Mozambique and natural disasters: human capital under threat

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Abstract

This paper assesses the effect of a sequence of natural disasters on children's health that hit Mozambique at the start of the 21st Century. The disasters in question were the floods of 2000 and the droughts of the years 2002 and 2003. Height-for-age z-scores of children between 1 and 3 years old is used to capture the cumulative effects of this sequence of natural disasters. It was found that the effect of the disasters on these children's height was, on average, -0.4236 standard deviations, which corresponds to the affected children being more than 1.5 cm shorter by the time of the survey. The findings in this paper are important because of the long term economic cost associated with the disasters, and urge the need for further public intervention to mitigate the damage caused by the shocks. This paper also contributes to the existing literature on the subject of the impact of shocks on child health in the developing world by focusing on measurement errors, differences in physical stature among ethnic groups and migratory movements.

Key words: Mozambique, Health, Natural Disaster, Human Capital, Developing Country.

Introduction

There is evidence that deficiencies in the height or weight of new-born and infants can have a long lasting effect on a person's wealth, earning potential and human capital accumulation[1]. This is a recurring problem in some countries due to economic shocks, in particular natural disasters. Therefore, understanding how or if natural disasters effect the well-being of infants or children still in the womb will not only stress the importance of providing adequate aid to countries affected by disasters but also provide guidance on how to respond more effectively.

Child health constitutes the basis of human capital accumulation. Being born and growing up in a sound environment has a great influence over the early development of the child's physical stature as well as cognitive capabilities. If the child is exposed to adverse conditions at a tender age it will not be able to recover at a later stage of its childhood. This has a direct impact on later productivity. It is also a determinant of educational achievements[2]. Policy makers in developing countries and development economists thus consider child health as a grave cause for concern.

Children are more vulnerable to economic shocks in low income countries. Many of these low income countries are victims of a specific kind of economic shock, namely natural disasters. The shock may vary in size, though; it can affect populations and children's health in many different ways. Prolonged droughts or massive floods can

[1] See Strauss and Duncan (1998).

[2] See Ashworth (1969); Martorell and Habicht (1986), Duflo (2003) and Case and Paxson (2006).

potentially lead to the loss of hundreds of thousands of hectares of farmland. Prices of agricultural goods that constitute the staple diet in developing countries increase considerably. This affects households in these countries directly given that they are very poor and cannot afford such increases in prices. Households manage the scarcity of food by decreasing the amount of calorie intake and switching to sub-nutritious, cheaper alternatives. In countries where populations suffer from chronic malnutrition this obviously has a severe impact on them and, specifically, on children's health. In the case of sudden and violent shocks such as floods many people lose their houses and literally need to be rescued from roofs, trees and other areas that become suddenly inaccessible by land at the time of the shock. The violent nature of the disaster may thus have an immediate effect on children's health at a very early age. Having lost their homes, these people are transferred to temporary locations such as schools, tents or camps provided by the government. These places, ill equipped to deal with the huge influx of people, soon become rife with disease given the high concentration of people and the lack of hygiene. Furthermore, these victims are largely dependent on aid as they have no income and have lost their wealth to the floods. Extremely vulnerable, they suffer from episodes of severe malnutrition. Violent floods also destroy roads and other communication infrastructures as well as schools and health units, which are crucial for economic activity, thus leaving even more people vulnerable. The effects of two kinds of climate shock, specifically floods and droughts, are analyzed here. The analysis is based on two measures of child's health; height-for-age and weight-for-height, in one of the poorest countries in the world, Mozambique.

In February and March of 2000, the south and part of the center of Mozambique were devastated by massive floods. The floods hit 36 out of the 58 districts that comprise the 5 affected provinces, killing over 700 people at the time of the shock and leaving around 500.000 victims homeless. Most of these people were first given temporary shelter in non affected schools and were then transferred to government accommodation centers. More importantly, for the purposes of this study, the floods were responsible for causing a lot of damage to institutional infrastructures, such as health units, schools, governmental headquarters, roads and other communications infrastructures, therefore affecting a huge proportion of the population. At an agricultural level, irrigation systems were seriously damaged and around 140.000 hectares of the cultivated area were lost affecting a considerable stake of agricultural production in the affected area. A huge amount of livestock disappeared and traditional fishing materials were lost in the coastal area in the affected provinces. The total damage caused by the floods was assessed by the World Bank as costing between $270 million and $430 million.

At the beginning of 2002, the same 5 provinces affected by the 2000 floods were now experiencing a very prolonged and severe drought that lasted for more than a year and a half. Apart from these 5 provinces to the south and centre of Mozambique, the remaining two provinces in the centre of the country were also affected. The long lasting nature of the drought was responsible for a significant decrease in calorie intake by the affected population. The harvests in the south and centre were very poor with near-total crop failure in some zones leading to a fast increase in the number of people facing food insecurity. Although the 3 provinces of the north had a very good harvest in 2002, high transportation costs, as well as the bad condition of roads, made it impossible to redistribute the excess supply in the north to the provinces in need. Huge amounts of crops, which form the population's staple diet, such as maize, beans and groundnuts were lost. Even more resistant crops like cassava were lost in these regions. During the most critical periods, victims were relying on the consumption of wild plants to survive. In 2003, the second year of drought, the north of the country was affected by a severe typhoon that destroyed a considerable proportion of the first and second harvests. At the same time, the north was also hit by the cassava bug, which destroyed much of this basic nutrient of the population. The damage done by these, combined with the general situation in the rest of the country, will be shown to have implications for the interpretation of the results, as will be seen later[3].

By using Mozambique Demographic and Health Survey (MDHS) data for the years 1997 and 2003, a difference-in-differences estimator is constructed to capture the impact of the sequence of climate shocks composed by the 2000 floods and the 2002/2003 droughts on children's health. As measures of children's health, height-for-age and weight-for-height are used. The main causes of growth and weight deficit in the developing world are malnutrition and infections. "The height-for-age of young children depends on accumulated investments over the life of the child" (Duflo, 2003, p.12). Height-for-age is thus a long term measure that takes into account the accumulation of shocks the child was exposed to. As for weight-for-height, "it reflects the short-run nutrition and illnesses and recovers quickly after periods of malnutrition when proper nutrition is resumed … It reflects the impact of current nutrition decisions by parents as well as that of the environment." (Duflo, 2003, p.8).

I begin with a literature review that establishes the importance of child health for later outcomes in childhood and adulthood. This also covers some important empirical findings concerning the impact of economic shocks and, specifically, climate shocks on

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3 The reports in the Mozambique News Agency along with articles in many newspapers, covered the droughts thouroughly.

children's health and educational outcomes. This is followed by the description of the data. Next empirical strategy is presented, describing assumptions as well as other important details of the study. The paper ends with the presentation of results and, finally, conclusions.

