

Poverty, risk and informal insurance in remote Papua New Guinea

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Declaration

This thesis is my own original work and contains no material that has been submitted for a degree at the Australian National University or any other university. It contains no copy or paraphrase of work published by another person, unless explicitly stated.

An earlier version of Chapter 3 was presented at the Australasian Development Economics Workshop in 2014, hosted by the Australian National University. A preliminary version of Chapter 3 was presented at the 26th PhD Conference in Economics and Business, hosted by the Australian National University in 2013.

All errors in this thesis are my own responsibility.



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Abstract

This thesis examines aspects of poverty, risk and coping mechanisms in remote rural Papua New Guinea. The three essays draw on a unique cross sectional data set, collected in February 2012, from a study area in Obura Wonenara District in Eastern Highlands Province. The essays contribute to filling a gap in the literature on poverty in Papua New Guinea, which, to date, has had limited household studies of poverty in remote areas, and has largely neglected the role of a range of risks and their relationships to poverty as well as the role of informal insurance networks in responding to different kinds of risks. The essays also add to the scarce international literature on poverty in remote locations, and extend the international literature on informal insurance by studying both inter-household and intra-household transfers, and examining the extent of external support networks. The results show that the study area households face extraordinarily high levels of risks and are very weakly networked. Geospatial factors interact with inadequate government services, low levels of human capital, a lack of markets and underdeveloped family and social capital to contribute to the community members living in poverty, with limited household assets. Even those with higher asset levels are likely to be animal-based protein deficient. Multiple market failures mean that coping mechanisms are limited and there is an excessive reliance on consumption-reducing strategies. Households are too poor to enter into extensive informal insurance networks, which are underdeveloped both between and within households. Only a handful of households have potential insurers outside of the study area. The poorest within the study area are relatively geographically disadvantaged, more food insecure, more exposed to serious risk, more reliant on consumption-reducing strategies and less insured through social networks. However, while relative poverty within the study area is certainly real, the main conclusion from the research is that nearly all of the people living in the study area are poor and extremely vulnerable to suffering from irreversible harm due to malnutrition.

Introduction

1.1 Introduction

The research aims to contribute to our knowledge of rural poverty in Papua New Guinea by examining poverty, risks, and coping mechanisms of households in a study area in remote Eastern Highlands Province. The thesis sets out to answer the following three questions:

1. Why are PNG's remote villages chronically poor, and what are the characteristics of the poorest in those villages?
2. How do PNG's remote poor manage risk?
3. How effective are informal insurance arrangements in remote PNG villages?

The next three chapters tackle these three questions in turn. This introductory chapter motivates the thesis and situates it within the existing literature (Section 1.2), provides an introduction to village level studies (Section 1.3), introduces the study area (Section 1.4) and outlines the survey method used to collect data (Section 1.5). The final chapter concludes the thesis.

1.2 Research motivation

Papua New Guinea (PNG) has a land mass of 462,840km² and is spread across the eastern half of the island of New Guinea and more than 600 smaller islands. The terrain is rugged and mountainous and the altitude ranges from sea level up to 4500m above sea level. A population of approximately 7.4 million people supports more than 800 different linguistic and cultural groups. Papua New Guinea is a lower middle-income country, with GNI per capita for 2013 of approximately \$US 2070 (current prices). The economy has two major sectors, agriculture, fishing and forestry and minerals and energy extraction. The latter is dominated by the PNG-Liquified Natural Gas (LNG) project, which provides the majority of export income for the country. More than 80 per cent of the population live in rural areas and practice subsistence agriculture.

The use of the word 'poverty' is not readily accepted in some parts of the Pacific, including in Papua New Guinea. O'Collins (n.d) notes that this is partly because

international definitions of poverty focus on cash income levels and these are seen as less relevant in traditional subsistence settings. In addition, she suggests that it may also be due to the strongly held belief that families and communities in Papua New Guinea are willing and able to care for each other (O'Collins n.d). The World Bank (2014) notes that the word 'poverty' has been associated with extreme hunger and deprivation, and that this is at odds with beliefs regarding traditional support in the Pacific (p.23).

Over the period 2001-04 the Asian Development Bank undertook "participatory assessments of hardship" in 150 villages and/or urban communities across eight Pacific countries.¹ As a result of consultations, it was agreed that poverty is viewed as:

hardship due to lack of or poor services like transport, water, primary health care, and education. It means not having a job or source of steady income to meet the costs of school fees or other important family commitments (Abbott and Pollard 2004, p.3)

In practice, the term 'hardship' has been used as a synonym for 'poverty' in the Pacific. While this is acknowledged, to avoid confusion in the context of the international literature, the term 'poverty' will be used throughout this thesis.

A study by the World Bank (2014) notes that across the Pacific, although the incidence of extreme poverty is low, small populations and remoteness mean that there are limited opportunities for economic diversification. Economic shocks are common and location and topography contribute to Pacific Islanders also being exposed to a range of natural shocks (p.4). The combination of low economic diversification and frequent shocks means that it may be difficult to make a sustained move out of poverty.

This thesis examines aspects of poverty in a remote rural community in Obura Wonenara District in Eastern Highlands Province in Papua New Guinea. This research draws on four main strands of literature: village poverty studies; poverty research in Papua New Guinea; literature on risk and coping mechanisms; and empirical work that utilises network analysis to study informal insurance or traditional support. The following section provides a brief overview of village level poverty studies as these

¹ Countries included in the assessment were the Republic of the Fiji Islands, Republic of the Marshall Islands, Federated States of Micronesia, Papua New Guinea, Samoa, Tonga, Tuvalu and Vanuatu.

motivate the rest of the thesis. The remaining three strands of literature are reviewed in Chapters 2, 3 and 4 respectively.

1.3 Village level poverty studies

The most well-known village poverty studies have been based in rural Ethiopia² (a joint project between Addis Ababa University and the Centre for the Study of African Economies) and villages in India, many of which are based on the ICRISAT data set³ (see Jayaraman and Lanjouw 1999 for a review of longitudinal village studies in India). The Ethiopia case studies commenced in 1996 and included 15 villages. They examined the villages in detail with respect to location, the village history, seasonal activities, farm and off-farm activities, institutions, beliefs and values and the community. Data were collected through qualitative approaches, such as drawing and agreeing to village maps and collection of village histories, as well as through the administration of three rounds of household economic surveys across the course of a year. The data from the case studies has informed a large number of academic papers, including some on the relationship between shocks, vulnerability and poverty such as Dercon and Krishnan (2000) and Calvo and Dercon (2007) referenced in Chapter 3.

Lanjouw and Stern's (1998) study of Palanpur, a village in rural North India, was as comprehensive in its breadth as the Ethiopian studies, and had the additional benefit of taking place over five decades. Lanjouw and Stern utilise several methods to rank the poor, including current income-based measures, an average income measures over time and a qualitative approach based on observation (p.369). They find that people who identify as being agricultural labour households were the poorest. This group also had low mobility into other occupations that could have improved their poverty status (p. 370). In the case of the village of Palanpur, factors such as access to non-agricultural employment, household partition and access to land all affected poverty status.⁴

² Information on these studies is available at www.csae.ox.ac.uk/evstudies/main.html.

³ The International Crops Research Institute for Semi-Arid Tropics (ICRISAT) collected data from 6 core villages located in India's semi-arid tropics including in Andhra Pradesh and Maharashtra. Data collection commenced in 1975. The current generation of Village Levels Studies commenced in 2001. The data set has supported a large body of research and publications. For more information see: <http://vdsa.icrisat.ac.in/vdsa-vls.aspx>

⁴ The sixth round of the Palanpur village study is underway. For more information see: <http://www.lse.ac.uk/asiaResearchCentre/countries/India/research/palanpur/palanpur.aspx>

The Ethiopian village studies, those based on the ICRISAT data and Lanjouw and Stern's analysis reinforce the importance of adopting the most appropriate methodology to measure poverty and in understanding the economic, geographic and social context in which poverty is being studied. The long time period over which Lanjouw and Stern's research was conducted was especially useful for identifying the close inter-relationship between poverty and vulnerability. The understanding that the experience of negative shocks may undermine the capacity of individuals and households to exit poverty in a sustained way is important to understanding why poverty can become entrenched (Lanjouw and Stern 1998, p.314).

The issues identified through the village studies highlighted above are important motivations for this study of a remote community in Obura Wonenara and were drawn on in framing the three broad research questions. The research methods employed in both the Ethiopian and Indian case studies, including both survey and qualitative approaches, were also considered in planning and carrying out the field research that informs this thesis.

It is anticipated that through answering the research questions and contributing to knowledge of poverty in rural Papua New Guinea, this thesis will add to the knowledge of and encourage consideration of policy options that may not have been identified through poverty research undertaken to date in Papua New Guinea.

The first essay (Chapter 2) seeks to answer the first research question of why PNG's remote villages are chronically poor and to identify the characteristics of the poorest in these villages. It aims to address a gap in the Papua New Guinea poverty literature, which has included studies of which areas are poor and the characteristics of poor people, but has not examined the relationship between asset poverty and the interaction with negative shocks in remote rural locations. The analysis conducted will help identify the poorest households within a poor community and explain why they are poor. The relationship between relative asset ownership within the villages and a range of known poverty correlates will be assessed, with a particular focus on the relationship between asset ownership and food insecurity. Food insecurity has been selected as a particular focus given the villages are engaged in subsistence agriculture and are remote from markets and alternative sources of food.

To date, there has been limited analysis of a range of risks faced by the poor and the behavioural responses to this by the poor in Papua New Guinea. This lack of research is particularly relevant as there is evidence that when faced with a shock, the event itself and the coping mechanisms employed by the household may reduce or destroy its physical, financial, human or social capital. Also, households may make risk management decisions that result in lower average incomes and may even contribute to their ongoing poverty (Dercon 2005, p.2). Better understanding of the behavioural responses of the poor can inform a broader range of policy responses to poverty, some of which may be directly targeted at reducing risk, or reducing the negative impact of risk management strategies. The second essay (Chapter 3) answers the second research question of how PNG's remote poor manage risks. It also contributes to the international literature on poverty in remote locations.

One way that the poor deal with risk is via risk-coping measures such as informal insurance. There are several contributions on the extent and nature of informal insurance in Papua New Guinea (see for example Mawuli and Guy (eds) 2007; Gibson et al 1998; Morauta 1984). Many of these studies set out to test the presumption that there is a strong mutual support via the "wantok system" (Gibson et al 1998, p.1). Information on who receives such support, what it consists of and who misses out, can be valuable for policy making aimed at addressing poverty and identifying the most vulnerable in the community. The third essay (Chapter 4) seeks to answer the third research question of how effective informal insurance arrangements are in remote PNG villages. It also adds to the international literature which has so far largely overlooked intra-household insurance arrangements, and also the issue of how much insurance is provided to households in a village by those outside of the village.

1.4 The study area

The study area is located in the southern-most part of the Eastern Highlands Province in Papua New Guinea. The Province is approximately 11,200 km², and is situated near the geographic centre of Papua New Guinea. The north of Eastern Highlands Province includes the Bismark Range and a number of valleys. This area is agriculturally productive and has relatively good road access. In contrast, the south of the Province, starting around Marawaka (Figure 1.1), is less accessible. The study area is comprised of four villages Andakombi, Andakombi Station, Diminye and Namboa. These are

located in the far south of Obura Wonenara District in the highland fringe and can be accessed by walking in from the nearest road in the neighbouring Morobe Province, or by charter flight. The airstrip was built by the community and opened in 1984. It forms the geographic centre of the study area, together with the local school and health centre. Adjacent to the airstrip is a communal area, where a small number of part-time trade stores operate, and a volley-ball and basket-ball court are located.

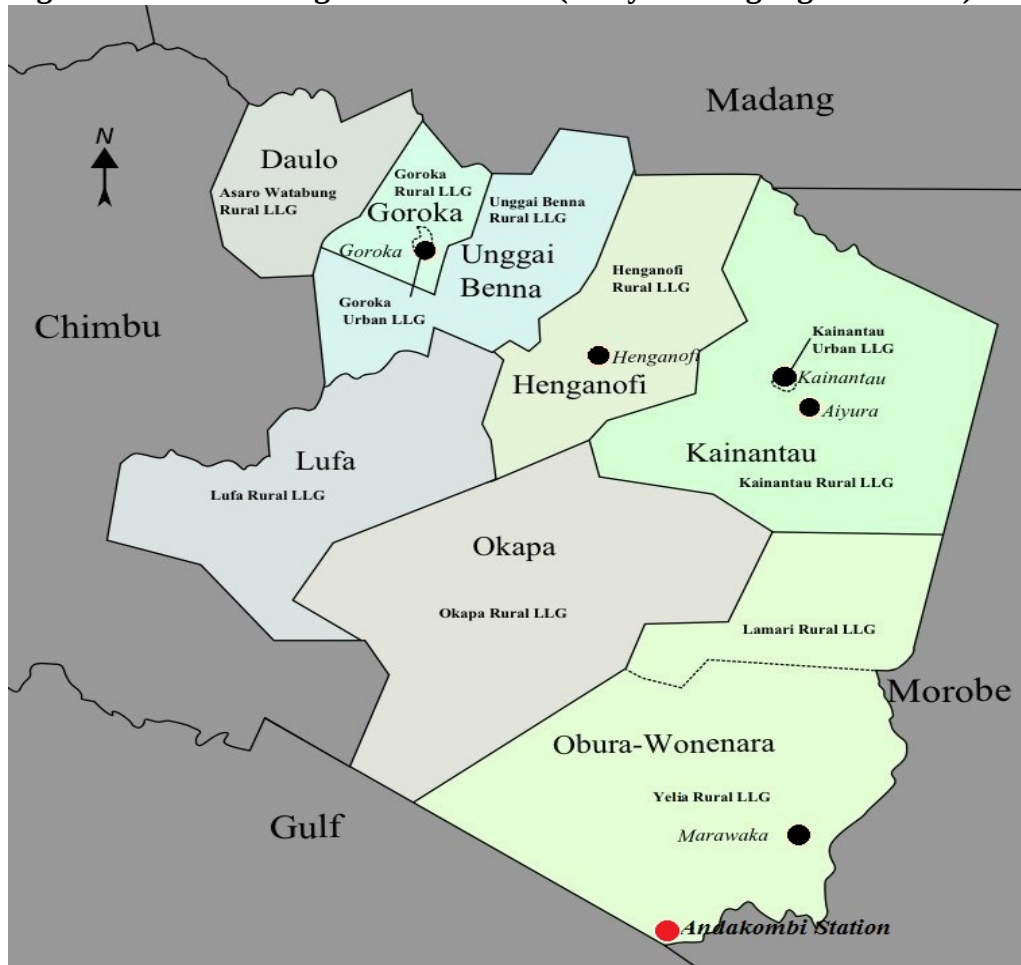
The study area is located at the base and on the slopes of a large valley. The village of Namboa is located on the north side of a river that divides the valley. The other three villages spread out around the slope and across to the south side of the same river. The four villages are separate in name only. In reality the area operates as one large village. This is clear from the organisation of the housing around the centrally located airstrip and services, as well as in the social organisation of the community. For example, rosters existed that drew on men from the entire area for airfield maintenance, and more recently, to build a new elementary school. In addition, there was one appointed village spokesperson for the area.

The location of households within different villages appeared to be driven by idiosyncratic features of the landscape. Distances between the closest households of adjoining villages were calculated and show that the minimum distance between Namboa and Andakombi was 1.93km. It is likely that this distance was the result of the presence of a small river and some steep land that would not support gardens. The distance between the closest houses in Andakombi and Andakombi station was 120m, and from Andakombi Station to Diminye the closest houses were 60m apart. The largest distance separating households in two villages was between Diminye and Namboa, with a distance of 2.34km. This was attributable to an area of land on the lowest mountain surrounding the valley not having been built on. When asked why the community had not expanded in this direction, there was feedback that this land was of a lower quality and led to the low-lands where malaria was considered to be a much greater problem.

The population of the study area is between 468 and 600 people. 468 is the number of people resident at the time of the survey in the 83 interviewed households. Another 23 households could not be interviewed. Given the average household size of 5.7, the missing households could push the village population up to about 600. At times the

population may exceed 600, as people from even more isolated villages visit to access schooling, the health centre and the airfield.

Figure 1 1: Eastern Highlands Province (study area highlighted in red)



The study area grew from an initial settlement of a handful of families who moved from Morobe Province in the late 1960s or early 1970s. The founding families settled together with some landowners from a neighbouring village (Interview with village elders, November 2011). Over time, the villages grew and spread up the slopes of the valley. The establishment of the community by a small number of families, together with limited in-migration means that there are strong and established kinship ties in the study area. This is confirmed by data on the length of time people have lived in the area showing that only 6 out of 83 households had lived there less than 10 years. The villagers are predominately Yagwoia-Angan speakers and belong to the Iwolaq-Malyce

territorial group.⁵ This differs from nearby villages and may contribute to the social isolation of the villagers, a topic further explored in Chapter 4.

Almost all houses in the study area are made of traditional materials. The water supply is untreated and comes from several rivers and streams running through the valley. There is no electricity supply. Mobile phone coverage began in 2011, but is intermittent and only available at particular locations in the villages. The main source of communication remains via a short-waved radio located at the health centre.

Both education and health services are hindered by an inability to attract and retain qualified personnel. At the time of the research, there was no qualified health worker at the health centre. A village health worker, trained as an aid post orderly, and a village health volunteer, staffed the centre. Records from the health centre show that in November 2011, they treated 384 people (Andakombi Health Centre Records, February 2012). The last medically qualified health worker (a nurse) left the clinic in August 2010, after approximately one year in the village. Prior to this, there had been no ongoing government health worker in the village since 2003. There were two teachers at the school and 228 students in late 2011. Education outcomes are poor; of people aged 14 and over, 70 per cent of males and 37 per cent of females are literate. Eighty three per cent of boys and 55 per cent of girls aged between 7 and 14 were enrolled in school.

The study area has no banking, credit or insurance facilities and no markets for labour or land. Rain-fed subsistence agriculture dominates, and all but one of the 83 households indicated that they were engaged in subsistence agriculture as their employment. Market activity is confined to several part-time trade stores with an intermittent supply of a small range of goods, and very small transactions around surplus agricultural production and coffee production. Approximately 17 per cent of households traded market produce in January 2012. Earnings were highly skewed, with one household earning more than half of the total value of traded produce in the villages (K792⁶). Almost half (39) of the surveyed households earned no cash income from any sources in the month leading up to the survey. When data on major expenses over the

⁵ Information on the language group of the study villages was provided via personal communications with J Mimica, December 2012.

⁶ This amount is equivalent to approximately AUD 328 using the average exchange rate for 2011 of AUD/PGK of 2.4093 (Source www.ozforex.com.au/historical_rate_tool/yearly_average_rates)

last year was examined, twelve households reported that they had no expenditures over this period. Given its isolation, the study area essentially operates as an autarky in relation to agricultural produce.⁷

The dominant market based activity in the study area is growing coffee as a cash crop; this involved approximately 71 per cent of households. Of these households, 47 per cent had earned income from coffee in the month of January, with a median income of K120. Coffee farmers typically sold coffee twice a year, and transported it to market via plane. A small number walked individual bags out to the closest road (Focus group, February 2012).

Apart from locally generated resources and those of the government, the community also received support from an aid project being implemented by a non-government organisation (NGO) CARE International PNG. The project included training and limited provision of equipment to coffee growers, the introduction of fish farming and support for a network of village birth attendants. At the time of the research CARE International's project had been active in the study area for one year. Given the early stage of project implementation it is expected that the project will have produced few impacts in the study area at the time of the study visit.⁸

1.5 Survey method

An economic case study approach is employed. Data collection methods include an administered survey, focus groups, semi-structured interviews and in-depth interviews. The research was conducted in cooperation with CARE International.

The project site was selected on the grounds that it is remote and in a district classified as being one of the most disadvantaged in Papua New Guinea. Data were collected by a team of five people, led by the researcher and including a staff member of CARE International Papua New Guinea, a translator and two research assistants. Data were collected via a single cross section household survey, focus groups and interviews over the period 6 February to 24 February 2012.

⁸ Two exceptions to this are the introduction of fish farming and of a healthy motherhood group. At the time of the study visit there were a number of fish farms in operation established with the assistance of the CARE International project. Given the short period since the project began, at the time of the study visit it was too early to draw conclusions about whether fish farming would be sustained over the long term.

Part one of the survey document was administered to household heads and focused on demographic and socio-economic characteristics of the household. Part two collected data from the household head on reported shocks experienced by the household and coping strategies employed in response to shocks. Part three focused on collecting data on actual and potential insurers. Where possible, the section of the survey that collected data on individual assistance networks was administered to both the household head and spouse/s. Attempts were made to separate household heads from their spouses for the administration of the section on individual assistance networks, although this was not always possible.

The numbers of possible households and actual households surveyed is shown in Table 1.1. Survey instruments are given in Appendix 5: Survey Instruments. Of the 13 households that were unavailable for interview, there were two households where the male household head was reported to be “in town”. In one of these households the male head was a teacher in Goroka, so it is arguable that this household was not resident. The other case was that of the school principal, who resided in the study area during the school term and had not yet returned from his home in Goroka for the start of the school year.

Three other households were excluded due to mental illness, the recent death of a spouse, and the household head suffering from a severe bout of malaria during the study visit.

In the remaining 8 cases the male household head was reportedly away hunting or fishing. These households were revisited over the three weeks of the data collection, but it was not possible to interview the male heads. In cases where spouses were at home alone they were not willing to be interviewed in their husbands’ absence. It did not appear that these households had any distinguishing features from the households that were captured in the survey.

There were 9 households that refused to cooperate or that were left for another survey. The four households left for another survey were randomly selected after the study area had been mapped and all households identified.

Table 1.1: Details of households surveyed in the study area

Households surveyed in four study area				
Village name	Number of households	Not available for interview	Refused to cooperate or left for another survey	Total of households interviewed in village
Namboa	33	3	2	28
Andakombi	22	1	5	16
Diminye	26	5	2	19
Andakombi Station	24	4	0	20
Total	105	13	9	83

Source: Survey data and village map.

1.5.1 Administered surveys

Surveys were administered over a three-week period in February 2012. The household survey collected information on the following:

- household demographic information
- expenditures and consumption
- income
- nutrition
- water and sanitation
- household assets
- illness experience and the capacity to perform daily tasks
- access to services
- production and livelihood activities undertaken
- idiosyncratic risks and their impacts
- covariate risks and their impacts
- challenges facing the household
- information on informal insurance networks.

The survey instruments are based on Hoddinott and Quisimbung (2003a) and also draw on questions used in the 2006 Demographic Health Survey, and other household surveys such as the 2009 Household Income and Expenditure Survey.

1.5.2 Focus groups

Focus groups were conducted to supplement the data collected in the administered survey. Where possible, participants were from each of the villages, and included both men and women. Groups were conducted on:

- formulating a seasonal calendar, noting changes over time
- constructing a timeline of key events and shocks in the villages
- identifying major coping strategies and to formulate a coping strategies index
- the history and success of coffee production in the study area.

1.5.3 Semi-structured interviews

Semi-structured interviews were conducted with key informants in health and education sectors. In the health related interviews the principal focus was on distance to the health facility, staffing and supply of equipment and essential medicines, level of staff training, state of staff housing, state of clinics and other facilities (Filled in health centre survey at Appendix 5: Survey Instruments). The education related interview included a focus on when the school is open, how many teachers were present, how many children enrolled, the state of teacher housing and school buildings, library and other facilities.

1.5.4 In-depth interviews

Several in-depth interviews were conducted. These aimed draw out the experience of older community members about the history of the villages, and how they have changed over time. Other issues covered in in-depth interviews related to cultural and social practices, for example around marriage. Interviewees included:

- school Principal⁹
- health centre worker and volunteer
- village elder and leader (one of the original families who settled the village)
- trade store owner
- local women (on marriage traditions).

⁹ The school Principal was interviewed during the introductory visit in November 2011, whereas the remainder of the interviews took place in February 2012. The school has not re-opened for the year at the time of the study visit in February 2012.

Chapter 2 Poverty and food insecurity in a remote rural area of Papua New Guinea

2.1 Introduction

People living in remote rural areas of Papua New Guinea (PNG) are likely to be poor and lacking in basic services and infrastructure (Hanson et al. 2001; Gibson and Rozelle 2002). Bourke and Allen (2009) estimate that in PNG approximately one million people (or one-seventh of the population) are living in disadvantaged and remote areas in severe poverty (p.4). It is also probable, based on international evidence, that they experience more environmental and other shocks than other areas (Bird et al. 2003, p.19). These shocks can affect the productivity and reliability of subsistence farming and lead to people being vulnerable to food shortages and malnutrition. These factors can compound to result in populations being caught in ‘spatial poverty traps’, and remaining in poverty after less remote and disadvantaged areas have developed (Jalan and Ravallion 1997, Bird et al., 2003).

Overcoming spatial poverty traps requires specific program interventions and policies that address the special characteristics of remote rural areas. However, Bird and Shepherd (2003) argue that worldwide there has been a lack of differentiation in policy and program approaches to these areas.

To date, most poverty research in Papua New Guinea has involved identifying the most disadvantaged districts or areas through geospatial characteristics such as distance to administrative centres and access to roads (Wilson 1975; De Albuquerque and D’Sa 1986; Hanson et al. 2001). Other research has mapped areas of relative poverty through methods that bring together nationwide household level data and geospatial characteristics (Gibson et al. 2004; NEFC 2004). While this body of research has successfully identified where the poorest communities are likely to be located, it has left important gaps. First, there have been limited village studies that aim to understand the characteristics of poverty at the household level in the most remote of these disadvantaged communities. Second, with the exception of Morauta (1984), there are limited examples of case study approaches to the examination of poverty that include consideration of geospatial issues. This essay aims to build on the literature on poverty in Papua New Guinea by specifically exploring the links between the geospatial

characteristics of poverty in the study area and characteristics of poor households in the study area.

The essay starts with a brief introduction to research on poverty in Papua New Guinea and the limited relevant international literature on poverty in remote locations. The literature review identifies the research gaps and questions, and outlines relevant methodological issues relating to measuring poverty at the household level. The third, fourth and fifth sections address the three research questions identified in the literature overview. The conclusion discusses the implications of the research.

2.2 Literature overview and research questions

Five major studies into poverty in Papua New Guinea, spanning forty years, have shown similar results in relation to which districts are the most disadvantaged. A summary of the main variables and data sources used by these five studies is at Appendix: Chapter 2, Table A2.1. Table A2.2 shows which districts are identified by these same studies as the most disadvantaged. They tend to be located along the Indonesian border and within the highland fringe of the central highlands and parts of Simbu and Morobe. They are identified by these studies as being in isolated areas, with low levels of cash income and poor access to services.

The literature uses several terms to refer to poverty that is entrenched and difficult to exit. Terms such as ‘persistent’ poverty (Adato et al. 2006; Carter and Barrett 2006) and ‘chronic’ poverty are used synonymously in the literature. Jalan and Ravallion (2000) define chronic poverty as what is left behind when “inter-temporal variability in consumption is smoothed out” (p.83). In other words, chronically poor people have consistently low consumption over time. Chronic poverty is intergenerational (Hulme and Shepherd 2003, p.405). Although it is only possible to assess whether individuals are chronically poor through assessing their consumption over time, the fact that many disadvantaged districts of Papua New Guinea have remained so for more than 40 years indicates that geographic factors may play a factor in poverty, and that households in these districts may be more likely than others to be chronically poor. Cammack (2007) notes that the chronically poor can be differentiated from the rural poor in PNG by their isolation, poor quality land and lack of services (p.22).

The link between isolation and poverty in Papua New Guinea is supported by international research on remoteness and poverty. This limited literature suggests that there is an interaction of spatial poverty with agro-ecology and that together, these determine 'geographic capital' (Bird et al. 2003, p.27). Remote locations have reduced opportunities for trade, specialisation and access to credit. People living in these communities may lack political power or influence (Bigman and Fofack 2000, p.135). These areas may also be seen as lacking in economic potential and have low population density. This makes it hard for governments to justify investments in infrastructure and makes service delivery difficult. These geospatial characteristics and their interaction with markets, government services, human capital formation, family structures and social capital can together result in an area having low village-level assets. In this scenario, poverty can become self-perpetuating (Jalan and Ravallion 2002, p.330).

At an individual level, the interaction between low geographic capital and poverty manifests itself in low levels of human capital, and constraints that limit economic and social mobility. In the case of Papua New Guinea, several studies have identified the characteristics of individuals who live in the most disadvantaged communities. Studies have identified that poor people in poor areas were less likely to earn regular cash incomes, for example through waged employment or the sale of cash crops (Allen et al. 2005; Gibson et al. 2004; Gibson and Rozelle 2002). Allen et al. (2005) estimated a model of consumption from household sample surveys and then utilised census data to predict consumption and the risk of each household living in poverty. By weighting the totals of predicted probabilities they were able to map poverty for relatively small geographic areas. From this work they were able to conclude that poorer areas were significantly worse off in terms of indices of child growth, adult literacy and school enrolment (p.211).

Mueller (2001) assessed the spatial distribution of child growth in PNG based on the 1982-83 Papua New Guinea National Nutrition Survey (NNS), the Mapping Agricultural Systems of PNG (MASP) and the PNG Resource Information Systems (PNGRIS) databases. The most influential variables in child growth within an area were found to be socioeconomic factors, but diet and, to a lesser extent, environmental factors, were also important in predicting growth levels between regions. Environmental factors that were important included the steepness of the terrain and the higher altitude. The former was associated with impaired growth, while the latter was associated with

being short but heavier (p.421). The study area is in a high altitude location with steep terrain. Steep terrain, in particular, is associated with greater energy requirements for farming activities (p.421).

The link between geography, poverty and diet is therefore clearly established in Papua New Guinea. Protein energy malnutrition has been consistently found to be widespread (Igua 2001, p.22; Benjamin et al. 2001, p.96; Bourke 2001, p.6). This affects both adults and children and is attributed to a diet where bulky root crops dominate, crowding out protein and energy requirements (Mueller 2001, p.421). Malnutrition is a particular problem for children, pregnant and post-partum mothers, sick adults and the elderly (Benjamin et al. 2001, p.96). Cripps et al. (2008) note that in PNG 34 per cent of deaths of children under 5 years old can be attributed to malnutrition (p.121). Malnourished children become sick more easily and have a low resistance to infection (Benjamin et al. 2001, p.96).

The brief review of literature above has shown that the existing poverty analysis in Papua New Guinea identifies a strong spatial dimension of poverty and that there is clear evidence linking geography, diet and poverty. To date however, there has been limited poverty research at the village and especially at the household level in remote areas identified as disadvantaged. PNG village studies have focussed on specific aspects of production such as pigs and subsistence (Lloyd 2001) and coffee production and gender relations (Overfield 1998). While these studies covered issues relevant to livelihoods, they did not consider the various dimensions of poverty, including access to food or diet. A village level study that examines both geospatial influences and village-level influences on asset poverty and the link to food insecurity will therefore provide new insight into poverty in remote Papua New Guinea.

The essay is organised around three research questions that explore the links between geospatial characteristics, poverty and food security. First, what are the geospatial influences on village level assets? Second, what is distribution of asset poverty in the study area and what household qualities influence this? Third, is there a relationship between asset ownership and food security in the study area?

These three questions are addressed in turn in the next four sections. Section 2.3 adapts a framework proposed by Bird et al. (2003) to answer the first question. This also serves

as a more detailed introduction to the villages. Section 2.4 constructs an asset index for village households using Principal Components Analysis. Section 2.5 investigates the differences in household characteristics between more and less asset-poor households using first bivariate and then probit regression analysis. Section 2.6 turns to the relationship between food security¹⁰ and asset ownership again using bivariate and probit regression analysis. Section 2.7 concludes.

2.3 Geospatial influences on village level assets

This section aims to provide a general introduction to the study area to assess the influence of geospatial characteristics on poverty. Although much of the analysis of rural poverty in Papua New Guinea has drawn links between location and poverty (see for example Hanson et al. 2001), there is an absence of case study research of village poverty that specifically considers the influence of geospatial features on village level characteristics. To fill this gap, we draw on the international typology developed by Bird et al. (2003) for linking remoteness and chronic poverty. The framework, which is modified to take into account PNG research provides a means to organise the analysis in a way that shows the close interrelationship between geospatial and village level characteristics.¹¹ A matrix (Table 2.1) of links between geospatial and village characteristics summarizes the results of the analysis as well as outlining the framework used in this chapter. Subsequent sub-sections analyse in turn each of the characteristics given in the four columns (government services; human capital; markets; family and social capital) with reference to the geospatial features in the four rows (topography; distance; environment; social, cultural and historical factors).

¹⁰ The definition of food security used in this thesis is as per Hoddinott and Yohannes (2002). This definition notes that there are three dimensions of food security; availability, access and utilisation (that is the capacity of the population to derive sufficient nutrients from the food it consumes in the given period) (p.3).

¹¹ Ecology has been broken down into topography – or the physical features of the area - and the environment, which includes other natural features, including the weather - to acknowledge the strong influence that geography has been found to have on poverty in PNG. Several of Bird et al.'s influences on remoteness have been captured by a focus on social/cultural and historical factors to take account of the possible impact of the large number of language/cultural groups in PNG. In line with Bird et al., distance is considered in terms of distance from urban centres, communication and political institutions. The columns of the table capture the influence of geospatial factors on village level characteristics.

Table 2.1: Summary of findings regarding the relationship between geospatial and village characteristics

Geospatial characteristic	Village level characteristics			
	Government Services	Human capital	Markets	Family and social capital
Topography	The topography means that provision of infrastructure such as roads and electricity is both difficult and expensive. In the event of a disaster it may be difficult to mobilise government assistance due to the isolation.	Limited quality land for expansion means that households may have problems meeting their subsistence needs. Malaria is common due to the altitude. Landslides are common, resulting in food shortages and injury/death.	Population in the villages is too small and poor to support internal markets. The mountainous topography makes it difficult to transport goods between villages.	Isolation means that villagers must cooperate to maintain village resources such as the airfield.
Distance from: • Urban centre • Communications • Political institutions	Geographic isolation leads to low investment in infrastructure and services and makes it difficult to attract and retain teachers and health workers Information on government policies is slow to reach the and government supervision of services is lacking.	No schooling beyond Grade 8. Emergency patients require charter plane evacuation.	Limited ability to transport coffee to market. High transport costs reduce returns to farmers Small internal markets limit access to privately provided goods and services, including telecommunications and credit. Transport costs make non subsistence food expensive.	
Environment	Heavy rain leads to closure of the airfield this makes it difficult for government services to be delivered consistently. Regular droughts put pressure on common resources.	Inability of planes to land may delay emergency health evacuations or delivery of supplies.	High humidity at times of the year can spoil coffee waiting to be transported.	Frequent weather shocks and the absence of credit, labour, or insurance markets means informal insurance is vital. Household structures may have developed to provide insurance against risk.
Social/cultural and historical factors	Failure of government to provide services in the past mean that there is little trust in the government.	Strong gender roles with women expected to undertake the majority of food production. This has implications for perceived value of women's education.	There is limited cash available to pay labour. Polygyny may be a means of horizontal expansion of the family to provide labour and maintain access to land. Coffee is predominately owned by men.	Villages are Yagwoia-Angan speakers and belong to the Iwolaq-Malyce territorial group. This differs from nearby villagers.

Basic economic and social statistics for the study area are presented in Table 2.2. Where comparable data exists in the 2006 demographic and health survey (DHS) for PNG, mean comparison tests have been conducted between the rural average in the DHS and the village level data. This was possible for the demographic data, sex of household head, household structure and the overall average household size.

Table 2.2: Economic and social statistics for the study area

Household characteristics				
Housing construction (n=83) Wall construction bamboo matting Roof construction grass thatch Floor bamboo palm Windows that do not close Windows with covers No ventilation Water source Tap water to home Tap water for community Unprotected river, stream or spring Toilet type Pit latrine None Other Shared toilet Distance to water supply (n=83) 0-15 minute walk More than 15 minutes less than 30 More than 30 minutes less than 60 Distance to services (n=83) 0-15 minute walk More than 15 minutes less than 30 More than 30 minutes			Demographic data Population aged 0-14 Population aged 15-64 Population aged over 65 Age dependency ratio, old Age dependency ratio, young Age dependency ratio, overall Sex of household head Male Female Household structure One adult Two opposite sex 3+ adults Polygynous (male) Average household size Namboa Andakombi Diminye Andakombi Station Overall	
	99%			45%
	99%			53%
	89%			2%
	25%			3%
	22%			88%
	53%			85%
	5%			96%***
	20%			4%***
	75%			
	98%			5%**
	1%			34%
	1%			61%***
	22%			17%***

*, **, *** indicates significantly different from the 2006 DHS figures at the 10, 5 and 1 per cent levels of significance respectively.

Source: Household survey, February 2012; NSO 2009, Table 2.3, Table 5.2.

2.3.1 Government services

The topography and isolation of the study area, combined with the relatively small population, mean that the cost of service delivery is high and economies of scale are not possible. The villages have no electricity or treated water, and the major form of communication is via short-wave radio. The short-wave radio was provided only after an incident in the 1990s, where there were long delays in the villages receiving help after a major landslide that reportedly caused more than 20 deaths. (The reported incidence of landslides and other natural shocks are examined in Chapter 3.)

The nearest road is a two-day walk into Morobe Province. Access to roads can be an important determinant of living standards (Jalan and Ravallion 2002; Bigman and Fofack 2000). In the case of Papua New Guinea, Gibson and Rozelle (2002) found that reducing travel time to the nearest road to 2 hours could reduce poverty by as much as 4.43 per cent (p.31).

Government services arrived late to the study area, and have been intermittent and of questionable quality. Although church health and school facilities are widespread in PNG, there are none in the study area. The health clinic opened in 1986 and the community school followed in 1989 (Focus group, February 2012). Table 2.2 shows distances that people must travel to obtain health and education services within the study area. The majority (59 per cent) live within a 0-15 minutes walk of both services. In the case of the health centre, patients travel in from up to five other villages. The longest travelling time to the health centre was reported as being from a village 7 hours walk away (Interview with village health volunteer, February 2012).

Staffing of both health and education services by appropriately qualified people has been erratic. In the case of health, there is one paid staff member, who trained as an aid post orderly and has been employed for 29 years. In addition, there is a longstanding health volunteer from the community. The last medically qualified health worker (a nurse) left the clinic in August 2010, after approximately one year in the village. Prior to that there had been no ongoing government health worker in the village since 2003 (Interview with village health volunteer, February 2012).

