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Migration, Economic Crisis and Child Growth in Rural Guatemala

Insights from the Great Recession

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Abstract

Migration has been demonstrated by various studies to be closely linked to improvements in individual- and household-level outcomes. Rather than examining the effects of migration, this paper explores whether an economic shock in United States negatively affected migrant households in rural Guatemala. Treating the Great Recession as a natural experiment affecting migrant and non-migrant households differently, the paper puts the spotlight on the effect on child anthropometry, including longer-term indicators of height-for-age z-scores. Panel data on children and multiple children in households enable double- and triple-difference estimation. In relative terms, migrant households fared far worse than non-migrant households over the period. In particular, large advantages in child anthropometric status for the youngest children in migrant households in 2008, just prior to the crisis, were substantially diminished four years later. The findings underscore the possible fragility of the benefits of migration, particularly in the face of a substantial economic shock, and point to the potential importance of deepening social safety nets.

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Migration, Economic Crisis and Child Growth in Rural Guatemala: Insights from the Great Recession

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1. Introduction

Migration and remittances have grown dramatically over the last few decades, contributing to economic growth and development. The recent COVID-19 pandemic has been a stark reminder of their importance by demonstrating the disruptive effects that a reduction in economic opportunities in migrant-receiving countries can have on poor households in migrant-sending countries (World Bank 2020a, 2020b). While the current pandemic is an extraordinary example of a health and economic crisis, other less extreme crises also can affect populations in migrant-sending countries, and with potentially long-lasting consequences.

One such example was the 2008 Great Recession, whose resulting economic crisis significantly disrupted trends. Job losses and lower migrant earnings led to large reductions in remittance flows to Latin America in particular. In 2008, remittances to the region totaled $65 billion and made up more than 10 percent of gross domestic product (GDP) in many countries (Mohapatra et al. 2010). During the latter part of 2008, however, flows began to slow, declining 11.8 percent to $57 billion in 2009 (World Bank 2013). Recovery was gradual, rebounding to only $62 billion by 2012, still below their 2008 peak (World Bank 2013). In Guatemala, the crisis resulted in a 9.3 percent decline in overall remittance inflows in 2009 (Funaro and Treadway 2012) alongside an overall slowing economy reflected by stagnant per capita growth between 2008 and 2011.[i]

In this paper we study the effects of the Great Recession beyond the borders of the United States. We examine child outcomes in a poor, rural and largely indigenous region of Guatemala where child undernutrition is severe, with nearly 60 percent of children stunted, and with substantial migration to the United States, remittances forming a substantial proportion of local incomes. High levels of remittances—commonly used for consumption expenditure support and investment, including in human capital (Adams and Cuecuecha 2010)—make Guatemala an important setting for examining such effects. Using household panel data collected in 2008 prior to the crisis and again in 2012, we treat the Great Recession as a natural experiment to assess the effect of a substantial economic shock in a migrant-receiving country on long-term indicators of child well-being in a migrant-sending country.

After quantitatively and qualitatively documenting significant decreases in migration and remittances in the study region consistent with the nature of the crisis that disproportionately affected the industries in which migrants from Guatemala typically worked (Kochhar 2009), we focus on child height-for-age Z-scores (HAZ), an important long-term indicator of human developmentparticularly vulnerable to shocks in early life (Almond and Currie 2010). Based on the intuition that migrant households were more directly exposed to the shock emanating from the United States, we estimate difference-in-difference (DD) models comparing relative changes for children under three years old in migrant versus non-migrant households over time. This is done separately for both same age cross-sectional cohorts and panel cohorts over the four years. Identification rests on the exogenous nature of the economic crisis from the perspective of Guatemalan households and the common trends assumptions for each type of comparison. In addition, for the panel cohort analysis we incorporate an additional difference, estimating a triple difference model using trends in HAZ for older cohorts who—based on the nutritional literature regarding child development—were less likely to have suffered from the shock and therefore plausibly capture prior differential trends in development between migrant and non-migrant children. As in many non-randomized DD analyses, we do not have prior data and are unable to conclusively demonstrate common trends. The likely violations of common trends, however, are conceptually ambiguous in their implications for the sign of bias in the DD estimates and we provide suggestive evidence that common trends do not appear to be strongly violated, including the result that estimated effects of the shock from the two types of analyses, each with different common trends assumptions, are similar.

In 2008, young children in households with migrants in the United States had far better nutritional status, with average HAZ scores about three-quarters of a standard deviation (SD) higher than their counterparts in households without migrants. From 2008 to 2012, however, as the economic crisis took its toll on industries and sectors employing migrants and remittances plummeted, children in migrant households lost substantial ground relative to children in non-migrant households. After four years the shock had erased as much as one-half of the apparent benefits of migration. Results are generally robust to inclusion of additional controls, variation in the exact age groups considered or definition of migration, and attrition.

Our research is at the intersection of literatures on migration and aggregate shocks. As the importance of migration for many low-income migrant-sending countries has grown, so has empirical evidence of its impacts on a wide variety of outcomes in both migrant-sending and receiving countries. At the individual and household level, this literature builds on Stark and Bloom's (1985) seminal work on the economics of labor migration, often emphasizing the benefits of diversifying livelihood strategies against local risk. Given the selective nature of who migrates, an underlying theme in much of the research is the rigorous estimation of the causal effects of migration (Hildebrandt and McKenzie 2005; Gibson et al. 2006; Yang 2008). For the sample we analyze, Carletto et al. (2011) find in 2008 that migration was associated with better child nutritional status, which they interpret as the effect of migration based on patterns of child growth and comparisons with older cohorts. In this paper we focus on a different, but related question, assessing the durability of possible prior migration benefits in the face of a significant shock that disproportionately affects migrant households.

Given that focus, research examining the effects of large aggregate (or covariate) negative shocks on household and child well-being is also relevant (Frankenberg et al. 2003; McKenzie 2003; Stillman and Thomas 2007; Yang 2008; Frankenberg et al. 2013, 2017). Aggregate shocks can have heterogeneous effects on households depending on the initial conditions and available coping mechanisms. At the national level, effects of aggregate shocks can also differ across countries depending on their income levels (Ferreira and Schady 2009). In addition, economic shocks in migrant-receiving countries can have important migration and remittance reducing consequences (McKenzie et al. 2014).[ii]

Research on the effects of aggregate shocks on child welfare indicate that in many settings child nutritional status outcomes are remarkably resilient in the medium term, likely reflecting a variety of coping mechanisms (Stillman and Thomas 2007; Ferreira and Schady 2009; Frankenberg et al. 2013, 2017). There is some evidence, however, that shocks may have larger and more persistent effects in lower income settings with high rates of malnutrition (Hoddinott and Kinsey 2001; Ferreira and Schady 2009; Akresh et al. 2011).

Our paper makes three contributions to these literatures. First, it provides new evidence on the geographic reach and global repercussions of an economic shock in a migrant-receiving country. Research on crises like the 2008 Great Recession often focus on direct effects in high-income economies and macroeconomic implications in the global economy. In contrast, indirect implications for subpopulations like the poor rural families in a migrant-sending country we examine are relatively understudied and less integrated in the discussion of the aggregate global effects of recessions. This can lead to incomplete understanding of the full impacts of a crisis, including some of the possible longer-term effects. Second, juxtaposed with other research examining the effects of aggregate shocks, our results illustrate conditions under which an aggregate shock can have large and persistent heterogeneous effects on a group of young children. The findings point to the possibility that effects may have been large and persistent in the specific study context because of its initial high levels of poverty and undernutrition. And third, the analysis highlights that gains from migration and remittances can be fragile. In Guatemala, this fragility may be related to the high cost of migration to the United States and insecure position of most migrants, hindering recovery from the shock.

2. Data

2.1 Household panel survey 2008–12 and qualitative data in context

The study is in the department of Huehuetenango, located in the Western Highlands along the Mexican border. Populated predominantly by indigenous Guatemalans, this remote, rural region is characterized by substantial outmigration and high levels of poverty and food insecurity (World Bank 2003, 2008). Based on the 2006 Guatemalan National Living Standards Survey (*Encuesta Nacional de Condiciones de Vida* or ENCOVI), 76 percent of the population in the Western Highlands was poor, compared to 51 percent nationwide. In 2008, household-level poverty in the study sample was 72 percent, and 40 percent of households had an international migrant, with more than one-third of them in the United States. A school census in 2008 indicated that although undernutrition had declined modestly since the prior 2001 census, 63 percent of children 6–10 years old in the Western Highlands were still stunted (HAZ < -2), compared to 46 percent nationally, among the highest in Latin America (*Ministerio de Educación* and SESAN 2008). Child undernutrition in the study region also was severe, with 60 percent of children under five years old stunted and 23 percent underweight (weight-for-age Zscore [WAZ] < -2). Overall, livelihood conditions in the study area were similar to those in rural areas elsewhere in Guatemala, Central America and Mexico, where households often turn to migration in the face of limited local economic opportunity.

We conducted a household panel survey in 2008 and 2012, beginning with a representative survey in areas purposively selected to reflect the geoclimatic heterogeneity of the region across four municipalities.[iii] In early 2008, a census in the selected areas generated a complete enumeration of approximately 5,500 households, including whether each household had former members (head, spouse of head or child) living abroad. Using the census, a random sample stratified on migration experience was drawn. Twenty-four households—evenly split between those with andwithout a former member currently living abroad—were randomly selected from each of 52 clusters,[iv] yielding a target sample of 1,248 households. Between April and August 2008, 1,222 households (97.9 percent) were interviewed.[v]

In April 2009, we coordinated a qualitative and short quantitative follow-up in one typical survey community from each of the four study municipalities to investigate the local effects of the economic crisis on migration, remittances and the livelihood patterns of households and their communities. Led by anthropologists, the study held seven focus groups with women drawn from the previously surveyed households and carried out 25 semi-structured interviews with conveniency sampled key informants and recently returned migrants. Focus group and semi-structured interview notes were coded and analyzed using WinMax (Kuckartz 1998; Saenz de Tejada 2009). In addition, a short quantitative survey updating information for original panel households was administered in the four communities.

From May to August 2012, a follow-up panel survey targeted all originally interviewed households. If only some of the original members of a 2008 household were located, all other members were classified as being in a split-off household (or households) and their current locations and other basic information collected. Split-off households that had moved anywhere within the four study municipalities were tracked for interviewing. Using this protocol, we followed181 split-off households, interviewing a total of 1,308 distinct households in 2012. At least one adult member from 1,127 (of the 1,222 originally surveyed households) was re-interviewed in 2012. Consequently, attrition at the household level over the four-year interval was 7.8 percent. In section 4.4.3, we document individual child-level attrition, which was higher, and consider its potential influence on the results.

Modeled on the comprehensive questionnaire used in the Guatemalan ENCOVI, the survey also incorporated a specially designed module (Section 2.2) to collect migration histories for all current household members, as well as residential location and other information for all adult children and siblings of the household head or spouse. In 2008, anthropometry was collected for children under six years old, and in 2012, the cut-off age was increased to ten in order to include all individuals measured in 2008. Enumerators used regularly standardized equipment to weigh and measure children. We then converted the measures into standardized HAZ, WAZ and weight- for-height (WHZ) z-scores, replacing flagged values with missing as recommended (WHO 2006;de Onis et al. 2007). Consequently, all anthropometric outcome measures examined are standardized and age-adjusted so that differences over time for the same individuals reflect changes in nutritional status rather than, for example, linear growth rates. We focus on HAZ as a long-term indicator but also examine the effect of the economic shock on WAZ and WHZ, which better capture current conditions and in combination with results for HAZ can be used to explorethe time patterns of effects. We also consider commonly used binary indicators for undernutrition, including stunting, underweight and wasting (WHZ < -2), to assess changes in the tails of the distributions and to understand whether any observed average changes also affect theworst-off children in the sample.

2.2 Measuring migration

At the individual level, researchers measure migration and define individuals as migrants in a number of ways, for example based on time spent away, destination location or links to those remaining behind (Smith and Thomas 2003). Correspondingly, there are even more ways to characterize migration at the household level and to define a "migrant household" (Carletto and de Brauw 2007). Since individuals can leave or return over time, the definition is further complicated when considering longer timeframes. For example, in recent decades there has been both short- and long-term international migration from the region, comprising short-term seasonal migration (e.g., for harvest season) to nearby Chiapas, Mexico and longer-term, though not necessarily permanent, migration to the United States.[vi] The latter migrants are typically undocumented and commonly spend several years away, with some returning for extended visits in between periods of migration (Saenz de Tejada 2009).

Researchers are often constrained in their characterizations of migration status by the limited information available in a general-purpose survey not explicitly designed with migration in mind and are therefore unable to represent well the various patterns. For this research, we piloted and then implemented comprehensive migration modules designed for the specific context. To identify both past and current migrants, we collected detailed migration histories for all current household members 15 years and older. We began with a standard household definition, including all the individuals who ate and slept in the same dwelling. We defined an individual as a household member if they had been present for at least one of the previous 12 months. Many household surveys such as the Guatemalan ENCOVI use a longer, more restrictive, three-month minimum residence period. The one-month period facilitated the inclusion of migrants who had made return visits in the past year, which is particularly common during the year-end holidays. The histories included the first and the most recent migration events for each of these current household members. This allowed us to incorporate individuals who were currently present but may have been migrants in the past, collecting information on their migration timing, location and occupations. Lastly, we also collected information on the migration events of heads, spouses oradult children who were not current household members.

3. Methodology

3.1 Defining migrant households

To examine the effect of the economic crisis on children, we draw on insights from the physiology of child development, which underscore that child growth is particularly vulnerable during the first 2–3 years of a child's life (Martorell 1997; UNICEF 1998). It is during this early life period when shocks are likely to have the greatest impact, particularly in comparison to older ages when childrenare less vulnerable. The child development literature emphasizes the importance of nutrition, sanitation and care during these early years. Young children have high nutritional requirements, in part because they are growing rapidly. The diets provided to them to complement breast milk in lower-income contexts like rural Guatemala, however, are typically monotonous and have low energy and nutrient density. As a result, multiple nutrient deficiencies are common. Moreover, young children are more susceptible to infections because their immune systems fail to protect them adequately, being developmentally immature and potentially compromised by poor nutrition. Foods and liquids are often contaminated, leading to infection, which both reduces appetite and increases metabolic demands. Finally, young children are fully dependent on others for care, including for their health care (UNICEF 1990).

