Conflict and Agricultural Portfolios: Evidence from Northern Uganda[1,2]

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Abstract: Conflict and insecurity are disproportionately concentrated in Sub-Saharan Africa, a region which relies extensively on agriculture. While the literature discusses the impact of insecurity on agricultural decisions, this has been directly been empirically tested only once. This study builds on the previous literature by examining the impact of conflict risk on livestock and crop portfolios. Uniquely, the study uses a sample of over 690,000 households, approximately 75% of all rural households in Northern Uganda. I find strong changes in the composition and size of the livestock portfolio and in the choice of crops. These changes are not due to shifting sources of income; households remain just as reliant on agriculture. The analysis suggests that shifts in the composition and levels of assets are one of the primarily paths by which insecurity and, more broadly, conflict affect agriculture and lower welfare.

JEL codes: Welfare and Poverty (I3), Economic Development (O10); Agriculture (O13); Conflict (D74), Risk (D81)

1. Introduction

Agriculture plays an especially important role in many developing countries as "three out of every four poor people in developing countries live in rural areas, and most of them depend directly or indirectly on agriculture for their livelihoods" (World Bank 2008 p.xiii). More broadly, roughly 2.5 billion people live in households which depend on agriculture (World Bank 2008). This reliance on agriculture is especially pronounced in Sub-Saharan Africa (SSA), a region which contains most of the agriculture-based economies.[4] At the same time, SSA has historically been disproportionately affected by violence and conflict; a trend which continues to this day. Since agriculture is linked to many outcomes of interest, such as poverty and nutritional status, and directly affects so many people, it is important to understand the impact of conflict on agriculture.

[1] Earlier versions were circulated under the title: Living within Conflicts: Risk of Violence and Livelihood Portfolios.

[2] The author thanks Pius Bigirimana, the Office of the Permanent Secretary to the Prime Minister of Uganda, and the Ugandan Bureau of Statistics for generously making the Northern Uganda Survey and the Ugandan Census available. Chris Barrett, George Jakubson, David Just, Jordan Matsudaira, Kevin Morrison, Lamuaka Grace Obita, and Godfrey Okot have provided excellent advice. Any remaining errors are solely attributable to the author. The research was partially supported by a travel grant from the Mario Einaudi Center at Cornell University.

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[4] The World Bank describes agriculture-based economies as countries for which agriculture is a major source of growth and in which most of the poor live rural areas. More broadly, it notes that "eighty-two percent of the rural Sub-Saharan population lives in agriculture-based countries" (World Bank 2008 p.4).

Conflict and the threat of violence may affect agricultural decision making in a variety of ways. For instance, (agricultural) assets that support peacetime livelihoods may become liabilities for conflicts (Lautze and Raven-Roberts 2007). Assets such as livestock, are not only more likely be looted, but their very presence may also increase the risk of being attacked, especially if they are difficult to conceal.[5] Similarly, the price of certain assets may be adversely affected by violence. During the Rwandan Genocide, cattle prices decreased by half suggesting that these types of assets may no longer be good ways to store purchasing power nor useful in coping in the aftermath of shocks (Verpooten 2009). Additionally, the composition of livestock portfolios may also respond to insecurity. Large livestock, such as cattle, need to graze and may further expose household members. In contrast, smaller livestock, such as goats or swine, can be kept within villages or individual compounds and are also more easily hidden.

The impact of conflict is not only limited to livestock but also extends to crop production. During periods of insecurity, households may prefer crops whose harvest can be delayed (e.g., root crops), which require little attention (e.g., calabashes) or which are difficult to loot (e.g., rice) (Finnström 2003). Similarly, farmers may shift from intensive cultivation and perennial crops to low-risk and seasonal crops such as green peas and bananas (Vlassenroot 2008). In contrast, more lucrative crops, such as fruits or vegetables, which need to be harvested within a short period of time (and are easily looted) may force households to choose between venturing to exposed fields to harvest and remaining in the relative safety of their village. More broadly, the nature of agricultural-based livelihoods may change. In considering the Democratic Republic of Congo, Vlassenroot notes that "agricultural production had become driven more by the push to minimize [conflict-related] risk than to maximize profit" (p. 210).

Research on the impact of conflict on agriculture has been hampered by the type of data available. These studies can be classified into two broad groups. The first compare pre- and post-conflict data and examine changes in crop production. Similar to Vlassenroot's observation, these studies typically find a shift away from "risky" but profitable crops towards "safer" and less profitable crops (for instance, Bundervoet 2007; McKay and Loveridge 2005). The wide

[5] The risk associated with important peacetime assets, such as cattle, is illustrated by the experience of Northern Uganda. Between 1985 and 1997, the cattle of population of the two of the most affected districts decreased by 98.2 percent (from 285,000 to 5,000), primarily due to raiding by rebels and neighboring cattle raiding communities (Gersony 1997).

ranging shift, in both attacked and non-attacked communities, along with the emphasis on risk suggests that many of the observed changes are not the direct result of violence but rather of the risk of violence (i.e. insecurity).[6] This implies that a narrow focus on violence may ignore many of the effects of conflict. Unfortunately, since insecurity is not observed in the data, analysis of strictly pre- and post-conflict samples do not allow for this distinction to be directly examined.

The second type of studies relies on data collected during conflicts. Many of these are based on samples of convenience or cases studies (rather can representative studies). As a group, these studies reinforce the idea that conflict changes agricultural behavior. For instance, they find strong changes in the composition of crops, and yields due to premature harvesting to reduce the risk of pillage, decreased fertilizer use resulting lower soil quality, and the inability to fallow fields (Bozzoli and Bruck 2009; Tschirley and Weber 1994; Vlassenroot 2008; Vlassenroot and Raeymaekers 2008). Other studies examining labor markets find changes in the allocation of labor between on-farm and off-farm non-agricultural work (Fernández *et al.* 2011).

While studies using data collected during conflicts offers some advantages compared to those using pre- and post- conflict data, they are similarly limited in their ability to isolate the particular pathways from violence to changes in agricultural behavior - this especially true for isolating the relative contributions of insecurity and exposure to violence.[7] This inability is due to the lack of data on insecurity. Since they only contain variables for the location or exposure of violence, these variables jointly capture the effects of violence and of insecurity (insofar as it is correlated with violence). Moreover, it ignores the effects of insecurity in non-violence affected areas. Therefore, even though the literature finds results consistent with responses to insecurity, it is never directly measured.

An important (and potentially unique) exception[8] is Arias *et al.* (2014) who explicitly examine the effect of (one type of) insecurity. The authors study the effect of the presence of non-state

[6] This would match the results of Rockmore (2013) who finds that more than half of the consumption per capita losses in the same Northern Ugandan setting arise from exposure to insecurity as opposed to direct exposure to violence.

[7] While not discussed here, there is also a small literature which casually links exposure to violence to change in risk aversion and time preferences. In turn, these could affect the choice of livelihoods along a variety of dimensions. See Callen *et al.* (2014); Moya (2014); Voors *et al.* (2011).

[8] Ibanez *et al.* (2013) examine the impact of the threat of violence on coffee production. They estimate the impact of violence using the number of military actions by warring factions against the civilian population. In this way, their estimate captures the effects of the risk and realization of violence in the community.

armed groups and the duration of their presence on the choice of perennial versus seasonal crops in Columbia. As the tenure of these groups in the area increases, the uncertainty (and hence risk) decreases, leading farmers to plant more perennial crops.

Building on Arias *et al.* (2014), this paper explicitly measures the impact of insecurity on agricultural decision making. In particular, I provide the first estimate of the relative effect relative effects of insecurity and exposure to violence on the livestock and the second on crop portfolios. Spatially disaggregated measures of the risk of attack are created using the spatial-temporal variation in the placement of attacks (Rockmore 2013). I find strong responses in both portfolios. In particular, both the composition and size of livestock portfolios are substantially impacted. Not only does the size of the livestock portfolio strongly decrease but there is also a pronounced shift from large to small livestock. This matches expectations that smaller livestock are less risky since they are less exposed than larger grazing livestock. There are shifts in the cropping choices at the extensive margin.