Literature Review

There is evidence that wealthier people live longer and are healthier (see Marmot and Wilkinson, (2003)). In a well known paper, Case, Lubotsky and Paxson (2002) find that this positive relationship between health and wealth, also known as the gradient, originates in childhood. Using large cross section datasets on the United States, the authors find evidence that children in wealthier households are healthier. They also find that the health status of children in poor households worsens as these children age. This is due, they argue, to the fact that these children accumulate negative health shocks throughout their childhood. Case et al.' results show that children from poorer households enter adulthood poorer and with lower education levels. These findings suggest that the impact of parents' wealth on children may be one cause of the transmission of socioeconomic status from one generation to another.

Currie and Stabile (2003) use panel data on Canada to identify between two possible alternative channels through which this phenomenon–that the health status of children in poor households worsens as these children age–occurs: either i) children in poorer households suffer more shocks than children in richer households (and both poor and rich have the same response capacity to the shocks), or ii) children in poorer households have less response capacity to the shocks than children from richer households. Distinguishing between these two alternative channels has important policy implications. In the first case, policies that aim at diminishing shocks should be provided whereas, in the second case, resources should be allocated to poorer households in order to better their response capacity. Currie and Stabile find evidence for the first channel, that is, they find that poorer Canadian children suffer more shocks than richer children and both rich and poor children have the same response capacity. Interestingly, Link (2005) finds evidence of the alternative channel. Using the Medical Expenditure Panel Survey on the United States he concludes that poorer children in the United States have a lower response capacity to shocks than richer children. This finding suggests that policies that aim at allocating resources to poorer households, so that their children are better prepared to respond to shocks, should not be discarded.

The populations in developing economies are usually characterized by a deficit in human growth. Weight-for-height is an indicator that captures recent shocks. It reflects illness and nutrition status and it recovers when the child returns to a stable environment. Height-for-age captures the accumulation of shocks. (Ashworth 1969; Martorell and Habicht 1986 in Duflo 2000). Referring more generally to height, Strauss and Duncan (1998) argue that “we might interpret it as an indicator of human capital much along the lines of education”. The importance of the environment while the child is in the womb has been found in the Development Economics literature. Fetal exposure has been shown to have strong consequences on the newborn’s weight, child and adult literacy as well as labor market status and accumulation of wealth[4]. Furthermore, the capacity of the child to recuperate height deficiencies after growing up in a bad environment is limited. The critical period for catching up is when the child is between 6 and 24 months of age (Ashworth 1969; Martorell and Habicht 1986 in Duflo 2000).

The height of the child in the first months of life is a predictor of cognitive capabilities (Case and Paxson 2006). Case and Paxson (2006) find evidence that taller British and American children respond better to mathematics, language and drawing tests. By finding that the correlation between child and adult height is of about 0.7 for American and British populations, Case and Paxson (2006) argue that one of the explanations for the fact that taller people, on average, receive higher incomes is that taller people are more intelligent.

Ferreira and Schady (2008) highlight that shocks may be of two different natures. They may be slow-onset lasting shocks (e.g., economic recessions, droughts, civil war, etc) or they may be of a sudden-onset nature (e.g., natural disasters like floods or hurricanes). The importance in distinguishing between these two is that slow-onset shocks act differently whether they occur in developed or in developing countries. In an economic contraction, there is a trade-off between the decrease in private and public consumptions of health promoting goods and the increase in the time available for child health care. Unlike what happens in developing countries, the increased time available for child health care that results from a reduction in employment more than offsets the decrease of private and public expenditures on health promoting goods in the developed world. As a consequence, in developed countries the effect of an economic shock of this nature on children's health is counter-cyclical while in developing countries their effect

[4] Almond, Hoynes and Withmore Schanzenbach (2008); Almond, Edlund, Li and Zhang (2007)

is pro-cyclical. The same pattern exists for the effects of an economic shock on education, depending on the stage of development of the country. For example, Dehejia and Lleras-Muney (2004) show that more babies die in the United States during economic expansions. Inversely, many other authors find pro-cyclical effects of slow-onset lasting shocks on health and education for children in low income developing countries.[5]

There is emerging literature on the effects of health shocks on future health, educational and socioeconomic outcomes of children in the developing as well as in the developed world. Using data on the Netherlands, Van Den Berg, Lindeboom and Portrait (2006) follow data for individuals born in the period 1812-1912. They find that being born in a recession is associated with dying younger. Alderman, Hoddinott and Kinsey (2004) studied the impact of drought and civil war exposure on children's height in a rural area in Zimbabwe. They found that the negative impact of these shocks is responsible for the children not becoming as tall in adolescence and performing worse at school. Akresh and Verwimp (2006) also look at the effects of exposure to civil war and crop failure in Rwanda. They find that girls that were exposed to both these shocks at birth or in early childhood did not grow to be as tall as girls that were not affected. The authors did not find any effect of exposure to these shocks for boys. Cordeiro (2009) uses a rich dataset on Uganda to measure the impact of conflict exposure on children at height given age and finds that children were more affected than previously suggested in the literature. Maccini and Yang (2006) use panel data on Indonesia to study the importance of rainfall on health and other socioeconomic outcomes. They find

[5] See, for example, Jensen (2000) for the effects of drought on education in Cote d'Ivoire. Note that this pattern on the effect of slow-onset shocks is less clear in middle-income countries, like Latin American countries. For these countries, in some situations there's pro-cyclicality while in others there's counter-cyclicality (Ferreira and Schady 2008).

that more rainfall in the year and place of birth of women leads these women to become taller, to complete more years of schooling and to having richer spouses[6]. Jensen (2000) studied the effect of the 1986 drought in Cote d'Ivoire. He finds a large negative impact of the drought on school enrolment. Similarly, lack of rainfall in Malawi led to an increase in absenteeism in schools. Carlo del Ninno and Mattias Lundberg investigate the effects of the terrible flood in the summer of 1998 in Bangladesh on children's health. They found that the flood had a negative effect of which children could not recover during the period under analysis. They also found that government programs undertaken before the disaster were more effective in protecting the flood victims and helping them in the recovery process than programs undertaken after disaster[7].

The Data

Data was used from the 1997 and 2003 MDHS. The data was collected by the Mozambican Statistics National Institute (INE) and the Health Ministry (MISAU) between March and June of 1997, covering 9282 households, and between August and December of 2003, covering 12315 households. The two surveys are based on samples representative at national and regional levels, and provide information on fecundity, child and mother health as well as socio-economic status. Women between 15 and 49 years old were interviewed. When including the main regressors in the regressions,

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[6] The authors found no effect on men.