Schooling is available up to Grade 8. Beyond this children must leave the study area to attend school. Problems with attracting and retaining staff have had two effects on the school. First, the school was closed between the years of 1997 to 2003 because teachers left during a severe drought and were not replaced. Second, teachers have often failed to return to school after holiday periods. The school Principal reported that in 2011 the school year commenced with four teachers, and that by November only the Principal and one teacher remained. As a result, the teacher student ratio was one teacher to 114 students. The attrition of teachers across the school year was reported to be a regular occurrence (Interview with Principal, November 2011).

Neither the school nor the health clinic received regular monitoring visits by relevant government agencies. Monitoring of service provision can ensure that standards are maintained, provide a means of disseminating information and give the community an opportunity to provide feedback on service delivery. It was reported that the school had never been visited by a School Inspector, yet inspection in the classroom is a pre-requisite for teacher promotion and would allow identification of teachers who did not report for duty. In the case of the health centre, it was reported that prior to the commencement of the CARE project approximately 12 months before the research, there had been only rare visits by District or Provincial health officials (Interviews with school Principal and volunteer health worker, November 2011 and February 2012). It was notable that during the research visit, the Provincial Health Officer visited the site with donors.

If a problem is identified with service delivery in the study area there can be logistical challenges in addressing it. During heavy rain, for example, the airfield is not useable. This can result in delays in repairing broken equipment, delivering essential drugs, transporting staff or evacuating emergency patients. At the time of the research, the solar powered fridges and lighting at the health centre were not functioning. As a result, all vaccines had been incinerated and the vaccination program halted. Given research that shows that isolated Highland populations are particularly vulnerable to infectious diseases, breaks in the immunisation program are likely to increase exposure to illness and diminish human capital (Blong 1986, p.243).

The interaction between the topography and the environment has, in case of the study area, magnified the negative impact of the study area's distance from urban areas and political institutions. The mountainous terrain has contributed to the lack of access roads, and the difficulty in using the air-field in bad weather is a barrier to monitoring the delivery and/or the quality of services. The high cost of travelling to the villages on charter-flights is another impediment. The lack of monitoring of the provision of government services to the study area increases the negative impact of isolation and may contribute to the erosion of some aspects of social capital. In addition, the lack of visits by health and education officials can be interpreted as a manifestation of a lack of government interest. In contrast, the engagement of the CARE International project in the study area, with the regular visits by outsiders that this entailed, had reportedly contributed to improvements in efforts to keep the common areas maintained. It was reported by several villagers that community tasks such as maintaining the airfield had improved dramatically with the commencement of regular visits to the study area by NGO staff.

2.3.2 Human capital

The study area's topography, environment and distance from services interact to reduce human capital. Most directly this occurs via the interaction of the topography and the environment on food supply, and the potential for this to lead to malnutrition among the villagers. For example, food consumption can drop significantly as a result of gardens on steep slopes being washed away in heavy rain. This issue, and a range of other shocks, their impacts and household coping mechanisms are further explored in Chapter 3.

In relation to health, the lack of qualified staff and the distance to other health care contribute to low levels of human capital. Only basic health problems and routine pregnancies can be treated at the village health centre. Although in theory the government funds emergency medical evacuations, in reality these are rare. In 2011, there were four evacuations, each time for obstetric emergencies (Interview Acting Officer in Charge Medical Centre, February 2012). People who are sick and not

categorised as medical emergencies must fund their own transport to hospital. As of 2012, the cost of a seat on a charter flight was K370.¹²

Illness was common in the study area. At the time of the survey, 25 per cent of the sample (115 people) was reported to have been ill in the previous month. Of those reported ill, 36 per cent were aged 10 or under.

According to health centre records for 2011, the most common conditions treated were malaria, pneumonia and pregnancy.

The altitude of approximately 1000-1300m means the study area is in the malaria zone. Malaria was the most prevalent illness reported over the period January – December 2011, with 522 cases recorded. Half of these cases were in children aged four and under. There were 74 children in this age group in the study area. The relatively large number of reports of malaria in this age group could represent multiple treatments in this group of children, and treatment of children from non-survey villages. Young children aged between six months and five years, as well as pregnant women, are particularly at risk from malaria. Immunity to malaria decreases during pregnancy and maternal malaria can lead to preterm deliveries, abortions and still-births (Igua 2001, p. 33).

The health centre records showed that there were 55 cases of pneumonia in infants under the age of 1 – this represented 70 per cent of all pneumonia cases treated. Pneumonia is the leading cause of death of children under the age of five in Papua New Guinea (Cripps et al. 2008, p.121).

Over the period January – December 2011 there were 42 babies, including two still-births, delivered at the clinic. Of the women who had given birth in the five years leading up to the survey, 81 per cent reported that they had accessed ante-natal care. Only 31 per cent of these women gave birth in the health centre with the aid of a health worker. Of the remainder, 17 per cent reported that they have given birth with no one else present.

¹² This amount is equivalent to approximately AUD153.57 using the average exchange rate for 2011 of AUD/PGK of 2.4093 (Source www.ozforex.com.au/historical_rate_tool/yearly_average_rates).

Education levels are low in the study area. For adults aged over 14, 70 per cent of men were literate (defined as being able to read and write), compared to 37 per cent of women. For the group aged over 14 and under 50, 16 per cent of men had no schooling. This compares to a national figure of 17.5 per cent (Table 2.2) according to the 2006 Demographic and Health Survey (DHS) data. For women, the proportion of this age group with no schooling was 59 per cent, compared to 30 per cent in the DHS (NSO 2009 p.21), this is significantly different at a 1 per cent level. Further breakdowns in the education level between males and females in the villages are in Table 2.2. The data show that the levels of participation in education are very low, and that there is a small gap in education between boys and girls. 47 per cent of boys between 7 and 14 years of age are enrolled in school compared to 45 per cent of girls. Household heads were not asked to provide information on children currently out of the community at school, so it is not possible to draw firm conclusions on the level of investment in education of boys and girls overall. However, even in the absence of data on children out of the community, the data reveal that schooling levels are very low.

Some families sent their children out of the villages to continue their education. When household heads were asked about their largest expenses over the past 12 months they nominated school fees as the largest single expense. The mean amount spent on school fees was K115, with a total of K9400 paid by all households. The Principal of the school reported that in 2011 the school received K2000 in fees (Interview, November 2011). This discrepancy in figures in part reflects the fact that some households pay fees for their children to attend school outside of the villages. Examination of the distribution of school spending shows that there are 8 households that spent K400 or more on schooling in the last year. This is likely to form the vast majority of the total school fees paid (K7140). If this is the case it would mean that around 10 per cent of households were sending their children outside of the community for further schooling. Of the 50 households with children of school age, 36 per cent (18) did not record any expenditure on schooling in the last year.

The geospatial characteristics of the study area therefore has a significantly negative impact on human capital. The topography and environment influence food availability, and the types of illnesses that are prevalent. The isolation of the study area and the

related lack of services lead to difficulties in attracting and retaining education and health personnel. The combined effect of these factors results in limited options in the study area for building or investing in human capital.

2.3.3 Markets

The topography, environment and distance from markets have a major impact on the development and maintenance of different markets in the study area. The rugged mountains, large rivers, swamps, high rainfall and cloud cover make transport expensive and difficult to arrange. Hanson et al. (2001) note that 98 per cent of the area of Obura Wonenara District is mountainous or hilly (p.167). Allen et al. (2005) note that environmental factors such as these have contributed to the fragmentation in PNG's transport system (p.212). Road coverage in the south of Obura Wonenara district is very limited with few internal roads (Hanson et al. 2001, p.167). This directly impacts on the ability of the villagers to participate in markets for labour and goods.

There is no labour market in the study area. 98 per cent of households are engaged in subsistence agriculture as their primary employment. The option of moving into a nearby village to obtain employment was also not available, given that surrounding villages generally were even more isolated, and therefore less likely to offer employment opportunities. The dominant market-based activity in the study area is coffee growing, with approximately 71 per cent of the households engaged in this activity. Of these households, approximately 37 per cent earned income from coffee in the month of January 2012, that is, the month before the survey (Table 2.3).

Coffee growers reported facing major issues with transporting coffee to markets. Some villagers carried small amounts of coffee (25kg bags) to the nearest road in Morobe Province where they sold it to traders. The walking paths to the nearest road were mountainous, at times narrow and involved crossings over large rivers with only felled logs as bridges. To sell any substantial quantity of coffee required it to be transported by plane.

Flights were irregular, and this introduced a large element of uncertainty into coffee sales. In addition, high humidity and rainfall meant that coffee could spoil while being

stored for transport. A focus group reported that there had been occasions where farmers had burned their entire coffee crop due to spoilage (Focus group, February 2012).

Table 2.3: Average cash earnings in study area, January 2012

Source	Per cent of households	Average earnings from source (Kina)	Standard deviation	Minimum (Kina)	Maximum (Kina)
Coffee	36.6%	169.80	746.72	0	6550
Fish	7.3%	2.51	10.12	0	70
Other cash crops	6.1%	3.90	23.13	0	200
Garden produce	17.1%	9.65	45.68	0	358
Chickens	6.1%	2.13	11.14	0	80
Pigs	11.0%	38.29	126.42	0	700
Other	7.3%	3.78	17.38	0	130

n=82^a

Note: ^aOne household refused to provide income or expenditure data.

Source: Household survey, February 2012.

Some households were also able to supplement their income through a small market for livestock and excess garden products (Table 2.3). Although it was observed that there were some people coming in from surrounding villages to the common market area in the evenings, goods could only be transported by person, which placed limits on the quantity transacted. Cash income earned in the markets was low, with a median of K12 earned from selling garden produce in January 2012. Apart from coffee, pigs were the second largest source of cash income, 9 pigs were traded over the month prior to the survey. During January 2012, 47.6 per cent of households earned no cash income. It is not possible to determine whether January was a representative month for either income or expenditure in a single cross-section survey. Rather, the data can be viewed as providing insight into the sources of income and the types of expenditure. Table 2.3 shows for example that coffee and pigs are the most prominent sources of incomes. Irrespective of when coffee or pigs are sold for income, we can conclude that households without these assets are likely to have significantly lower potential income.

Data were collected on expenditure over the last month (Table 2.4).

Table 2.4: Average household expenditure, January 2012

Average household expenditures in the last month (Kina)					
Expenditure	Per cent of households	Average expenditure (Kina)	Standard Deviation	Minimum (Kina)	Maximum (Kina)
Clothes	25.6%	11.95	31.02	0	200
Bedding	3.7%	1.6	11.56	0	100
Soap	54.9%	3.82	5.08	0	21
Noodles	41.5%	3.35	7.98	0	40
Rice	29.3%	4.74	12.19	0	90
Fish	13.4%	0.63	1.78	0	9
Cooking oil	45.1%	3.9	8.53	0	50
Salt	43.9%	1.89	3.14	0	18
Phone card	8.5%	1.5	6.08	0	45
Funeral expenses	4.9%	6.83	45.65	0	400
Bride Price	4.9%	31.34	192.52	0	1500
Cigarettes	7.3%	0.38	1.69	0	10
Betelnut	11.0%	0.15	0.66	0	5
Church	25.6%	1.86	8.76	0	75
Other	12.2%	12.31	64.53	0	500

n=82^aNote: ^aOne household refused to provide income or expenditure data.

Source: Household survey, February 2012.

Over January 2012, 19.5 per cent of households did not expend any cash income. Approximately 12 per cent of households did not earn nor expend any cash income. Of the cash expenditures listed, items such as clothing and bedding were not available in the villages to purchase. Although only four households were required to pay brideprice, it was the largest average expenditure. Bride price contributions ranged from K20 to K1500.

The remainder of the items were available at five small trade stores operating in common area of the village. Of the items that households did purchase, soap was the most common, followed by vegetable oil and salt (Table 2.4). The trade-stores were run by people who were also engaged in subsistence agriculture. The stores typically opened only in the early evening. The availability of goods they offered for sale depended on the frequency of charter flights, which in turn were dependent on whether people purchased charter-seats and whether the plane could land given weather conditions. Typically, store-owners paid pilots a fee of K100 to shop for them in larger

towns. Freight charges were applied at a rate of K1000 for 80kg of goods (Interview store-holder, February 2012). Turnover of trade-stores was reported to be between one and two thousand kina per year, with the best sales coinciding with coffee earnings. The trade-stores operated on a cash only basis. Community members paid a substantial premium for the small range of goods available. For example, one kilogram of rice was 43 per cent more expensive in the study area than from a basic store in Goroka, the provincial capital (Table 2.5).

Table 2.5: Price comparison between study area and Goroka for trade store goods

Item	Prices in trade store (K)	
	Goroka	Study area
Rice 1kg	3.40	6.00
Maggi noodles	0.80	1.40
Cooking oil 500mls ^a	3.80	6.00
Dripping 170g	2.70	4.70
Salt 500g	4.90	3.50 ^b
Soap 1 bar	0.80	1.30

Notes: ^aThere was no cooking oil available in February 2012, however in November 2011 it was priced at K6.00. ^bFor 200g.

Source: Data were collected by the researcher in the study area at one trade store, after determining that prices were approximately the same between stores. Prices in Goroka were collected by the researcher from a low cost store.

Thus, although there were markets for goods in the study area, they were likely to be intermittently supplied with store goods. The markets did not offer a consistent income for the store-holders, or supply of goods to the customers.

As in other parts of Papua New Guinea, the study area has no formal land markets. Land that was not already owned, and therefore possibly available for expansion, was to the south of the study area into Gulf Province. This land was considered undesirable due to the lower altitude making malaria an even greater problem.

There were no markets for credit or insurance, and no facilities available to accept savings. At the time of the study visit there was no mobile phone reception, and hence no capacity for mobile banking. For the few people in the community who were paid employees (for example, the teachers), banking was conducted in Goroka or other urban centres when they were able to leave the study area.

The topography and environment are therefore critical contributors to the multiple market failures mostly through their influence on access to transport. In the case of the weather, there were direct impacts on storage of coffee.

The multiple market failures in turn reduce the capacity of households to earn cash income, cope with shocks and augment their subsistence supplies with traded goods. In the absence of markets, credit and savings facilities and insurance, the size and composition of the household is an important consideration (Fafchamps and Quisumbing 2007).

2.3.4 Social capital and family structures

The absence of range of government services in the study area means that a degree of cooperation between households is necessary to build or maintain village infrastructure. The village airfield, for example, was built by members cooperating to clear and level a suitable site over a period of three years. More recently, during the research visit, a group of men from the study area built an elementary school. Community members described how there was an expectation that men would contribute regular labour to various maintenance tasks and there were rostered days for activities such as airfield maintenance (Interview with village elder, February 2012).

Apart from organised cooperation for community-wide tasks, there were a number of other forms of social capital evident in the study area, including four active churches. Other organisations present were the school board, the village health volunteers' network and, more recently, a healthy motherhood group (introduced by an aid project). The latter two groups appeared to wane in between visits of aid project staff.

The isolation of the study area, the environment, and the social and historical factors have interacted to influence family structure. Family structures are significantly different from PNG-wide averages provided in the 2006 DHS (Table 2.2). The largest differences between DHS averages and the study area are in the low number of female-headed households in the study area, the low number of single person households, and the higher than average number of households comprised of more than three adults.

Family structure can be influenced by a range of factors: risk, specialisation of labour, technology and markets, capital accumulation and the urge to have children

(Binswanger et al. 1991, p.131; Fafchamps and Quisumbing 2007, pp.18-33). On risk, Binswanger et al. (1991) note that extended households can provide an insurance substitute. Households can extend either horizontally, where siblings live together, or vertically, where different generations live together (p. 131). The relatively high number of households with more than three adults (61 per cent) is likely to be a form of horizontal expansion in response to environmental, economic and man-made risks.

The high rate of polygyny (17 per cent of households) could also be a form of horizontal extension of the household (Jacoby 1995, p.942). It may also be a means of expanding access to land and/or labour. Sillitoe (1999), working in the Southern Highlands of Papua New Guinea, notes that when rights to land pass to both males and females, a woman's husband may negotiate access to land claimed by her (p.338). Other research in the Highlands suggests that women's access to land is via their husbands (Overfield 1998, p.53). Working the land is essential to maintaining property rights in Papua New Guinea. The close relationship between land ownership and access to labour may enter into men's decisions to marry more than one woman (Lea 2004, p.37; Sillitoe 1999, p.356).

In interviews regarding marriage traditions in the study area it was noted that, in some cases, families gifted their daughters with coffee gardens on marriage (Interview, February 2012). On marriage, these coffee gardens mostly became communal property of the household, or were considered to transfer to the husband's ownership. Data on coffee garden ownership showed that only two female spouses in the study area owned coffee gardens. The remainder were owned by men, other relatives or by the entire family. Households with more than two wives had coffee gardens 18 per cent larger than the average in the villages. These coffee gardens may have been accumulated through marriage, or it may be that additional wives were needed to provide labour for land already owned.

The social capital and the household structures appear to be organised to respond to the geospatial characteristics of the study area, in particular, the isolation and the environment. Social capital plays an important role in building and maintaining the limited stock of village level assets. The differences in average family composition

between DHS data and the study area are consistent with household structure being adjusted to respond to geospatial characteristics of the villages. The most likely explanation for the large number of households with more than three adults, including the horizontal expansion through polygyny, is that there is a need to have sufficient labour to work the land, and possibly to provide insurance against household illness and other shocks.

2.3.5 Summary

This section aimed to assess the influence of geospatial characteristics on village level characteristics. It showed that the geospatial characteristics are important determinants of the poor provision of government services, human capital and market development. As a result, there are few village level assets available to the study area that can be harnessed in the event of a negative shock. While the study area has social capital, this is mostly drawn on for building and maintaining community assets such as the airfield and school buildings. It seems likely that any assets built will deteriorate in the event that teachers and health workers are not retained and charter flights do not visit the study area. In addition to the low level of assets in the study area, the topography and environmental features of the location mean that households are likely to be exposed to a number of environmental shocks, including to their food supply and their health.

The analysis above is consistent with the large body of research on poverty in Papua New Guinea that identifies a relationship between where a person lives and poverty (See Appendix: Chapter 2, Table A2.1 for examples of research). However, a shortcoming of these studies to date is that they identify but do not explain the links between geography and poverty. This analysis has attempted to fill that gap.

2.4 The distribution of asset poverty in the study area

As noted in the introduction, there has been limited research in PNG that focuses on the characteristics of poverty within remote areas known to be disadvantaged. While there is no doubt that the study area is poor, not all households are equally poor.

Given the relatively low cash-flow in the study area and labour and goods market failures, an asset based measure was utilised to assess relative poverty. Imputing the kina value of assets, in the absence of markets and price information, was not

considered practical or meaningful. As noted in Chapter 1, the study area operates as an autarky. Using prices from an external area to value self-production would not be meaningful, particularly given that there is no intention to compare the data collected with data from other villages. In addition, there are theoretical reasons for using asset-based measures in these types of village level studies. Asset based measures are thought to be more representative of long-term welfare than consumption or income, which in subsistence environments may fluctuate seasonally (Filmer and Pritchett 2001, p.155).

Asset based measures of poverty have been shown to be accurate at identifying poor households when compared with expenditure and consumption based measures (Filmer and Scott 2012, p.360). In the case of Papua New Guinea, Sahn and Stifel (2003) used Papua New Guinea Household Survey (1996) data on child nutrition outcomes to compare predictions generated from an asset index and expenditure measures. The ranking of household welfare based on the asset index was found to be better in predicting child nutrition outcomes than reported expenditures (p.484).

The asset index in this research was constructed drawing on a list of assets compiled with reference to the 2006 DHS, and the PNG economic and anthropological literature. Housing quality indicators were excluded on the grounds that there is very limited variation in house quality (see Table 2.2). Assets were grouped into three broad categories: livestock, land and consumer goods.

The livestock included in the index were pigs and chickens. Guyer (1997) notes that, in the absence of formal sector financial institutions, many of the assets of the poor need to be multi-purpose and that this quality is more important when income sources are fragile (p.118). Assets can be more than stores of value, or a means of producing an income stream, they can also be important in the context of social and cultural processes (Guyer 1997, p.123). In the Highlands, pigs are multi-purpose assets that have an important social and cultural role. Pigs are used as a store of protein, a means of compensation, and for strengthening relationships, settling marriages, curing the sick and in ceremonies associated with burying the dead (Boyd 2001, p.267). The multiple roles of pigs may make households reluctant to sell them when they need access to cash. Chickens, on the other hand, hold no cultural or ceremonial importance. They are also

of low value, so may be less useful than other livestock as a form of insurance against risks (Hesselberg and Yaro 2006, p.49).

Only the size of coffee gardens was included in the asset index. It was assumed that only households able to meet their subsistence needs would own coffee gardens. The size of coffee gardens was measured with a hand-held Global Positioning System (GPS). For the 29 households that had multiple coffee gardens, the closest was measured and then the size of others estimated relative to the first garden. Carletto et al (2015) find that self-reported estimates of garden size tend to over-report land area, and that this may be exacerbated in sloped areas, such as those in the study area (p.595-596). In addition, they find that the over-estimation problem is worse for those at the lower end of the size distribution (p.595). In the case of the study area, given GPS was used to measure the size of the first coffee garden, this source of bias is less likely. However, it is possible that there was overestimation of garden size by those with multiple gardens.

Many households had a number of relatively small food gardens dispersed over a distance. This made it impractical to measure food garden size with the hand-held GPS. In addition, the absence of developed food markets suggests that the focus of households was primarily on subsistence production, not income generation, and that few households were able to generate a surplus. This in turn suggests that the size of food gardens would not be a good predictor of economic well-being.

Household goods were limited in the study area. Cooking utensils and gardening tools were included in the index as these were identified through discussions with NGO staff and researchers familiar with the area as being a means of differentiating between the wealth of households. Interviews with several of the polygynous household heads confirmed that ownership of cooking utensils and gardening tools was not shared between wives. And in the case of gardening tools, the number of adults in the household represented the number of potential garden labourers. Therefore, in the apparent absence of economies of scale, cooking utensils were divided by the number of wives in the household and gardening tools by the number of adults. Other household goods such as mobile phones and radios were also included in the asset index. Descriptive statistics of each of the items included in the index are at Table 2.6.

Table 2.6: Household ownership and factor loadings of assets included in the index

Asset type	Average/ (Standard deviation)	Per cent of households	Factor Score
Livestock			
Pigs per household	1.3 (1.83)		
No pigs		44.3	-0.38
1 to 4		50.6	0.30
5 or more		5.1	0.19
Chickens per household	3.4 (8.17)		
No chickens		55.7	-0.37
1 to 5		26.6	0.22
6 or more		17.7	0.22
Coffee garden size (square metres)	3469.2 (3956.78)		
No coffee garden		22.8	-0.29
Small (less than 1600)		24.0	0.05
Larger (more than 1600)		54.4	0.21
Consumer goods			
Mobile phone		29.1	0.10
Radio		15.2	-0.01
Cooking utensils per spouse ^a	4.1 (4.09)		
No utensils		6.0	-0.26
1 to 3		54.4	-0.25
4 or more		37.9	0.36
Garden tools per adult	1.9 (1.06)		
Less than 2		68.3	-0.22
2 or more		31.6	0.22
Sample size	79 ^b		

Notes: ^aWhere there is no spouse the figure includes all cooking utensils owned by the individual.

^b Sample size is 79 as one household refused to answer asset questions and three coffee gardens could not be measured.

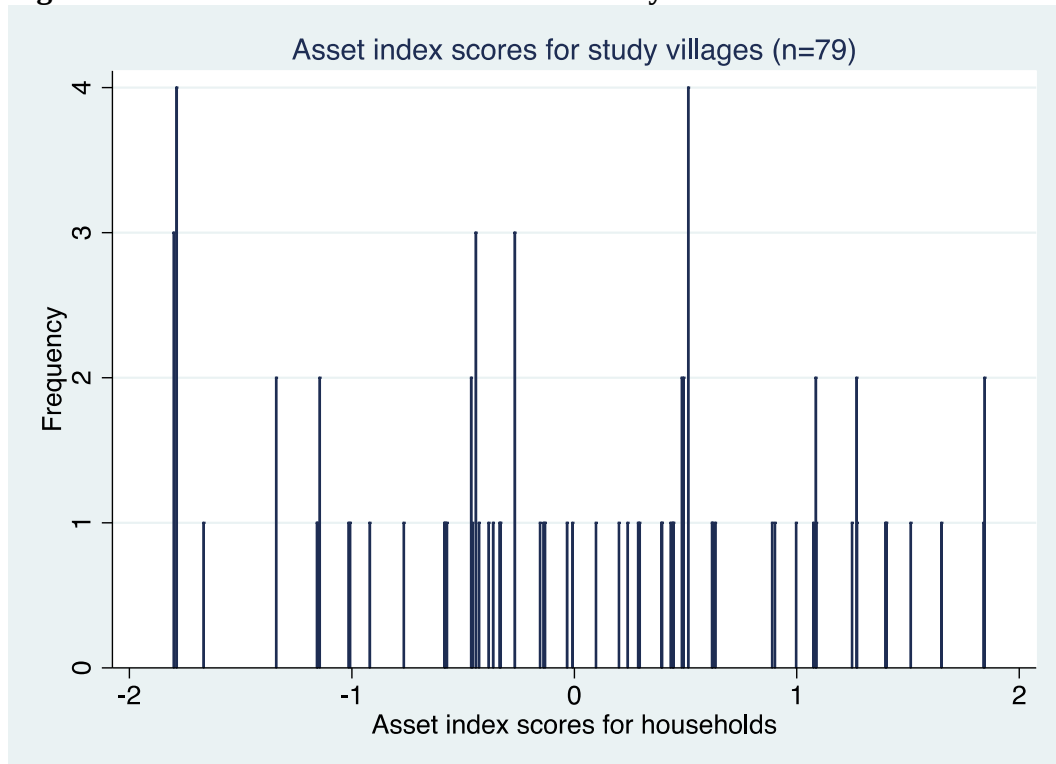
Source: Household survey data, February 2012 and Author's calculations.

To construct the asset index, the assets were grouped into categories based on the dispersion of assets. In most cases the boundary was around the median. The exceptions were mobile phones and radios, where a value of 1 was given if at least one item was owned and 0 otherwise. Once grouped, other categories were given a score of 1 if they applied to a household and 0 if they did not. Principal Components Analysis (PCA) was then used to construct the asset index, as recommended by Filmer and Pritchett (2001).

Using PCA, each component is a linear weighted combination of the original variables (OECD 2008, p.65). The first component explains the largest amount of variation in the data and subsequent components explain additional variation (Vyas and Kumaranayake 2006, p.460). The first component is used to represent household wealth. To construct the index the factor scores generated under the first component are used as weights for ownership of each type of asset. Weighted asset scores are then summed and the resulting index is standardised to have a mean of 0 and a standard deviation of 1.

The factor scores are also shown in Table 2.6. High positive coefficients in the factor score indicate that ownership of that asset is likely to mean ownership of other assets (Howe et al. 2008). Negative coefficients indicate that ownership of that asset is correlated with owning few other assets. (Moser and Felton 2007, p.4). Thus, a factor score of -0.38 for owning no pigs indicates that households that don't own pigs are unlikely to have many other assets. The distribution of asset index scores is shown in Figure 2.1.

Figure 2.1: Distribution of asset scores for study area



The distribution of scores is relatively wide and there is limited ‘clumping’ together of scores around a narrow value (McKenzie 2005, p.235; Vyas and Kumaranayake 2006, p.461). Although there are several instances of households sharing the same score, it is possible to divide the asset index scores into groups for further analysis. Summary statistics for the asset index scores split into quintiles are in Table 2.7.

Table 2 7: Summary statistics asset index scores in study area, by quintile

Asset index in quintiles							
	Number of households	Per cent	Minimum score	Maximum score	Mean	Standard Deviation	Difference in mean ^a
Lowest	16	19.3%	-1.80	-1.00	-1.47	0.33	
Low-mid	16	19.3%	-0.92	-0.33	-0.50	0.16	0.97
Middle	16	19.3%	-0.27	0.43	0.07	0.26	0.57
Mid-upper	16	19.3%	0.44	1.00	0.60	0.18	0.53
Upper	15	18.1%	1.07	1.84	1.39	0.28	0.79
Total	79						

Note: ^aDifference in mean is defined as the absolute value of mean of the quintile above minus the mean of the current quintile.

Source: Author's calculations.

The standard deviations of asset index scores is largest at both the upper and lower bounds of the score range. Differences in the means also show that asset scores are unevenly spread. An even distribution of assets between quintiles would lead to equality in the differences in mean between quintiles (Vyas and Kumaranayake 2006, p.464). However, column 7 in Table 2.7 shows a large difference in means between the middle-upper and upper quintile as well as between the middle and lower-middle quintiles. This suggests that the groups in middle of the asset distribution are quite similar, and different from groups at the upper and lower end of the distribution.

Table 2.8: Breakdown of Asset Index Score in study area, by quintile

	Distribution of assets by asset index quintile				
	Lowest	Low-mid	Middle	Mid-upper	Upper
Livestock					
No pigs	100.0%	75.0%	25.0%	12.5%	6.7%
Between 1 and 4	0.0%	25.0%	68.8%	87.5%	73.3%
5 or more pigs	0.0%	0.0%	6.3%	0.0%	20.0%
No chickens	100.0%	75.0%	43.8%	43.8%	13.3%
Between 1 and 5	0.0%	25.0%	25.0%	37.5%	46.7%
6 or more chickens	0.0%	0.0%	31.3%	18.8%	40.0%
Coffee garden size (square metres)					
No coffee	56.3%	18.8%	25.0%	12.5%	0.0%
Small coffee garden (less than 1600)	12.5%	37.5%	31.3%	18.8%	20.0%
Large coffee garden (more than 1600)	31.3%	43.8%	50.0%	68.8%	80.0%
Consumer goods					
Own a mobile phone	12.5%	37.5%	31.3%	50.0%	20.0%
Own a radio	12.5%	12.5%	18.8%	25.0%	6.7%
No utensils	25.0%	6.3%	0.0%	0.0%	0.0%
Between 1 and 3	68.8%	81.3%	75.0%	43.8%	0.0%
4 or more utensils	6.3%	12.5%	25.0%	56.3%	93.3%
Less than 2 tools	100.0%	50.0%	81.3%	68.8%	40.0%
2 or more tools	0.0%	50.0%	18.8%	31.3%	60.0%

Source: Author's calculations.

Ownership of assets was analysed by quintile (Table 2.8). Livestock ownership is skewed towards the upper quintiles. 20 per cent of the households in the upper quintile own five or more pigs whereas in three out of the remaining four quintiles no households own this number of pigs.

The distribution of ownership of between 1 and 4 pigs is more even between quintiles. Although no households in the lowest quintile own any pigs, a quarter of households in the low-mid quintile own between 1 and 4 pigs. This number increases as overall asset ownership increases.

Chicken ownership is also skewed towards households with more assets. None of the households in the lowest quintile own any chickens. A lack of chicken ownership may indicate that the households concerned are too poor to enter into tradeable asset accumulation.

When household goods are considered, the bottom two quintiles are the only two groups with households owning no utensils. All households in the bottom quintile own less than two gardening tools per adult. The relative lack of household goods ownership in the bottom two quintiles may reflect poor access to cash via coffee production. This is particularly the case for the bottom quintile, where 56 per cent do not own coffee gardens.

More generally, coffee garden ownership appears to be a prerequisite for a high level of assets, as all the households in the top quintile own a coffee garden. However, it does not appear to be a guarantee of asset accumulation. 31 per cent of households in the bottom asset quintile had large coffee gardens. Given the uncertainty related to coffee transport and trading in the study area, ownership of a coffee garden represents potential rather than actual cash income. The ability of a household to translate this potential into actual cash income may depend on environmental factors, transport availability and human and social capital, to the extent that this helps to negotiate transport arrangements and coffee sales.

2.5 Asset poverty and household characteristics

This section addresses the question of how the most asset poor households differ from others. Two types of analysis are conducted. First, bivariate analysis assesses asset poverty against a range of known poverty correlates. Second, a probit regression analysis is undertaken. Possible specification errors are managed by undertaking the bivariate analysis first, and then including in the probit model only the variables that show a significant association with asset poverty (Haughton and Khandker 2009, p.156).

The cut-off point for being considered (relatively) asset poor is set at the lowest 40 per cent of the asset distribution: that is, the bottom two quintiles are considered poor. This reflects a gap in the distribution of asset scores showing a large difference in mean between the low-mid and middle quintiles (Table 2.7). It also follows the practice of other empirical work, for example, Filmer and Pritchett (2001). Poverty correlates for the bivariate analysis include the following:

Elevation: Elevation was included as a variable as a proxy for land steepness and quality. Altitude was measured at each household using a handheld Global Positioning System (GPS). Given that (as shown in the next chapter) the fourth most common natural shock reported by villagers was landslides, and the main result of this was ruined gardens and reduced food consumption, it is possible that more marginal land for subsistence agriculture is more elevated. Therefore, it is expected that households located on steep land may have fewer assets.

Membership of organisations: Darlauf and Fafchamps (2004) review research on the impacts of social capital and development. They find that, although definitions of social capital vary, most focus on social relationships and their effects on the efficiency of social exchanges (p.7). In the study area, social networks may transmit information on coffee prices, transport or programs of assistance and allow for actions to be coordinated. The relationship between social capital and assets is likely to be positive if the former improves information flows, productivity of agriculture or access to markets. If membership of organisations offers a means of accessing informal insurance, then this type of social capital may help households to protect the assets that they have. On the other hand, if involvement in community organisations reduces time available for essential subsistence tasks, the relationship may be negative.

Female ownership of assets: A study of gender and smallholder coffee production, which spanned two years and covered 18 households across six villages in Eastern Highlands Province, concluded that women's productivity in coffee production could be increased by providing them with greater cash returns for their labour inputs (Overfield and Fleming 2001 p.155). This, in turn, would have positive implications for overall household production and cash income. In coffee production, women were found to have less access to extension services and other productivity enhancing resources than men. This was attributed to patriarchal traditions including access to land, where a woman's access to land is via her husband. In addition, the introduction of cash-crop production was found to have reduced the relative value of women's labour in traditional activities (Overfield and Fleming 1999 p.3). Ownership of assets and access to other resources that can help lift productivity are therefore identified as important

incentives for lifting female productivity in relation to smallholder coffee growing in Papua New Guinea.

In many countries women's asset ownership is considered endogenous to household wealth because women may bring assets to the marriage (Quisumbing and de la Brière 2000). However, in the study area women typically cannot retain control of productive assets, even when they bring them into the marriage. The qualitative research conducted in the study area identified that women are frequently gifted coffee gardens by their family on marriage, but that ownership of these gardens shifts to the men in almost all cases.

Nevertheless, women are still significant asset owners in the study area: they owned 14 per cent of their household's assets (land, pigs, chickens and fishponds). This included 32 per cent of the chickens, 30 per cent of the pigs, and only 3 per cent of the coffee gardens. Quisumbing and Maluccio (2003) note that asset ownership can be used as a proxy for female bargaining power in intra-household negotiations. It is expected that women who have greater bargaining power will be more motivated to increase household wealth, given the potential for their preferences to be adopted, including in relation to the retention of private income generated from assets they own. In the study area it is hypothesised that female ownership of assets will therefore be associated with higher levels of household asset ownership. A household is given a value of 1 if a female owns a productive asset.

Literacy: Research across a range of countries, including Papua New Guinea, has shown poor households are less well educated and have lower literacy rates (Allen et al. 2005; Mueller 2000; Haughton and Khandker 2009, p.153). In the study area where there has been discontinuous access to schooling (noting that the school was closed between 1997-2003), literacy was considered a reasonable indicator of human capital. A household is given a value of 1 if the household head could read and write. It is hypothesised that households with a literate head will have a higher level of asset ownership.

Age of household head: International poverty research has shown that better off households tend to have older household heads (Haughton and Khandker 2009, p.153).

However, recent research by the World Bank in Pacific Island Countries found evidence to the contrary, in that the incidence of hardship was substantially higher for households with an elderly head relative to national averages (World Bank 2014, p.39). Given contradictory results, it is unclear whether the age of the household head will be associated with higher asset levels. To allow measures of association to be calculated, the age of household heads was given a value of 1 if above the median age (36) and a 0 if below.

Polygynous family: In the villages surveyed 17 per cent of households were polygynous. Tertilt (2005) studied polygyny in 28 countries where the rate was higher than 10 per cent, and concluded that polygyny may have been a factor in the “continuing underdevelopment” of sub-Saharan Africa (Tertilt 2005, p.1366). Tertilt argues that polygyny leads to higher fertility and thus population, and that higher population density combined with limited natural resources increases poverty. A similar mechanism may be a factor in the study area at the household level, given that as households increase in size they may not be able to acquire more land. If this were the case, it would be expected that polygyny would be associated with greater asset poverty in the household. On the other hand, if richer husbands are able to attract more wives, there may be a positive association between polygyny and wealth.

Dependency ratio: Higher dependency ratios can be associated with higher levels of poverty (Haughton and Khandker 2009, p.153) including in the Pacific (World Bank 2014, p.40). In a subsistence setting with limited access to land, higher dependency ratios may have implications for access to food. The dependency ratio was calculated by dividing the sum of those younger than 15 and older than 64 by the number of adults (15-64 year olds) in the household. A dependency ratio greater than one implies that each adult member must support more than one dependent. A dependency ratio higher than 1 was therefore considered to be high. It is hypothesised that households with a higher dependency ratio will have fewer assets.

Gender of household head: There is a widely view that female headed households have higher levels of poverty, although empirical evidence suggests that the link between female headship and poverty is not clear-cut (for a discussion see studies by Chant

2003, Quisumbing et al. 1995). In a recent World Bank study of Pacific Island Countries the evidence on female-headed households was mixed across the countries included in the study (Vanuatu, Tuvalu, Fiji, Papua New Guinea, Kiribati and Solomon Islands). Based on a 2009-10 Household Income and Expenditure Survey, it was found that having a female household head was not associated with a higher likelihood of hardship in Papua New Guinea (World Bank 2014, p.38). In the study area, welfare is directly related to access to land for agricultural production, and females can only access land through males. It would therefore be expected that female-headed households would have lower asset levels than their male counterparts. For the analysis, female-headed households are given a value of 1.

Summary statistics for the possible poverty correlates are presented in Table 2.9. All of the variables are presented in a binary form, with a value of 0 if the household does not have the particular characteristic and 1 if it does.