The analysis uses several different data sets to overcome potential problems with identification and to test the robustness of the results. The primary analysis relies on the 2002 Ugandan Census. The final sample contains information for more than 690,000 rural households, roughly 75 percent of all rural households in Northern Uganda. The scope of the survey is important since much of the variation in the "placement" of violence is across geographical regions. Consequently, the risk of violence is necessarily correlated with a variety of other factors that influence the relevant outcomes. While this can be overcome with geographic fixed effects, the remaining variation in the risk of violence makes it difficult to accurately identify the impacts of (the risk of) violence in conventional samples.

The Census data are supplemented by the 2004 Northern Uganda Survey. In addition to providing an alternate data set to test the robustness of the results, the rich set of variables allow us to control for a variety of concerns linked to individual exposure, remoteness and the availability of inputs and output markets. The results for the livestock are robust at the 1 percent level with very similar coefficients across data sets (and years). Since there are no data on cropping patterns, the robustness of these results cannot be investigated.

The results suggest that conflict risk causally changes agricultural decision making with respect to livestock and crop portfolios. While this could arise for a variety of reasons, the data allow us to rule out certain possibilities such as endogenously changing livelihood. In particular, although there are strong changes within agriculture, there is limited to no change in whether or not households rely on agriculture. This implies important welfare effects from conflict risk.

Taken together, the analysis suggests that, in the context of Northern Uganda, households primarily responded to insecurity through the size and composition of their portfolios, particularly by shifting from profitable opportunities to low-risk low returns activities. More broadly, these responses are also suggestive as to the origins of the important adverse health consequences associated with growing up during conflicts. While current studies have found that growing up during conflict leads to higher rates of stunting (Akresh *et al.* 2011, 2012; Bundervoet *et al.* 2009; Minoiu and Shemyakina 2014), they do not identify the particular pathways from conflict to stunting. The results presented here suggest that insecurity (separately from violence) leads to strong shifts in dietary diversity, as found by Debalan and Paul (2014) and, most likely, in calories and nutrients.

The remainder of the paper is organized as follows. Section 2 provides a detailed description of the context and the data. Section 3 presents the methodology and the main results. Section 4 considers additional pathways and section 5 concludes.

2. Northern Uganda: Background and Data

While Uganda has experienced a variety of internal conflicts since independence, the conflict in Northern Uganda lasted from 1986 until 2008 with only briefs respites. The Lord's Resistance Army (LRA) was formed by Joseph Kony from the remnants of Alice Lakwena's Holy Spirit Movement, which had sought to replace the national government in Kampala, along with elements of other insurgent groups. While the LRA initially sought support from the Acholi, one of the main ethnic groups in Northern Uganda, the local population did not support them. As a result, the LRA raided local communities for supplies and forced recruits. These raids were widespread during the conflict as representative data suggests that 19, 25 and 25 percent of Northern Uganda communities were attacked in 1992, 1999, and 2004 respectively (Ssewanyana *et al.* 2007).

The prolonged conflict resulted in a variety of responses by Northern Ugandans. While the conflict led to voluntary migration, the number of internally displaced persons (IDP) increased substantially beginning in 1996 when the government forced the populations of the most affected regions into IDP camps (Fiala 2009). At their peak, an estimated 1.8 million persons lived in IDP camps and many districts were virtually emptied (IDMC 2010).

The analysis relies on three primary datasets. The first is the 2002 Ugandan Census. It contains an agricultural module on livestock holdings at the time of question and on crops grown during the January-June, 2002, period (the last growing season prior to the Census). In addition to being the most recent census, it was also collected during the conflict and provides a variety of information on the 24.2 million individuals in Uganda. Consequently, rather than relying on representative data (as with research based on surveys), it is possible to directly observe crop and livestock portfolios for the full population. Additionally, the scope of the survey provides sufficient variation to overcome potential problems linked to the use of fixed effects.

Although the Census contains data on 920,958 households in rural areas of Northern Uganda, the final sample contains only 690,836 rural households (75.0% of the overall rural population in Northern Uganda). This discrepancy arises for three reasons. First, as is described below, the empirical strategy relies on linking the census data with a geo-referenced map. The only parish level map of Northern Uganda is from 2006 but a variety of new parishes were established between 2002 and 2006. One of these new parishes could not be matched with the Census data, resulting in the loss of its 41,002 households (5.2 percent).

Second, while the agricultural module was administered to each household, 139,299 households (15.1 percent) could not be matched with the agricultural module. The pattern associated with the matching does not appear to be systematically related to exposure to conflict or to cropping or livestock patterns. Rather, it is primarily due to the incorrect coding of parish identifiers. For instance, the identifier might be for the 4^{th} parish in a district with only 3 official parishes. Although households that cannot be matched to the geo-referenced have a slightly higher average incidence of exposure to conflict at the parish level (45.6 versus 41.0 percent), their mean estimated conflict risk is slightly lower (38.0 versus 38.8 percent). Third, a further 49,891 households are omitted due to missing information from the community portion of the census (5.4 percent).

The second data set is the Northern Uganda Survey (NUS) 2004, which was similarly collected during ongoing violence. It is a geo-referenced community and household dataset representative for Northern Uganda. It contains detailed information on a variety of topics including individual and community exposure to violence and household consumption. After omitting communities and associated households with recorded coordinates outside of Uganda, households without food consumption or abnormally high holdings of land[9] and urban households, the final NUS sample contains 230 rural communities and 2,300 associated households. While the NUS contains information on livestock holdings, there is no information on cropping decisions.[10]

The last data set is the Armed Conflict Location and Event Data (ACLED) for Uganda (Raleigh and Hegre 2005). The ACLED data are drawn from a variety of sources including press accounts, books, and humanitarian worker accounts. The data are disaggregated by event type, year, participants, and geographical coordinates. This paper only uses the events that are violent, include the LRA, and occurred in 2003 or earlier. Additionally, since the precision of the geographical coordinates varies, I only include those that are precise to the village or sub-region location and exclude those which are only recorded at the regional level. The ACLED data are used to supplement the data on the geo-spatial variation of LRA attacks from 1997 until 2003.

These data are supplement by geo-spatial environmental data generously shared by Lang *et al.* (2010). Further information can be found in that paper. These include parish level measures of the percent of the parish land in different land types and agro-ecological zones. Appendix tables 1 and 2 present descriptive statistics for the data used.

3. Empirical Strategy and Results

Since this paper aims to separately estimate the effects of exposure to violence and of insecurity, it requires data on each. While the data described above contains information on the location of violence, it does not contain similar information on insecurity. Consequently, I follow Rockmore (2013) and use the geo-spatial variation in the location of violence to construct spatially disaggregated measures of the risk of violence. Having created these measures, I then use them to estimate portfolios responses to conflict risk.

[9] Households who report more than 200 acres of land are omitted as outliers. The overall sample for all of rural Northern Uganda has mean holdings of 3.7 acres with a standard deviation of 5.4 acres.

[10] There is indirect information related to consumption of self-produced food but is not sufficient for use as a robustness check.

In the following sections, I begin by describing how the Northern Uganda context influences the estimation of conflict risk and then describe how conflict-risk is specifically estimated for using Census and NUS data.

