World Development 110 (2018) 63–74

Contents lists available at ScienceDirect

World Development

journal homepage: www.elsevier.com/locate/worlddev

The distributional effect of investment in early childhood nutrition: A panel quantile approach

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ARTICLE INFO

Article history:
Accepted 9 May 2018

JEL classification:
I14
J13
C30
C33

Keywords:
Childhood nutrition
Distribution
Panel quantile model

ABSTRACT

This article examines the distributional effects of early nutritional investments on child health outcomes. Depending on the difference between a child's actual and potential health status, the effects of investment in early childhood nutrition can differ across child health status distributions. To establish a causal inference, I merge village-level rainfall data with a child-level longitudinal survey—the Ethiopian Rural Household Survey—and apply a Correlated Random Effect quantile regression for panel data model. The findings suggest that a standard deviation increase in a village-level precipitation z-score has heterogeneous effects across the weight-for-height and weight-for-age z-score distributions and gender. The positive effects are more pronounced at the lower end of health status distributions and on girls. To the extent that the increase in a village-level precipitation z-score increases investment in child nutrition, its stronger effect on girls and at the lower end of the health status distribution implies that policy interventions that aim to promote nutritional investment reduces the health inequality gap across health status and gender.

1. Introduction

Because of their lasting benefits, early nutritional intervention programs have become popular early childhood development policy tools (Linnemayr & Alderman, 2011). While their effects on long-term human capital outcomes are well documented (Currie & Vogl, 2013; Hoynes, Schanzenbach, & Almond, 2016), evidence on the contemporaneous returns across the health status distribution are scant. Theoretically, the return from nutritional intervention programs can concentrate at either end of the health status distribution. On the one hand, because the health status of less-endowed children is far from their potential endowment, a dollar spent on nutrition can be more productive at the lower end of the health status distribution than at the upper end, compensating them for investments that had never been made in the past. On the other hand, because better endowment serves as a fertile ground, a dollar spent on nutrition can yield more return at the upper end of child health distribution than at the lower end of health status distribution. Thus, where investments on early childhood nutrition provide greater return is still an empirical question. From a policy perspective, this is an important question. For example, if the return from such investments benefit children at the upper end of the health status distribution, policy interventions would need to target the determinants of health endowments such as access to prenatal care and maternal nutrition because those interventions will not only close the endowments gap, but will also make future investments more productive. In contrast, if the return from these investments is concentrated at the lower end of health status distribution, to help those children catch-up with their peers at the upper end of the distribution, policy interventions would need to focus on improving the health status of children at the lower end of health status distribution because those interventions would yield less inequality at an earlier age.

The literature on the interaction of child human capital and early childhood intervention programs focuses on how investment in early skill formations interacts with human capital endowments or past investments (Bitler, Hoynes, & Domina, 2014; Cunha & Heckman, 2007; Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010). These studies documented significant heterogeneous effects of these programs across skill distribution and socioeconomic status. Aizer and Cunha (2012), for instance, showed the return from a nationwide Head Start preschool program in the US is more productive among children at the top of IQ distribution than others. Heckman et al. (2010), on the other hand, found a strong positive return from investing in disadvantaged and less able minority children from the Perry preschool program, even after accounting for

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https://doi.org/10.1016/j.worlddev.2018.05.018
0305-750X/

the potential sample size and selection problems. Bitler et al. (2014) also showed large and statistically significant gains in cognitive achievement during the pre-school period at the lower end of the cognitive measurement distribution. The results from these studies imply that early childhood intervention in skill formation benefits children at the lower end of skill and socioeconomic status distribution. The literature on early childhood health-related intervention programs, especially in developing countries, focuses on their average contemporaneous and long-term treatment effects (Field, Robles, & Torero, 2009; Hoddinott, Maluccio, Behrman, Flores Ayala, & Martorell, 2008; Linnemayr & Alderman, 2011; Maluccio et al., 2009). Causal evidence on the health status distributional effects of such investments in developing countries is almost non-existent and evidence on the distributional effects of policy interventions, such as Bitler, Gelbach, and Hoynes (2006) and Abadie, Angrist, and Imbens (2002), shows that the average treatment effect estimate misses an important causal impact across the conditional distribution of key policy outcomes. Thus, using village-level precipitation z-scores (VPZ) as nutritional investments, this paper provides new evidence on the distributional effects of early nutritional investments on the health status of children in rural Ethiopia.