Table 2.9: Summary statistics for possible poverty correlates in study area

Summary statistics for poverty correlates		
Poverty correlates (n=83)	Mean	Standard Deviation
Elevation above average (1131m)	0.49	0.50
Membership of organisations	0.31	0.47
Household head literate	0.71	0.46
Female ownership of assets	0.21	0.41
Age of household head above median (36 years)	0.48	0.50
Polygynous family	0.17	0.38
Dependency ratio above 1	0.45	0.50
Female head of household	0.04	0.19

Source: Author's calculations.

The contingency table of poverty correlates (Table 2.10) divides the households into asset poor and less poor according to the particular poverty correlate. Each row adds up to 35 asset-poor households (42 per cent) and 48 non-poor households (58 per cent). Thus, the first line of the table shows that of the 32 households that are considered asset poor, approximately 63 per cent live above 1131m elevation, and 38 per cent live below 1131m. It is possible to detect an association between asset level and living above

1131m that is significant at the 10 per cent level. Thus the level of asset ownership is not independent of the household's elevation.

Table 2.10: Poverty correlates by asset group - contingency table

Contingency table: Poverty correlates by asset group (n=79)

Poverty correlates		Per cent Yes	(Frequency)	Per cent No	(Frequency)	Chi-squared or Fisher's exact	p-value
General							
Elevation above average (1131m)	Asset poor	62.5	(20)	37.5	(12)	3.03	0.08*
	Less poor	42.6	(20)	57.5	(27)		
Membership of organisations	Asset poor	21.9	(7)	78.1	(25)	0.068*	
	Less poor	40.4	(19)	59.8	(28)		
Female ownership of assets	Asset poor	9.8	(3)	90.6	(29)	0.041**	
	Less poor	27.7	(13)	72.3	(34)		
Education							
Household head literate	Asset poor	59.4	(19)	40.6	(13)	0.011**	
	Less poor	85.1	(40)	14.9	(7)		
School aged children not in school	Asset poor	50.0	(16)	50.0	(16)	1.06	0.302
	Less poor	38.3	(18)	61.7	(29)		
Birth related (n=45)							
Received ante-natal care	Asset poor	83.3	(15)	16.7	(3)	0.343	
	Less poor	92.0	(23)	8.0	(2)		
Gave birth in health centre	Asset poor	55.6	(10)	44.4	(8)	0.331	
	Less poor	44.0	(11)	56.0	(14)		
Demographic factors (n=79)							
Age of household head above median (36 years)	Asset poor	43.8	(14)	56.3	(18)	0.206	0.650
	Less poor	48.9	(23)	51.1	(24)		
Polygynous family	Asset poor	15.6	(5)	84.4	(27)	0.563	
	Less poor	17.0	(8)	83.0	(39)		
Dependency ratio above 1	Asset poor	50.0	(16)	50.0	(16)	0.707	0.400
	Less poor	40.4	(19)	59.6	(28)		
Household member with disability	Asset poor	6.3	(2)	93.8	(30)	0.553	
	Less poor	8.5	(4)	91.5	(43)		
Female head of household	Asset poor	6.3	(2)	93.8	(30)	0.161	
	Less poor	0.0	(0)	100.0	(47)		

*, **, *** indicates 10, 5, and 1 per cent levels of significance respectively.

Note: ^a Fisher's exact score used if any frequency value was less than 10.

Source: Author's calculations.

Membership of organisations is identified as having a positive association with asset level, significant at the 10 per cent level. In this case, only seven out of 32 asset poor households report being members of organisations. This contrasts with 19 out of 37 of the less poor households. The literacy of the household head was also significant at a 5 per cent level. The number of less poor household heads who were literate was more than double the number who were asset poor.

Female ownership of assets was found to be associated with higher asset levels, this was significant at the 10 per cent level.

Contrary to expectations, there was no statistically significant relationship between asset poverty and a range of other poverty correlates. The lack of a relationship between age and asset levels may reflect a process whereby assets are accumulated while young and divested with age as children leave home. The lack of association between a higher dependency ratio and polygyny on the one hand, and asset levels on the other are both likely to reflect the limited benefits from additional labour. In the study area, even children under the age of 15 often assist with gardening tasks, childcare and other household tasks. Given that 45 per cent of girls aged between 7 and 14 are not in school, it is possible that these children are contributing substantially to household production, and that there are limited benefits from additional wives, and limited costs to having more children.

To further explore the relationship between being asset poor and the demographic and socioeconomic characteristics mentioned above, a probit model was estimated. Prior to estimating a probit model, it is necessary to test for the possibility of spatial autocorrelation, given the use of spatial data in the model. In the case of this data it is possible that spatially correlated variables may drive asset accumulation. If this is the case, the estimates of the probit model would be unchanged but the spatial autocorrelation of the error terms would lead to less reliable inference (Case 1991 p. 953).

In other studies that test for the existence of spatial autocorrelation (for example, Gibson and Olivier 2007) the aim is to test whether location specific factors, such as proximity

to infrastructure, lead to unobserved interactions between households that may result in different behaviours and hence social or economic outcomes. In the case of the study area, our interest is in asset accumulation. Given this, we test for spatial autocorrelation between households against the three most significant assets: the number of coffee gardens, the number of pigs and the number of chickens. Given the spread of households throughout the area, and the diversity in the quality of land over very short distances, it is expected that if spatial autocorrelation does exist it will do so for households that are relatively closely located to each other.

Moran's I test was used to check for the existence of spatial autocorrelation among households located relatively closely to each other (distance was set to 2km). In response to a null hypothesis that there is zero spatial autocorrelation, p-values were recorded of 0.39, 0.39 and 0.43 against ownership of coffee gardens, ownership of pigs and of chickens respectively. Hence, it is not possible to demonstrate the existence of spatial autocorrelation in error terms related to key assets in the study area.

Given this, a probit model was estimated with no adjustment to the error terms to account for spatial autocorrelation. Due to the small number of observations, in order to limit the potential loss of degrees of freedom it was decided that only those independent variables identified as having a statistically significant relationship in the bivariate analysis above would be included in the model. Descriptive statistics for each independent variable are at Appendix: Chapter 2, Table A2.3.

The dependent variable was set equal to 1 if the household was in the bottom 40 per cent of asset ownership¹³. The conditional probability that a household will be asset poor is therefore:

$$(1) \quad \Pr(y = 1 | x) = F(x_i'\beta)$$

¹³ Sensitivity analysis was conducted with the asset level specified as the bottom 30 and 50 per cent of households. With 50 per cent there was no change to the results on which variables were shown to be statistically significant. With 30 per cent, only literacy was statistically significant. The model with the bottom 30 per cent had a p value of 0.0075, whereas those for the bottom 40 and 50 had p value of 0.000. Given the results for the bottom 40 and 50 models, overall the findings are considered robust.

The probability that $y=1$ is therefore a function of an index function $(x_i'\beta)$ where x is a $K \times 1$ vector of regressors and β is a vector of unknown parameters. In a probit model $F(\cdot)$ is specified as the standard normal cumulative distribution function (Cameron and Trivedi 2010, p.460). The model is therefore:

$$(2) \quad \Phi(x'\beta) = \int_{-\infty}^{x'\beta} \phi(z) dz$$

where $\phi(z) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{z^2}{2}\right)$

All coefficients on the independent variables were significant at least at the 10 per cent level, with the exception of membership of organisations. A Hosmer-Lemeshow test for overall goodness of fit of the model gave a test statistic of 6.39 ($p=0.846$) and provided support for the model. Tests for sensitivity and specificity were then conducted. The former is the probability of predicting asset poverty among the asset poor, whereas the latter is the probability of predicting not being asset poor, among the non-asset poor; the values were 68.57 per cent and 83.33 per cent respectively. Overall, the predicted values were correct in 77.11 per cent of cases, which indicates that the model has good predictive value.

Average marginal effects were calculated (Column 3, Table 2.11). Given that variables were binary, marginal effects report the effect as the value changes from 0 to 1.

Table 2.11: Model of asset poverty in study area

Estimates of Model of Low Asset Ownership in Study area (n=79)						
Lowest 40 per cent of asset ownership	Coefficient	90% Confidence Interval		Average marginal effect	90% Confidence Interval	
Elevation (above 1131m)	0.57 (0.06)*	0.06	1.07	0.19 (0.05)**	0.03	0.34
Membership of organisation/s	-0.23 (0.52)	-0.81	0.35	-0.08 (0.51)	-0.27	0.12
Household head literate	-0.78 (0.04)*	-1.41	-0.15	-0.26 (0.03)**	-0.45	-0.07
Female ownership of assets	-0.91 (0.03)**	-1.60	-0.22	-0.30 (0.02)**	-0.51	-0.09
Constant	0.28 -0.43	-0.29	0.84			
LR chi2 (4)	15.14					
Prob>ch2	0.00					

Standard errors in brackets. *, **, *** indicates 10, 5 and 1 per cent levels of significance respectively.
Source: Author's calculations.

The signs on the coefficients indicate that there is a positive relationship between higher elevation and asset poverty. When average marginal effects are considered, a shift in the location of a household from a lower elevation to a higher elevation increases the probability of being asset poor by 19 per cent.

Membership of organisations was shown to have a negative relationship with being asset poor, although this was not statistically significant. This was in contrast to the bivariate analysis, which showed a positive, significant relationship. As expected, having a literate household head was an advantage and decreases the probability of being asset poor by on average 26 per cent.

Households with female ownership of income generating or tradeable assets have a 30 per cent lower probability of being asset poor than those with no female ownership of assets.

In summary, the regression analysis provides a number of interesting insights. Being located at a higher elevation is associated with lower asset levels. Given the fixed quantity of land available in the villages and the lack of a land market, households have

little capacity to acquire land at a lower elevation. It is possible that the relationship between these two variables reflects better quality land being located at a lower elevation. Given the topography of the study area, the land closer to the valley floor is less steep and therefore subject to less erosion and landslides. If individual households cannot obtain better quality land in the study area, it may make it difficult for them to improve their asset ownership. For those with few assets this may mean that, even within the villages, they are trapped in an asset ordering that is difficult to change. As such, these households may be the most disadvantaged people in the villages.

The finding that households with literate heads are less likely to be in asset poverty is not unexpected. Despite overall human capital levels being low, literacy in this context may offer advantages in relation to the ability to access resources, engage in organisations and negotiate coffee transport.

Female ownership of assets is also positively associated with higher household asset ownership. Given that females primarily own chickens and pigs, it is possible that owning livestock motivates these women towards higher productivity and asset accumulation. This may provide support for a hypothesis that women with higher bargaining power have a larger incentive to accumulate additional asset wealth.

It is important to note that we cannot always be confident of the direction of causation. The location of the households is unlikely to be a function of household wealth, but it may be that richer households are more likely to send their children to school (and thus more likely to produce literate household heads). Nevertheless, the exercise is useful for the insights it provides, especially with respect to elevation, an exogenous variable.

2.6 Food security

Although there is no historical data available on the nutritional status of the study area, Wonenara District, which includes the study area, was classified as having high malnutrition rates in the National Nutrition Survey of 1988 (Igua 2001, p.32). This, together with the geospatial characteristics of the study area that contribute to interrupted food supply (for example the steep landscape and heavy rainfall leading to

landslides), provides a rationale for examining different aspects of food security in the study area.

Given the research is based on a single cross-section in February, and food production differs from month to month, it is possible that measures of food security collected in February may not reflect food security across the course of the year. Given the seasonality of crop production, and the different weather across the course of the year, it is not expected that food security will remain constant across the year. To understand likely seasonal variation in food security, data were collected on seasonal agricultural activities and planting and harvesting of different food types grown in the study area across the entire year. This provided information on what food was available in each season, as well as what months of the year were less productive for food growing (Tables 3.1-3.2). The seasonal calendar identified that the most common time for food shortages in the study area was in September and October (Table 3.1). The data on seasonal availability of different crops was verified by comparing it to independent data on the agricultural systems of Papua New Guinea (Bourke et al. 2002). Given data on seasonality and crop production across the course of the year, reports of food insecurity in February are likely to reflect idiosyncratic factors such as shocks affecting a particular household, or longer-term issues related to access to food due to a lack of access to gardening land.

In addition, a number of different methods were employed to test the extent of food insecurity. A direct question was asked in the household survey about how frequently over the past 12 months the household had to employ strategies in response to not having enough food or money to buy food. In response to this question, 20 households identified as having to employ strategies to cope with food shortages. The mean number of weeks these strategies were employed was 13.2 weeks. 10 households indicated that they employed these strategies for four weeks in the last year. Findings regarding food insecurity therefore draw on a range of data.

In addition to the self-reported food insecurity, two other measures of food insecurity – dietary diversity and frequency of meat-based protein consumption – are examined, and for each the link between food insecurity and asset poverty is explored.

Diet diversity is widely accepted as a measure of food security. Higher levels of dietary diversity are associated with increased food consumption and energy availability (Hoddinott and Yohannes 2002, p.3; Ruel 2003, p.1). Data were collected from households on food consumption in the 24 hours leading up to the survey (Table 2.12). It can be seen that the two foods most commonly consumed by households were sweet potato (69.5 per cent) and greens (76.8 per cent).

Table 2.12: Food consumed in last 24 hours (n=82)

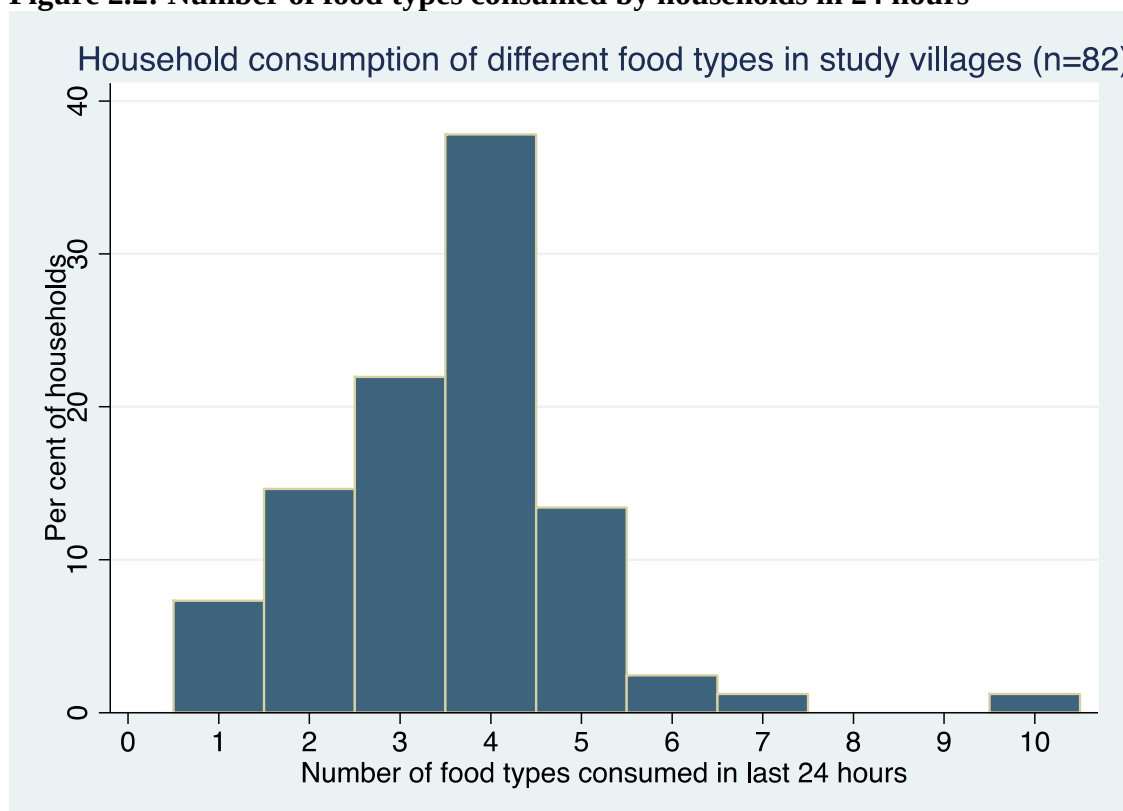
Type of food	Number of households	Per cent
Sweet potato	57	69.5%
Cooking banana	39	47.6%
Taro	40	48.8%
Greens	63	76.8%
Cassava	3	3.7%
Pumpkin	8	9.8%
Corn	12	14.6%
Red Pandanus Fruit	29	35.4%
Cucumber	1	1.2%
Pineapple	4	4.9%
Paw paw	1	1.2%
Sugar cane	1	1.2%
Peanuts	11	13.4%
Winged beans	5	6.1%
Pig	4	4.9%
Fish	5	6.1%
Chicken	2	2.4%
Noodles	5	6.1%
Rice	1	1.2%

Source: Household survey, February 2012.

Meat-based protein consumption was very low. Only 12 per cent of households consumed animal protein in the day leading up to the survey.¹⁴ The most commonly consumed source of protein was fish. Protein consumption levels this low indicate that animal-based protein deficiency is a problem in the study area.

Figure 2.2 illustrates that the distribution is skewed towards the lower end of the number of food types consumed over the twenty-four hour period. Only 4 households consumed more than five different food types. At the other extreme, there were 6 households that consumed only one food type (sweet potato). The mean number of different foods consumed was 3.56, and the median was 4.

Figure 2.2: Number of food types consumed by households in 24 hours



Source: Household survey, February 2012.

Maintaining food security requires that households are able to acquire sufficient quantity and quality of food to meet the nutritional and productivity requirements of all household members and that they have the biological capacity to utilise this food (Swindale and Bilinsky 2005, p.1).

Households were split into two groups based on the number of food types they had consumed in the 24 hours leading up to the survey. The low food variety group consumed between 1 and 3 food types, and included 40 per cent of households ($m=2.34$ different foods, $s.d=0.76$). The remaining 60 per cent of households (the high food variety group) consumed between 4 and 10 food types ($m=4.52$ different foods,

s.d=1.07). When the asset poor group is compared to the less poor group (Table 2.13), it can be seen that 34.02 per cent of the asset poor are in the higher food variety group, compared to 65.96 per cent of the less asset poor. The difference is significant at the 10 per cent level ($p=0.087$). Thus there appears to be a positive association between asset wealth and food variety in the study area.

The second measure of food security is based on the consumption of animal-based protein. Ruel (2002) notes that if malnutrition is a concern, measuring the number of food groups can be preferable to measuring the number of different foods consumed (p.16). However, food group analysis should be driven by the specific purpose of the study (p.39). Given research that shows deficiencies in animal-based protein (meat) consumption in Papua New Guinea (see Igua 2001, p.22), households were asked questions about frequency of consumption of a range of meats, as well as several plant-based proteins (Table 2.13).

Table 2.13: Household consumption of different meat and vegetable proteins

Protein source	Food frequency: meat and vegetable proteins			
	At least daily	At least weekly	At least monthly	Never or rarely
Fish	0.0%	8.4%	45.8%	45.8%
Chicken	0.0%	0.0%	27.7%	72.3%
Cassowary	0.0%	1.2%	6.0%	91.6%
Other bird	0.0%	3.6%	28.9%	67.5%
Pig	0.0%	0.0%	21.7%	78.3%
Peanut	78.3%	8.4%	9.6%	3.6%
Winged bean	60.2%	4.8%	24.1%	10.8%
One type of meat	0.0%	13.2%	25.3%	36.1%
More than one type of meat	0.0%	0.0%	38.6%	

n=83

Source: Household survey, February 2012

Consumption of meat is very low. Approximately 36 per cent of households reported that they never, or only rarely (that is, less than monthly), consumed even one type of meat. Column 1 and 2 in Table 2.13 shows that no households in the villages consumed meat on a daily basis and that only around 13 per cent consumed one or more type of meat weekly.

Meat is an important source of animal-based protein. Animal-based protein is essential for provision of vitamin B₁₂. Children, in particular, need access to meat in order to establish their store of vitamin B₁₂. When left untreated, vitamin B₁₂ deficiency can lead to irreversible nerve damage and neuropsychiatric abnormalities (such as memory loss and depression) (Zeuschner et al. 2012, pp. 27-32). Meat is also rich in iron which helps prevent anaemia, especially in children and pregnant women (Heinz and Hautzinger 2007). Overall, the evidence on meat consumption within the study area shows that animal-based protein is insufficient to provide for vitamin B₁₂ and iron needs.

More generally in terms of protein consumption, the World Health Organisation has identified that the safe level of protein for adult women and men (over 18 years of age) is 46g of protein daily for someone weighing 55kg (WHO 2007, p.243). Infants up to the age of 2 require between approximately 10-12g a day, and increasing levels from aged 2 onwards. Pregnant and lactating women also require more than normal levels of protein, with increasing levels depending on where they are in their pregnancy and whether they are lactating (WHO 2007, p.244). Although there are peanuts and winged beans available in the villages as plant based sources of protein, neither is available in quantity all year around. Peanuts were typically planted July through to August, with a four-month maturation (see Chapter 3, Table 3.2). Bourke et al. (2004) note that there are seasonal variations in the quantity of peanuts produced in Eastern Highlands Province (Bourke et al. 2004, p.43). Winged beans were typically planted by villagers over September to November, and also had a four-month maturation (Seasonal calendar, February 2012). Although Bourke et al. (2004) do not have specific information on when winged beans are typically available in Eastern Highlands Province, they report that elsewhere in Papua New Guinea, such as Port Moresby, winged beans can be available for several months twice a year (p.15). Thus, the limited plant based proteins

that are available in the study area are neither a reliable nor a sufficient substitute for animal-based protein for the villagers.

The data on meat consumption suggests that those who own livestock are not consuming it regularly. For example, around 42 per cent of households own chickens and yet only 28 per cent consumed chicken in the last month. There were no reports of egg consumption, which suggests that chickens were kept as a meat source and as assets. The low chicken consumption is consistent with households treating chickens as an asset rather than as a regular part of their subsistence diet.

In order to assess whether meat consumption differed by asset level, two meat variables were used. The first was simply an indicator of whether meat had been consumed in the last 24 hours. There was a statistically significant relationship identified between meat consumption in the last 24 hours and asset poverty status ($p=0.09$).

A second indicator variable was generated by giving households a score of 1 if they never or rarely consumed four out of five listed meat types, excluding fish. Given that fish farming had only recently been introduced by the CARE International project, it was considered too early to determine its long-term influence on diet. Focusing on extremely low meat consumption of one type and those who reported never or rarely consuming any meat was considered a more accurate representation of diet. A score of zero was given to those households consuming meat more regularly. When the asset poor group was compared to the less poor group (Table 2.14), 75 per cent of asset poor were in the low meat consumption group, compared to approximately 47 per cent of the less poor. The difference between the groups is significant at the 5 per cent level (Fisher's exact=0.011).

Table 2.14: Food-related welfare indicators by asset group in study area

Contingency table: food-related indicators of welfare by asset group

	Per cent Yes	(Frequency)	Per cent No	(Frequency)	Chi-square or Fisher's exact statistic ^a	p- value
Top 60 percent of food variety						
Asset poor	43.75	(14)	56.25	(18)	0.21	0.65
Less poor	48.94	(23)	51.06	(24)		
Consumed meat in last 24 hours						
Asset poor	3.12	(1)	96.88	(31)	0.09*	
Less poor	14.89	(7)	85.11	(40)		
Low meat consumption (never or rarely eat four out of five meats)						
Asset poor	75.00	(24)	25.00	(8)	0.01**	
Less poor	46.81	(22)	53.19	(25)		

*, **, *** indicates 10, 5 and 1 per cent levels of significance respectively.

Note: ^aFisher's exact score used if any frequency value was less than 10.

Source: Author's calculations.

The analysis shows that meat consumption is low for all villagers, and that there is an association between asset levels and meat consumption.

As the next step in the analysis, probit models were used to quantify the correlation between asset ownership and a range of other variables on food variety and low meat consumption.

First, probit regressions were conducted using variables that were included in the regressions on asset poverty to determine if, in the study area, asset poverty and food-related welfare measures have the same determinants. Two regressions were run. Independent variables included the household being located on steep land, the household head being a member of an organisation, females owning assets and the household head being literate. The dependent variables were the household being in the top 60 per cent of food variety and the household having low meat consumption. In the first regression, with food variety as the dependent variable, none of the independent variables were shown to be statistically significant (Appendix 2 Table A2.4). Goodness of fit tests showed that this model had relatively low predictive power (57.8 per cent) and that it was possible to reject the hypothesis that the model is a good fit at the 10 per

cent level ($p=0.07$). It is possible that the lack of statistical significance in this first model is related to the limited range of food types consumed overall. Among the households consuming the top 60 per cent of food types, most consumed only 4 different food types in the 24 hours before the survey. These households may not have shown sufficient variation in other characteristics to be statistically significant.

In the low meat consumption regression, there is a statistically significant relationship between female ownership of assets and having a lower probability of low meat consumption ($p=0.047$) (Appendix: Chapter 2 Table A2.5). It is possible that, despite very low consumption of livestock overall, this result reflects the fact that some of the assets that females own are potential sources of meat-based protein (chickens and pigs).

The low predictive value of the first model, and its poor score on goodness of fit provides little support for there being common determinants for asset poverty and the food-variety measure of food welfare. In the second model the possibility that female ownership of assets is not independent of the low meat consumption variable undermines any possible explanatory value. As such, it is not possible to show common determinants for asset poverty and food-related welfare measures.

Another set of regressions were run which included the asset index and a range of variables directly related to the food-related welfare indicators. Two meat-related control variables were also included. These were whether the household engaged in hunting, and whether it had a fish farm. Household size was also included, on the grounds that as this increases, economies of scale in subsistence gardening may free labour to hunt or fish for protein.

Model 1 uses the household being in the top 60 per cent of food variety in food consumed over the previous 24 hours (Table 2.15). In Model 1 only the coefficient on household size was both positive and significant at a 5 per cent level. The asset index was not statistically significant. Whether a household owned a fish farm or hunted was not associated with higher variety in their food consumption. When marginal effects are examined, for every one person increase in household size the probability of the household having a higher range of food variety increases by 4 per cent. Thus larger household size was on average associated with more food variety.

Table 2.15: Probit model of higher food variety in the study area

Model 1: Probit model for food variety

	Coefficient	90 percent confidence interval		Average marginal effects	90 percent confidence interval	
Asset index	0.22 (0.15) ^a	-0.03	0.46	0.08 (0.05)	-0.01	0.16
Household size	0.12** (0.06)	0.02	0.22	0.04** (0.02)	0.01	0.07
Subsistence hunting	0.00 (0.30)	-0.05	0.48	-0.00 (0.10)	-0.17	0.17
Owns a fish farm	-0.17 (0.11)	-0.36	0.02	-0.06 (0.04)	-0.12	0.00
Constant	-0.24 (0.38)	-0.87	0.38			

LR chi2 (4)=9.87 Prob>chi2=0.042 Log likelihood=-48.75

Standard errors in brackets. *, **, *** indicates 10, 5 and 1 per cent levels of significance respectively.

Source: Author's calculations.

Model 2 has a dependent variable equal to one if the household has low meat consumption and 0 otherwise. Coefficients and average marginal effects are reported (Table 2.16).

Table 2.16: Probit model of low meat consumption in the study area

Model 2: Probit model for low meat consumption

	Coefficient	90 per cent confidence interval		Average marginal effects	90 per cent confidence interval	
Asset index	-0.58*** (0.16)	-0.85	-0.32	-0.18*** (0.04)	-0.24	-0.11
Household size	0.14** (0.05)	0.05	0.23	0.04** (0.01)	0.02	0.07
Subsistence hunting	-0.69** (0.32)	-1.21	-0.17	-0.21** (0.09)	-0.35	-0.06
Owens a fish farm	0.01 (0.11)	-0.17	0.18	0.00 (0.03)	-0.05	0.06
Constant	-0.187 (0.39)	-0.82	0.45			

Wald chi2 (4)=21.57 Prob>chi2=0.0002 Log likelihood=-42.59

Standard errors in brackets. *, **, *** indicates 10, 5 and 1 per cent levels of significance respectively.

Source: Author's calculations.

Goodness of fit measures show that the model correctly predicts the outcome in 69 per cent of cases¹⁵. There is a negative relationship between increasing asset ownership and low meat consumption, significant at the 99 per cent level. The relationship is also negative if the household identifies as a subsistence hunter (p=0.03). The coefficient on owning a fish farm although positive, was negligible (0.01) and not statistically significant. There is a positive relationship between household size and the likelihood of low meat consumption, significant at the 95 per cent level.

For every unit increase in assets, there is, on average, a reduction of 18 per cent in the probability that the household will have low meat consumption, holding all other variables constant (Column 4, Table 2.16). In addition, households that are willing or able to hunt can reduce their average probability of low meat consumption by 21 per cent. Family size is a relatively minor influence on low meat consumption. On average

¹⁵ In addition, the area under the ROC curve is 0.7833. A model with no predictive power would have an area of 0.50.

for every person added to the family, the probability of having low meat consumption increases by 4 per cent. That said, the hypothesis that household size would increase meat consumption is certainly rejected. Again in a surplus labour economy, a larger household appears to be at a disadvantage for accessing protein and only a very minor advantage in terms of accessing greater food variety.

Overall, the data collected on food security suggests that households in the study area are both food insecure and animal-based protein deficient. Of the two measures of food security assessed, the measure based on meat consumption was judged to be a better indicator of relative welfare. This is because, in the absence of meat, even households consuming the largest variety of food in the study area would still be deficient in animal-based protein.

There is evidence that asset poor households are more food insecure than those with more assets. While traditional activities such as hunting offer some protection from protein deficiency, about half of the households do not engage in this activity. In this respect, common resources offer some protection, but not enough to make up for the lack of access to sufficient small-scale livestock, or a market and the cash income necessary to purchase meat.

2.7 Discussion and conclusion

This essay sought to address the question of why PNG's remote villages are disadvantaged and to identify the characteristics of the poorest in the villages, including the links to food insecurity. This has important implications for the estimated one million people who may be living in similar circumstances across PNG.

The geospatial influences on village level assets were examined and it was found that the isolation of the study area is a major determinant of village level poverty. This is consistent with the limited international research on remote rural poverty (Bird et al. 2003) and a range of PNG specific poverty research (Cammack 2007; Allen et al. 2009). In the case of the study area, isolation impedes the development of markets for labour, food, and financial services. Isolation also directly reduces access to and quality of health and education services.

The topography of the villages and the surrounding area both contributes to and exacerbates the impact of the isolation. To travel to the nearest road villagers must walk over mountainous terrain for two days. This limits their capacity of villagers to transport their coffee crop to market or to bring in supplies. The altitude of the study area also places it in the malaria zone. This is reflected in the statistics from the health centre records and reports of ill-health from the household survey. Frequent ill-health, in the context of households that engage in subsistence farming, impacts directly on food supply.

The distribution of asset poverty within the study area was examined along with the household qualities that influence asset levels. The asset ownership index calculations showed that coffee garden ownership was generally associated with but is no guarantee of higher asset wealth across the board. This is likely to be a specific finding for the study area that relates directly to its isolation. Even though coffee is the dominant cash income source for households, the distance to markets and irregular access to air transport means that owning large coffee gardens is not a guarantee of commensurate cash income and the financial resources to acquire additional assets.

Livestock was mostly owned by those with higher levels of assets. Chicken ownership, in particular, was skewed towards households with other assets. Pig ownership, on the other hand, was less associated with owning other assets. This reflects the multi-purpose nature of pigs in the study area. It was possible to own several pigs in the village but still be asset poor in other respects. This finding is relevant for future use of asset based poverty measures in Papua New Guinea.

The regression analysis of asset ownership and a range of poverty correlates showed that, in the context of the study area, the households with more assets were located at a lower elevation. It seems likely that land quality decreased as households spread up the mountains onto steeper ground.

In the context of a group of villages where village level assets are low, the ordering of the asset ranking for households could help identify those most vulnerable to food insecurity or malnutrition. The results of the regressions of different food security measures showed that higher asset ownership was not associated with higher food

variety. In this context, higher food variety may not be closely related to better welfare, particularly if no meat is consumed.

In a situation where meat-based protein deficiency is reported to be common, higher meat consumption is a significant advantage for a household. The regression analysis showed that households with more assets had greater meat consumption than those with low asset levels. This has significant implications for welfare. Activities such as hunting appear to only partially offset the reduced meat-based protein consumption associated with lower asset levels. This suggests that a traditional lifestyle involving hunting and subsistence agriculture, at least in this location, cannot currently meet nutritional needs. Also, in the absence of markets, even those households with cash income may struggle to meet their requirements for meat-based protein.

This essay adds to poverty research in PNG by being the first village level study to examine geospatial influences and village level influences on poverty together with the link to food insecurity. It finds that geospatial influences disadvantage the study area as a whole, and those households at a higher elevation in particular. It also finds that the study area as a whole is food-insecure, and that those with fewer assets are more food insecure.

Appendix: Chapter 2

Table A2.1: Summary of main variables and data sources used in poverty analysis in PNG

Wilson (1975)	De Albuquerque and D'Sa (1986)	Hanson et al. (2001)	Gibson et al. (2004)	National Economic and Fiscal Commission (NEFC) District Development Index (2004)
Small holder cash crop production by sub-district (government estimates for 1969-70)	Population density (Census 1980 and Provincial Data System 1978-79)	Land potential (Mapping Agricultural Systems of PNG Project (MASP), and PNG Resource Information System database (PNGRIS))	Size of dwelling (PNG Household Survey 1996)	Income levels (based on World Bank estimates of share of people in district who are poor – see Gibson et al., 2004)
Hospital beds per 1000 (Administrative data)	Sex ratios (Census 1980)	Agriculture pressure (MASP)	Age of household members (PNG Household Survey 1996)	Health standards - life expectancy (Census 2000)
Enrolments in primary and secondary schools per 1000 (Administrative and Mission data)	Dependency ratios (Census 1980)	Access to services (MASP)	Schooling of household head. (PNG Household Survey 1996)	Education standards - literacy and school attendance (Census 2000)
Administration staff per 1000 (Administrative data)	Urbanisation (Census 1980, paper by Boutau ^a)	Income from agriculture (MASP)	Main source of income (PNG Household Survey 1996)	
Accessibility to district headquarters (Index constructed)	Internal Migration (Census 1980)	Child Malnutrition (based on 1982-83 National Nutrition Survey (NNS))	Geographic and climatic features (PNGRIS database)	
Level of local services (Administrative data)	Employment (Census 1980)	Population (estimates for 2000 based on 1980 and 1990 census data)	Agriculture system remote from services (MASP)	
	Education status (Census 1980)		% of wages as main income source in Local Level Government (LLG) (Census 2000)	
	Health (Townsend and Nou Taboro ^b)		% of betelnut as income source in LLG (Census 2000)	
	Accessibility (Provincial Data System)			

Notes: ^a Boutau, G et al. 1983 '1980 national population census: district level analysis' Department of Geography and Demography, University of Papua New Guinea.

^bTownsend, P and Nou-Taboro, O 1984 'Mapping maternal and child health coverage in Papua New Guinea' PNG Institute of Applied Social and Economic Research.

Table A 2.2: Most disadvantaged districts

District	Wilson (1974)	De Albuquerque and D'Sa (1986)	Hanson et al. (2001)	Gibson et al. (2004)	NEFC District Development Index (2004)
Middle Ramu (Madang)	X	X	X	X	X
Rai Coast (Madang)	X	X	X	X	X
Telefomin (Sandaun)	X	X	X	X	X
Vanimo-Green River (Sandaun)	X	X	X	X	X
Aitape-Lumi (Sandaun)	X	X		X	X
Koroba-Lake Kapiago (Southern Highlands)		X	X	X	X
Jimi (Western Highlands)	X	X	X	X	X
Oburu-Wonenara (Eastern Highlands)	X			X	X
Goilala (Central)	X	X	X	X	X
Ambunti-Dreikikir (East Sepik)	X	X		X	X

Sources: de Albuquerque and D'Sa (1986) (pp29-32), Gibson et al. 2004 (p.43), Hanson et al. 2001 (p.310)

Table A2.3: Descriptive statistics model of low asset ownership

Descriptive statistics: probit model of low asset ownership				
Independent Variables	Poor		Less Poor	
	Mean	S.D	Mean	S.D
Elevation (above 1131m)	0.63	0.49	0.43	0.50
Membership of organisation/s	0.22	0.42	0.40	0.50
Household head literate	0.59	0.49	0.85	0.36
Female ownership of assets	0.09	0.30	0.27	0.45
n=79				

Source: Household survey, February 2012.

Table A2.4: Probit model for food variety - using variables from asset poverty model

Probit model for food variety (using variables from asset model)				
	Coefficient	p-value	90 per cent confidence interval	
Elevation (above 1131m)	0.238 (0.24) ^a	0.395	-0.22	0.7
Membership of organisation/s	0.109 (0.33)	0.743	-0.44	0.66
Household head literate	0.193 (0.34)	0.572	-0.37	0.75
Female ownership of assets	-0.317 (0.34)	0.357	-0.88	0.25
Constant	-0.055 (0.39)	0.856	-0.55	0.44
LR chi2 (4) =2.20 Prob>chi2=0.699 Log likelihood=-55.70				

Standard errors in brackets. *, **, *** indicates 10, 5 and 1 per cent levels of significance respectively.
Source: Author's calculations.

Table A2.5: Probit model for low meat consumption - using variables from asset poverty model

Probit model for low meat (using variables from asset model)				
	Coefficient	p-value	90 per cent confidence interval	
Elevation (above 1131m)	0.118 (0.28)	0.675	-0.34	0.58
Membership of organisation/s	-0.024 (0.33)	0.943	-0.57	0.52
Household head literate	-0.212 (0.35)	0.541	-0.78	0.35
Female ownership of assets	-0.696 (0.35)	0.047**	-1.27	-0.12
Constant	0.413 (0.31)	0.179	-0.09	0.92
LR chi2 (4) =4.65 Prob>chi2=0.325 Log likelihood=-54.47				

Standard errors in brackets. *, **, *** indicates 10, 5 and 1 per cent levels of significance respectively.
Source: Author's calculations.

Chapter 3 Poverty, risks and coping strategies in a remote rural area of Papua New Guinea

3.1 Introduction

People who are poor and live in remote locations face substantially different challenges to the urban poor, or those who have fallen into poverty as a result of a negative shock. One major difference is the types of geophysical and environmental shocks that they are exposed to. Another difference is the type of coping mechanisms available to choose between when responding to a shock. Coping mechanisms can be limited by market failures, access to, and distance from, services. Reducing the consumption of food is a damaging coping mechanism because of its impact on health and other aspects of human capital. However, in some circumstances, reducing food consumption may be considered by households to be less harmful than alternatives such as selling assets. Understanding the broader circumstances in which reduced food consumption is adopted as a regular coping mechanism provides insight that may be applicable to the design of assistance programs for chronically poor communities.