3.1 Conflict risk in Northern Uganda

Conceptually, violence can be thought of as occurring on two separate but related levels: geographic and within area. The former "placement effect" encompasses the reasons that determine which areas experience violence (see Jacoby 2000 for a discussion of placement effects). In the context of conflict, the characteristics of an area, such as the physical geography or its ethnic homogeneity, may influence the likelihood of being attacked (as well as the observed outcomes). The second effect is the within community heterogeneity - even within a community that is attacked, households may face very different risks of experiencing violence. For instance, in ethnic or religious conflicts, such as genocide in Rwanda or inter-communal violence in India, this risk may vary greatly among households within a community and will therefore result in different household responses.

In the context of Northern Uganda, however, there are a variety of reasons to believe that both actual and perceived conflict-risk may be largely homogenous within communities. The indiscriminate nature of the violence emerges in interviews with rebel commanders who note that their strategy was to attack and capture as many people and then to sort them out later (Blattman and Annan 2010). This reflected the ideology of the LRA to "purify" Northern Uganda of corruption and witchcraft through violence (Allen and Schomerus 2006; Branch 2010; Titeca 2010; and Finnström 2003). This resulted in an in-group (LRA members) and out-group (everyone else) mentality which was reinforced by the widespread attacks and abductions in the area – close to 40 percent of males and 20 percent of females aged between 14 and 30 were abducted in the most affected areas (Beber and Blattman 2010).

An analysis of representative[11] data from two of the most affected districts finds quantitative support for this view. Using recall data on household and community characteristics, Blattman

[11] Blattman and Annan (2010) use World Food Programme (WFP) food distribution lists from 2002 and a retrospective household roster to create household rosters for 1996, a time which predated 85 percent of local abductions. The roster was used to create a representative sample of young men from eight sub-counties within Kitgum and Pader districts.

and Annan find no significant differences in the mean characteristics of abducted and non-abducted youths (and their families) with the exceptions of the age of the individual and the size of the household. The former reflect the preference of the LRA for children old enough to be militarily useful but also sufficiently young to be controlled. The importance of the size of the household is due to households with 25 or members, a rare occurrence in Northern Uganda. For instance, in the Census data, only 0.1% of rural households in Northern Uganda reported having 25 of more members. This suggests, that conditional of being with a village during an attack, abductions (and presumably therefore exposure to violence) by the LRA were largely exogenous of individual and household characteristics. Consequently, after controlling for the "geographical placement of attacks", cross-sectional data can be used to identify the effects of risk

In contrast, the "geographic placement" of attacks by the LRA was not random. Although the LRA operated throughout Northern Uganda, it primarily operated in the Acholi districts. While the tactics and motivations of the LRA are unclear, there are several plausible explanations for this targeting, such as the substantial linguistic differences throughout Northern Uganda. Since the original LRA members primarily came from the Acholi districts, it was also easier for the LRA to operate in these areas and to communicate with abducted individuals from these districts. Moreover, although the main bases for the LRA were in Southern Sudan, they had a number of smaller bases in the area including in Pader district (Fiala 2009). Over time, especially after 2002, LRA attacks became more frequent in other parts of the country (Ssewanyana *et al.* 2007). This is partially due to the forced displacement within the Acholi districts by the government which deprived the LRA of potential targets for supplies and abductees, thereby forcing the LRA to shift their attacks.

More broadly, the only study (of which I am aware) on within versus across community differences in perceptions suggests that across-community variation in beliefs is substantially higher than within-community variation (Doss *et al.* 2008). While there is surely some intra-community heterogeneity in beliefs, as is subsequently discussed, the regression controls for many of the arguably most important factors – previous exposure to violence, demographic structure of the household, female head of household – so that any remaining heterogeneity is likely small and random.

3.2 Measuring conflict risk

As shown in the preceding section, conflict-risk was likely relatively homogenous within communities and consequently the estimation focuses on more aggregated levels. In general, for both data sets, I estimate a variation of:

$$(1)\ \ln\left[\frac{\Pr(Y_i=1)}{1-\Pr(Y_i=1)}\right] = A + \sum_{t=1}^{n}\beta_{it}distance_{it} + E_i$$

where conflict risk for location *i* is a linear combination of the distance to the nearest attacks in the previous periods, *t*. The coefficients in the equation are the relative weights for attacks in the previous periods.

Census

The Census data offers some advantages and disadvantages for estimating conflict risk. In contrast to the NUS and ACLED data, which only record some instances of violence, the Census allows for a full map of rebel activity for the region. That is, survey data provides a representative map of the location of violence; the ACLED data give reports on certain acts of violence but certainly only for a subset. Since the Census was given throughout the country, it contains reports from every village/community within the country.

However, in the Census, the timing of attacks (relative to the data collection) is somewhat unclear; the specific question in the Census asks whether there was any rebel activity[12] within the past 12 months. Since the Census occurred over a period of time, rebel activity in one area may have occurred after data in another area. In practice, this concern is largely mitigated. The entire census lasted only 1 week, so it is very likely that all reported rebel activity preceded the data collection in all of the areas. Consequently, while the spatially disaggregated risk parameters creating from the Census data cannot be interpreted in the same casual manner as those from the NUS data, they are very suggestive.

[12] While "incidents of rebel activity" are potentially less precise than "attacks by the LRA" (as recorded in the NUS), this is the only relevant information available in Census. Moreover, the LRA was essentially the only rebel group operating in Northern Uganda.

As noted earlier, the dependent variable is formed using a question which asks whether there was any rebel activity[13] within the past 12 months.[14] [15] Since it does not contain any detail on the specific months and only examines the previous 12 months, equation (1) is modified to:

$$(2)\ \ln\left[\frac{\Pr(Y_i=1)}{1-\Pr(Y_i=1)}\right] = A + \beta_i distance_i + E_i$$

where the dependent variable, Y_i, refers to whether there were any incidents of rebel activity within any enumeration area with parish i. A denotes the level of conflict risk within a parish if the distance to rebel activity in the year is 0. *distance* measures the distance from parish *i* and the nearest parish *(*excluding parish *i*) which has rebel activity during the preceding 12 months. E_i is an error term that is assumed to have mean 0. The errors in the logistic regression are clustered at the parish level. The results of the estimation of (2) are presented in table 1. Despite the low number of explanatory variables, there is a relatively strong fit as 69% of the data is predicted correctly.[16]

NUS

The NUS is complementary to the Census data. While it does not have the same scope, it offers several advantages. First, it is possible to estimate the conflict risk at the village level thereby reducing concerns about unobserved variables. Second, the NUS contains information regarding historical attacks. Similarly, ACLED also has historical attacks. Consequently, it is possible to use only attacks that clearly precede the survey as independent variables when estimating risk levels.

[13] While "incidents of rebel activity" are potentially less precise than "attacks by the LRA" (as recorded in the NUS), this is the only relevant information available in Census. Moreover, the LRA was essentially the only rebel group operating in Northern Uganda.

[14] While this question was asked at the community level, the answers are aggregated up to the parish level since this was the lowest aggregation which we could spatially map. The results in a loss of precision although parishes are still relatively small; they are the level of geographic aggregation immediately above the village and typically contain only a handful of villages (generally 3-9).

[15] The community questionnaire was administered to a group of local leaders including the local chairperson, the Secretary for Youth and the Secretary for Women Affairs. As with the NUS data, there is little reason to believe that the data are systematically incorrect.

[16] To verify the quality of the estimation, I verify whether the distribution of the predicted dependent variable matches well with the actual distribution of the dependent variable. To do this, I classify predicted values of over 0.5 to 1 and values at 0.5 or below to 0. I then see what percent are predicted correctly. Note that the recoding of the predicted variable is only for the purposes of looking at the fit. For the subsequent analysis, it is a continuous variable bounded by 0 and 1.