Based on this literature, alongside the intuition that the economic shock from the Great Recession would affect migrant more than non-migrant households, we define migrant households for this analysis based on child age, highlighting whether a child lived in ahousehold with a migrant to the United States during their early, most vulnerable years. Specifically, a child under three years old measured in 2008 is defined to be in a migrant household if the household had a migrant to the United States (including the head, spouse of head or children of either as described above)[vii] in at least three of the four calendar years 2005–08, and not in a migrant household otherwise.[viii] This definition includes migrants who left prior to 2005 and remained away for at least three of the four years 2005–08.[ix] Since the baseline household survey was implemented from April to July of 2008, the four-year window covers the entire lifespanof any child under three years of age at the time of the baseline, including part or all of the in-utero period. Similarly, a child under three years old in 2012 is defined as living in a migrant household if the household had a migrant to the United States in at least three of the four calendar years 2009–12. For older children, living in a migrant household is defined in parallel fashion, i.e., based on having a migrant in the United States during the years corresponding to when the child was under three years old, adjusting the window based on exact age at measurement (see Appendix Figure 1).[x]

3.2 Cross-sectional cohort comparison model

Categorizing cohorts of children under three years old in 2008 or 2012 by migration status as defined in Section 3.1 results in four groups. These are used to set up a difference-in-difference (DD) analysis in which outcomes for children in migrant versus (comparison) non-migrant householdsin 2012, i.e., children for whom the economic shock occurred during early childhood, are contrasted with children in migrant versus non-migrant households in 2008, for whom the crisis occurred after they were measured.[xi] We posit that children in non-migrant households in 2012were less exposed to, and therefore would have been less affected by, the economic crisis, as their households did not have migrants living in the United States and hence were less directly linked to the United States economy. The simple DD specification is:

$$y_{ict} = \alpha_0 + \alpha_1 yr12_t + \alpha_2 m_i + \delta_{DD}(m_i \times yr12_t) + \varepsilon_{ict} \quad (1)$$

where y_{ict} is an age-adjusted and standardized outcome for child *i* in cluster *c* at time *t*; $yr12_t$ equals 1 in year *t*=2012 and 0 in *t*=2008; m_i equals 1 if the child lived in a migrant household when under three years old and 0 otherwise; and ε_{ict} is an assumed idiosyncratic error term. As it compares same-aged cohorts of children (all under three years old when measured), we refer to this model as the cross-sectional cohort comparison and individual children *i* appear only once, either in 2008 or 2012. δ_{DD} yields the DD estimate of the effect of the economic shock on the cohort of children in migrant households during the period in early childhood when they were most vulnerable. Identification of δ_{DD} as the causal effect of the economic crisis relies on the exogeneity of the shock (or no-correlated policies assumption) and the validity of the comparison group comprising children in the same age cohorts living in non-migrant households, i.e., the parallel or common trends assumption. We consider each of these assumptions in turn.

First, we argue it is reasonable to assume that the 2008 Great Recession and the ensuing economic downturn in the United States were exogenous from the perspective of rural Guatemalan households. Moreover, we find little evidence that the uptake of available social programs or other types of shocks are correlated with the economic crisis and no evidence that they differentially affected migrant versus non-migrant households. The questionnaire collected information on receipt of benefits from all social programs as well as on multiple-year retrospectivehousehold-level shocks experienced before each survey. We examined whether there were differences over time in exposure to important governmental and non-governmental social transfer or health programs, such as the national cash transfer program *Mi Familia Progresa*, which operated in three of the four municipalities. While health program services declined over the period, there were no significant or substantive exposure differentials between migrant and non-migrant households for health or other social assistance programs (Appendix

Table 1). Similarly, there were no differences in exposure to other types of shocks (illness, natural disastersor security shocks). Consequently, although our investigation is limited to data available in the survey, we find no evidence that the effects of programs or other shock events, at least, are likelyto introduce substantial bias in the estimates of the effect of the economic shock.

Also implicit in the exogeneity of the shock is that children in non-migrant households were unaffected (directly or indirectly) by the economic crisis itself. As the crisis had global repercussions, this assumption is unlikely to hold completely, but plausibly leads to underestimation of any negative effect of the shock on migrant households. There were almost certainly direct effects on non-migrant households related to the general downturn in the Guatemalan economy (with near zero growth in 2009) or diminished future migration possibilities for these households, as well as indirect effects operating through affected migrant households residing in the same communities. If migrant households experienced lower incomes as a direct result of the crisis (e.g., due to reduced remittances), this could translate into lower spending in the local economy, for example on local purchases or labor employment, which in turn could affect both migrant and non-migrant household neighbors. About 15 percent of households operated some form of non-agricultural business (three-quarters of which were small shops) and about 20 percent hired in labor for agriculture. While any such indirect effects on non-migrant households were probably heterogeneous in severity, it is reasonable to assume that few non-migrant households in these remote, agricultural communities relying predominantly on subsistence agriculture would have on net benefited from the crisis.[xii] Consistent with these possibilities, real total and per capita expenditures for non-migrant households of children under three years old declined by 15 percent between 2008 and 2012 (and by even more for migrant households). Moreover, the 2009 qualitative research pointed to negative spillover effects of the crisis on non-migrant households in the four communities studied (Section 4.2). Therefore, the direct and indirect channels of the crisis likely would have negatively affected non-migrant households as well, leading to attenuation of the DD estimates of the full effect of the crisis on migrant households alone.

The second principal assumption for identification relates to parallel or common trends, which for the cross-sectional cohorts are that in the absence of the economic shock, the age-adjusted nutritional status measures of children under three years old in migrant and non-migrant households would have trended similarly between 2008 and 2012. As in most non-randomized DD analyses, we are unable to conclusively demonstrate common trends.[xiii]

Extensive empirical and theoretical literatures make clear that migration is selective, however, and therefore both observable and unobservable differences between migrant and non-migrant households potentially threaten the common trends assumption. In Section 4.1, we document in this context that migrant households in 2008 are better off on a range of indicators of economic well-being and the nutritional status of their children under three is substantially higher. Although we do not directly assess the impact of migration (and remittances) on child nutritional status or other outcomes in this paper, previous literature suggests the migrant advantage is likely the combination of beneficial impacts of the migration as well as of selectivity—migrant households are different and some outcomes for their children might have been better even in the absence of migration (Mckenzie and Sasin 2007; Mckenzie et al. 2010; Carletto et al. 2011). This selectivity might lead to continued relatively higher outcomes for migrant households and their children, or even larger gaps over time. On the other hand, it is possible that broad based development improvements (for example in health and sanitation services in households and communities) might benefit children in non-migrant households relatively more over time so that they would (partially) catch up, particularly if non-migrant households have less access to private resources for services like health care. The catch-up possibility is consistent with the observed improvements in nutritional status documented over time between the 2001 and 2008 school censuses. If trends in nutritional status are relatively better for children in migrant households, the DD approach would attenuate any estimated negative effects of the economic shock (positive bias); if trends are relatively better for children in non-migrant households, it would overstate the absolute magnitude of the effects (negative bias).

Another reason trends might differ is that the type or selectivity of households that send migrants might change over time in ways associated with child nutritional status. The 2009 qualitative study revealed that the perceived cost-benefit calculations of migration were changing,so it is possible that the types of individuals and households newly undertaking or continuing migration were also changing (Section 4.2). We indirectly examined this possibility in two ways.First, we explored whether there were differences in fertility for migrant and non-migrant households over time using a DD framework. However, in contrast to the main analyses presented below, the interpretation of significant differences here is not that the economic shock necessarily caused these outcomes, but rather that the DD captures possible changingaverage characteristics of households with migrants in 2008 and 2012 that could reflect changes in selectivity. Using the sample of all households and a household-level version of equation (1), we observe that migrant households in 2008 had slightly fewer young children but had caught up by 2012 (Appendix Table 1). Second, we similarly compared selected characteristics (all measured in 2008) of migrant and non-migrant households with young children in 2012 versus those with young children in 2008. While there are average differences between migrant and non-migrant households, we find few significant or substantive DD estimates for several household measures including household size, poverty status and characteristics of the household head (Appendix Table 2). Together, the results suggest the types of households that had migrants and young children were relatively unchanged over the four-year period.

In summary, while possible direct and indirect effects of the economic shock on non-migrants point to positive bias, the influence of migration selectivity for common trends is less clear, and therefore theoretical arguments regarding net potential bias are ambiguous. The available suggestive evidence is consistent with the assumption of common trends for the cross-sectional cohort comparisons. Nevertheless, the concern remains that even in the absence of the economic shock, outcomes for children born into migrant households could have trended relatively poorly compared to those born into non-migrant households, leading to negative bias in the DD estimates and overstating the potential negative impacts of the shock. In section 3.3, we describe a complementary analytical approach examining the effect of the shock following a longitudinal cohort of children in the sample that relies on a different common trends assumption and permitsan additional strategy for assessing potential bias from non-parallel trends.

3.3 Panel cohort analyses

The cross-sectional cohort analysis described above examines the effect of the economic crisis on same-age cohorts of children under three years old at the time of measurement. With the four-year panel, however, it is also possible to explore the effect of the economic crisis following the same children over time, highlighting whether exposure to the shock in early childhood altered the developmental trajectories of individual children in migrant versus non- migrant households. As above, the approach is based on evidence that growth (and hence HAZ) is more vulnerable in early childhood. For this approach, we also begin with children under three years old in 2008, but instead of examining different children in 2012, we follow the same children to ages 4–7 years old. Nearly all children in this age range would have experienced theeconomic shock while still under three years old, except for the small portion just under three when first measured in 2008, who experienced it shortly after age three.

As with the cross-sectional cohort, the panel cohort approach allows categorization of observations into four groups by survey year and migration status. In contrast, after restricting to the balanced panel in this approach, each child *i* appears in both 2008 and 2012. With that modification, the simple DD estimating model is still represented by equation (1). As before, identification of δ_{DD} relies on the exogeneity of the shock and common trends or the validity of the comparison group, in this case children under three years old in 2008 living in non-migrant households who were also measured in 2012.

Children in migrant households in 2008 had better nutritional status than those in non-migrant households (Section 4.2), likely due to benefits from migration or migration selectivity. Therefore, it is possible that changes in outcomes for the two groups of children would also have had different trends, even in the absence of the crisis. For example, they would have different trends if migration (or migration selection) not only influences HAZ in 2008, but directly influences growth rates and therefore changes in HAZ subsequently. Since HAZ in 2008 is itself the cumulative effect of prior growth, a positive effect of migration on child growth is plausible. It is also possible that different trajectories would occur for the two groups, as on average they start (in 2008) at different levels of nutritional status. Evidence on the potential for catch-up growth (Mani 2012; Prentice et al. 2013; Frankenberg et al. 2013), for example, is consistent with growth being more positive from lower starting points (i.e., the non-migrants) and faltering for those at higher starting points (i.e., the migrants). Other recent evidence supports possible divergence, however, finding that better maternal health can increase child growth rates, even conditional on early life starting point measured by birthweight (Bevis and Villa 2020). This evidence complements an earlier literature examining the role of parental (in particular maternal) education on child growth (e.g., Thomas et al. 1991). These patterns raise the possibility that children in better-off or better-educated migrant households might grow more quickly than those in non-migrant households. Therefore, the net influence on child growth and consequently HAZ in the two groups is ambiguous.[xiv] As seen for the cross-sectional cohort, this could lead to negative or positive bias in the estimates of the DD effect of the shock on changes in child nutritional status.

To further explore the potential bias in the DD due to non-parallel trends between the young migrant and non-migrant children, we incorporate in the analysis the less vulnerable older cohort of children 3–6 years old, estimating a triple-difference specification (Duflo 2003; Nobles 2007). As with the younger cohort, we treat older cohorts as having lived in migrant or non-migrant households based on migration exposure of their households when they were under three years old (see Appendix Figure 1). By virtue of their older ages when the economic shock occurred, the cohorts of 3–6-year-olds measured in 2008 provide a measure of the trends in nutritional status over time for children less vulnerable to the shock in either household type.[xv] In that sense, since they are less likely to have been affected by the shock, they arguably capture trends in the age-adjusted nutritional status measures for children in migrant and non-migrant households that would have occurred in the absence of the shock. Importantly, although unadjusted child growth rates are more rapid for younger cohorts, it is plausible that changes in age-adjusted measures would be similar across the age cohorts within the migrant and non-migrant groups, respectively, even if different across migrants and non-migrants. In this specification, the identifying assumption no longer relies on common trends for the young cohort alone but controls for potential differential trends between migrant groups in the older cohorts.

The resulting triple-difference (DDD) specification for the panel cohort analysis is:

$$y_{it} = \alpha_0 + \alpha_1 yr12_t + \alpha_2 m_i + \delta_{DD}(m_i \times yr12_t) + \alpha_3 young_i + \alpha_4 yr12_t \times young_i + \alpha_5 m_i \times young_i + \delta_{DDD}(m_i \times yr12_t \times young_i) + \varepsilon_{it} \quad (2)$$

where $young_i$ is an indicator variable for whether the child was less than three years old in 2008. γ_{DD} in equation (2) captures the DD estimate for the older age group and γ_{DDD} represents the triple-difference, i.e., the difference between the DD estimator as described above for young children in equation (1), minus the DD estimator for older children.

3.4 Additional controls and final specifications

To increase power and control for other possible differences, we step in additional controls for both the cross-sectional and panel cohort analyses. These controls do not, however, directly address concerns about possible violations of common trends. In addition to using age-adjusted Z-scores, we control for possible differences in age composition of the samples (using age-in-month binary indicators). This is important because of patterns commonly seen in low-income settings experiencing ongoing deprivation such as average HAZ declining during the first 2–3 years of life before stabilizing (Victora et al. 2010). The binary age indicators also further control for potential differences in the trajectories of HAZ and the other indicators across the younger and older cohorts in the panel cohort analyses. For the cross-sectional analyses, we introduce cluster-level fixed effects to control for all time-invariant characteristics of the 52 clusters, including unobserved aspects of their health and sanitation environments that might be associated with child health; identification is then based on within-cluster comparisons of children. For the panel cohort analyses, we incorporate individual-level fixed effects (using the balanced panel), additionally controlling for any time-invariant characteristics of children and their households, for example unobservable fixed genetic differences or other time-invariant characteristics of their households including those associated with migration selectivity. Finally, for both types of analyses we include cluster-level time-variant effects (implemented as binary indicators for each cluster in 2012). These may be particularly relevant if over the four years communities experienced different changes in, for example, health services, sanitation services or food prices. They control for effects of the crisis that impact migrant and non-migrant children equallyin each community.

