and income generation; for each area, the responses to questions regarding involvement in making decisions over production and influence over how income generated from the activity is spent are included in the

[1] This item was added by the author and was not part of the original WEAI.

summation if the household participated in that area of agricultural production in the last 12 months (or the last one to two cropping seasons). Women are asked whether they are involved in very few decisions, some decisions, most decisions or all decisions if they responded that they participate in the decision-making over this item.

Section C includes 14 areas of access to productive capital, including: agricultural land, large livestock, small livestock, poultry, fish pond or equipment, non-mechanized farm equipment, mechanized farm equipment, business equipment or supplies, house, large consumer items, small consumer items, cell phone, non-agricultural land, and means of transportation. Women are asked who the main owner of the item is, who makes decisions over the sale or rent of the item and who makes decisions about the purchase of new items in that category. The responses to these questions depend on whether the individual responded that the household currently has this item.

Section D contains five areas or sources of credit, including a non-governmental organization (NGO), informal lender, formal lender, friends or family, and group-based micro lender. For each of these areas, questions are asked about who made the decision to borrow and who made the decision about how to use the money or item borrowed. These responses are included in the summation if the individual responds that they or anyone in their household has taken a loan or borrowed from one of the sources in the first question.

Response options for Sections C and D include: (a) Self; (b) Partner/Spouse; (c) Self and partner/spouse jointly; (d) Other household member; (e) Self and other household member(s); (f) Partner/Spouse and other household member(s); (g) Someone (or group of people) outside the household; (h) Self and other outside person; (i) Partner/Spouse and other outside people; (j) Self, partner/spouse and other outside people.

Table A.0.1: Agricultural Bargaining Power Sections

A. Household Decision-Making	
(1) Agricultural Production (2) Inputs for Agricultural Production (3) Crop Type (4) Serious Health Problem (5) Wage or Salary Employment (6) Household Expenditures	(1) When decisions are made, who is that normally takes the decision?
B. Production and Income Generation	
(1) Food Crop Farming (2) Cash Crop Farming (3) Livestock Raising (4) Non-Farm Economic Activities (5) Wage and Salary Employment	(1) How much input did you have in making decisions? (2) How much input did you have in decisions on the use of income generated from this activity?
C. Access to Productive Capital	
(1) Agricultural Land (2) Large Livestock (oxen, cattle) (3) Small Livestock (goats, pigs, sheep) (4) Chickens, Ducks, Turkeys, Pigeons (5) Fish Pond or Fishing Equipment (6) Farm Equipment (non-mechanized) (7) Farm Equipment (mechanized) (8) Non-farm Business Equipment (9) House (and other structures) (10) Large Consumer Durables (fridge, TV) (11) Small Consumer Durables (radio) (12) Cell Phone (13) Non-Agricultural Land (14) Means of Transportation	(1) Who can decide whether to sell, rent, or give away this item? (2) Who contributes most to decisions regarding a new purchase of this item?
D. Access to Credit	
(1) Non-Governmental Organization (2) Informal lender (3) Formal lender (bank/financial institution) (4) Friends or relatives (5) Group based micro-finance or lending	(1) Who made the decision to borrow? (2) Who makes the decisions about what to do with the money/item borrowed?

Appendix B

Child Health Knowledge Survey

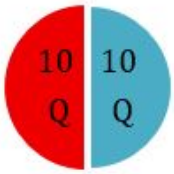
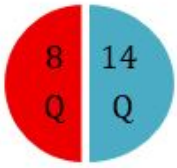
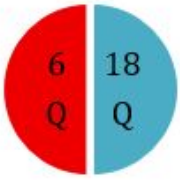
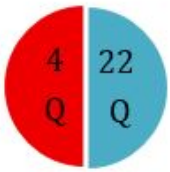
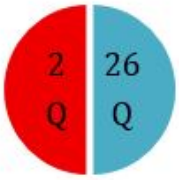
1. True or false, if your child has diarrhea, reduce the amount of liquids he or she drinks in order to stop the diarrhea.
2. True or false, if your child is younger than 10 years of age and is not getting any taller, that is a sign that he or she is malnourished.
3. True or false, if you have a wound, you should wash it, but not cover it up so it can get fresh air to avoid an infection.
4. True or false, vaccination is the best way to avoid polio in children.
5. True or false, the only way to have safe, clean water is to purchase bottled water.
6. True or false, as soon as you introduce solid foods to a baby, you should stop breast-feeding.
7. True or false, if your child has a cough, runny nose, and earache he or she may have a respiratory infection.
8. True or false, you should place your baby to sleep on their stomach.
9. True or false, smoke in the house is bad for a baby's lungs.
10. True or false, you should start introducing complimentary foods by three months.

Appendix C

Risk Experiment

This appendix shows the visual representation of the game that women in the study played following the survey questionnaire. Women were shown this game with six options, each of which show a circle with half colored red (50 percent chance of low payoff) and the other half colored blue (50 percent chance of high payoff). Inside the colored halves of the circle, the payoffs are written in common currency form, such as 10Q, where Q represents the Guatemalan currency, Quetzales ($1 = 7.7 Guatemalan Quetzales). Women were asked to choose one of the six gambles, each of which have equal probabilities of the high and low payoffs occurring. Next, three blue chips and three red chips were placed into a paper bag. The enumerator showed the individual the six chips before placing them in the bag, and then randomly drew one. If the chip drawn was red, the woman received the low payoff and if the blue chip was drawn the woman received the high payoff.

Figure C.1: Risk Experiment

Gamble	Payoff with Chances 50/50	Your Selection (Mark only one)
1		
2		
3		
4		
5		
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