Lastly, with the Census, it was only possible to estimate the risk of the LRA being active in an area. That is, instead of estimating perceptions, which determines behavior, the conflict risk estimated from the Census is more of a probability. In contrast, with the NUS data, it is possible to essentially measure perceptions. While the two are likely highly correlated, they may differ in important ways.[17]

The following logistic regression is estimated using the NUS data:

$$(3)\ ln\left[\frac{\Pr(Y_i=1)}{1-\Pr(Y_i=1)}\right] = A + \sum_{t=1992}^{2003} \beta_{it} distance_{it} + E_i$$

where the dependent variable, *Y*, is measured at the community level. For perceived risk, the dependent variable *Y* is a binary variable for whether any section of the community found it hard to cultivate their land in 2004 because of insecurity. Therefore, the predicted value is the likelihood that any section of the community found it hard to cultivate land during the year.[18] Importantly, this is not a direct measure of the perception of insecurity. Rather, finding it hard to cultivate the land is a result of this perception and therefore it may slightly underestimate the prevalence of perceived risk.

The independent variables, *distance*, represent the distance of community *i* from the closest LRA attacks in each of the previous years. Separate distance measures are constructed from the NUS and ACLED data. The NUS data only contain recall data for attacks on each community in the sample for 1992 and 1999. The ACLED data contain yearly data for 1997 until 2003. There are therefore 9 independent variables (2 from the NUS and 7 from the ACLED data).

The results from the estimation of equation (3) are presented in table 3. The errors in the logistic regression are clustered at the community level. As can be seen, a little over 80 percent of LRA attacks at the community level are correctly classified suggesting that the model does a good job of predicting attacks.

[17] Within the specific context of Northern Uganda, Rockmore (2013) demonstrates that the two lead to qualitatively similar (but not identical) results.

[18] This segment of the questionnaire was administered to a group of community leaders representing different segments of the community, including women. Insofar as LRA attacks were important events, it is unlikely that the leaders would be unaware of prior attacks. Additionally, since the questionnaire was administered by a statistical agency unconnected with relief work, there is little incentive to falsely report attacks. Since this refers to a subjective belief, it is possible that the community leaders may have been unaware of the activities of others within communities. However, since most respondents are directly involved with agriculture, it is likely that difficulties related to farming are shared and communicated within communities.

3.3 Agricultural portfolios

According to the recall data in the NUS, in both 1999 and 2004, agriculture was the primary source of income for at least 75% of the NUS sample, making it the leading candidate for the sector in which responses to conflict-risk might occur. I examine this possibility by focusing on livestock holdings and cropping choices.

Livestock

The number of each major livestock type[19] is estimated using a series of tobit models and the Census data.

$$(4)\ Livestock_{ijk} = \alpha + \beta_1 \widehat{Risk}_j + \beta_2 \widehat{Risk}_j^2 + \theta Violence_j + \delta X_{ij} + \gamma_k + \varepsilon_{ijk}$$

where the livestock holding of household *i*, in parish *j* and sub-county *k* are presumed to be correlated with: (1) α: an intercept; (2) *Risk*: as estimated earlier using equation (2) and which enters with both linear and quadratic terms; (3) *Violence*: any LRA activity within the parish; (4) X: a vector of controls for household characteristics (demographic profile[20], proportion of literate adults, and the gender, age, literacy, marital status and education of the head of the household), whether or not the household also produces crops, household assets[21], community characteristics[22], and parish level agro-ecological measures[23]; and (5) γ_k: sub-county fixed effects. The sub-county is the geographical level immediately above the parish and adds 198 additional fixed effects that control for a variety of unobserved sub-county invariant factors.

One important concern and potentially omitted variable are refugee camps. Importantly, these tended to be concentrated in the Acholi districts so the sub-county fixed effects reduce the potential impact. This concern is also be explicitly addressed in the estimation with NUS data. Additionally, the fixed effects also address any regional differences in livestock holding patterns, weather and preferences (such as between Karamoja and the rest of Northern Uganda).

[19] These are cattle, sheep, goats, poultry and pigs.
[20] Household demographics are disaggregated by gender and by the total number of individuals aged 0-5, 6-16, 17-50 and 51 and older in each household.
[21] The binary asset variables measure ownership of land, house, motor vehicle, motorcycle, bicycle, and mobile phone.
[22] Binary variables include those for a human disease epidemic, the presence of micro-finance institutions and for the presence of an all-weather road, and for the presence of seasonal roads in the enumeration areas.
[23] The agro-ecological controls include measures for the percent of the parish area with shrub or tree leaf, herbaceous, coniferous plantation, woodland, bushland, grassland, or wetland cover. These also include the percent of land in humid, sub-humid, semi-humid or transition agro-ecological zones respectively.

Atypically large holdings of livestock are also omitted[24]. The error term, ε_{ijk}, is assumed to be mean zero and normally distributed.

As noted earlier, the risk estimates from the Census data are estimated using data from current attacks and therefore the timing of surveys relative to attacks is somewhat uncertain. Consequently, the estimated effect of conflict risk, β, cannot be interpreted as having a causal effect on livestock holdings. Despite this, the literature review on the effects of conflict risk along with the literature on the placement of attacks in Northern Uganda suggests that these results may be stronger than mere correlations. In particular, since the LRA tended to attack whichever village they encountered, shifts in household livestock holdings should not influence risk levels (especially at the parish level).

The results for the primary livestock in Northern Uganda are presented in table 3. Livestock holdings are relatively prevalent with both goats and poultry owned by roughly half of the sample. Ownership of sheep or cattle is less prevalent (10 and 20 percent ownership, respectively) while pigs are the least widely owned type of livestock.

The clear quadratic relationship between risk and the amount of livestock owned suggests that the magnitude of responses to risk decreases as risk increases. Interestingly, livestock that need to be grazed showed the largest implied[25] declines due to conflict risk. Moreover, poultry, which can be exclusively raised within a compound or village, showed the lowest relative decline. These results strongly match priors from previous studies on how household livestock portfolios respond to conflict risk. The large implied increases in pig holdings are also consistent with the particular context in Northern Uganda as both the LRA and the Karamajong, a neighboring ethnic group which frequently raided livestock, are not interested in pigs. The overall effect,

[24] A conservative measure of outliers is used; an outlier is any observation that is more than 6 standard deviations away from the mean of individuals who have positive holdings. If the sample were normally distributed, there should not be a single household that is 6 standard deviations from the mean (even in a sample with over 500,000 observations), much less than the mean of non-zero holdings.

[25] The average effect of risk is created by multiplying the coefficients for the risk terms, β_j, with the averages for linear and squared risk within the sample. The implied effect is the average effect of risk divided by the average non-zero holdings. That is, the implied effect of livestock j = $\frac{\beta_j * mean\ Risk}{mean\ holdings\ for\ households\ with\ level\ of\ livestock\ j>0}$ This is a more conservative estimate than when the mean holdings of livestock j are used. Since certain livestock, such as pigs, are kept by a relatively small amount of households, the mean holdings are substantially smaller than the mean positive holdings. The implied effect is the average effect divided by the average positive holdings.

however, may be limited due to the relatively low amount of households reporting any pig holdings.

Overall, the results suggest that conflict risk is correlated with a strong decrease in the wealth held in livestock. While the census does not contain information on the prices of livestock nor on household income/consumption, this information is available in the NUS data. Using the median 2004 prices[26], at the mean risk levels, the value of the average livestock portfolio declined by roughly 260,746 shillings ($150), which represents roughly 65% of the average value of livestock holdings and 25.5% of the mean annual consumption. The data are not sufficiently detailed to examine what happens to the proceeds from the livestock sales. Since Rockmore (2011) finds that increased conflict-risk leads to lower consumption levels, these proceeds do not appear to be consumed. While it cannot be verified, households may use the proceeds to self-insure against possible future shocks.

In sum, within the livestock portfolio, there is a significant shift away from large grazing animals, such as cattle, towards smaller livestock which can be maintained within villages or compounds. Additionally, the relative importance of pigs in the livestock portfolio increases greatly.

