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# Children at Risk: The Effect of Crop Loss on Child Health in Rural Mexico

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Maren M. Michaelsen and Songül Tolan[1]

# Children at Risk: The Effect of Crop Loss on Child Health in Rural Mexico


## Abstract

*This study investigates the effect of an economic shock due to crop loss on health outcomes of children in rural Mexico. Data from the Mexican Family Life Survey for the years 2002 and 2005 offer retrospective information on economic shocks since 1997 and height-for-age z-scores (HAZ) to measure long-term effects on child health. Since crop losses are exogenous to the children, simple OLS regressions are used to estimate the effect of crop loss overall and over time. Children who were hit by crop loss have on average 0.4 standard deviations smaller HAZ two and three years after the shock than other children. For boys and children aged 25 to 60 months being hit by crop loss also increases the probability of being stunted by 20 and 27 percentage points, respectively. The findings demonstrate that, albeit its large poverty reduction programs, Mexico has to invest more to combat poverty and provide mechanisms to help households to cope with sudden economic losses.*


*JEL Classification: I15, J13, Q12*

*Keywords: Economic shock; crop loss; child health; Mexico*

*October 2012*

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# 1 Introduction

Mexico is still facing problems of malnutrition, especially among its rural population. The prevalence of malnutrition for children under the age of 5 within the Mexican population in 2006 lies between 3.4% when using a weight-based indicator and 15.5% when using a height-based indicator.[1] One reason for a higher prevalence of malnutrition in a developing country is the strong relationship between household income or socioeconomic status and health, which is well acknowledged in the literature (e.g. Deaton and Paxson, 1998; Chen et al., 2006). Not only wealth, but also a wide range of aggregate and idiosyncratic shocks, which people in rural areas face from time to time, affect nutrition and hence health outcomes. Particularly for poor families, the recovering process from such shocks may be long-lasting and involve long-term consequences on labour market and health outcomes in adult age.[2]

Due to the Mexican Peso crisis in the 1990's, there already exists a vast literature on Mexico which deals with the effect of aggregate shocks on child human capital outcomes such as health or schooling (see Cutler et al., 2002; Ferreira and Schady, 2009; McKenzie, 2003). However, less is known about how and to what extent idiosyncratic shocks affect children's health in the long-term. One shock that can have severe effects on nutrition is crop loss. Naturally, (total) crop loss only occurs in rural areas and affects the most vulnerable of the rural population: children. For poor families, the loss of crop can be a threat to daily subsistence.

We are particularly interested in studying the impact of total crop loss on children's health using a large representative household panel for Mexico, the Mexican Family Life Survey (MxFLS, or ENNVIH in Spanish). The MxFLS contains information on community, household and individual level for the years 2002 and 2005 on different aspects of human life, cognitive ability, health and economic conditions as well as mental well-being, on children and adults. The data provides us with detailed information on the year of the shock, dates of birth and interview, and detailed health measures. We analyse long-term impacts of total crop loss on child health using an anthropometric measure – the height-for-age z-score (HAZ) – as outcome variable. HAZ is a commonly used indicator to measure children's health status because it reacts in the long-run to general impacts on child health (O'Donnell and Lindelow, 2008). We estimate the impact of crop loss on health outcomes of children under the age of fifteen, controlling for individual, household, and municipality characteristics. We also study the effect of crop loss on the probability on being stunted as a consequence of the shock. For a more differentiated view, we identify the time span in

[1] Source: World Bank `http://data.worldbank.org/indicator/SH.STA.MALN.ZS/countries`

[2] See Strauss and Thomas (1998) for an overview.

which health differences are observed and if children eventually recover in terms of height-for-age.

We find large and significant effects of crop loss on HAZ after one and two years for children aged 25 to 60 months and after two and three years for older children. In particular, girls up to the age of 167 months are on average 0.4 standard deviations smaller two and three years after the shock, translating into a height deficit of 0.8 to 2.78 cm relative to the WHO median of their respective age group. Affected boys are on average 0.38 standard deviations smaller two years after crop loss suffering from a height deficit of 0.8 to 2.92cm. The shock is severe for both boys and girls, while boys face a higher probability of being stunted due to the shock. That the shock also affects children between the age of 6 and 13, i.e. school age children, is worrying since malnutrition not only affects long-term health status, but also short-term learning outcomes (Alderman et al., 2006). The results imply that even though Mexico's social protection system has been expanded largely in the last decades, it cannot serve as insurance to smooth consumption when exposed to economic shocks. Rural farming households need to be provided with better means to protect their children from malnutrition.

The following section gives an overview on the previous literature on the effect of economic shocks on child health. After this the basic sample data will be explained and analysed in order to point out the prevalence of shocks and existing health problems in the population, which is followed by a detailed description of the estimation methods in Section 3. The estimation results will be presented and discussed in Section 4 and Section 5 concludes.

## 2 Previous Findings and Background

Several articles document the negative relationship between families' socioeconomic status and poor health reports for children, such as Chen et al. (2006) in a cross-sectional, nationally representative sample of US children. Moreover, Case and Paxson (2008) show similar results for the US and the UK. Especially the results for the UK show that a positive relationship between income and child health exists even in countries with a national health care system.

The channels through which income affects child health are both access to health care and nutrition. Since household shocks should not have an impact on government provided access to health care, the focus will be on malnutrition. Several studies show that malnutrition leads to lower height-for-age scores of children who experienced malnutrition during perception and early age. Often, and especially for poor families, sudden economic shocks can be so severe that malnutrition is the consequence. One shock that does not only cause income losses but is also a threat to daily subsistence is the loss of crop and other production goods. The effect of total crop loss is documented in several studies, which estimate the magnitude of the effects for various countries. Since every country possesses different social programs and different populations deal with economic shocks in different ways, we find it important to investigate the consequences of crop loss on child health in Mexico.

In the following we summarize some previous findings of the effects of economic shocks on child outcomes. For Indonesia, Rukumnuaykit (2003) tests the effect of economic crises on child mortality and birth weight and finds significant results for the relationship between drought / smoke crisis and infant mortality, indicating that the probability of post-neonatal mortality for children in rural areas who were born at the time of a drought/smoke crisis is higher than for children who were not born during a crisis period. Additionally, he finds that the children in rural areas during crisis periods whose mothers belong to a higher education group were less affected by a drought/smoke crisis than children whose mothers belong to a lower education group. Children's health is also correlated with women's bargaining power within the household. E.g., Atkin (2009) shows that women who choose to work in a rather male work environment certainly exhibit characteristics, which are correlated with strength and power.

Hoddinott and Kinsey (2001) find that children in Zimbabwe, who were 12-24 months old in the aftermath of a drought in 1994-1995, grew on average about 2cm less than other children. The permanency of this effect has been proven by showing that the same children that were born in the aftermath of a drought have lower health outcomes at the age of 36-48 months compared to children who did not belong to the drought cohort. Later, Alderman et al. (2006) show similar adverse child health outcomes in Zimbabwe in case of exposure to civil war and support these findings by using this information to identify differences in preschool nutritional status among siblings. Akresh et al. (2011) test the effect of crop failure in Rwanda, and only find significantly negative child health outcomes for girls, but not for boys. In addition, they find that children born in regions after a civil war have 0.623 standard deviations lower HAZ than children from other regions, which is similar to the results obtained by Bundervoet et al. (2009) for children in rural Burundi who were exposed to civil war. Osberg et al. (2009) finds that poverty is correlated with slower growth in height-for-age in China and that food coupons significantly increase height-for-age growth.