[7] These programs undertaken before the disaster aimed at improving the nutrition status of the children

which will be introduced in the next section, the total number of observations used breaks down to 6.115.

Because the data available was only at province level, it was not possible to precisely distinguish the most affected regions by district. The 5 provinces from the south and centre that were affected both by the 2000 floods and the 2002/2003 droughts thus comprise the affected region in this study. These were the provinces of Manica and Sofala in the centre and Inhambane, Gaza, Maputo and the capital Maputo in the south. But because in some of the affected provinces some districts were not affected by the disasters, the coefficients are underestimates (in absolute value) of the true total effect of the natural disasters[8].

The World Health Organization (WHO) recommends the use of data on anthropometric measures of children between birth and 5 years old (WHO, 1986). In the 1997 survey there is data on height and weight of children from 0 to 3 years old while in the 2003 survey the corresponding data covers children from 0 to 5 years old. For the sake of comparison data for children between 0 and 3 years old in the two samples was used. Two variables, height-for-age z-score and weight-for-height z-score, were constructed.[9]. This was done for each observation on height and weight by subtracting the median and dividing by the standard errors for each age in months (height in cm for the case of weight-for-height) using the tables of the WHO growth standards' as reference population as defined by the WHO Multicentre Growth Reference Study. As

[8] The floods affected the provinces of Maputo and Gaza in their entirety. But they only affected 3 of the 9 districts in Manica (Sussendenga, Mossurize, Machaze), 8 of the 12 districts in Inhambane (Govuro, Maxixe, Vilankulos, Mabote, Inhassoro, Panda, Inharrime, Inhambane) and 3 of the 12 districts in Sofala (Búzi, Machanga, Chibabava). As for the droughts, although most of the districts in the 5 provinces have been affected at some point, the degree of intensity of the droughts, as well as the onset of food insecurity, was different from district to district.

[9] A variable for weight at birth was also constructed but was not used in this study as it soon became apparent it was full of measurement errors.

said above, height-for-age captures growth deficits the child inherited from the shocks she has been exposed to. This variable thus captures the impact of the sequence of disasters on children that were affected both by the floods and droughts. Weight-for-height captures episodes of malnutrition and infection in 2003, the year of the second survey. It only reflects the effects of the 2002/2003 droughts. The choice of these two health indicators is made to distinguish the impact of the sequence of disasters from the impact of the 2002/2003 droughts.

Measurement errors

There is a concern about our data regarding measurement errors in the anthropometric measures, height-for-age and weight-for-height. Mozambique is a developing country lacking many public services already taken for granted in the developed world. A simple but important one is individual registration at birth. According to the United Nations Development Program (2004), only around 6% of children had a birth registration card in Mozambique before 2004. This leads mothers to make errors in the exact month and, possibly, year of birth of their children when answering the surveys. This error is likely to increase the older the child is at the time of the survey. Also, the measure of child height is another common source of measurement error, as children are particularly difficult to measure at young ages[10]. We assume these measurement errors (in both the dependent variables, height-for-age and weight-for-height) are uncorrelated with the independent variables.

[10] An attempt is made, however, to mitigate this source of error by taking into account in the variables if the child has been measured standing or lying.

The consequence of measurement error in the dependent variable, as is the case in this work, is that the error variance in the model becomes larger. This can easily be seen in the following illustration. Consider a regression of child height given the age on k explanatory variables, where height, age or both were measured with error:

$$ht\_for\_age = \beta_0 + \beta_1.x_1 + \ldots + \beta_k.x_k + u + e_0,$$

Where ht_for_age is our dependent variable measured with error, $x_1, \ldots, x_k$ are explanatory variables and e_0 is the measurement error defined as

$$e_0 = ht\_for\_age^* - ht\_for\_age,$$

where ht_for_age* denotes the true measure without error[11]. It is easy to see that the variance of the error term, where the error term is given by $u + e_0$, is larger due to the presence of the measurement error component, e_0. This makes the standard errors of the coefficients' estimators in the regression become larger. Hence, ultimately the estimates are less precise.

A way to mitigate this problem is to drop observations that are outliers. Following the WHO (1995) indications, all the observations for which height-for-age z-scores were less than 4 standard deviations below the sample mean and above 3 positive standard deviations have been dropped [12].

[11] This framework was taken from Wooldridge , "Econometric Analysis of Cross Section and Panel Data" Massachussets Institute of Technology, 2002, pg. 70-72. The dependent variable in the book, y, is replaced by one of the dependent variables used in this work, ht_for_age.

[12] The WHO suggests two ways of addressing the problem of measurement error, depending on the the mean of the variable measured with error. The way I approach height-for-age z-scores corresponds to the "flexible exclusion range", which is intended for whenever the mean of the variable measured with errors is bellow -1.5 standard deviations. The alternative "standard exclusion range" is used for weight-for-

Selective survivor

Another drawback in the data is the fact that there only exist observations on children that survived the natural disasters. If only the genetically stronger and smarter children survived the shocks then this will bias the results towards not finding any effect[13]. Hence, if it is the case that many children died during the sequence of disasters, and specifically during the drought, for which there is no reliable information available, then the estimates are biased upwards (that is, they do not totally capture the negative effect of the shocks on children's health).

Migration movements

Another problem is bias that might arise due to migratory movements resulting from the climate shocks. If people who have suffered one or both of the natural disasters have migrated to another region of the country or to neighboring countries, then the estimates will again be biased. An undocumented migration movement from the south and center of the country to South Africa has been found to exist. The people who constitute these migration movements are forced to flee their homes due to Natural disasters and settle in the border of South Africa where they can usually find work[14].

height z-scores. In this latter case only observations in the range between -5 and 4 standard deviations are kept.

[13] This problem is common in studies that capture effects of shocks on health in early life. See, for example, Maccini and Young (2006).

[14] See Cardoso Muanamoha, (2007)

Additionally, it is also known that Mozambique receives migration movements from Zimbabwe, and that there exists a migration corridor through the country from Mozambique's neighboring countries to South Africa. Among the emigrants in this corridor, some settle in Mozambique[15]. Finally we cannot discard the possibility of Mozambicans fleeing from the affected areas to the north of the country due to the natural disasters.