Robustness of livestock change

Although the Census contains data on livestock, it does not contain information on prior attack on households. While the variable for rebel activity within the parish may account for attacks in the current year, there is also no information on prior attacks. Insofar as previous attacks are correlated with the current placement of violence, the estimated parameter may reflect both factors. That is, the strong effect of risk may simply reflect the results of prior attacks.

This possibility is investigated using the NUS data which allow us to control for prior exposure to violence at both the household and community levels. In particular, I estimate the following tobit for each livestock grouping:

(1) $Livestock_{ijk} = a + b_1\widehat{Risk}_i + b_2 Experience_{ij} + b_3 X_{ij} + e_{ij}$

[26] Since the price data are imprecise and contain clear outliers, the price data were purged of prices which were more than six standard deviations above the non-zero price mean for that particular livestock. The median value of this adjusted price distribution is then used.

where the subscripts refer to community *i*, household *j* and livestock group *k*. As described earlier, in the NUS data, conflict risk is estimated at the community level. Consequently, $\widehat{\text{Risk}}_i$ refers to the conflict risk experienced by community *i*. The vector contains both the fitted risk value and its square (thereby allowing for non-linearities in responses to risk).

The *Experience* vector measures the experience of violence in community *i* and household *j*. These variables are separated based on the level of aggregation (community or household). Community and household experiences of violence may differ for a variety of reasons including migration, the spatial distribution of household or even the nature of the specific attacks. Additionally, the effects of the two experiences are likely to be different. Whereas community level attacks may affect the broader economy and public goods, household attacks may lead to the destruction or theft of personal assets, the abduction or death of household members or psychological trauma.

The experiences are also divided based on the time elapsed since the shock. In particular, binary variables are included for whether community *i* and household *j* have experienced an attack from rebels since 1992. A binary variable for whether community *i* was attacked by rebels in 2004 is included. The survey did not contain a similar question for households. There are questions regarding abductions in 2004 as well as abductions since 1992 which are included in the control vector, X_{ij}.

The control vector, X_{ij}, contains a variety of household and community-level controls including the demographic structure of the household, migration, highest education IDP camp residence. It also contains district fixed-effects. Since livestock returns may be affected by a variety of community characteristics, I also estimate an enhanced version which includes a variety of controls (potentially endogenous for markets and remoteness). In this enhanced specification, the vector also contains controls for the type and availability of local roads, agricultural and non-agricultural markets, availability of electricity, availability of credit, food distribution, proximity to an IDP camp (<5 km), and army and police bases.

Table 4 presents the results and compares them with those from the estimation using the Census data. Column (1), (2) and (3) present the results from the estimation of the base specification, the

enhanced specification and from the Census respectively.[27] The results are all relative to the mean positive holdings for each livestock category.

Despite changing the type of data, the year of the data, and the measure of conflict risk as well controlling for current and historical exposure to violence, the results remain qualitatively similar. There is a pronounced move from large livestock towards smaller livestock, particularly poultry. The ordering of the decline changes as there is a sharper decline in the largest livestock (i.e. cattle) in the NUS data. Interestingly, despite the notably smaller number of observations, the results are highly significant for all livestock groupings. The main difference between the NUS and Census results is that pig breeding declines sharply in the NUS data. Since few households breed swine (less than 5% of rural households in the Census data), this change might reflect the relatively low percentage households with swine in the much smaller NUS dataset.

One remaining concern is related to the government forcing households in certain areas to relocate to IDP camps. Presumably, the forced relocations were located in areas which were likely to be attacked. In order to avoid panic sales, households in these areas might anticipate the relocation and decrease their livestock herds and shift towards livestock that fit better in an IDP camp context. Since the results are qualitatively similar across years and datasets, this concern is somewhat muted. Moreover, the NUS results control for both IDP camp residence and proximity to a camp.

Cropping

While livestock are important, many households own little or no livestock. In part, this is the outcome of the war which led to livestock losses and sales. Consequently, the choice of crops provides another way to mitigate conflict risk within agriculture. In contrast to the information on livestock, the total production of crops is not in the Census data. Therefore, cropping patterns are estimated using a series of probit models.[28] These models largely match equation (4) except that the control variable for the household producing crops is switched with a variable for the household owning any livestock. For households with livestock, the size or the composition of

[27] The full results are available upon request.

[28] The probits are not estimated using a system of equations due to the size of the data. With over 670,000 households, the system would have over 4 million observations and over 200 independent variables. Computationally, this would require considerable time and computing power for limited gains in standard errors.

livestock portfolios might also influence cropping decisions due to the need for draught power, manure or means to sell crop output.

Table 5 shows the effects of the estimation. As compared to the previous examination of livestock, this estimation "underestimates" the effects of risk. Since the probit examines the probability that a household grows a particular crop, it does not capture shifts in the intensive margins of production that leave crop choice unchanged. Despite this, there appear to be strong effects of risk on the most prevalent crops. Moreover, these affects largely follow the predictions from the literature.

The large decrease in households growing cassava (-7.4% marginal effect at the sample mean for risk) is likely due to two factors. First, relative to other alternatives, cassava takes long to mature. Consequently, in areas where there was the threat of the LRA displacing populations, crops with long maturation periods could leave households without a harvest. Additionally, despite cassava's ability to well in marginal and stressed environment, its yields crucially depend on weeding with delays leading to yield reductions of over 90 percent (FAO 2005). Insecurity may reduce the ability of households to consistently weed their plots, particularly if these are not located near there homesteads.

Beans (-9.7%) and sweetpeas (-1.6%) similarly require extensive weeding and care. For instance, bean production is very labor intensive due to the need to clear the bushes and tall grasses endemic to Northern Uganda as well as labor intensive to harvest and to winnow (Fit Uganda Ltd. 2007). Moreover, these were viewed as being crops liked by the LRA since they are easily harvested and prepared and are very nutritious. Consequently, during an attack, these were highly likely to be stolen. In contrast, millet (+1.6%) is difficult to harvest making it more likely to survive a raid by the LRA.

In general, table 5 shows a clear and important response in cropping decisions along the extensive margin. While it is not possible to identify the exact reasons for the declines of particular crops nor the relative magnitude, the results are consistent with the qualitative literature; in times of insecurity, households appear to favor crops with short maturation times, crops which don't require repeated work (such as weeding), and crops which are relatively difficult to steal.

4. Further Household Responses

Although the results above find strong changes in livestock and crop portfolios due to conflict risk, this is possibly driven by other factors. In this section, we examine a specific explanation: namely, households relying less on agriculture and switching to other sources of income. If households remain dependent on agriculture, any changes to the portfolios have much more severe consequences for households and their welfare. As we show below, the evidence strongly suggests that sources of income are broadly unaffected by the conflict risk.

Note that throughout this section, the measure of conflict risk for the NUS changes. Earlier, I used a question regarding whether any section of the community found it hard to cultivate their land in 2004 because of insecurity. Unfortunately, it is not possible to do so for 1999.

I therefore (re-)estimate risk for the NUS sample in the same manner as earlier, with equation (3), but change the dependent variable to whether or not a community was attacked in 1999 or 2004. Since the ACLED data only starts in 1997, I standardize the number of lags on attacks to two years for both the 1999 and 2004 estimates.[29] The resultant predicted variable therefore measures conflict-risk, similar to when the Census is used.

Sources of income

One potentially important response to conflict risk is a shift in household income sources (i.e., changes in livelihoods). This shift may be voluntary as households seek to minimize exposure or forced as assets or infrastructure which underpin certain income sources become unavailable or less effective. This is examined by looking at the self-declared primary sources of income for households in 1999 and 2004.

Household responses are examined by comparing changes in the main sources of income[30] between household in the communities which experience the greatest changes in estimated conflict risk levels between 1999 and 2004.[31] By comparing changes in income sources within locations across time, it is possible to eliminate the effects of any time invariant location-specific

[29] The results for this estimation are available in the online appendix table 3. Note that the relative fit is close 80 percent.

