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Interpersonal, Intertemporal and Spatial Variation in Risk Perceptions: Evidence from East Africa

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Summary. — This study investigates variation over time, space and household and individual characteristics in how people perceive different risks. Using original data from the arid and semi-arid lands of East Africa, we explore how individuals assess their relative level of concern about risks. The primary determinants of risk rankings are found to be changing community level variables over time, with household specific and individual specific variables exhibiting much less influence. Individuals throughout this area are most concerned about food security and human health, so that development efforts that directly address these problems should be given the highest priority.
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1. INTRODUCTION

Residents of the arid and semi-arid lands (ASALs) of East Africa are exposed to myriad risks. Some originate from the nature of the pastoral production system that is the main economic activity in these areas. ASALs have rainfall patterns that are highly variable temporally and spatially, making pasture and water availability for livestock unpredictable. In addition, pastoral reliance on livestock to convert pasture and water into food for human use exposes pastoralists to risk though loss or diminished productivity of these livestock. Other risks originate from government policy; for example, livestock sales used to generate cash to buy food can be suddenly halted due to the imposition of quarantine. The lack of government presence can also lead to risk exposure; for example, formal security services and border defense are weak in these areas. Finally, the relatively poor infrastructure found in these areas makes *ex ante* forecasting of these risks problematic—information dissemination is often lacking of forecasts that are generated and the forecasts are often too coarse to be of much use (Luseno, McPeak, Barrett, Gebru, & Little, 2003). It also makes *ex post* coping with risks difficult, as roads, health centers, veterinary services and markets are poorly maintained or nonexistent.

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We designed this study to investigate how ASAL residents perceive risks facing their households. We wanted to understand what risks people are concerned about. In addition, we wanted to understand the degree to which risk perceptions varied across time, across communities, and across households and individuals within a community. Appropriate policy responses to these risky environments clearly depend on how the risks vary across time and space and how they vary across and within households.

Expressed risk perceptions are based not only on the objective risks that individuals face—such as the probability of low rainfall—but also on their subjective assessment of their exposure to different shocks. Their subjective assessments combine their expectations about the likelihood of different events occurring with their beliefs about their own abilities to deal with various contingencies. Even in environments such as the ASALs of northern Kenya and southern Ethiopia, where covariate risks such as drought, infectious disease, and armed violence feature prominently, individual household members—much less different households or communities—may perceive the risks they face quite differently. As a consequence, the welfare and behavioral effects of risk may differ across individuals, households and communities, and over time. Interventions and policies intended to help vulnerable peoples manage risk—either through *ex ante* mitigation strategies or through *ex post* coping mechanisms—may need to account for such variation in order to prove effective. More nuanced understanding of the variation in subjective perceptions of risk can inform the design and targeting of policies, research and interventions to address objective sources of risk.

A small, relatively recent literature explores patterns of variable risk assessment with respect to individual risks, such as asset price shocks, weather, or disease. [1] However, there is scant empirical evidence that explores subjective risk perceptions across a range of stochastic phenomena, especially in the context of developing countries. So while the literature tells us something about how individual characteristics might affect risk perceptions with respect to a given contingency, it is relatively silent with respect to how individuals' ordering of concerns varies over space, time and individual characteristics. Scarce resources necessitate prioritization of interventions, however, and it would make sense to match these interventions to the concerns reflected in the risk rankings of intended beneficiaries.

This paper offers what we believe to be the first study to explore how individuals' subjective risk rankings among a range of potential perils vary across individuals, households, space and time. We exploit a unique quarterly panel data set from northern Kenya and southern Ethiopia that covers a 2.5 year period of drought and recovery. We build on an earlier study conducted among the same population that used focus groups, rather than individual-level survey data (Smith, Barrett, & Box, 2001). The questionnaire used a list of risks that were commonly identified through the focus groups of the earlier study. Thus the distinct risk categories we study reflect the subject population's self-identified labeling and mental classification of relevant risks. The individual-level survey data permit us to probe deeper on the issue of cross-sectional heterogeneity in risk assessment, enabling us to explore individual- (e.g., gender, age) and household-level (e.g., wealth) differences that were coarse in Smith *et al.*'s (2001) groups data. Moreover, the longitudinal dimension of the data permit us to study not only seasonality, but also, more interestingly, the extent to which past shocks, both those suffered by the respondent household and those experienced by others in the local community, affect risk perceptions. Previous work in the region on climate forecasting found strong evidence of partial updating of climate risk assessments in response to new information conveyed by climate forecasts (Lybbert, Barrett, McPeak, & Luseno, 2007). We explore, more generally, whether there appears to be updating of risk assessments across a range of risks in response to personal experience or observation of shocks.

2. RISK PERCEPTIONS

Some risks faced by individuals in ASALs can be measured—or at least estimated—objectively, including the probability of below-normal rainfall, disease outbreaks, armed violence and poor market prices for the livestock they sell or the grain and other basic necessities they buy. Yet these risks are rarely estimated and communicated at the spatio-temporal scales relevant to individuals' choices. [2] Moreover, research in a variety of fields suggests that people's behavior is influenced not only by the measurable, objective risks that they face but also, perhaps especially, by their subjective perceptions of risks and the possible consequences of different events (Kahneman & Tversky, 1982).

The policy implications are important. The WHO Health Report for 2002 notes, "[d]uring the 1980s, scientific predictions were seen to be rational, objective and valid, while public perceptions were believed to be largely subjective, ill-informed and, therefore, less valid" (p. 30). They note that this has changed as public interest and pressure groups gained the ability to argue for their own assessments and interpretations of risks. "Risk had different meanings to different groups of people and ... all risks had to be understood within the larger social, cultural and economic context" (p. 31). Slovic (1987) emphasizes that public policy dialogue with respect to risk management evolves only modestly in response to the introduction of new, credible scientific evidence on objective risk exposure because strongly-held prior beliefs affect the way information is processed and people update beliefs.

Subjective risk perceptions are particularly valuable because they incorporate multiple factors, including the individual's understanding of the objective risks, the individual's expectations about his or her own exposure to risks, and his or her ability to mitigate (*ex ante*) or cope (*ex post*) with the adverse events if they occur. Individual capacity to manage risk can feed back into risk perceptions. As a result, people often ignore new information altogether—so-called "belief perseverance"—or willfully misread new evidence as supporting prior beliefs, a tendency called "confirmation bias" (Darley & Gross, 1983; Kahneman & Tversky, 1982; Lord, Ross, & Lepper, 1979; Plous, 1991; Rabin & Schrag, 1999; Tversky & Kahneman, 1982). Such biases in learning then affect individuals' forecasts of stochastic events and the pace at which they update their beliefs in response to new information, especially when their welfare depends on the realization of the stochastic variable, in which case individual preferences introduce further cognitive bias, with preference-consistent information often accepted uncritically while preference-inconsistent data are processed critically (Ditto & Lopez, 1992; Kunda, 1990; Nisbett & Ross, 1980).