This essay focuses on the interaction between poverty, risks faced by households and coping strategies adopted by people living in the remote study area. Although there has been significant examination of these issues in parts of Africa and elsewhere, there has been a lack of attention to these issues in Papua New Guinea. A recent World Bank report on hardship and vulnerability in Pacific Island Countries (2014) notes that data on shocks and their impact is limited (p.6). This research therefore represents an important step in addressing these gaps in poverty research in Papua New Guinea.

The paper contributes to the international literature in two ways. First, it adds to the scant economic literature on poverty in remote areas. Second, it examines the relationship between shocks, consumption-reducing strategies and assets in the context of multiple market failures. This has also been relatively unexplored in the literature to date.

The research uses a single cross section survey and qualitative data to address the research question of whether, in response to a negative shock, there are differences in

the adoption of harmful coping strategies among households in a poor community. The next two sections provide a brief introduction to the main strands of literature and the methodology used. The fourth and fifth sections outline the results of the research in relation to reported shocks, their impacts, recovery time, and coping strategies. Sections six and seven apply two different statistical methods to analyse the results by asset level in order to address the research question. Section eight concludes the essay.

3.2 Overview of the literature

This essay touches on several interrelated strands of literature related to chronic poverty, vulnerability to shocks and the adoption of consumption-reducing coping strategies. These will be briefly reviewed below to provide context for the research. Given the lack of a PNG literature that brings together these three subjects, the focus of this section is the international literature.

The literature on chronic poverty notes that it is associated with low levels of human capital (Jalan and Ravallion 2000, p.93) and assets (Carter and Barrett 2006, McKay 2009). Chronically poor households may be vulnerable to falling into a deeper state of poverty or into destitution. Exposure to risk is one factor in determining vulnerability; the other is a household's access to resources. These resources may come from within the household, or from the wider community, and may take the form of human and social capital as well as assets. For households located in chronically poor locations, there are likely to be few resources to draw on in response to a negative shock. This is particularly the case for chronically poor locations that are also remote, where there may be limited provision of services by government and/or a lack of interest by governments in providing assistance in the event of a village wide – or covariate – shock. The consistent status of Obura Wonenara among the most disadvantaged districts in Papua New Guinea suggests that it may be a chronically poor location. The evidence presented in Chapter 2 supports this view.

Literature on coping strategies assumes that households have a continuum of strategies available to them, which they implement sequentially depending on the severity and frequency of shocks. Households weigh up the potential costs of a strategy when deciding how to deal with a shock. Research has shown that the costs of risk-coping

strategies can include lower average incomes, the creation of future obligations that will be hard for the household to meet, or reductions in human capital that may make it difficult to recover to pre-shock levels of consumption (Rosenzweig and Binswanger 1993, p. 58; Kanbur and Squire 2000, p.210; Dercon and Hoddinott 2005, p.125).

Another strand of the literature explores the relationship between short-term shocks, asset levels, and coping strategies. Traditionally, according to the permanent income hypothesis, households faced with a temporary negative shock would attempt to smooth their consumption. However, the evidence that, even in wealthy countries, people do not fully smooth their consumption supports an alternative approach to assets and consumption smoothing (Bardhan and Udry 1999, p.102). Zimmerman and Carter (2003) developed a model of the relationship between negative shocks and consumption that posits that there is a level of assets beyond which households focus on consumption smoothing, and below which they focus on defending their asset base by reducing their level of consumption (Zimmerman and Carter 2003, p.234). For households in the higher asset group, assets may be sold in order to smooth consumption in response to short-term shocks. However, for those in the lower group of asset ownership, the primary aim is to avoid disaster in their management of assets, and consumption smoothing is a secondary goal.

There is considerable evidence to support the proposition that households of different asset levels adopting different coping strategies. Dercon (1996) found that households in Tanzania with higher levels of assets allocated less land to relatively low risk and return sweet potato and more to other crops. As a result of being able to absorb the risk of new crops, households in the top quintile had agricultural yields 25 per cent higher per adult than those in the bottom wealth quintile (Dercon 2002, p.152). Households with higher levels of assets are also better able to resist adopting harmful coping strategies. Harrower and Hoddinott (2005), working on Zone Lacustre in Mali, found that asset poor households were more likely to rely on risk reduction strategies generally considered harmful, such as out-migration of members, and risk coping measures such as food rationing (p.511).

In some cases consumption reduction is assessed through changes in body mass index (BMI) and other direct measures. These studies show mounting evidence that body weight is used by poor households as a buffer to income shocks.¹⁶ Dercon and Krishnan (2000) study fluctuations in consumption over 18 months in Ethiopia, and conclude that households facing a variety of shocks over the period allow their consumption to fluctuate in response to seasonal changes in incentives for labour and prices (p.45). Similarly, Hoddinott (2006) working with data from Zimbabwe on a drought in 1994-95, concludes that households chose to maintain physical capital, and traded off a temporary reduction in women's health, and a likely permanent reduction in the human capital of children, by reducing their consumption of food (p.316). Dercon and Hoddinott (2005) conclude that consumption reduction in the face of shocks is due to a lack of integration between returns to assets, food stocks and to human capital via the labour market. Market imperfections may therefore tilt the decision that households make in responding to a shock towards consumption reduction.

The inter-generational effects of extended periods of low food consumption are well established. Malnourishment increases the maternal death rate, and leads to lower birth weight babies who are at increased risk of dying (Shen and Williamson 1999, p.199; WFP and CDC 2005, p.22). Low birth weight is a particular issue in Papua New Guinea, and accounts for half of neonatal mortality (Cripps et al. 2008, p.121). In children, malnutrition leads to lower growth rates and poorer performance at school. Poor cognitive development in childhood is associated with poor achievement in adulthood (Hoddinott 2006, p.316). There is also a link between low body mass and lower agricultural productivity (Dercon and Hoddinott 2005, p.125). In villages that rely on subsistence agriculture, the adoption of consumption-reducing strategies may contribute to households being trapped in a cycle of low productivity that entrenches disadvantage and makes them more vulnerable to negative shocks. Consistent use of consumption reduction as a strategy in response to shocks could therefore be a factor in households remaining chronically poor. In extreme cases, human capital could be depleted to such an extent that destitution occurs.

¹⁶ Income includes returns from subsistence activities.

The literature briefly examined above shows strong links between living in a chronically poor location and the range of coping strategies available, asset wealth and the choice of strategies, and negative shocks and consumption-reducing strategies. However, to date there has been only limited research that draws together these interrelated literatures. There is also a lack of literature on the choice of consumption reduction as a strategy in situations where due to remoteness there are long-term multiple market failures in the assets, food and labour markets. This paper begins to address these gaps in the literature by testing whether, in a chronically poor area with multiple market failures, the relationship between low levels of assets and increased use of consumption reduction as a coping strategy is maintained, or, whether all households are equally likely to reduce consumption in response to shocks. It is expected that this research will provide valuable insights into the link between poverty, coping mechanisms and the choice of consumption reduction as a response to a shock. The research will contribute to the limited number of economic studies of poverty in remote Papua New Guinea, and is the first with a focus on identifying shocks and coping mechanisms.

3.3 Methodology

The cross-sectional data collected in the survey has several limitations. The first is that it relies on a single survey of self-reported measures of a range of variables related to welfare, including cash income, health and risks and coping strategies. The literature on the accuracy of self-reported welfare measures has mainly focused on consumption and income and has shown mixed results. Pradhan and Ravallion (2000) found that actual measures of consumption were a significant predictor of perceived consumption adequacy (p.466). Others have found that demographic factors, perceptions of relative welfare and anticipation of future shocks can contribute to differences between subjective and objective measures of wellbeing (Carletto and Zezza 2006, p.742; Lokshin et al. 2006, p.599). To the extent possible, multiple methods were utilised to verify survey data. Where relevant, focus group data on agricultural shocks and coping strategies was compared to household data for consistency. Data provided on growing times and crops were compared to published data on agricultural systems in the district.

In the case of reports of drought and excess rain, it was possible to obtain independent verification of reported shocks via satellite data.

A second set of limitations relate to issues of seasonality and the representativeness of the survey month February. This is likely to affect data on income, expenditures and consumption of food. To mitigate the impact of this, while data is presented on income and expenditure – it is not presented as representative and is not extrapolated to draw conclusions about cash income or expenditures across the course of the year. In the case of food, data were also collected on seasonal production, on frequency of consumption of different food types and on other measures of food insecurity. Findings regarding food insecurity therefore draw on a range of data.

A third limitation of a single cross section relates to the measurement of chronic poverty. By definition, measuring chronic poverty requires multiple measurements over-time of the same individuals in order to identify change/or lack of change in their poverty status. This is not possible with one single cross section survey. Given this limitation, this thesis does not attempt to measure chronic poverty at a household level, but is instead focused on a chronically poor remote location.

A final limitation of a single cross section of data is that it makes it difficult to address issues of causation. In this case, the causation issue is whether asset poverty causes people to adopt consumption reduction as a coping strategy, or whether households that reduced consumption in the past eroded their human capital to such a degree that they have been driven into asset poverty. The low level of assets across the study area, together with the absence of asset markets, may provide support for the view that the causality runs from asset poverty to the adoption of consumption-reducing strategies, rather than the other way around. However, in the end this question cannot be resolved by the data available. The research question is therefore best thought of to be: is there a relationship between shocks, coping strategies and asset poverty?

Two methods are used to answer this question.

The first employs bivariate analysis to compare the coping strategies of households. Initially two methods were explored to group households into asset groups for bivariate

analysis, cluster analysis and Principle Components Analysis (PCA) (as used in Chapter 2). As discussed in Appendix:Chapter 3, the cluster analysis approach yielded three asset groups, a high asset group of 9 households that was distinguishable by having coffee gardens on average 10 times larger than the low asset group and double the average of the middle group. The bivariate analysis using the cluster analysis groups offered useful insights in relation to the small group of households in the high asset group but did not differentiate sufficiently between ownership of some assets that are important indicators of poverty in the study area, namely cooking utensils and garden tools (see Appendix: Chapter 3, Table A3.1). The large group of 70 households in the lower two clusters of asset ownership were relatively similar in most of their asset ownership, their experience of shocks and their choice of coping measures (Tables A3.2 and A3.3). Given our interest in households at the bottom of asset ownership, it was therefore determined that subsequent analysis would draw on the relative wealth index constructed using PCA.

The second method, multivariate regression analysis, is used on those households who have experienced a natural shock, in order to model the relationship between the number of shocks experienced, asset levels, and the adoption of consumption-reducing strategies.

Before deploying these methods (in Section 3.6) we summarize the results relating first to shocks (Section 3.4) and then to coping strategies (Section 3.5).

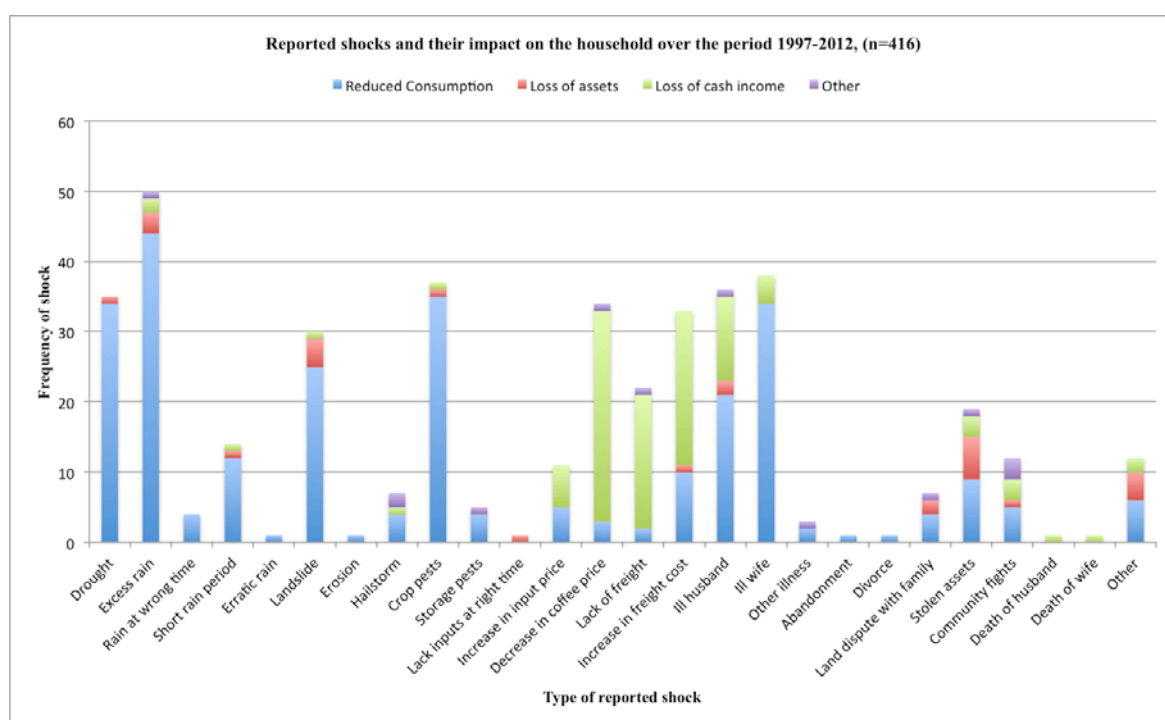
3.4 Results – reported shocks and their impacts

Household heads were asked about the impact of all shocks the household had experienced since the end of the drought of 1997. This period was chosen because the drought of 1997 stood out both for its severity, and because villagers received aid from the government. Household heads were asked to provide the year of the shock, to classify it as one of 26 types of shocks, to rank the shocks in terms of severity, and to choose one impact for each nominated shock from among the following categories: a reduction in consumption of food, a loss of assets, a fall in cash income and ‘other’. It was not expected that households would recall every single individual shock they experienced over this period, and it was expected that accuracy of recall would increase

in more recent years. Due to the long timespan and possible recall issues, data from this section of the survey is mainly utilised to show patterns in the types of shocks and their impacts on the household.

Many household heads found it difficult to rank the severity of shocks. Figure 3.1 shows all reported shocks over the period since 1997. Each column is then divided into proportions representing the reported impact of the shock.

Figure 3.1: Reported shocks by type and their impact on the household



Source: Household survey, February 2012.

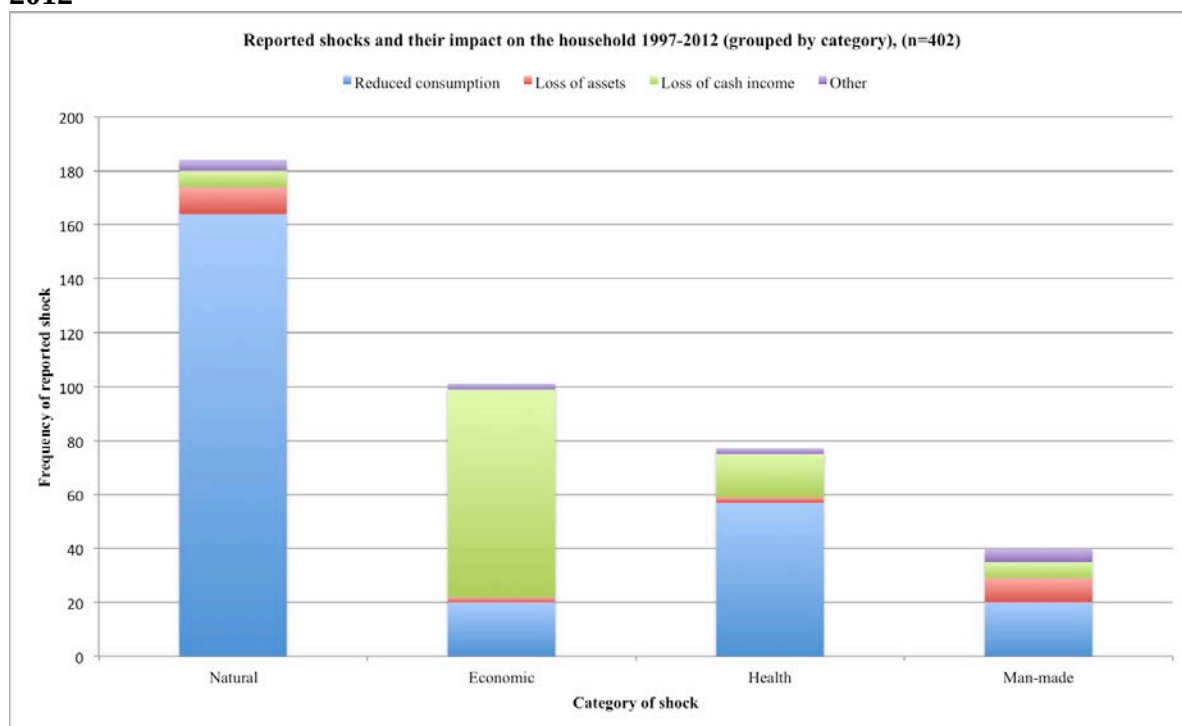
The average number of shocks reported by households over the period was 5. The most common shock reported was excess rain (12 per cent of all reported shocks); this was followed by drought, having an ill wife or husband, and crop pests (all approximately 9 per cent of reported shocks). Decrease in coffee price and increased cost of freight for coffee crops were the next most commonly reported shocks.

Comparative data were sought from international research on the frequency of shocks. Tusliuc and Lindert (2002) conducted research on risks and coping mechanisms in 10 villages in Guatemala. In the year prior to the survey, 53 per cent of households surveyed in Guatemala experienced at least one shock, whereas in the study area the equivalent figure was 69 per cent.¹⁷ A relatively high level of reported shocks in the study area is consistent with research that finds that the Papua New Guinea Highlands are particularly prone to natural disasters due to geological factors, steep slopes, high and intense rainfalls and weak sediments, and isolation leading to limited immunity to infectious diseases (Blong 1986, p.235).

The various shocks reported can be grouped into categories of natural, economic, health, 'man-made' and other. Natural shocks include weather-related, agricultural and geological events. Economic shocks include coffee price shocks and shocks to the availability and cost of inputs and transport. Health shocks are self-explanatory. 'Man-made' shocks include conflict over land, stealing or destruction of assets and relationship breakdowns. Figure 3.2 groups the reported shocks and impacts into the four categories. Shocks reported in Figure 3.1 under the category of 'other' as well as the deaths of husband and wives are excluded.

¹⁷ Calculated by assessing which households reported at least one shock in 2011 or 2012 among all reported shocks over the period since the drought.

Figure 3.2: Reported shocks by category and their impact on the household, 1997-2012



Source: Household survey, February 2012

As can be seen from Figure 3.2, the most common impact of the natural and man-made shocks is loss of consumption, whereas the economic shocks led overwhelmingly to a loss of cash income. Health shocks are a mixed case, reflecting the distinct gender roles in the study area. An ill husband results in a loss of cash income, reflecting men's role in coffee production, whereas an ill wife leads to a loss of consumption, reflecting women's role in the production of household food.

The remainder of this section discusses each category of shock. There is a particular focus on natural shocks on the grounds of their prevalence.

3.4.1 Natural shocks

Natural shocks accounted for 46 per cent of reported shocks over the period 1997-2012. The high proportion of natural shocks is a particular problem for the villages because these shocks are often sequential. For example, a period of limited rainfall may be followed by heavy rainfall, which then leads to an increase in landslides. Successive inter-related shocks can deepen poverty and reduce the capacity of villagers to assist each other (Dercon 2002, p.143; Bird et al. 2003, p.19).

In the case of rain related shocks, it is possible to verify the reports of household heads with independent data. Data on reported shocks since 1998 showed a spike in natural shocks in 2009-10. This mainly consisted of reports of drought, or insufficient rain¹⁸ by 42 per cent of households in 2009-10. When household heads were asked to consider shocks and their impacts in the two years leading up to the survey (2010-12) drought was reported by at least 50 per cent of households and made up 21 per cent of the total number of shocks reported. The fact that only half reported a drought over this period is likely to reflect household characteristics such as proximity to rivers.¹⁹ Among the households that did report the drought, the reported impact was mainly a decrease in household consumption.

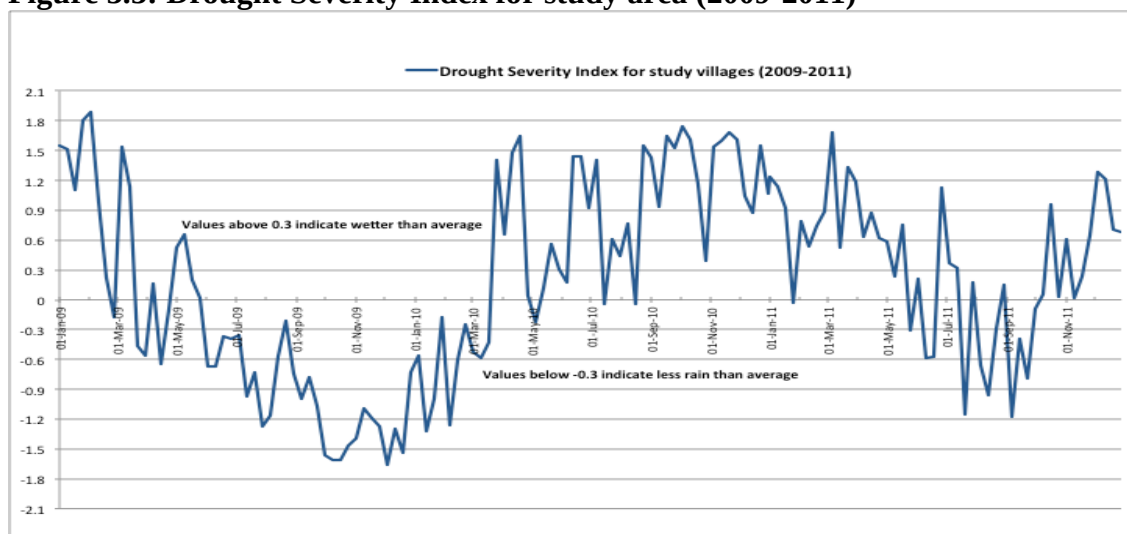
There are no records available from within Papua New Guinea that can be used to verify reports of a drought over the period 2009-12. An alternative approach is to utilise satellite data via an international drought severity index (DSI) for the relevant period and geographic coordinates (145.44E, 7.08S)²⁰. Each data point covers 0.05 degree spatial resolution, which is equivalent to a surface area of around 4-5km. The DSI compares rainfall levels for the data point to 12 years of satellite data for the area. A drought is defined as a progressive lack of rainfall usually over a period of month or longer (Mu et al. 2013, p.92). A normal range of rainfall is when the DSI measures between + or – 0.30. Positive values indicate rain, and negative values an absence of rain. A DSI between -1.2 and -1.49 indicates a severe drought and less than this is considered an extreme drought. (Mu et al. 2013, p.93). Figure 3.3 shows the DSI for the study area in eight-day intervals over the period January 2009 to December 2011.

¹⁸ Definitions of drought vary. The 26 shock categories included those of drought and short rain (or not enough rain). Responses in either of these two categories were regarded as reports of a drought.

¹⁹ The relevant question was ‘Since the end of the long drought has this household been affected by a shock – an event that led to a reduction in your assets, caused household income to fall, or reduced consumption?’

²⁰ The DSI was developed by the University of Montana and combines data from the terrestrial evapotranspiration (ET) and vegetation greenness (NVDI) indices, both of these draw on data from NASA’s MODIS satellite. More information on the DSI can be found at: <http://www.ntsg.umn.edu/project/dsi>

Figure 3.3: Drought Severity Index for study area (2009-2011)



Source: <http://www.ntsg.umn.edu/project/dsi>

High rainfall can be seen in Figure 3.3 from January through to March in 2009. However, from June 2009 to April 2010 the index is below -0.3 for the majority of time. Thus, the DSI data show that the study area had less rainfall than average in 2009-10, consistent with reports of drought. The period between April 2010 and May 2011 was then characterised by periods of excess rain, including during the period identified by villagers (Table 3.1) as being the optimal gardening time of June, July and August (Focus group, February 2012). Excess rain was the second most frequently reported shock over the 2010-12 period (10 per cent).

More generally, the extreme fluctuations in DSI data over the period 2009-11 show that the study area is highly exposed to weather shocks, because their subsistence agriculture is rain-fed, weather shocks have a direct impact on food supply. This impact is particularly important given the lack of an established food market, and the unsuitability of food crops for long-term storage once harvested.

Table 3.1: Seasonal calendar for study area

Seasonal calendar	
Month	Weather conditions/activities
January	Heavy rain
February	Heavy rain
March	Heavy rain
April	Rain and sunshine
May	Less rain/cloud cover
June	Less rain/cloud cover/good gardening time
July	Less rain/cloud cover, pests likely/good gardening time
August	Sunshine, pests likely, possible food shortages/good gardening time
September	Possible food shortages
October	Possible food shortages
November	Heavy rain
December	Heavy rain

Source: Focus group, February 2012.

Other household survey data confirm that households are exposed to agricultural shocks on an ongoing basis. When asked specifically to nominate agricultural shocks over the last growing season, 77 per cent of households reported shocks. Many of these shocks were not severe enough to be reported elsewhere as they did not lead to a drop in income or consumption for the household. Respondents were asked to rate the damage to their crop as bad, moderate or slight. The majority of ratings fell in the first two categories. The two most prominent shocks were too much rain (28 per cent of reported shocks) and too little rain (24 per cent).

The combination of severe agricultural shocks and the less severe but relatively frequent agricultural shocks described above means that households are continually making judgements and adjusting their agriculture activities. These portfolio choices are based on available crops, preferences, crop maturation times and expectations regarding the weather. A focus group identified the main agricultural crops, planting and maturation cycles (Table 3.2). This information was verified by comparing it to independent data on the agricultural systems of Papua New Guinea (Bourke et al. 2002).

Table 3.2: Main food types in the study area - planting and harvest times

Main food types: planting and harvesting cycles		
Food type	Planting time	Maturation/harvest
Sweet potato	All the time	6 months
Banana	All the time	6-10 months
Taro/taro konkong	All months	8 months
Greens	Varied	Varied
Tapioca	All the time	1-2 years
Winged beans	September-November	4 months
Peanuts	July/August	4 months
Yam	July-September	6-9 months
Corn	July-August	3 months
Pitpit	All the time	3 months
Pitpit (stick)	All the time	1 year
Sugar cane	All the time	6 months
Pineapple	All the time	6 months

Source: Focus group, February 2012.

The most popular foods for planting were sweet potato, banana and taro. These take between 4 and 10 months to mature and can be planted at any time in the year. In the event of a weather event that affected all gardens, it would therefore take at least four months re-establish staple crops. This timeframe was confirmed when households were asked how long it took them to recover to their previous level of consumption after a shock. In 86 per cent of cases, the recovery time was less than one year. In the event of a covariate shock, the small-scale sale of surplus garden products would be likely to stop. However, the location of the study location in a forested area means it is possible for villagers to supplement their food supply through increased foraging for ferns.

3.4.2 Economic shocks

Economic shocks were the second largest category of reported shocks over the period 1997-2012 and accounted for 25 per cent of the total. Approximately 70 per cent of households reported at least one economic shock. All of these households owned coffee gardens. The two most common economic shocks were reported to be increases in freight costs (31 per cent) and decreases in the coffee price (34 per cent).²¹

Household heads also reported other freight related shocks. The most significant of these was the lack of planes landing in the villages that could transport coffee to the markets. Charter companies only accepted coffee as backloads to flights already landing in the villages. Thus, if there were no flights in the general vicinity, there was no capacity to collect coffee. Many of the other airfields in the vicinity are unsafe to land on in poor weather. This reduces the likelihood of planes being in the area that could collect coffee from the study area (Interview New Tribes representative, January 2012). The government owned Coffee Industry Corporation has a program that collected coffee from remote locations; however, it was reported that this rarely transported coffee from the study area (Coffee focus group, February 2012).

Coffee parchment²² can be stored for more than a year without major deterioration in quality; however, it requires cool and dry storage conditions as exposure to humidity can spoil the coffee beans. The villagers had built a storage facility near the airfield, but lacked capacity to control exposure of the coffee parchment to humidity. Whether coffee would survive extended periods of storage was therefore a major source of uncertainty for farmers, alongside the inability to guarantee transport out of the study area (Coffee focus group, February 2012).

²¹ It was not possible to verify the reports of economic shocks as neither of the two air-freight companies made available historical data on freight charges, so net returns to farmers could not be calculated. Also, given the practice of coffee being transported out of the villages as a backload to flights already landing, there is unlikely to be a straightforward relationship between freight charges and the cost of aviation inputs, such as fuel.

²² Parchment is a thin membrane that covers the coffee bean after the fruit has been removed via initial processing.

3.4.3 Health shocks

Health shocks accounted for 19 per cent of the reported shocks. As reported in Chapter 2, household survey results showed that, at the time of the fieldwork, almost one quarter of the sampled population were reported to have been ill in the past 30 days. The most common illness nominated was a fever (32.5 per cent). Of those that were ill, 35 per cent were unable to collect water or bend over, both essential tasks in subsistence farming. The average time in the last month that people were not able to complete basic tasks was 4.3 days. 42 per cent of household heads reported that illness had prevented gardening tasks from taking place in the last growing season, and that this had affected a range of crops, including the staple crop, sweet potato. This shows a strong link between ill health and lower agricultural productivity.

Household heads were asked about the death of a spouse and of infants and children under the age of five. There were reports of one death of a husband and one of a wife. When questioned about the deaths of infants and children under the age of five, 23 per cent of households replied that they had experienced at least one death in their family. While it was not possible to collect detailed histories of how children and infants died, health centre records showed high rates of malaria and pneumonia amongst children, as discussed in Chapter 2.

3.4.5 Man-made shocks

Man-made shocks accounted for 11 per cent of the reported shocks. They included a broad range of events, the most prominent of which was stolen or destroyed assets (24 per cent), followed by community disputes (14.5 per cent). The majority of the community disputes were over land. The last major land dispute was reported to have been in 2010 between residents of Namboa and those in a neighbouring village in the next valley. The level of disputes is relatively low, compared to data from the Highlands more generally. The 2009-2010 Household Income and Expenditure Survey reports that 18.5 per cent of households were involved in disputes over land in the past year (NSO Table 8.1, p.123).

3.5 Coping strategies and recovery from shocks

The portfolio approach to risk managing and coping is captured in a social risk management matrix developed by Holzmann (2001). This breaks coping strategies up

into ex-ante and ex-post measures. The former include risk reduction and risk mitigation, and the latter consisted of risk coping mechanisms. The range of alternative coping strategies may vary according to collective resources of the community, the characteristics of the household, and the nature, severity and frequency of shocks that the household experiences. Thus, households living in chronically poor communities may have fewer coping strategies to choose between than those living in better resourced communities. Table 3.3 below draws on Holzmann's social risk management matrix (Holzmann 2001, p.9), modified for the study area.

Table 3.3: Risk management matrix for study area

Risk management and coping measures and examples	
Ex-ante measures	
Risk reduction	• Low risk crops • Reduction in family size via migration or informal adoption • Immunisation and other health measures
Risk mitigation	• Food and hygiene
	Portfolio approach
	• Investing in human and social capital • Taking on multiple jobs
	Insurance
	• Marriage and family ties • Network of reciprocal assistance with family and friends (informal insurance) • Accumulating savings
Ex-post measures	
Risk coping	• Help from government • Selling assets • Pre-selling harvest • Using savings • Loans from family or friends • Reducing consumption • Help from family and friends (informal insurance)

Source: Holzmann 2001, p.9.

The matrix developed by Holzmann implies that knowledge is important in adopting ex-ante measures. The World Bank identifies knowledge as a critical first step in risk management (World Bank 2014, p.17). However, in doing so, they acknowledge that factors such as cost and behavioural factors may prevent households from utilising their knowledge (ibid p.17).

With the exception of questions in relation to informal insurance, discussed further below and explained in detail in the next chapter, household heads were not asked directly about ex ante measures. Nevertheless some of the farming practices adopted

may have, initially at least, been responses to risk. For example, the dominance of sweet potato as the main staple crop may partly be a response to reduced soil fertility over time (Benjamin et al., 2000, p.96). There was also anecdotal evidence that some households had sought out plants such as Chinese taro for their drought resistant qualities.

Other ex-ante measures include health and hygiene related activities. On preventative health measures such as immunisation, it was reported by the health volunteer that demand for immunization existed, but due to a broken refrigerator vaccines had to be destroyed (Interview with health volunteer, February 2012). On sanitation and hygiene issues, none of the households treated their water before use, despite it coming from unprotected streams. Only 18 per cent (15) of household heads stated that they always washed their hands after going to the toilet and before food preparation.

Coffee growing may be an example of risk mitigation. Given that coffee gardens require land that could be used for food production, and offer uncertain returns, it may be that only households confident they can meet their consumption needs maintain coffee gardens. Social capital measures such as membership of organisations and marriage are also potentially risk mitigation measures. McKay (2009) argues that social capital is an important complement to other assets in helping poor people cope with shocks (p.6). In the case of membership of organisations, 31 per cent of households indicated that they were members of at least one organisation.

Rosenzweig and Stark (1989) propose that marriage can be an insurance mechanism against covariate shocks (p.907). Looking at marriage in this way as a mitigation measure would require that spouses come from an area that is unlikely to experience a shock at the same time. This did not appear to be the case in the study area, as the vast majority (113 out of 118) of wives were Yagwoia-Angan speakers, which is the language of the study area and implies that they came from the village or from not far away.²³ Seventeen per cent of the households were polygynous. Jacoby (1995) notes

²³ Information on the language group of the study villages was provided via personal communications with J Mimica, December 2012.

that polygyny can be a response to risk, as men may seek to marry several women in order to access their family support in the event of a shock (p.942).

The focus of the survey was on informal insurance and a number of ex-post risk coping measures. Informal insurance is both a mitigation measure and a coping measure, as the network of insurers is developed over time and triggered in the event of a shock. In the remainder of the analysis in this section, help from family and friends will be considered as a coping measure. The next chapter considers informal insurance as a mitigation measure.

Out of all shocks experienced over 1997-2012 (discussed in Section 3.4), household heads were asked to nominate the five most severe, and to identify the coping measures that they had adopted in response to these shocks. A list of sixteen different strategies was provided for household heads to choose from (Appendix: Survey Instruments, Table A5.2, Section 2.3). It is possible that there will be overlap between the impacts of shocks and their risk mitigation and coping strategies. Coping strategies that involve reducing food consumption are an obvious example. Households may have less food due to a shock, and may then choose to prioritise access to the remaining food within the household or decide that all should decrease consumption for a period.

The risk coping measures employed for all households across the five most commonly reported most severe shocks are shown in Table 3.4. Of the 16 alternative strategies presented to household heads, four received a zero response and so were excluded from further analysis. These included strategies around asking for cash loans from family members or friends and assistance from NGOs or churches.

For most shocks, consumption-reducing strategies dominate. “All family members reducing consumption” was the most frequently cited coping measure for shocks in all categories.

Table 3.4: Risk coping measures for five worst shocks (1997-2012)

Risk coping measures for the five most commonly reported worst shocks (1997-2012)				
	Natural	Health	Economic	Man-made
Risk coping measures				
Help from family	9.7%	38.5%	3.4%	0.0%
Help from friends and neighbours	1.8%	0.0%	0.0%	0.0%
Help from government	1.4%	2.6%	1.7%	0.0%
Spent savings	2.9%	0.0%	0.0%	8.3%
All family members reduced consumption	41.4%	38.5%	10.2%	8.3%
Stopped consuming some goods	23.4%	10.3%	3.4%	0.0%
Mothers reduced consumption	5.0%	0.0%	1.7%	0.0%
Increased hunting	7.9%	2.6%	5.1%	0.0%
Sold animal	0.0%	0.0%	1.7%	0.0%
Sold harvest in advance	0.0%	0.0%	5.1%	0.0%
Did nothing	6.5%	7.7%	67.8%	83.3%
Frequency of reported shock (by category) ^a	278	39	59	12

Note: ^aThe 'other' category of shock was excluded; it includes deaths and where the shock was not specified (23 reported shocks). The 'other' category of responses was excluded because there was insufficient information to analyse it (63 responses).

Source: Household survey data, February 2012.

Table 3.5: Risk coping measures in response to five worst shocks by household (1997-2012)

Use of risk coping measures by each household (1997-2012)		
	Number of households that used the strategy	Per cent of households
Risk coping measures		
Help from family	31	37.3%
Help from friends and neighbours	7	8.4%
Help from government	5	6.0%
Spent savings	11	13.3%
All family members reduced consumption	67	80.7%
Stopped consuming some goods	38	45.8%
Mothers reduced consumption	12	14.5%
Increased hunting	14	16.9%
Sold animal	1	1.2%
Sold harvest in advance	4	4.8%
Did nothing	50	60.2%
Other	34	41.0%
Number of households	83	

Source: Household survey data, February 2012.

Table 3.5 shows that approximately 81 per cent of households relied on a consumption-reducing measure on at least one occasion over the period of 1997-2012. There is limited international data for comparative purposes. One similar study was identified that was conducted in Guatemala over the year 2000 (Tesliuc and Lindert 2002). In the Guatemala study a similar number of shock types were identified. However, the nature of shocks differed to reflect the greater engagement of households in the formal sector (so for example, enterprise closure and bankruptcy were included as shocks). Despite experiencing different types of shocks, the study shows that reducing consumption was still the most common response to a shock, and was used by 44 per cent of households in a one year period.

Many coping measures that were popular in Guatemala were not available, or only used in a limited way in the study area. For example, 35.3 per cent of households in the Guatemala study sold their harvest in advance, their assets or their labour (Tesliuc and Lindert 2002, p.36). In contrast, in the study area across all reported shocks, there were

only four instances of harvests being sold in advance, and only one of an asset being sold (livestock). Selling labour was not an option in the study area.

It is possible that there are location specific factors that contribute to household's reluctance to use their assets to smooth consumption. First, the only assets that could be sold are pigs, chickens and the coffee harvest. As discussed in Chapter 2, pigs have an important role in Papua New Guinea society and culture. The multiple roles of pigs may mean that households are unwilling to sell them when faced with shocks. Second, although it is possible to purchase livestock in the villages, to do so requires the buyer to seek out a seller. In the event of a covariate shock, this limited market would deteriorate, as such, households may avoid livestock sales (Dercon 2002, p.149).