[30] The NUS data do not record the amount of income from each source. Since it only notes the principle self-reported source of income, it is not possible to examine change in the relative contributions of differences sources.

[31] Objective risk levels in 1999 are estimated in the same manner as previously described. Since the available information on the placement of violence differs between the two periods (due to the shorter available time series for 1999), the risk levels for 2004 in this section are re-estimated using the same number of lags on the distance to violence as in the 1999 estimation. Again, the relative fit of the risk measures is close to 80%.

effects. Since communities have statistically indistinguishable levels of estimated risk in 1999, this approach resembles a difference-in-difference methodology.

Specifically, comparisons are made between the households with the greatest increase and decrease in conflict risk. Since these households experience the greatest change between the two periods, they should be the ones most likely to show changes. These households are grouped according to the distribution in the change of estimated risk between 1999 and 2004. Table 5 presents the results for the 1st and 5th quintile where the households in 1st quintile have the greatest decrease in risk between 1999 and 2004.[32]

This analysis relies only on the non-IDP NUS sample due to the substantial difference in income sources in IDP camps and the great increase of IDP camps during this period. The number of internally displaced individuals greatly increased during this period, particularly in late 2002 after Operation "Iron Fist" with reported increases of 100,000 internally displaced individuals in 7 months in 2002 (NRC 2004). Within IDP camps, since there was limited access to land and income generating opportunities, the population became increasingly dependent on food aid (Allen and Schomerus 2006). The percent of households that report that "other transfer (food aid, other aid)" was the main sources of income increased from 4.3 to 19.8% for households who were in IDP camps in 2004 as compared to a constant 0.3% in non-IDP households. Consequently, when the IDP camp population is included, there appears to be a strong change in income sources due to risk.

As can be seen at the top of table 6, despite almost identical levels of estimated risk in 1999, the groups (1st and 5th quintiles) have significantly different levels of risk by 2004. In 1999, there are some differences in terms of principle sources of income. Wage employment is higher in the 5th quintile, primarily driven by higher permanent employment levels. There is also evidence of lower self-employment within these same groups.

5. Conclusion

[32] Since the choice of groups is arbitrary, these results are also estimated with quartiles with qualitatively similar results. These results are available upon request. The choice to report the quintiles relative to quartiles is because as the groups grow smaller, the absolute difference in risk levels between the first and last group grows but sample sizes decrease. Due to the small sample size of communities, significant results in the quintiles are perhaps more indicative than in the quartiles.

Although violence and conflict often occur in largely agricultural regions and conflict, our understanding of how it affects agricultural decisions has been limited. Analyses have consistently found results consistent with strong responses to conflict risk but have generally been unable to empirically confirm this. This inability to separately quantify the relative impacts of violence and insecurity has also hindered our ability to identify the specific pathways from conflict to lower post-conflict outcomes. Using unique data, including potentially the largest dataset on conflict (~690,000 households), this paper has investigated different potential pathways in which households might adjust their livestock and crop portfolios.

Although conflict-risk strongly affects livelihoods of rural households in Northern Uganda, responses to insecurity primarily occurred on the intensive, as opposed to extensive, margins. Reflecting the limited options for income diversification in rural Northern Uganda, households do not change livelihoods even in response to vary large changes in conflict-risk. That is, farmers remain farmers. While the analysis focuses on Northern Uganda, these results likely are true for many other developing country conflicts.

Within the dominant source of rural livelihoods, agriculture, there are substantial shifts in the composition of portfolios. These shifts only partially support the widely held belief that household shift away from profitable but risky (in terms of exposure to violence) activities towards lower risk and return activities. Within livestock portfolios, there is strong shift away from large, grazing livestock, despite the positive marginal returns, to smaller livestock which can be kept within compounds. Moreover, the overall value of livestock herds, which are typically targeted during conflicts, declined by roughly two thirds. Crop choices exhibit a similar shift towards low-risk low-return activities.

This suggests a potentially important pathway from insecurity to dietary diversity and overall nutrition by changing the composition of crops and may explain the decreased diversity during conflicts observed by Dabalen and Paul (2014). Since local food markets may cease functioning during conflicts, this may have potentially important effects especially on the long run human capital of adolescents (and therefore on the intergenerational transfer of poverty).

The large decreases in the size and value of livestock herds should result in large proceeds for households. Since the value of livestock portfolio declines by roughly one of fourth of annual mean consumption, this is an important unanswered question that cannot be examined with the

data used here. While multiple possibilities exist, it is possible that household conserve the income to insure themselves against potential attacks and to have capital in case of forced migration due to insecurity or the government. At the same time, the saving levels may be higher than desired as the insecurity likely reduces the opportunities for households to productively invest; many peace-time opportunities may not be available while others only payoff over prolonged periods of time making them very risky during periods of conflict. Consequently, insecurity may lead households to decrease investment in a productive activity, livestock, without providing opportunities to reinvest the funds.

As a whole, the results suggest that the households (in Northern Uganda) primarily responded to the risk of violence through shifts in the livestock and crop portfolios. This suggests that important avenues for research linking insecurity to adverse post-conflict nutritional and health outcomes via the shifts in the agricultural portfolios. Similarly, policy interventions can attempt to help household cope by offering less costly ways to respond to insecurity such as crops which are both nutritional and having qualities which are desirable in uncertain times or by helping households diversify into smaller livestock without resorting in widespread forced sales of larger livestock.

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Table 1: Logit Estimating Objective Risk for the Census data

	Attack
Distance to nearest activity	-0.18***
	[0.02]
Constant	1.12***
	[0.13]
Observations	1174
Pseudo R^2	0.14
Percent of LRA attacks in 2004 correctly classified	69.0%

Robust standard errors in brackets.

*, **, *** statistically significant at the 10%, 5%, 1% levels respectively

Table 2: Logit Estimating Perceived Risk of Community Attacks

	Perceived
Distance to nearest attack 1992. NUS	-0.80
	[2.04]
Distance to nearest attack 1999, NUS	2.56
	[2.92]
Distance to nearest attack 2004, NUS	-1.54
	[2.61]
Distance to nearest attack 1997, ACLED	8.00***
	[1.81]
Distance to nearest attack 1998, ACLED	-1.92
	[1.80]
Distance to nearest attack 1999, ACLED	-8.14***
	[2.19]
Distance to nearest attack 2000, ACLED	0.73
	[1.65]
Distance to nearest attack 2001, ACLED	1.19
	[2.06]
Distance to nearest attack 2002, ACLED	-5.04***
	[1.81]
Distance to nearest attack 2003, ACLED	-1.56
	[1.84]
Constant	0.43
	[0.50]
Observations	353
Pseudo R^2	0.35
Percent of LRA attacks in 2004 correctly classified	80.2%

Robust standard errors in brackets, community weights used

*, **, *** statistically significant at the 10%, 5%, 1% levels respectively

Table 3: The Relationship Between Livestock Holdings and the Risk of Violence

	Goats	Sheep	Pigs	Cattle	Poultry
Coefficient on Estimated Risk-Linear Term	-5.14***	-12.27***	3.55***	-10.66***	-2.54***
	(0.42)	(1.13)	(0.53)	(0.90)	(0.36)
Coefficient on Estimated Risk-Quadratic Term	5.79***	13.0***	-3.27***	15.05***	2.53***
	(0.42)	(1.51)	(0.64)	(1.17)	(0.45)
R^2	0.05	0.13	0.10	0.11	0.04
Sample Size	690,615	690,658	690,764	690,514	690,714
Effect of Risk Evaluated at Sample Mean	-0.87	-2.24	0.74	-1.22	-0.49
Percent of Households with Positive Holdings	40.8%	10.9%	4.5%	20.0%	50.2%
Average Holdings for Households with Positive Holdings	5.8	8.6	2.4	8.2	6.5
Mean Effect as Percent of Average Positive Holdings	-14.9%	-26.1%	30.2%	-14.9%	-7.6%