One way to measure subjective risk perceptions is to ask people to rank different risks. This does not give an intensity measure, but it does provide an ordinal measure that is important when one needs to prioritize the allocation of scarce resources, as is chronically the case when considering development alternatives in the ASALs of Africa. Early work of this type asked American respondents to estimate the number of deaths for 40 different hazards and compared these with known statistical estimates. Results indicated that people tend to overestimate the number of deaths from rarer and infrequent risks, while underestimating considerably those from common and frequent causes, such as cancer and diabetes. "However, people's rank ordering by the total number of deaths does usually correspond well overall with the rank order of official estimates" (Fischloff & Lichtenstein, 1981; Lichtenstein, Slovic, Fischhoff, Layman, & Combs, 1978, cited in WHO, p. 32).

Behrman, Kohler, and Watkins (2003, p. 2) note, however, that "very little research has focused on the determinants of subjective risk assessments." There are, however, a few examples. Smith, Barrett, and Box (2000) document how subjective perceptions of the risk of violent conflict vary directly with proximity to ethnic frontiers in the Horn of Africa. Lybbert *et al.* (2007) explore how recent rainfall and forecast information affect pastoralists' beliefs about the likelihood of different rainfall patterns in this same region.

Gender has been widely considered in studies of risk, largely to test the hypothesis that women are more risk averse than men. This may show up in a number of different ways. Studies of the financial sector and investment behaviors sometimes find gender differences in willingness to take risks. For example, when asked about the amount of financial risk that an individual and his or her spouse were willing to take with their savings and investments, 60% of female respondents, but only 40% of male respondents, said they were unwilling to take any risks (Jianakoplos & Bernasek, 1998). Using an experimental design with three decision environments, Eckel and Grossman (2003) find a significant sex difference in risk aversion. In addition, they find that both men and women predict that women will be more risk averse in these situations. Schubert, Brown, Gysler, and Branchinger (1999), however, suggest that such results may be due solely to differences in men's and women's opportunity sets, rather than their attitudes. But these studies do not specifically examine risk perceptions by gender.

The limited literature on risk perceptions thus offers relatively little evidence on the correlates of alternative assessments of individual risks and, as best as we can tell, no evidence on how individuals rank distinct risks they face nor how such assessments might evolve over time in response to seasonal patterns or the arrival of new information. By studying the risk perceptions of individuals from communities facing a range of serious risks that may vary across space, time and household or individual characteristics, we hope to shed new light on this important issue.

3. STUDY AREA AND SURVEY DATA

From March 2000 through June 2002, the USAID Global Livestock Collaborative Research Support Program (GL CRSP) "Improving Pastoral Risk Management on East African Rangelands" (PARIMA) project collected quarterly survey data from 330 households in ten communities within a single, contiguous livestock production and marketing region in the arid and semi-arid lands of northern Kenya and southern Ethiopia. The specific sites were chosen to capture relative variation in agricultural potential, market access, livestock mobility and ethnic diversity (Table 1). Rainfall is low and variable and the study period coincides with a major drought that affected much of the area in 2000 and continued well into 2001 in some sites. The infrastructure is extremely weak throughout the region, in terms of roads, schools, and health facilities.

In each household, we interviewed the household head and, if applicable, one randomly selected spouse and one other randomly selected adult (age 18 years or older; not the head or a spouse). The household head answered questions regarding the income, livestock and other assets, and activities of the entire household. The other individuals surveyed reported on their own livestock and other assets, incomes and activities. In addition to these standard household survey questions, we asked respondents whether they were concerned that any of 12 different types of risks common in the study area could adversely affect their household in the coming 3 months. [3] We then asked them to rank those that they were concerned about. For each household, we have information on risk perceptions for up to three respondents, enabling us to look not only at how risk perceptions vary across households, but also how they vary by gender, age and status within the household.

In each site, a baseline survey was conducted in March 2000. Repeat surveys were conducted quarterly for an additional nine periods, through June 2002. The repeated survey recorded information both on events occurring during the three-month period preceding the fielding of the survey and respondents' subjective risk assessments for the upcoming three-month period. The quarterly interval of the survey was designed to correspond to the bimodal distribution of rainfall in the study area. Thus, for example, a survey fielded in June recorded information on the period during which the long rains usually fall (March–May) as well as forecasts for what is usually the ensuing dry season (June–August).

Table 2 presents sample descriptive statistics. Educational attainment is very low; 88% of those interviewed had completed no schooling at all. Mean income—which includes the value of goods produced and consumed within the household (most notably milk and meat), wages, salaries, remittance and business income—valued at approximately 76 Kenyan Shillings/US dollar or 8.5 Ethiopian Birr/US dollar, [4] was

Table 1. *Descriptive information on study sites*

Community name	Country	Market access	Ethnic majority	Relative agricultural potential	Annual rainfall
Dirib Gombo	Kenya	Medium	Boran	High	650
Kargi	Kenya	Low	Rendille	Low	200
Logologo	Kenya	Medium	Ariaal	Medium–low	250
Ng'ambo	Kenya	High	Il Chamus	High	650
North Horr	Kenya	Low	Gabra	Low	150
Dida Hara	Ethiopia	Medium	Boran	Medium	500
Dillo	Ethiopia	Low	Boran	Low	400
Finchawa	Ethiopia	High	Guji	High	650
Wachille	Ethiopia	Medium	Boran	Medium	550

Notes: Those with high market access are located near a market town while those with "low market access" are located some distance from a market town, with irregular transportation. In this context, relatively "high agricultural potential" means that they can harvest a crop (typically maize) in an occasional good year, although crop failure is common. Those in relatively "low agricultural potential" areas do not plant any crops.