When analysing impacts on child health in Mexico, there is one aspect that requires particularly attention. In 1997 the Mexican Federal Government launched a large scale poverty reduction program – which was first named Progresa (Program for Education, Health and Nutrition), and later renamed Oportunidades – with the principal aim to develop human capital in low-income households (Rivera et al., 2004). The number of covered families rose from 300,000 families in 1997 to 2.6 million in 2000 (covering 40% of the rural families or 10% of all families) to then 4.5 million households in 2005, which is about 20% of all families in Mexico (Rivera et al., 2004). Oportunidades is not a pure cash transfer program, but provides many different health and education related services to chosen families which are partly compulsory to pursue. The most important services, which are also expected to increase child health, are the following.

Oportunidades families receive monthly cash transfers, which are intended to increase expenditure on more and better food for the family in order to improve the nutritional status (Fernald et al., 2008). These cash transfers are only submitted under the condition that the family members attend a number of preventive health services such as vaccinations and medical check-ups that are free of charge. Moreover, the participation at monthly meetings to discuss health issues is obligatory (Leroy et al., 2008). In addition to this, the program regularly provides micronutrient fortified food for babies at the age of 6-23 months and for children at the age of 2-4 years if they have a low weight-for-age ratio (Leroy et al., 2008).

One potential drawback of the study is that we cannot be sure that the received transfers are really spent on nutrition. However, Hoddinott and Skoufias (2004) find that a 10% increase of income of families that participate in the program results in a 3.5-4% increase in caloric availability (Behrman and Hoddinott, 2005). Additionally, Oportunidades directs cash transfers to mothers who are expected to direct a larger share to child health than fathers (Behrman and Hoddinott, 2005). The general positive impact of Oportunidades on child health has been proven in many evaluation studies (see Leroy et al., 2008; Rivera et al., 2004; Fernald et al., 2009; Andalón, 2011). De Janvry et al. (2010) investigate the role of conditional cash transfers (CCTs) as safety nets to protect uninsured children in poor and vulnerable non-poor households from negative impacts on their human capital due to idiosyncratic shocks and generally acknowledge the function of CCT programs as safety nets for poor families.

Since we are concerned with rural farming households, another government program has to be considered in the analysis, which is Procampo. Procampo was introduced to compensate farmers for potential income losses through NAFTA and provided all farming households with benefits proportional to their land size. After the Mexican revolution 1910, a large land reform had taken place, in which land was allocated to peasant communities, called *ejidos*. Today, the *ejido* sector comprises more than half of Mexico's agricultural land and more than 60% of the rural population is involved in *ejido* agriculture (De Janvry and Sadoulet, 1997). Mexico's second land reform, Procede, started in 1992. This national land certification program has reached 92% of its target population by 2006 (De Janvry and Sadoulet, 2011). Poverty is very high among these farming households, not least because of insufficient property rights, which constrain farmers from access to commercial credit. The poverty reduction potential of land is found to be high as documented by Finan et al. (2005). De Janvry and Sadoulet (2001) analyse income strategies of *ejido* farmers. They find that off-farm strategies account for about 50% of their household income with indigenous households participating less in off-farm activities. Taking into account that indigenous household tend to have smaller land size, they often find themselves in vulnerable positions.

Against this background, we investigate to what extent children's health outcomes are affected by crop losses albeit Mexico's extensive provision of benefits from Oportunidades and Procampo. Using a representative data set of children and their families in rural Mexico, which includes a battery of questions on socioeconomic characteristics *and* anthropometric measures, this analysis provides further insights into the vulnerability of children in a country which faces large scale child poverty, has a considerable share of inhabitants trying to make a living on farming activities, and are hit by natural disasters regularly. With this study we intent to inform decision makers about the extent to which rural children are protected by poverty reduction programs and where more effort has to be made.

## 3 Data and Empirical Methods

The dataset used is the Mexican Family Life Survey for the years 2002 and 2005. The MxFLS is a nationally representative survey on the state, household and individual level which covers information about various socioeconomic and demographic aspects of Mexican families. The first wave (MxFLS-1) covers more than 8000 households and over 35000 individuals (Rubalcava and Teruel, 2006), and for the second wave (MxFLS-2), which was conducted from mid 2005 to 2006, a re-contact rate of about 90% on the household level could be achieved (Rubalcava and Teruel, 2007).

In the scope of this study, we focus on children aged 0 to 13 years and the effect of the shock "total crop loss". Adult household heads were asked about sudden economic losses and their reasons and year of event within the last 5 years before the interviews took place. Hence, the period of events covered by the data ranges from

1997 to 2005/2006. Other shocks, such as aggregate shocks or sudden unemployment of a household member have the caveat that these shocks could be endogenous since this event also depends on household behaviour. However, crop loss is exogenous to the children in these households. This allows us to use relatively simple estimation strategies. In order to investigate after how many years the effect of a shock can be observed, dummy variables were generated, which take on the value 1 if the shock happened $c$ years ago and 0 otherwise, with $c = 0, ..., 5$.

In some cases the age of the child stated by the parents did not coincide with calculated age from interview date and reported date of birth. This problem was solved by replacing date of birth stated in the other wave if no information was given in the respective wave and replacing date of birth in the respective year with date of birth in the other year, given in the other year an official document prove the date. Still, we lose one third of observations due to inconsistent age. Even allowing an interval of 6 month differences in stated age and stated date of birth does not alter this fact. Since it is most likely that those families who do not know the exact birthday or do not have a birth certificate are those living in areas with little access to health care, the consequence is likely to be that the poorest children drop out of our sample, implying that the estimated coefficients are lower bounds and the real average effect of crop loss on child health is likely to be higher.