*,**,*** Significant at the 1, 5, 10% level, respectively

Standard Errors in Parentheses

Table 4: Robustness of relationship between livestock and insecurity

	NUS Base	NUS Enhanced	Census
Cattle	-26.4%***	-20.2%***	-14.9%***
Sheep	-14.9%***	-19.2%***	-26.1%***
Goats	-16.1%***	-16.9%***	-14.9%***
Poultry	-8.3%***	-8.3%***	-7.6%***
Pigs	-66.9%***	-69.4%***	30.2%***

Note that observations more than 6 standard deviations from the mean of positive holdings are dropped. These are coefficients evaluated at the mean risk levels relative to mean non-zero holdings.7

*,**,*** significant at the 10, 5, and 1 levels, respectively

Table 5: The Relationship Between Crop Choice and the Risk of Violence

	Cassava	Sweetpea	Groundnuts	Sorghum	Maize	Beans	Millet	Sesame
Coef. on the Estimated Risk-Linear Term	0.72***	0.41***	0.08	0.23***	-0.14***	1.00***	-0.85***	-1.62***
	(0.06)	(0.07)	(0.08)	(0.07)	(0.06)	(0.06)	(0.07)	(0.07)
Coef. on the Estimated Risk-Quadratic Term	-0.97***	-0.49***	-0.43***	-0.27***	0.05	-1.39***	0.94***	1.62***
	(0.07)	(0.08)	(0.09)	(0.07)	(0.01)	(0.07)	(0.08)	(0.08)
R^2	0.18	0.18	0.14	0.30	0.16	0.28	0.18	0.20
Sample Size	673,870	689,737	689,737	689,737	690,836	689,737	689,737	672,694
Marginal Effect at Mean								
Estimated Risk-Linear Term	0.22***	0.09***	0.01	0.04***	-0.04***	0.25***	-0.16***	-0.33***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Estimated Risk-Quadratic Term	-0.29***	-0.10***	-0.06***	-0.05***	0.01	-0.35***	0.18***	0.33***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Overall Effect on Probability to Grow Crop	-7.4%	-1.6%	-4.6%	-0.7%	-2.4%	-9.7%	1.6%	0.1%
Percent of Sample Growing Crop	32.6%	17.9%	8.5%	17.3%	22.1%	30.1%	15.2%	16.9%

*,**,*** Significant at the 1, 5, 10% level, respectively

Standard Errors in Parentheses

Table 6: Changes in Sources of Income Between Households in non-IDP Communities with the Greatest Increase and Decrease in Estimated Risk Between 1999 and 2004

Group Type: **Quintile**

	1st	5th	Difference
Change in risk levels between 1999 and 2004	-0.27	0.33	0.60***
Average risk levels in 1999	0.36	0.35	0.00
Sample size	512	486	

	% reporting each source in 1999		
Sources	1st	5th	Difference
Self-Employed, Agriculture	0.83	0.81	-0.02
Self-Employed, Non-Agriculture	0.10	0.05	-0.05**
Wage Employment	0.05	0.12	0.07***
of which Temporary	0.03	0.03	0.00
of which Permanent	0.02	0.10	0.08***
Remittances	0.01	0.01	0.00
Other Sources	0.00	0.00	0.00

	Difference between 1999 and 2004 in % reporting each source		
Sources	1st	5th	Difference
Self-Employed, Agriculture	-0.06	-0.07	-0.01
Self-Employed, Non-Agriculture	0.01	0.02	0.01
Wage Employment	0.02	0.02	0.00
of which Temporary	0.02	0.04	0.02
of which Permanent	0.01	-0.01	-0.02*
Remittances	0.03	0.02	0.00
Other Sources	0.00	0.00	0.00

*,**,*** Significant at the 1, 5, 10% level, respectively

Online Appendix 1: Description of data from NUS and ACLED

	Mean	Min	Max
Estimated objective risk 1999	0.25	0.00	0.71
Estimated objective risk 2004 using same model as the 1999	0.28	0.00	0.95
Estimated subjective risk	0.26	0.00	0.97
Estimated subjective risk, squared	0.14	0.00	0.94
Expenditure, ln(per capita annualized household expenditure)	0.08	0.00	0.97
Log of per capita consumption (shillings)	12.10	8.66	15.61
Total number of oxen or cattle	1.40	0.00	200.00
Total number of sheep or goat	2.56	0.00	100.00
Total number of poultry	3.47	0.00	75.00
Total number of pigs	0.22	0.00	15.00
Binary variable for ownership of a hoe (0=no, 1=yes)	0.93	0.00	1.00
Binary variable for ownership of a plough (0=no, 1=yes)	0.12	0.00	1.00
Female head of household	0.31	0.00	1.00
Number of household members in school	1.59	0.00	12.00
Number of disabled individuals in household	0.28	0.00	5.00
Proportion of household members literate aged 10 or older	0.51	0.00	1.00
Presence of market which sells agricultural inputs with LC1 (0=no, 1=yes)	0.05	0.00	1.00
Presence of market which sells agricultural produce with LC1 (0=no, 1=yes)	0.15	0.00	1.00
Presence of market which sells non-agriculture production with LC1 (0=no, 1=yes)	0.24	0.00	1.00
No schooling (0=no, 1=yes), head of household	0.10	0.00	1.00
Some schooling but did not finish primary (0=no, 1=yes), head of household	0.53	0.00	1.00
Finished primary (0=no, 1=yes), head of household	0.14	0.00	1.00
Some secondary schooling (0=no, 1=yes), head of household	0.17	0.00	1.00
Finished secondary (0=no, 1=yes), head of household	0.01	0.00	1.00
Specialized degree or diploma (0=no, 1=yes), head of household	0.05	0.00	1.00
Finished tertiary (0=no, 1=yes), head of household	0.00	0.00	1.00
No answer for schooling (0=no, 1=yes) , head of household	0.00	0.00	1.00
Presence of WFP or other food distribution within 5km of LC1 center	0.11	0.00	1.00
Presence of NGO assisting former combatants within 5km of LC1 center	0.07	0.00	1.00
Total land in the largest plots (acres)	3.70	0.00	88.00
Total amount of irrigated land (acres)	0.03	0.00	16.00
Number of individual aged 14-60 from household who are away	0.08	0.00	5.00

Presence of urban center or other major source of employment within 10 km (0=no, 1=yes)	0.14	0.00	1.00
Community, LRA attack in 2004 (0=no, 1=yes)	0.29	0.00	1.00
Community, cattle rustling in 2004 (0=no, 1=yes)	0.17	0.00	1.00
Community, LRA attack since 1992 (0=no, 1=yes)	0.45	0.00	1.00
Household attacked since 1992	0.43	0.00	1.00
Self-Employed, Agriculture (2004)	0.67	0.00	1.00
Self-Employed, Non-Agriculture (2004)	0.13	0.00	1.00
Wage Employment (2004)	0.12	0.00	1.00
of which Temporary (2004)	0.08	0.00	1.00
of which Permanent (2004)	0.04	0.00	1.00
Remittances (2004)	0.07	0.00	1.00
Other Sources (2004)	0.00	0.00	1.00
Self-Employed, Agriculture (1999)	0.73	0.00	1.00
Self-Employed, Non-Agriculture (1999)	0.09	0.00	1.00
Wage Employment (1999)	0.07	0.00	1.00
of which Temporary (1999)	0.03	0.00	1.00
of which Permanent (1999)	0.04	0.00	1.00
Remittances (1999)	0.02	0.00	1.00
Other Sources (1999)	0.00	0.00	1.00
Work	0.98	0.00	1.00
of which Employer	0.00	0.00	1.00
of which Self-Employed	0.87	0.00	1.00
of which Employee	0.11	0.00	1.00
of which Family Worker (unpaid)	0.01	0.00	1.00
Unemployed	0.00	0.00	1.00
Student	0.00	0.00	1.00
Domestic Duties/Homemaker	0.01	0.00	1.00
Other	0.00	0.00	1.00
Any abduction since 1992 (0=no, 1=yes)	0.00	0.00	1.00
Any abduction in 2004 (0=no, 1=yes)	0.06	0.00	1.00
Female head of household	2.61	0.00	12.00
Total number in household younger than 14	2.28	0.00	9.00
Total number in household between 14-60	0.20	0.00	3.00
Total number in household older than 60	0.06	0.00	3.00
Total number in household older than 60	0.02	0.00	4.00
Head of household migrated due to insecurity, 2004 (0=no, 1=yes)\	0.02	0.00	1.00
Head of household migrate due to insecurity, ever (0=no, 1=yes)	0.22	0.00	1.00
Distance to nearest attack 1997, ACLED	0.83	0.02	2.43