Finally, we examine the sensitivity of the specifications to alternative definitions for migrant households and alternative age cohorts of children. Additionally, for the cohort panel analyses, we provide an assessment of the potential effects of attrition, including reweighting for attrition (Section 4.4). All standard errors are estimated, allowing for clustering at the sample cluster levelin all models.

3.5 Assessment of mechanisms

There are many ways in which the economic shock arising from the Great Recession that influenced migration and remittances might have affected child anthropometrics in rural Guatemalan households. Three broad mechanisms include changes in nutrition, sanitation and care, including healthcare (UNICEF 1990). Although it was not feasible to carryout a complete assessment with the available data (at least in part because much of the information—such as food expenditure—is available only at the household and not the individual level), we use the same estimation framework to examine an array of household- and individual-level indicators related to the three mechanisms.[xvi] For household-level indicators, theDD approach relies on the same general exogeneity and common trends assumptions outlined above, but for individual-level indicators, the DDD is no longer justifiable based on greater vulnerability in early life. We therefore present only DD estimates for both types of outcomes and interpret them more as suggestive evidence regarding potential mechanisms rather than causal impacts.

4. Results

4.1 Migration and its correlates in 2008

International migration from the Western Highlands has been significant for decades, and therelative importance of migration to the United States grew substantially in the 21st century (Camus 2007; Saenz de Tejada 2009). Although nearly three-quarters of the overall household sample in 2008 was poor, migrant households were substantially better off than non-migrant households on many important dimensions (Carletto et al. 2011). Table 1a confirms that prior to the crisis, migration status is associated in the cross-section with higher well-being for the subset of households with children under three years old in 2008. While the vast majority is also poor (76 percent of migrant and 85 percent for non-migrant households), various expenditure measures were markedly higher for migrant households in 2008. For example, per capita expenditures were one-quarter higher, despite migrant households also having one additional member on average. This expenditure difference was concentrated in non-food expenditures, with per capita food expenditures similar across the two types of households. Despite that similarity, however, non-migrant households were substantially less likely to report adequate food expenditures or food security for children in the household, with only half of non-migrant households being food secure.[xvii] Household heads in migrant households were older, less likely to be male (reflecting higher male migration) and less educated, in a region with relatively low education compared to national levels. About half of the household heads report identifying as indigenous as opposed to *ladino* (mixed Spanish Amerindian) heritage. Unsurprisingly, migrant households were substantially more likely to receive remittances.

The better conditions in migrant households also were reflected in far better outcomes for their children, although there was substantial chronic undernutrition for both groups. In Table1b, we summarize average HAZ and other indicators of child nutritional status. HAZ and stunting reflect cumulative processes and are therefore often considered longer-term indicators of nutrition, while the other measures also reflect shorter-term or current conditions, in particular WHZ and wasting. Consistent with the chronic undernutrition measured in the school census described earlier, in 2008, more than half of children under three years old were stunted and nearly 20 percent underweight; prevalence of both conditions, however, was substantially higher for non-migrants. Wasting, an acute form of current undernutrition, was rare but still higher than would be expected in a healthy population. Notably, maternal education in migrant households was higher, with possible implications for present and future child health.

In summary, migrant households and their children were substantially better off on a number of dimensions, but even they experienced high levels of poverty and child undernutrition. The migration strategies utilized in this region evidently do not provide a full exit from poverty.

Table 1a. Average household statistics in 2008 by household migration status

	Overall average	Migrant average	Non-migrant average	Difference (migrant - non-migrant)
Total expenditures (Quetzales)	35161.01	47143.97	31314.63	15829.34 ***
	(30319.71)	(38190.96)	(26250.58)	(3925.61)
Per capita expenditures (Quetzales)	5074.35	6000.77	4776.98	1223.79 **
	(4069.83)	(4548.96)	(3864.32)	(495.26)
Per capita food expenditures (Quetzales)	2753.62	2641.30	2789.67	-148.37
	(2695.92)	(1790.15)	(2929.31)	(234.96)
Food share (food / total expenditures)	0.57	0.51	0.59	-0.07 ***
	(0.19)	(0.20)	(0.18)	(0.02)
Poor = 1	0.83	0.76	0.85	-0.10 **
	(0.37)	(0.43)	(0.35)	(0.04)
Extremely poor = 1	0.49	0.38	0.52	-0.14 **
	(0.50)	(0.49)	(0.50)	(0.06)
Reported their income adequate for necessities = 1	0.41	0.58	0.35	0.22 ***
	(0.49)	(0.50)	(0.48)	(0.05)
Reported their food expenditures sufficient = 1	0.46	0.63	0.41	0.21 ***
	(0.50)	(0.49)	(0.49)	(0.05)
Children < 6 years old food secure = 1	0.38	0.47	0.35	0.12 *
	(0.49)	(0.50)	(0.48)	(0.05)
Household size	7.47	8.41	7.17	1.24 ***
	(2.86)	(3.20)	(2.68)	(0.36)
Head is male = 1	0.82	0.67	0.87	-0.20 ***
	(0.38)	(0.47)	(0.33)	(0.05)
Head age (years)	41.29	49.23	38.75	10.48 ***
	(14.16)	(12.56)	(13.70)	(1.22)
Head education (grades)	2.12	1.65	2.27	-0.62 ***
	(2.25)	(1.77)	(2.36)	(0.22)
Head identifies as indigenous = 1	0.55	0.58	0.54	0.03
	(0.50)	(0.50)	(0.50)	(0.06)
Own more than 1 hectare land = 1	0.24	0.40	0.19	0.22
	(0.43)	(0.49)	(0.39)	(0.05)
Receives remittances = 1	0.27	0.84	0.08	0.75 ***
	(0.44)	(0.37)	(0.28)	(0.04)
Number of household observations (N)	428	104	324	428

Notes: Sample of households with a child under three years old in 2008. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08. Standard deviations in parentheses under average and standard errors estimated allowing for clustering at the sample cluster level in parentheses under difference. Exchange rate was 7.7 Quetzales to U.S. dollar in 2008. *** indicates significantly different at p<0.01, ** at p<0.05, and * at p<0.10.

Table 1b. Average individual statistics for children under three years old in 2008 by household migration status

	Overall average	Migrant average	Non-migrant average	Difference (migrant - non-migrant)
Age in months	17.89	17.08	18.14	-1.06
	(10.15)	(9.99)	(10.20)	(0.84)
Male = 1	0.51	0.50	0.52	-0.02
	(0.50)	(0.50)	(0.50)	(0.05)
HAZ	-2.17	-1.59	-2.35	0.76 ***
	(1.50)	(1.55)	(1.44)	(0.13)
Stunted (HAZ < -2) = 1	0.58	0.43	0.63	-0.20 ***
	(0.49)	(0.50)	(0.48)	(0.05)
WAZ	-1.08	-0.71	-1.19	0.49 ***
	(1.11)	(1.10)	(1.09)	(0.11)
Underweight (WAZ <-2) = 1	0.19	0.13	0.22	-0.09 ***
	(0.40)	(0.34)	(0.41)	(0.03)
WHZ	0.16	0.24	0.14	0.10
	(1.24)	(1.19)	(1.25)	(0.12)
Wasted (WHZ < -2)	0.04	0.04	0.04	0.00
	(0.20)	(0.20)	(0.20)	(0.02)
Father completed primary school = 1	0.12	0.15	0.12	0.03
	(0.33)	(0.35)	(0.32)	(0.04)
Mother completed primary school = 1	0.12	0.20	0.10	0.10 ***
	(0.32)	(0.40)	(0.30)	(0.03)
Father is coresident = 1	0.77	0.52	0.84	-0.32 ***
	(0.42)	(0.50)	(0.36)	(0.05)
N	518	123	395	518

Notes: Sample of children under three years old in 2008. Migrant household is defined as a household with at least one migrant to the U.S. in three of the four years 2005-08. Sample size is smaller (N=514 total) for WHZ and wasted due to flagged out-of-range values. Standard deviations in parentheses under average and standard errors estimated allowing for clustering at the sample cluster level in parentheses under difference. *** indicates significantly different at p<0.01, ** at p<0.05, and * at p<0.10.

4.2 The economic crisis and migration[xviii]

We argue the economic crisis caused by the Great Recession was transmitted to rural Guatemala primarily through its effects on migration and remittances, and consequently likely to affect migrant households more than non-migrant households. Undocumented immigration flows may be particularly sensitive to business cycles (Papademetriou and Terrazas 2009) and immigrants to the United States from Mexico and Central America were concentrated in industries (construction, landscaping and low-skill manufacturing) that experienced high unemployment during the crisis (Kochhar 2009). The mid-2009 qualitative and quantitative findings provide a snapshot taken near the height of the crisis and between the two main household survey rounds, and substantiate these channels—migration and remittances both decreased due to the crisis, withapparent local consequences in the study communities (Saenz de Tejada 2009).

Focus group discussions all spontaneously highlighted increased return migration and it was widely understood that the economy in the United States was in a downturn, with many migrants having become under- or unemployed. Correspondingly, most of the migrants who had returned did so because they could not find work, though a small fraction had been deported. The perceived cost-benefit calculations of migration were changing significantly due to decreased economic opportunity as well as increased travel cost and risk associated with the Mexican leg of the migration journey and stricter immigration law enforcement in the United States. One implication of the muted incentives for new migration to the United States was that shorter-term migration to Mexico became relatively more attractive for some, although devaluation of the Mexican peso and concerns about a “new disease” (influenza AH1N1) somewhat offset the relative advantages. Respondents to the short quantitative survey administered in the four communities overwhelmingly indicated they believed obtaining work in the United States had become much more difficult and that laws and attitudes toward immigrants hadworsened in the previous year.

Most, though not all, reported receiving lower remittances, as migrants experienced reductions in work hours. The few who did not see reductions in their remittances attributed it to the migrant having a more permanent presence in the United States such as legal status or a salaried position. For the others, as one focus group participant summarized: "They are making just enough to pay for their living expenses and cannot send money home." Similar to findings from other settings (Cox Edwards and Ureta 2003; Taylor and Mora 2006; Adams and Cuecuecha 2010), remittances typically support consumption and debt maintenance,[xix] but also some investment in both human and physical capital. Most remittance-receiving families had to readjust their spending patterns or, when possible, increase their own labor supply. Households maintained consumption of staple foods (maize and beans), however, and the adjustments centered on cutting back on so-called *lujos* or luxury purchases like clothing and shoes, as well as more expensive protein sources like meat, potentially reducing protein intakes and dietary diversity. Investment in home improvements stalled, but respondents indicated that education expenses were maintained.

For some, remittances enable investment in agriculture by overcoming capital or labor constraints, for example allowing households to purchase fertilizer or hire in labor during peak periods for households that predominantly rely on subsistence agriculture. For about half of all households, agricultural income comprised 90 percent or more of their income with dominant crops grown the local staples, maize and beans. Often negotiations with the migrant specifically earmarked remittances for these expenditures. With the crisis, this local spending and funds for wage labor were curtailed, and respondents reflected on reduced local labor demand and wages (down by about 15 percent) alongside increases in food prices.

Further qualitative semi-structured interviews in study municipalities in 2010—with two dozen respondents (including local leaders, members of households with a migrant and returned migrants themselves) identified through a snowball sampling method—complemented many of the patterns evident the year before and revealed that the local economy had not yet fully rebounded. Several respondents continued to report diminished remittances, often due to migrants having only part-time work. While migration continued, it was lower than in the past and additional migrants had returned to weakened local economic opportunities. Respondents underscored the potential costs of failed migration or early return for which the initial investment had not yet been recouped, leaving return migrants in substantial debt, usually to another family member or local money lender.

The quantitative household panel data between 2008 and 2012 confirm a drop in migration from the region, consistent with the timing reported in the 2009 qualitative study and demonstrating a slow recovery to previous levels. Figure 1 shows the fraction of households by year who had at least one international migrant in any location and at least one international migrant in the United States, calculated from the retrospective information on migration experiences of all household members described in Section 2.2. The fraction of households with a migrant in the United States rose steadily until 2008 when it dropped sharply, after which it remained fairlystable through 2012. Total international migration, however, began to recover somewhat with increases in migration to Mexico, consistent with the qualitative evidence on the changing relative advantages of that destination for which the upfront costs were substantially lower. Travel to nearby Chiapas was relatively easy and Guatemalans could enter legally, usually afterindicating the name of a farm in which they intended to work.

