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Weather Shocks, Coping Strategies, and Consumption Dynamics in Rural Ethiopia

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SUMMARY

Rural households adopt a broad range of strategies to cope with adverse weather shocks. Previous studies have examined the effectiveness of individual coping strategies in mitigating the impact of adverse weather shocks, but no study to date has presented a comprehensive evaluation of alternative coping strategies. We employ household panel data spanning 15 years to estimate the impact of weather shocks on consumption and poverty dynamics in rural Ethiopia, along with the effectiveness of household coping strategies in alleviating the impact of shocks. We find that rainfall increases are positively associated with per adult equivalent consumption, while high temperatures are negatively associated with consumption. In terms of household coping strategies, formal social safety net transfers mitigate the impact of adverse rainfall shocks on consumption and off-farm employment mitigates the impact of high-temperature shocks. Simulations suggest that rainfall shocks and formal social safety net transfers significantly influence household poverty dynamics. By contrast, high-temperature shocks and off-farm employment have less impact on poverty dynamics. The results highlight the need for social protection programs that support existing household coping strategies and that can rapidly respond to weather shocks.

1. Introduction

Adverse (poor and variable) weather conditions have been shown to reduce the mean yields of agricultural producers and increase their output variance in developing countries (Cabas, Weersink, & Olale, 2010; Felkner, Tazhibayeva, & Townsend, 2009; Fisher, Hanemann, Roberts, & Schlenker, 2012; Kaylen, Wade, & Frank, 1992; Schlenker *et al.*, 2009; Schlenker & Roberts, 2006; Thornton, Jones, Alagarswamy, & Andresen, 2009). When households rely heavily on *rain-fed* agriculture, rainfall-induced production shocks often translate into income shocks and, in turn, into negative consumption shocks. Rural households adopt a broad range of strategies to mitigate the negative impacts of adverse weather shocks. Common ex-ante resiliency strategies include precautionary savings to smooth consumption (Paxson, 1992) and diversification into income-generating activities that are less vulnerable to weather shocks, including migration (Barrios, Bertinelli, & Strobl, 2006; Marchiori, Maystadt, & Schumacher, 2012), off-farm employment (Bezabih, Gebreegziabher, GebreMedhin, & Köhlin, 2010; Ito & Kurosaki, 2009), and adoption of heat- and drought-tolerant crop varieties (Phiri & Saka, 2008). Ex-post, households may sell livestock or productive assets during hard times (Dercon, 2002; Kazianga & Udry, 2006; Zimmerman & Carter, 2003). Asset sales often lower future earnings potential and, thus, are seen as a negative coping strategy (Del Ninno, Coll-Black, & Fallavier, 2016). Households also make use of formal or informal social safety nets (FSSNs or ISSNs) to mitigate the consumption impacts of adverse weather shocks (Fafchamps, 1992, 2011; Pan, 2009).

Previous studies have examined the effectiveness of individual coping strategies such as precautionary savings (Paxson, 1992), migration (de Brauw & Harigaya, 2007; Taylor, Rozelle, & de Brauw, 2003), off-farm employment (Kochar, 1999), asset sales (Fafchamps, Udry, & Czukas, 1998; Kazianga & Udry, 2006), and FSSNs as well as ISSNs (Berhane, Gilligan, Hoddinott, Kumar, & Taffesse, 2014; Pan, 2009; Quisumbing & McNiven, 2010). But to the best of our knowledge, no study to date has presented a comprehensive evaluation of different coping strategies in terms of effectiveness in mitigating the negative impact of weather shocks. Further, the literature shows that individual coping strategies employed by households often do not fully buffer the adverse impacts of weather shocks on household welfare. For example, Dercon (2004) finds persistent negative impacts of rainfall shocks on per capita consumption in rural Ethiopia. This leaves the crucial question of which coping strategies, or combination of coping strategies, successfully buffer against adverse weather shocks

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and which strategies do not. A systematic evaluation of coping strategies can identify successful existing strategies, and assist policy makers and development agencies to devise social protection programs and interventions that help rural households become more resilient to adverse weather shocks.

The objectives of this paper are to assess the impact of weather shocks on household consumption and on household poverty dynamics in rural Ethiopia, and to evaluate the effectiveness of widely used coping strategies in mitigating weather shock impacts. The study differs from previous efforts in several important aspects. First, it systematically evaluates the effectiveness of a basket of rural household coping strategies in buffering against weather shocks. Household use of coping strategies may be correlated, thus examining coping strategies together provides more accurate estimates of their effectiveness by avoiding potential omitted-variable bias. We show that several coping strategies employed by rural Ethiopian households are effective, but in combination they only partially mitigate the impact of adverse weather shocks on consumption. Second, we construct a new dataset and employ novel empirical strategies to generate more reliable estimates of the weather impacts on household consumption. Third, our results are used to simulate weather shock and coping strategy impacts on household poverty dynamics and to suggest modifications in social protection programs and policies in order to assist rural households in sub-Saharan Africa (SSA) to increase their resilience to weather shocks.