Another international study by Dercon and DeWeerd (2006) studied responses to ill health shocks in Nyakatoke in Tanzania. They found that the most common response to an ill health shocks was risk sharing (informal insurance) at 50 per cent of all responses (p.347). In Nyakatoke villagers then opted to sell assets (44 per cent), use their cash savings (37 per cent) and earn additional income (14 per cent). In the study area, ill health was the type of shock for which households reporting most frequently having received help from family and friends (28 per cent of total coping measures nominated in response to an ill-health shock). However, the last three of the coping measures utilised in Nyakatoke were either rarely used (dissaving and selling assets) or not available as an option (earning additional income) in the study area due to the remoteness and the lack of goods and labour markets. Instead, the second most common response to an ill-health shock was to employ harmful coping measures that involved reducing consumption of food.

The comparisons with Tesliuc and Lindert's study of Guatemala, and Dercon and DeWeerd's of Tanzania, provides a useful benchmark for assessing the number of coping measures available in the study area, and show that, in comparison, households in the study area have only a limited range of coping measures available to them. This means that, when faced with a shock, the continuum of coping measures that households can choose from is small. As a consequence, it is possible that households arrive at harmful consumption-reducing strategies sooner.

3.6 Do risks and coping measures differ by household asset ownership?

This section uses Principal Components Analysis to divide households into different asset groups. The data on coping measures will then be assessed in relation to these asset groups in the study area in order to determine if households in different asset wealth groups adopt different coping measures. In the next section (Section 3.7) multivariate analysis is utilised to model the relationship between the adoption of consumption-reducing strategies and relative asset wealth.

3.6.1 Asset index analysis

The asset index constructed using Principal Components Analysis in Chapter 2 was utilised to compare the coping measures of different asset groups. The two groups of asset poor and less poor used in Chapter 2 were replaced by three groups: the poorest 40 per cent, the middle 40 per cent, and the richest 20 per cent by asset ownership.

When categories of shocks over the period of 1997-2012 are compared to the sample means it can be seen that the average number of all reported shocks increases with asset ownership (Table 3.6). Within this, there are differences in the types of shocks each group reports. For example, the low asset group report a statistically significant lower average of economic shocks and health shocks than the sample mean ($p=0.01$, $p=0.02$). The difference in economic shocks can be explained by the lesser engagement of the low asset group in the coffee trade. The lower average reports of health shocks are harder to explain. All households in the study area are subject to the same exposure to malaria and other common illnesses, and it would be expected that health shocks would be distributed relatively evenly between groups. The fact that the middle group reports significantly higher levels of health shocks than the average suggests that the results reflect the random distribution of health shocks, and not the general health of the different asset groups.

In the case of man-made shocks, it is expected that the low asset group would suffer from fewer “stolen assets” than the other two groups, but that the distribution of other man-made shocks should be randomly spread between asset groups. Given that reports of stolen assets are the largest single group in the man-made shock category, the fact that reports are skewed towards the medium and high asset group (14 versus 5 in the

low asset group) is sufficient to explain the lower overall average reports of man-made shocks among the low asset group.

The high asset group, on average, reported statistically significant fewer natural shocks than the overall mean ($p=0.01$). In Chapter 2 we established an association between higher elevation and asset poverty. Households with higher asset levels were more likely to be situated at a lower elevation, on less steep land. Some of the natural shocks experienced, in particular landslides and erosion, are associated with steeper land.

Table 3.6: Categories of shocks experienced by households, 1997-2012 (by asset group)

	Average number of shocks (by asset group)				Sample standard deviation
	Low asset mean	Middle asset mean	High asset mean	Sample mean	
Natural	2.31	2.21	1.93**	2.20	1.03
Economic	0.97**	1.22	1.93***	1.25	1.00
Health shock	0.74**	1.12**	1.00	0.95	0.76
Man-made	0.56	0.69	0.67	0.63	0.74
Average no. of shocks	4.65*	5.15	5.47	5.01	1.81
Number of households in group	32	32	15		

*, **, *** indicates different from the sample mean at 10, 5 and 1 per cent levels of significance respectively.

Source: Author's calculations.

The data on coping measures can be examined to determine if one asset group relied more on a particular coping measure than the other (Table 3.7).

Table 3.7: Average use of different coping measures by asset wealth group in the study area, 1997-2012

Risk coping measures by asset group					
	Low asset mean ^a	Middle asset mean	High asset mean	Sample mean	Sample standard deviation
Risk coping measures					
Help from family	0.59	0.66	0.40**	0.58	0.94
Help from friends	0.03***	0.09	0.20**	0.09	0.28
Help from government	0.12	0.06	0.07	0.09	0.39
Spent savings	0.06	0.28	0.20	0.18	0.50
Sold animals	0.00	0.03	0.00	0.01	0.11
Sold harvest	0.00	0.09	0.07	0.05	0.22
Reduced consumption	1.78	1.69	0.93***	1.58	1.18
Stopped consuming some goods	0.94	0.81	1.00	0.89	1.21
Mothers decreased consumption	0.19	0.19	0.12	0.17	0.50
Increased hunting	0.31	0.09***	0.33	0.23	0.66
Did nothing	0.69**	1.06	1.07	0.91	1.00
Number of households	32	32	15		

*, **, *** indicates different from the sample mean at 10, 5 and 1 per cent levels of significance respectively.

Note: ^aThe means are obtained by dividing the number of times the coping measure is nominated as a response by households in the asset group by the number of households.

Source: Household survey, February 2012.

High asset households reported above average levels of help from friends, and below average help from families. These differences were both significant at the 5 per cent level. The average for reporting reduced consumption for this group was 0.93, compared to an overall average of 1.58. This difference was also significant at the 1 per cent level.

The middle asset group differed significantly from the sample means in only one respect. They were significantly less likely to hunt than the average ($p=0.000$). Strong preferences were observed among household heads in relation to hunting. It therefore seems unlikely that this result is related to asset ownership.

The low asset group, on average, reported less assistance from friends than the average ($p=0.004$). There were also fewer reports than average that they did nothing in response to a shock ($p=0.030$). This group had the highest response rate for reducing

consumption in response to a shock, although it was not significantly different from the overall average.

Overall, this analysis of risk coping measures suggests that there are differences in several important respects between households at the extremes of asset ownership. Households in the low asset group cannot afford complacency in the face of negative shocks: they have to act. They have the highest level of consumption-reducing responses and received on average less assistance from friends. In contrast, the high asset group reported the lowest levels of consumption reduction in response to shocks and more help from friends. The relationship between assistance from friends and families and asset levels will be further examined in Chapter 4.

More generally, the bivariate analysis conducted so far has shown consistent evidence that as asset wealth increases, so too does the experience of economic shocks. However, the relationship between assets and other types of shocks is less clear-cut.

On the issue of reducing consumption as a coping measure, there are several points to note. First, the bivariate analysis highlights once again the reliance on consumption-reducing strategies. Reducing consumption and stopping consumption of some goods were the first and second ranked coping measures in the analysis. On the specific measure of reducing consumption the asset index analysis shows that the rich do this less than the average. The next section uses regression analysis to assess the adoption of consumption-reducing strategies in response to a shock.

3.7 Regression model of consumption-reducing coping measures

Given that the economic shocks such as those that affect the coffee market are only directly experienced by market participants, including all shocks as a variable in a regression model would bias the results. Instead, natural shocks were chosen on the grounds that given the small geographic confines of the study area they are likely to be experienced by the broadest range of people. Natural shocks such as drought and excess rain can also be verified through independent data (Figure 3.2). The period of 2010-11 was chosen as a focus because it was the period that had the maximum number of natural shocks nominated by households as amongst the worst shocks experienced over

the medium term. Once households were excluded that did not report at least one natural shock over this period, 46 households remained in the sample. Households were only asked to report one coping mechanism per shock.

A probit model was estimated with a dependent variable of $y=1$ if the household adopted a consumption-reducing strategy and $y=0$ if they did not. The conditional probability that a household will adopt a consumption-reducing strategy is therefore:

$$(1) \quad \Pr(y=1 | x) = F(x_i' \beta)$$

The probability that $y=1$ is a function of $(x_i' \beta)$ where x is a $K \times 1$ vector of regressors and β is a vector of unknown parameters. In a probit model $F(.)$ is specified as the standard normal cumulative distribution function Φ (Cameron and Trivedi 2010, p.460). The model is therefore:

$$(2) \quad \Phi(x' \beta) = \int_{-\infty}^{x' \beta} \phi(z) dz$$

where $\phi(z) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{z^2}{2}\right)$

The model used the asset index wealth variables and included the number of organisations and level of schooling, to represent social and human capital. Table 3.8 shows descriptive statistics for variables used in the model.

Table 3.8: Descriptive statistics for regression using wealth groups identified through asset index

Descriptive statistics of independent variables in model of adoption of a consumption reducing strategy in response to a natural shock in 2010-11				
	Mean	Standard Deviation	Minimum	Maximum
Low asset group (Group 1, n=19)				
Number of natural shocks reported in 2010-2011	4.05	0.91	2	5
Number of dependents	2.21	1.58	0	6
Schooling of household head	5.21	4.14	0	13
Membership of organisations	0.26	0.45	0	1
Middle asset group (Group 2, n=20)				
Number of natural shocks reported in 2010-2011	3.75	0.85	2	5
Number of dependents	1.8	1.58	0	7
Schooling of household head	4.55	2.95	0	10
Membership of organisations	0.35	0.49	0	1
High asset group (Group 3, n=7)				
Number of natural shocks reported in 2010-2011	3.28	1.38	1	5
Number of dependents	2.02	1.49	0	7
Schooling of household head	5	4.35	0	10
Membership of organisations	0.57	0.53	0	1

Source: Household survey, February 2012.

The descriptive statistics show that as asset ownership increases, the number of natural shocks reported decreases. There is also a clear increase in membership of organisations as asset ownership increases. There is no clear pattern or relationship that can be identified between increased asset ownership and the number of dependents or the schooling of household heads. Model estimates are below (Table 3.9). Given the relatively small sample size, confidence intervals of 90 per cent are reported for coefficients.

Table 3.9: Model of the use of consumption-reducing strategies in response to a natural shock

Use of consumption-reducing measures in response to a natural shock in 2010-11				
Variable	Coefficient	Average marginal effects	90 % confidence interval	
Number of natural shocks reported	1.53** (0.67)	0.25*** (0.09)	0.1	0.39
Wealth				
Middle asset group	-0.06 (0.66)	-0.01 (0.11)	0.19	0.17
High asset group	-2.38** (1.08)	-0.50*** (0.16)	0.76	-0.23
Number of dependents	0.79** (0.36)	0.13*** (0.05)	0.05	0.20
Schooling of household head	0.00 (0.11)	0.00 (0.02)	0.03	0.03
Membership of organisations	-0.38 (0.78)	-0.06 (0.12)	0.27	0.14
Constant	-2.12 (1.32)			
LR chi2(6)=24.34 Prob>chi2=0.0005 Pseudo R2=0.4809 Log Likelihood=-13.13				

Standard errors in brackets. *, **, *** indicates 10, 5 and 1 per cent levels of significance respectively.
Source: Author's calculations.

The model was found to be a reasonable fit and predictor of the correct outcome.²⁴ It shows that there is a statistically significant increased likelihood that a consumption-reducing strategy will be adopted when an additional shock is experienced. Similarly, the probability of adopting a consumption-reducing strategy is positively associated with an additional dependent. Relative to the low asset group, both the middle and the high asset group are less likely to adopt consumption-reducing strategies in response to an additional shock. However, only the coefficient of the high asset group is statistically significant ($p=0.027$). Although not statistically significant, there is a slight negative

²⁴ A Hosmer-Lemeshow test for overall goodness of fit was then conducted on the model. The test indicates the extent to which the model provides a better fit than the null model with no predictors (Archer and Lemshow 2006, p.99). The test statistic of 9.75 had a p-value of 0.28 and provided support for the model. The model was also found to have good predictive value, correctly predicting the outcome in 89.47 per cent of cases.

relationship between the measures of human and social capital included in the regression (education of household head and membership of organisations) and the probability of adopting a consumption-reducing strategy in response to a shock.

Average marginal effects were calculated (Table 3.9). For continuous variables such as the number of natural shocks and of dependents, the marginal effects are partial changes in each variable. For categorical variables, the marginal effects are in relation to the reference category (the low asset group in this case). The average marginal effects show that for an additional shock experienced by a household, holding all other variables constant, there is, on average, a 25 per cent probability that a consumption-reducing strategy will be adopted. Similarly, for each additional dependent, the probability increases by around 13 per cent. Moving from the low asset group to the middle group would result in a negligible decrease in probability of adopting a consumption-reducing strategy, and is not statistically significant. However, a move from the low asset to the high asset group reduces the probability of adopting a consumption-reducing strategy by 50 per cent on average ($p=0.002$). Although the number of households in the highest asset group is small, the large gap between this group and the poorest group suggests that relative asset poverty is an important factor in identifying those most likely to adopt consumption-reducing strategies in response to a natural shock.

3.8 Conclusion

This research sought to examine the interaction between poverty, risks faced by households and coping measures and mechanisms of a disadvantaged population of subsistence farmers in remote Papua New Guinea. It is the first study of its type in remote Papua New Guinea. It contributes to a scant international literature of poverty in remote areas, and on the relationship between shocks, consumption reduction and asset ownership in the context of multiple market failures.

All households report similar numbers of shocks, although households with more assets report a greater proportion of economic shocks, in line with their greater participation in coffee markets.

This research provides strong evidence that the people living in this isolated community rely on the adoption of consumption-reducing strategies when faced with a shock. A similar study conducted in Guatemala showed that reported use of consumption-reducing strategies was the most common response to a shock over the course of the year. In the study area, reducing consumption was also the most common strategy. Focus groups with villagers identified that food shortages were relatively common. The high proportion of households that report the use of consumption-reducing strategies may mean that people are at risk of irreversible harm from malnutrition.

Distance from government services, and failures in the assets, food, finance and labour markets restrict the choice of coping mechanisms available to villagers in the event of an idiosyncratic shock. Having a smaller range of alternative coping measures available means that households may be forced to choose between consumption reduction and other harmful coping measures after relatively minor or few shocks. It seems likely that other remote villages, with under-developed or non-existent markets may also have a limited range of coping measures available to them.

In the context of the high use of consumption-reducing strategies among the study area, the essay showed that the adoption of consumption-reducing strategies was less likely for households with the most assets. These households, on average, adopt consumption-

reducing strategies 50 per cent less than the poorest group when faced with an additional natural shock. This suggests that asset wealth, in this context, offers some protection from the long-term implications of reducing consumption. It is possible that in the study area, those with greater asset wealth have a higher level of human capital as a result. As such, when they do reduce their consumption, it may not have the same negative effect as it would on households who face the shock with low levels of human capital. However, the data also shows that even those with relatively higher asset levels commonly adopt consumption-reducing strategies. In this chronically poor location assets are not an adequate protection against the adoption of harmful coping measures even for the relatively asset rich.

Appendix: Chapter 3

Cluster analysis of asset ownership, shocks and coping strategies

Cluster analysis was carried out as an exploratory approach to offer a comparison to Principal Components Analysis (PCA) in identifying households with similar asset ownership. Ultimately, division of households into groups by cluster analysis was not convincing. However, the analysis is still of interest, and is reported in this Appendix.

Whereas PCA combines correlated variables into a smaller number of underlying dimensions (components), cluster analysis works by combining observations into groups based on dissimilarities in characteristics (Hamilton 2009, p337).

The assets included as clustering variables were the same as those used in Chapter 2 (and in the previous sub-section) to construct the asset index using Principal Components Analysis (PCA).

Variables to capture human and social capital were also included.

The education of the household head was included to represent human capital. Membership of organisations was included as a social capital variable. As well as being an important form of risk mitigation, in the context of the study area, involvement in organised groups may be a sign of status. Organisations included church councils, the school board and the coffee cooperative.

Hierarchical cluster analysis groups the households into small groups based on differences in characteristics. It involves three steps. First, variables were standardised to a zero mean and unit standard deviation. Then the distances between households for each characteristic are calculated using the square of the Euclidean distance (Hamilton 2009, p.352).

Second, dendrograms, or tree diagrams, were constructed to help identify clusters. The dendrograms begin with each individual household along the bottom axis and show the process of agglomeration where groups are progressively placed together as they become more similar. Ultimately, if continued, the agglomeration process results in one large group. The dendrograms showed one group of 9 households to be significantly different from the rest of the households the differences were less clear among the

remainder. However, in order to balance the small number of observations against the need for sufficient numbers in each group for subsequent analysis, it was determined that there would be three groups.

Third, once it was determined that there would be three groups, K-means clustering was utilised to assign observations to the group with the closest mean. The result of the K-means clustering was three groups of 56, 17 and 9 households respectively (Table A3.1).

Table A 3.1: Asset groups in study area (identified with cluster analysis)

Cluster Analysis of Villages					
Clustering variables	Cluster 1 mean	Cluster 2 mean	Cluster 3 mean	Sample mean	Sample standard deviation
Number of pigs	0.85***	2.06***	2.56***	1.3	1.86
Number of chickens	4.09	2.76*	2.22***	3.59	8.21
Size of coffee gardens (square metres)	1172.79***	6020.32***	12173.72***	3369.2	3956.78
Number of mobile phones	0.36	0.23	0.44	0.34	0.59
Number of radios	0.21	0	0.11	0.15	0.36
Number of cooking utensils per spouse	3.95	4.56	3.39*	4.02	4.04
Number of garden tools per adult	1.89	2.08	1.65**	1.9	1.07
Schooling of head (years)	4.28	3.23*	6.00***	4.25	3.35
Organisational membership (number)	0.43	0.29**	0.55*	0.41	0.69
Number of households in cluster	53	17	9		

*, **, *** indicates significantly different from the sample mean at 10, 5 and 1 per cent levels of significance respectively.

Source: Author's calculations.

When asset distribution was analysed among the three groups it can be seen that there are large difference in ownership of several assets between clusters. This is most noticeable with the size of coffee gardens. Households in Cluster 3 had average coffee garden sizes of more than 10 times those in Cluster 1 and double those of Cluster 2. Household heads in Cluster 3 were also better education than those in either of the other two clusters. The other asset where there is a very clear distinction between clusters is pigs. Cluster 3 households own on average three times as many pigs as those in Cluster 1.

In contrast to the results from the PCA (see Table 2.8), there is no clear pattern of increased ownership across all assets between different wealth clusters. In fact some of the averages for asset ownership are counter-intuitive. The statistically significant lower than average ownership of both garden tools and utensils by households in Cluster 3 is a case in point. In the study area, the absence of these two items is associated with more severe poverty. The asset index constructed using PCA shows, for example, that all of the households that own less than two garden tools per adult are in the bottom 20 per cent of the asset distribution. None of the households owning no utensils are in the top 60 per cent of the asset distribution (Table 2.8). In the case of the households in the study area it seems that the grouping of households via cluster analysis may not be sufficiently sensitive to small differences in assets such as utensils and tools to be helpful in differentiating between the poorest of households.

Mean comparison tests were carried out to compare cluster means with each other and the sample mean in relation to the types of shocks experienced, significant differences are marked by asterisk/s. When individual categories of shocks are examined, the asset poor group did not differ substantially from the sample means with respect to any of the types of shocks (Table A3.2).

Table A 3.2: Categories of shocks experienced by households (by cluster)

Average types of shocks (by Cluster)					
	Cluster 1 mean	Cluster 2 mean	Cluster 3 mean	Sample mean	Sample standard deviation
Natural	2.23	1.94**	2.56***	2.20	1.03
Economic	1.13	1.47***	1.56***	1.25	1.01
Health shock	0.94	1.31***	0.33***	0.94	0.76
Man-made	0.68	0.70	0.22***	0.63	0.73
Average no. of shocks	4.98	5.23***	4.78	5.01	1.8
Number of households in group	53	17	9		

*, **, *** indicates significantly different from the sample mean at 10, 5 and 1 per cent levels of significance respectively.

Source: Author's calculations.

The asset poor group experienced, on average, fewer economic shocks than either of the other two groups. This is consistent with the finding based on the asset index analysis (Section 3.7). Of the 19 households that do not own a coffee garden, 18 are in the asset poor group. Consistent with this, the middle and high asset groups, where coffee garden ownership was almost universal, both reported higher than average economic shocks. The differences between groups in experience of other types of shocks do not appear to be directly linked to their asset ownership. As discussed in Section 3.7, the higher than average health shocks for the middle group and the lower than average for the high asset group are likely to be random and non related to asset ownership.

The average use of each coping strategy was examined by cluster (Table A3.3). The columns illustrate that as asset levels increase, the number of risk mitigation and coping measures employed decreases. The distinction is clearest between the asset poor group (Cluster 1) and the asset rich group (Cluster 3). The asset poor group use all 9 of the measures listed and also do nothing, whereas the asset rich group use only 5 of the measures and report doing nothing at a higher rate than the overall average ($p=0.09$). Of the risk mitigation and coping measures used by the asset rich, they utilise help from the family significantly less, on average, than the other two groups and the sample mean ($p=0.000$), and they did not report seeking help from friends.

Table A 3.3: Average use of coping measures by asset group in the study area (cluster analysis)

Risk coping measures by cluster groups					
	Cluster 1	Cluster 2	Cluster 3	Sample mean	Sample Standard Deviation
Risk coping measures					
Help from family	0.66	0.59	0.11***	0.58	0.94
Help from friends	0.11	0.06	0.00	0.09	0.28
Help from government	0.11	0.06	0.00	0.09	0.39
Spent savings	0.13	0.23	0.33	0.18	0.50
Sold animals	0.02	0.00	0.00	0.01	0.11
Sold harvest	0.06	0.06	0.00	0.05	0.22
Reduced consumption	1.58	1.41	1.89**	1.58	1.18
Stopped consuming some goods	0.83	1.05	1.00	0.89	1.21
Mothers reduced consumption	0.17	0.18	0.22	0.17	0.50
Increased hunting	0.24	0.29	0.00	0.23	0.65
Did nothing	0.81	1.05	1.22*	0.91	1.00
Number of households	56	17	9		

*, **, *** indicates significantly different from the sample mean at 10, 5 and 1 per cent levels of significance respectively.

Source: Author's calculations.

While all three groups utilise consumption-reducing strategies, the asset rich report that they reduce consumption at a rate significantly higher than the overall average ($p=0.01$). Yet, they do not report seeking help from friends and they report significantly lower rates of seeking assistance from family. This result is difficult to reconcile with the findings in Chapter 2 that show that households with higher asset levels perform better in terms of several food-related welfare indicators. It may reflect that households in this group have greater capacity to reduce their food consumption because they have higher food consumption prior to the shock than those in other groups. When food variety was compared across the three clusters, Cluster 3 households had greater variety in their diets than the other groups. Households in this group averaged 3.9 food types (consumed in the last 24 hours), compared to 3.6 food types for households in Clusters 1 and 2.

In summary, the cluster analysis, while interesting, is not convincing. It provides very little differentiation between Clusters 1 and 2 in relation to the coping measures employed in response to a shock and gives the counter-intuitive result that the asset rich rely more on consumption reducing strategies than do the asset poor. Given our interest is primarily in relation to those at the bottom end of the asset ownership scale subsequent analysis is based on the asset index constructed using PCA.

Chapter 4 Informal insurance in a remote rural area of Papua New Guinea

4.1 Introduction

While credit and insurance markets offer mechanisms for coping with risk, in many developing countries, insurance markets are not well developed due to moral hazard, asymmetric information and high enforcement costs (Alderman and Paxson 1992, p.14). In the absence of formal insurance markets the poor may engage in ‘insurance substitution’. Binswanger et al. (1991) note that this may include the holding of reserves, diversification of prospects, conservative input levels, credit and investment in “creditworthiness” and extension of social ties (p.124). The composition of the household itself may also be relevant, given evidence that in low-income environments the household is an institution that is used for risk mitigation (Rosenzweig 1988, p.1149).

Interest in how poor households manage risk in the presence of market failures in provision of credit and insurance has led to research on informal insurance arrangements. The existence and strength of informal insurance mechanisms has important implications for the approach taken to social protection in developing countries. It can also provide insight into the capacity of individual households and communities to cope with negative shocks. Households without access to informal insurance are likely to be more vulnerable to catastrophic declines in their welfare, than those with developed informal insurance networks. On the other hand, by identifying the characteristics of those who have many relationships, it may be possible to design programs to encourage the development of these qualities amongst the broader population to reinforce informal insurance networks.

The literature on informal insurance can broadly be broken into two classes. One class of papers examines the rationale behind informal risk sharing, looking at altruism and other indirect motivations. This includes non-legal approaches to contract enforcement such as punishment by guilt and shame, in the event that an informal insurance contract is breached (Fafchamps 2011, 1262). Another class of papers test for the existence and

extent of informal insurance mechanisms. This essay falls into the second category of papers and tests for the existence and extent of informal insurance mechanisms in the study area.

Since the early 1990s economists have increasingly used network analysis to analyse the structure and the strength of informal insurance arrangements. This essay will use network analysis to examine and test the strength of informal insurance arrangements in the four remote study area in Papua New Guinea. The essay will answer two broad questions. First, what is the nature of the informal insurance network in the study area? Second, what household attributes determine informal insurance relationships?

The essay is organised as follows. Section two is a literature review that canvasses research on informal insurance with a focus on studies that utilise network analysis. It explains more precisely the gaps in the literature which this essay is attempting to fill. Section three introduces network analysis, the data and the regression model used in this chapter. Section four analyses the difference between actual and expected insurance. Section five examines the role of insurers outside of the study area. Section six examines expected assistance within households. Sections seven to nine analyse the informal (expected) insurance network between households and its determinants: section seven presents the network graphically and analyses it using the clustering coefficient; section eight looks at network determinants using bivariate analysis; and section nine studies network determinants using multivariate analysis. Section ten concludes.

4.2 Literature review

Many of the early papers on informal insurance test for full insurance at the village level. In these models it is assumed that if there is a Pareto optimal allocation of risk among households in the village, individual household consumption will co-move with average consumption in the village and be independent of individual household income (Murgai et al. 2002, p.247). The most prominent of these early papers is Townsend (1994), centred on a group of villages in southern India. Townsend hypothesised that there was a complete market for insurance at the village level, and he used a general equilibrium approach to test this hypothesis (p.540). Townsend rejected the full

insurance model. Udry (1994) also used a general equilibrium model to assess the village loan market in Northern Nigeria for its role in risk sharing and rejected the hypothesis that there was Pareto efficient full risk-pooling (p.517).

There followed a series of studies that tested for full insurance in groups smaller than the village level, or with particular characteristics. For example, Goldstein et al. (2005) found that they could not reject full insurance at the village level, but that it could be rejected for certain groups, in their case – a sub-group who were short of cash (p.241). Jalan and Ravallion (1999) tested whether full insurance worked better for some wealth groups than for others. They reject the full-insurance hypothesis, with the rejection of the full insurance model being strongest for the households in the lowest wealth groups (p.72).

Grimard (1997) tested for the extent of risk sharing amongst households of the same ethnic group in Côte d'Ivoire. Although they reject full insurance, they observe some consumption sharing between households of the same ethnic group (p.393). Fafchamps and Lund (2000) found that there was insurance among family groups and friends in their study of the Philippines. Vanderpuye-Orgle and Barrett (2009) found evidence that the 'socially invisible' are less likely to engaged in informal insurance networks. They conclude that evidence of partial insurance at the village level may reflect full insurance for some and negligible insurance for the socially invisible (p.7).

Researchers have also tested whether informal insurance is more prevalent in response to particular types of shocks. Several prominent studies have examined health shocks. Gertler and Gruber (2002) analysed the response of Indonesian households to health shocks and find that they are not able to fully insure against the economic costs of illness (p.67). De Weerd and Dercon (2006) assessed health shocks in villages in Ethiopia and found that households were not fully insured against illness shocks (p.338). Fafchamps and Gubert (2007) on the other hand, find that the strongest evidence of risk sharing in villages surveyed by them in the Philippines was in relation to health risk. They concluded that informal insurance networks may respond more to health risk than to income risk (p.345).

In contrast to the literature which treats informal insurance as state-contingent, Platteau (1997) argued that it is not insurance, but ‘balanced reciprocity’ at work in traditional agrarian societies where gift exchange is prevalent. While any ‘gift’ must be returned at some point in the future, the date of the return may be unknown and it is possible that the value of the gift may not be equal. (p.768). This is consistent with a view that insurance is based on internalized norms regarding mutual help, it is also consistent with evidence of altruism (Platteau 1997, p.771).

Ligon et al. (1997) picked up on the idea of balanced reciprocity and argued that, if it exists, informal insurance arrangements may resemble credit or quasi-credit arrangements. Their model allows people to update their decisions over time, so that those who experience a negative shock in one period and receive a payment will not repay their transfer until another shock occurs. At this point, the household suffering the new shock receives a transfer. They find support for this limited commitment model. (p.5). Foster and Rosenzweig (2001) adopt a similar approach but incorporate altruism into a model of risk sharing with imperfect commitment. They conclude that imperfect commitment creates a barrier to efficient risk sharing but that this is countered to a limited extent by the existence of altruism (p. 405).

The literature discussed so far has focused on informal insurance at the village and household level. The focus at the household level is consistent with the economic literature linking poverty and risk, which tends to focus on what poor households do to manage risk or to cope with its effects (see for example Alderman and Paxson 1992 for a review of this literature). However, the assumption that households adopt strategies as if there was a single set of preferences is at odds with research into models of the household. There is a growing body of research that shows that risk pooling does not happen at a household level (Hayashi et al. 1996; Doss 2001 and Robinson 2012). In addition, increasingly household decisions are viewed as being made through a collective bargaining process (see Alderman et al. 1995; Quisumbing and Maluccio 2003).

When households make decisions by collective bargaining, it raises the possibility of inequitable sharing of risk within the household. Those holding less bargaining power

may bear the majority of the risk. Adams et al. (1998) note that the choice of coping measures in the household can create conflicts between generational or individual needs due to power imbalances (Adams et al. 1998, p.269).

Goldstein (2004) assessed the extent to which husbands and wives insure each other in response to an agricultural or illness shock in Ghana. He found that risk sharing depended on the type of assistance being offered, the type of shock and the gender of the individual (p.1). Husbands and wives did not share risks with each other. Instead they entered a variety of risk pooling groups, based on the type of risk they experienced (p.24). For ill health shocks, men tended to receive assistance in the form of labour from family members. In contrast, when women fell ill, they received help from non-family friends (p.1).

Drawing together the research to date, it seems that the nature of informal insurance arrangements varies significantly between communities and even within communities. While there is not conclusive evidence of full insurance networks at a village level, it does seem that risk sharing networks form between groups. Research has shown that these groups may comprise family and friends and ethnic groups. There is also evidence that those who do not have access to cash, or who are socially invisible may lack the opportunity to participate in informal networks of insurance.

Transfers that emerge in informal insurance relationships may range from gifts and loans to labour sharing. Obligations to reciprocate in kind vary and can be driven by social obligations or altruism. It also seems likely that, particularly in isolated village communities, insurance relationships may span many years and possibly even generations. If this is the case, then research that rests on data covering several years may not identify all insurance relationships. In addition, the research on insurance in relation to health shocks suggests that coverage of insurance may vary according to the shock. Finally, the evidence that husbands and wives may not insure each other suggests that focusing only on relationships between households may not identify individuals within households who are particularly exposed to risk due to their weak bargaining power within the household.

This essay utilises network analysis to examine and test the strength of the informal insurance relationships in the study area. The empirical papers using network analysis fall into two broad camps, those that explore the structure or architecture of a network and those that test for coverage of informal insurance in a community (e.g Goldstein et al. 2005; Jalan and Ravallion 1999). Both of these are important, although only the former will be discussed in this essay. Most of the papers that draw on network analysis to understand informal insurance and coping mechanisms amongst poor communities have been written since 2000. Table 4.1 provides an overview of significant papers that use network analysis to analyse the characteristics of informal insurance networks.

The papers surveyed all use regression analysis to explain the nature of the networks observed in terms of various explanatory variables. Typically, they find that variables such as physical distance and social distance are important in explaining networks (DeWeerdt 2002; Murgai et al. 2002; Fafchamps and Gubert 2007). Wealth is also identified as a significant explanatory variable in a number of studies (Fafchamps and Gubert 2007; Vanderpuye-Orgle and Barrett 2009; Comola and Fafchamps 2010). Further reference to this literature is made later in this chapter in the discussion of our results.

Table 4.1: Summary of research on informal insurance utilising network analysis^a

Study	Sample	Type of link	Explanatory variable (* indicates statistical significance)
De Weerd J (2002)	Census of Nyakatoke (Tanzania) a village with 119 households	Potential insurance link	Kinship*, geographical proximity*, No. of common friends*, clan membership, religious affiliation*, wealth, education, activity overlap*, difference in age of household head*
Fafchamps and Lund (2002)	Random sample across four villages in the Philippines, with a total of 206 households.	Potential and realised insurance link	(see Fafchamps and Gubert 2007 below)
Murgai, Winters, Sadoulet and Janvry (2002)	Census with matches within the sample. Pakistan.	Real insurance links between water traders	Physical distance*, social distance*
Dekker (2004)	Census across 27 households in rural Zimbabwe.	Real insurance links	Membership of pre-school group*, marriage*, similar geographic origin*, clan membership*, same religion*, history of past insurance*, historical wealth difference
Hoddinott, Dercon and Krishnan (2005)	Sample across 15 communities in Ethiopia, the sample size is 1227.	Real insurance links	Landholdings*, whether the household head in in a funeral association*, parent influential in village, relative in an official position, religious minority, neighbours, head has schooling, head born in village, household size.
Fafchamps and Gubert (2007)	Random sample across four villages in the Philippines, with a total of 206 households.	Potential insurance links and realised insurance links	Geographic distance.*,gender of household head, education of head, age of head*, health index, wealth*, number of children in head's family of origin, number of children in spouses family of origin, birth order of head*, occupation.

Santos and Barrett (2007)	Random sample with random matching within the sample of pastoralists in Ethiopia.	Potential insurance links The aim was to test the methods of random sampling versus random matches within the sample	Same clan, same sex, bigger family, more land, less land, more cattle, less cattle, more experience as a herder, less experience.
Vanderpuye-Orgle and Barrett (2009)	Sample with random matching across four village clusters in Ghana.	Real insurance links The aim was to test social visibility and its impact on formation of links,	Male, age*, no schooling, primary school education, higher than middle school education*, non farm occupation*, unemployed, value of non land wealth*, value of inheritance, major clan*, herelong*, fostered*, parents held office.
Krishnan and Scuibba (2009)	Sample across 15 villages in Ethiopia with matches within the sample	Real insurance links	Share of quality land*, land on slope, share of land that is flat, number of adults, functional scores of adults, whether there is a male head of h/hold*, average years of education, livestock value, community fixed effects. Blood relatives in village, born in village, years resident for head of h/hold, neighbourhood fixed effects
Comola and Fafchamps (2010)	Census of 119 households in a village of Nyakatoke in Tanzania, matches within the sample.	Potential insurance links using gifts and loans.	Wealth*, same religion*, same clan, distance*, household members*, female dependents, male dependents, kinship.
Comola (2010)	Census of 119 households in a village of Nyakatoke in Tanzania, matches within the sample.	Potential	Wealth*, neighbours*, same clan, religion* kinship*, same education, labour share for cropping, trade, difference in wealth.

Note: ^aThis table draws on and updates Santos and Barrett (2007, p.9)

One limitation of the literature to date, identified by Fafchamps and Gubert (2007), is neglect of the role of connections outside of the immediate research area in insuring against idiosyncratic risk (p.332). While the broader literature on risk supports a view that households can insure against covariate risk through forming links with others outside of the community, there has been limited research on the role of these outside links in insuring against idiosyncratic risk.

To date there has been limited research on risk sharing between or within households in Papua New Guinea. Morauta (1984) undertook a case study of Kukipi, a coastal village in Gulf Province, with high rates of out-migration. This study examined the role of transfers generally, not transfers in response to specific negative shocks. The study found that there was no systematic pattern of assistance to the households that were in the most hardship. Instead, transfers were driven by kin relationships, with the most frequent transfers being between children who had moved to urban areas to their parents back in the village (p.94). A similar conclusion was drawn by Gustaffson, in relation to M'buke, an island situated near the south coast of Manus (p.89).

On inter-household risk sharing, Gibson, Boe-Gibson and Scrimgeour (1998) surveyed the village of Hanuabada, Port Moresby for evidence of the insurance properties of transfers. They found that transfers insure against reduced earnings caused by unemployment, but that results are less clear for other shocks (p.17). Also in Port Moresby, Ialo (2007) found evidence that households provided transfers in response to shocks. In a survey of 40 households in Rainbow Village, Port Moresby, Ialo found that 45 per cent sought help from wantoks, including: kin, neighbours and work colleagues in response to economic and social shocks. This assistance was mostly in kind and formed part of a reciprocal relationship (p.125). Morauta (1985) researched low income urban areas in Port Moresby and Madang and also found that the highest number of transfers were between kin. She observed that living "within sight and earshot" of those who need your help and can help you was an important influence on transfers (p.8).

Other research by the World Bank, based on Household Income and Expenditure Survey data, showed that households in Papua New Guinea were more likely to participate in gift exchange networks if they had a sick or injured member than healthy

households. Although the evidence showed that the net value of gifts received by these households was no higher than for other households, participation by households with existing illnesses implies that the networks are seen as a form of informal insurance network (World Bank 2014, p.85).

The feature of transfers being part of an existing reciprocal relationship is a common feature of the literature on informal insurance in PNG. One exception to this reciprocal relationship was found in a study of the community of Wagifa Island, located in Milne Bay Province. In Wagifa Island there was kin-based assistance, in addition there was community assistance for households in particular need. This assistance was in-kind and aimed at assisting the household to help themselves (Guy 2007, p.53).

None of the literature identified on informal insurance in the context of Papua New Guinea addresses instances where assistance is provided from outside of the village or district in response to particular shocks. Although Morauta (1984) acknowledges that transfers may occur in response to stresses such as illness (p.111), transfers are primarily driven by relationships. Relationships can provide insurance against covariate risks if the insurer is situated outside of the immediate geographical area.

Relationships in Papua New Guinea are frequently described in terms of the 'wantok system'. De Renzio (2000) describes the 'wantok system' ('one talk' in Tok Pisin) as a source of social capital, where there are relationships or obligations which are formed because of a common language, kinship, geographical area of origin or social associations or religious group (p.21). Gustafsson (2007) concludes that the only social safety net that can be relied upon in times of need comes from 'true' wantoks. These are close relatives, from whom one can demand continuous support (Gustafsson, p.15).