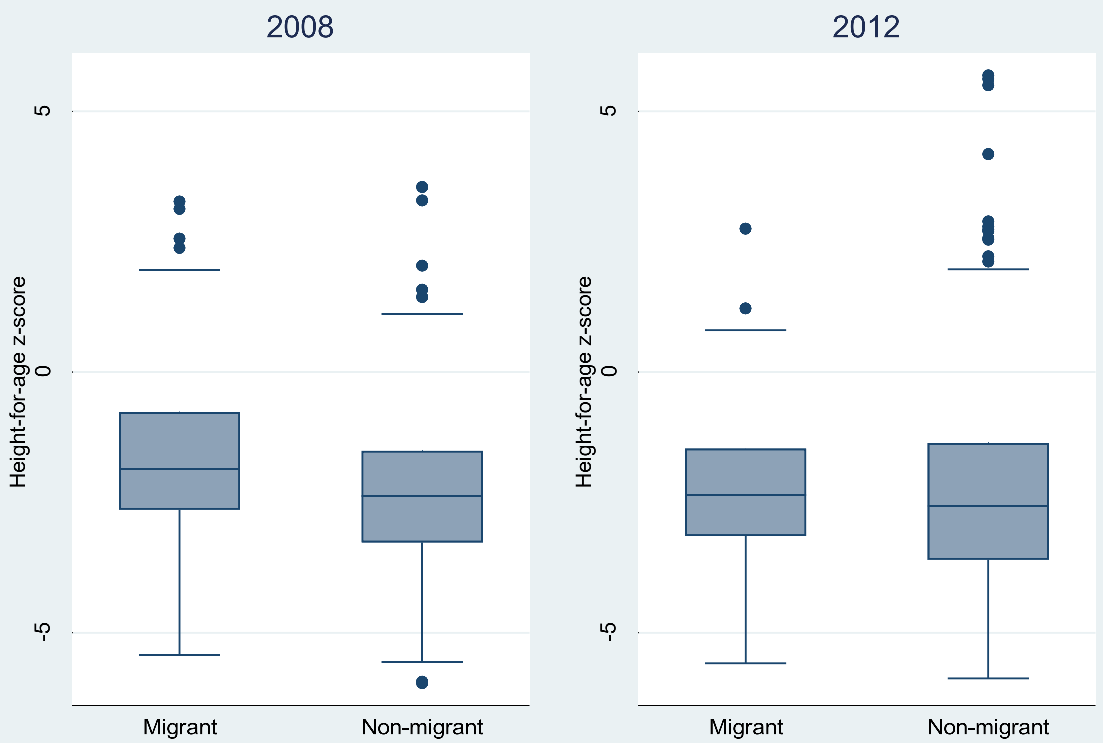
The panel survey data also confirm a reduction in remittances deeper than seen at the national level, possibly reflecting weaker permanency of the less educated migrants from this region, compared to other regions of Guatemala. The percent of all migrant households receiving any remittances in the past 12 months was 53 percent in 2012 (down from 82 percent in 2008) and total real remittances for the receiving households also declined slightly. Finally, the 2012 household survey indicates that while the percent of households hiring in labor was the same as in 2008, thewages paid had been reduced by about one-quarter, consistent with depressed local wages anddemand. Even after substantial recovery in the United States, these patterns suggest persistent economic effects of the crisis in Huehuetenango, where households pursuing migration strategies may have been less able to recover as quickly.

4.3 The economic crisis and child nutritional status

4.3.1 Cross-sectional cohort analysis

Before turning to the DD specifications, we visually examine HAZ for children under three years old in each survey round, by migrant household status. Whereas children in migrant households were substantially better off in 2008 (Figure 2, left panel), this was no longeras apparent in 2012 (right panel). The pattern foreshadows the principal results, indicating that the effect of the economic shock on child HAZ in migrant households was substantially negative.

Figure 2. Children under three years old (Cross-sectional cohort)



In Table 2, we present the full set of child anthropometric outcomes estimating the DD models for the cross-sectional cohort comparison for this age cohort based on equation (1). Examining the simple DD without controls, the first finding is that while on average children in the sample are undernourished, apart from WHZ and wasting which indicate there was little acute short-term undernutrition, children in migrant households had substantially better outcomes. Second, HAZ-related outcomes for the non-migrant children were fairly stable over time, while the shorter-term measures exhibited improvement in 2012 relative to 2008. This is consistent with the possibility of at least partial recovery or with improvements in generally available public services, for example, benefiting non-migrant children relatively more than migrant children. The DD estimates of the effect of the economic shock on children in migrant households indicate substantial deterioration for all three anthropometric measures but did not significantly increase the prevalence of stunting, underweight or wasting. Notably, the point estimates of the negative effect on both HAZ and WAZ are about one-half a standard deviation, significant despite their fairly wide confidence intervals [95% CI for HAZ: (-1.04, -0.13); for WAZ (-0.97, -0.25)]. Despite its size, however, the effect on HAZ still does not overcome the even larger advantage that children in migrant households had prior to the crisis. Stepping in the various controls described in Section 3.4 modestly changes point estimates, but the estimated effects on HAZ and WAZ in the cross-sectional cohort analyses remain large, a finding we return to below.

Table 2. Estimates of the effect of the crisis on child anthropometrics for children under three years old in migrant households: Cross-sectional cohort analysis

	HAZ	Stunted = 1	WAZ	Underweight = 1	WHZ	Wasted = 1
Simple DD without controls						
Migrant household = 1	0.761***	-0.197***	0.485***	-0.085**	0.104	-0.003
	(0.131)	(0.050)	(0.106)	(0.035)	(0.124)	(0.023)
Year 2012 = 1	-0.071	0.024	0.359***	-0.034	0.462***	-0.011
	(0.129)	(0.031)	(0.094)	(0.027)	(0.095)	(0.013)
DD	-0.587**	0.124	-0.610***	0.055	-0.308*	0.023
	(0.227)	(0.075)	(0.179)	(0.045)	(0.179)	(0.029)
Constant	-2.348***	0.628***	-1.195***	0.215***	0.138*	0.043***
	(0.092)	(0.030)	(0.056)	(0.019)	(0.079)	(0.010)
Cluster-level fixed effects DD with age controls						
DD	-0.497**	0.106	-0.559***	0.070	-0.299	0.022
	(0.224)	(0.069)	(0.181)	(0.047)	(0.180)	(0.029)
Cluster-level fixed effects DD with age controls and cluster-level time trends						
DD	-0.536**	0.109	-0.612***	0.070	-0.304	0.031
	(0.245)	(0.074)	(0.203)	(0.051)	(0.186)	(0.034)
N	1,133	1,133	1,121	1,121	1,106	1,106

Notes: Sample of children less than three years old in 2008 or 2012. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08 for 2008 or three of the four years 2009-12 for 2012. Age controls are binary indicators for age-in-months at measurement; cluster level time trends are binary indicators for each cluster in 2012. Standard errors estimated allowing for clustering at the community level in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

4.3.2 Panel cohort analysis

Next, we consider the panel cohorts. As with the cross-sectional cohorts, we examine the effect of the economic shock occurring during early childhood, but here we follow the cohort under three years old in 2008 (whose 2008 outcomes were also used in the cross-sectional analysis) to 2012, when they were approximately 4–7 years old. For these analyses, the commontrends assumption is that changes over time in age-adjusted nutritional status z-scores for individual migrant and non-migrant children would have been similar in the absence of the economic shock (Section 3.3). Figure 3 shows the distribution of HAZ scores for the panel cohorts over time.[xx] Similar to the cross-sectional cohorts, children in migrant households are substantially better off in 2008, but the difference was greatly diminished by 2012 (right panel).

Figure 3a. Children three years old in 2008 (panel cohort)

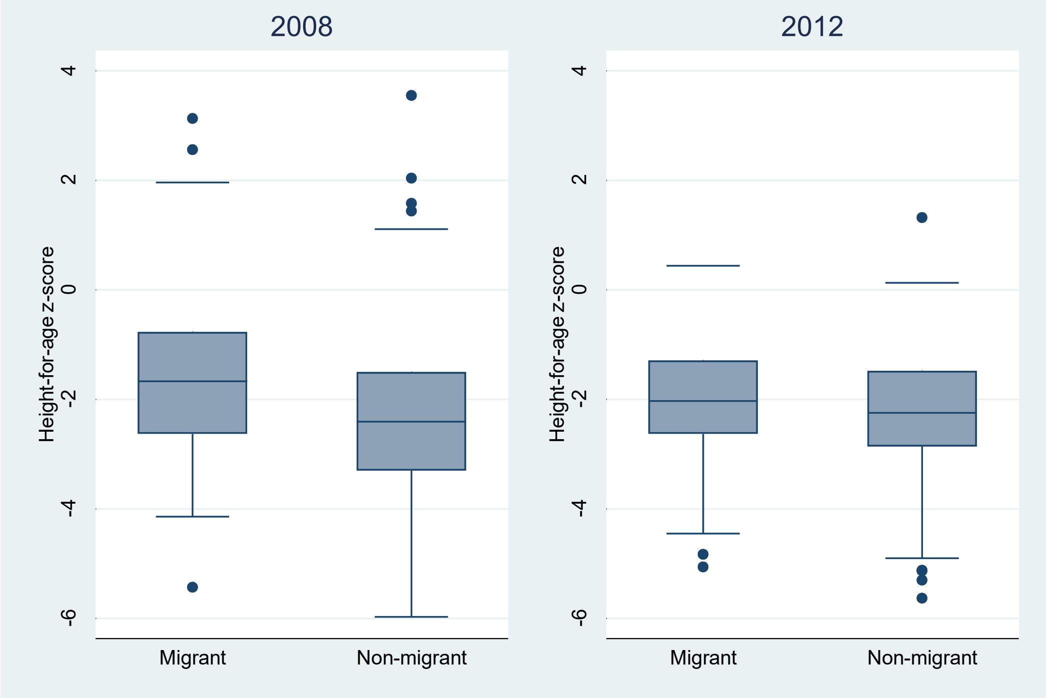
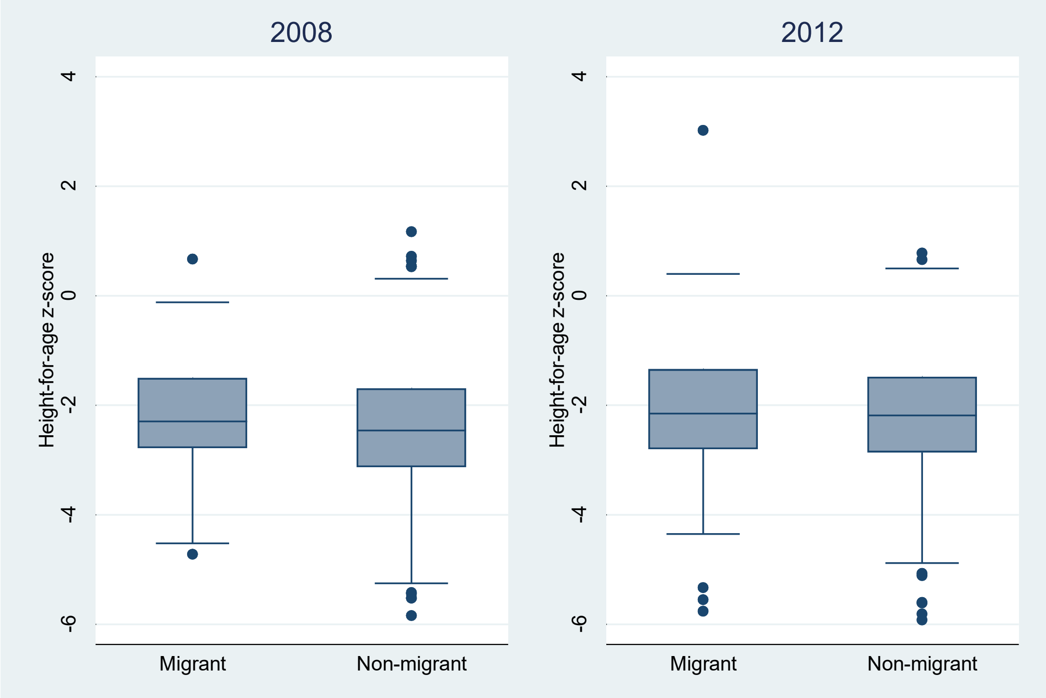


Figure 3b. Children three to six years old in 2008 (panel cohort)



Examining the simple DD without controls based on equation (1), there is no clear pattern for non-migrant children over time, with average HAZ improving slightly but WAZ declining more than 0.2 SD (Table 3, left side of Panel A). The DD estimates of the effect of the economic shock on children indicate a large reduction in HAZ (and corresponding increase in stunting) but smaller and insignificant effects on WAZ and underweight. As was the case for the cross-sectional analysis, the point estimate of the effect on HAZ is about half a standard deviation and significant[95% CI (-0.86, -0.23)]. Another similar finding is that despite its size, the effect on HAZ did not overcome the even larger advantage that children in migrant households had prior to the crisis; migrant children remained slightly better off on average.

Table 3. Estimates of the effect of the crisis on changes in child anthropometrics in migrant households, by child age in 2008: Panel cohort analysis

	Children under three years old in 2008				Children 3-6 years old in 2008			
	HAZ	Stunted	WAZ	Underweight	HAZ	Stunted	WAZ	Underweight
Panel A: Difference-in-difference (DD) models								
Simple DD without controls								
Migrant household = 1	0.775***	-0.227***	0.385**	-0.060	0.208	-0.020	0.030	-0.041
	(0.160)	(0.054)	(0.152)	(0.045)	(0.134)	(0.055)	(0.091)	(0.044)
Year 2012 = 1	0.111	-0.060	-0.225***	0.019	0.195**	-0.088***	-0.184***	0.108***
	(0.093)	(0.037)	(0.062)	(0.022)	(0.076)	(0.032)	(0.057)	(0.027)
DD	-0.548***	0.173***	-0.222	0.002	-0.121	0.021	0.010	0.043
	(0.158)	(0.062)	(0.161)	(0.053)	(0.149)	(0.060)	(0.104)	(0.045)
Constant	-2.357***	0.629***	-0.748***	0.218***	-2.407***	0.642***	-1.295***	0.192***
	(0.106)	(0.033)	(0.248)	(0.022)	(0.081)	(0.031)	(0.055)	(0.022)
Individual-level fixed effects DD with age controls								
DD	-0.414**	0.116*	-0.126	-0.017	-0.133	0.024	0.007	0.064
	(0.164)	(0.062)	(0.182)	(0.063)	(0.130)	(0.055)	(0.100)	(0.050)
Individual-level fixed effects DD with age controls and cluster-level time trends								
DD	-0.574***	0.187***	-0.301	0.012	-0.199	0.047	-0.099	0.069
	(0.181)	(0.064)	(0.192)	(0.074)	(0.147)	(0.071)	(0.108)	(0.051)
N	830	830	824	824	952	952	932	932
Panel B: Triple difference (DDD) models								
DDD without controls								
Migrant household = 1					0.208	-0.020	0.030	-0.041
					(0.134)	(0.056)	(0.091)	(0.044)
Year 2012 = 1					0.195**	-0.088***	-0.184***	0.108***
					(0.076)	(0.033)	(0.057)	(0.027)
DD					-0.121	0.021	0.010	0.043
					(0.149)	(0.061)	(0.104)	(0.045)
Young cohort (child < 36 mo) = 1					0.051	-0.014	0.151*	0.026
					(0.098)	(0.036)	(0.088)	(0.030)
Migrant * Young					0.567***	-0.207***	0.349**	-0.019
					(0.208)	(0.066)	(0.159)	(0.059)
Year 2012 * Young					-0.084	0.028	-0.041	-0.089**
					(0.117)	(0.044)	(0.068)	(0.035)
DDD					-0.427**	0.152*	-0.233	-0.041
					(0.206)	(0.081)	(0.205)	(0.065)
Constant					-2.407***	0.642***	-1.295***	0.192***
					(0.081)	(0.031)	(0.055)	(0.022)
Individual-level fixed effects DDD with age controls								
DDD					-0.338*	0.113	-0.178	-0.056
					(0.172)	(0.075)	(0.210)	(0.079)
Individual-level fixed effects DDD with age controls and cluster-level time trends								
DDD					-0.409**	0.140	-0.245	-0.021
					(0.186)	(0.086)	(0.212)	(0.082)
N					1782	1782	1756	1756

Notes: Samples include balanced panels of children with valid anthropometric measurements in each age group. Age controls are binary indicators for age-in-months at measurement; cluster-level time trends are binary indicators for each cluster in 2012. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08 for children under three years old in 2008 and three of the four years when children three to six years old in 2008. Standard errors estimated allowing for clustering at the community level in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

The pattern of findings of a more detrimental effect on the longer-term outcome measure of cumulative HAZ and stunting, alongside smaller effects on WAZ (which partly reflects long-terminfluences but is also influenced by current conditions), is consistent with our knowledge about the crisis. The Great Recession was deepest in 2009 and 2010, when the children were younger and potentially morevulnerable to the shock, leading to persistent effects on HAZ. Consequently, the pattern of results for nutritional status reflects the evolution of the crisis, strengthening the plausibility of the causal interpretation. Adding the controls, which for the panel cohort analyses also include individual-level fixed effects, changes point estimates to different degrees but does not substantively alter the conclusions.