Table 2. *Descriptive statistics of variables used in the analysis*

	Mean	Std. Dev.	Min.	Max.
Household characteristics				
TLU	14.62	25.32	0	236
Asset Value (KSh)	6515	32766	0	374050
Income over past 3 months[a] (KSh)	5778	11718	0	121140
Share of income from livestock	0.68	0.43	0	1
Share of income from salary	0.09	0.26	0	1
Household Size (persons)	8.3	3.6	1	19
Individual characteristics				
Age (years)	45.5	16.5	16	98
Male (1 = yes)	0.47	0.50	0	1
Highest grade completed (years)	0.68	2.1	0	13
Wife of household head (1 = yes)	0.29	0.45	0	1
Head (1 = yes)	0.49	0.50	0	1
Female head (1 = yes)	0.16	0.36	0	1
Community characteristics				
Average herd size (TLU)	14.5	9.1	2.1	43.2

1 TLU (Tropical Livestock Unit) = 0.7 camel = 1 cow = 10 sheep = 11 goats.
[a] Income includes both cash income and the value of goods produced and consumed by the household and remittances. Data from Ethiopia was converted from Ethiopian birr to Kenyan shillings.

less than $76 per month per household in the period from April 2000 to July 2000. Average herd size was 14.6 TLU, [5] with average household size just over eight persons. On average, households rely on livestock and livestock products for 73% of their income, although the median level is higher. Fifty-four percent of households receive all of their income from livestock, while 19% report receiving no income at all from livestock. This underscores that communities in ASALs include: pure herding households who are almost wholly reliant on their livestock for their livelihoods; those who have "dropped out" of the pastoral system and live in towns, commonly relying on food aid, casual labor, and small-scale activities such as producing charcoal, brewing alcohol or selling firewood; and those who have diversified beyond pastoral activities into full-time wage work or business. As noted for this area by earlier studies (McPeak & Little, 2005; Little, 1985), settling in towns attracts both the poor who have no other options and the wealthy who diversify into town-based activities with higher returns while maintaining herding through family or contract labor, leaving nonsedentarized those who tend to comprise the middle portion of the income distribution and who are most reliant on livestock.

The median age of those interviewed is 45.5. Of those interviewed, 49% were the head of household. One third of these household heads were women. Twenty-nine percent of those interviewed were wives of the head, while 22% were other adults in the household, neither the head nor the wife of the head.

4. RISK RANKINGS

We seek to understand how risk perceptions vary among residents of the ASALs of East Africa across a variety of risks as well as how those perceptions vary over time in response to seasonality and the experience of shocks by respondents or those close to them. We expect several factors to affect risk perceptions. Individual characteristics such as gender, headship, age and education may affect both objective risk exposure and one's ability to mitigate risk *ex ante* or to cope with it *ex post*. Since risk assessments result from each of those processes, individual attributes may matter. Household level characteristics such as wealth, income, and household size may similarly affect risk exposure and mitigation and coping ability. Location-specific, time invariant effects may partially reflect cultural and community factors, such as the existence of strong social safety nets or effective conflict resolution mechanisms. These location effects may also reflect variation in culturally determined gender roles that place responsibility for managing particular sorts of risks on men or women.

From each respondent we obtained rankings of a series of risks facing his or her household. In each period, each respondent was told, "We know that households in this area are concerned about problems that could happen to them. We have made a list of concerns people commonly tell us about. I am going to read you this list of concerns, and I would like you to tell me which of these you are afraid could affect your household in the coming 3 months." Note that the question is explicitly about prospective risk for the coming season; it is not retrospective. The specific risks enumerated included: lack of pasture for animals, insufficient water for animals, animal sickness or death, animal loss due to theft or raiding, physical insecurity and violent conflict, human sickness, no buyers for animals you wish to sell, low prices for animals you wish to sell, food shortages, high prices for things you buy, crop failure, and an open-ended "other" option. Clearly, many of these risks can overlap and be correlated, as when precipitated by a common exogenous shock. Part of our effort in asking respondents to define and categorize risks in the participatory effort (Smith *et al.*, 2000, 2001) was to "unpack" the nature of the risks generated by such shocks. In particular, "drought" or "insecurity" as standard, broad responses could encompass many different risks and thereby mask much variation among and within households. By using a reasonably disaggregated classification scheme based on prior participants' categorization and labeling, we minimize both aggregation and reflection bias in the data and resulting analysis. This improves our ability to establish which particular aspect(s) of drought or insecurity was of greatest concern to the respondent(s).

After identifying the risks that the individual was concerned about, respondents were asked in a follow up question to rank those risks that they identified as ones they were worried about in order of concern, from greatest worry to least. Therefore, these responses are ordinal rather than cardinal measures. [6] Moreover, each individual ranked only those items that he or she identified as a positive concern. Therefore the relevant set of enumerated risks varies across respondents. The risk rankings cannot be interpreted as absolute intensity measures, only as measures of relative importance of each concern to the particular respondent at a particular point in time. A specific risk's ranking may fall (rise) over time for an individual respondent because that issue becomes less (more) of a concern or because another issue becomes more (less) of a concern.

The ordinality and varied dimensionality of the data force some difficult methodological choices, as Smith *et al.* (2001) discuss in detail. Our approach, following Smith *et al.*, who found similar outcomes across different possible estimation methods with such data, is to normalize and convert the rankings so that we evenly space each individual's rankings across the 0 to 1 interval, where 0 means not a concern and 1 reflects the respondent's greatest concern. The risk assessment index thus becomes $R_{ij} = 1 - ((r_{ij} - 1)/n_i)$ for individuals $i = 1,\ldots,m$ and risks $j = 1,\ldots,n_i$, where r_{ij} is the ordinal, integer risk ranking reported by the respondent and n_i is the number of risks ranked by individual i. [7] For example, if three items were ranked, the concern rated as the most serious by individual I thus receives the ranking $R_{ij} = 1 - ((1 - 1)/3) = 1$, the second receives the ranking $R_{ij} = 1 - ((2 - 1)/3) = 2/3$, and the third receives the ranking $R_{ij} = 1 - ((3 - 1)/3) = 1/3$. Each of the other concerns, none of which was ranked by i, would be assigned $R_{ij} = 0$.

The mean rankings offer a crude indicator of the relative importance of each source of risk, aggregated across each interviewee and time period. The highest ranked concern was a fear that there would be food shortages (Table 3). This was followed by a related concern for human health. Pastoral livelihood specific issues, most prominently adequate pasture for animals, appear only after these first-order con-

Table 3. *Overall risk rankings, mean and standard deviation*

Concern	Mean	Std. Dev.
Food shortages	0.58	0.36
Human sickness	0.42	0.36
Lack of pasture	0.39	0.40
High consumer prices	0.35	0.29
Animal sickness	0.35	0.34
Insecurity/violence	0.30	0.36
No livestock buyers	0.29	0.28
No water	0.28	0.35
Crop loss	0.27	0.38
Low livestock sales prices	0.22	0.26
Animal loss/theft	0.16	0.25

Scale is 0–1, with 1 being the highest concern, 0 the lowest.

cerns for food security and health. But there is considerable variation over time and across respondents with respect to all of these rankings, with none of the risks unconditionally statistically significantly more prominent than any other concern.