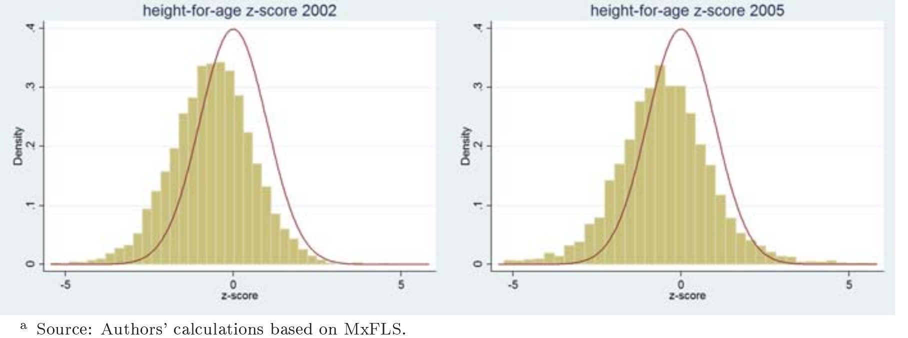
Table 1: Summary of HAZ

| | 2002 | | | 2005 | | |
|---|---|---|---|---|---|---|
| *Age in months* | 0-24 | 25-60 | 61-167 | 0-24 | 25-60 | 61-167 |
| *All* | | | | | | |
| Mean | -0.61 | -0.80 | -0.59 | -0.36 | -0.67 | -0.45 |
| SD | 1.55 | 1.26 | 1.12 | 1.77 | 1.50 | 1.29 |
| % below -2SD | 0.19 | 0.16 | 0.11 | 0.16 | 0.18 | 0.10 |
| % below -3SD | 0.06 | 0.04 | 0.02 | 0.05 | 0.05 | 0.03 |
| **N** | 529 | 1171 | 4122 | 536 | 924 | 3568 |
| *Girls* | | | | | | |
| Mean | -0.64 | -0.81 | -0.60 | -0.21 | -0.74 | -0.48 |
| SD | 1.51 | 1.19 | 1.13 | 1.60 | 1.46 | 1.25 |
| % below -2SD | 0.18 | 0.16 | 0.11 | 0.12 | 0.18 | 0.10 |
| % below -3SD | 0.06 | 0.03 | 0.02 | 0.03 | 0.06 | 0.03 |
| **N** | 262 | 580 | 2115 | 260 | 449 | 1835 |
| *Boys* | | | | | | |
| Mean | -0.59 | -0.80 | -0.58 | -0.50 | -0.61 | -0.42 |
| SD | 1.59 | 1.32 | 1.12 | 1.91 | 1.54 | 1.32 |
| % below -2SD | 0.20 | 0.17 | 0.10 | 0.19 | 0.18 | 0.10 |
| % below -3SD | 0.06 | 0.05 | 0.02 | 0.07 | 0.05 | 0.02 |
| **N** | 267 | 591 | 2007 | 276 | 475 | 1733 |
| **N** | | 5822 | | | 5028 | |

Note: Authors' calculations based on MxFLS.

The dependent variable that is used to describe child health outcomes is the z-score for height-for-age, which is calculated for each child based on comparisons with an as healthy classified international reference population (O'Donnell and Lindelow, 2008). The data for this reference population is provided by the World Health Organization (WHO).[3] More detailed, z-scores are standard deviations (SD) scores, which are computed by dividing the difference between individual height/length (in cm) and the mean of the reference population according to sex and age (in months) by the standard deviation of the reference population (O'Donnell and Lindelow, 2008). Height-for-age belongs to the most commonly used anthropometric indicators for child health (Alderman et al., 2006; Behrman and Hoddinott, 2005). Height-for-age can be seen as a stock index which reflects past events of malnutrition or illnesses in a child's life but does not respond immediately to fluctuations in health (O'Donnell and Lindelow, 2008). Therefore, the height-for-age z-score (HAZ) is used to observe long term changes in child health. The cut-off score for HAZ is -2 standard deviations. Children with z-scores below this value are referred to as "stunted" (O'Donnell and Lindelow, 2008).[4] Table 1 shows a summary of mean and standard deviations of HAZ and the prevalence of stunted children. It can be seen that children aged 25-60 months exhibit the smallest mean HAZ (about -0.7) and together with the 0-24 months old children they are the groups mainly affected by stunting (between 5 and 8%). Figure 1 shows the distribution of the HAZ of the first wave. It can be seen that the whole distribution of the sample population is shifted to the left, "short", side which already indicates a mean score of the sample population below the healthy reference population.

Figure 1: Distribution of Height-for-age Z-Scores




[a] Source: Authors' calculations based on MxFLS.

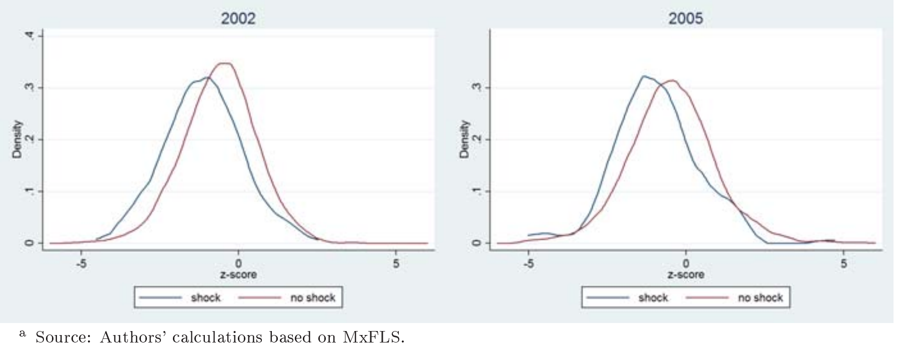
Comparing density plots of HAZ for children who were hit by a crop loss shock within the last five years to those who were not reveals large differences between the

[3] For detailed information see: http://www.who.int/childgrowth/en/.

[4] HAZ scores outside the range of [-6;6] are classified as implausible (physically impossible) and are therefore automatically excluded from the sample which accounts for less than 1% of the observations.

groups (Figure 2).

Figure 2: Kernel Density Plots of Height-for-age Z-Scores




[a] Source: Authors' calculations based on MxFLS.

A particular difficulty is to control for income or at least poverty. The data set does not provide a clear monetary indicator for household income. Therefore, a composed indicator was calculated, which aims at measuring the household's status of integration into society on the basis of information on the possession of supposedly social status determining goods. For the calculation of this variable, in the following referred to as "status", a method presented by P. and Papadopulos (2002) will be used. In order to calculate this variable, information on the possession of certain household assets is used. Adequate variables for this calculation are the possession of (1) electric devices, (2) a washing machine and/or a stove, (3) domestic appliances, (4) financial assets, (5) bicycles, (6) a motor vehicle, (7) a house for living, (8) an additional house, (9) a separate room for cooking, (10) a house-internal source for water from the tap or a decanter and (11) a toilet. The status is then calculated by multiplying these dummy variables with the correlation coefficient of the respective item with a variable that indicates happiness.[5] The sum of the results is divided by 11, i.e. the number of household assets. The outcome of this calculation is the status variable which is a continuous variable between 0 and 1 with 1 = highly socially integrated and 0 = socially not integrated. To make interpretation of this variable more intuitive, the distribution was translated into percentiles. Thus, the 100th percentile in the distribution represents the household with the highest status.

Particularly for Mexico, it is important to control for the participation in a large scale poverty reduction program called Oportunidades, which was introduced by the Mexican government in 1997 and today provides Conditional Cash Transfers (CCT) and medical services to 5 million Mexican households (Leroy et al., 2008). We include

[5]The variable is based on the question "Compared to 3 years ago, has your life improved?" in MxFLS-2. Answers were from 1 = Improved a lot to 5 = Become a lot worse.

a variable for the amount in Peso received in the last 12 months by the household. Similarly, a variable for the amount in Peso received in the last 12 months by the program Procampo was created, which is 0 if the household does not participate in the program. Procampo was introduced to compensate farmers for anticipated negative price effects from NAFTA. Farmers were assigned to the program if they cultivated one of nine basic crops. Procampo accounts for about 8% of total income of *ejido* farmers in 1997 (Sadoulet et al., 2001). In our sample, about 14% receive benefits from Procampo, amounting to on average 3,000 pesos. Since Procampo transfers are proportional to land size, this variable is also an indicator for the size of land the household cultivates. Sadoulet et al. (2001) finds that Procampo benefits serve as income multipliers for recipients since they relax liquidity constraints.

