



Climate variability and educational attainment: Evidence from rural Ethiopia



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ABSTRACT

This paper examines the effects of climate variability on schooling outcomes in rural Ethiopia. Investments in education serve as an important pathway out of poverty, yet reduced agricultural productivity due to droughts or temperature shocks may affect educational attainment if children receive poorer nutrition during early childhood, are required to participate in household income generation during schooling ages, or if households can no longer pay for school-related expenses. We link longitudinal socioeconomic, demographic, and schooling data from the Ethiopian Rural Household Survey to high-resolution gridded climate data to measure exposure to temperature and precipitation relative to historical norms. We then estimate a set of multivariate regression models to understand how climate variability impacts grade attainment and school enrollment. Results indicate that early life climatic conditions – namely milder temperatures during all seasons and greater rainfall during the summer agricultural season – are associated with an increased likelihood of a child having completed any education. In addition, greater summer rainfall during both early life and school ages is associated with having completed any schooling as well as with attending school at the time of the survey. These findings suggest that future climate change may reduce children's school participation in rural Sub-Saharan Africa, slowing progress toward human development goals and poverty alleviation.

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1. Introduction

Climate change can act as a barrier to development among rural populations in low- and middle-income countries. Environmental change impacts agricultural productivity, which in turn affects the ability for households to invest in human capital and improve living standards. Populations in sub-Saharan Africa are particularly vulnerable to climate variability, as over 60% of the workforce is employed in agriculture and 96% of cropland is rain-fed (FAO, 2012; World Bank, 2015b). Indeed, variations in rainfall and temperature have impacted agricultural output more so there than in other regions of the developing world (Barríos et al., 2008). Warming temperatures over the past several decades have been found to lead to large reductions in the yields of maize, wheat, sorghum, and barley (Lobell and Field, 2007), and extreme heat waves are becoming more common in Africa (Russo et al., 2016). Future temperature increases and precipitation changes are predicted to

reduce crop productivity, particularly in semi-arid regions (Niang et al., 2014; Schlenker and Lobell, 2010). This is especially relevant among the extreme poor, who tend to live on smaller or more marginal plots of land. These households may be caught in what Barrett (2008) terms a “resource degradation poverty trap” – persisting at low levels of human development and unable to invest in additional income producing activities (e.g. irrigation technologies, machinery, or small businesses) or in human capital (e.g. paying school fees, accessing healthcare, or purchasing nutritional foods).

Investments in human capital – particularly education – serve as an important pathway out of poverty by expanding skills and labor market opportunities. However, the lack of access to schooling has impeded development in many low-income nations. In response, the United Nations aimed one of its eight Millennium Development Goals (MDGs) at achieving universal primary school education by 2015. Though great progress has been made since the adoption of the MDGs in 2000, 20% of primary school-aged children in sub-Saharan Africa remained out of school as of 2015 (United Nations, 2015). These children may have never begun their schooling or may have dropped out before completing primary school. In addition, among those in school, many children are not in

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the appropriate grade for their age due to late entry as well as interruptions in school attendance (Lewin, 2009). One important factor keeping rural children out of school is the demand for child labor, including assisting adult household members with agricultural activities, helping with other income generating activities, and performing domestic tasks (Abebe, 2007; Admassie, 2003; Cockburn and Dostie, 2007; Haile and Haile, 2012; Psacharopoulos, 1997). Additional factors that affect school attendance in rural sub-Saharan Africa include poverty, gender norms, and food insecurity (Belachew et al., 2011; Hunt, 2008; Lewin 2009; Mani et al., 2013). Despite falling short of their MDG schooling goals, the United Nations recently released a set of more ambitious Sustainable Development Goals (SDGs), one of which aims to achieve universal primary and secondary attainment by 2030 (United Nations, 2016).

Both environmental change and the lack of access to schooling are linked to the ability for agricultural households to improve living standards, and lower educational attainment could represent an important and unexplored pathway by which future climate change undermines gains in human development. However, research on the relationship between environmental conditions and schooling remains limited. The goal of this paper is to examine the intersection between environmental change and education by studying how temperature and precipitation variability impact schooling outcomes in rural Ethiopia. Ethiopia is particularly vulnerable to the effects of changes in temperature and precipitation, as 84% of the population lives in rural areas, 42% of the country's GDP is derived from agriculture, and only 3% of agricultural land is irrigated (Dorosh and Schmidt, 2010; World Bank, 2016; FAO, 2011). In order to examine the relationship between climate and schooling in Ethiopia, we ask whether climate variability impacts schooling outcomes among children from rural agricultural households. Our paper offers new insights into the social impacts of global environmental change in sub-Saharan Africa, which can inform policies that address education, socioeconomic development, and poverty reduction in the face of increasing environmental variability.