Assessing the extent to which any wantoks who live outside of the community are involved in risk-sharing networks with households in a remote community will shed further light on the nature of the informal insurance network and the extent to which it is driven by close relatives or 'true' wantoks.

In relation to risk sharing within the household in response to shocks, no research was identified in a Papua New Guinean context and there was limited international research.

Goldstein's (2004) study of risk sharing between husbands and wives in Ghana (discussed in Section 4.6) was an exception (p.24).

Although risk sharing within households has not been explicitly studied in a PNG context, there has been some research on economic interdependence between spouses. Overfield (1998) argues, based on a two year study of 18 coffee growing households in the Benabena District of Eastern Highlands Province, that the marital contract is one where, in return for access to land, women are obliged to provide household food requirements and other labour, plus unpaid labour for male owned coffee gardens (p.53). Under this arrangement, men and women have separate roles and operate quite independently of each other. Both try to maximise their income. However, due to women's lower bargaining power, they contribute more labour overall for less individual return (p.54). The relatively independent behaviour of spouses in relation to income generation may also extend to risk sharing between spouses within the household.

The analysis in this essay will address several gaps in the international literature and augment the very limited research on informal insurance in a Papua New Guinea context. The analysis of intra-household links and of relationships between households in the study area and potential insurers in other locations, particularly for idiosyncratic risks, are both relatively neglected areas in the international literature. The essay will also be the first to use network analysis to examine informal insurance in remote Papua New Guinea.

4.3 Introduction to network analysis and the data

Data requirements for network analysis of informal insurance are significant and specific. The literature outlines two general approaches to collecting this data. The first technique involves obtaining information from all adult individuals within the chosen population on different economic and social attributes and their relationships with all other adults in the chosen population (examples include: DeWeerd 2002; Dekker 2006; Murgai et al. 2002; Comola and Fafchamps 2010; Comola 2010). This approach allows the global network to be mapped (Santos and Barrett 2007, p.4). A second approach involves sampling. Attribute and relationship information is collected from the sampled

population and matches are made within it. This technique leads to what Santos and Barrett (2007) refer to as a local network being mapped (examples include: Fafchamps and Lund 2002; Hoddinott et al. 2005; Fafchamps and Gubert 2007; Santos and Barrett 2007; Vanderpuye-Orgle and Barrett 2009; Krishnan and Scuibba 2009). The sampling approach is less costly than a census approach, but it is inefficient in terms of data collection, as data on individuals or households that are not matched with others is discarded.

In the case of the study area, the geography and the history provided a strong rationale for adopting a census approach. As described in Chapter 1, the four villages operate as one community, with the health centre, school and market area as a geographic focal point at the bottom of the valley. The study area's history, its growth from an initial settlement of a handful of families that moved from Morobe Province and settled with some landowners from neighbouring villages (Chapter 1) – also supports the view that it is essentially one community. This history makes it likely that there are strong family connections across households in the study area.

The isolation of the community offered the opportunity to attempt to capture the global network of informal insurance within this community. At the time of the survey (February 2012), there were 105 individual households in the study area. It was not possible to obtain survey data from 24 of the 105 households. Section 1.5 and Table 1.1 in the Introduction provide details of these households. Without data from these missing households it was not possible to verify their identity, or if they had been nominated by other households as potential insurers. As a result, it is possible that subsequent analysis does not capture all of the possible informal insurance relationships.

For the purposes of this research the term 'informal insurance' is taken to include any state contingent transfer from one individual or household to another in response to a shock. In the study village context, these transfers can take the form of cash, labour, childcare, food, water, firewood and other. The 'other' category includes actions such as bringing medicine to someone ill and assisting someone to walk to the health centre.

In order to study networks, surveys need to ask people about relationships. These questions most often take the form of:

Could you list the people to whom you would give assistance, or from whom you would obtain assistance in the event of a shock? (see De Weerd 2002)

In designing the network analysis question several issues were considered. The first issue was what kind of network data to collect. Comola and Fafchamps (2014) argue that network data can confuse a desire to link with actual links and that this may lead to incorrect inferences regarding the effect of pre-existing networks (p.956). The focus of this analysis is on expected insurance relationships, given the role that expectations of receiving assistance may play in relation to the choice of other alternative coping mechanisms (Fafchamps and Gubert 2007, p.9). Nevertheless, given the possibility of expectations of insurance being confused with the desire to link, the question was framed so that data were collected on both actual insurance networks and expected experience. This allowed a comparison to be made between actual insurance and expected insurance networks: this is undertaken in the next section.

The second issue in forming the network analysis question was how to frame the negative shock. Given the possibility that people will perceive the severity of a shock differently, the question was specific about the kind of shock and its impact. Given we are focused on household level informal insurance, it was necessary to select a shock that is idiosyncratic but that could be experienced by any of the adults in the study area. Thus, economics shocks were ruled out – given that not all households owned coffee gardens. Most of the natural shocks, for example drought and too much rain were also likely to be experienced by multiple households at once. Research by Fafchamps and Gubert (2007) in the Philippines showed that networks were strongest for health related shocks. The question was therefore framed around a health shock and its impact on the interviewee's capacity to carry out their subsistence activities. The question aimed to capture information on both expected and actual insurance links, as such, it asked the following question separately of household heads and their spouses:

Can you name people inside and outside of the community that would provide help to you if you were sick and unable to work for two weeks, please rank according to priority (1=who would be most likely to help)?

The question was also reversed so that household heads and their spouses indicated who they would provide help to in the same scenario using the following language:

Can you name people inside and outside of the community that you would help to if they were sick and unable to work for two weeks, please rank according to priority (1= who you would most likely help)?

The actual insurance questions were similar but with reference to real life examples over the past two years:

Over the past two years (since the resource centre was built) can you give an example of where you have received assistance from anyone in the community or outside of the community when you have been sick for two weeks and unable to work?

and:

Have you provided assistance to anyone in the community or outside when they have been unable to work for two weeks due to illness?

Transfers may be between individuals within the household or between households. A household is considered to have a relationship, or a link with another household if there is an expectation by the household head, or their spouse, that a transfer will be received in the event of a negative shock. In total, there are 177 household heads and spouses in the study area. When conducting network analysis it is assumed that every other individual (or household) in the area is a potential partner. In the case of the study area, given the geographic isolation and its genesis from a small number of families, this is a reasonable assumption.

A potential shortcoming of analysis of informal insurance at the household level is that it does not address intra-household decision making. However, if the network analysis is conducted at the individual level the assumption that anyone else could be a partner would mean that there are potentially 31152 directed links. Each potential link between individuals or households is referred to as a dyad, and in subsequent analysis is given a value of 1 if a link exists and 0 if it does not. Given there were 389 identified links, of

the potential dyads, 30763 would have a value of 0. DeWeerd (2002) highlighted that in such circumstances, the small number of links relative to the large number of potential links provides too little variation for econometric analysis (p.3). There is therefore a practical reason for conducting econometric analysis of the networks at the household level, which is the approach taken in the literature to date.

An additional rationale, in the case of this research, for undertaking the econometric analysis at the household level is that data on a range of other coping mechanisms was collected with reference to the household.

While the network analysis (presented in Sections 4.7 to 4.9) is undertaken at the household level, individual responses to network questions are analysed (in Section 4.6) in order to examine intra-household transfers and to address concerns regarding the treatment of the household as a unit of decision making.

The literature review highlighted that a gap in the research to date has been the absence of analysis of informal insurance links outside of the direct community being examined. In fact, previous studies of informal insurance using network analysis have discarded such data on insurance partners from outside of village surveys due to difficulties in collecting data on these households. However, the need for matching data across the range of attributes reduces in the event that a link is unilateral, that is, where one partner in the insurance relationship is a receiver of the pay-offs and the other is the giver and these roles do not change.

Comola and Fafchamps (2014) argue that links may be unilateral due to social norms and that giving households may not be able to withdraw from such arrangements (p.966). This scenario seems likely in Papua New Guinea, given the high costs associated with the social capital built into the wantok system. De Renzio (2000) cites examples of situations where income earning individuals find it impossible to save money or get ahead because of demands made on them by wantoks (De Renzio 2000, p.22). In the case of the study area, it may be that people who have left the area and are now earning cash income are expected to provide assistance in the event of a shock in the villages. There may be no expectation that this assistance will be reciprocated in the

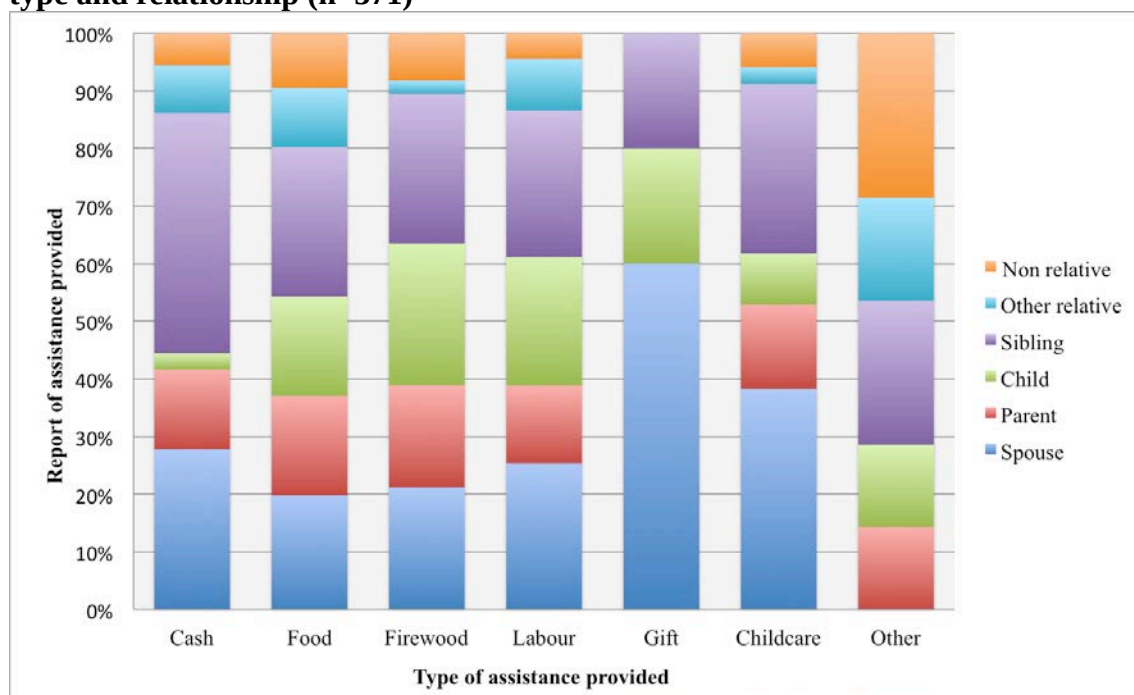
short or medium term, particularly given the level of disadvantage experienced by the villages.

In the survey, respondents were allowed to nominate counterparts from outside the community that they either expected help from, had received help from, would offer help to, or have offered help to. These links are analysed in Section 4.5.

4.4 Comparing actual and expected insurance.

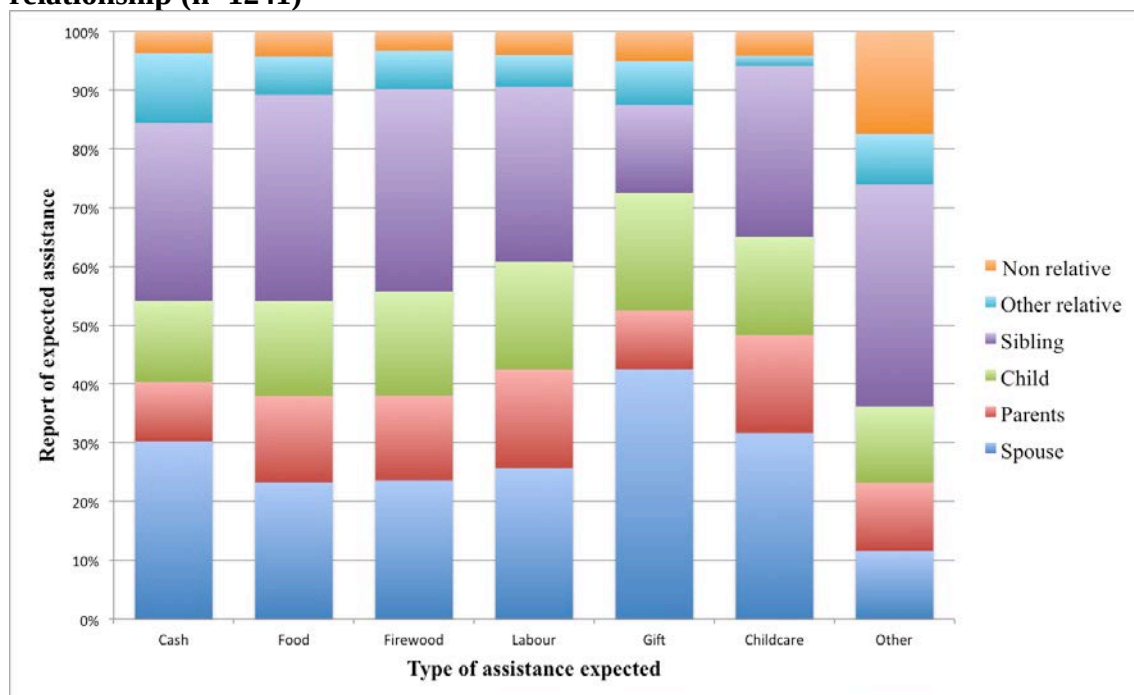
Prior history of an insurance relationship has been found to be a significant explanatory variable for informal insurance networks (Dekker 2006). Previous analysis of informal insurance also identifies the potential for respondents to network insurance questions to confuse actual insurance links with desired insurance links (as outlined in Section 4.3). In other words, individuals may not have realistic expectations of their expected insurance links. This section compares individual level data on actual and expected insurance to examine the extent to which current expectations reflected past experience. This will give an indication of how realistic expectations of future insurance are. Relationship categories were consolidated from 17 to six groups, namely: spouses, parents, siblings, children, other relatives – which included aunts/uncles and cousins, and non-relatives. The type of assistance that was provided or expected to be provided by these groups was then graphed (Figures 4.1 and 4.2 below).

Figure 4.1: Actual assistance in response to a health shock over the past 2 years, by type and relationship (n=371)



Source: Household survey data, February 2012

Figure 4.2: Expected assistance in response to a health shock, by type and relationship (n=1241)



Source: Household survey data, February 2012.

Figure 4.1 shows that 140 people provided 371 transfers in the last two years in response to a health shock. Whereas looking ahead, 370 people are expected to provide 1241 transfers in response to a health shock. The pattern of assistance is approximately the same for both actual and expected assistance provided in response to a shock. Food, firewood and labour are the three most common forms of assistance (Table 4.2) for both actual and expected insurance.

Table 4.2: Actual and Expected Insurance (frequency)

Types of assistance provided	Actual insurance	Expected insurance
Cash	9.7% (36)	8.8% (109)
Food	31.3% (116)	28.4% (353)
Firewood	22.9% (85)	24.6% (304)
Labour	18.1% (67)	19.7% (245)
Gift	1.3% (5)	3.2% (40)
Childcare	9.2% (34)	9.7% (120)
Other	7.5% (28)	5.6% (69)
Total	(371)	(1241)

Source: Household survey, February 2012.

Patterns of who provides the assistance are also similar for actual and expected assistance provided. Statistical tests comparing the proportion of each relationship type that did provide assistance or was expected to provide assistance, show no differences at a 5 per cent level of significance for any of the relationship categories. In both actual and expected assistance, siblings were the highest proportion (32 per cent for expected versus 27 per cent for actual), followed by spouses (23 per cent for both) and then children (18 per cent for both).

One possible reason for the discrepancy in numbers between actual and expected insurance is that the actual experience of illness shocks over the last two years was probably less than what might be expected in the indefinite future. As a result, households may not have needed to call on their networks for assistance, or not call on them as extensively. Alternatively, the reality and expectations of assistance may be misaligned. To study this, a comparison was made between for a small group of households. This group was identified via a separate component of the survey that reported on the most severe shocks in the two years leading up to the survey. Nineteen households (23 per cent of the total) nominated that either the head or their spouse had experienced a severe illness shock over this period. It would be expected that a severe illness shock would trigger a request for assistance.

The network data provided by these households revealed that only 53 per cent received assistance for an ill-health shock over this period. Despite this, 89 per cent of these households indicated that they expected to receive assistance in the event of an ill health shock in future. It is possible that this result reflects that responses to the survey question reflect a desire to link, rather than a realistic expectation (Comola & Fafchamps 2014, p.969). However, there are also other interpretations, including that households hold out in requesting assistance for ill health related shocks. Yet, if households do not draw on their networks for severe illness shocks, it begs the question of when they do use them. This may indicate that informal insurance networks are considered a resource to be rationed. An alternative explanation is that households simply do not receive the assistance they expect and therefore systematically over-estimate the strength of their networks (perhaps because they are embarrassed to admit that they are in fact unlikely to receive support). All of these possible explanations mean that the data on expected assistance data is likely to overstate the strength of the network.

The similarity in the pattern of relationships between who has provided assistance and who is expected to provide assistance in the event of future illness suggests that expectations are grounded in reality even if they are over-optimistic. Expectations of future assistance are relevant even when they are over-inflated as they inform behaviours in the current period such as risk mitigation measures. This is confirmed by

research by Dekker (2006) on informal insurance relationships in Ethiopia, where past insurance history was found to be a statistically significant in predicting future insurance relationships. The analysis to follow will therefore be conducted using the data on expected assistance, with the understanding that the network data is likely to overstate the extent of the informal insurance relationships.

4.5 The role of ‘wantoks’ outside of the community in providing assistance

As noted in Section 4.2, there has been little study of the extent to which those from outside a rural community support those inside it. Those links are excluded from the network analysis of Sections 4.7, 4.8 and 4.9, but are analysed separately here. To assess whether unilateral insurance links existed with wantoks (relatives or people with other ties) outside of the study area, household heads and spouses were asked for information on where potential insurers lived (Table 4.3).

Table 4.3: Location of people named as potential insurers

Location of expected insurers	Per cent
Where expected insurer lives (n=370)	
Village in Ward	93.24%
Other Ward in District	5.14%
Other District, EHP	1.35%
Other Province	0.27%

Source: Household survey data, February 2012.

The vast majority of potential insurers lived in the study area or in Obura Wonenara District. There were only 5 potential insurers nominated who lived outside of the district and one who lived in another province.

The very low number of potential insurers from outside of the immediate vicinity reflects the limited opportunity that villagers have to engage with and form relationships with people outside of their immediate area. Although data were not collected on the number of people who had left the villages overall, households were asked where potential insurers were born. Of the 25 potential insurers located outside of the study

area, 14 were born in the study area. There is therefore a small amount of potential insurance available from individuals who have left the study area.

The lack of potential insurance links with people outside of the district means that the people living in the villages are particularly vulnerable to the impacts of covariate shocks. For example, if the villages were to experience a major drought, such as that experienced across Papua New Guinea in 1997, they would be reliant on government assistance. Data suggests that the level of government assistance in response to covariate risks in the past has been low. Older villagers were asked to recall the impact of the 1997 drought and how they coped with it at the time. Of the 170 responses on different coping mechanisms, only 11 per cent of the responses involved the provision of assistance from the government.

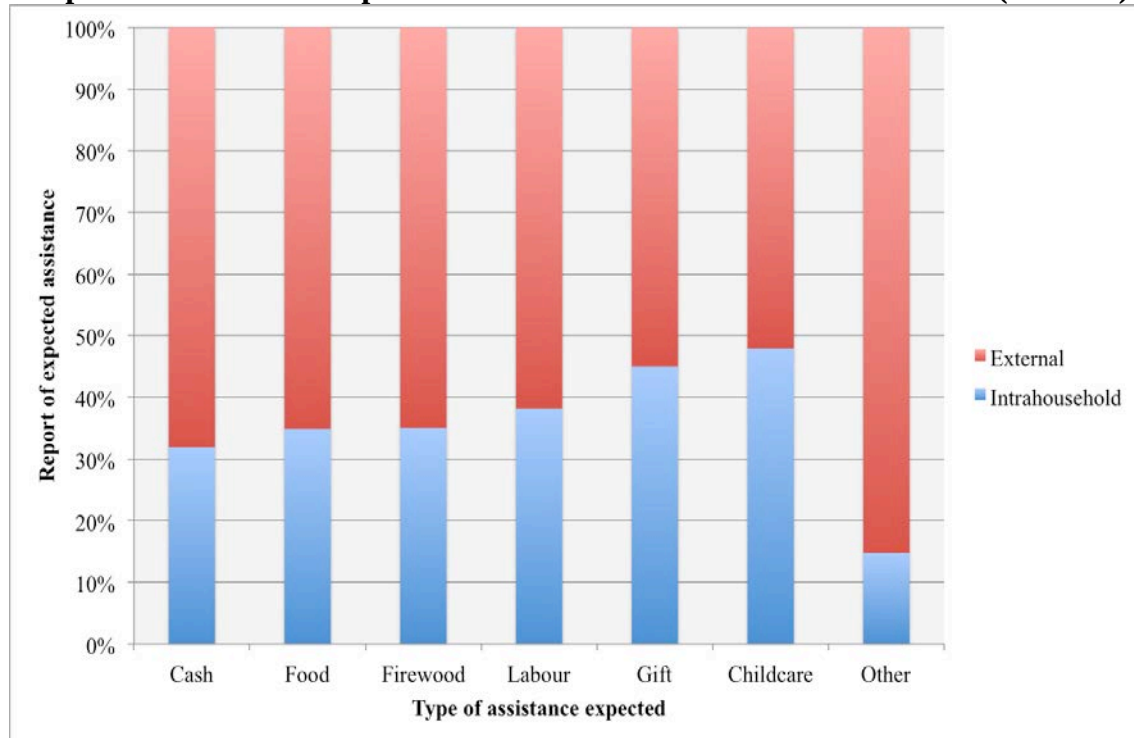
4.6 Intra-household insurance²⁵

As is consistent with the literature, and for the reasons given in Section 4.3, the network analysis of this essay is conducted at the household level. However, it is of interest to also examine individual insurance links. There has been limited international research on individual informal insurance links.

The survey question asked respondents to rank, in order, the people who they expected would assist them in the event of an ill health shock. These potential insurers could be from within the household or external to the household. 64 per cent of household heads and spouses nominated other people from within their household as potential providers of assistance.

It would be expected that given their co-location, other members of the household would be better placed to provide some forms of assistance than external potential insurers. In particular, household members may be expected to dominate in provision of food, firewood, labour and childcare. Figure 4.3 shows that intra-household assistance does not dominate in any of the categories of assistance types.

Figure 4.3: Expected assistance from within the household (intra-household) compared to assistance expected from individuals outside the household (external)



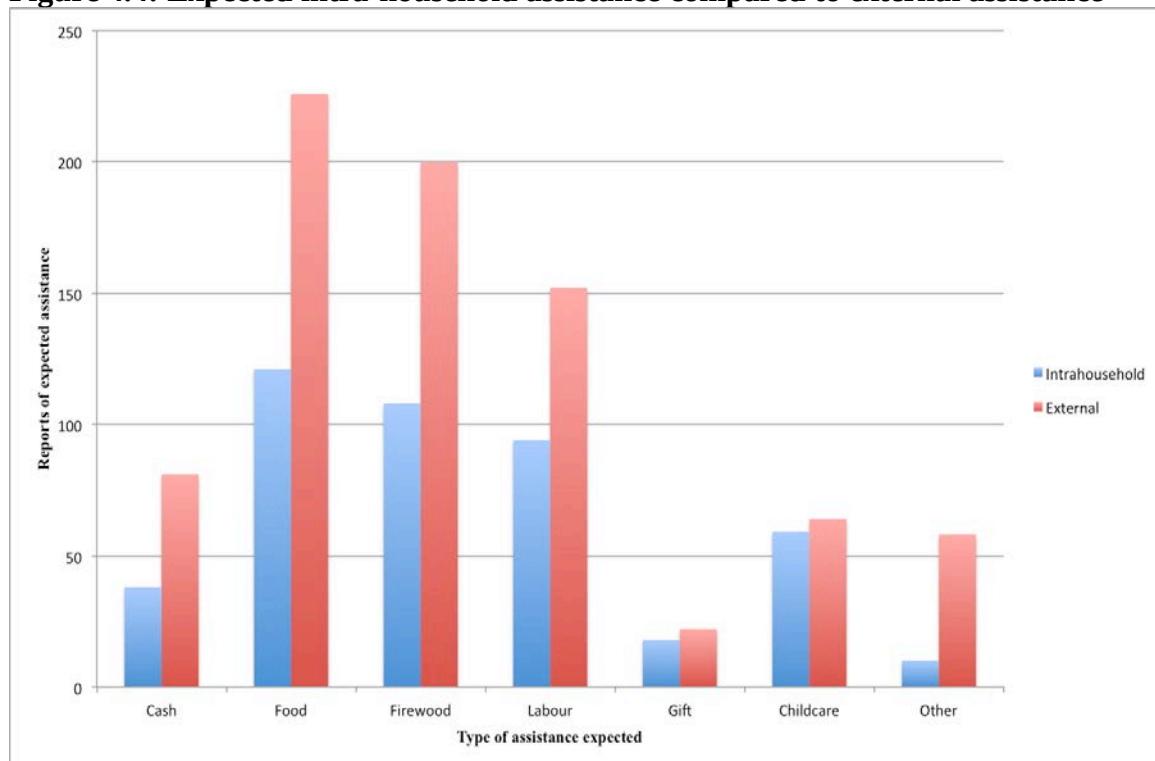
Source: Household survey data, February 2012.

Childcare is the dominant type of assistance most frequently reported to be expected from within the household (Figure 4.3). Childcare assistance is predominately provided by spouses and other children. In one polygynous family, with four co-wives, women nominated their co-wives as providing childcare assistance. More generally, the dominance of externally provided assistance over intra-household transfers is likely to align with the relationships of those who are expected to provide assistance. Siblings dominated the source of assistance and for adults, they were likely to be outside of the household (Figure 4.2). Other large categories of assistance providers who may be located outside of the households are children (for older couples) and parents.

Figure 4.4 shows that the type of assistance expected follows the same pattern irrespective of whether it comes from within the household or from an external insurer. Food, firewood and then labour are ranked 1 to 3 in both cases. However, the fourth ranked type of assistance differs depending on whether the source of assistance in

within the household or outside of it. There were more reports of cash being expected from external sources, and more of childcare from within the household.

Figure 4.4: Expected intra-household assistance compared to external assistance



Source: Household survey, February 2012.

Data were examined on the expectations of husbands and wives of assistance from each other. Of the 370 individuals who were nominated by household heads and spouses as being expected to provide assistance, 15 per cent were husbands or wives. Excluding polygynous families, single person households and those where the wife was not present, 41 per cent of wives named their husbands as potential sources of assistance. For men, the figure was slightly higher: 48 per cent of men named their wives as potential sources of assistance. For both husbands and wives the main assistance expected of each other were food, firewood and then labour.

The spousal expectations of assistance are broadly consistent with many husbands and wives living relatively separate economic lives and having strong gender roles. Just under half of couples of husbands and wives both named their spouses as expected insurers. For those that did not name their spouses, it is possible that they have relatively separate economic lives and informal insurance networks. Despite appearing to be relatively low, the husbands and wives nominate each other as expected insurers more frequently than those in a similar study in Africa. In Goldstein's (2004) study in Ghana, where there was also evidence that husbands and wives led separate economic lives. Using a methodology to test for Pareto optimal risk sharing, Goldstein found that husbands and wives did not share risk with each other at all, and instead drew on other risk sharing networks when faced with an ill health shock (p.24).

Demographic data from the study area implies that households are vertically and horizontally extended. In the study area, 61 per cent of households had more than three adults present. This is significantly higher than the national figure for households in rural areas of 44.5 per cent (Table 2.2). It is possible that polygyny is one way that households in the study area are extended. Seventeen per cent of household are polygynous, most commonly with two wives. The largest polygynous family had four wives and a total of 24 members. Jacoby (1995) cites gaining access to larger networks of informal insurance as one possible explanation for polygyny (p.942). The extent of intra-household and inter-household assistance was therefore examined amongst the polygynous households in the study area.

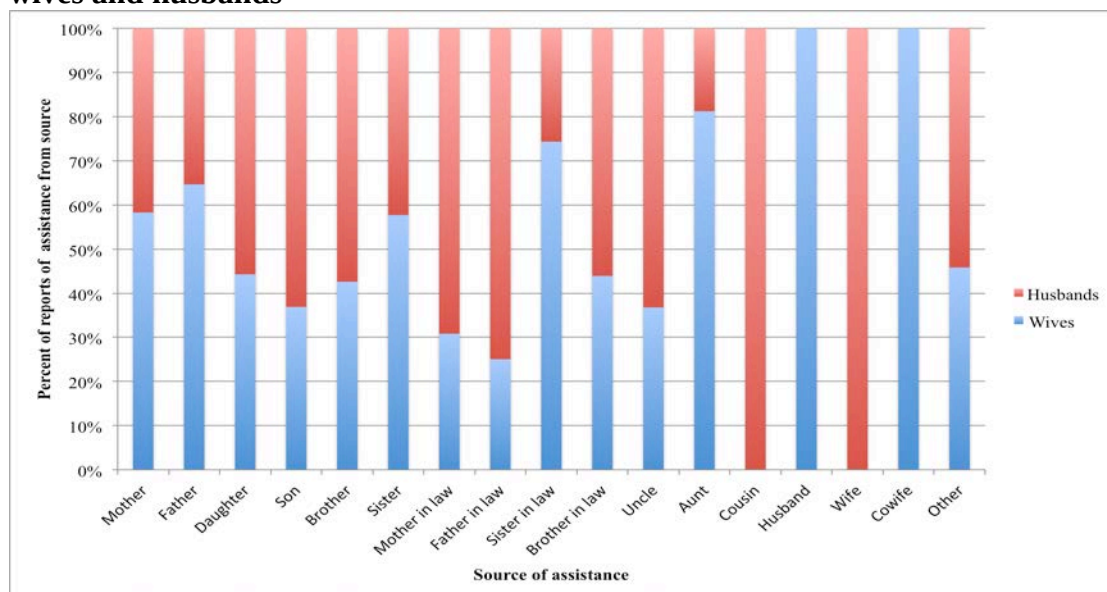
Amongst the polygynous households, 10 out of 14 men answered the network questions. Of these, 40 per cent did not name any of their wives as potential sources of assistance, compared to 52 per cent for non-polygynous married men. When the total number of potential insurers is considered for the household, polygynous households have, on average 7.07 links, compared to 5.71 for non-polygynous households. This difference is not statistically significant.

Sources of expected assistance for husbands and wives were graphed (Figure 4.5). There appears to be a gender dimension to expectations of assistance. This is possibly a reflection of the strong gendered roles in the study area, with women typically spending

substantial time with other women in subsistence gardening. An exception to this gendered approach is that women expect assistance from their fathers.

For men, the gender preference in relation to expectations of assistance was less pronounced. However, apart from mother-in-laws and daughters, men mainly expected assistance from sons, fathers-in-law, uncles and brothers-in law.

Figure 4.5: Expected assistance in response to a health shock by relationship for wives and husbands



Source: Household survey data, February 2012.

Overall, the data on intra-household assistance is consistent with the household being an important part of institutional arrangements for risk mitigation (Rosenzweig 1988, p.1149). In the case of more than half of the married men and women who did not nominate their spouses as expected insurers, alternate insurance arrangements show a preference for relatives and friends of the same gender, for men this was predominately their uncles brothers and brothers-in-law and for women it was aunts, sisters and sisters-in-law.

For the polygynous households, the addition of spouses did not confer proportional increases in expectations of assistance. This may mean that expanding the network of informal insurers is not a primary motivation for polygyny.

4.7 The informal insurance network between households

This section focuses on the 60 per cent of expected assistance relationships that take place outside of the household but within the village. Section 4.5 discussed links with households outside of the village and Section 4.6 intra-household links both of which are ignored in this analysis.

Of the 83 households surveyed in the villages, there are potentially 6806 dyads (Table 4.4). Out of a potential 6806 dyads, there are 142 cases where there was at least one nomination from one household of another household in the villages (multiple nominations of a household, or individuals within a household, are counted as one link).

Table 4.4: Basic network statistics

Basic network data	
Number of possible household dyads	6806
Number of household dyads identified in study area	142
Number of reciprocal nominations	24
Average number of household to household links	1.7

Source: Survey data, February 2012.

Network density refers to the ratio of identified dyads relative to the potential number of dyads. In this case, the network density is 0.021. The literature review identified one other study in which it was possible to compare a range of network data, DeWeerdts (2002) study of 119 households in Nyakotoke, Tanzania.²⁶ Based on the data presented in DeWeerdts study, the network density in Nyakotoke can be calculated as 0.070 (p.3). By comparison, therefore households in the study area have a much less extensive network of informal insurance.

In the study area, approximately 17 per cent of nominations were reciprocal between households. In comparison, in Nyakotoke this was the case for 28 per cent of nominations. The overall average number of links is also much lower in the case of the study area, at 1.7 per household compared to 4.1 in DeWeerdts research.²⁷ It is also

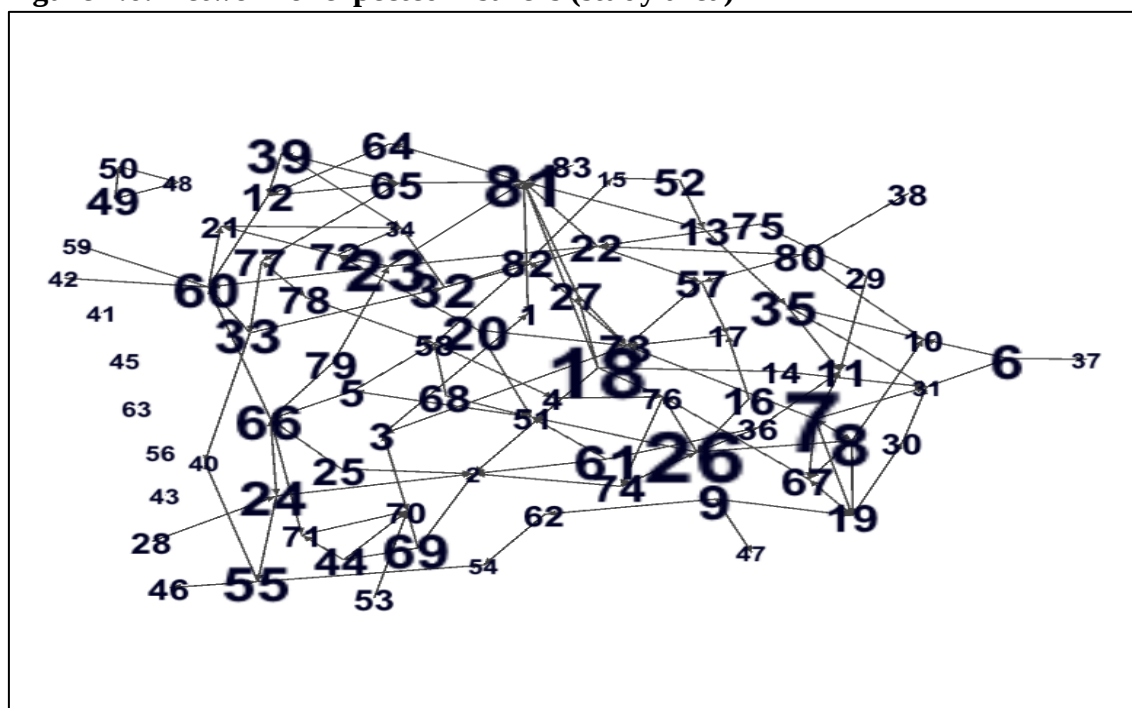
²⁶ Note: The same data set was also used in Comola and Fafchamps (2010) and Comola (2010).

²⁷ The average number of links in was calculated by taking the number of reports of at least one link (490) and dividing it by the number of households surveyed (119). Statistics can be found on DeWeerdts 2002, p.4.

noteworthy that in Nyakotoke there were no households that reported having zero links, whereas in the study area there were five such households.

The basic network of expected insurers within the households surveyed in the study area is displayed in Figure 4.6. Each number in the graph represents a household, and lines connect households with links. The numbers are scaled so that households with the largest number of relationships (both expected receiving and expected to provide assistance) are larger. It can be seen that households 26, 7, 18 and to a lesser extent 23 and 81 have a larger number of expected assistance relationships that other households in the network.

Figure 4.6: Network of expected insurers (study area)



Source: Survey data, February 2012 graphed with *Gephi*²⁸

The network consisted of 7 components, a large sub-group in which most of the households are connected, a smaller component of three households (48,49 and 50) and the five households that have no links to others (41, 43, 45, 56 and 63).

²⁸ Gephi is an open source interactive visualization and exploration platform for networks. It is available at <https://gephi.org>

Within the network there is evidence of clustering. A cluster in network analysis refers to a small neighbourhood of a larger network where there is a higher density of ties than would be expected for a random group of the same size (Hanneman and Riddle 2005). In the informal insurance literature, clustering gives insight into the enforceability of contracts.

Murgai et al. (2002) examine clusters among a water-trading network in Pakistan. They find that when the costs of forming a network are high and the costs of enforcing commitments are low there is greater probability of clusters with Pareto efficient full insurance.²⁹ Low network formation costs and high enforcement costs, on the other hand, will lead to community level partial insurance (p.279). In the case of the study area, geographic isolation means that the cost of entry into an insurance arrangement is most likely to be low. Enforcement of informal arrangements may be difficult because of the general level of disadvantage. Given these factors it is unlikely that there will be clusters of households with full insurance.

The clustering coefficient, when applied to an individual household, shows how complete the household's insurance connection is to its neighbours. A higher clustering coefficient³⁰ would imply that there are groups of households offering more extensive insurance to each other. Households 48, 49 and 50 had the highest clustering coefficients in the study area (0.5). Each of these households was connected to the others either as an expected giver or receiver of assistance. The close relationship between these three households mirrors their geographic proximity. In addition, the three households were linked by sibling relationships. The head of household 48 was

²⁹ Pareto efficient full insurance implies that individual household consumption moves with average consumption of the other households in the cluster, irrespective of individual household income.