Furthermore, we control for indigenous origin and number of household members. In order to control for maternal characteristics, a variable indicating the mother's cognitive ability was added.[6] This variable is based on results in Raven's test of Progressive Matrices, which is a test that measures cognitive ability without requiring literacy.[7] This variable ranges from 0 to 1, whereupon 0 indicates very low and 1 very high cognitive ability.[8] We assume that the mother's ability is correlated with the comprehension of what healthy nutrition is. This will in turn be positively correlated with HAZs of their children. We also control for the recipience of remittances. Unfortunately, we cannot differentiate between international or national remittances. However, it still seems important to include this variable since remittances are shown to have a strong contribution to income smoothing for many rural families when exposed to shocks (see Amuedo-Dorantes et al., 2007; Choi, 2007).

Table 2 displays means and standard deviation of all variables of interest, separately for households, which experienced the economic shock due to crop loss and those who did not. It can be seen that children who experienced a crop loss have significantly lower HAZ (-1.19) compared to children who did not experience crop loss (-0.72). Furthermore, affected children are more often indigenous, live in larger households and in municipalities which exhibit smaller levels of health, education and income standards. The average amount of transfers from Oportunidades is significantly higher among children who were affected while the average amount received through remittances is not significantly different. Unfortunately, we do not know if transfers from Oportunidades and remittances have been received already before the

[6] Including this variable lead to a loss of a total 8.68% (468) of observations.

[7] For more information on the Raven test see Raven and Court (2003).

[8] In previous estimations we also included control variables on the father's cognitive ability and the parent's health status. However, these variables were not significant and had many missing observations. Since the inclusion of these variables did not change the main results, they were excluded from further estimations.

Table 2: Descriptive Statistics

| | Crop Loss | | No Crop Loss | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | Std.Dev. | Mean | Std.Dev. | Diff | Std.Dev. |
| HAZ | -1.19 | (1.30) | -0.72 | (1.34) | 0.48*** | (0.07) |
| Indigenous | 0.5 | (0.50) | 0.3 | (0.44) | -0.2*** | (0.0) |
| Female | 0.49 | (0.50) | 0.51 | (0.50) | 0.02 | (0.02) |
| HH size | 6.79 | (2.20) | 6.17 | (2.25) | -0.62*** | (0.11) |
| Mother's ability | 0.41 | (0.27) | 0.46 | (0.24) | 0.05*** | (0.01) |
| Economic status | 35.2 | (29.4) | 38.5 | (27.6) | 3.3** | (1.4) |
| Oportunidades | 2.50 | (3.65) | 1.86 | (3.23) | -0.64*** | (0.16) |
| Procampo | 1.74 | (3.64) | 0.40 | (1.95) | -1.34*** | (0.11) |
| Remittances | 0.34 | (1.38) | 0.29 | (2.34) | -0.05 | (0.11) |
| Child died $<$ age 14 | 0.19 | (0.40) | 0.09 | (0.29) | -0.10*** | (0.02) |
| HDI health | 0.78 | (0.05) | 0.81 | (0.06) | 0.03*** | (0.00) |
| HDI education | 0.74 | (0.08) | 0.78 | (0.07) | 0.05*** | (0.00) |
| HDI income | 0.57 | (0.10) | 0.63 | (0.10) | 0.06*** | (0.01) |
| N | 447 | | 4084 | | 4531 | |

Note: Authors' calculations based on MxFLS. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

shock or if families became recipients after the shock. Consequently, we cannot make any causal interpretation about the impact of remittances or Oportunidades on child health, or if they serve as safety nets. However, including these indicators as controls seems reasonable since they have generally been found to be correlated with child health.

Finally, rural regions are defined as regions, which are populated by less than 2,500 persons. After the mentioned reductions and basic data cleaning, an unbalanced panel of 4,531 individuals remains.

# 4 Results

## 4.1 Main Effects

By examining the effect of crop loss on child health we want to determine the overall effect and the time effect of the exogenous economic loss induced by the loss of crop on a long-term measure of child health, the height-for-age z-score. Since the economic loss due to crop loss, or more generally a natural disaster or crop disease, is exogenous to the child, we are able to employ simple OLS estimation. We pool the waves 2002 and 2005 and cluster standard errors at the household and municipality level,[9] since observations per child are likely to be correlated as well as observations of children within the same household.[10]

[9] We use the user written command IVREG2 by Baum et al. (2002) for two-way clustering in OLS estimation.

[10] We do not control for unobserved individual fixed effects because our variables of interest are retrospective information, which do not change from wave to wave, and hence would drop out when estimating a fixed effects model. Further, we do not control for household fixed effects, since we

Table 3: OLS Regressions of Overall Effect of Crop Loss on Height-for-Age Z-scores

| | All | | Girls | Boys | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Crop loss | -0.479*** | -0.219*** | -0.196** | -0.233** | -0.049 | -0.457** | -0.216*** |
| | (0.150) | (0.077) | (0.084) | (0.105) | (0.300) | (0.189) | (0.082) |
| Female | – | 0.032 | – | – | 0.329* | 0.017 | -0.012 |
| | | (0.044) | | | (0.181) | (0.102) | (0.042) |
| Indigenous | – | -0.097 | -0.126 | -0.065 | 0.429* | -0.108 | -0.168** |
| | | (0.061) | (0.085) | (0.083) | (0.229) | (0.119) | (0.067) |
| HH size | – | -0.043*** | -0.050*** | -0.037** | -0.026 | -0.040 | -0.051*** |
| | | (0.015) | (0.017) | (0.016) | (0.033) | (0.029) | (0.015) |
| Oportunidades | – | -0.003 | 0.000 | -0.007 | -0.012 | -0.008 | -0.003 |
| | | (0.009) | (0.008) | (0.013) | (0.042) | (0.027) | (0.008) |
| Procampo | – | 0.014 | 0.019** | 0.012 | -0.015 | 0.035** | 0.019 |
| | | (0.012) | (0.009) | (0.020) | (0.047) | (0.016) | (0.012) |
| Mother's ability | – | 0.188* | 0.235 | 0.148 | -0.512 | 0.291 | 0.224* |
| | | (0.113) | (0.144) | (0.137) | (0.318) | (0.185) | (0.119) |
| Economic status | – | 0.005*** | 0.006*** | 0.004*** | 0.000 | 0.004 | 0.006*** |
| | | (0.001) | (0.001) | (0.001) | (0.004) | (0.002) | (0.001) |
| Remittances | – | 0.004 | 0.015 | -0.011* | 0.097*** | 0.014 | -0.005 |
| | | (0.009) | (0.014) | (0.006) | (0.028) | (0.009) | (0.008) |
| 2005 | – | 0.105 | 0.170* | 0.030 | -0.033 | 0.168 | 0.113 |
| | | (0.077) | (0.096) | (0.078) | (0.224) | (0.122) | (0.079) |
| Regional dummies | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional characteristics | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 4531 | 4531 | 2302 | 2229 | 418 | 890 | 3223 |
| $R^2$ | 0.011 | 0.149 | 0.172 | 0.137 | 0.090 | 0.165 | 0.204 |
| F | 10 | 12 | 10 | 17 | 5 | 6 | 15 |
| p | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: Standard errors are two-way clustered at the household and municipality level. Standard errors in parentheses. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