Distance to nearest attack 1998, ACLED	0.45	0.00	1.36
Distance to nearest attack 1999, ACLED	0.86	0.01	2.22
Distance to nearest attack 2000, ACLED	0.92	0.00	2.49
Distance to nearest attack 2001, ACLED	0.69	0.01	2.11
Distance to nearest attack 2002, ACLED	0.37	0.00	1.60
Distance to nearest attack 2003, ACLED	0.21	0.00	0.95
Distance to nearest attack 2004, NUS	0.34	0.00	1.09
Distance to nearest attack 1999, NUS	0.28	0.00	1.25
Distance to nearest attack 1992. NUS	0.31	0.00	1.37

Online Appendix 2: Description of data from the 2002 Ugandan

	Mean	Min	Max
Was there any rebel activity in the parish in the past 12 months?	0.40	0.00	1.00
Estimated Risk (Logit)	0.39	0.00	0.75
Estimated Risk*Estimated Risk (Logit)	0.19	0.00	0.57
Any livestock in the household (0=no, 1=yes)	0.65	0.00	1.00
Any crops in the household (0=no, 1=yes)	0.82	0.00	1.00
Goats, owned (total)	2.37	0.00	133.00
Sheep, owned (total)	0.94	0.00	196.00
Pigs, owned (total)	0.11	0.00	29.00
Cattle, owned (total)	1.64	0.00	190.00
Chicken, owned (total)	3.27	0.00	104.00
Cassava, grown in last season (Jan-Jun 2002)	0.33	0.00	1.00
Sweetpeas, grown in last season (Jan-Jun 2002)	0.18	0.00	1.00
Groundnuts, grown in last season (Jan-Jun 2002)	0.08	0.00	1.00
Sorghum, grown in last season (Jan-Jun 2002)	0.17	0.00	1.00
Maize, grown in last season (Jan-Jun 2002)	0.22	0.00	1.00
Beans, grown in last season (Jan-Jun 2002)	0.31	0.00	1.00
Millet, grown in last season (Jan-Jun 2002)	0.15	0.00	1.00
Sesame, grown in last season (Jan-Jun 2002)	0.17	0.00	1.00
Male household members, aged 0-5	0.61	0.00	10.00
Male household members, aged 6-16	0.88	0.00	15.00
Male household members, aged 17-50	1.00	0.00	48.00
Male household members, aged 51 or older	0.19	0.00	10.00
Female household members, aged 0-5	0.61	0.00	10.00
Female household members, aged 6-16	0.84	0.00	18.00
Female household members, aged 17-50	1.12	0.00	19.00
Female household members, aged 51 or older	0.18	0.00	11.00
Proportion of household members aged 10 or older who are literate	0.36	0.00	1.00
Head of the household male, (0=no, 1=yes)	0.78	0.00	1.00
Head of the household married, (0=no, 1=yes)	0.84	0.00	1.00
Head of the household, no education	0.33	0.00	1.00
Head of the household, some education	0.38	0.00	1.00
Head of the Household, completed P7	0.16	0.00	1.00
Head of the Household, completed J3	0.09	0.00	1.00
Head of the Household, completed S6	0.01	0.00	1.00
Head of the Household, completed a certificate	0.02	0.00	1.00
Head of the Household, completed diploma training	0.01	0.00	1.00
Head of the Household, completed a degree	0.00	0.00	1.00
Is the head of the household literate? (0=no, 1=yes)	0.60	0.00	1.00
Age of the head of the household	41.16	10.00	95.00
Own a house, (0=no, 1=yes)	0.95	0.00	1.00
Own land, , (0=no, 1=yes)	0.04	0.00	1.00
Own at least one motorvehicle, (0=no, 1=yes)	0.00	0.00	1.00

Own at least one motorcycle, (0=no, 1=yes)	0.01	0.00	1.00
Own at least one bicycle, (0=no, 1=yes)	0.40	0.00	1.00
One at least one mobile phone, (0=no, 1=yes)	0.01	0.00	1.00
Did the LC1 experience any cattle rustling in the past 12 months? (0=no,	0.15	0.00	1.00
Did the LC1 experience any incidence of rebel activity in the past 12	0.27	0.00	1.00
Did the LC1 experience any drought in the past 12 months? (0=no, 1=yes)	0.76	0.00	1.00
Is there a market place for crops in the LC1? (0=no, 1=yes)	0.21	0.00	1.00
Is there a market place for animals/poultry in the LC1? (0=no, 1=yes)	0.05	0.00	1.00
Did the LC1 experience any major disease affecting crops in the past 12	0.90	0.00	1.00
Did the LC1 experience any major disease affecting livestock in the past	0.95	0.00	1.00
Did the LC1 experience any human epidemic in the past 12 months?	0.86	0.00	1.00
Do you have any formal micro-credit institutions in the LC1> (0=no,	0.10	0.00	1.00
Is there an all weather road in or bordering the LC1? (0=no, 1=yes)	0.42	0.00	1.00
Is there an a seasonal road in or bordering the LC1? (0=no, 1=yes)	0.56	0.00	1.00
Distance of the parish to an urban center	21.30	0.40	68.90
Fraction of the parish which is populated	0.99	0.24	1.00
Fraction of the parish covered by water	0.01	0.00	0.76
Fraction of the parish covered by trees/shrub	0.00	0.00	0.27
Fraction of the parish covered by herbaceous	0.36	0.00	1.00
Fraction of the parish in the humid agro-ecological zone	0.01	0.00	1.00
Fraction of the parish in the sub-humid agro-ecological zone	0.13	0.00	1.00
Fraction of the parish in the semi-humid agro-ecological zone	0.84	0.00	1.00
Fraction of the parish in the transition agro-ecological zone	0.01	0.00	1.00
Fraction of the parish covered by coniferous plantation	0.00	0.00	0.30
Fraction of the parish covered by woodland	0.15	0.00	1.00
Fraction of the parish covered by bushland	0.05	0.00	1.00
Fraction of the parish covered by grassland	0.13	0.00	1.00
Fraction of the parish with wetland cover	0.00	0.00	0.36

Online Appendix 3: Logit Estimating Objective and Subjective Risk of Community Attacks for 2004, 1999

	Obj 1999	Obj 2004
Distance to nearest attack t-1, ACLED	-3.27***	-20.40***
	[0.64]	[4.04]
Distance to nearest attack t-2, ACLED	-1.29***	-6.52***
	[0.39]	[2.11]
Constant	0.96**	2.95***
	[0.39]	[0.62]
Observations	353	353
Pseudo R^2	0.22	0.53
Percent of LRA attacks in 2004 correctly classified	78.7%	87.8%

Robust standard errors in brackets, community weights used

*, **, *** statistically significant at the 10%, 5%, 1% levels respectively