The long term effects of being born in a drought: Evidence from South Africa

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1 Research question and context

Adverse weather events in early life have been found to have significant effects on adult health (height, stunting, mortality) and human capital outcomes (total years of schooling, child enrollment) in countries such as Indonesia (Maccini and Yang (2006), Zimbabwe (Alderman, Hoddinott and Kinsey (2004) and the Netherlands (Van den Berg, Lindeboom and Portrait, (2006)). Much of this literature emphasizes that human capital outcomes are directly and negatively affected by nutritional stress in early life. Since the data requirements for estimating these long term relationships are enormous, economists are still building an understanding of how pathways from early life environmental conditions matter for later life outcomes.

My paper contributes to this literature in two ways. I use longitudinal data from the Cape Area Panel Study (CAPS) to provide evidence from South Africa that being born in a drought has long term effects on adult height and negative effects on the total stock of human capital (years of education attained, tests of ability in adolescence). I compare outcomes for children who are born before and after the drought to those who are born during the drought, in places that have more and less severe drought conditions. My findings add to the weight of evidence about the effect of early environmental conditions on long term outcomes.

Second, using the same identification strategy, I analyze detailed schooling calendar data to uncover some of the channels through which the final stock of human capital is adversely affected by these early life events. In much of the economics literature, identifying a relationship between these early events and later human capital outcomes has been a first step that leads to further questions about the mechanisms through which the shock operates. Apart from negative health effects which could directly reduce the ability to produce human capital, adverse weather events may also delay school enrollment, slow down school progression and affect grade repetition. We know nothing about the latter two outcomes in particular, since data requirements for this exercise are even more extreme. The CAPS data allow us to examine these "flow" variables for human capital, which help to understand final differences in stocks related to adverse and early life weather conditions.

Currie and Madrian (1997) document several studies that examine the direct impact of early life health conditions on cognitive development as measured by scores on tests administered to children. Most of these studies use data from the USA, and are limited to the cognitive outcomes as the sample is still in childhood. Maccini and Yang (2006) look at the effects of variation in early life health stocks (identified by rainfall variation at birth) on years of schooling, marriage and labor market outcomes for men and women in Indonesia. They speculate that early life health shocks that generate variation in height work through differential human capital accumulation to affect adult outcomes. However, they are unable to look more closely at how health produces human capital with their data as they only have total years of schooling. Alderman, Hoddinott and Kinsey (2006) find that rainfall shocks and civil conflict affect height and early educational attainment of children in Zimbabwe but are unable to trace through any longer term effects on the final stock of human capital.

2 Research design

The paper adopts a difference-in-differences strategy and exploits variation in drought severity over time and space to identify the effects of adverse weather conditions. The main outcome variables of interest will be height, age of school entry, enrollment in each year, grade repetition, total years of schooling and ability as measured by a score on a literacy and numeracy test. The main equation to be estimated for person i is:

$$y_i = \alpha + \delta D_i + \lambda Y_i + \beta D_i * Y_i + X_i'\gamma + \epsilon_i \qquad (1)$$

where D_i measures the severity of drought conditions in the birth location, Y_i is an indicator for whether the individual was born during the drought period or not, and X_i are a set of controls including age, sex and other socioeconomic variables of the young adult's household. Y_i controls for differences in outcomes across cohorts, D_i controls for differences in outcomes across areas severely versus less severely affected by the drought, while β represents differences in y_i that result from being born during the drought compared to being born in a non-drought year.

Selective survival and migration present the largest challenges to identification in this context. First, the literature on early life health shocks always faces the issue of who survives the health shock to be observed in the data. As Maccini and Yang (2006) point out, if only the fittest survive the health shock then this should bias estimates away from finding negative health and human capital effects.