In order to try to monitor for these migration movements, regressions that only include data for households living in the same area for more than 4 years are used. This is done for both the affected region and the north. The reason why it is done in the north is to ensure people who have migrated to the north from the affected regions are not included. Including these people in the north would also bias the results, leading to underestimates (in absolute value) of the effects of the disasters. There is however a problem in only including households living in the affected region for more than 4 years. If Mozambicans that flee to the north or to a neighboring country were forced to do so because they were the most affected by the natural disasters, then the results would be biased upwards (that is, underestimated in absolute value). However, this is judged to be better than including people from different backgrounds, e.g., immigrants from neighboring countries, who could bias estimates in different directions. Regressions where I control for migration movements in the way described above are estimated. The coefficients for these regressions are compared with the coefficients for regressions where migration has not been controlled for. If the estimated coefficients between the two models are different then migration is a problem.

[15] See John O Oucho (2007)

Empirical Strategy

In order to capture the effect of the floods in 2000 and the droughts in 2002/2003, a difference-in-differences (DD) estimator for the period 1997-2003 is used. In economics, the DD method became widespread after Ashenfelter and Card have used it in their 1985 paper. The idea of the DD is to capture a fixed effect of some treatment in an aggregate group that was exposed to the treatment. It does this by comparing the average outcome of the treated group to a "comparison group" (which was not exposed to treatment) before and after treatment. Indeed, the DD estimator is the subtraction of the average outcome in the comparison group from the average outcome in the treated group, both after the treatment, minus the subtraction of the average outcome in the comparison group from the average outcome in the treated group, both before the treatment.

In this paper the treatment is the sequence of the 2000 floods plus the 2002/2003 droughts. The treated group is the region of the south and centre composed of the 5 provinces that were exposed to both the floods and the droughts[16]. The comparison group is the region in the north, made of the 3 provinces that were not affected by any shock[17]. Part of the center[18] was excluded from the analysis because it

[16] This region is comprised of the provinces of Manica and Sofala in the centre, and Gaza, Inhambane, Maputo and the capital, Maputo in the south.

[17] These provinces are Niassa, Cabo Delgado and Nampula.

[18] This region is comprised of the provinces of Zambezia and Tete.

was also hit by floods in 2001. Therefore, this region could not be used in the comparison group[19].

Angrist and Pischke (2009) are followed to illustrate our DD estimator (using the first of the outcomes of interest, height for age z-scores)[20]. According to these authors, the use of this method implies that we assume

$$E[ht\_for\_age_{0irt} / r, t] = \gamma_r + \lambda_t, \tag{2.1}$$

where r denotes region ("affected" south or "comparison" north) and t denotes the time period (1997 or 2003). Basically, the equation above states that, in the absence of a shock, the height given age of children is given by a (time invariant) region fixed effect, γ_r, plus a time effect that is the same for the whole country, λ_t. Let $shock_{rt}$ be a dummy that is equal to 1 for regions affected by the sequence of natural disasters and after the occurrence of the shocks (i.e., in 2003). Then, if the effect of the sequence of shocks on child's height given age is a constant, say, δ, then observed height given age can be written

$$ht\_for\_age_{irt} = \gamma_r + \lambda_t + \delta.shock_{rt} + \varepsilon_{irt},$$

where $E[\varepsilon_{irt} / r, t] = 0$. From here it can easily be seen that δ gives the desired effect:

$$\{E[ht\_for\_age_{irt} / r = affected\_south, t = 2003] -$$

19 See figure in appendix.

20 Angrist and Pischke (2009), "Mostly Harmless Econometrics, An Empiricist's Companion", 1st edition, Princeton University Press, United States of America, 2009, pg. 228-229.

$$E[ht\_for\_age_{irt} / r = non\_affected\_north, t = 2003]\}$$

$$-$$

$$\{E[ht\_for\_age_{irt} / r = affected\_south, t = 1997] -$$

$$E[ht\_for\_age_{irt} / r = non\_affected\_north, t = 1997]\} = \delta$$

or,

$$\delta = \{(\gamma_{affected\_south} + \lambda_{2003} + \delta) - (\gamma_{non\_affected\_north} + \lambda_{2003})\} -$$

$$\{(\gamma_{affected\_south} + \lambda_{1997}) - (\gamma_{non\_affected\_north} + \lambda_{1997})\}$$

Following the framework above, we estimate

$$ht\_for\_age_{irt} = \beta_0 + \beta_1.affected + \beta_2.t + \delta.shock$$

where affected is a dummy equal to 1 for observations in the affected south, t is a dummy equal to 1 if the time period is 2003 and shock is the dummy introduced above (that is, shock is the variable of interest, the interaction between affected and t).

The main assumption underlying the DD method is that the dependent variable would have a similar trend in both groups, “affected” and “comparison”, in the absence of the shocks. It is visible in the data that the anthropometric measures of child health are following a continuous, positive trend in both the north and south of the country. The main assumption here is thus, that this trend would have been approximately the same in both the north and affected region if there had been no shocks. Nevertheless, the affected region is more developed than the north. Thus it might have been the case that child health development was faster in the affected region as compared to the north (or, equivalently for the purposes of this paper, slower in the north as compared to the affected region). If this was the case, then the results would be underestimates in absolute value of the real effect of the disasters. Unfortunately, without panel data for the period of 1997-2003, it is unclear whether there is a pattern in the data that could cast doubts on the underlying assumption.

An implication of the assumption stated above is that the treatment, in this case the sequence of natural disasters, was the only relevant shock that occurred during the period under analysis. Care needs to be taken regarding this assumption since a lapse of 6 years exists between the two MDHS surveys. An important thing in favor of the natural disasters having been the only major negative shocks is that the government has not changed. Joaquim Chissano was nominated President of Mozambique when the preceding President, the revolutionary leader Sambora Machel, died in a plane crash in 1986. And he remained in power until 2005[21]. Of course, the fact that the government has not changed, in itself does not guarantee there was political stability: having the same person as president does not mean there were no political shifts over time. But President Chissano had a good reputation among international aid organizations in what concerned his political engagement.

An exhaustive search was undertaken and no evidence was found that could threaten this assumption. There have been floods that hit part of the center of the country in 2001, and this is why this region was excluded from the analysis[22]. Furthermore, because the comparison group, the north of the country, was also hit by

[21] In 1994 Chissano was elected President in the first democratic elections in the country and, in the second elections in 1999, he won again.

[22] This region that was not included in the study comprises of the provinces of Zambezia and Tete.

climate shocks and agricultural bug infections in 2003, data for children born in this year is excluded from the regressions. This will be explained in more detail in the next section. No relevant shocks happened in Mozambique between 1993 and 2000. Hence the belief is children from the 1997 survey and children from non affected regions from the second survey, excluding those that were born in 2003, constitute a good comparison group.