Examination of the older panel cohort ages 3–6 in 2008, on the other hand, provides only minimal evidence of differences over time for migrant relative to non-migrant children (Figure 3b and Table 3, right side of panel A). As observed for the younger cohort, older children in migrant households are better off than non-migrant children in 2008, although the differences aremore modest and are not statistically significant without additional controls (P-value=0.12).[xxi] Moreover, average HAZ for non-migrant children improved significantly (0.2 SD) over the period. By virtue of their older age in 2008, this cohort would have been less vulnerable to the economic shock. In Section 3.3, we hypothesized that any differentials would possibly reflectdifferent trends in migrant versus non-migrant child development. The small negative DD effect on HAZ for the older cohort, albeit insignificant, points to the possibility that in the absence of the economic shock, outcomes for migrant and non-migrant children would have partly converged over time. This contrasts with a pattern in which children in migrant households would have on net had increasingly better outcomes for the age-adjusted measures over time and suggests instead that at least some catch-up may have been occurring.[xxii]

This possibility leads to our final specification estimating equation (2), shown in Panel B. Without additional controls, the DDD estimates follow immediately from the results in Panel A, indicating a slightly smaller but still substantial effect of the economic shock on HAZ, corresponding to a large 15 percentage point increase in the prevalence of stunting but no significant effects on WAZ or underweight. The introduction of controls slightly reduces the point estimates further, but they remain significant.

While the cross-sectional and panel approaches examine the effect of the economic crisis following different groups of children, the estimated effects tell a consistent story for the longer-term measure of nutritional status, with large negative effects on HAZ as well as large, but only marginally significant estimates for the prevalence of stunting. For WAZ, the cross-sectional approach that examines the younger cohort in 2012 is also negative and significant, about twice as large as for the panel cohort. As the comparison groups, and thus relevant common trends assumptions, differ for each approach, the similarity across the approaches for HAZ suggests that the results may not suffer from substantial bias stemming, for example, from non-parallel trends. This provides assurance that, while large, the estimated effects are not negatively biased.

Nevertheless, the SD effect sizes are larger than many reported in the literature, in particular for other studies of aggregate shocks, where in several cases there were no or only small significant persistent effects (Stillman and Thomas 2008; Ferreira and Schady 2009) even after substantial effects in the shorter-term (Frankenberg et al. 2013, 2017; Frankenberg and Thomas 2017).[xxiii] The magnitudes we estimate, however, are on par with other related work including Hoddinott and Kinsey (2001), who examined the effect of a substantial drought on child growth longitudinally in Zimbabwe and found reductions of 1.5–2 centimeters (0.5–0.66 SD) for children 12–24 months old, but minimal effects on older cohorts. The effects are also smaller than those estimated after crop failure and civil conflict in Rwanda, where Akresh et al. (2011) found impacts between -0.5 and -1.0 SD. Like Guatemala, these latter two settings are ones in which undernutrition is also highly prevalent, leading us to hypothesize that children in areas with more severe undernutrition may be more sensitive to large shocks, as they already beginat levels near stunting and likely have few physical reserves.

4.4 Sensitivity analyses and individual-level attrition

In this section, we consider the extent to which results shown in Tables 2 and 3 are robust to different specifications, including alternative definitions for migrant households and alternative age cohorts of children. Additionally, we provide an assessment of the potential effects of attrition for the cohort panel analyses.

4.4.1 Alternative definitions of migration

The definition of a migrant household was motivated by the patterns of migration and by the period of vulnerability in child growth to focus on children likely to have been influenced by the economic crisis. In this section, we examine two alternative definitions: 1) the household had a migrant to either the United States or Mexico in three of the four years when the child was under three years old; and 2) the household had a migrant to the United States in as few as one of the four years when the child was under three years old. Both alternatives likely capture reduced exposure, in the first case because the economic shock emanated from the United States (and there was evidence of migration shifting to Mexico) and in the second case because of a shorter potential exposure, which may be important as it often requires about a year to pay back migration-related travel debt. For both, however, there is some overlap with the primary definition.[xxiv]

Results in Appendix Tables 3a and 4a are largely consistent with expected changes resulting from reduced exposure. Estimated effects of the economic shock on households with migration to the United States or Mexico are smaller and slightly less significant, except for the effects on short- term WHZ, which were somewhat larger. Effects of the shock on households with migration in at least oneof the four years display a similar pattern.

4.4.2 Alternative age cohorts

The choice of age cohorts was motivated by the literature on nutrition, which points to definitive threshold cut-offs between vulnerable and not vulnerable periods in early childhood. In addition, accurate anthropometric measurement of the youngest children (under 6 months old) is often more difficult, particularly for height (or more accurately length, since children under two years old are measured lying down). To maximize power in the main analyses, we used the widest plausible age range. We also examined alternative age ranges for theyoung group (0–30, 6–30 and 6–36 months old), while continuing to define the older age group as 3–6 years for the panel cohort analyses. If exposure is more important earlier in life, then we might find even larger effects for analyses cut off at 30 months.

Results in Appendix Tables 3b and 4b indicate relatively modest differences from the main findings and are consistent with earlier exposure being more important. For the cross-sectional analyses, estimated DD effects on HAZ are larger for children under 30 months and modestly smaller for the age groups excluding those under six months old. Results for WAZ are similar to the main results, but effects for WHZ are larger when children under six months old are excluded.For the cohort panel, estimated DDD effects on HAZ are similar or larger in magnitude for groups under 30 months, and similar or modestly smaller when children under six months old areexcluded.

4.4.3 Attrition in the sample

While household level attrition was only 8 percent, attrition at the individual level for the age groups we analyze was substantially higher, treating as attrited both individuals entirely lost to follow-up as well as those without valid anthropometric measurements in 2012.[xxv] For children under three years old, attrition over the four years was 20 percent and for children 3–6 years old, it was 16 percent. For both age groups, however, the difference in attrition between the children of migrant and non-migrant households, which would be particularly concerning for the differential effects we examine,is less than two percentage points and insignificant.

To assess the possibility of attrition influencing the results, we examined the 2008 household and individual characteristics in Table 1 by attrition in 2012 (Appendix Tables 5a and 5b). Of the more than two dozen indicators, only a handful are statistically different. In addition, and possibly more importantly for our analyses, we examined whether differences for those who attrited versus those who did not were different between migrant and non-migrant households. Similarly, only a small number were statistically different and nearly all were modest in size.

Finally, for the cohort panel analysis, we constructed inverse probability weights (IPW) estimating the probability of re-survey in 2012, allowing weights to vary for each age cohort and migration status. In addition to an array of household and individual characteristics in 2008 summarized in the tables already presented, the prediction model incorporated indicators from the baseline survey likely to suggest stronger ties to the community and increase the chance of re-interview. These included additional household characteristics, as well as whether the household provided atelephone number, whether information on neighbors was collected, and whether household members were engaged in local social or other organizations. To account for collinearity between predictors, the baseline predictor set was limited by conducting stepwise selection of variables with backward elimination and using the adjusted R^2 as the information criterion; the methodology is described in the appendix. Results for IPW weighted DD and DDD estimates of the effect of the economic crisis on HAZ were marginally smaller than the main results, but mostremain remained significant at a 10 percent level (Appendix Table 6).

4.5 Potential mechanisms influencing child nutritional status

In this section, we consider potential mechanisms that may have influenced child outcomes, exploring several indicators related to: 1) food and nutrition availability and sanitation at the household level for the sample of households with young children in the cross-sectional cohort,as well as for all households to increase power (Table 4); and 2) care at the individual level for children in the cross-sectional cohort (Table 5).

Table 4. Estimates of the effect of the crisis on potential household-level mechanisms in migrant households

	Receives remittances = 1	Logarithm of total expenditures	Logarithm of per capita expenditures	Logarithm of per capita non-food expenditures	Logarithm of per capita food expenditures	Expenditure share on protein	Children <6 years old food secure = 1	Have improved toilet = 1	Have piped water = 1	Chimney to let out smoke = 1	Home improvement (walls, ceiling, floor) = 1
Panel A: Households with child in cross-sectional cohort analysis											
Migrant household = 1	0.76***	0.37***	0.22***	0.40***	0.04	0.02*	0.11**	0.17***	0.02	0.09*	0.02
	(0.04)	(0.08)	(0.08)	(0.10)	(0.08)	(0.01)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)
Year 2012 = 1	-0.06***	-0.15**	-0.14*	-0.30***	-0.10	-0.05***	-0.15***	0.07**	-0.05	0.10**	-0.05**
	(0.02)	(0.07)	(0.07)	(0.09)	(0.09)	(0.01)	(0.04)	(0.03)	(0.04)	(0.04)	(0.02)
DD	-0.37***	-0.21*	-0.09	-0.11	0.02	0.00	-0.03	-0.11	-0.06	-0.06	0.05
	(0.07)	(0.11)	(0.13)	(0.17)	(0.11)	(0.02)	(0.09)	(0.08)	(0.06)	(0.08)	(0.05)
Constant	0.08***	10.14***	8.24***	7.25***	7.65***	0.13***	0.36***	0.20***	0.81***	0.53***	0.11***
	(0.02)	(0.05)	(0.05)	(0.06)	(0.05)	(0.01)	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)
	963	963	963	963	962	961	963	963	963	963	963
Panel B: All households											
Migrant household = 1	0.72***	0.30***	0.35***	0.44***	0.23***	0.02***	0.20***	-0.03	0.02	0.05**	0.05**
	(0.02)	(0.05)	(0.06)	(0.08)	(0.04)	(0.01)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Year 2012 = 1	-0.08***	-0.15**	-0.15**	-0.38***	-0.07	-0.06***	-0.06**	-0.08***	-0.07**	-0.03*	-0.03*
	(0.01)	(0.06)	(0.06)	(0.07)	(0.07)	(0.01)	(0.03)	(0.02)	(0.03)	(0.01)	(0.01)
DD	-0.21***	-0.08	-0.14*	-0.08	-0.08	0.00	-0.11***	0.05	-0.01	0.02	0.02
	(0.04)	(0.06)	(0.08)	(0.10)	(0.07)	(0.01)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
Constant	0.10***	10.10***	8.39***	7.48***	7.71***	0.14***	0.55***	0.20***	0.81***	0.09***	0.09***
	(0.01)	(0.04)	(0.05)	(0.07)	(0.04)	(0.01)	(0.03)	(0.04)	(0.03)	(0.01)	(0.01)
	2,530	2529	2529	2529	2519	2422	2,530	2,530	2,530	2,530	2,530

Notes: Panel A includes sample of all households with one or more children under three years old in 2008 or 2012. Panel B includes all households. Standard errors estimated allowing for clustering at the sample cluster level in parentheses . *** indicates significantly different at p<0.01, ** at p<0.05, and * at p<0.10.

Table 5. Estimates of the effect of the crisis on potential individual-level mechanisms in migrant households

	Diarrhea last month = 1	Respiratory infection last month = 1	Has vaccine card = 1	Has any polio shots = 1	Has any DPT or Pentavalente shots = 1	Any individual health expenses last month = 1
All households						
Migrant household = 1	-0.001	-0.062	-0.023	0.028	0.023	-0.002
	(0.059)	(0.057)	(0.046)	(0.036)	(0.032)	(0.047)
Year 2012 = 1	0.015	-0.066*	0.131***	0.084***	0.073***	-0.109**
	(0.043)	(0.037)	(0.026)	(0.023)	(0.021)	(0.048)
DD	0.087	0.157*	-0.008	-0.006	-0.020	0.078
	(0.092)	(0.087)	(0.061)	(0.039)	(0.038)	(0.080)
Constant	0.435***	0.603***	0.814***	0.850***	0.869***	0.559***
	(0.028)	(0.030)	(0.025)	(0.024)	(0.020)	(0.032)
	985	985	947	939	956	985

Notes: Sample of all children under three years old at time of survey in 2008 or 2012 with valid information (cross-sectional cohorts). Standard errors estimated allowing for clustering at the sample cluster level in parentheses . *** indicates significantly different at p<0.01, ** at p<0.05, and * at p<0.10.