³⁰ The cluster coefficient if applied to an individual household is the probability that two randomly selected neighbours are connected to each other. When applied to an entire network, the cluster coefficient is simply the average of the individual cluster coefficients. A value of 1 implies that all possible insurance relationships are realised. If a network (G) consists of a set of households (V), and each connection between households is a set of edges (in our case informal insurance relationships) (E) then the network can be represented by: G=(V,E). If i, j are both elements of G and of E, they are connected by an edge or have an informal insurance relationship. The clustering coefficient of household i, denoted c(i) is a fraction of those pairs that are neighbours of each other over all possible directed relationships. N_i is the neighbourhood of immediately connected relationships, which consisted of k_i households.

$$C_i = \frac{|\{e_j : v_j v_k \in N_i, e_j \in E\}|}{k_i(k_i - 1)}$$

the brother of the head of household 49, and the spouse in household 48 was the sister of the spouse in household 50. When the relationships of people expected to provide assistance were examined (Figures 4.1 and 4.2), siblings were the most nominated group.

Overall, the average clustering coefficient for the network is 0.061, twice what would be expected from a randomly generated network (Comola 2010, p.6). Using the same data as DeWeerd (2002) from Nyakatoke, Tanzania, Comola (2010) finds a clustering coefficient of 0.23 (p.6). Thus, by comparison, there is a low level of clustering in the study area. This may imply that there are limited repercussions for households who renege on informal insurance arrangements.

Households 7, 18, 26 and 81 are all prominent in Figure 4.6 as having a large number of expected insurers. Of these, the only obvious difference between these and other households was that household 18 and 81 are both polygynous (two and four wives respectively). Earlier analysis (Section 4.6) showed that these households have more links than non-polygynous households (although the average differences between polygynous and non-polygynous households were not statistically significant).

Households 41, 43, 45, 56, and 63 have no expected insurers. These five households include two headed by divorced women living with their children either part or full-time (households 41 and 63). These two women nominated no potential insurers from within or outside of their households. In another instance, the household head nominated his spouse and an individual who lived outside of the study area (household 43). A fourth household comprised a couple that nominated each other as potential sources of assistance and no-one else (household 45). The final household (household 56) was a polygynous household with no sources of assistance nominated from within the household or the study area (one of the wives was unavailable for interview). Of the households with no expected insurers, those headed by the divorced women appear the most at risk from shocks given their lack of potential for intra-household assistance.

Overall, the initial exploration of the potential insurance networks in the study area shows that they are sparse and underdeveloped. Although the cost of entering an insurance relationship is low, the value of the clustering coefficient indicates

enforceability is also low. This may be a factor in limiting the size of the network. There are also some households that are completely isolated.

4.8 Attributes that may determine the insurance relationship and bivariate analysis

Possible explanatory factors that may influence the establishment of insurance relationships were identified through the literature review of informal insurance networks. They include: measures of geographical distance, kinship, wealth and different measures of social engagement (De Weerd 2002; Murgai et al. 2002; Fafchamps and Gubert 2007; Comola and Fafchamps 2010). This section introduces these variables and undertakes bivariate analysis in relation to them. The next section uses multivariate analysis.

A brief description of variables and their expected relationship follows:

Geographic distance: Geographic proximity has consistently been found to be a significant explanatory variable in empirical work on informal insurance networks completed to date (DeWeerd 2002; Murgai et al. 2002; Fafchamps and Gubert 2007; Comola and Fafchamps 2010). Neighbours have access to more information than people living further away. It is therefore expected that geographic proximity will be positively related to the probability of forming an informal insurance link. Geographic coordinates of each household were collected via a handheld global positioning system. The ellipsoidal distance between each possible combination of households was then calculated.³¹

³¹ The user written *geodist* command was used in Stata 12. This command calculates ellipsoidal distances using Vincenty's (1975) equations.

Same religion: Being a member of the same religious group has been found to be significant in number of studies (DeWeerd 2002; Dekker 2006; Comola and Fafchamps 2010; Comola 2010). There were at least four churches operating in the study area and three additional denominations nominated by villagers. In the context of the study area, same religion is therefore taken to mean belonging to the same church or denomination. It is possible that the information exchange involved in regular church going may influence decisions on informal insurance. It is also possible that churches may play a role in enforcing informal insurance contracts. It is therefore expected that being a member of the same church will have a positive effect on the likelihood of forming an informal insurance link.

Insurance history: Given data on ill-health in the villages, it seems likely that over time the risk of falling ill will be frequently realised. As such, insurance partners are likely to receive regular evidence of repayment of assistance (Platteau 1997, p.780). This may reinforce relationships that commenced through family connections, and allow insurance partners to test out the reliability of different network members (Fafchamps 1992, p.159). The relatively low levels of assistance in the form of cash, and the high levels of in-kind assistance also provide insurance partners with a range of options for balancing assistance over time. Therefore, even households who are cash poor may be able to meet obligations by actions such as provision of firewood, water or childcare. Historical insurance relationships have been shown to be positively associated with future insurance (Dekker 2006; Fafchamps and Lund 2003). It is therefore expected that a history of a household receiving assistance from another in the past will be positively associated with future insurance links in the study area.

Whether the household is polygynous: The descriptive data on the potential insurance links of polygynous households showed that these households have more links than non-polygynous households, but that the difference was not statistically significant. It is possible that there are two opposing influences on network formation for polygynous households. First, it may be expected that at a household level, the potential ties to other households would increase with the addition of members. On the other hand, additional wives and children may also increase the potential for households to self-insure. Given

this, and the lack of other studies relating insurance to polygyny, the effect of polygyny on the probability of intra-household insurance links is unknown.

Schooling: In most of the literature to date, schooling has not been found to be a significant factor in forming an insurance link. One exception to this is research by Vanderpuye-Orgle and Barrett (2009), who found that people with higher levels of schooling had a greater probability of forming a link. In the context of the study area, where schooling levels are very low (21 of the 83 household heads have no schooling), it is unlikely that schooling will have a strong effect on the probability of forming an insurance link. Nevertheless, it is included because schooling, along with organisational membership and age, are attribute characteristics in the study area that allow us to differentiate between individuals.

Organisational membership as a proxy for social capital: Common membership of an organisation offers clear information and, possibly, enforcement advantages, much like being the member of the same church. However, organisational membership may also provide some information about social status and connectedness that may be associated with increased insurance ties. Barr, Dekker and Fafchamps (2008) find a positive relationship between being in a network and organisation membership (p.5).

In contrast, a lack of membership of organisations may be a sign of social exclusion. Studies have shown a relationship between being less socially visible and having poor insurance networks (Vanderpuye-Orgle and Barrett 2009, p.16). Santos and Barrett (2011) study informal credit networks amongst pastoralists in southern Ethiopia and find that those in the poorest group are excluded from social networks, which, in turn, leads to an inability to access informal credit (p. 345). Taking previous research into account, it is that greater engagement in organisations is positively associated with the likelihood of forming an insurance link. In addition, there may be an association between a lack of organisation membership and a reduced network size.

Asset ownership: The asset ownership variable utilised was the asset index constructed in Chapter 1 using Principal Components Analysis (PCA). The index was then divided into quintiles so that there were five groups of asset ownership, with group 1 having the lowest level of asset ownership and group 5 having the highest.

The relationship between asset ownership and the likelihood that an insurance link is formed is likely to be specific to the characteristics of the villages. There is an argument that wealth could be endogenous to network formation. Fafchamps and Gubert (2007) instrument for wealth on the grounds that network insurance could affect the capacity of households to accumulate wealth. This implies that households with strong insurance networks may have been protected from having to erode their assets during previous shocks. The data on coping mechanisms in the study area analysed in Chapter 3 shows that the most common response to a shock is to reduce consumption. There was only one instance out of 472 reported responses to a shock where a household reported selling an asset. It therefore seems unlikely that asset accumulation is endogenous to insurance network size in the study area. As such, the variable representing asset ownership can enter the regression equations directly.

It is expected that it will be more difficult for households in the lowest asset group to establish informal insurance links with other households. This is both because these households are less likely to produce an agricultural surplus that they can share with other households in the event of that household requiring assistance, and because these households have less surplus time available to provide other forms of in-kind assistance.

Age of household head: As with schooling and organisational membership, it would be expected that household heads of similar age would be more likely to form links with each other. DeWeerd (2002) found that household heads being of similar age was a small but statistically significant effect (p.12).

Three other variables that seem relevant from the international literature were not included in the analysis. Data on kinship was collected from households when identifying potential insurers, but not for all other households living in the villages as would be required for regression analysis. To do so would have required household heads and their spouses to identify all of their relatives in the villages, which was not feasible.³² Marriage was not included as an explanatory variable on the grounds that

³² In other research where kin relationships have been included (e.g Dekker 2006), interviewees are shown a list of other villagers and asked to identify their kin. Given individuals in these villages were known by multiple names, and households did not have a specific identification number – it was beyond the scope of the research to map all kin relationships in the villages.

there would be negligible variation in the variable, given only four household heads with potential insurers were not married. Finally, “length of time lived in village” was not included for the same reason. Although it would be expected that more established households would have a greater likelihood of forming links (Vanderpuye-Orgle and Barrett 2009), the small number of households (6 out of 83) that are more recent arrivals to the villages means that there is insufficient variation to include this variable in the regression analysis.

Descriptive statistics (Table 4.5 below) show that the average distance between households with relationships is 2.84 km. The largest distance between two households in an insurance relationship was 9.06 km, whereas the smallest distance was just 20 metres. The average level of schooling of household heads is 4.65 years. The low level of schooling reflects the fact that schooling in the villages only commenced in 1989 and has been discontinuous, with no schooling available between 1997 and 2003 (Village history, February 2012).

Table 4.5: Descriptive statistics of relational and attribute variables used in analysis

Descriptive statistics of relationship variables in the study area

	Mean	Standard Deviation	Minimum	Maximum
Relational variables				
Distance (kilometres)	2.85	1.93	0.002	9.06
Same religion (1=yes, 2=no)	0.16	0.37	0	1
Insurance history (1=yes, 2=no)	0.01	0.10	0	1
Attribute variables				
Polygynous marriage	0.16	0.36	0	1
Schooling of household head (years)	4.65	3.78	0	13
Age of household head	38.14	13.39	18	74
Organisation membership (number)	0.95	1.60	0	5
Number of adults in household	3.21	1.91	1	12
Asset quintile of household	2.96	1.42	1	5

n=6806

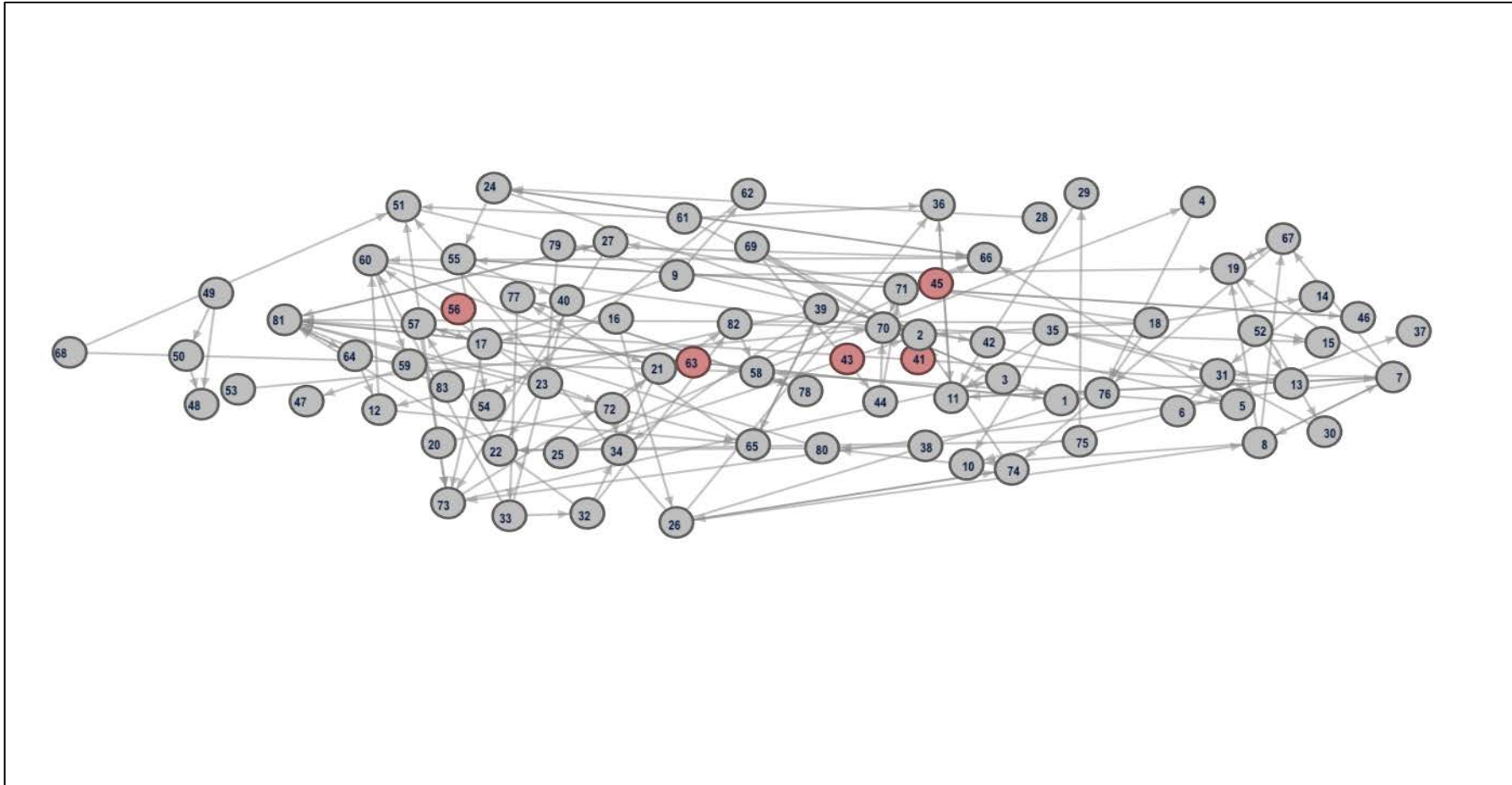
Source: Household survey, February 2012.

The expected assistance relationships were graphed according to distance, organisation membership as a proxy for social capital and by their asset ownership quintiles. The

geographical distance between households is represented in Figure 4.7.³³ The five households identified as having no links are coloured red. The arrow heads show the direction of the expected assistance relationship. Thus an arrow head pointing at a household (the target household in network analysis terms) indicates that it is expected to provide assistance to the household from which the arrow originates (the source household).

³³ *Gephi* can display relationships according to differences in the geographic coordinates of households. Scaling is 5000:1. In order to avoid overlapping nodes, an algorithm has been applied that prevents overlaps, this means that the vertical distance is not an accurate representation. In addition, for ease of visualisation, the graph has been rotated 180 degrees.

Figure 4.7: Network of expected insurers - by geographical distance

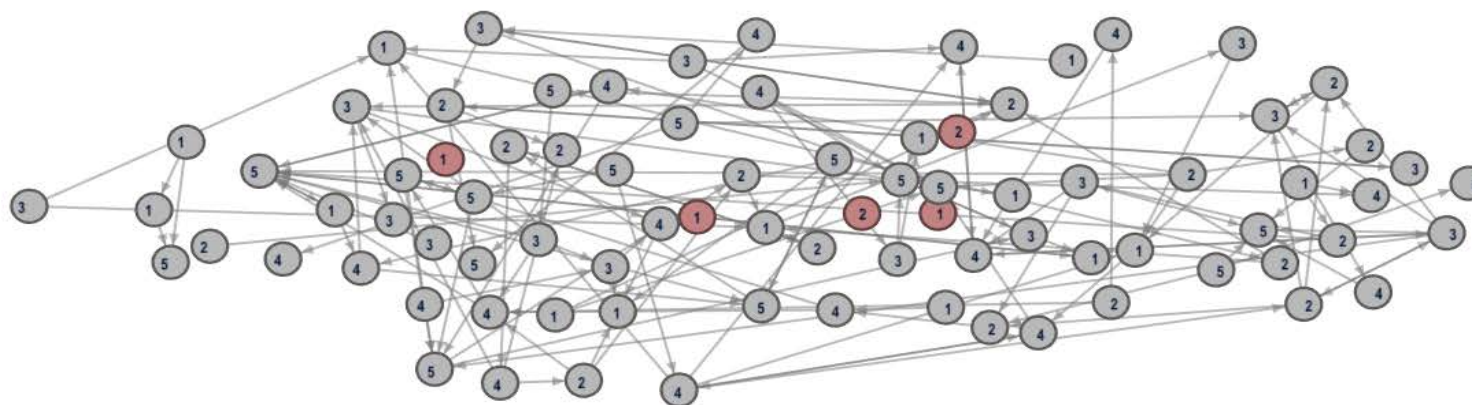


The first point to note is that the households without links are not geographically isolated from the others. In fact, they are more or less in the middle of the geographical distribution. Of the households identified in Figure 4.7 as having the most links, household 26 appears to be quite separate from the others, and households 81 and 7 are also set slightly apart. The visual analysis of the relationships relative to geographical distance therefore suggests that living near others does not guarantee relationships, and being relatively isolated does not appear to be an impediment to expectations of assistance.

The expected assistance relationships were then graphed according to geographical distance and asset quintile, by modifying Figure 4.7 to replace the number of the household by its asset quintile (Figure 4.8).

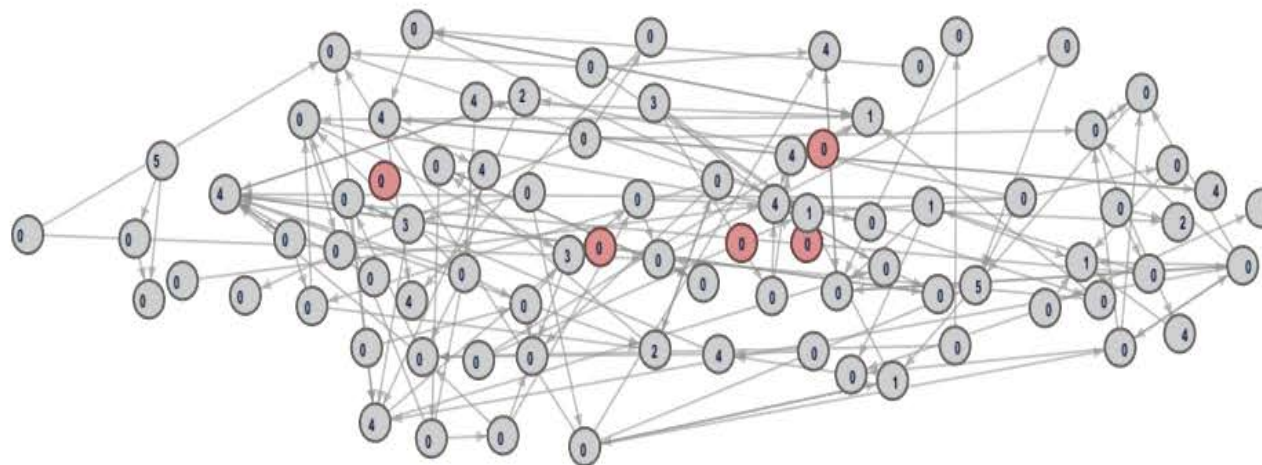
Figure 4.8 shows that the households with no expected assistance relationships (coloured red) are all in either the lowest or second lowest asset ownership quintiles (quintiles 1 and 2). The households in the 5th or top asset quintile all have expected insurance relationships, although household 37, located in the far right of the graph does not have any expectations of receiving assistance.

Figure 4.8: Network of expected insurers by geographic distance and asset quintile



Relationships were then graphed according to distance and the social capital measure, membership of organisations (Figure 4.9). The number in each circle indicates the number of organisations the household belongs to. The maximum number of organisations that a household belongs to is five.

Figure 4.9: Network of households expected to provide assistance by social capital measure (membership of organisations)



The majority of households do not belong to any organisations. None of the households with zero links are members of any organisations. Of the households identified as having the most links, only household 81 has any organisational memberships.

The households with no expectations of giving or receiving assistance (in other words no expectation of informal insurance) are of particular interest given that they have fewer options for coping with negative shocks than their better connected neighbours. While the figures are too small for any conclusions to be drawn, it is noteworthy that two of the three households with female heads have no links. Table 4.6 compares households with no insurance links across a range of economic and social statistics to averages across the study area.

Table 4.6: Comparison of economic and social statistics for households with no insurance links to averages for study area

	No insurance links		All households	
	Average	Std Dev.	Average	Std Dev.
Number of adults	3.80	4.20	3.16	1.96
Average age of household head	38.20	10.92	38.17	13.55
Polygynous	0.20	0.45	0.17	0.38
Asset quintile**	1.40	0.55	2.96	1.43
Number of organisations	0.00	0.00	0.40	0.68
Schooling	1.80	2.49	4.92	4.64
Major expenditures across 2011 ^a (Kina)	38.62	62.49	83.46	214.57
Number of severe shocks since 1998	4.40	0.89	5.00	1.79
Number of different food types consumed in last 24 hours	3.20	1.48	3.56	1.44
Meat consumption in past 24 hours	0.00	0.00	0.11	0.31

*, **, *** indicates 10, 5 and 1 per cent levels of significance respectively.

Note:^a n=82 (one household refused to answer)

The descriptive statistics show that with the exception of asset ownership, there are no statistically significant differences between the households with no links and the broader averages. However, across a range of economic and social indicators, including schooling levels, organisational membership and major expenditures, households with no links do have lower averages.

In relation to asset ownership, the average asset quintile of households with no links is 1.4 and the overall average is 2.96. The difference is significant at the 5 per cent level. Thus, the households with no links, on average, own fewer assets than others.

4.9 The regression model and analysis

Using the dyadic data it is possible to use regression analysis to assess the association between household (or individual) attributes and the likelihood of their being linked (Hoddinott et al. 2005, p.6). The link, whether it is directed or undirected, is the endogeneous variable in these regressions. Most models of informal insurance networks have relied on pairwise regressions based on a model where Y_{ij} is the propensity to form a link between i and j . $Y_{ij}=1$ when a link is formed. The regression usually takes the following form:

$$(1) \quad Y_{ij} = \alpha + \beta X_{ij} + u_{ij}$$

X_{ij} is a series of $N(N-1)$ matrices containing regressors that capture information on both the individual households and the links themselves, where N is the number of households.

A challenge in dealing with network data is that observations in network data are not independent. There are in fact two potential violations of independence in network data. First, is the possibility that the existence of a link between two households will influence the formation of other links within the network. If all households are equally likely to be chosen as a possible link, and household i experienced a shock and seeks assistance, the choice by household i of household j , precludes household k , from being chosen on that occasion. As such the error term u_{ij} will be negatively correlated with the error term of u_{ik} . The second possible violation of independence occurs because there may be unobserved attributes of a household that make them more or less likely to form links.

The lack of independence between observations means that error terms also are not independent. There are three main approaches in the economic network analysis literature on informal insurance for dealing with the issue of the possible dependence of error terms. The first is through the use of individual fixed effects for both the sending and the receiving households (DeWeerd 2002; Udry and Conley 2004). Fafchamps

(2010) notes that in network data the pattern of correlation across residuals is not consistent with what is standard in fixed effects (p.6). Dekker (2006) notes that this approach does not take into account the dependence between relations that may occur because a household entering into an insurance relationship with another household may reduce the likelihood that either household enters into a relationship with a third household.

A second approach involves using a nonparametric, permutation based approach called the quadratic assignment procedure (QAP) (Krackhardt 1987, p.174). This method works by permutating the data on the dependent variable in such a way that any relationship between the dependent and the independent variable is eliminated, but any correlations between observations are retained. This process is replicated numerous times to generate a Monte Carlo distribution of the coefficient, under the null hypothesis that it is equal to 0. The p-values are then constructed to be a proportion of the results from the permuted matrices with coefficients at least as high as those from the original model (Fafchamps 2010, p.8).

The third approach, and one followed in this essay, involves correcting for cross observation correlation in the error terms. Fafchamps and Gubert (2007) utilise a corrected covariance matrix that they develop based on a method developed by Conley (1999).³⁴ An advantage of the network corrected covariance matrix over QAP in this context is that the former approach also corrects for heteroskedasticity. Deaton (1997) notes that heteroskedasticity is expected in regressions based on survey data (Deaton 1997, p.79).

³⁴ The formula for the network corrected covariance matrix utilised by Fafchamps and Gubert (2007) is as follows:

$$AVar(\hat{\beta}) = \frac{1}{N-K} (X'X)^{-1} \left(\sum_{i=1}^N \sum_{j=1}^N \sum_{k=1}^N \sum_{l=1}^N \frac{m_{ijkl}}{2N} X_{ij} u_{ij} u_{kl}' X_{kl} \right) (X'X)^{-1}$$

Where β is a vector of coefficients, N is the number of dyads and K the number of regressors, X_{ij} is the vector of regressors for dyad ij , $m_{ijkl} = 1$ if $i=k, j=l, i=l$ or $j=k$ and 0 otherwise.

Following the discussion in the previous section, our analysis at the household level, and the links are directed (that is, not all links are reciprocated). Following Fafchamps and Gubert (2007), a model for a directed network takes the form:

$$(2) \quad Y_{ij} = \alpha + \beta_1(z_i - z_j) + \beta_2(z_i + z_j) + \gamma w_{ij} + \mu_{ij}$$

Where z_i and z_j are attribute variables that describe network members i and j and w_{ij} is an relational variable that is unique to the relationship between i and j , for example, the geographic distance between their homes. Data from i and j enter the model in relation to each other. The data entering the model in this way captures the potential impact of homophily, which is the tendency of similar households to form links with each other. β_1 therefore captures the influence of differences in a particular attribute between i and j on the propensity to form a link³⁵. Thus, if households with greater wealth differentials were more likely to form links with each other, β_1 would be significant. β_2 captures the combined level of i and j on the propensity to form a link. In the wealth example, if β_2 were positive and significant it would indicate that more wealthy households were more likely to form links with each other.

An alternative specification of (2) is provided by Bromoullé and Fortin (2009), who argue that pairwise regressions of directed data should include regressors for individual attributes for i and j , together with the absolute value of the difference between attributes for i and j (p.5). This model specification has the advantage of accounting for individual characteristics and their role in influencing the propensity to seek a link. Both model specifications will be utilised in subsequent analysis.

The first model follows Fafchamps and Gubert (2007) and is based on equation (2). This model requires that data enter the model as both the sum of and the difference between attribute variables of both the household nominating the link and the households that they believe will provide them with informal insurance in the event that

³⁵ Santos and Barrett (2007) use the term ‘social distance’ to describe the difference between two individuals (p.6). In equation 4.2 this is equivalent to the expression $(z_i - z_j)$

they face an illness shock. In this model, the “difference in” attribute variables can be interpreted as highlighting differences between the households, whereas the “sum of” attribute variables are a measure of similarity between households.

The second model follows Bromoullé and Fortin (2009) and Santos and Barrett (2006). It adapts (2) to include a measure of the absolute difference in attributes between households (referred to as social distance by Santos and Barrett (2006)). In addition, the model incorporates attribute variables of the household seeking the insurance link. It therefore provides specific information on the attributes of households who believe that they have established insurance relationships.

Regression results for Model 1 (Table 4.7) show the coefficient of each variable, the robust standard error and the dyadic corrected standard error and t-values. Coefficients are significant at the 95 per cent level of confidence if the t-value has an absolute value greater than 1.96.

Table 4.7: Model 1 - likelihood of expected links in the study area

Regression of the likelihood of an expected insurance link between households in the study area				
	Coefficient	Robust Std Error	Dyadic Std error	Dyadic t-value
Dependent variable = 1 if a there is an expected insurance relationship between households				
Relational variables				
Distance (kilometres)	-0.32	0.06	0.07	-4.53*
Same religion	0.37	0.22	0.30	1.23
Insurance history	4.18	0.29	0.38	11.11*
Attribute variables				
Difference in:				
Dummy=1 if a polygynous marriage	-0.24	0.19	0.15	-1.56
Schooling of household head	0.04	0.02	0.02	1.65
Age of household head	0.00	0.01	0.01	-0.15
Organisation membership	-0.11	0.04	0.03	-3.40*
Asset score of household	-0.02	0.08	0.07	-0.35
Sum of:				
Dummy=1 if polygynous marriage	0.11	0.210	0.15	0.72
Schooling of household head	0.01	0.018	0.02	0.33
Age of household head	0.01	0.006	0.01	1.27
Organisation membership	0.02	0.048	0.03	0.76
Asset score of household	0.20	0.072	0.05	3.60*
Constant	-4.61	0.609	0.76	-6.06
n=6806				

*indicates that the t-value is higher, in absolute terms, than the critical value of 1.96, for a 95 per cent level of confidence.

Source: Author's calculations.

The negative relationship between increasing distance and the likelihood of forming an insurance link in Model 1 is consistent with previous research. The expected strong relationship between prior history of insurance and expected links is also confirmed.

Among the “difference-in” attribute variables, only membership of organisations was statistically significant. The larger the difference in organisation membership, the less likely it was that a link is formed (the maximum number of organisations was 5). However, when membership of organisations enters the regression as a sum, it is not

significant. Thus, potential insurance partners having higher collective organisational membership does not increase the probability of forming a link. The relationship between organisation membership and insurance network formation is not straightforward. Being a member of multiple organisations does not guarantee access to informal insurance networks. An alternative interpretation of these results is that not being a member of organisations is a problem in terms of forming informal insurance relationships, but being a member of multiple organisations offers no advantages.

Differences in the asset index score are not a significant factor in the probability of an expected insurance link. However, when asset ownership enters the regression as a sum effect it is positive and significant. In the context of the study area, this can be interpreted as meaning that households with similar wealth levels may be more willing to enter insurance relationships because they are confident of their ability to reciprocate assistance. They may also have more time available to assist others as they are under less pressure to meet their subsistence needs.

Unlike Model 1, Model 2 provides information on the differences between the households expected to form the insurance relationship (the difference in attributes) and separately on the household seeking the relationship (the attributes of the household expecting insurance). Model 2 shows a statistically significant positive relationship between asset ownership and the probability of the source household forming a link. Thus households with higher asset ownership are more likely to form a link. However, it also shows that the greater the difference in asset ownership between two households, the less likely they are to form a link, and a history of insurance is also positively associated with link formation (Table 4.8).

Table 4.8: Model 2 - the likelihood of forming an expected insurance link

Regression of the likelihood of an expected insurance link between households in the study area

	Coefficient	Robust Std Error	Dyadic Std error	Dyadic t- value
Dependent variable = 1 if a there is an expected insurance relationship between households				
Difference in attributes (between households)				
Distance (kilometres)	-0.33	0.06	0.06	-5.10*
Same religion	0.37	0.22	0.30	1.22
Similar age (within 5 years)	-0.15	0.26	0.30	-0.49
History of insurance	4.10	0.28	0.38	10.81*
Difference in asset ownership	-0.22	0.10	0.09	-2.50*
Difference in schooling	0.04	0.02	0.03	1.17
Both in organisations	0.68	0.39	0.36	1.90
Attributes of household expecting insurance				
Age of household head	0.00	0.01	0.01	0.37
Asset score for household	0.44	0.14	0.12	3.53*
Schooling of household head	0.01	0.03	0.04	0.24
Organisation membership	-0.72	0.27	0.26	-2.82*
Number of adults in the household	0.01	0.07	0.09	0.16
Constant	-3.60	0.39	0.45	-8.05

n=6806

*indicates that the t-value is higher, in absolute terms, than the critical value of 1.96, for a 95 per cent level of confidence.

Source: Author's calculations.

Models 1 and 2 reinforce the strong and positive relationship between previous insurance history and the creation of a link, and the negative relationship between geographic distance and link formation. Richer households are more likely to form links (Model 1) and expect insurance (Model 2). In relation to membership of organisations, it appears that this does not increase the probability of a link but that differences in the number of organisational memberships are associated with a lower probability of forming a link.

4.10 Discussion and conclusion

The essay set out to answer two broad questions. What is the nature of the informal insurance network in the study area? What household attributes determine insurance relationships? In answering these questions, the essay addresses two gaps in the international literature: first a lack of focus on intra-household insurance relationships and second, the limited attention paid to informal insurance from people outside of the community. The essay is also the first to employ network analysis to understand informal insurance networks in remote Papua New Guinea.

The network analysis question asked people to nominate individuals from both within and outside of their household who would assist them in the event of a prolonged illness. The data on intra-household assistance shows that almost two-thirds expected that they would receive assistance from other members of their household. When the nominations of potential insurers of men and women were examined separately, it was found that 40 to 50 per cent of spouses nominated each other. This is a higher level of insurance than found in Goldstein's research in Ghana that found no pareto optimal full insurance between spouses (2004, p. 23). Additional comparative studies would be necessary to accurately benchmark the levels of spousal insurance in the study area.

Given the existence of polygyny in the study area, these households were examined separately to test the theory put forward by Jacoby (1995), that one reason for polygyny is to extend informal insurance networks. However, polygynous households did not have significant differences in the size of their informal insurance networks and polygyny was not found to be a significant factor influencing the likelihood of forming a potential assistance link (Model 1). There is therefore no support for the proposition that polygyny in the study area is a means of extending access to informal insurance networks.

To establish the nature of insurance in the study area it is also important to understand the role of transfers from people outside of the study area. Although external transfers are most important when households are subject to covariate shocks, it would be expected that external insurers would play some role in informal insurance networks for idiosyncratic health shocks. Noting the limited range of health services available in the

villages, assistance may be required to fund transport to larger health centres for instance. However, there were only 6 individuals out of a total of 370 nominated potential insurers that lived outside of Obura Wonenara District. Thus the potential for assistance from outside of the study area was almost non-existent. Expectations that a system of 'wantoks' living outside of the study area may offer informal insurance is not supported. The limited access to potential insurers outside of the vicinity also means that these households are reliant on government aid in the event of a village wide shock.

Inter-household links were examined with respect to actual insurance experience of a health shock in the previous two years, and expected insurance looking ahead. Although there was wide variation in the number of insurers and of transfers, the patterns of the types of assistance provided and the people who provided it were very similar between actual and expected insurance. Thus it seems that actual experience may inform expectations, but that expectations of the provision of assistance may be inflated.

The examination of the inter-household links for expected assistance using tools from network analysis confirmed that informal insurance networks are not well developed or strong, including in comparison to studies from other countries. It was shown that there were five households that were completely isolated from others with respect to expectations regarding potential insurance. These households had lower averages across a range of socioeconomic attributes than the average, although only their lower asset levels was statistically significant. Of the three female-headed households in the villages, two are among this group.

When considering what household attributes determine insurance relationships, the two statistical models support a finding that households with higher asset ownership are more likely to establish links, and to have larger insurance networks. The strong finding with respect to relative asset ownership is consistent with other studies, as is the relationship between previous insurance experience and geographic distance between households. Thus this research supports the quasi-credit, limited commitment model of insurance put forward by Ligon et al. (1997), where those who experience a negative shock in one period do not repay the transfer received from another household until it

suffers a shock. The strong links between close family members, particularly siblings, also suggest a role for altruism consistent with Foster and Rosenzweig (2001).

Nevertheless, the isolation of the five uninsured households is a strong reminder that the decision to insure another household is also driven by the benefits of participation in the insurance network. This is evident when it is considered that given that the study area grew out of a few families, and have had limited in-migration, these uninsured households are likely to have kin in the study area.

Overall, the data on coping mechanisms and informal insurance in the study area supports a conclusion that households are simply too poor to enter into extensive mutual insurance relationships. All households face multiple shocks, and reducing consumption is the most frequent coping mechanism. Choice of partners is therefore driven by those who live close-by, where there is a historical insurance relationship and who are most able to provide help because they have more wealth.

Ideally, the informal insurance network should be encouraged to expand, but this is unlikely to happen until there is a general increase in the wealth of the households in the study area.

Chapter 5 Conclusions and policy implications

5.1 Summary

There are an estimated one million people living in remote Papua New Guinea in either moderate or severe disadvantage. This is the first research to date that focuses specifically on poverty, shocks and coping mechanisms and informal insurance mechanisms in relation to a community of poor people living in remote rural Papua New Guinea. The thesis is motivated by concerns that, by virtue of their remoteness, the poverty experienced by these people is not understood and not addressed with specific policies. Without specific measures to assist this poor population, they are likely to remain poor into the foreseeable future. This thesis contributes new evidence on the links between location and poverty in Papua New Guinea, the shocks experienced by people in these locations and their limited access to assistance by addressing three specific questions:

1. Why are Papua New Guinea's remote villages chronically poor and what are the characteristics of the poorest in those villages?
2. How do Papua New Guinea's remote poor manage risk?
3. How effective are insurance arrangements in remote Papua New Guinean villages?

The research is an economic case study that included a range of data collection methods including focus groups, semi-structured and in-depth interviews as well as a single cross-section household survey. The data were collected in February 2012. There are a number of limitations on the conclusions that can be drawn from a single cross-sectional survey. These include extrapolations with respect to the conditions across the rest of the year, in particular with respect to consumption of seasonal food, expenditures and income data. In addition, a single cross section of data is insufficient to determine whether individuals or households are chronically poor.

Another limitation related to a lack of comparable data from other studies. This was particularly so with respect to the analysis of the strength of informal insurance

networks. In part, this weakness is due to the small number of data sets that form the majority of the research base on this issue.

Chapter 2 fills a gap in the literature on poverty in Papua New Guinea and in the international literature on poverty in remote places by using a case study approach to examine poverty in an area of Obura Wonenara District. While it is known that certain remote parts of PNG are very poor, this essay, for the first time, examines the association between poverty and geospatial characteristics, such as isolation and topography, and village level characteristics. An asset index is created to show which households are relatively poorer. Those living in higher elevations are shown to be more asset poor than others. Households with a literate household head and where there is female ownership of assets are less poor.

At the time of the survey (February 2012) the study area as a whole is found to suffer from food insecurity. Diet diversity, a common measure of food security, is relatively low. The average number of different foods consumed by households in the 24 hours leading up to the survey was 3.6. The most common foods consumed were sweet potato, greens and taro. A diet comprised predominately of these foods cannot provide sufficient access to animal-based protein. Given research showing deficiencies in animal-based protein in PNG, meat consumption was specifically examined. In this environment where all households are meat-based protein deficient it is found that there is a correlation between lower meat consumption and low asset levels. Larger household size is also correlated with lower meat consumption. Subsistence hunting does not offer complete cover for low meat consumption.

Overall, the evidence in Chapter 2 suggests that geospatial factors interact with inadequate government services, low levels of human capital, a lack of markets and underdeveloped family and social capital to contribute to the villagers living in chronically poor conditions. In the case of the study area, and other areas like it, food insecurity, including protein-based malnutrition, is a major characteristic of poverty. Geospatial characteristics, such as topography, are found to determine not only the poverty level of villages within PNG, but also impact on the distribution of relative poverty within remote villages.