According to the Macro indicators provided by the second report on the Millennium Development Goals (2005), the percentage of underweight children under 5 changed from 26% in 1997 to 23.7% in 2003. The mortality rate of children under 5 years decreased from 21.9% to 17.8% during the 6 year interval. Life expectancy at birth increased, from 42.3 years in 1997 to 46.3 years in 2003, as did adult literacy, by almost 15% during the 6 years. Hence, the country actually seems to have been progressing at a moderately good pace, even if most development indicators are still very low.

A vector of covariates has been included in the regressions in order to reduce the likelihood of capturing undesirable indirect effects in the coefficient for the variable shock. Included in this vector is a dummy for urban or rural residence, variables for mother's age, father's age, mother's education, father's education. Also included is a variable for mother's height in cm that we use as a proxy for genetic factors that determine the child's physical stature. Finally we included a dummy for whether birth had been assisted by either a nurse or a midwife. This variable also serves as a proxy for the quality of health care households have access to. The choice of these covariates has been made carefully, as many variables, such as a wealth index or a variable monitoring for the number of children in the household, are themselves an outcome of the sequence of natural disasters[23]. The inclusion of covariates that are themselves output of the sequence of floods plus droughts leads to a selection bias.

Controlling for differences in physical stature between ethnic groups

Five dummies for the most numerous ethnic groups in the country are also included. There are several ethnic groups in Mozambique. The largest ethnic group are the Emakhuwa. This group inhabits the north of the country. The second largest ethnic group, the Xichangana, live mainly in two provinces in the south, namely the provinces of Gaza and Maputo. In the data, Emakhuwa children, which are represented by 23.79% of the observations, have a mean height-for-age z-scores of -1.9847 standard deviations. The Xichangana children represent 20.88% of the observations in the samples. The mean of their height-for-age z-scores is -1.4667 standard deviations. These differences across these two ethnic groups alone give rise to underestimating the impact of the sequence of disasters. Furthermore, the presence of the Portuguese is much more important in the affected region than in the north. Given the legacy that these people have inherited from ancient colonizers, they have better health and are wealthier, on average, than the remaining African ethnic groups. Supporting this idea, the average height-for-age z-scores of Portuguese children in the data is -1.0664 standard deviations, a significantly lower value in magnitude when compared with the other ethnic groups. Dummies for the Cisena and Xitswa ethnic groups, who live in the south

[23] The floods have left thousands of households homeless, taking all their belongings. By the same token, peasants living off the harvests of their lands were severely affected by the 2002/2003 droughts that reduced their wealth significantly.

and represent 9.32% and 6.68% of the observations in the data, respectively, are also included. These dummies are thus included in order to monitor for differences in physical stature among different ethnic groups. As a base group for the series of ethnicity dummies there are a mixture of many different minority ethnic minority groups. These constitute 34.40% of the observations and, with a mean height-for-age of children of -1.7383, represent well the average height of Mozambican in both the north and the affected region. Table 1 shows the distribution of distribution of ethnic groups between the north and the affected area while table 2 shows the mean of the height-for-age of children among ethnic groups.

Table 1 - Descriptive statistics: distribution of ethnic groups between north and affected area

	country		north		affected	
ethnicity	(Freq.)	%	(Freq.)	%	(Freq.)	%
Portuguese	343	4.93	38	11.08	305	88.92
Emakhuwa	1656	23.79	1639	98.97	17	1.03
Xichangana	1453	20.88	0	0	1453	100
Cisena	649	9.32	4	0.62	645	99.38
Xitswa	465	6.68	2	0.43	463	99.57
mixture of minority ethnicities (base group)	2394	34.4	469	19.59	1925	80.41
Total	6960	100	2152	100	4808	

Table 2 - Descriptive statistics: mean height for age of children among ethnic groups

ethnicity	
Portuguese	-1.0664
	(0.0789)
Emakhuwa	-1.9847
	(0.0403)
Xichangana	-1.4667
	(0.0344)
Cisena	-1.9298
	(0 .0631)
Xitswa	-1.3864
	(0.0647)
mixture of minority	-1.7384
ethnicities (base group)	(0.0310)
standard errors in parenthesis	

Results

Given the presence of heteroskedasticity, all the regressions shown in this section are estimated with heteroskedasticity-robust standard errors[24]. Table 3 estimates the simple DD excluding children who were born in the year of the surveys (1997 and 2003). Both height-for-age z-score and weight-for-height z-score are used as dependent variables. I opted to drop children born in 2003 (and born in 1997) because the comparison group was affected by climate shocks and agricultural infections in 2003, as explained above. These children were excluded from all the regressions. The coefficient on the variable of interest suggests there has been an effect of the sequence of natural disasters on both child height and weight. Indeed, the coefficients on the regressor of interest, shock, are negative and statistically significant in both cases.

[24] The Breusch-Pagan test for heteroskedasticity accused the presence of heteroskedasticity in all the regressions but the regression where only children born in 2001 and 1997 are included. For this regression, the simplified version of the White test was used to detect Heteroskedasticity.

Table 3 - Simple DD for children born in 1994, 1995, 1996 , 2000, 2001 and 2002

	height for age	weight for height
affected	0.6999	0.4445
	(0.0804)***	(0 .0651)***
t	0.0990	0 .4844
	(0.0835)	(0.0669)***
shock	-0.3299	-0.2288
	(0.0965)***	(0 .0800)***
constant	-23,266	-0.4210
	(0.0698)***	(0.0544)***
Observations	5189	6115
R-squared	0.0296	0.0234

Robust standard errors in parenthesis
* significant at 10%; ** significant at 5%; *** significant at 1%

Tables 4 shows the coefficients for the DD regressions with the selection of covariates included. Columns 1, 2 and 3 in this table include children that were 3 years old, 2 years old and 1 year old by the time of the surveys, respectively. Column 4 regroups the children that were between 3 years old and 1 year old by the time of the surveys.