We had expected that individual characteristics, especially gender, would affect the risk rankings. Simple bivariate correlations suggest, however, that such effects are modest at best. Figure 1 shows the ranking of each of the 11 concerns by gender. It suggests that there is almost no difference in risk ranking by gender. Nor is there a difference in the number of items ranked by gender (men ranked an average of 6.45 and women an average of 6.28, a statistically identical count).

Time and place variables, however, are strongly associated with variation in risk rankings (Figures 2 and 3). Figure 2 shows the risk ranking by location for the three top concerns. It demonstrates the very large differences by location. The patterns for the other risks are similar, showing large spatial differences. We omit these from Figure 2 so as to reduce clutter. Figure 3 shows the evolution of risk rankings

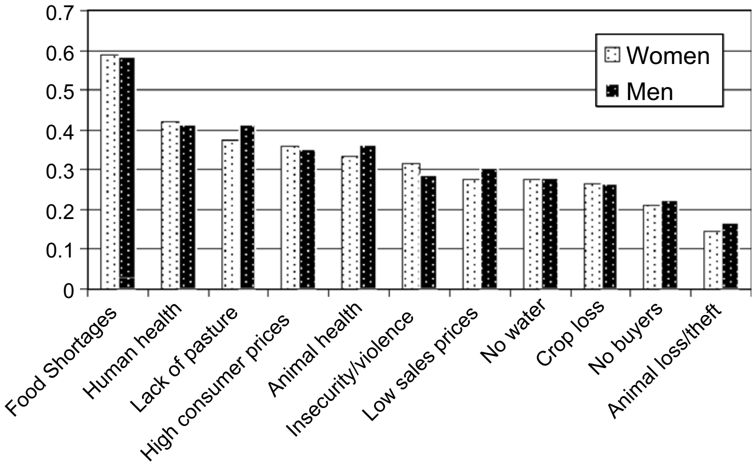

Figure 1. *Risk ranking by gender for all risks.*

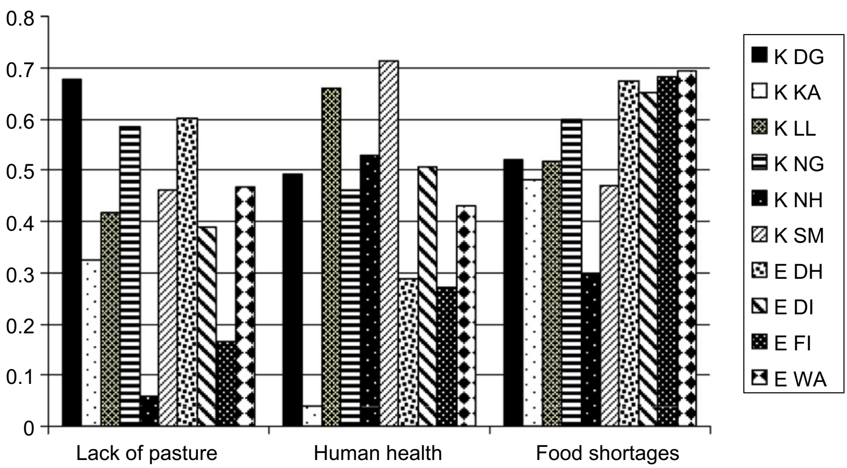

Figure 2. *Risk ranking by site, top three concerns.*

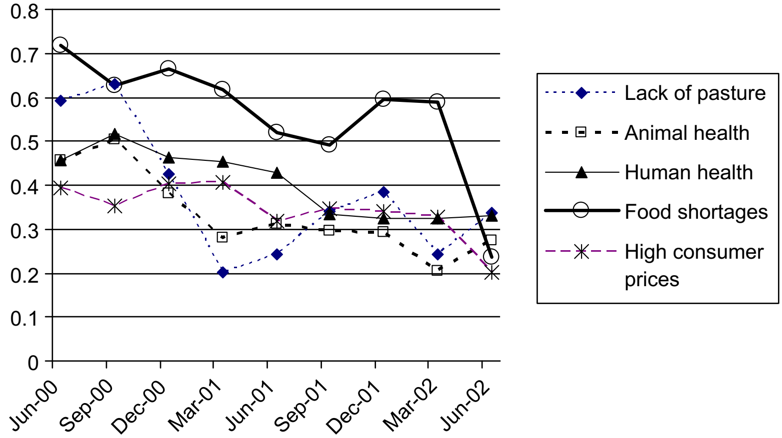

Figure 3. *Risk ranking over time for top five concerns.*

for the top five concerns over time. Within country differences appear greater than between country differences, suggesting that agro-ecological factors trump policy differences between the two nations in driving variation in risk assessments. This interpretation is reinforced by the steady fall over time in the number of concerns raised, from an average of 8.1 in June of 2000 to 3.6 in June 2002. As the drought situation improved, people said that they were concerned about fewer things happening in the following 3 months.

These results raise the question as to whether this spatio-temporal variation in risk assessments within a stable population reflects responses to different recent experiences—that is local shocks cause localized updating of subjective risk assessments—rather than just unconditional seasonality and time-invariant location-specific effects. Multivariate econometric analysis allows us to look at this issue and to probe in greater depth the preceding associations observed (or not observed) in simple cross-tabulations.

Because our dependent variable, the risk assessment, $R_{ij} \in [0,1]$, falls in an interval we use a doubly censored Tobit estimator applied to the full rankings data. The independent variables include individual characteristics such as gender, age, the highest grade attained, and status within the household (head or wife of head, with "other" as the omitted variable). Household characteristics included as regressors are TLU holdings, the self-reported cash value of nonlivestock assets, full household income, share of income earned from livestock and livestock products, share of income earned from salary or wages (a relatively stable source of income in this region), and household size. We also include seasonal and annual dummy variables (with the December survey round dummy—reflecting concerns for the upcoming dry season that follows the "short" October–December rains—and the 2002 year dummy as the omitted variables). The June survey captures perceptions looking forward to the dry season following the period of the March–May "long" rains. The March and September rounds thus capture perceptions looking forward to the respective rainy seasons. The drought was most severe in 2000, and by 2002 all of the surveyed areas were in a recovery phase.