First, we document the decline in the probability of having received remittances in the 12 months prior to each survey. Remittance receipts declined modestly for both groups, but there wasa dramatic reduction of 37 percentage points for migrant households with a child (Panel A) and 21 percentage points for all households (Panel B). Correspondingly, real logarithmic total expenditures declined about 15 percent for both migrant and non-migrant households, with somewhat sharper declines among migrant households. Logarithmic per capita total, non-food and food expenditures also declined for both types of households, also with steeper (though not generally significantly different) reductions in migrant households for measures other than per capita food expenditures which were more similar prior to the crisis. Consistent with the qualitative findings (Section 4.2), reductions were sharper for non-food expenditures and there were significant declines over time in the share of food expenditures spent on high-protein source foods such as meat. Subjectively measured food security for children under six years old declined for all households, and much more significantly so for all migrant households. Together, the economic indicators related to food and nutrition availability point to deterioration for both migrant and non-migrant households, along with modestly larger estimatedDD declines for migrant households in several measures. Even for indicators for which there were substantial relativedeclines, however, migrant households were roughly even or continued to have a slight absolute advantage over non-migrant households in 2012.

Examination of the indicators of sanitation in the household also did not point to large significant DD effects. For the sample of households with children, there were some modest increases in sanitation not reflected in the overall household sample, where there were declines in the sanitation measures more consistent with the declines seen for expenditures.

DD estimates for child outcomes related to care also were generally insignificant, with small positive point estimates for the probability of diarrhea or respiratory infection in the last month but point estimates near zero for having a vaccine card or vaccination status. There was a general trend toward improved vaccination coverage in both groups, consistent with an improving public health care environment. Possibly reflecting the patterns for the reported illnesses requiring additional medical expenses, insignificant DD estimates on health expenditures are positive.

In summary, there is clear evidence of reductions in expenditures and food security for bothmigrant and non-migrant households, and some evidence of larger reductions for migrant households. The results, however, fail to pinpoint a single expenditure type or other channel through which the shock reduced child nutritional status more in migrant households, and we conclude the effects likely result from a combination of factors.

4.6 Policy implications

Remittances to households in low-income migrant-sending countries play an important role in their economies, and recipients spend them on both current consumption and investment. Migration strategies can serve as important forms of risk diversification, but at the same time open the door to shocks emanating from the migrant-receiving country. Whether the shock is a result of financial turmoil (and ensuing economic crisis) as in the 2008 Great Recession, climate-related disasters or the COVID-19 pandemic, migrants and their families in migrant-sending countries are exposed to the repercussions of such events, extending the potentially detrimental reach of the shock across borders. Since migrants represent only about 3 percent of the global population, widespread reductions in remittances alone are unlikely to lead to global meltdown. Nevertheless, implications for households relying on remittances can be consequential, forcing them to cut back on essential expenditures such as food, education or health, with potential long-termimplications for human capital and the perpetuation of poverty.

Countries heavily dependent on remittances such as Guatemala and its Central American neighbors must be prepared for such negative shocks. One possible policy approach comprises strengthening social assistance mechanisms to protect vulnerable households. This could include expanding the coverage of existing programs to households with migrants, even if these households are not necessarily among the poorest. Of course, wider safety nets have substantial fiscal implications. Emerging evidence from the COVID-19 pandemic, however, suggests that countries withstronger social assistance platforms in place were better positioned to quickly provide necessary relief (World Bank 2020b).[xxvi] In doing so, they likely more effectively mitigated the transmission of negative effects and limited longer-term consequences, including those on the human capital of the next generation that we found to have been significant after the 2008 Great Recession.

5. Conclusions

Research demonstrates that migration is closely linked to improvements in individual- and household-level well-being and children living in migrant households often have better human capital outcomes. In this paper, we examined whether an economic crisis emanating from the United States affected children in migrant households in a predominantly indigenous, rural region of Guatemala characterized by high outmigration, poverty and child undernutrition.The 2008 Great Recession had substantial negative effects on migrants living in the United States, but full assessment of the crisis must incorporate effects transmitted elsewhere.

Using difference-in-difference strategies with panel data and baseline measurement prior to the economic shock, we find that young Guatemalan children were negatively affected by the crisis. The large advantages seen in nutritional status for young children living in migrant households in 2008 were substantially diminished four years later. While there still may have been some benefits for children who avoided undernutrition at an earlier period in their development (e.g., related to cognitive development), many children were put back on the path to stunting, with potential longer-term effects.

We conclude that while gains from migration can be substantial, maintaining those gains in the face of a crisis disproportionately affecting migrants can be difficult. The evidence suggests the fragility of such gains and underscores the possibly tenuous nature of migration benefits, if households are unable to adequately protect against unexpected shocks in the migrant-receiving country. Moreover, the results illustrate another way in which the Great Recession hadsignificant global consequences beyond the borders of the United States, as well as how the geographic reach of economic shocks is exacerbated by migration.

Finally, the results provide potentially useful insights for the ongoing COVID-19 pandemic that, while also an unprecedented health crisis and with even more severe and widespread economic effects, has had many of the same consequences for migrants from low-income countries. Remittances to Latin America were expected to drop 20 percent, in part because migrants are concentrated in Italy, Spain and the United States where the economic fallout was greatest (World Bank 2020a) and because within those countries migrants are concentrated in some of the most heavily impacted industries (Borjas and Cassidy 2020). More recent evidence indicates that such large declines did occur in Guatemala, although they may have been only temporary (LópezCalva 2020). Where feasible, it may prove beneficial to strengthen social assistance mechanismsand expand them to the families of migrants who rely on remittances and are therefore typically less poor. This would likely mitigate the longer-term consequences of the COVID-19 pandemic, as well as other future severe and protracted calamities, whether caused by financial meltdowns, conflicts orpandemics.

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[i] Duryea and Morales (2011) and Inchauste and Stein (2013) provide additional evidence on economic conditions and consequences in Central America after the 2008 Great Recession.

[ii] There is also work that examines whether and how migration and remittances mitigate the risk fromvarious types of shocks (for example, Yang and Choi 2007).

[iii] For governmental planning, rural Guatemalan municipalities are subdivided into microregions determined by geoclimatic affinity and agricultural potential. From two larger municipalities, four such microregions (one of four in Jacaltenango and three of 13 in Cuilco) were selected, and in two smaller municipalities, one microregion each (San Gaspar Ixchil and Santa Ana Huista).

[iv] The census included 72 distinct villages, a number of which were combined into 52 clusters based on proximity prior to sampling. We report unweighted results; statistics using population weights based on the stratified sampling procedure differ only slightly from unadjusted statistics because the average share of households with a migrant in 2008 was 40 percent, similar to the 50-50 sampling split.

[v] Carletto et al. (2011) provide additional information on the Study of the Impact of Remittances and Migration on Food and Nutrition Security data.

[vi] Migration to Mexico from the region has a long history, beginning in the 1980s during the period of civil warwhich posed substantial risks for adult men (Camus 2007).

[vii] In about one-fifth of cases, the migrant is a parent (nearly always the father) of the young child; more often the migrant is anuncle or grandparent.

[viii] In the years leading up to 2008, migration from the region to Mexico was becoming relatively less important. For example, based on our definition, 20 percent of all sampled households in 2008 had a migrant to the United States, but only 11 percent had a migrant to Mexico (half of whom also had another migrant to the United States). We focus on migration to the United States, where the shock first emanated, but consider the role of migration to Mexico in Section 4.4.1.

[ix] It also includes about ten households (depending on the sample) where no single individual was away for three years, but the combination of migration events for different individuals spanned at least three years.

[x] As household member migration can change over time, it is possible, but rare, for different children within the same household to have had different exposures to migration as we define it. Five percent of children under six years old were categorized differently from a sibling in 2008 and 9 percent in 2012. In section 4.4.1, we consider alternative definitions for migration exposure to assess sensitivity.

[xi] Over 2002–08, there were no substantial deviations or shocks in Gross National Income (GNI) or consumer price inflation (CPI), with GNI averaging 4 percent and CPI about 8 percent. Both fell substantially in 2009, after which they slowly recovered to pre-crisis levels (World Bank 2021).

[xii] This is in contrast to other possible crises, for example, country-specific currency crises with dramatic relative price changes such as in Indonesia (Frankenberg et al. 2003) or the Philippines (Yang 2008), where specific subsetsof households benefited.

[xiii] As migration can have wide-ranging influences on households, without prior information we are unable to comprehensively assess common trends for migrant compared to non-migrant households, including for child anthropometric outcomes. One piece of evidence that is available, however, comes from subjective poverty questions asked in 2008, in which households were asked to place themselves on a six-step poverty ladder in 2008 and in the prior year. Both migrant and non-migrant households reported slight improvements, with 3 percent fewer households on the lowest two steps in 2008 compared to 2007, but no difference (0.2 percentage points) between migrant and non-migrant households.

[xiv] Other nonexperimental research provides evidence that catch-up growth at later ages (particularly in adolescence) is also possible (Foster 1995; Mani 2012; Prentice et al. 2013). The findings in Bevis and Villa (2020) contrast here as well, suggesting impacts of maternal health extending into adolescence. Since we examine children under six years old in 2008 (and thus under 10 in 2012), patterns of potential later adolescent catch-up would not influence the findings but could lead to modified conclusions in the longer term.

[xv] Children three years old or older in 2008 would be seven years old or older in 2012. While we measure children seven years old and older in 2012, we do not observe that age group in 2008, so cannot carry out a similar triple difference specification for the cross-sectional cohort analyses. All children 4–7 years old in 2012 were exposed to the shock in early childhood.

[xvi] As the child anthropometric analyses are reduced form and the variables examined in this assessment are potentially directly influenced by the shock, we do not directly condition on them in the models.

[xvii] We categorized households as food secure based on the Household Food Insecurity Access Scale (HFIAS), consisting of nine items and four frequency responses, using a 30-day recall period with reference to children under age six in the household (Coates et al. 2007). The widely used and validated scale was developed to reflect three universal domains of the experience of inadequate household-level food access: (1) anxiety about household food supply, (2) insufficient quality, which includes variety and preferences, and (3) insufficient quantity of food supply, the amount consumed, and the physical consequences of insufficiency.

[xviii] This subsection draws from Saenz de Tejada (2009).

[xix] This is particularly relevant in the period just after migration, to pay off debt incurred to undertake the journey(usually about $5,000), taking a year or more and likely an inflexible portion of household spending.

[xx] The left-side panels of Figures 2 and 3a differ slightly, as the latter is based only on the balanced panel sample of children.

[xxi] Controlling for age, however, the difference in 2008 is 0.30 (P-value=0.035).

[xxii] It is also consistent with the possibility that the shock influenced the older as well as the younger cohorts, and therefore leads to attenuation of the negative effects of the shock.

[xxiii] In the other direction, positive effect sizes of 0.5 SD are also considered to be substantial in carefully controlled settings examining feeding or other interventions (Panjwani and Heidkamp 2017). A systematic review of approximately 40 of the best complementary feeding interventions in developing countries indicated that children who received the interventions grew 0.0–0.64 SD by 12 to 24 months compared to control children (Dewey and Adu-Afarwuah 2008).

[xxiv] The first definition reclassifies 18 percent of children under three years old to living in migrant households and the second definition reclassifies 36 percent of children under three years old to living in non-migrant households.

[xxv] We categorize three deceased children as attrited.

[xxvi] For example, in early 2020 the World Bank approved a $14 billion Fast-Track COVID-19 Facilityto support the strengthening of safety nets, with projects being developed in dozens of low-income countries to protect the vulnerable populations most affected by the crisis. Expansion of networks has been more rapid and possibly effective in settings with pre-existing frameworks (World Bank 2020b).

Supplemental Appendix to:

Migration, Economic Crisis and Child Growth in Rural Guatemala: Insightsfrom the Great Recession

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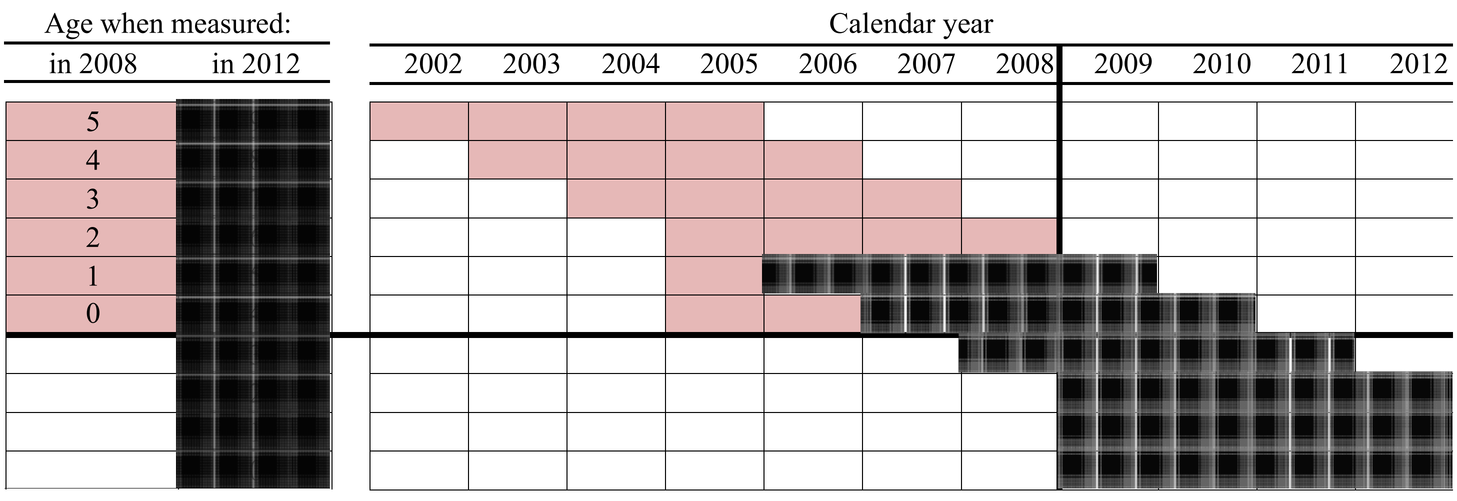
In this appendix, we present all appendix figures and tables referenced in the main text for onlinepublication. In addition, we provide a note on attrition weight construction.

Appendix Figure 1: Definition of household migration exposure in early life by age and survey year



Notes: Age 0 years equals 0 to <12 months old, age 1 year equals 12 to <24 months old, and so on. Children above the horizontal solid line were born by the 2008 survey. Shaded areas indicate the four-year periods considered for each child by age and survey (colored for 2008 measurement, dotted black for 2012 measurement). For measurements in 2008 the period includes all four calendar years 2005-08 for children less than three years old and for measurements in 2012 it includes all four years 2009-12 for children less than three years old. In the main definition used, a household was a migrant if there was a migrant to the United States for at least three of the four years. For older children (for example a four year old in 2008 who was eight in 2012) migration status is measured by whether the household had a migrant to the United States in three of the four years shaded during her early childhood (from 2003-06). For 0 and 1 year olds measured in 2008, the four calendar years included in the reference period differ depending on the survey year. However, in less than five percent of cases is there a difference in measured migration status depending on the measurement year for those children.