Table 4 - DD with covariates

dependent variable: height-for-age	(1)	(2)	(3)	(4)
affected	0 .7417	0.5351	0.7905	0.6161
	(0.2328)***	(0.2218)**	(0.1744)***	(0.1227)***
t	0.7445	0.6004	-0.2000	0.1686
	(0.2026)***	(0.1692)***	(0.1507)	(0.1005)*
shock	-0.3776	-0.4544	-0.6829	-0.4090
	(0.2259)*	(0.2015)**	(0.1772)***	(0.1169)***
urban	0.0843	0.0031	0.3798	0.1416
	(0.0939)	(0.1184)	(0.0948)***	(0.0600)**
mother_ht_cm	0.0571	0.0530	0.0494	0.0519
	(0.0065)***	(0.0074)	(0.0072)***	(0.0042)***
motherage	0.0154	0.0144	0.0206	0.0170
	(0.0075)**	(0.0092)	(0.0078)***	(0.0048)***
fatherage	-0.0007	-0.0021	-0.0100	-0.0060
	(0.0047)	(0.0069)	(0.0050)**	(0.0033)*
motheredu	0.0289	0.0599	0.0203	0.0335
	(0.0216)	(0.0256)**	(0.0204)	(0.0133)**
fatheredu	0.0321	0.0147	0 .0449	0.0330
	(0.0158)**	(0.0197)	(0.0172)***	(0.0105)***
assistance_nurse_or_midwife	0.1677	0.1698	0.2426	0.1913
	(.0920)*	(0.1115)	(0.0954)**	(0.0593)***
ethnic_portuguese	-0.0869	0.3455	0 .3901	0.2752
	(0.2957)	(0.2072)*	(0.2054)*	(0 .1342)**
ethnic_Emakhuwa	0.2976	0.1302	0.2967	0.2446
	(0.2023)	(0.1840)	(0.1495)**	(0.1011)**
ethnic_Xichangana	0.1543	0.1161	0.0697	0.0776
	(0.1141)	(0 .1507)	(0.1212)	(0.0757)
ethnic_Cisena	-0.3312	-0.2260	-0.1437	-0.2465
	(0.1420)**	(0.1459)	(0.1563)	(0.0883)***
ethnic_Xitswa	0.2357	-0.1833	0.4702	0.1587
	(0.1851)	(0.2113)	(0.1692)***	(0.1145)
constant	-12.6367	-11.5296	-10.3674	-11.0578
	(1.0393)***	(1.1812)***	(1.1394)***	(0.6611)***
Observations	926	862	1199	2987
R-squared	0.1664	0.1293	0.1923	0.1279

Robust standard errors in parenthesis
* significant at 10%; ** significant at 5%; *** significant at 1%

Ramsey RESET tests; H0: model has no omitted variables

(1)	F(3, 907) = 0.04; Prob > F = 0.9884
(2)	F(3, 843) = 0.29; Prob > F = 0.8329
(3)	F(3, 1180) = 0.51; Prob > F = 0.6747
(4)	F(3, 2968) = 0.17; Prob > F = 0.9189

In the 4 tests above, the p value>10%. Hence H0 fails to be rejected

Column 1 of table 4 compares children born in 1994 in the whole country plus children born in 2000 in the north with children born in 2000 in the south. This regression captures the causal, cumulative effect of the disasters on children that were born in the year of the flood, the year 2000. First these children were affected by the flood and then, by the time they were 2, they suffered the impact of the 2002 drought. They were 3 years old during the 2003 drought. Hence, these children were exposed to the complete sequence of disasters for the period under analysis. The impact of the sequence of disasters for these children was, on average, -0.3776 standard deviations. This result is statistically significant at 10%. This result states that these children were around 1.5 cm shorter due to the disasters. Note that from this result it is not possible to say which proportion of the damage is due to the floods and which is due to the droughts. It is normal, however, to expect these children to have suffered the highest damage if it is to be believed that the sequence of disasters was more devastating than any of the disasters taken separately.

When estimating the same regression only for children that were 2 years old by the time of the surveys (that is, by comparing children born in 1995 in the whole country plus children born in 2001 in the north with children born in 2001 in the south), it was found that the effect of the disasters on those affected children born in 2001 was, on average, -0.4544 standard deviations (see column 2). This result is statistically significant at 5%. This captured effect is probably due to a mixture of the long lasting consequences of the 2000 floods and the 2002/2003 droughts[25]. Note that the coefficient for the variable of interest in the regression where children born in 2000 are included is almost 0.8 standard deviations smaller (in absolute value) than the correspondent

[25]It took time for the country to repair the physical damage of the flood on health units, schools and communication infrastructure. Furthermore, mothers may have also taken time to recover from health problems caused by the disaster.

coefficient in the regression where children born in 2001 are included. This seems to contradict the hypothesis stated above, that children born in 2000 suffered more from the disasters when compared to the children born after them. This is because children born in 2000 were affected both by the floods and the droughts, while the children born in 2001 were only affected by the long term effects of the floods, and the droughts.

In column 3 I repeat what is done in columns 1 and 2, now including only children born in 1996 and 2002. This regression suggests that the largest and most statistically significant coefficient for the variable of interest is found in children born in the year of the 2002 drought. The impact of the droughts on these children was, on average, -0.6829 standard deviations. This is equivalent to say that children with one year in 2003, that have been affected by the 2002/2003 droughts, were about 2 cm shorter. Furthermore, this result is statistically significant at 1%, thus considerably reliable. Because these children were also exposed to the 2003 drought, this result suggests that the effects of the droughts were huge, affecting largely the children born in the year of the 2002 drought.

The results in these 3 columns suggest that the hypothesis stated above, that children born in 2000 suffered more from the disasters when compared to the children born after them, is wrong. In fact, these results indicate the exact opposite: children who were exposed to the totality of the disasters suffered less than children that were affected only by the droughts. This may be explained by 1) the droughts were more devastating than the floods and 2) children are more sensitive to shocks the younger they are at the time of the shock. Also, note the *crescendo* in *noise* in the results: these are statistically significant at 1%, 5% and 10% in columns 3, 2 and 1, respectively. I attribute this *crescendo* in *noise* to the measurement error arising from mothers saying the age of the children by memory. Given these children included in tables 2 and 1 were born more than 2 and 3 years before the 2003 survey and that the vast majority of children do not have a birth certificate, it is likely that mothers did not accurately know the date of birth of their children. As mentioned above, it is assumed that measurement errors are uncorrelated with the explanatory variables.

When checking for the effect of the sequence of disasters for the group of children born in 2000, 2001 and 2002, it is found it was -0.4090 standard deviations, on average (see column 4). This result is statistically significant at 1%. Taken literally, this means that the overall effect of the shocks on these children was responsible for them becoming more than 1.5 cm shorter. This result is extremely important: it shows that children living in the area of the country that is recurrently affected by floods and droughts[26] suffer significantly from these disasters. As a policy implication, further aid is needed in this area of the country. Mitigating strategies aiming at preventing the damage of the disasters on children's health should be promoted. These should comprise training programs and cash transfers, or subsidized loans, to households. These strategies would help households to make use of coping mechanisms to smooth consumption in order to better resist, and reduce the impact of, the disasters.