Increasing household resilience to weather shocks is a particularly important issue in Ethiopia. The country's economy is dominated by its agriculture sector, which accounts for 43% of the GDP and 90% of exports.[1] Further, agriculture is primarily *rainfed* and thus highly dependent on rainfall, which according to USAID. (2015) is increasingly erratic, with marked seasonal deficits and more frequent drought and heavy rainfall events. In the past four decades alone, devastating droughts occurred in 1973–74, 1983–84, 1987–88, 1990–91, 1993–94, and 2015–16.[2] On the other hand, rural households in Ethiopia employ a variety of strategies to cope with weather shocks, including participating in the Productive Safety Net Program (PSNP)—one of the strongest FSSN programs in SSA. Variable weather conditions and existing extensive use of coping strategies assist us to identify the impacts of weather shocks on household consumption and evaluate the effectiveness of household coping strategies in mitigating adverse weather shocks.

The remainder of this paper is structured as follows: Section 2 describes the data and the Ethiopian context; Section 3 outlines the conceptual and empirical framework; Section 4 presents the main results and associated robustness tests; and Section 5 concludes the paper.

2. Data and context

Household-level data from the Ethiopian Rural Household Surveys (ERHS)[3] are joined with village-level climatic data from the African Flood and Drought Monitor (AFDM)[4] to form a unique panel dataset. The data contain detailed information on consumption, household characteristics and composition, household use of coping strategies, and weather shocks for households in 15 rural villages (kebeles, wards, or peasant associations) in 1994, 1999, 2004, and 2009.

(a) Household data

The households were surveyed twice in 1994, and subsequently in 1995, 1997, 1999, 2004, and 2009, with a sample of approximately 1500 households in 15 villages across the country (locations are shown in Figure 1[5]). Within each village, households were sampled through a stratified random sample. We use household-level panel data from the 1994, 1999, 2004, and 2009 rounds to form an equally spaced, unbalanced panel dataset, with 1,121, 1,262, 1,322, and 1,333 household observations in each year, respectively, and a total sample size of 5,038 observations.

The 15 villages covered in the ERHS are characterized by seasonal and fluctuating rainfall (Gray & Mueller, 2012). Average annual precipitation in the study villages ranges from 470 to 1300 mm (18–51 inches). Historically, widespread severe droughts occurred in 1999, 2002–2003, 2005, and 2008. Rainfall occurs mainly during the main (Kiremt) season, but some villages also have a second minor (Belg) season.[6] For uniformity, we focus on main season rainfall.

The structured questionnaire administered to each household collected information on household demographics, assets, income, credit, food and nonfood consumption, and agricultural activities. A community questionnaire was also distributed in 1997, 2004, and 2009 to obtain village-level data on infrastructure, services, education, non-governmental organization (NGO) activity, migration, wages, and production and marketing.

The survey is notable for its low attrition rate and representativeness of Ethiopian households in non-pastoralist farming systems (Dercon & Hoddinott, 2011), but the survey design also generates some limitations for our study. First, while about 1500 households were surveyed, they are concentrated in only 15 villages, leading to moderate cross-sectional variation in village-level weather variables. Second, although the core modules of the questionnaire are consistent, some questions change over survey rounds, making it problematic to analyze changes in several important variables including exposure to idiosyncratic shocks.

(b) Weather data

Climatic data were drawn from the African Flood and Drought Monitor (AFDM), which contains countrywide precipitation (mm), maximum temperature (K), and minimum temperature (K) on a daily basis with a grid resolution of 0.25 decimal degrees. Village-level estimates are generated by inverse distance weighting interpolation using weather data from the four nearest grids around the village centroid. Thus, rainfall and temperature are treated as covariate village-level shocks.

Daily rainfall is first averaged for the main rainy season (June 16th to September 15th) in each year. These yearly rainfall data are then used to calculate the "standard deviation" of average daily rainfall in the main rainy seasons over the past five years for each panel period. The standard deviations provide a relatively short-term inter-annual measure of rainfall variability, which can be perceived by the households and, thus, potentially influence coping strategy adoption and consumption behavior. Daily maximum and minimum temperatures are employed to derive the total growing degree days (GDDs) and total extreme heat degree days

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[1] *Source:* https://www.usaid.gov/ethiopia/agriculture-and-food-security.

[2] *Source:* http://www.fao.org/nr/water/aquastat/countries_regions/eth/index.stm.

[3] These data have been made available by the Economics Department, Addis Ababa University, the Centre for the Study of African Economies, University of Oxford and the International Food Policy Research Institute. https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/15646.

[4] The AFDM, developed by Princeton University, uses available satellite remote sensing and in-situ information, a hydrologic modeling platform, and a web-based user interface for operational and research use in Africa. Based on macro-scale hydrologic modeling, the system employs available data to provide real-time assessment of the water cycle and drought conditions, and puts this in the context of the long-term record dating back to 1950. http://hydrology.princeton.edu/monitor.

[5] Figure 1 also includes three additional villages that were visited in 1999 and 2009 only.

[6] The main rainy season in Ethiopia typically occurs between June 16th and September 15th, and the minor rainy season between February 1st and May 31st.