ELSEVIER
www.elsevier.com/locate/worlddev

CrossMark

World Development Vol. 86, pp. 59–78, 2016
0305-750X/

http://dx.doi.org/10.1016/j.worlddev.2016.05.005

Extreme Weather Events and Child Height: Evidence from Mongolia

VALERIA GROPPO and KATI KRAEHNERT*

German Institute for Economic Research (DIW Berlin), Berlin, Germany

Summary. — We provide new evidence on the impact of one severe weather event on child height in Mongolia. While previous studies mostly focus on rainfall shocks in tropical or dry climate areas, our focus is on the extremely harsh winter that hit Mongolia in 2009–10. The severe winter—locally referred to as a dzud—caused catastrophic damage and resulted in the death of 10.3 million livestock. Our analysis identifies the causal impact of the weather shock on children's height by exploiting exogenous variation in the intensity of the shock across time and space. We use data on the height of children from two waves of a panel survey specifically designed to assess the impact of weather events. Results reveal that the shock significantly slowed the growth trajectory of exposed children from herding households. This negative effect is persistent, remaining observable in both panel waves, three and four years after the shock. The effect is driven by children who experienced the shock in utero. There is indicative evidence that the provision of emergency aid mitigates the negative consequences of the shock. Moreover, child height has a significant and positive association with households' receipt of informal help. Our findings are robust to alternative measures of shock intensity from different data sources.

Key words — aid, anthropometrics, children, extreme weather events, health, Mongolia

1. INTRODUCTION

Shocks experienced during childhood can have long-lasting effects on health. This can translate into negative macroeconomic effects in terms of human capital accumulation and economic growth (Almond & Currie, 2011a, 2011b). Hence, it is essential to understand how shocks impair children's health and what strategies are effective at mitigating the consequences of shocks. This analysis is especially relevant for developing countries, where incomplete or non-existent insurance markets limit the capacity of households to smooth consumption (e.g., Townsend, 1994; Udry, 1994; Zimmerman & Carter, 2003). Moreover, it is particularly important to focus on extreme weather events because these are likely to become more frequent in the future (IPCC, 2014).

In this paper, we provide new evidence on the impact of a severe weather shock on child height in Mongolia. Our focus is on the extremely harsh winter of 2009–10, which caused 10.3 million livestock to perish. This threatened the sustenance of the herding households that use livestock as source of income, food, and wealth storage. The phenomenon of high livestock mortality due to extreme winter conditions is referred to as *dzud* in Mongolian. From a methodological perspective, the 2009–10 dzud exhibits characteristics that facilitate the identification of causal effects. First, the intensity of the shock varied strongly in space, and, second, its abrupt start, severity, extremely long duration, and disastrous effect on livestock came unexpectedly to households. Thus, we argue that the shock is exogenous. We explore the effects of the 2009–10 winter on the height of children three to four years after the shock. The data used in this paper is a household panel survey with two waves collected in western Mongolia during 2012–14.

Our study contributes to the literature on the impact of shocks experienced in early childhood in three ways. First, we provide evidence on the negative consequences of one particular type of weather shock—an extremely severe winter. Our results are relevant for other regions characterized by a continental climate with large seasonal variation in temperature, such as Russia, inland China, or the Himalayas. In contrast, most of the existing literature on the impact of weather shocks on child outcomes focuses on drought and rainfall shocks in tropical or dry climate zones.

Second, we use exceptionally detailed data that allow us to overcome shortcomings in previous studies. In particular, we exploit the longitudinal nature of our survey and use anthropometric outcomes measured at different points in time for the same child. This allows us to assess the persistence of shock effects in the medium term while the previous literature mainly focuses on either short- or long-term effects. In addition, we employ climatic data and historical data on livestock mortality to obtain two district-level measures of shock intensity, while previous studies mainly use one regional-level weather shock measure. We are also able to precisely match children to their districts of residence during the shock. [1]

Third, we provide new evidence on the role of emergency aid and household coping strategies, thus contributing to research on coping mechanisms and on the effects of food aid. We are able to do so by drawing on unique data on the amount of food aid and fodder distributed by district, as well as a specific module on household coping behavior within the household panel survey.

In line with previous studies, we identify the impact of the shock by exploiting exogenous variation in shock intensity across time and space. Results reveal that the 2009–10 dzud significantly slowed the growth trajectory of exposed children from herding households. This finding is robust to using

*We are grateful to Alexandra Avdeenko, Batbuyan Batjav, Veronika Bertram-Hümmer, Bayarkhuu Chinzorigt, Michael Grimm, Adam Lederer, Katharina Lehmann-Uschner, Kristina Meier, Olga Shemyakina as well as two anonymous referees for helpful comments. The paper also benefited from comments received at seminar and conference presentations in Berlin, Braga, Bremen, Hamburg, Kiel, Passau, and Toulouse. Uuriintuya Batsaikhan, Marrit Teirlinck, and Myriam Thömmes provided excellent research assistance. The Mongolian Red Cross Society kindly provided data on emergency aid. The research was generously funded by the German Federal Ministry of Education and Research, funding line 'Economics of Climate Change,' research grant 01LA1126A. The responsibility for the content of this paper lies solely with the authors. Final revision accepted: May 5, 2016.

alternative measures of shock intensity and to measuring children's height in either the first or the second survey waves. Children exposed to the 2009–10 shock while in utero are more strongly affected by the shock than children who experienced it as infants. Moreover, girls are significantly less affected than boys. Our results also indicate a positive and statistically significant association between emergency aid and health in dzud-affected districts and for cohorts experiencing the dzud. Likewise, obtaining informal help during the dzud by borrowing money or receiving assistance from relatives is significantly positively correlated with better child health.