2. Climate shocks and educational outcomes in developing countries

Research on the links between climatic conditions and educational outcomes is limited, and the findings are mixed. One set of studies examines how shocks experienced during school ages impact education. Björkman-Nyqvist (2013) found that in Uganda, negative rainfall shocks in the year of the survey led to lower primary school enrollment among older girls. She finds no evidence that boys' or younger girls' enrollment is affected by rainfall shocks and attributes this to the fact that older females play a more important role in household labor during periods of stress than other children. In contrast, Mani et al. (2013) discovered that in rural Ethiopia, higher rainfall during the year of the survey was negatively correlated with enrollment and grade attainment for males relative to females, as male children are often pulled out of school to assist with farm labor. Similarly, Shah and Steinberg (2013) found that in India, children who experienced positive rainfall shocks in the year prior to the survey were more likely to drop out of school than those who experienced drought. The authors argued that positive shocks led to higher agricultural productivity, and therefore during these periods the returns to labor among children were higher than the returns to schooling.

Further, a study in Tanzania found that children from households who experienced severe crop loss increased their labor by 30% and were twenty percentage points less likely to be enrolled in school, but that wealthier households were buffered from these effects (Beegle et al., 2006). Lastly, a study in Honduras examined the impacts of Hurricane Mitch on secondary school attainment

and found that children from credit-constrained households impacted by the hurricane experienced lower attainment (Gitter and Barham, 2007). These studies indicate that the demand for child labor among agricultural households is an important determinant of educational outcomes, but that the effect of rainfall shocks may vary based on individual- and household-level characteristics as well as the cultural, environmental, and economic context in which the household operates.

Other studies have examined the relationship between shocks experienced in utero or infancy and educational outcomes in later childhood and adulthood. A study in Burkina Faso found that negative rainfall shocks in utero and before age two were negatively correlated with cognitive ability and school enrollment, and were positively correlated with child labor (Akresh et al., 2012). Likewise, in Indonesia, rainfall shocks during the year of birth were found to impact women's educational attainment in adulthood (Maccini and Yang, 2009). In addition, children exposed to El Niño floods in Ecuador in utero, particularly during the first trimester, scored lower on cognitive tests five to seven years later (Rosales-Rueda, 2014). Lastly, Shah and Steinberg (2013) found that in India, exposure to drought in utero and during the first few years of life led to lower cognitive abilities and lower likelihood of school enrollment. These findings suggest that lower agricultural output during periods of rainfall shocks is associated with decreased health and nutrition among pregnant mothers and infants, and therefore with lower levels of biological human capital among exposed children. This supports the argument by Alderman (2011) that the physical, cognitive, and socio-emotional effects of shocks in early childhood act as key determinants of future life outcomes.

We build on this emerging literature in three primary ways. First, while most prior studies focus solely on rainfall, we examine both rainfall and temperature. Because fluctuations in both temperature and precipitation due to climate change are expected to affect agricultural productivity in sub-Saharan Africa (Niang et al., 2014; Schlenker and Lobell, 2010), examining the effects of precipitation alone does not provide a comprehensive picture of the impacts of climate change. Second, we look at climate over the first seven years of a child's life instead of studying only discrete shocks or climatic conditions experienced during the year of or year prior to the survey. Early childhood is a critical period for physical and cognitive development and is the time of life before formal schooling begins in Ethiopia. In addition, because climate change is a decadal process, we measure climate as deviations from long-term historical conditions, which may serve as a better proxy for understanding how climate change may impact educational outcomes in the future. Lastly, given the gendered nature of child labor in Ethiopia (Abebe, 2007; Haile and Haile, 2012; Rose and Al-Samarrai, 2001) and the results of prior studies on the differential effects of climate on girls' and boys' schooling outcomes (Björkman-Nyqvist, 2013; Mani et al., 2013), we examine the interactions between climatic conditions and the child's sex to determine whether climate variability impacts girls and boys differently.

3. The Ethiopian context

Ethiopia is a low-income country in which 61% of rural primary school-aged children attend school (World Bank, 2015a). Primary school runs for eight years from ages seven to 14, though many children do not begin their schooling on time. Secondary school consists of two two-year cycles, from ages 15 to 16 and 17 to 18 (Ministry of Education, 2011). The Ethiopia Rural Socioeconomic Survey, a nationally-representative study of rural areas and small towns, found that among rural children aged seven to 18, primary school enrollment was 57% for boys and 59% for girls, and secondary school enrollment was approximately 2.5% for both

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