Given the unconditional variation in risk rankings across time and space, we probe further as to whether this reflects spatial path dependence, recurrent seasonality, or perhaps localized beliefs updating in response to local shocks. In particular, we explore how the events of the previous period affect how people perceive the risks they face in the coming period. The data allow us to look at both household and community level shocks. At the household level, we have information on changes in household herd size (herd size at the end of the most recent period minus herd size at the end of the preceding quarter), whether any household member experienced an illness or injury in the previous 3 months that prevented him or her from working, and whether any household member died in the previous period.

At the community level, we control for the mean percentage change in household herd

Table 4. *Means of shock variables*

	Mean	Std. Dev.	Minimum	Maximum
Community level shocks				
Change in community mean household herd size (TLU)	−0.6	4.2	−20.7	10.4
Price Deviation	−0.004	0.12	−0.3	0.4
Raid[a]	0.14	0.34	0	1
Quarantine[a]	0.21	0.41	0	1
Outbreak of Animal Disease[a]	0.31	0.46	0	1
Outbreak of Human Disease[a]	0.44	0.50	0	1
Ease of selling	−0.25	0.51	−1	1
Number of Traders	23	35	0	120
Rainfall—past 3 months (mm)	92	91	0	394
Rainfall—past 6 months (mm)	175	123	3	439
Household Level Shocks				
Change in HH herd size (TLU)	−0.6	10.3	−124.2	108.6
Illness or injury of household member[a]	0.27	0.44	0	1
Death in household[a]	0.02	0.14	0	1

[a] Dummy variable = 1 if occurred in preceding 3 months in community, =0 otherwise.

sizes within the respondent's community over the previous survey period, the occurrence of any livestock raids, animal quarantines, or outbreaks of animal or human diseases in the community during the previous quarter, the deviation of monthly consumer prices from their mean over all months in that location, the number of livestock traders buying animals in the community in the previous 3 months, and a subjective indicator variable, collected each month from key informants, as to the ease of selling livestock, with above normal assigned a value of 1, normal 0, and below normal −1. These covariates permit us to study how individual risk assessments respond to shocks occurring in their community, controlling for the shocks they experience directly and other individual and household attributes, which represents a "learning from others" effect quite distinct from the learning effect associated with their own experience. [8] Table 4 reports the means of these shock variables. [9]

5. REGRESSION RESULTS

Table 5 presents the key results for the top three concerns reported. [10] Site, season and year variables were included in the estimations, but we omit those coefficient estimates from the table in the interest of conserving space. [11]

Each of the community-level shock variables was statistically significant in explaining the ranking of at least one of the concerns at a 5% level of significance, with the lone exception of the outbreak of animal disease which was significant at the 10% level for two concerns. Wald tests found the community level shocks were jointly statistically significant at the 1% level for each of the 11 risks studied. [12] Clearly, individual level risk assessments respond significantly to broader, community-level shocks, indicating information flow and social learning with respect to risk.

Once we control for community-level variables, household-level characteristics and shocks have surprisingly modest effects on risk rankings. There are only two household characteristics, asset value and income, that had a significant impact at the 5% level on more than one of the top five concerns reported in Table 5. Household size and herd size impact one ranking each at a 5% significance level. Jointly, household level characteristics were statistically significantly associated, at the 1% level, with individual-level risk rankings for only 6 of the 11 risks enumerated, in striking contrast to the community-level characteristics that were uniformly highly statistically significant.

Even more surprisingly, household-level shocks had little effect on individuals' risk rankings. Illness is the only household shock variable that is associated at a 5% significance level in the results in Table 5, and this is only for one of the risks. Change in herd size is significant for one ranking at the 10% level and the indicator of a recent death in the family is not significant for any of the rankings presented in Table 5. Joint Wald tests indicate that household-level shocks were not