Appendix Table 1. Estimates of differences over time in social programs, household-level shocks and fertility by migrant status

	Social programs			Household shocks			Fertility		
	Received social assistance = 1	Value social assistance received (Quetzales)	Health program beneficiary = 1	Illness shock = 1	Natural disaster shock = 1	Security (crime or robbery) shock = 1	Number of children < 1 years old	Number of children < 2 years old	Number of children < 3 years old
Difference-in-difference (DD) model									
Migrant household = 1	-0.013	-23.302	0.030	0.022	0.022	0.006	-0.091***	-0.143***	-0.239***
	(0.012)	(16.047)	(0.027)	(0.017)	(0.033)	(0.016)	(0.022)	(0.031)	(0.037)
Year 2012 = 1	-0.012	0.600	-0.158***	-0.013	-0.012	-0.008	-0.032	-0.035	-0.046
	(0.011)	(18.959)	(0.034)	(0.016)	(0.039)	(0.015)	(0.020)	(0.031)	(0.037)
DD	-0.005	-0.344	-0.052	-0.010	-0.004	0.015	0.130***	0.192***	0.282***
	(0.017)	(19.550)	(0.032)	(0.027)	(0.053)	(0.025)	(0.033)	(0.059)	(0.068)
Constant	0.058***	34.913**	0.279***	0.103***	0.602***	0.080***	0.202***	0.370***	0.554***
	(0.011)	(16.066)	(0.032)	(0.015)	(0.036)	(0.013)	(0.018)	(0.027)	(0.032)
N	2,530	2,530	2,530	2,524	2,530	2,530	2,530	2,530	2,530

Notes: Sample includes all households. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08 for 2008 and three of the four years 2009-12 for 2012. Social assistance includes cash or in-kind transfers from government or non-governmental organizations. Health programs include child and maternal health programs. Shocks retrospectively measured for past five years in 2008 and past four years in 2012. Standard errors estimated allowing for clustering at the community level in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

Appendix Table 2. Estimates of differences over time in characteristics of households with a child under three years old by migrant status

	Household size	Poor = 1	Household head is Ladino = 1	Household head age (years)	Household head schooling (years)	Household head is male = 1
Difference-in-difference (DD) model						
Migrant household = 1	1.374***	-0.109**	-0.033	10.605***	-0.609***	-0.201***
	(0.433)	(0.047)	(0.057)	(1.238)	(0.218)	(0.050)
Year 2012 = 1	-0.321	-0.075***	-0.028	5.099***	-0.308**	-0.054*
	(0.246)	(0.025)	(0.037)	(0.783)	(0.147)	(0.029)
DD	-0.132	0.040	-0.034	-2.062	-0.091	0.124*
	(0.617)	(0.080)	(0.092)	(1.756)	(0.271)	(0.066)
Constant	7.456***	0.873***	0.456***	38.899***	2.210***	0.876***
	(0.176)	(0.023)	(0.061)	(0.751)	(0.175)	(0.018)
N	1,133	1,133	1,133	1,133	1,133	1,133

Notes: Sample of households with children less than three years old in 2008 (N=518) or 2012 (N=615), with multiple observations if multiple children. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08 for 2008 and three of the four years 2009-12 for 2012. Standard errors estimated allowing for clustering at the community level in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

Appendix Table 3a. Estimates of the effect of the crisis on child anthropometrics for children under three years old in migrant households: Cross-sectional cohort analysis for alternative migrant definitions

	HAZ	Stunted = 1	WAZ	Underweight = 1	WHZ	Wasted = 1
Panel A: Migration to United States or Mexico three of four years						
Simple DD without controls						
Migrant household = 1	0.477***	-0.124**	0.417***	-0.087**	0.226**	-0.013
	(0.136)	(0.046)	(0.101)	(0.035)	(0.106)	(0.020)
Year 2012 = 1	-0.098	0.030	0.373***	-0.046	0.489***	-0.013
	(0.136)	(0.032)	(0.098)	(0.029)	(0.100)	(0.013)
DD	-0.402*	0.086	-0.538***	0.087*	-0.329**	0.025
	(0.209)	(0.060)	(0.166)	(0.048)	(0.163)	(0.024)
Constant	-2.306***	0.617***	-1.200***	0.220***	0.097	0.047***
	(0.092)	(0.031)	(0.059)	(0.021)	(0.080)	(0.010)
Cluster-level fixed effects DD with age controls						
DD	-0.342	0.068	-0.512***	0.089*	-0.352*	0.027
	(0.223)	(0.058)	(0.183)	(0.052)	(0.178)	(0.025)
Cluster-level fixed effects DD with age controls and cluster-level time trends						
DD	-0.377	0.063	-0.568***	0.099	-0.375*	0.035
	(0.242)	(0.063)	(0.203)	(0.061)	(0.188)	(0.029)
N	1,133	1,133	1,121	1,121	1,106	1,106
Panel B: Migration to United States in at least one of four years						
Simple DD without controls						
Migrant household = 1	0.565***	-0.149***	0.421***	-0.093***	0.145	-0.026
	(0.120)	(0.044)	(0.105)	(0.032)	(0.118)	(0.018)
Year 2012 = 1	-0.119	0.034	0.394***	-0.054*	0.532***	-0.023*
	(0.128)	(0.034)	(0.099)	(0.028)	(0.108)	(0.014)
DD	-0.181	0.031	-0.497***	0.089**	-0.430**	0.053**
	(0.212)	(0.072)	(0.162)	(0.044)	(0.167)	(0.026)
Constant	-2.376***	0.636***	-1.235***	0.229***	0.109	0.052***
	(0.095)	(0.032)	(0.060)	(0.020)	(0.091)	(0.012)
Cluster-level fixed effects DD with age controls						
DD	-0.193	0.036	-0.447***	0.100**	-0.345*	0.051**
	(0.198)	(0.062)	(0.165)	(0.047)	(0.175)	(0.024)
Cluster-level fixed effects DD with age controls and cluster-level time trends						
DD	-0.215	0.029	-0.494**	0.103*	-0.368*	0.054*
	(0.209)	(0.068)	(0.188)	(0.053)	(0.191)	(0.029)
N	1,133	1,133	1,121	1,121	1,106	1,106

Notes: Sample of children of indicated ages in 2008 or 2012. Migrant household in Panel A is defined as a household with at least one migrant in the U.S. or Mexico in three of all four years 2005-08 for 2008 or three of all four years 2009-12 for 2012. Migrant household in Panel B is defined as a household with at least one migrant in the U.S. in at least one year from 2005-08 for 2008 or at least one year from 2009-12 for 2012. Age controls are binary indicators for age-in-months at measurement; cluster level time trends are binary indicators for each cluster in 2012. Standard errors estimated allowing for clustering at the community level in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

Appendix Table 3b. Estimates of the effect of the crisis on child anthropometrics for children by age in migrant households: Cross-sectional cohort analysis for alternative age groups

	HAZ	Stunted = 1	WAZ	Underweight = 1	WHZ	Wasted = 1
Panel A: Children under 30 months old						
Simple DD without controls						
Migrant household = 1	0.855***	-0.215***	0.520***	-0.086**	0.092	-0.015
	(0.148)	(0.052)	(0.114)	(0.035)	(0.130)	(0.025)
Year 2012 = 1	-0.034	0.023	0.360***	-0.024	0.423***	-0.018
	(0.149)	(0.036)	(0.108)	(0.027)	(0.099)	(0.015)
DD	-0.635**	0.113	-0.569***	0.021	-0.218	0.036
	(0.261)	(0.086)	(0.210)	(0.047)	(0.205)	(0.033)
Constant	-2.293***	0.612***	-1.148***	0.199***	0.143	0.053***
	(0.103)	(0.032)	(0.064)	(0.020)	(0.087)	(0.012)
Cluster-level fixed effects DD with age controls						
DD	-0.620**	0.126	-0.554**	0.045	-0.220	0.030
	(0.254)	(0.079)	(0.217)	(0.050)	(0.218)	(0.033)
Cluster-level fixed effects DD with age controls and cluster-level time trends						
DD	-0.611**	0.118	-0.592**	0.050	-0.241	0.044
	(0.285)	(0.086)	(0.243)	(0.055)	(0.230)	(0.036)
N	936	936	925	925	911	911
Panel B: Children 6-30 months old						
Simple DD without controls						
Migrant household = 1	0.755***	-0.197***	0.520***	-0.093**	0.156	-0.007
	(0.181)	(0.058)	(0.126)	(0.039)	(0.147)	(0.031)
Year 2012 = 1	-0.193	0.071*	0.335***	-0.039	0.578***	-0.032**
	(0.170)	(0.040)	(0.120)	(0.030)	(0.109)	(0.015)
DD	-0.425	0.074	-0.534**	0.014	-0.411*	0.032
	(0.304)	(0.094)	(0.208)	(0.049)	(0.220)	(0.036)
Constant	-2.449***	0.655***	-1.278***	0.225***	0.016	0.055***
	(0.110)	(0.032)	(0.068)	(0.022)	(0.090)	(0.013)
Cluster-level fixed effects DD with age controls						
DD	-0.440	0.094	-0.598**	0.050	-0.522**	0.032
	(0.320)	(0.089)	(0.231)	(0.054)	(0.230)	(0.037)
Cluster-level fixed effects DD with age controls and cluster-level time trends						
DD	-0.380	0.092	-0.632**	0.057	-0.571**	0.052
	(0.360)	(0.098)	(0.253)	(0.061)	(0.247)	(0.044)
N	754	754	746	746	741	741
Panel C: Children 6-36 months old						
Simple DD without controls						
Migrant household = 1	0.647***	-0.175***	0.470***	-0.089**	0.155	0.006
	(0.158)	(0.056)	(0.116)	(0.038)	(0.134)	(0.027)
Year 2012 = 1	-0.202	0.061*	0.341***	-0.048	0.592***	-0.021*
	(0.142)	(0.033)	(0.104)	(0.029)	(0.101)	(0.012)
DD	-0.401	0.094	-0.587***	0.057	-0.477***	0.018
	(0.255)	(0.080)	(0.175)	(0.046)	(0.178)	(0.032)
Constant	-2.482***	0.665***	-1.306***	0.239***	0.036	0.044***
	(0.097)	(0.030)	(0.058)	(0.021)	(0.077)	(0.010)
Cluster-level fixed effects DD with age controls						
DD	-0.307	0.068	-0.574***	0.075	-0.541***	0.019
	(0.268)	(0.076)	(0.186)	(0.051)	(0.182)	(0.032)
Cluster-level fixed effects DD with age controls and cluster-level time trends						
DD	-0.312	0.073	-0.619***	0.076	-0.551***	0.023
	(0.293)	(0.084)	(0.204)	(0.054)	(0.189)	(0.038)
N	951	951	942	942	936	936

Notes: Sample of children of indicated ages in 2008 or 2012. Migrant household is defined as household with at least one migrant in U.S. in three of the four years 2005-08 for 2008 or three of the four years 2009-12 for 2012. Age controls are binary indicators for age-in-months at measurement; cluster level time trends are binary indicators for each cluster in 2012. Standard errors estimated allowing for clustering in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

Appendix Table 4a. Estimates of the effect of the crisis on changes in child anthropometrics for children under three years old in migrant households by migration definition: Panel cohort analysis

	Migration to U.S. or Mexico three of four years				Migration to U.S. at least one year			
	HAZ	Stunted	WAZ	Underweight	HAZ	Stunted	WAZ	Underweight
Panel A: Difference-in-difference (DD) models								
DD without controls								
Migrant household = 1	0.493***	-0.141**	0.299**	-0.051	0.600***	-0.182***	0.395***	-0.090**
	(0.166)	(0.054)	(0.127)	(0.046)	(0.143)	(0.049)	(0.127)	(0.041)
Year 2012 = 1	0.085	-0.054	-0.236***	0.017	0.086	-0.057	-0.200***	0.019
	(0.095)	(0.038)	(0.064)	(0.023)	(0.105)	(0.040)	(0.071)	(0.023)
DD	-0.366***	0.122**	-0.146	0.010	-0.282**	0.103**	-0.209	0.001
	(0.134)	(0.057)	(0.151)	(0.052)	(0.129)	(0.050)	(0.144)	(0.052)
Constant	-2.313***	0.615***	-1.140***	0.218***	-2.395***	0.643***	-1.201***	0.237***
	(0.107)	(0.034)	(0.069)	(0.024)	(0.108)	(0.035)	(0.070)	(0.023)
Individual fixed effects DD with age controls								
DD	-0.247*	0.078	-0.081	-0.005	-0.180	0.046	-0.127	0.001
	(0.139)	(0.056)	(0.170)	(0.062)	(0.148)	(0.052)	(0.167)	(0.059)
Individual fixed effects DD with age controls and cluster-level time trends								
DD	-0.370**	0.133**	-0.224	0.023	-0.209	0.076	-0.214	0.030
	(0.164)	(0.062)	(0.190)	(0.076)	(0.147)	(0.062)	(0.167)	(0.063)
N	830	830	824	824	830	830	824	824
Panel B: Triple difference (DDD) models comparing with children 36-72 months old using same migration definition								
DDD without controls								
DDD	-0.332*	0.123	-0.216	0.009	-0.378**	0.186***	-0.262*	-0.002
	(0.181)	(0.074)	(0.200)	(0.064)	(0.165)	(0.066)	(0.145)	(0.061)
Individual fixed effects DDD with age controls								
DDD	-0.288*	0.104	-0.183	0.008	-0.308	0.148**	-0.240	-0.013
	(0.166)	(0.074)	(0.212)	(0.079)	(0.192)	(0.073)	(0.165)	(0.072)
Individual fixed effects DDD with age controls and cluster-level time trends								
DDD	-0.336*	0.117	-0.246	0.040	-0.379**	0.158*	-0.335*	0.029
	(0.188)	(0.090)	(0.214)	(0.082)	(0.188)	(0.084)	(0.174)	(0.074)
N	1782	1782	1756	1756	1782	1782	1756	1756