Second, selective migration may operate to undermine the representativeness of the original sample of young adults in Cape Town. Although the sample is representative of Cape Town's population, a feature of this part of the country is that there is substantial migration from the poorer Eastern Cape region to the wealthier Cape Town. As a result, much of the variation in birth location between Africans is driven by the difference between Africans born in Cape Town and those born in the Eastern Cape who subsequently moved to Cape Town. Since the drought conditions were more severe in the Eastern Cape, the individuals who were most affected by the drought are also those who are more likely to be migrants in to the city. If we were comparing individuals born in different areas, this would be an issue since non-migrants living in Cape Town are unlikely to be a good counterfactual for migrants from the Eastern Cape. However, with the difference-in-differences strategy, I am comparing differences in outcomes for youths born during versus before or after the drought, conditioning on location. The Cape Town group of youth essentially serve as a control group dealing with trend differences in inter-cohort outcomes (for example, macro-level institutional changes in schooling that are cohort-specific).

3 Data

I combine three sources of data to investigate the links between early life adverse weather events, later life health outcomes and the accumulation of human capital.

CAPS data from waves 1 (2002), wave 2-3 (2003-2005) and wave 4 (2006) provide me with most of the demographic, health, education and family background information on young people. The sample consists of 1512 African youth aged 14-22 in 2002. This places dates of birth between 1980 and 1988. In the final wave, all of these young adults except for a few boys are old enough (17-26 years) to have attained their final adult height. I restrict the analysis to African boys and girls as there is more geographic variation in the birthplace of Africans compared to Coloureds and Whites in the sample.

The data contain detailed measures of education, labor market outcomes and health.

- Education: a life calendar of schooling outcomes from age 6: enrollment, grade advancement or repetition; literacy and numeracy test scores from a test administered in wave 1; subject symbols for high school leaving examinations; total overall educational achievement by 2006.

- Health: height, weight, hip and waist measurements taken in 2006; the same measurements for siblings of some individuals in households where more than one young adult is interviewed

To identify a proxy variable for birth place location, I use the GIS location of the first school attended by each young adult (the survey does not collect physical birth place). Given that these children were born in the 1980s when apartheid still severely restricted movement of the African population, I expect migration between birthplace and place of first schooling to be minimal. [1] GIS data for location of first school are gathered from the 1996 Schools Register of Needs.

Finally, I will link rainfall and temperature data for 1982-1983 with the birth-place proxy variable to construct a measure of D_i for each individual. South Africa experienced a severe drought during these years: speaking of the drought conditions affecting rural areas of South Africa in this period, Tutu (1998) says "I'm fearful that people will begin to kill for food".

For the preliminary analysis, I assume drought conditions in the Eastern Cape are more severe than in the Western Cape. This is a reasonable assumption, since the Eastern Cape is more predominantly rural and dependent on weather for local livelihoods whereas the Western Cape is more urban and likely to be shielded from the most extreme drought conditions. Hence, $D_i = 1$ if the young adult is born in the Eastern Cape and $= 0$ if not.

4 Preliminary analysis

Tables 1 and 2 describe the variation in timing and birth place. About 24% of the sample is born during the drought years of 1982 and 1983, while over 47% of these young adults are born in the Eastern Cape. There is considerable variation in the main variables required to implement the research design.

Table 3 presents some descriptive statistics separately for African males and females. African females have higher mean years of education, higher z-scores on the tests of language and numeracy are are more likely to have been enrolled at age 6 than African males.

Table 4 presents some preliminary results using equation (1) and substituting for D_i an indicator variable denoting the Eastern Cape as the location of birth.

[1] Pass laws were repealed in 1986.

I present OLS regressions with and without adjusting for a set of controls that include age, sex, household per capita income measured in the 2004 wave, an indicator for missing household income and indicators for mother or father co-resident with the young adult.

Although the interaction term is not always significant at conventional levels, the sign suggests that young adults born during a drought period have poorer long term health outcomes, attain fewer years of education and score lower on tests of ability. Part of these negative effects on human capital attainment may operate through persistent disadvantage. The coefficient on the interaction term in the final two columns suggests that young adults who were born during a drought were 8-9% points less likely to be enrolled at age 6, the usual school starting age. These findings will be investigated further using the full retrospective schooling calendar available in CAPS. This calendar will allow me to look at enrollment in each year as well as grade repetition over time.