To see if migration represents a problem for the conlusions drawn above, in table 5 I reproduce what is done in table 4, but now only including households that did not change their place of residence between 1998 and 2003. Because the estimated coefficients in tables 5 and 4 do not differ much, it is believed that there were no migration movements of affected victims to the north of the country or to neighboring countries. The only difference between table 5 and table 4 is that the coefficient of

[26] Since the period under analysis in this study, the same affected area has been hit by droughts in 2004/2005, 2006/2007 as well as 2007/2008, and by floods in 2007 and 2008.

interest in column 2 of table 5 (regression for children born in 2003) is only statistically significant at 10%. Nevertheless, this does not change the conclusions taken from the results in table 4. Results in table 5 continue to support the fact that children who were exposed to the totality of the disasters were not more affected than children that suffered only the droughts. Also, the explanation given for the presence of more measurement error in the regressions in columns 1 and 2 is still valid. In fact, the t statistic for the coefficient of interest in column 2 of table 5 is larger than the correspondent t statistic in column 1 of the same table. To check that the regressions in table 5 truly supports the statement that there are measurement errors in regressions where only children that were 3 and 2 years old are included, I estimate a short version of the regression in column 2 of table 5[27]. This is shown in table 6. When covariates that are jointly insignificant are excluded from this regression, the t statistic increases significantly in (absolute value) to -1.94. Hence, the results obtained in table 5 have the same interpretations as the results in table 4.

[27] This is the only case where a short version of a regression improves the statistical significance of the coefficient estimate for the variable shock.

Table 5 - DD with covariates controlling for migration movements

dependent variable: height-for-age	(1)	(2)	(3)	(4)
affected	0.7903	0.5187	0.7820	0.6149
	(0.2372)***	(0.2287)**	(0 .1785)***	(0.1240)***
t	0.7671	0.6221	-0.1807	0.1756
	(0.2067)***	(0.1767)***	(0.1544)	(0.1014)*
shock	-0.4098	-0.3901	-0.6887	-0.4073
	(0.2303)*	(0.2090)*	(0.1845)***	(0.1180)***
urban	0.0635	-0.0430	0.3939	0.1356
	(0.0986)	(0.1266)	(0.1020)***	(0.0616)**
mother_ht_cm	0.0550	0.0531	0.0485	0.0518
	(0.0069)***	(0.0077)***	(0.0078)***	(0.0043)***
motherage	0.0155	0.0125	0.0223	0.0174
	(0.0077)**	(0.0100)	(0.0082)***	(0.0050)***
fatherage	-0.0005	-0.0010	-0.0104	-0.0061
	(0.0049)	(0.0074)	(0.0052)**	(0.0034)*
motheredu	0.0308	0.0650	0 .0297	0.0377
	(0 .0228)	(0.0278)**	(0.0220)	(0.0136)***
fatheredu	0.0295	0.0169	0.0427	0.0311
	(0 .0167)*	(0.0213)	(0 .0188)**	(0.0108)***
assistance_nurse_or_midwife	0 .2178	0 .2166	0 .2050	0 .1798
	(0 .0986)**	(0.1209)*	(0.1039)**	(0 .0612)***
ethnic_portuguese	-0.0223	0.3476	0.2243	0 .1923
	(0.3155)	(0.2292)	(0.2392)	(0 .1427)
ethnic_Emakhuwa	0.3376	0 .1211	0 .2758	0.2354
	(0.2108)	(0 .1961)	(0 .1570)*	(0 .1035)**
ethnic_Xichangana	0.1220	0.0724	0.0655	0.0762
	(0 .1245)	(0 .1612)	(0.1319)	(0.0782)
ethnic_Cisena	-0.4097	-0.1799	-0.1787	-0.2629
	(0.1460)***	(0.1508)	(0.1680)	(0.0903)***
ethnic_Xitswa	0.2294	-0.2214	0 .5176	0 .1670
	(0 .1935)	(0.2313)	(0.1743)***	0.1161
constant	-123,692	-115,536	-102,545	-110,393
	(1.0919)***	(1.2238)***	(1.2276)***	(0. .6795)***
Observations	837	782	1096	2884
R-squared	0.1620	0.1339	0.1859	0.1252

Robust standard errors in parenthesis

* significant at 10%; ** significant at 5%; *** significant at 1%

Ramsey RESET tests; H0: model has no omitted variables	
(1)	F(3, 818) = 0.12; Prob > F = 0.9494
(2)	F(3, 763) = 0.31; Prob > F = 0.8178
(3)	F(3, 1077) = 0.11; Prob > F = 0.9553
(4)	F(3, 2865) = 0.03; Prob > F = 0.9933

In the 4 tests above, the p value>10%. Hence H0 fails to be rejected

Table 6 - short regression for children born in 1995 and 2001

dependent variable: height-for-age		
	complete regression	short regression****
affected	0.5187	0 .6087
	(0.2287)**	(0 .1912)***
t	0.6221	0.5784
	(0.1767)***	(0.1569)***
shock	-0.3901	-0.3616
	(0.2090)*	(0.1861)*
urban	-0.0430	----
	(0.1266)	----
mother_ht_cm	0.0531	0.0519
	(0.0077)***	(0.0068)***
motherage	0.0125	----
	(0.0100)	----
fatherage	-0.0010	----
	(0.0074)	----
motheredu	0.0650	0.0718
	(0.0278)**	(0 .0177)***
fatheredu	0.0169	----
	(0.0213)	----
assistance_nurse_or_midwife	0 .2166	----
	(0.1209)*	----
ethnic_portuguese	0.3476	0 .4929
	(0.2292)	(0.1935)**
ethnic_Emakhuwa	0 .1211	0 .1968
	(0 .1961)	(0.1677)
ethnic_Xichangana	0.0724	0.1908
	(0 .1612)	(0.1332)
ethnic_Cisena	-0.1799	-0.2377
	(0.1508)	(0 .1357)*
ethnic_Xitswa	-0.2214	-0.0460
	(0.2313)	(0.1821)
constant	-115,536	-110,275
	(1.2238)***	(1.0803)***
Observations	782	1016
R-squared	0.1339	0.1271

Robust standard errors in parenthesis

* significant at 10%; ** significant at 5%; *** significant at 1%

**** A F test robust to heteroskedasticity has been made for the nulity of the excluded variables in the short regression:

H0: βurban=βmotherage=βfatherage=βfatheredu=βassistance_nurse_or_midwife=0

F(5, 766) = 1.23

Prob > F = 0.2938

P value>10%, hence we excluded these variables in the short regression

Ramsey RESET test for the short regression; H0: model has no omitted variables

F(3, 1002) = 1.89; Prob > F = 0.1298

p value>10%, hence H0 fails to be rejected

The fact that affected victims did not migrate to a safe area at the time of the floods also has policy implications. Significant investments in communication infrastructure should be made. Resistant roads and railways connecting the affected districts to safe districts in the country should be constructed. This would allow households living in affected areas to migrate to safe areas in the most critical periods. It would also allow for a better redistribution of the excess supply of agricultural products from the north, which usually has good harvests, to the provinces in need.