Table 3 shows the overall effect of crop loss on children's HAZ. In column 1 the unconditional effect is estimated. It suggests that children whose families experienced an economic shock due to crop loss within the last 5 years (3 years for children aged 0-24 months) have lower HAZ of almost 0.5 standard deviations on average. However, the shock itself does not explain much of the variance in HAZ. Adding the described control variables on individual, household and municipality characteristics leads to a smaller effect of crop loss on HAZ. Though, the effect is still large and statistically significant. Children who were exposed to crop loss are on average 0.22 standard deviations smaller than children who were not exposed to crop loss. We do not find significant differences between boys and girls, and no significant difference between children aged 25-60 months and older children. Surprisingly, children younger than 24 months do not seem to have a smaller HAZ when experienced crop loss than

cannot imagine any unobservable effect on the household level, which may be correlated with the loss of crop. E.g., Beegle et al. (2006); Carter and Maluccio (2003) use household fixed effects models when estimating the effect of shocks on child outcomes. However, they are concerned with the impact of household assets and social capital, respectively, as coping mechanisms which are likely to be correlated with unobservable household characteristics.

children who did not experience a crop loss. However, this result may be due to the limited precision of the time since the point of time of the shock. Since we only know the year and not the month of the shock, the difference in time since the event within these age groups may distort the result of the effect for this age group. For older children this seems less important. It can also be seen that children in larger households have smaller HAZs and that economic status and higher income standards on the municipality level lead to significantly higher HAZs. Furthermore, the positive coefficient of mother's ability for girls and children older than 5 years is in line with findings by, e.g., Rukumnuaykit (2003) and Atkin (2009) who find that mother's education and bargaining power is positively correlated with child health.

The results are similar to the results of Hoddinott and Kinsey (2001) on the effect of drought shocks on children in Zimbabwe, as discussed in Chapter 2, who find lower annual growth rates for affected children. There are different reasons why a crop loss shock has such a strong effect on the health of children. For instance, total crop loss will have a strong negative impact on income if the main income source is the sale of the crops. In addition to this, this shock will also reduce the availability of food, if, and this is very likely, crop growing households use their crops as a source of nutrition. Furthermore, Kochar (1995) shows that rural households in India increased engagement on the labour market when crop shocks occurred in order to smooth household consumption. However, the additional time spent on alternative employment may be time that could have been invested in child care. Thus, the loss in income due to total crop loss shocks reduces the household income which may result in a reduction of both monetary and time investment in child health.

In many studies, it is not possible to determine after how many years the negative effect of sudden economic losses affects children's height. This may lead to the possibly false conclusion that the impact of crop loss is similarly visible after different periods of time and that children do not recover from the shock in terms of growth. However, due to the large poverty reduction program Oportunidades and transfers received through Procampo or remittances, it is possible that children recover from malnutrition after some years, which is of course desirable. Unfortunately, we do not know when any of the transfers have been received by the households, so we cannot directly estimate their potential to buffer economic shocks. However, we can find out after how many years HAZs are smaller for affected children and if the difference disappears after some time.

Table 4 displays the regression results including the dummies for years since shock. In all groups, except the young children, there is no difference in average HAZ between children affected by crop loss and children not affected one year after

Table 4: OLS Regressions of Time Effects of Crop Loss on Height-for-Age Z-scores

| | All | | Girls | Boys | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Crop loss in t-1 | -0.251 | -0.105 | -0.084 | -0.118 | -0.770** | -0.642* | 0.019 |
| | (0.153) | (0.100) | (0.109) | (0.176) | (0.327) | (0.334) | (0.114) |
| Crop loss in t-2 | -0.815*** | -0.405*** | -0.401** | -0.395** | 0.502 | -0.910** | -0.449*** |
| | (0.274) | (0.137) | (0.157) | (0.187) | (0.659) | (0.376) | (0.096) |
| Crop loss in t-3 | -0.735*** | -0.352** | -0.331*** | -0.333 | -0.557 | -0.523* | -0.324** |
| | (0.157) | (0.149) | (0.126) | (0.244) | (0.464) | (0.311) | (0.157) |
| Crop loss in t-4 | 0.006 | 0.047 | 0.125 | -0.004 | – | -0.079 | -0.045 |
| | (0.153) | (0.128) | (0.191) | (0.171) | | (0.386) | (0.167) |
| Crop loss in t-5 | -0.702* | -0.302 | -0.231 | -0.411** | – | -0.359 | -0.328 |
| | (0.391) | (0.199) | (0.261) | (0.184) | | (0.478) | (0.241) |
| Other characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional dummies | No | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 4531 | 4531 | 2302 | 2229 | 418 | 890 | 3223 |
| $R^2$ | 0.016 | 0.150 | 0.174 | 0.138 | 0.100 | 0.168 | 0.206 |
| F | 6 | 13 | 11 | 21 | 5 | 8 | 15 |
| p | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: Standard errors are two-way clustered at the household and municipality level. Standard errors in parentheses. *,** and *** denote significance level of 10%, 5% and 1%, respectively. include the same controls as in Table 3.

the shock. The unconditional effects show that affected children have on average smaller HAZs of about 0.8 standard deviations than non-affected children after two and three years. Also when holding all observable characteristics constant, the effect of an economic shock due to crop loss one year ago does not lead to smaller average HAZs. Since HAZ differences are long-term indicators of child health, this result is not surprising. When the shock happened two and three years ago, respectively, average HAZ scores for affected children are almost 0.4 standard deviations smaller than for non-affected children, i.e. the coefficients halve by including individual, household, and municipality characteristics. An average of 0.4 standard deviation smaller translates to an average height gap of -1.29 to -2.78cm for affected girls compared to the median of the age groups 24 and 167 months, respectively. For boys, a 0.4 standard deviation difference in HAZs means that they are -1.22cm (24 months) to -3.08cm (167 months) smaller than the respective median of their age group. The effects are large and can lead to severe long-term consequences as will be explained in the next section. While the effects are large after two and three years, we find no differences in HAZs after four or five years. Interestingly, in the regression of the unconditional effects, average HAZs are lower after 5 years of the shock while the coefficient in the regression controlling for characteristics is not. It is likely though that households were able to cope with the shock some years later by receiving either Oportunidades transfers or remittances. If families were not recipients of the CCT when the shock occurred it is likely that they became eligible due to the shock. However, immediate recipience is unlikely due to time-consuming bureaucratic obstacles (Rodriguez, 2008). Furthermore, remittances may have been sent from family members as a response to the shock, but probably also with some delay, so that the household could cope with the shock a few years later, reducing the negative effect of crop loss on HAZs.

The effects are not significantly different between boys and girls but across age groups. For children between the age of 0 and 24 months, we find no difference in HAZs can be found. For children aged 25 to 60 months, the negative effect of crop loss can be observed in the coefficients of the crop loss one and two years ago and for older children two and three years ago. For both age groups, the difference in HAZs between affected and non-affected children seems to disappear after three and four years, respectively.

### 4.2 The Probability of Stunting

Small HAZs do not necessarily harm health and other human capital outcomes in the long-term. However, if sudden malnutrition is the reason for stagnating or smaller growth of children, it is likely to be paralleled by lower school outcomes through less capability to concentrate or because the child may have to contribute to household income which may additionally lower both health and education outcomes. Severely dangerous consequences from malnutrition or illness due to crop loss are likely among those children who possess a small HAZ even before the shock.[11] Then, a sudden economic loss of the household that leads to average 0.4 smaller HAZ as shown above, can lead to stunting, i.e. possessing an HAZ of smaller than -2SD.