5 References

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Table 1: Distribution of year of birth data

Year of birth	African girls	African boys	All
1973	1	0	1
1976	0	1	1
1978	0	2	2
1979	23	16	39
1980	78	82	160
1981	83	60	143
1982	89	68	157
1983	113	88	201
1984	99	67	166
1985	101	71	172
1986	109	64	173
1987	83	85	168
1988	55	62	117
1989	5	4	9
1990	1	0	1
1991	1	0	1
2001	0	1	1
Total	841	671	1512

Table 2: Province of birth information for African youth

Place of birth	African girls	African boys	All
Cape town	383	319	702
Other western cape	11	8	19
Eastern cape	399	312	711
Northern cape	6	4	10
Free state	1	0	1
Kwazulu-Natal	11	6	17
Gauteng	28	20	48
Outside South Africa	2	2	4
All	841	671	1512

Table 3: Descriptive statistics for outcome variables

	height	years of education	test score	enrolled at age 6
African female	1.581	10.571	-0.453	0.196
	0.080	1.474	0.797	0.397
n	833	835	828	841
African male	1.682	10.190	-0.530	0.173
	0.089	1.711	0.883	0.378
n	647	670	662	671

Table 1: Means, standard deviations and number of observations with non-missing values. All variables measured in 2004 CAPS (i.e. when respondents are 17-26 years old) Enrollment at age 6 is asked retrospectively. Test score is the z-scored test result from the young adult's literacy and numeracy test. Height is measured in meters, weight in kilograms.

Table 4: Difference-in-differences results - unadjusted and adjusted

	Height		Years of education		Test score		Enrolled at age 6	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drought year	0.133	0.113	0.592	0.356	0.141	0.07	0.046	0.048
	[0.072]*	[0.075]	[0.127]***	[0.127]***	[0.075]*	[0.077]	[0.037]	[0.038]
Eastern Cape	-0.156	-0.157	0.02	-0.098	-0.061	-0.091	-0.033	-0.026
	[0.062]**	[0.064]**	[0.096]	[0.095]	[0.051]	[0.054]*	[0.023]	[0.025]
Dought*EC	-0.162	-0.149	-0.355	-0.289	-0.207	-0.172	-0.086	-0.092
	[0.117]	[0.119]	[0.198]*	[0.194]	[0.103]**	[0.103]*	[0.047]*	[0.047]*
Age		0.007		0.103		0.028		0.001
		[0.011]		[0.015]***		[0.009]***		[0.004]
Male		0.006		-0.395		-0.088		-0.029
		[0.052]		[0.082]***		[0.044]**		[0.021]
Log per capita		-0.028		0.335		0.112		0.023
household income		[0.030]		[0.055]***		[0.034]***		[0.013]*
Missing income indicator		-0.225		1.779		0.689		0.163
		[0.192]		[0.353]***		[0.212]***		[0.083]**
Mother in home		0.061		0.317		0.125		0.013
		[0.063]		[0.090]***		[0.053]**		[0.023]
Father in home		-0.062		-0.206		-0.114		0.009
		[0.067]		[0.095]**		[0.055]**		[0.024]
N	1466	1466	1505	1491	1490	1476	1512	1498
R^2	0.011	0.013	0.014	0.096	0.007	0.035	0.007	0.011

Table 2: Robust standard errors, clustered on household identifier. Indicator variables are: drought year, Eastern Cape, Drought*EC, Male, missing income indicator, mother in home and father in home. The log of per capita income is measured in South African Rands. All variables measured in 2004 CAPS wave. Information on birth province (Eastern Cape or other) and enrollment in school at age 6 collected retrospectively. Height and test scores both measured as z-scored variables.