Table 5. *Estimation of risk ranking, top five risks overall*

Variable name	Food shortage	Human health	Lack of pasture	High consumer prices	Animal health
Community level					
6 month rainfall × 10^{-2}	0.3431[a] (0.0377)	0.0450 (0.0348)	−0.3440[a] (0.0446)	0.0369 (0.0244)	−0.1133[a] (0.0352)
6 month rainfall^2 × 10^{-5}	−0.6606[a] (0.0903)	0.0164 (0.0842)	0.6029[a] (0.1074)	−0.0060 (0.0580)	0.1287 (0.0854)
3 month/6 month rainfall	−0.0979[a] (0.0356)	−0.0098 (0.0325)	−0.3951[a] (0.0464)	−0.1070[a] (0.0248)	−0.0667[b] (0.0327)
Raid	0.1779[a] (0.0304)	−0.1450[a] (0.0291)	−0.1747[a] (0.0363)	−0.0046 (0.0204)	−0.2471[a] (0.0291)
Quarantine	0.0354 (0.0383)	−0.0150 (0.0352)	−0.1046[b] (0.0432)	−0.0115 (0.0252)	−0.1034[a] (0.0349)
Ease sell	−0.0150 (0.0258)	−0.0400[c] (0.0241)	0.2539[a] (0.0301)	−0.0877[a] (0.0176)	−0.0130 (0.0237)
# Traders	−0.0012 (0.0014)	0.0075[a] (0.0013)	0.0068[a] (0.0017)	0.0001 (0.0009)	0.0052[a] (0.0014)
Animal disease	−0.0565[c] (0.0311)	0.0331 (0.0295)	−0.0638[c] (0.0372)	0.0071 (0.0210)	−0.0111 (0.0289)
Human disease	−0.1187[a] (0.0199)	0.0075 (0.0189)	0.0086 (0.0239)	−0.0092 (0.0133)	−0.0223 (0.0187)
Price deviation	−0.2531[b] (0.1052)	0.4681[a] (0.1000)	0.1020 (0.1322)	0.1782[b] (0.0694)	0.2544[b] (0.1004)
Community average TLU	−0.0201[a] (0.0038)	−0.0163[a] (0.0036)	0.0512[a] (0.0045)	−0.0117[a] (0.0025)	−0.0001 (0.0035)
Community average ΔTLU	0.0139[a] (0.0026)	−0.0018 (0.0023)	−0.0221[a] (0.0029)	0.0039[b] (0.0016)	−0.0098[a] (0.0023)
Household level					
TLU × 10^{-1}	−0.0023 (0.0038)	0.0019 (0.0035)	0.0038 (0.0043)	−0.0069[a] (0.0025)	0.0004 (0.0035)
ΔTLU	−0.0015[c] (0.0009)	0.0002 (0.0008)	0.0006 (0.0010)	−0.0003 (0.0005)	0.0006 (0.0007)
Household Size	−0.0085[a] (0.0029)	−0.0016 (0.0027)	0.0020 (0.0034)	−0.0014 (0.0019)	0.0015 (0.0027)
Asset value × 10^{-3}	−0.0009[a] (0.0003)	−0.0007[b] (0.0003)	−0.0005 (0.0003)	0.0003 (0.0002)	−0.0008[a] (0.0003)
Income × 10^{-4}	−0.0050 (0.0090)	0.0242[a] (0.0081)	0.0397[a] (0.0106)	0.0050 (0.0061)	0.0485[a] (0.0080)
Livestock share of income	−0.0049 (0.0230)	0.0108 (0.0215)	0.0365 (0.0269)	−0.0068 (0.0150)	0.0402[c] (0.0214)
Salary share of income	0.0130 (0.0389)	−0.0286 (0.0368)	−0.0699 (0.0495)	−0.0508[c] (0.0265)	−0.0571 (0.0365)
Illness	0.0349[c] (0.0209)	0.0101 (0.0193)	0.0079 (0.0243)	0.0291[b] (0.0137)	−0.0308 (0.0193)
Death	0.0841 (0.0624)	−0.0577 (0.0561)	0.0591 (0.0683)	0.0583 (0.0384)	−0.0124 (0.0558)
Individual level					
Age	−0.0002 (0.0005)	0.0005 (0.0005)	−0.0007 (0.0006)	−0.0002 (0.0003)	−0.0006 (0.0005)
Male	−0.0158 (0.0357)	−0.0040 (0.0335)	0.1053[b] (0.0418)	0.0208 (0.0233)	0.0375 (0.0336)
Highest Education Level	0.0007 (0.0044)	0.0057 (0.0041)	−0.0050 (0.0055)	0.0007 (0.0030)	−0.0039 (0.0040)
Wife	−0.0091 (0.0325)	0.0212 (0.0205)	0.0605 (0.0384)	0.0293 (0.0212)	0.0366 (0.0307)
Head	0.0126 (0.0267)	0.0181 (0.0248)	0.0641[b] (0.0306)	0.0011 (0.0174)	0.0686[a] (0.0248)
Female Head	0.0193 (0.0438)	−0.0190 (0.0408)	0.0105 (0.0512)	0.0513[c] (0.0287)	−0.0296 (0.0408)
Regression details					
Sigma	0.4840[a] (0.0078)	0.4456[a] (0.0070)	0.5291[a] (0.0096)	0.3260[a] (0.0045)	0.4379[a] (0.0071)
Pseudo R^2 (Decomp.)	0.48	0.24	0.26	0.32	0.18
Number of obs.	4104	4104	4104	4104	4104

Time period and site specific dummies are not reported.
[a] Indicates significance at the 1% level.
[b] Indicates significance at the 5% level.
[c] Indicates significance at the 10% level.

statistically significant at the 1% level in explaining individual rankings with respect to any of the 11 risks we study. Once one controls for household and community characteristics and community-level shocks, households' idiosyncratic risk experiences seem to have negligible effect on individuals' risk perceptions.

Finally, we consider the impact of individual characteristics. The only variable that is significant at the 5% level or better in more than one ranking reported in Table 5 is whether or not the individual is a head of household. The variable recording whether the individual is a male is significant at the 5% level for only one of the risks in Table 5. The variable recording whether the individual is a female head of household is significant only at the 10% level and for only one of the risks in Table 5. Age, education, and status as a wife do not significantly influence the rankings of any of the top five concerns. Wald test results illustrate that individual characteristics had a relatively modest impact on individual risk rankings, being jointly statistically significant at the 1% level for only 6 of 11 risks.

Figures 4–6 and Table 6 illustrate the quantitative significance of these overall patterns by considering the joint impact of various variables through simulation of estimation results. We use these simulations to contrast the following: changes in rankings over time within a site; changes in rankings over time across sites; changes in rankings over time across households in a given site; and finally changes in rankings across individuals within a site. These simulations based on multivariate regression results provide a direct comparison with the unconditional results previously depicted in Figures 1–3.

Figure 4 illustrates how the risk rankings in one community are affected by the community level variables over time. It shows simulated risk rankings over time in the North Horr (Kenya) study site for the five risks that received the highest ranking over all periods for this site. To generate these results, household and individual variables are held at the site specific means for all time periods, the North Horr site dummy is set to one and other site dummies are set to zero, the site specific and time specific community level variables (raids, quarantines, ease of selling animals, number of traders, animal disease outbreaks, price deviation, community average herd size, community average change in herd size, rainfall variables) and time variables (seasonal and year dummy variables) are inserted into the estimation results as they change over time.

Figure 5 conducts a similar exercise, contrasting two very different sites. It shows the risk rankings over time for two communities, North Horr (Kenya) and Finchawa (Ethiopia), for the concern that there will be food shortages, which is the risk ranked the highest overall. North Horr is a much drier, more remote area which relies primarily on livestock. Finchawa has

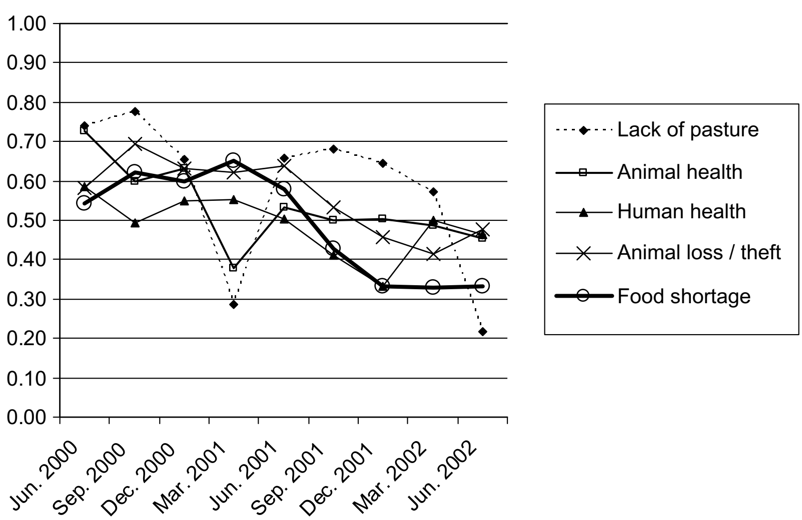

Figure 4. *Simulated risk rankings for top five concerns in North Horr over time.*