It is possible to find the same sign of the coefficients for the covariates in nearly all the regressions[28]. It seems that children are, on average, taller in urban areas. Our proxy for genetics has the expected outcome: a mother being taller leads to a taller child, on average. Also, the data suggests that the older the mother is, the taller the child is. For both the father and the mother, the more years of education they have, the taller the child is. This is probably due to the fact that more educated parents earn higher wages, which in turn translates into more resources available when taking care of the child. Or that the jobs held by more educated people are less likely to suffer due to natural disasters – university educated people are more likely to work in business than on farms. In addition more educated mothers should know how to better take care of their children. The mother having received assistance of either a nurse or a midwife when giving birth improves child height. When it comes to the estimates for the coefficients on the series of ethnic dummies, it should be noted that these cannot be interpreted in isolation. This is because the variable affected already controls for a significant part of the differences in physical stature of ethnic groups. For example, the estimate for the coefficient for the Emakwua is positive and statistically significant in

[28] Because the regression in column 4 uses considerably more observations, this regression delivers more statistically significant coefficients for the covariates than the other regressions.

column 4 of table 2. Given that the coefficient for the affected variable is also positive (which means the north has shorter children than the affected area) and larger in magnitude, this means that the Emakwua are shorter when compared to the base group. This is so because, as previously stated, the Emakwua are the main ethnic group living in the north. Looking at the coefficients for the other variables, we see that children in the affected area were taller than those in the comparison group. Also, things seem to have improved in the country overall, as indicated by the statistically significant positive coefficient for the 2003 dummy variable, t. Finally, the coefficient for the constant does not have an interesting interpretation given that, for instance, no mother in the data is 0 cm height, nor is 0 years old.

When weight for height is used as the dependent variable and the effect of the sequence of disasters is estimated for children born in 2000 to 2002, there is evidence that there was an effect (see table 7). The effect of the 2002/2003 droughts on children living in the affected area was, on average, -0.2827 standard deviations, a result significant at 1%. This result is reassuring in fact. Because weight given height reflects the physical condition of the child at the time of the survey, this result indicates that these children were affected by the 2002/2003 droughts. Hence, this confirms that the 2 consecutive years of drought have affected child development, very likely due to malnourishment because of lack of food.

Table 7 - DD with covariates ; weight-for-height

dependent variable: weight-for-height	short regression****
affected	0.2764
	(0.1085)**
t	0.5000
	(0 .0870)***
shock	-0.2827
	(0.1024)***
urban	0.0831
	(0.0574)
mother_ht_cm	0.0027
	(0 .0039)
motherage	0 .0091
	(0 .0042)**
fatherage	-0.0019
	(0.0029)
motheredu	0 .0151
	(0.0119)
fatheredu	0.0110
	(0 .0094)
assistance_nurse_or_midwife	0.1188
	(0.0558)**
ethnic_portuguese	0 .1151
	(0.1401)
ethnic_Emakhuwa	-0.1399
	(0.0890)
ethnic_Xichangana	0.0538
	(0.0712)
ethnic_Cisena	-0.3813
	(0.0792)***
ethnic_Xitswa	0.4040
	(0.1007)***
constant	-0.9911
	(0.6048)
Observations	3532
R-squared	0.0469

Robust standard errors in parenthesis
* significant at 10%; ** significant at 5%; *** significant at 1%

Ramsey RESET test for the short regression; H0: model has no omitted variables
$F(3, 2962) = 0.87$; Prob > F = 0.4539
p value>10%, hence H0 fails to be rejected

Regressions to seek the effect of the disasters on weight for age, a measure that reflects a mixture of short and long term impacts, have also been estimated[29]. These deliver coefficients with the expected signs. The effect of the disasters in this case, for children born in the years 2000, 2001 or 2002, was, on average, -0.3478 standard deviations, a result statistically significant at 1%. When considering children born in each year separately, the estimates grow in magnitude and gain statistic significance as the year of birth of children gets closer to the date of the second survey, 2003.

Conclusion

This work empirically shows there was indeed a negative effect of the 2000 floods followed by the 2002/2003 droughts on children's health. Height-for-age z-scores of children between 1 and 3 years old is used to capture the cumulative effects of this sequence of natural disasters. Children born in 2003 (and born in 1997) were not included in any of the regressions because the comparison group was affected by climate shocks and agricultural infections in 2003. The data shows that children born in the year of the 2002 drought were the most affected. The causal effect of the droughts is in accordance with the estimate found for the coefficient of the variable shock when using weight given height z-scores as the dependent variable, which captures the short term effects of the 2002/2003 droughts by the time of the 2003 survey.

29 These regressions are not shown in this paper as they do not provide new relevant information. They are available upon request.

The effect of the disasters on height-for-age z-scores for the group of children exposed that were born in 2000, 2001 or 2002 is -0.4090 standard deviations, a result significant at 1%. This is equivalent to say that these children were more than 1.5 cm shorter in 2003 due to the shocks. When looking at each of the regressions that only consider children born in a specific year (2000, 2001, 2002) separately, it is found that those children born in 2000 and 2001 were less affected by the disasters than the children born in 2002. The impact of the 2002/2003 droughts on affected children was, on average, -0.6829 standard deviations, a significant result at 1%. This result states that these children were the most affected, they were about 2 cm shorter in 2003 due to the droughts. Contrary to expectations, this seems to indicate that children who were exposed to all of the disasters were not more affected than children that suffered only the droughts. This may be explained by 1) the droughts were more devastating than the floods and 2) children are more sensitive to shocks the younger they are at the time of the shock. It would be interesting to further investigate these hypotheses because this area of Mozambique is continuously hit by this sequence of disasters. Understanding the effects of the disasters allows for a better implementation of mitigation strategies.

This paper urges the need to implement mitigating strategies given the huge economic cost of the shocks that were found. Particularly, programs aiming at improving coping mechanisms of households should be implemented. Investments in communication infrastructures should also be made in order to allow households in affected districts to migrate to safe districts during critical periods. A contribution to the literature on the effects of shocks on child health in the developing world is also made by focusing on measurement errors, controlling for differences in the physical stature of different ethnic groups and trying to mitigate bias that arise due to migratory movements. It was possible to address these issues in this paper given the large dataset used. All of these problems are quite common in developing countries and it is thus important to take them into account.

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Appendix

Map of Mozambique

Source: UNDP (2006)