Table 5 summarises the estimated marginal effects from Probit regressions with a dummy variable as dependent variable which is 1 if HAZ is below the cut-off line of -2SD, and 0 otherwise. Thus, this variable indicates when a child is, according to WHO guidelines, classified as stunted. As expected, total crop loss increases the probability of being stunted. While the shock leads to an about 3.9% higher probability for all children on average, with a 6.8% higher probability for boys, respectively, it also indicates that children between 25 and 60 months of age even show a 10.3% higher average probability of falling below the cut-off line and older children possess a higher average probability of 3.3% over the time period of shocks observed. These results are in line with the results represented in Table 3 and highlight the significance of the impacts of crop loss on child health in rural areas – especially for boys and young children.

Differentiating by years since the shock happened shows that the results are much

[11] For the relationship between height and adulthood outcomes see e.g. Strauss and Thomas (1998).

Table 5: PROBIT REGRESSIONS OF OVERALL EFFECT OF CROP LOSS ON STUNTING

| | All (1) | Girls (2) | Boys (3) | Age 1 (4) | Age 2 (5) | Age 3 (6) |
|---|---|---|---|---|---|---|
| Crop loss | 0.039** | 0.011 | 0.068** | 0.073 | 0.103* | 0.032* |
| | (0.018) | (0.019) | (0.028) | (0.089) | (0.053) | (0.018) |
| Indigenous | 0.008 | 0.020 | -0.006 | -0.079* | 0.012 | 0.017 |
| | (0.013) | (0.016) | (0.020) | (0.047) | (0.033) | (0.014) |
| Oportunidades | -0.002 | -0.002 | -0.001 | 0.008 | -0.001 | -0.002 |
| | (0.002) | (0.002) | (0.002) | (0.007) | (0.005) | (0.001) |
| Procampo | 0.000 | -0.003 | 0.003 | 0.006 | -0.013 | 0.001 |
| | (0.003) | (0.003) | (0.004) | (0.006) | (0.010) | (0.002) |
| Remittances | 0.001 | 0.001 | 0.002 | -0.004 | -0.013 | 0.003 |
| | (0.002) | (0.002) | (0.003) | (0.009) | (0.009) | (0.002) |
| Female | -0.019* | – | – | -0.064* | -0.003 | -0.012 |
| | (0.010) | | | (0.035) | (0.021) | (0.010) |
| Mother's ability | -0.045** | -0.047* | -0.041 | 0.104 | -0.073 | -0.050** |
| | (0.022) | (0.026) | (0.032) | (0.082) | (0.050) | (0.024) |
| HH size | 0.009*** | 0.009*** | 0.006* | 0.005 | 0.011** | 0.007*** |
| | (0.002) | (0.003) | (0.003) | (0.008) | (0.005) | (0.002) |
| Economic status | -0.001*** | -0.001*** | -0.001*** | -0.001 | -0.001** | -0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) |
| 2005 | 0.002 | -0.015 | 0.019 | -0.006 | 0.004 | -0.002 |
| | (0.011) | (0.011) | (0.017) | (0.044) | (0.025) | (0.010) |
| Regional dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional characteristics | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 4531 | 2302 | 2229 | 418 | 890 | 3223 |
| Pseudo $R^2$ | 0.131 | 0.152 | 0.121 | 0.082 | 0.168 | 0.162 |
| $\chi^2$ | 437 | 250 | 217 | 35 | 163 | 319 |
| p | 0.000 | 0.000 | 0.000 | 0.181 | 0.000 | 0.000 |

Note: Standard errors are clustered at the individual level. Standard errors in parentheses. *,** and *** denote significance level of 10%, 5% and 1%, respectively. include the same controls as in Table 3.

more severe in particular years than indicated by the time average. After three years, affected boys are 20 percentage points more likely to be stunted than non-affected boys, while for girls we find no effect at all. Children aged 25 to 60 months are even more likely to be stunted by about 27 percentage points after two and three years.

In summary, we find strong evidence for negative impacts of economic losses through crop loss on children's HAZs one to three years after the shock.[12] Our results differ from the findings of the effect of crop loss in other countries in that respect that girls are not more affected than boys. For example, Akresh et al. (2011) find effects of crop failure on HAZs only for girls but not for boys in Rwanda, Maccini and Yang (2009) find positive effects of rainfall in Indonesia only for girls, implying that better socioeconomic conditions improve parents' ability to provide nutrition and medical inputs for girls. The different gender effects may be ascribed to the fact that gender discrimination is generally lower in Mexico than in, e.g., Indonesia and East African

[12]As a robustness check, we have conducted the same estimations reducing the sample to only farming households to avoid pitfalling into comparing apples and oranges. We find qualitatively similar results as can be seen in Appendix Tables A1 andA2. Due to the small sample size of only farming households, we preferred to discuss the results obtained from the larger sample. This also reduces the possibility of accidentally excluding rural households which abandoned farming activities only after a crop loss shock occurred.

Table 6: PROBIT REGRESSIONS OF TIME EFFECTS OF CROP LOSS ON STUNTING

| | All (1) | Girls (2) | Boys (3) | Age 1 (4) | Age 2 (5) | Age 3 (6) |
|---|---|---|---|---|---|---|
| Crop loss in t-1 | 0.008 | 0.001 | 0.012 | 0.326* | 0.036 | -0.009 |
| | (0.028) | (0.031) | (0.046) | (0.167) | (0.093) | (0.024) |
| Crop loss in t-2 | 0.094** | 0.052 | 0.132* | -0.030 | 0.283* | 0.084* |
| | (0.045) | (0.048) | (0.071) | (0.132) | (0.146) | (0.045) |
| Crop loss in t-3 | 0.122*** | 0.065 | 0.188*** | 0.117 | 0.292** | 0.091** |
| | (0.041) | (0.042) | (0.071) | (0.152) | (0.137) | (0.040) |
| Crop loss in t-4 | -0.059** | -0.061** | -0.051 | – | -0.001 | -0.047 |
| | (0.030) | (0.029) | (0.049) | | (0.087) | (0.030) |
| Crop loss in t-5 | 0.012 | -0.013 | 0.060 | – | 0.079 | 0.002 |
| | (0.041) | (0.041) | (0.072) | | (0.097) | (0.040) |
| Other characteristics | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 4531 | 2302 | 2229 | 418 | 890 | 3223 |
| Pseudo $R^2$ | 0.134 | 0.155 | 0.125 | 0.092 | 0.176 | 0.167 |
| $\chi^2$ | 456 | 256 | 230 | 38 | 174 | 334 |
| p | 0.000 | 0.000 | 0.000 | 0.157 | 0.000 | 0.000 |

Note: Standard errors are clustered at the individual level. Standard errors in parentheses. $^{*}$,$^{**}$ and $^{***}$ denote significance level of 10%, 5% and 1%, respectively. include the same controls as in Table 5.

countries, at least with respect to educational attainment (World Economic Forum, 2011). The results imply that even though Mexico has a large poverty reduction program, many families are at risk of severe poverty, resulting in malnutrition and ill-health when exposed to sudden economic losses. Affected households are not able to protect their children from detrimental impacts on their human capital outcomes. While we only examine the impact of crop loss on children's HAZ, many other studies document the detrimental effect of sudden economic losses on educational outcomes (e.g Alderman et al., 2006; Ferreira and Schady, 2009; McKenzie, 2003). Taken together, coping mechanisms and protection for falling deeper into poverty need to be provided for families at risk and should be subject to policy discussion.