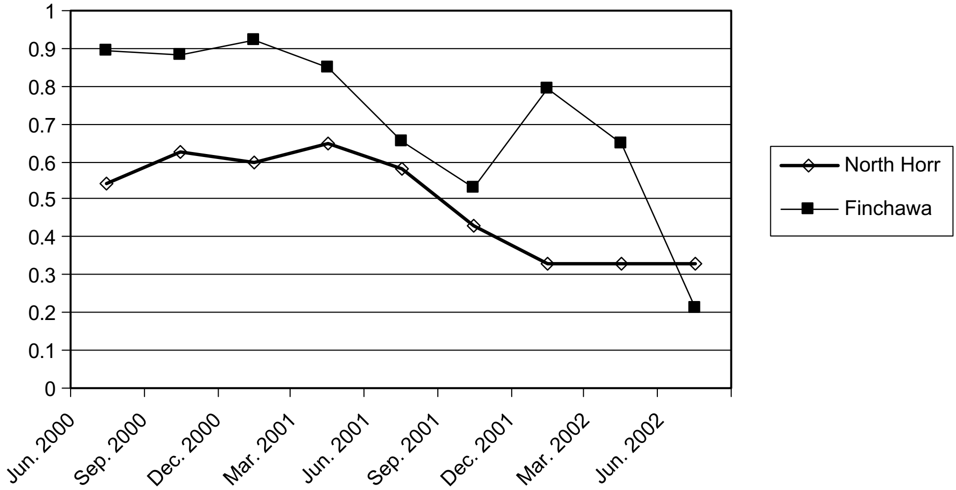

Figure 5. *Simulated risk ranking for food shortages, North Horr and Finchawa.*

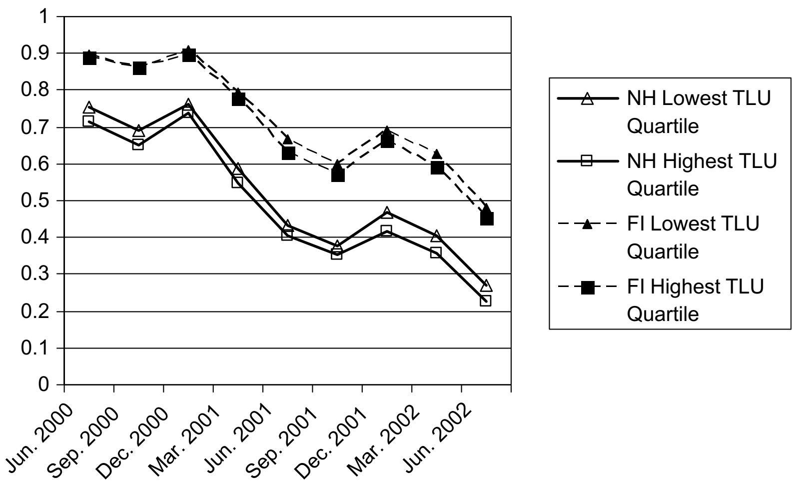

Figure 6. *Simulated risk rankings for food shortages by highest and lowest herd size quartiles in North Horr and Finchawa.*

Table 6. *Simulated risk rankings for Finchawa, with individual specific variables changing*

	Food shortages	Human health	High consumer prices	Lack of pasture	Animal health
Male	0.741	0.206	0.121	0.109	0.092
Female	0.750	0.204	0.132	0.107	0.098

much greater market access and combines livestock herding with some crop cultivation.

Figure 6 contrasts Finchawa and North Horr over time, holding community level variables constant while allowing the household level variables to change. In this case, the community level variables are fixed at the means calculated over all time periods for the given site, individual level variables are held fixed at their site specific means for all periods, but time period specific household level variables (herd size, change in herd size, illness, death, asset level, income level, share of income from livestock, share of income from salary, and household size) are calculated for the highest and lowest quartile with herds arranged by size at each point in time. Site-specific herd size and year and season dummies are included.

Finally, in Table 6, we turn to the question of the impact of individual characteristics on risk rankings. We present simulation results that contrast male and female rankings for the Finchawa site for the five highest ranked risks in table one. In this case, the site and time specific variables for individual variables (age, education, and status within the household) for males and for females are calculated separately, then used in the simulation, with all other variables held at their site specific means over all time periods.

Overall, these simulations clearly reinforce the finding that risk rankings vary highly across sites and across time. Although risk rankings are influenced by household- and individual-specific characteristics, in these data the major source of variation appears to be across sites and across time, rather than across individuals or households within a given site.

6. IMPLICATIONS AND CONCLUSIONS

The clear and important results of this analysis are four. First, risk perceptions vary markedly across time, which has important practical implications. Common development practices such as Rapid Rural Appraisal, in which researchers drop into a village for a brief visit to ask about needs and concerns, may give results that are far more time-bound than is commonly appreciated. Within just a 27 month period, we observed both sharp seasonality and striking interannual changes in risk rankings that call into question the generalizability of static, snapshot assessments of risk in dynamic communities. Figure 4 illustrates that no single risk is at the top of the list for all time periods. In fact, we find that risk assessments respond especially sharply to recent local events, such as cattle raids, drought, the imposition of a quarantine for animal disease control, etc. Since rapid assessments are commonly fielded in response to such events, they may be especially prone to distortion. These results imply a need for ongoing, longitudinal monitoring of locations thought vulnerable to multiple risks in order that external interventions can adapt appropriately to changing risk profiles in dynamic settings such as the pastoralist areas of East Africa.

Second, variation in risk rankings is more pronounced between communities than within them. Figure 5 illustrates that the Finchawa and North Horr rankings differ in magnitude in most periods, and even cross at one point. They also do not show clear co-movement over time. [13] There can be differences across households as stratified by herd wealth or across individuals based on gender, but these differences are much smaller than those we see in response to the spatial and intertemporal changes. Within a community, variation in household and individual characteristics has some effect on individual-level risk rankings, reflecting important differences in social standing, economic opportunity and constraints, etc. But inter- and intra-household variation in risk rankings is relatively modest compared to the inter-community and inter-temporal variation. The practical implication of this is that there needs to be community-specific planning to mitigate and cope with risk, because a single plan for the larger region runs the risk of overlooking community specific concerns. Since most of this variation is between rather than within communities, community-based monitoring and formulation of development plans may suffice. Our findings do indicate that a community plan that does not take into account the heterogeneity of concerns across and within households runs the risk of being biased towards a subset of community members, but given tight budgets, our results indicate that it is more important to push for finer grained analysis between communities rather than within them.