The paper proceeds as follows. The next section provides an overview of the existing literature on fetal and early childhood shocks. Section 3 describes herding in Mongolia and summarizes the characteristics of the 2009–10 dzud. Section 4 introduces the household survey data and the shock measures. The estimation strategy is outlined in Section 5, followed by a discussion of results and robustness tests in Section 6. The last section summarizes the results and discusses policy implications.

2. REVIEW OF THE EXISTING LITERATURE

A rich empirical literature analyzes the effects of shocks during pregnancy and early childhood on subsequent child development and health trajectories.[2] Within this branch of research, one group of studies focusses on the short-term impact of droughts in contexts where households strongly depend on rainfed agriculture. These studies provide mixed results. Some find beneficial effects of excess rainfall (Maccini & Yang, 2009; Rocha & Soares, 2015) while others document detrimental effects (Kudamatsu, Persson, & Strömberg, 2012; Skoufias & Vinha, 2012). These diverging results stem from the specific mechanisms linking rainfall shocks with health outcomes in different contexts. In particular, Rocha and Soares (2015) identify three main channels: first, excess rainfall may improve nutrition through increased agricultural production; second, positive rainfall shocks may increase the amount of drinkable water, again bringing health benefits; and thirdly, excess rainfall may increase the incidence of diseases, which negatively affects health.

A related literature assesses the long-term effects of famines. For instance, Dercon and Porter (2014) find that children from households affected by the 1984 Ethiopian famine are significantly shorter as young adults than individuals of the same cohort who lived in unaffected households. Similar long-term negative effects are reported for the 1974 flooding in Bangladesh that caused mass starvation, as well as for other famines (see Hernández-Julián, Mansour, & Peters, 2014 and the literature cited therein).

Our paper also relates to studies on health and violent conflict, which generally find negative effects for children residing in areas with high conflict intensity (Akresh, Bhalotra, Leone, & Osili, 2012; Akresh, Verwimp, & Bundervoet, 2011; Akresh, Lucchetti *et al.*, 2012; Grimard & Laszlo, 2014; Mansour & Rees, 2012; Minoiu & Shemyakina, 2014). Most of these studies identify the shock impact by exploiting the spatial variation in shock intensity and the temporal variation in shock exposure.

We identify three gaps in the existing literature that we address in our study. First, most studies on the impact of weather shocks on child outcomes focus on drought and rainfall shocks in tropical or dry climate zones, while little attention is paid to other types of extreme weather events, such as cold spells.[3] Second, most existing studies are constrained to using cross-sectional data containing one observation per individual, which does not allow for the assessment of shock persistence. Third, few studies disentangle the impact of damages caused by the shock from household shock-coping behavior.

3. HERDING AND WEATHER SHOCKS IN MONGOLIA

Livestock is an important source of income for Mongolians living outside the capital city of Ulaanbaatar. In 2011, about 29.6% of Mongolian households owned livestock and 21.7% were herders for whom pastoral activities represent the main food and income source (NSO, 2011, 2013). Herders typically hold a mix of camel, cattle, horses, sheep, and goats. Most herders are nomadic or semi-nomadic, rotating seasonally between campsites.

Weather risk and shocks are an inherent part of the pastoral livelihood. In particular, the extreme continental climate of Mongolia makes herders vulnerable to dzuds. While dzuds have occurred in the past, we argue that the 2009–10 dzud was an exogenous shock to Mongolian herders. Figure A1 in the Appendix represents the development of the livestock sector in Mongolia during 1960–2011. The figure shows that the extent of livestock mortality caused by the 2009–10 dzud, a single winter season, was unprecedented. More than 10.3 million livestock perished in 2010, about 23.9% of the national herd. Herders had been exposed to dzuds also in relatively recent years—indeed three consecutive dzuds in the winters of 1999–00, 2000–01, and 2001–02 challenged their herds. Yet, the mortality in each of these winters did not exceed 5 million losses, well below that of the 2009–10 dzud. Moreover, it was the long duration of unfavorable weather conditions during 1999–2002, with droughts in summertime and cold winters that weakened livestock over many months that caused animals to die of exhaustion.

In contrast, the 2009–10 dzud caused massive livestock death within a relative short time period.[4] Unfavorable weather conditions started with a drought in summer 2009 that prevented animals from building up fat reserves. Heavy snowfall started in October 2009, preventing animals from reaching grass. From November 2009 onward, livestock started perishing. Record low temperatures were registered in December 2009 and January 2010. By March 2010, 5.8 million livestock had perished. Starting in May 2010, the thick layer of snow melted, resulting in flash flooding that further damaged livestock. Given the short time period during which these extreme climatic conditions occurred, we assume that households did not anticipate the magnitude of livestock losses caused by the 2009–10 dzud.

Dzuds are a major cause of rural poverty (World Bank, 2006, 2009). Formal insurance markets are not well developed in rural Mongolia. Thus, herders must draw on informal strategies to manage risk and cope with the consequences of dzuds (Skees & Enkh-Amgalan, 2002). Yet, given the severity and covariate nature of dzuds, the effectiveness of informal risk management mechanisms is limited. Consequently, "high levels of livestock mortality are often unavoidable even for the most experienced herders" (Mahul & Skees, 2007, p. 10).

The effects of the 2009–10 dzud were disastrous for herders, many of whom lost half or more of their herd (NSO, 2010, p. 92). An assessment conducted by the International Federation of Red Cross and Red Crescent Societies (IFRC) and the Mongolian Red Cross Society (MRCS) in January 2010 reported that children faced a risk of chronic malnutrition due to diminished food intake and poor dietary diversity.