### 4.3 Robustness Checks

Two potential sources of sample selection may bias our results. First, since we can only observe children who survived the economic shock, the actual effect on children's HAZ scores are probably even more intensive had the children who died 'just' survived. We try to remedy this potential pitfall by including gender-age-specific mortality rates by municipalities as additional regressors. Gender-age specific mortality rates are calculated from death records data for the years 1998 to 2005 (1997 is not available) accessible from SINAIS[13]. Since we do not have information on the number of children born we divide the number of deceived children by the total population in the municipality (in 1,000). Including these variables, we do not find significant changes in coefficients in the regressions of HAZ scores on crop loss. However, the

[13] Sistema Nacional de Informacion en Salud, `http://www.sinais.salud.gob.mx/basesdedatos/estandar.html`

impact of being stunted is even higher, but only marginally. Due to the imperfection of the measurement of these mortality rates we do not report these results, but note that the estimates are indeed slightly downward biased. Furthermore, we include a variable that is equal to one if the interviewed households have lost a child within the last five years before interview and zero otherwise. The results do not change when including this variable.

The second potential source of sample selection is due to differences in vulnerability and the possibility of migrating when crop loss occurs. It could be that families who have been affected by crop loss decide to move away in order to find employment in another area or sector. If these families do not report their new address to the data collectors, they will not be interviewed in subsequent survey rounds. If this kind of sample attrition is more likely among households who have been affected by loss of crop and have the financial means to out-migrate from the affected locality, the observed sample disproportionately contains households who are more vulnerable to the shock. This may cause an upward bias in our estimates. We try to account for this type of sample selection by estimating a Heckman (1979) sample selection model for the 2005 sample of households who did not move since the previous wave. We calculated the attrition rate which serves as exclusion restriction. The attrition rate is constructed on the locality level by subtracting the number of children in 2002 living in a certain locality from the number of children in 2005 in the same locality and dividing by the number of children living in this locality in 2002. The number of children in the certain locality does not count those children who entered the survey in 2005 but only those who have definitely remained living in this locality between 2002 and 2005. Only 50% of children lived in 2005 in the same locality as in 2002. For these children we estimate the Heckman model. The control variables in the first stage are the calculated attrition rate, household size, status, state dummies, HDI indicators and the gender-age-specific mortality rates. The second stage equation does not differ from the original equation. In this model, we cluster standard errors at the municipality level. We compare the results of the Heckman model to the OLS results based on the same sample of children in 2005 who had not moved (Tables A3 and A4). We find almost no change in coefficients and statistical significance, which leaves us rather confident that our main results are not biased due to sample selection bias.

## 5 Conclusion

In rural Mexico, farming households are at risk of losing crop due to natural disasters or crop disease. Since poverty is still high among rural households the loss of crop can lead to substantial losses of economic resources. For households that rely on subsistence farming, the loss of crop also means the loss of food, leading to malnutrition and possibly bad health outcomes. The most vulnerable individuals of such households are children for whom malnutrition can have severe long-term consequences, such as low growth and, therefore, low height-for-age z-scores (HAZ).

The present study investigates the effect of a negative economic shock due to crop loss on health outcomes of children in rural Mexico. We use data from the Mexican Family Life Survey for the years 2002 and 2005, which offer retrospective information on different economic shocks experienced up to five years before the interview. This allows us to estimate the effect of crop loss from 1997 onwards on children's health outcomes in 2002 and 2005. Using HAZ as a measure of health stock allows us to estimate long-term effects of crop loss on children's health outcomes. Since crop losses are completely exogenous to the children of the affected household, simple OLS regressions are used to estimate the effect of crop loss overall and over time, i.e. we include variables measuring years since shock to determine the time span after which effects on children's HAZs occur. The results indicate that children who were hit by crop loss are on average 0.20 (girls) and 0.23 (boys) standard deviations smaller within the five years after the shock than children who did not experience the shock. In particular, children aged 25 to 167 months are on average 0.46 standard deviations smaller two and three years after the shock, translating into a height gap of -2.3 to -2.9cm relative to the median of their respective age group.

Affected boys suffer from an average height gap of -1.7cm (24 months) and -3.9cm (167 months). While the unconditional effects imply that the difference in HAZ is also large and significant five years after the shock, the coefficient is rendered insignificant when including individual, household and municipality characteristics. Since we control for the recipience of the conditional cash transfer program Oportunidades and the recipience of remittances, families seem to be able to cope with the shock at least several years afterwards. However, we cannot determine if households received cash transfers and/or remittances as a response to the shock or if they were also recipients beforehand. In any case, significantly lower HAZ scores are a consequence of malnutrition and/or ill-health induced by the economic shock due to crop loss.

For boys and children aged 25 to 60 months being hit by crop loss also increases the probability of dropping below the cut-off line of being stunted according to WHO definitions. For boys the probability of being stunted is almost 20 percentage points higher two and three years after the shock than for boys who did not experience the shock. Affected children aged 25 to 60 months are almost 30 percentage points more likely to be stunted two and three years after the shock.

The long-term consequences of economic losses due to crop loss are significant and worrying, given that Mexico has already introduced large scale poverty reduction programs. The findings demonstrate that Mexico has to invest more into the vulnerable poor in rural Mexico and provide mechanisms that reduce the risk of subsistence loss and help households to cope with sudden economic losses.

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# Appendix

Table A1: OLS Regressions of Overall Effect of Crop Loss on Height-for-Age Z-scores – Farming Households only

| | All | | Girls | Boys | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Crop loss | -0.259** | -0.140* | -0.084 | -0.244** | 0.533 | -0.492*** | -0.102 |
| | (0.111) | (0.083) | (0.100) | (0.116) | (0.340) | (0.180) | (0.089) |
| Female | – | -0.021 | – | – | -0.241 | 0.058 | -0.053 |
| | | (0.067) | | | (0.344) | (0.136) | (0.064) |
| Indigenous | – | -0.234** | -0.224* | -0.242* | -0.671 | -0.214 | -0.225** |
| | | (0.104) | (0.121) | (0.136) | (0.706) | (0.252) | (0.103) |
| HH size | – | -0.035* | -0.016 | -0.048** | -0.026 | -0.106** | -0.026 |
| | | (0.021) | (0.026) | (0.024) | (0.060) | (0.041) | (0.022) |
| Oportunidades | – | -0.002 | 0.005 | -0.008 | -0.032 | -0.001 | -0.002 |
| | | (0.012) | (0.013) | (0.017) | (0.093) | (0.042) | (0.011) |
| Procampo | – | -0.003 | 0.006 | -0.014 | -0.126*** | 0.050 | 0.005 |
| | | (0.014) | (0.012) | (0.024) | (0.030) | (0.034) | (0.013) |
| Mother's ability | – | 0.107 | 0.006 | 0.229 | -0.801 | -0.318 | 0.244 |
| | | (0.154) | (0.221) | (0.171) | (0.630) | (0.358) | (0.159) |
| Economic status | – | 0.009*** | 0.009*** | 0.008*** | 0.020** | 0.008** | 0.009*** |
| | | (0.001) | (0.002) | (0.002) | (0.010) | (0.004) | (0.001) |
| Remittances | – | 0.002 | 0.004*** | 0.012 | -0.032 | 0.047* | 0.002** |
| | | (0.001) | (0.001) | (0.016) | (0.157) | (0.025) | (0.001) |
| 2005 | – | 0.063 | 0.013 | 0.073 | – | -0.224 | 0.113 |
| | | (0.104) | (0.136) | (0.126) | | (0.318) | (0.098) |
| Regional dummies | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional characteristics | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1541 | 1541 | 771 | 770 | 86 | 254 | 1201 |
| $R^2$ | 0.008 | 0.259 | 0.277 | 0.256 | 0.400 | 0.420 | 0.290 |
| F | 5 | 19 | 11 | 16 | 23 | 32 | 12 |
| p | 0.023 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: Standard errors are two-way clustered at the household and municipality level. Standard errors in parentheses. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