Third, community-level shocks associated with rainfall, violence, animal and human disease, market conditions, etc. have a pronounced effect on individual-level risk perceptions, while household-level shocks associated with human illness and mortality or herd losses do not. This suggests that people learn actively from the experiences of others around them and adjust their risk assessments quickly in response, corroborating prior work in the area on subjective expectations of rainfall (Lybbert *et al.*, 2007). Although covariate shocks are relatively weakly correlated with individual-level income and asset shocks in this area (Lybbert, Barrett, Desta, & Coppock, 2004; Lentz & Barrett, 2005), individuals appear to adapt their risk assessments more in response to community-level shocks than to those that strike their own household. This would also be consistent with the argument that social networks or sharing mechanisms within communities lead individuals to be less concerned about household specific shocks compared to community covariate shocks, though investigating this interpretation is left as a topic for further research.

Fourth and finally, the project that supported this research was premised on the idea that residents of ASALs are exposed to a high degree of risk, and that this risk is multidimensional. The goal was to understand this risk and its related vulnerability in order to identify development interventions that help mitigate and cope with these risks. While this study has placed much emphasis on understanding the differences across people and time periods in risk perceptions, it is worth taking a step back to look at the broader picture.

To do this, we close by returning to the finding that the most prevalent fear was of food insecurity. The fear of food insecurity is largely driven by the fact that the study area regularly suffers drought, herd loss, and sudden decreases in food (especially milk) availability. The perception of risk is highest for the core outcome of not having enough food, rather than underlying causes such as insufficient pasture, crop failure, high consumer prices or livestock mortality. Policy responses to food insecurity in the area continue to focus heavily on emergency assistance in the form of food aid, the implementation of which is often not timely or well targeted (Lentz & Barrett, 2005). More emphasis also needs to be given to designing humanitarian assistance that is triggered in a timely fashion (Mude, Barrett, McPeak, Kaitho, & Kristjanson, 2006) and to developing distribution networks that are compatible with pastoralists' preferred drought mitigation strategy: migration (Morton, 2006; Aklilu & Wekesa, 2001). Food aid is all too often distributed from towns, which discourages mobility to remote rangelands (McPeak, 2003).

Beyond the issue of food insecurity, we close by noting a few other findings in the risk rankings that merit special note. Human sickness is a major concern throughout the study area. Our time working in this area has vividly illustrated to us that far too many people suffer and die from diseases that are both preventable and treatable. Both preventative public health interventions and curative health care are minimal and improving them would help reduce vulnerability to shocks to human health. Another finding is that lack of pasture is a much greater concern than lack of water, suggesting that pasture is viewed as the more binding constraint on pastoral production in this area. Related work (Haro, Doyo, & McPeak, 2005; McPeak, 2003) indicates that constraints on pasture availability are often due to the fear of insecurity rather than due to biophysical limits on rangeland productivity; even in a drought year there is enough fodder for animals, but it goes unused for fear that anyone using it may be attacked. Dialogue across communities bordering these "no man's lands" can play an important role in reducing these fears and allowing access to pastures currently under used or totally abandoned (Haro *et al.*, 2005). Improved public security services would also be beneficial toward this end. Finally, as the insecurity in this area is often characterized as a result of "cattle rustling," it is worth noting that the results indicate the fear of losing animals in a raid is relatively minor in our results compared to the fear of insecurity overall. Individuals in this area view insecurity as multi-dimensional, suggesting policy responses must go beyond anti-stock theft efforts and consider how fear of insecurity can influence decision-making, particularly by limiting livestock mobility.

NOTES

1. See Rabin (1998) for an excellent survey.

2. For example, Luseno *et al.* (2003) emphasize that improvements in seasonal climate forecasting in the ASALs of East Africa are not affecting household level behavior in part because the spatial resolution remains too coarse to be of much use to individual decision-makers.

3. The first 11 items on the list were based on the findings of the Smith *et al.* (2000) study and pre-testing of the questionnaire, and the 12th item was "other" to allow flexibility. Very few "other" responses were recorded, so we will focus on the 11 specific concerns described below.

4. For the analysis, Ethiopian birr was converted into Kenyan shillings at the exchange rate for that period. The exchange rate for Kenyan shillings ranged from 76 to 79 per US dollar and for Ethiopian birr from 8.21 to 8.56 Birr/US dollar.

5. TLU stands for total livestock units, where 1 livestock unit = 10 sheep or goats = 1 head of cattle = 0.7 camels (Schwartz, Shaabani, & Walther, 1991).

6. Ties were allowed. If two risks were viewed as of equal concern, they were assigned the same value for the ranking, and the next item ranked was assigned the value of the tied rank plus two.

7. The other option would be to use a uniform distribution of intervals, which allows for an ordered multinomial estimation. The measure of risk rankings, R, would be calculated as follows: $R_{ij} = 1 - (((r_{ij} - 1)/n^{*}))$ for individuals $i = 1,\ldots,m$ and risks $j = 1,\ldots,n$, where n^{*} is the maximum number of risks identified by any respondent.

8. This is analogous to the distinction in the technology adoption literature between "learning by doing" and "learning from others" (Foster & Rosenzweig, 1995; Moser & Barrett, 2006).

9. Note that there are fewer observations for the community level data as some community surveys from the later periods are not available.

10. Results for the other concerns are available from the authors on request but do not differ qualitatively from what we report here.

11. The site dummies are jointly significant at the 1% level for all risk rankings as are the time dummies by Wald tests.

12. A table summarizing the Wald test results for all 11 risks ranked is available from the authors by request.

13. It is interesting to note that the lowest rainfall area of North Horr generally ranks the risk of food insecurity lower than the highest rainfall area of Finchawa. One interpretation is that the nomadic pastoral system practiced in North Horr ensures greater food security than the largely sedentarized, rainfed agro-pastoralism practiced in Finchawa. The more cultivation-dependent Finchawa sample is less concerned about many of the more livestock and livestock production related risks and focuses more on food security risk, whereas for North Horr the only risk that is essentially irrelevant is crop failure. Supporting this interpretation, the average household in North Horr said they were worried about 9.7 out of the 12 risks on average, while the average household in Finchawa indicated concern about only 3.6 of the 12. We reiterate that the risk rankings data reflect the ordering of subjects' assessed risk severity and not necessarily the absolute level of risk faced.

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