Making causal inferences on the distributional effects of childhood nutritional investments on health using a VPZ is challenging. This is partly because rainfall variation can be more common in some geographical locations than others and this can determine the return from a standard deviation increase in a VPZ through unobserved child heterogeneity. When the incidence of rainfall shock is correlated over time, the estimates of the effects of a VPZ on child health status might pick up the cumulative effects of past and current rainfall shock rather than the effects of current rainfall. The concern, as discussed in Deaton (2009), is that correlated rainfall shock might shape factors that determine the response to nutritional investments, but are difficult to observe, such as immunity (Thai & Falaris, 2014), lung capacity (Maccini & Yang, 2009), and birth-weight (Andalón, Azevedo, Rodríguez-Castelán, Sanfelice, & Valderrama-González, 2016). For example, children in lowland and arid areas tend to be taller than children from highland and wetland areas. The disease environment associated with lack of rainfall in lowland areas might increase the survival threshold and provide them superior unobservable health endowments (Bozzoli, Deaton, & Quintana-Domeque, 2009). Thus, the correlation between rainfall and child health outcomes might reflect the effect of living in a wet or drought-prone areas rather than the causal child health effect of rainfall. To identify the effects of a VPZ on child health, the estimation strategy needs to allow a correlation between unobserved child heterogeneities and village-level rainfall. To that end, I used the correlated random effect (CRE) quantile regression for panel data model developed by Abrevaya and Dahl (2008). This model allows a correlation between child unobserved heterogeneity and a VPZ. To control child fixed effects, it linearly projects the child-level unobserved heterogeneity as a function of observed child-level, household-level, and village-level covariates, including village-level rainfall, and cancels them out in the process of estimation.[1] The CRE panel quantile model also provides a consistent estimate for panel data as short as two periods.

The study combines a village-level rainfall data with child-level longitudinal data. The village-level rainfall data was obtained from the University of Delaware Center for Climatic Research. The child health outcomes are drawn from four rounds of the Ethiopian Rural Household Survey (ERHS), which was obtained from the International Food Policy Research Institutes. These four rounds of the survey were conducted between 1994 and 1997, providing panel data of health outcomes for children between ages 0 and 5. A standard deviation increase in the most recent completed agricultural season's VPZ increases crop yields and per capita household consumption expenditures, but a standard deviation increases in the current a VPZ decreases total household time spent on domestic activity—another important child health input. The average treatment effect estimates show that a standard deviation increase in the most recent completed agricultural season's VPZ increases weight-for-height and weight-for-age z-scores. The CRE quantile estimates indicate that a standard deviation increase in a similar VPZ has more pronounced effects at the lower end of the weight-for-age and weight-for-height z-score distributions.[2] Across gender, both the average and the distributional effects if a VPZ are greater on girls than boys. The average weight-for-height and weight-for-age z score of girls, both at the mean and across the distribution, are lower than boys' weight-for-height and weight-for-age z-scores. Thus, the stronger effects of a standard deviation increase in a VPZ at the lower end of the health status and on girls' anthropometric measurements distribution can be a consequence of diminishing marginal return to nutritional investments at the upper end of these distributions.

The contribution of this study is twofold. First, this paper provides causal evidence on the child health effects of rainfall shock. To the extent that positive rainfall shock represents investment in child nutrition, the finding also speaks to the literature of the child human capital effects of investment in early childhood nutrition. The main contribution of the finding to this literature is that it shows the effects across the child health status distribution. Second, to control for child fixed effects, it uses a CRE quantile regression for panel data model, which allows correlation between village-level rainfall and child unobserved heterogeneity.

The rest of this article is structured as follows: Section 2 discusses the data and presents the descriptive statistics of the sample. The identification strategy is presented in Section 3. Section 4 discusses the results. The final section presents the conclusions.

2. Data

Ethiopia is of particular interest for examining the child health effects of nutritional investments via rainfall. Close to 85% of the population lives in rural areas and their livelihoods largely depend on rain-fed agriculture (Asfaw, 2017; Dercon, 2004; Gray & Mueller, 2012). The country is also subject to volatile levels of precipitation. The study sample is drawn from the Ethiopian Rural Household Survey (ERHS) data. It is a longitudinal data set that covers 1477 households from 15 rural villages in Ethiopia. It was collected through collaboration between the International Food

[1] To compare, I also estimated a model that assumes no correlation between unobserved child heterogeneity and rainfall shock—a random effect model. A test on the validity of the CRE and random effect model, however, rejected the null hypothesis of no correlation between unobserved heterogeneity and rainfall, suggesting that a causal inference on the child health effects of rainfall necessitates controlling for child-level unobserved heterogeneity.

[2] Rainfall affects child health outcomes through parental income and time investment. An increase in the amount of rainfall increases harvest, which increases income and investments in nutrition. In rural areas, because "good" rainfall increases the demand for labor on the farm, it can reduce investment in time-intensive health inputs (Shah & Steinberg, 2017). While the income effect improves child health outcomes, the substitution effect of investment in time-intensive health inputs worsens them. The net effect, therefore, depends on whether the income effect dominates the substitution effect. To examine whether the substitution effect played a role, I examine the effect of rainfall on time spent on domestic activity. The result suggests that the time adult household members spend on domestic activity decreases with better rainfall. To the degree that the negative effects of higher rainfall reduce the time adults spent on domestic activities, a standard deviation increase in the VPZ will underestimate the true health benefits of investments in child nutrition.