## Table A2: OLS Regressions of Time Effects of Crop Loss on Height-for-Age Z-scores – Farming Households only

| | All | | Girls | Boys | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Crop loss in t-1 | -0.124 | -0.125 | -0.027 | -0.244 | -0.116 | -0.855** | 0.043 |
| | (0.136) | (0.106) | (0.127) | (0.165) | (0.373) | (0.337) | (0.112) |
| Crop loss in t-2 | -0.628*** | -0.337** | -0.299** | -0.459** | 1.121 | -0.792** | -0.343*** |
| | (0.212) | (0.134) | (0.150) | (0.203) | (0.914) | (0.321) | (0.115) |
| Crop loss in t-3 | -0.382** | -0.134 | -0.163 | -0.105 | -0.021 | -0.473 | -0.094 |
| | (0.165) | (0.153) | (0.170) | (0.249) | (0.492) | (0.304) | (0.150) |
| Crop loss in t-4 | 0.197 | 0.149 | 0.321 | -0.137 | – | 0.107 | 0.048 |
| | (0.169) | (0.151) | (0.211) | (0.170) | | (0.335) | (0.146) |
| Crop loss in t-5 | -0.275 | -0.200 | -0.116 | -0.344 | – | -0.133 | -0.201 |
| | (0.392) | (0.341) | (0.401) | (0.317) | | (0.606) | (0.375) |
| Other characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional dummies | No | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1541 | 1541 | 771 | 770 | 86 | 254 | 1201 |
| $R^2$ | 0.018 | 0.261 | 0.282 | 0.258 | 0.427 | 0.433 | 0.294 |
| F | 2 | 19 | 11 | 14 | 25 | 33 | 12 |
| p | 0.045 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: Standard errors are two-way clustered at the household and municipality level. Standard errors in parentheses. *,** and *** denote significance level of 10%, 5% and 1%, respectively. include the same controls as in Table 3.

## Table A3: OLS and Heckman Selection (HM) Regressions of Overall Effect of Crop Loss on Height-for-Age Z-scores for Children in 2005

| | OLS | HM | OLS | HM | OLS | HM | OLS | HM |
|---|---|---|---|---|---|---|---|---|
| Crop loss | -0.626*** | -0.617*** | -0.359*** | -0.361*** | -0.419*** | -0.422*** | -0.345** | -0.360*** |
| | (0.211) | (0.215) | (0.123) | (0.122) | (0.147) | (0.147) | (0.139) | (0.135) |
| Female | – | – | -0.014 | -0.015 | – | – | – | – |
| | | | (0.072) | (0.072) | | | | |
| Indigenous | – | – | -0.181 | -0.181 | -0.149 | -0.152 | -0.149 | -0.125 |
| | | | (0.116) | (0.117) | (0.152) | (0.153) | (0.131) | (0.141) |
| HH size | – | – | -0.058** | -0.051** | -0.043 | -0.038 | -0.079*** | -0.054* |
| | | | (0.023) | (0.025) | (0.034) | (0.036) | (0.024) | (0.033) |
| Oportunidades | – | – | -0.002 | -0.002 | 0.004 | 0.004 | -0.011 | -0.011 |
| | | | (0.011) | (0.011) | (0.013) | (0.013) | (0.014) | (0.014) |
| Procampo | – | – | 0.013 | 0.014 | 0.008 | 0.008 | 0.022 | 0.024 |
| | | | (0.015) | (0.015) | (0.014) | (0.014) | (0.028) | (0.029) |
| Mother's ability | – | – | 0.301 | 0.298 | 0.154 | 0.154 | 0.385 | 0.368 |
| | | | (0.193) | (0.194) | (0.243) | (0.245) | (0.245) | (0.246) |
| Economic status | – | – | 0.004** | 0.004* | 0.004* | 0.004* | 0.005* | 0.004 |
| | | | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) |
| Remittances | – | – | 0.249*** | 0.249*** | 0.254*** | 0.254*** | 0.254 | 0.249 |
| | | | (0.028) | (0.028) | (0.019) | (0.019) | (0.275) | (0.281) |
| Regional dummies | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional characteristics | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1110 | 2107 | 1110 | 2107 | 570 | 1052 | 540 | 1055 |
| $R^2$ | 0.021 | | 0.181 | | 0.189 | | 0.192 | |
| F | 9 | | 17 | | 26 | | 7 | |
| p | 0.005 | | 0.000 | | 0.000 | | 0.000 | |

Note: Standard errors are clustered at municipality level. Standard errors in parentheses. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

Table A4: OLS Regressions and Heckman Selection (HM) of Time Effects of Crop Loss on Height-for-Age Z-scores for Children in 2005

| | OLS | HM | OLS | HM | OLS | HM | OLS | HM |
|---|---|---|---|---|---|---|---|---|
| Crop loss in t-1 | -0.641*** | -0.622*** | -0.201 | -0.202 | -0.246 | -0.253 | -0.174 | -0.175 |
| | (0.242) | (0.240) | (0.208) | (0.209) | (0.231) | (0.236) | (0.342) | (0.333) |
| Crop loss in t-2 | -1.614*** | -1.574*** | -1.495*** | -1.508*** | -2.029*** | -2.036*** | -1.066*** | -1.167*** |
| | (0.376) | (0.402) | (0.197) | (0.194) | (0.584) | (0.586) | (0.158) | (0.193) |
| Crop loss in t-3 | -1.114*** | -1.135*** | -0.498*** | -0.502*** | -0.103 | -0.106 | -0.725*** | -0.743*** |
| | (0.320) | (0.306) | (0.190) | (0.191) | (0.278) | (0.280) | (0.224) | (0.238) |
| Crop loss in t-4 | -0.228 | -0.196 | -0.190 | -0.193 | -0.140 | -0.139 | -0.218 | -0.228 |
| | (0.212) | (0.216) | (0.181) | (0.182) | (0.164) | (0.164) | (0.278) | (0.276) |
| Crop loss in t-5 | -0.585 | -0.592 | -0.225 | -0.228 | -0.332 | -0.334 | -0.174 | -0.194 |
| | (0.384) | (0.395) | (0.296) | (0.297) | (0.325) | (0.326) | (0.334) | (0.317) |
| Regional characteristics | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Other characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional dummies | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1110 | 2107 | 1110 | 2107 | 570 | 1052 | 540 | 1055 |
| $R^2$ | 0.030 | | 0.188 | | 0.204 | | 0.197 | |
| F | 10 | | 22 | | 78 | | 41 | |
| p | 0.000 | | 0.000 | | 0.000 | | 0.000 | |

Note: Standard errors are two-way clustered on individual and household level. Standard errors in parentheses. *,** and *** denote significance level of 10%, 5% and 1%, respectively. include the same controls as in Table 3.