Chapter 3 explicitly considers the role of risk and coping measures in these remote villages. In doing so it adds to the scant economic literature on poverty in remote areas. It also addresses a gap in the international literature on the relationship between shocks, consumption-reducing strategies and assets in the context of multiple market failures.

This is the first time that data has been collected and analysed on a comprehensive range of shocks and coping measures employed by households in remote Papua New Guinea. It is found that households are subject to numerous and often sequential environmental shocks which can be both covariant and idiosyncratic. In the year leading up to the survey 69 per cent of households reported a serious shock. This compared to 53 per cent in a study across 10 villages in Guatemala. The most common environmental shocks include drought, excess rain, pests and landslides. The low levels of human capital combined with geospatial characteristics of the villages mean that health shocks are also common. In a context of multiple market failures, the villagers have a limited number of coping measures to choose between when faced with a shock. This results in an early and excess reliance on consumption-reducing strategies. The reliance on consumption-reducing strategies as the main coping mechanism is consistent with international research in Guatemala. However, in the case of the Guatemala study, households were able to employ a range of market based coping strategies as well, including sale of labour and assets. In the study area, there was only one example of an asset sale in response to a shock.

Households with the most assets were found 50 per cent less likely to utilise consumption-reducing strategies than the most asset poor households. Given the regularity of shocks in the villages, households with higher asset levels may be able to maintain a higher level of human capital over time than the most asset poor households. However, in the context of the overreliance on consumption-reducing strategies in the villages, this research suggests that assets are not sufficient protection against the negative health consequences of repeated episodes of consumption-reduction, even for the high asset group.

Chapter 4 focuses on the effectiveness of informal insurance arrangements in the study area. This is the first time that network analysis has been utilised to test informal

insurance mechanisms in remote Papua New Guinea. In addition, the essay is one of the only examples in the international literature to specifically examine intra-household insurance, and the existence of a network of potential insurers outside of the villages.

Around two-thirds of households expected that they would receive assistance from someone within their household in the event of an ill-health shock. Just under half of all husband-and-wife couples named each other as expected insurers, indicating that many lead relatively separate economic lives and rely on different informal insurance networks. No support was found for polygyny being a means of expanding access to informal insurance networks.

The potential for households in the villages to receive assistance from individuals outside of the villages was very low. Only 6 out of 370 nominated insurers lived outside of Obura Wonenara District. Thus, households in the study area are isolated in terms of potential insurers in the event of a covariate shock. One implication of this is that it places greater importance on the need for government or non-government assistance in the event of a village wide shock.

Inter-household informal insurance links were also found to be weak, relative to the most similar data from other countries. Of particular note was that there were a small number of households that did not nominate any others in the villages as being potential insurers in the event of an illness shock. This group of 5 households all had asset levels that were statistically significant lower than the average. In the event of idiosyncratic or covariate shocks, these households are very vulnerable to irreversible harm.

The overwhelming finding of this essay is that when an individual in the study area falls ill, they do not have developed informal insurance networks to assist them. The lack of informal networks within the study area and with individuals outside the vicinity, means that the households are likely to be unsupported in the case of idiosyncratic and covariate shocks. Households are too poor to enter into extensive informal insurance networks, even in the face of multiple shocks. When such relationships are formed, the choice of partners is driven by proximity, a history of previous insurance and is more likely to be formed with households more able to assist, because they have higher asset wealth.

Taken as a whole, the three essays certainly show that some in the villages are poorer than others, and that relative poverty has real consequences. The poorest within the villages are relatively geographically disadvantaged, more food insecure, more exposed to serious risk, more reliant on consumption-reducing strategies and less insured through social networks. That said, the overall message of the three essays is that taken as a whole the people living in the study area are poor and vulnerable to suffering from irreversible harm due to malnutrition as a result of the high number of negative shocks they face and an excessive reliance on consumption-reducing strategies. The sparse informal insurance networks mean that households may not receive assistance in the event of food shortages and are therefore particularly vulnerable to irreversible harm from malnutrition.

5.2 Policy implications

A number of policy implications can be drawn from the case study presented in this thesis. Many of these suggestions could be addressed to the government, as they relate to better access and quality of services currently provided by government. However, in the absence of government action, there is a role for the non-government sector in monitoring the delivery of essential government services and advocating for improvements. In other cases, it may be possible for non-government-organisations (NGOs) or churches to play an active role in sharing skills, increasing the range of coping measures and in helping households accumulate assets and address nutritional deficiencies.

The first set of implications relate to the geospatial aspect of the poverty experienced by the study area. Attempts to address disadvantage in remote rural locations, such as the study area, are unlikely to be successful unless they tackle specific elements of geospatial disadvantage as well as individual level characteristics of poverty. Some aspects of low geographic capital could be ameliorated through intervention. For example, some of the disadvantages related to isolation could be offset by increased efforts to ensure regular flights to and from the village to facilitate the movement of people, delivery of government services and transport of coffee to markets. However, this type of intervention is expensive, would require a large degree of coordination between different parts of the government to reduce costs, and would still depend on the

weather being safe for flying and landing in the remote location. Although the link has been established between access to roads and poverty alleviation, the low population density and ruggedness of the topography mean that the villages are unlikely to be connected by roads in the foreseeable future.

Assistance could target the three very significant challenges in relation to human capital. The first is the inability to ensure a consistent level of education and health service due to the absence of qualified personnel. The second challenge is the excess reliance on consumption reducing strategies in response to a shock. The third relates to the high levels of protein deficiency amongst the villagers. On the first challenge, in the event that the government was able to send qualified health and education staff to the villages, regular visits by health and education inspectors would allow for equipment failures in the health centre to be identified and fixed, and the early identification of teacher absenteeism. Identification and training of teachers from the local area may assist in ensuring more continuity in education.

On the second challenge, the fact that even those with relatively higher asset levels adopt consumption-reducing strategies indicates that geospatial characteristics of the villages dominate household level characteristics in the choice of coping mechanisms. This provides support for the development of assistance programs that are geographically targeted. This is especially important in the context of village-wide shocks such as drought. Satellite imagery such as that used in Chapter 3, based on the Drought Severity Index, could be utilised to determine whether a particular area is suffering from lower than average rainfall over an extended period. It would then be relatively straightforward to determine whether the villages required assistance through conducting representative focus groups using a version of the coping strategies index used in Chapter 3 of this thesis. In the event that assistance was provided, this research suggests that particular efforts should be taken to monitor those with the lowest asset levels, and those living on steeper land.

The third challenge was identified through finding that even those with higher levels of asset ownership are still likely to be animal-based protein deficient. One way to address this is through village-based assistance for malnutrition. In the study area, the recent

introduction of fish farms by CARE International may assist in targeting animal-based protein deficiencies, although as yet, the food frequency data show little evidence of fish consumption. The success of fish farming as a means of addressing animal-based protein deficiencies will depend on the balance between households seeing fish as a new source of cash income, or as part of their subsistence production. If the former view dominates, it is possible that the asset will be protected, rather than consumed by the families with the fish farms. This would result in families in the villages with the cash available to purchase fish improving their access to animal-based protein.

Although all the households in the study area are poor, those with the least assets are less likely to be reached by any programs of assistance because they are more likely to be illiterate and to have lower social capital. The high overall level of poverty in the study area suggests that assistance should be targeted at a village level, and not at particular households within the villages. However, for the purposes of monitoring, households with the lowest asset levels should be identified.

A second set of policy implications relate to the vulnerability that villagers experience as a result of the large number of shocks that they face. Appropriate assistance programs that would support the study area to address their vulnerability would be two pronged.

First, they could introduce a greater range of ex-ante risk management approaches to the study area. Measures might include the introduction of a wider range of low risk crops to the villages. Agricultural extension could assist with garden design to reduce landslide risk, help retain soil moisture and manage pests. Given the association established between being asset poor and living on steeper slopes, it is possible that adjustments to land management practices or the introduction of new crops may assist poorer households living on more marginal steep land. Another way in which ex ante risk could be managed is through health interventions. Ensuring that immunization programs are not interrupted by equipment failures is one step that could immediately reduce health risks. Increasing access to tapped water and hand-washing may also help reduce health risks related to poor hygiene practices. Any actions to increase the proportion of women giving birth in the health centre would lower risks to mother and baby of birth related complications.

Second, there could be interventions focused on increasing the range of coping measures available to people. In general terms, coping measures that increase the capacity of villagers to save would widen coping strategy options. This would require an increase in either cash or garden produce. Thus, moves to ensure more reliable transport of coffee crops over time may encourage villagers to put aside some income for savings. Similarly, agricultural extension that introduced crops that could be stored may also increase the range of coping measures. The introduction of new foods or crops would need to be accompanied by education on how to farm, prepare and store the crops. Programs targeting increasing or diversifying the asset base should consider that households may need to acquire assets above a threshold level before they are willing to utilise these assets when faced with a shock, instead of adopting consumption reducing strategies.

Informal insurance was a relatively under-utilised coping strategy. Informal insurance networks were underdeveloped and weak. This is unlikely to change until there is more development. The low level of informal insurance against health shocks may support the need for programs to be considered to assist areas such as these cope with covariate shocks. A starting point for targeting assistance within the study area could be those households with no inter-household insurance links, for whom idiosyncratic shocks could lead to catastrophic declines in food consumption at any time.

While the sample of the study area is small, the case study suggests several possibilities for identifying those most at risk of not having informal insurance networks. The data suggest that a lack of engagement in village based organisations could be a useful means of identifying a sub-group of a village population that is more likely to be vulnerable to not having well formed informal insurance networks. Other household attributes that it may be worth monitoring more closely for the impact of negative shocks are those that are headed by single females, have negligible consumption of animal-based protein, and own low levels of assets. In the context of a poor community, it would not be difficult to administer a survey of asset ownership. Similarly, it is relatively straightforward to survey people on the frequency with which they consume meat-based protein through specific food frequency surveys.

5.3 Suggestions for further research

In addition to the policy implications of the research for the study area, there are several research implications arising from this work. First, the high reliance on consumption-reducing strategies in the study area highlights the possibility that this may be the case in other remote areas in Papua New Guinea. The wide variation in geospatial characteristics of remote villages in Papua New Guinea means that it would be worthwhile conducting further research specifically on shocks and coping mechanisms in other locations. Such research may form the basis of an early intervention approach for assistance in the event of reported covariate shocks.

Second, the collection of panel data would help in numerous ways, including through identification of the threshold level of assets above which households smooth their consumption. In the context of the study area, this asset level appears to be towards the high end of asset ownership. This may differ elsewhere. If a range of asset levels were identified, it would be possible to use larger surveys such as Demographic and Health Surveys to improve understanding of the extent and nature of remote poverty in Papua New Guinea.

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Appendix 5: Survey Instruments

Table A5.1 Household survey: general information

Section 1: General information

Name of interviewer: _____

Date: _____

1.1 Interview details

General	(Fill in the details below)	Interview information	(Fill in details below)
Location:	Yelia LLG, Ward 30	Start time:	
Village:		Finish time:	
Household number:			
Household head name:		Sections completed (yes=1, no=0)	
		Section 1: Household information	
Global positioning system (note minutes and seconds on the GPS)		Section 2: Shocks and coping strategies	
Elevation (m)		Section 3: Response to shocks	
South		Coffee plants/and or fish ponds counted	
East		Signature of supervisor	

1.2 Household details

Fill in questions 1-5 before interviewing	Code		3. Electricity			Code
1. Housing			Does the house have electricity (yes=1,no=0)		5. Proximity to local services	
Major construction materials of external walls 1=Traditional bamboo matting 2=Metal sheets/tin 3=Other (specify)			4. Security of household and assets against climatic shocks		How far (walking) is it to the closest aid post? 0-15 minutes.....1 15-30 minutes.....2 30-60 minutes.....3 More than 60 minutes.....4	
Major material of roof 1=Grass thatch 2=Metal sheets/tin 3=Other (specify)			Does the house look waterproof? 1=yes 2=no		How far (walking) is it to the closest school? 0-15 minutes.....1 15-30 minutes.....2 30-60 minutes.....3 More than 60 minutes.....4	
Primary material of floor 1=Bamboo/betelnut palm 2=Earth/sand 3=Other (specify)			Is there a structure to house livestock in poor weather? 1=yes 2=no		How far (walking) is it to the local markets? 0-15 minutes.....1 15-30 minutes.....2 30-60 minutes.....3 More than 60 minutes.....4	
2. Ventilation			Does the household have a separate kitchen? 1=yes 2=no		How far (walking) is it to the closest trade stores? 0-15 minutes.....1 15-30 minutes.....2 30-60 minutes.....3 More than 60 minutes.....4	
What kind of ventilation does the household have? 1=windows which don't close 2=windows with covers						

Person number	Sex (copy from question 4)	Age (copy from question 5)	1. Name What are the names of the people who live in this household? (Note define household as living together the majority of the year and share most meals together)	2. Relationship What is (Name's) relationship to the head of this household? 01=Head 02=Wife/husband 03=Own son/daughter 04=Adopted/foster/step child 05=Grandchild 06=Niece/nephew 07=Parent (mother/father) 08=Brother/sister 09=Brother/sister in law 10= Son/daughter in law 11=Grand mother/father 12=Mother/father in law 13=Other relative 14=not related 9.	3. Residency How many months out of the last 12 did (name) reside in the household? 1= six months or less 2= more than 6 months	4. Sex What is (Name's) sex? 1=Male 2=Female	5. Age What was (Name's) age last birthday? Estimate if exact age not known If less than one year write '00'	6. Marital status What is the present marital status of (Name)? 1= never married 2=married 3=divorced 4=separated 5=widowed	7. Spouse No. Write the person number of the wife/husband Use second column if two wives/husbands If 1 st or 2 nd spouse is not living in the household, write '97' If no second spouse write '00'	
01										
02										
03										
04										
05										
06										
07										
08										
09										
10										
11										
12										
13										
14										
15										
16										
17										
18										

	8. Place of birth	9. Religion	10. OrganisationMembership	11. Length of time living here	12. Reason for move	13. Schooling	14. Current students	15. Literacy	16. Disability	17. Disability
Person number:	In which Province was (Name) born? 1=EHP 2=Other (specify)	1= Anglican 2=Evangelical alliance 3=Pentecostal 4=Evangelical Lutheran 5=Salvation Army 6=Seventh Day Adventist 7=Uniting 8=Roman Catholic 9=Other	1= church committee 2=ward planning committee 3=school board 4=other (specify)	How long has you/(name) lived here? 1=always lived here (if this for all members go to question 13) 2= less than five years 3= more than five years less than 10 years 4= more than 10 years	What was the reason for (name) to move here? 1= married 2=moved to be with family 3=other	What is the highest grade you /(name) have completed in school? 00=no schooling 01-12 =grade of school completed 13= trade certificate 14=other certificate 15=diploma 16=bachelor's degree 17=above bachelor's degree 18= currently at school (go to Q.14)	What is the highest grade you/ (name) have completed in school? 01-12 =grade of school completed	Can you/(name) read and write? 1= yes 2=no mark answer in row of relevant person)	Is there anyone living in your house who has a disability? 1=yes 2=no If no go to Q.18 (mark answer in row of relevant person)	What form of disability does the person have? (answers might include: blind, deaf, birth related problem, not able to speak, not able to walk, mental illness)
01										
02										
03										
04										
05										
06										
07										
08										
09										
10										
11										
12										
13										
14										
15										
16										
17										
18										

Person number:	18. Illness	19. Illness type	20. Basic activities for daily Living	21. Intermediate activities for daily living	22. Treatment	23. Successful pregnancies	24. Ante-natal care	25. Delivery
	Did you/ (name) have any health complaints over the last 30 days? For example a cough, diarrhoea, fever etc. 1=yes 2=no 3= don't know	What was the nature of the illness? 1=diarrhoea 2=fever 3=respiratory illness 4=injury 5=other	In the last 30 days were there days when you/(name) were not able to do the following tasks? - wash yourself - feed yourself - put clothes on - stand up from sitting on a seat - go to the toilet without help - rise from sitting on the floor If so, how many? Write '0' if none	In the last 30 days, were there days when you/ (name) were not able to do the following tasks? - carry a bucket of water 20m - sweep the floor or yard - walk 5km - collect water - bend, kneel or stoop If so, how many? Write '0' if none	In the past 30 days did you/ (name) seek treatment at a health facility for your /(name's) problem? 1=yes 2=no	Have there been any successful pregnancies and childbirths in the last 5 years (meaning both mother and child survived) (place the number of successful pregnancies in last five years in the row corresponding to the person number)	What kind of ante-natal care did the mother receive? 1=attended ante-natal clinics 2=followed traditional birth practices 3=other (specify) (If mother had multiple pregnancies and used different care include both codes in order of birth)	2.How did (name) deliver? 1= with help of VBA in birthing hut 2=with help of VBA at home 3=with help of VBA at health-centre 4=with help of health worker at health centre 5=other (specify) (for multiple pregnancies with different care include both codes in order of birth)
			Days	Days				
01								
02								
03								
04								
05								
06								
07								
08								
09								
10								
11								
12								
13								
14								
15								
16								
17								
18								

1.3 Household employment and assets

Person number:	1. Employment What type of cash generating activity were members of your household engaged in last year? 1=employed by government 2=employed by an NGO 3=cash labourer 4=small shop/trader 5=agriculture (go to question 20) 6=forest products 7=Other (specify)	2. Subsistence Agriculture What kind of agriculture product? 1=pigs 2=chickens 3=coffee 4=food crops 5=fish 6=other (specify)	3. Subsistence Forest products What kind of forest product? 1=timber 2=hunting wild game 3=firewood 4=forest edible products 5=other (specify)	4. Assets 1. How many of the following does the household or any member of the household own :	How many?	Who owns? (write person # down) If jointly owned put '99' in first column							
				Livestock									
01				a. pigs									
02				b. cassowary									
03				c. chickens									
04				d. other poultry									
05				e. fish ponds									
06				Cash crops									
07				a. coffee									
08				b. betel nut									
09				c. other (specify)									
10				Household assets									
11				a. Mobile phone									
12				b. radio									
13				c. farming tools									
14				d. cooking utensils									
15				e. mats									
16				f. furniture (specify)									
17				g. others									
18				Control of assets									
				2. If the asset were sold, or given to someone else, who would make the decision?									

Note: ask to see the household's main garden and/or fishpond verify area of coffee crops and fish ponds at end of interview.

1.4 Household income and expenditure

Income	Approximate amount in last month	Who earned the money? (person number)	Who decided how to spend the money? (person number) if joint decision place '99' in column		3. What are the households major expenditure items over the last 12 months?	
1. What income was earned in the last month from the following sources?					a) clothes	
a) selling coffee					b) food	
b) selling other cash crops					c) cooking oil	
c) selling fish					d) furniture (eg. Table)	
d) selling pigs					e) tools	
e) selling chickens					f) house construction materials	
f) selling garden produce					g) mobile phone	
g) selling firewood					h) bride price	
h) other (specify)					i) funeral	
					k) transport	
2. What household items did you purchase over the last month? (only fill in the first column)					l) school fees	
a) clothing					m) other (specify)	(
b) bedding						
c) soap					Household decisions	Person number) (if joint enter '99')
d) noodles					4. Who in the household usually makes decisions on:	
e) rice					a) purchase of food for household	
f) fish					b) purchase of clothing for you	
g) other food (specify)					c) purchase of clothing of children	
h) cooking oil					b) spending on medicine for you	
i) soap					e) spending on medicine for children	
k) phone card					f) education for boys	
m) funeral					g) education for girls	
n) bride price					h) care of elderly	
o) kerosene					i) to enter into or pay-back a loan	
p) cigarettes						
q) betelnut						
r) church						
s) other (specify)						

1.5 Water supply and sanitation

Water supply	Code		Sanitation	Code
1. Who has primary responsibility for collecting water?			6. What type of toilet is used by your household? 1=Pit latrine with slab 2=Pit latrine without slab 3=bowl or bucket 4= none 5=other (specify)	
2. Who has secondary responsibility for collecting water?			7.Does the household share the toilet with another household? 1=yes 2=no	
3.Where does the household obtain its water for drinking and cooking from? 1= tap water piped in 2=tap water for community 3=protected spring (means it is protected from animals fouling) 4=unprotected spring 5=river or stream 6=rainwater in a drum or tank 7=other (specify) 15.			8. Do you wash your hands after going to the toilet? 16. 1= never 2=sometimes 3=always	
4. How long does it take to travel to the water source? 20. 1=0-15 minutes 2=15-30 minutes 3=30-60 minutes 4=greater than 60 minutes			9. Do you wash your hands before eating or food preparation? 1= never 2=sometimes 3=always	
5.Does the household treat the water in any way? 1=yes 2=no				

Table A5.2 Shocks and coping strategies

2.1 We'd like to ask you about the drought in 1997 and its impact on you and your household

What was the impact of the drought in 1997?	Code	Coping strategies	Code	Code	Code	Recovery time	Code
1. Loss of productive assets 2. Loss of household income 3. Reduced consumption 4. Other (specify		What did the household do? List the three most important activities from most to least important? 1. Spent savings 2. Asked for a loan of money from a family member 3. Asked for a loan of money from a friend 4. Sold animals 5. Help from church 6. Help from a non government organization 7. Help from government 8. Non monetary help from family 9. Non monetary help from neighbours or friends 10. All family members reduced food consumption 11. Mothers reduced food consumption to feed husband and children 12. Stopped consuming some goods 13. Increased hunting 14. Increased foraging 15. Consumed seedstock 16. Consumed livestock 17. Didn't do anything 15. Other, what?				How much time did it take to go back to the position you were in before the shock? Less than a year.....1 One to two years.....2 Two to five years.....3 Six to 10 years.....4 More than 10 years.....5 Never recovered.....6	

2.2 Since the end of the long drought has this household been affected by a shock – an event that led to a reduction in your assets, caused household income to fall, or reduced consumption? We’d like to know more about the worst shocks since the drought finished.

Nature of shock	Specifics of shock (do each category separately and continue down to category 4) 27.	Code	Place an 'X' if shock felt	Of the shocks experienced list the three worst years (from worst to least worst) For each of the shocks identified listed ask the following follow up questions. Did these shocks result in: 1. Loss of productive assets 2. Loss of household income 3. Reduced consumption 4. Other 28. How widespread was this shock? 1. Only affected my household 2. Affected some households in the village 3. Affected all households in the village 4. Affected this village and those nearby Place relevant code in columns next to year.									Focusing on the last two years (since the resource centre was built), have you experienced any of these shocks? When? For each of the shocks identified listed ask the following follow up questions. Did these shocks result in: 1. Loss of productive assets 2. Loss of household income 3. Reduced consumption 4. Other 29. How widespread was this shock? 1. Only affected my household 2. Affected some households in the village 3. Affected all households in the village 4. Affected this village and those nearby Place relevant code in columns next to timeframe.								
				Worst shock (Year)			Lesser shock (Year)			Least shock (Year)			Last four weeks			Between 1 month and 1 year			Between 1 year and 2 years		
1. has there been a weather shock?	Drought	100																			
	Too much rain	101																			
	Rain at wrong time for crops	102																			
	Short rain (not enough)	103																			

[illegible]

listed here..(specify)																			
				When did the person die? (year)	If more than one death fill in year	If husband or wife died ask the following: Did this result in: 1. reduced income 2. reduced consumption 3. other (specify)													
5. We need to ask you some questions about deaths in the family, the circumstances and the impact.	Death of a husband	500																	
	Death of a wife (see next question if applicable)	501																	
	Did she die during or just after childbirth?																		
	Death of an infant (see next question if applicable)	502																	
	Did the infant die during childbirth or in the month after childbirth?																		
	Death of a child (see next question if applicable)	503																	
	Was the child under the age of 5?																		

2.3 Ask the respondent to list the five worst crises from the list above. What did the household do about it to address the loss of assets, income or consumption?

Five most important crises		What did the household do? List the three most important activities from most to least important?			How much time did it take to go back to the position you were in before the shock?
List the five most important crises with the codes from above		1. Spent savings 2. Asked for a loan of money from a family member 3. Asked for a loan of money from a friend 4. Sold animals 5. Sold harvest in advance 6. Help from church 7. Help from a non government organization) 8. Help from government 9. Help from family 10. Help from neighbours or friends 11. All family members reduced food consumption 12. Mothers reduced food consumption to feed husbands and children 13. Stopped consuming some goods 14. Increased hunting 15. Didn't do anything 16. Other, what?			Less than a year.....1 One to two years.....2 Two to five years.....3 Six to 10 years.....4 More than 10 years.....5 Never recovered.....6
Code	Year				

2.4 Seasonality and agriculture related shocks

2.4.1. Over the last season, were there any agriculture shocks experienced? Please mention which crops were affected (up to three crops)

Crop affected (crop codes)	List the three agricultural shocks most from most to least important : 1= too much rain, 2= rain at wrong time, 3=not enough rain, 4=rain at unexpected time, 5= wind/storm damage, 6=flooding/waterlogging, 7= plant diseases, 8= insects, 9= livestock eating or trampling			How badly was the crop affected? 1. slightly 2. moderately 3. badly

Crop codes: coffee=1, sweet potato=2, banana=3, taro=4, greens=5, cassava=6, sago=7, yam=8, pumpkin=9, beans=10, other (specify)=11

2.4.2 Were any crops affected by the following in this period? Place crop code in relevant column (up to three crops)

Household too ill to work at right time	Could not plant at right time	Could not obtain right inputs at right time	No cash for inputs (eg gardening tools, seeds etc)	Other (specify)

2.4.3. We would like to ask about your household food security

In the past 30 days, if there have been times that you did not have enough food or money to buy food, how often has your household had to:	of days	ighting	al
1=Rely on less preferred food			
2=Eat seedstock			
3=Eat breeding stock			
4=Borrow food or rely on help from friends or relatives			
5=Consume more bush food			
6=Hunt more			
7=Reduce number of meals		.	.
8=Reduce size of meals	.	.	.
9=Mothers restrict their meals so that husbands and children can eat more	.	.	.
10=Send children or other family members to friends/relatives houses to eat	.	.	.
.	.	.	.
In the past 12 months, if there have been times that you did not have enough food or money to buy food, how often has your household had to (insert code from above for up to five coping strategies)	No. of weeks	(from) Month	(to) Month
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.

2.4.3 We would like to know what food your household consumed yesterday. Were there members of your household who did not consume this food item?

Food type (insert number from list below)	Household head code (insert here) _____	H/h member code if <u>did not</u> consume food type	H/h member code if <u>did not</u> consume food type	H/h member code if <u>did not</u> consume food type	H/h member code if <u>did not</u> consume food type	H/h member code if <u>did not</u> consume food type	H/h member code if <u>did not</u> consume food type

Food Codes: 1=Sweet potato, 2=banana, 3=taro, 4=greens, 5=tapioca, 6=sago, 7=yam, 8=pumpkin, 9=paw-paw, 10=sugar cane, 11=ripe bananas, 12=corn, 13=cucumber, 14=pineapple, 15=red pandanus fruit (marita), 16=bread fruit, 17=coconut, 18=onion, 19=beans, 20=peanuts, 21=fish, 22=pig, 23=cassowary, 24=chicken, 25=duck, 26=other bird, 27=snake, 28=rice, 29=noodles

2.4.4 We would like to know more about the food your household consumes (place an 'X' in relevant column)

Can you tell me how many times your household consumes the following foods	Household head code (insert here) _____	Number of times consumed per day on average	Number of times consumed per week on average	Number of times consumed per month on average	Never or rarely consumed.
Fresh fish					
Chicken/poultry					
Cassowary					
Bird of other sort					
Pig					
Snake					
Peanuts					
Winged beans					
Vegetable oil					

Table A5.3 Network questions

For the final section of the survey, we'd like to ask each adult in the household the same questions about who helps them when there is a problem and who they help. This will be very repetitive so we would like to split into groups.

NOTE: when finished this section with household head, please ask to see gardens (measure area of coffee crop) and/or fishponds (count fishponds)

3.1 .Can you name people inside of the community or outside that you would help if they were sick and unable to work for two weeks, please rank according to priority. (1= most likely to help)

Name of person (full name)	Person number: (if known)	Relationship code	Where they live 1=village in this ward 2=other ward in Obura Wonenara 3=other district in E.H.P 4=Other Province (specify)	Where they were born 1=village in this ward 2=other ward in Obura Wonenara 3=other district in E.H.P 4=Other Province (specify)	Kind of assistance: 1=cash 2=food 3=firewood 4=labour 5=gift 6=childcare 7=other (specify)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

Codes: 1=mother, 2=father, 3=daughter, 4=son, 5=brother, 6=sister, 7=mother-in-law, 8=father-in-law,9=sister-in-law,10=brother-in-law,11=uncle,12=aunt, 13=cousin (as in English not PNG definition), 14=wife, 15=husband, 16=co-wife
17=other (specify)

3.2 Can you name people inside and outside of the community that would provide help to you if you were sick and unable to work for two weeks please rank according to priority. (1= most likely to help)?

Name of person (full name)	Person number (if known)	Relationship code	Where they live 1=village in this ward 2=other ward in Obura Wonenara 3=other district in Eastern Highlands Province 4=Other Province (specify)	Where they were born 1=village in this ward 2=other ward in Obura Wonenara 3=other district in E.H.P 4=Other Province (specify)	Kind of assistance: 1=cash 2=food 3=firewood 4=labour 5=gift 6=childcare 7=other (specify)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

Codes: 1=mother, 2=father, 3=daughter, 4=son, 5=brother, 6=sister, 7=mother-in-law, 8=father-in-law, 9=sister-in-law, 10=brother-in-law, 11=uncle, 12=aunt, 13=cousin (as in English not PNG definition), 14=wife, 15=husband, 16=co-wife 17=other (specify)

3.3 Over the past two years (since resource centre was built) can you give an example of where you have received assistance from anyone in the community or outside of the community when you have been sick for two weeks and unable to work?

Name of person (full name)	Person number (if known)	Relationship code:	Where they live 1=village in this ward 2=other ward in Obura Wonenara 3=other district in E.H.P 4=Other Province (specify)	Where they were born 1=village in this ward 2=other ward in Obura Wonenara 3=other district in E.H.P 4=Other Province (specify)	Kind of assistance: 1=cash 2=food 3=firewood 4=labour 5=gift 6=childcare 7=other (specify)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

Codes: 1=mother, 2=father, 3=daughter, 4=son, 5=brother, 6=sister, 7=mother-in-law, 8=father-in-law, 9=sister-in-law, 10=brother-in-law, 11=uncle, 12=aunt, 13=cousin, 14=wife, 15=husband, 16=co-wife 17=other (specify)

3.4 Measurement of Fishponds

3.5 Measurement of Area of Coffee Crops

Any other comments:

Thank you very much for your time

Table A5.4 Health Centre Questionnaire

4.1 Table 4: Health centre questionnaire³⁶

General Information	
1. Name of health facility	Andakombi Health Centre
2. Name of respondent	xxx
3. Position of respondent	A/g Officer in Charge
4. Funding of facility	
a) Does the facility receive funding from the government?	Yes
b) How does the facility access funds from the government?	No direct funding, xxx's salary and supply of medicines
c) What does the facility spend the funds on?	
5. When did the clinic open?	A day clinic opened in 1986, it was constructed out of bush materials
6. Does the facility have electricity?	Yes
a) what is the electricity used for?	The electricity is from a solar panel. It should supply the fridge and a light in the birth ward. However, at the moment the light and the fridge are broken.
7. How often is electricity not available?	The electricity is almost always available
Almost always available A few times a year A few times a month Once or twice a week	
8. Source of water	Raintanks, however the pump is broken. Also have water piped (via a PVC pipe) to the facility from a small dam constructed in the river. The facility has taps.
9. Toilet facilities	Pit latrines with a base.
Services offered	

³⁶ Identifying information has been removed and names replaced with "xxx"

1. in-patient care	Yes there is a ward, one stained and uncovered foam mattress, patients need to bring their own bedding.
2. Stitching wounds	Yes
3. Changing wound dressing	Yes
4. Incision of abcess/piercing of boils	Yes
5. Medical treatment for tuberculosis	Yes
6. Check up/health examination	Yes
7. Dental examination	No
8. Prenatal care	Yes
9. Aid for childbirth	Yes
10. Child immunization	Yes but no fridge since November so these have been suspended.
- BCG	Not at the moment see above re fridge
- DPT	Not at the moment see above re fridge
- Polio	Not at the moment see above re fridge
- Measles	Not at the moment see above re fridge
11. Immunization for pregnant women	Yes, tetanus
12. Immunization against Hepatitis B	Yes,
13. Does the clinic offer any contraceptive services such as birth control pills?	Yes, the pill, the mini-pill, condoms (both male and female) and deprovera
10. Does the clinic have regular hours?	
11. What are they?	
12. Are patients charged any fees for visiting the clinic?	

4.2 Staff at clinic

Names	Position	Qualifications	Years of experience	Hours per weeks seeing patients?
	A/g Officer in Charge	Trained as an aid post orderly in 1977	32	
	Village health volunteer	Trained by A/g officer in charge.	18	

4.3 Medical equipment

Equipment type	How many in the facility	How many that work
1. regular stethoscope	yes	
2. stethoscope for pregnant mothers	Yes	3
3. Sterilization/ autoclaves	No	
4. Scales for adults	Yes	1
5. Scales for infants	Yes	1
6. Measures for body height	no	
7. Thermometer	Yes	10
8. Beds	Yes	1
9. Delivery kit	Yes	1
10. Forceps	Yes	2
11. Refrigerator	2	0
12. Alcohol antiseptic	Yes, lots	
13. Betadine antiseptic	No	
14. Bandages	Yes, lots	
15. Minor surgical instruments	Yes, lots	
16. Radio	Yes	
17. Gloves	No	
18. Scissors	Yes, around 15 pairs	
19. Pregnancy tests (strips)	Yes	
20. Protein urine tests (strips)	No	
21. Glucose urine tests (strips)	No	
22. Giemsa dyeing solutions (test for malaria)	A few	

4.4 Medications

Medications	In stock	During past 12 months how many months have you had the medicine available?
1. penicillin	yes	12
2. ampicillin	No	
3. tetracycline	No	
4. Chloroamphenicol	Yes	12
5. Antaligin	NA	
6. Acetosal	NA	
7. Paracetamol	Yes	12
8. INH	NA	
9. Rifampicin	NA	
10. Ethambutol	NA	
11. Streptomycin	No	
12. Anti malarial	Yes Quinine, Chloroquine, Artemidine	12
13. Skin ointment	NA	
14. Cough syrup	No, Co-trimoxazole tablets	12
15. Oralit /gastrolyte etc	Yes	12
16. Iron tablets	Yes	12
17. Vitamin A	Yes, but only one left	
18. BCG	No (burned with fridge broke)	
19. DPT	No	
20 Anti polio	No	
21. Measles	No	
22. Tetanus toxoid	No	
23. Hepatitis B	No	
24. Condoms	Yes	
25. Female condom	Yes	
26. Spermicide		

4.5 Observations

1. Cleanliness of floors, benches and curtains - not clean, dead bugs around
2. Privacy – privacy in birthing suite because it's a separate room
3. Sheets/bedding – one old dirty foam mattress.
4. Temperature of fridge, other stuff stored in it. – fridges broken since November 2011
5. Is there a chart recording temperatures. No

4.6 Other questions

Can you tell me about staffing at the clinic over time?

One health worker stayed from 2009-2010 xxx left last August. xxx has been here for 29 years. Over the period 2003-2008, there was no government health worker.

How frequently has there been no government funded health officer at the clinic?

Generally a problem that health workers come for 2-3 months and then leave.

Any changes in funding, staffing over the past few years?

Lots of visits from Provincial Health office last year, he came three times. He also came in January and promised a box of medicine. Normally would get one visit a year from the PHO. Last year the District health officer came, prior to that he had not visited the facility.

Major change is the introduction of VHVs and VBAs with CARE project. xxx and the VBAs help at the centre. VBAs do the delivery. The A/g OIC sometimes goes to check on mother and baby afterwards.

Follow up interview with xxx (VHV)

Asked about how the emergency notifications worked.

In an emergency the A/g OIC radios Goroka base and they contact the Provincial Health Officer. If he believes the situation is serious he gives permission for the plane to collect the patient.

The PHO will ask the following questions:

- 1) condition of patient
- 2) Whether the baby and mother are strong
- 3) Whether they will die without evacuation.

In 2011, four people were evacuated this way, all were mothers having difficult/dangerous births.

For other injuries, how do you assess their seriousness?

Looks at the patient, in particular their face. If the patient is responsive, it is assumed they are ok. For people who are sick and not emergencies, they are treated in the community. If they do not get better, calls for help in Goroka. They say that they can refer the patient to Goroka hospital, but the patient must pay themselves. If the patient does not have the funds, they cannot go to the hospital.

Sometimes they call for a plane but none is available. Typically it would cost K370 for a seat on a plane. They radio New Tribes, MAF and SDA and see which planes are available to pick up sick patients.

The interviewee confirmed the times that there was no health worker. He also added that when the last qualified worker was in place, she put restrictions on what he could do, now that she was gone there were no such restrictions.

Patients come from:

Yakana (5 hour walk), Wangua (1 hour walk), Yasakane (4 hour walk), Wia Wia (7 hours), Sine (1 hour) and Gualio (2 hours)

The VHV administers IV to patients who require it.

In 2011 there were 42 births at the centre, two still-births. He noted that some families were suspicious of males delivering babies. He says that there are four people who were trained to deliver babies (VBAs and VHVs). Two had since given up.

Table A5.5 : Excerpt from health centre records

	Jan -March 2011	April 2011	May 2011	June 2011	July 2011	August 2011	September 2011	October 2011	November 2011	December 2011
Malaria										
Males										
0-4	16	15	10	7	7	8	4	20	30	22
5-14	1	13	8	3	2	8	2	14	30	12
15+	1	6	1	1	1	1		11	17	7
Females										
0-4	12	10	2	6	4	5	10	18	29	26
5-14	3	11	5	1		2	10	18	27	15
15+	2	10	4		3	3	6	9	23	7
Pnuemonia										
Males										
<1	16	2		1	2	2	4	1	7	
1-4	3	2		2				1	2	2
5+	1									
Females										
<1	3		5		1		3	4	4	
1-4		1		3	1	1			1	
5+					1					
Total visits to clinic for month	74 (male) 68 (female)	96 (male) 99 (female)	73 (male) 53 (female)	50 (male) 67 (female)	50 (male) 45 (female)	71 (male) 88 (female)	57 (male) 79 (female)	110 (male) 139 (female)	194 (male) 190 (female)	87 (male) 96 (female)