Notes: Samples include balanced panels of all children with valid anthropometric measurements in each age group. Results based on children under three years old in 2008 in Panel A and under six years old in 2008 in Panel B. Age controls are binary indicators for age-in-months at measurement; cluster level time trends are binary indicators for each cluster in 2012. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08 for children under three years old in 2008 and three of the four years for children three to six years old in 2008. Standard errors estimated allowing for clustering at the community level in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

Appendix Table 4b. Estimates of the effect of the crisis on changes in child anthropometrics in migrant households, by child age in 2008: Panel cohort analysis for alternative age groups

	Children under 30 months old in 2008				Children 6 to 30 months old in 2008				Children 6 to 36 months old in 2008			
	HAZ	Stunted	WAZ	Underweight	HAZ	Stunted	WAZ	Underweight	HAZ	Stunted	WAZ	Underweight
Panel A: Difference-in-difference (DD) models												
DD without controls												
Migrant household = 1	0.867***	-0.248***	0.424***	-0.074*	0.970***	-0.230***	0.478***	-0.085*	0.737***	-0.204***	0.408***	-0.065
	(0.190)	(0.059)	(0.145)	(0.043)	(0.190)	(0.060)	(0.157)	(0.046)	(0.175)	(0.057)	(0.149)	(0.049)
Year 2012 = 1	0.057	-0.046	-0.231***	0.008	-0.165	-0.095**	-0.116*	-0.014	0.258***	-0.102***	-0.132**	0.004
	(0.113)	(0.040)	(0.066)	(0.024)	(0.581)	(0.042)	(0.069)	(0.026)	(0.095)	(0.037)	(0.062)	(0.024)
DD	-0.664***	0.199***	-0.306*	0.053	-0.838***	0.182**	-0.376**	0.072	-0.524***	0.151**	-0.260	0.009
	(0.184)	(0.072)	(0.167)	(0.057)	(0.195)	(0.076)	(0.185)	(0.066)	(0.175)	(0.067)	(0.180)	(0.062)
Constant	-2.280***	0.601***	-1.096***	0.206***	-2.632***	0.650***	-1.228***	0.232***	-2.498***	0.673***	-1.257***	0.240***
	(0.123)	(0.036)	(0.077)	(0.024)	(0.538)	(0.036)	(0.083)	(0.026)	(0.103)	(0.033)	(0.070)	(0.024)
Individual fixed effects DD with age controls												
DD	-0.551***	0.152**	-0.258	0.035	-0.666***	0.164**	-0.352*	0.053	-0.487**	0.120*	-0.183	-0.011
	(0.176)	(0.067)	(0.186)	(0.065)	(0.201)	(0.067)	(0.208)	(0.071)	(0.194)	(0.066)	(0.204)	(0.070)
Individual fixed effects DD with age controls and cluster-level time trends												
DD	-0.716***	0.216***	-0.414**	0.113*	-0.914***	0.259***	-0.571**	0.141*	-0.661***	0.201**	-0.392*	0.017
	(0.183)	(0.071)	(0.202)	(0.067)	(0.247)	(0.074)	(0.238)	(0.079)	(0.239)	(0.078)	(0.220)	(0.083)
N	696	696	690	690	578	578	576	576	712	712	710	710
Panel B: Triple difference (DDD) models comparing with children 36-72 months old as in Table 3												
DDD without controls												
DDD	-0.544**	0.177*	-0.317	0.009	-0.557**	0.161*	-0.386*	0.029	-0.403*	0.130	-0.270	-0.034
	(0.229)	(0.089)	(0.207)	(0.067)	(0.239)	(0.094)	(0.226)	(0.075)	(0.220)	(0.086)	(0.223)	(0.074)
Individual fixed effects DDD with age controls												
DDD	-0.489***	0.151*	-0.312	-0.004	-0.581***	0.179**	-0.389	0.017	-0.389*	0.132	-0.218	-0.048
	(0.176)	(0.079)	(0.217)	(0.082)	(0.214)	(0.087)	(0.242)	(0.085)	(0.212)	(0.084)	(0.235)	(0.083)
Individual fixed effects DDD with age controls and cluster-level time trends												
DDD	-0.519**	0.159*	-0.336	0.028	-0.612**	0.197*	-0.418*	0.045	-0.461*	0.168*	-0.291	-0.016
	(0.194)	(0.090)	(0.220)	(0.084)	(0.241)	(0.099)	(0.246)	(0.092)	(0.234)	(0.098)	(0.237)	(0.089)
N	1648	1648	1622	1622	1530	1530	1508	1508	1664	1664	1642	1642

Notes: Samples include balanced panels of all children with valid anthropometric measurements in each age group. Age controls are binary indicators for age-in-months at measurement; cluster level time trends are binary indicators for each cluster in 2012. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08 for children under three years old in 2008 and three of the four years for children three to six years old in 2008. Standard errors estimated allowing for clustering at the community level in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

Appendix Table 5a. Average household statistics in 2008 by attrition

	Overall average	Nonattrited average	Attrited average	Difference (Nonattrited - attrited)	Difference-in-difference (DD) migration & attrition
Total expenditures (Quetzales)	35161.01	34196.60	38996.24	-4799.64	-4868.20
	(30319.71)	(28867.70)	(35443.61)	(4514.09)	(11412.73)
Per capita expenditures (Quetzales)	5074.35	4966.82	5501.96	-535.14	-304.64
	(4069.83)	(4053.67)	(4129.60)	(627.37)	(1032.10)
Per capita food expenditures (Quetzales)	2753.62	2680.57	3044.12	-363.56	-556.99
	(2695.92)	(2719.36)	(2595.67)	(300.99)	(678.92)
Food share (food / total expenditures)	0.57	0.57	0.57	0.00	-0.07
	(0.19)	(0.19)	(0.19)	(0.02)	(0.05)
Poor = 1	0.83	0.85	0.78	0.07	0.11
	(0.37)	(0.36)	(0.42)	(0.06)	(0.11)
Extremely poor = 1	0.49	0.50	0.44	0.06	-0.04
	(0.50)	(0.50)	(0.50)	(0.05)	(0.15)
Reported their income adequate necessities = 1	0.41	0.42	0.37	0.05	0.01
	(0.49)	(0.49)	(0.49)	(0.07)	(0.14)
Reported their food expenditures sufficient = 1	0.46	0.47	0.44	0.03	0.04
	(0.50)	(0.50)	(0.50)	(0.07)	(0.15)
Children < 6 years old food secure = 1	0.38	0.41	0.27	0.14 **	-0.08
	(0.49)	(0.49)	(0.45)	(0.06)	(0.11)
Household size	7.47	7.45	7.56	-0.11	0.71
	(2.86)	(2.83)	(2.98)	(0.36)	(0.93)
Head is male = 1	0.82	0.83	0.79	0.04	0.15
	(0.38)	(0.37)	(0.41)	(0.04)	(0.14)
Head age (years)	41.29	40.62	43.97	-3.34	3.96
	(14.16)	(13.57)	(16.10)	(2.05)	(3.97)
Head education (grades)	2.12	2.17	1.93	0.24	0.39
	(2.25)	(2.27)	(2.16)	(0.27)	(0.48)
Head identifies as indigenous = 1	0.55	0.55	0.55	0.01	0.02
	(0.50)	(0.50)	(0.50)	(0.06)	(0.12)
Own more than 1 hectare land = 1	0.24	0.26	0.16	0.10 **	0.19 *
	(0.43)	(0.44)	(0.37)	(0.04)	(0.11)
Receives remittances = 1	0.27	0.25	0.31	-0.06	0.01
	(0.44)	(0.44)	(0.47)	(0.05)	(0.11)
Number of household observations (N)	428	342	86	428	428

Notes: Sample of households with a child under three years old in 2008. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08. Nonattrited indicates child in the household has valid measurement in 2012. Standard deviations in parentheses under average and standard errors estimated allowing for clustering at the sample cluster level in parentheses under difference and difference-in-difference (DD). The DD shows averages for (nonattrited migrant - attrited migrant) - (nonattrited non-migrant - attrited non-migrant). Exchange rate was 7.7 Quetzales to U.S. dollar in 2008. *** indicates significantly different at p<0.01, ** at p<0.05, and * at p<0.10.

Appendix Table 5b. Average individual statistics for children under three years old in 2008 by attrition

	Overall average	Nonattrited average	Attrited average	Difference (Nonattrited - attrited)	Difference-in-difference (DD) migration & attrition
Age in months	17.89	18.38	15.92	2.46 ***	0.69
	(10.15)	(10.19)	(9.80)	(0.88)	(2.30)
Male = 1	0.51	0.49	0.61	-0.12 **	-0.03
	(0.50)	(0.50)	(0.49)	(0.06)	(0.12)
HAZ	-2.17	-2.18	-2.13	-0.04	-0.07
	(1.50)	(1.50)	(1.50)	(0.19)	(0.36)
Stunted (HAZ < -2) = 1	0.58	0.58	0.60	-0.03	0.14
	(0.49)	(0.49)	(0.49)	(0.06)	(0.13)
WAZ	-1.08	-1.06	-1.17	0.11	0.52 *
	(1.11)	(1.12)	(1.07)	(0.13)	(0.30)
Underweight (WAZ <-2) = 1	0.19	0.20	0.17	0.04	-0.11
	(0.40)	(0.40)	(0.37)	(0.04)	(0.09)
WHZ [N=514]	0.16	0.18	0.09	0.10	0.76 **
	(1.24)	(1.25)	(1.19)	(0.13)	(0.29)
Wasted (WHZ < -2) [N=514]	0.04	0.05	0.02	0.03	-0.03
	(0.20)	(0.22)	(0.14)	(0.02)	(0.03)
Father completed primary school = 1	0.12	0.12	0.14	-0.02	0.12
	(0.33)	(0.33)	(0.34)	(0.05)	(0.09)
Mother completed primary school = 1	0.12	0.11	0.15	-0.03	0.02
	(0.32)	(0.32)	(0.35)	(0.04)	(0.11)
Father is coresident = 1	0.77	0.78	0.73	0.05	-0.11
	(0.42)	(0.42)	(0.45)	(0.05)	(0.13)
N	518	415	103	518	518

Notes: Sample of children under three years old in 2008. Migrant household is defined as a household with at least one migrant to the U.S. in three of the four years 2005-08. Nonattrited indicates child has valid measurement in 2012. Standard deviations in parentheses under average and standard errors estimated allowing for clustering at the sample cluster level in parentheses under difference and difference-in-difference (DD) . The DD shows averages for (nonattrited migrant - attrited migrant) - (nonattrited non-migrant - attrited non-migrant). *** indicates significantly different at p<0.01, ** at p<0.05, and * at p<0.10.

Appendix Table 6. Estimates of the effect of the crisis on changes in child anthropometrics in migrant households, by child age in 2008: Panel cohort analysis weighted for attrition

	Children under three years old in 2008				Children 3-6 years old in 2008			
	HAZ	Stunted	WAZ	Underweight	HAZ	Stunted	WAZ	Underweight
Panel A: Difference-in-difference (DD) models								
Simple DD without controls								
Migrant household = 1	0.723***	-0.206***	0.373***	-0.085	0.227	-0.033	0.016	-0.036
	(0.164)	(0.057)	(0.136)	(0.054)	(0.147)	(0.058)	(0.094)	(0.047)
Year 2012 = 1	0.098	-0.063	-0.221***	0.021	0.195**	-0.088***	-0.188***	0.104***
	(0.096)	(0.038)	(0.066)	(0.043)	(0.075)	(0.032)	(0.056)	(0.027)
DD	-0.479***	0.161**	-0.189	-0.018	-0.117	0.030	0.034	0.038
	(0.156)	(0.065)	(0.166)	(0.058)	(0.156)	(0.061)	(0.105)	(0.048)
Constant	-2.339***	0.628***	-1.132***	0.227***	-2.405***	0.640***	-1.291***	0.191***
	(0.109)	(0.033)	(0.067)	(0.028)	(0.082)	(0.032)	(0.055)	(0.022)
Individual-level fixed effects DD with age controls								
DD	-0.361**	0.103	-0.095	-0.029	-0.140	0.030	0.016	0.062
	(0.157)	(0.062)	(0.184)	(0.064)	(0.129)	(0.054)	(0.099)	(0.048)
Individual-level fixed effects DD with age controls and cluster-level time trends								
DD	-0.524***	0.176***	-0.276	0.025	-0.192	0.049	-0.075	0.068
	(0.168)	(0.062)	(0.192)	(0.072)	(0.146)	(0.069)	(0.105)	(0.049)
N	830	830	824	824	952	952	932	932
Panel B: Triple difference (DDD) models								
DDD without controls								
Migrant household = 1					0.227	-0.033	0.016	-0.036
					(0.147)	(0.058)	(0.094)	(0.047)
Year 2012 = 1					0.195**	-0.088***	-0.188***	0.104***
					(0.075)	(0.032)	(0.056)	(0.027)
DD					-0.117	0.030	0.034	0.038
					(0.156)	(0.061)	(0.106)	(0.048)
Young cohort (child < 36 mo) = 1					0.066	-0.012	0.159*	0.022
					(0.101)	(0.037)	(0.088)	(0.030)
Migrant * Young					0.496**	-0.173**	0.356**	-0.040
					(0.222)	(0.071)	(0.164)	(0.059)
Year 2012 * Young					-0.096	0.025	-0.033	-0.086**
					(0.120)	(0.047)	(0.074)	(0.036)
DDD					-0.363*	0.131	-0.223	-0.024
					(0.214)	(0.085)	(0.206)	(0.067)
Constant					-2.405***	0.640***	-1.291***	0.191***
					(0.082)	(0.032)	(0.055)	(0.022)
Individual-level fixed effects DDD with age controls								
DDD					-0.257	0.092	-0.148	0.278
					(0.161)	(0.073)	(0.208)	(0.245)
Individual-level fixed effects DDD with age controls and cluster-level time trends								
DDD					-0.327*	0.118	-0.224	0.687
					(0.172)	(0.085)	(0.209)	(0.472)
N					1782	1782	1756	1756

Notes: Samples include balanced panels of children with valid anthropometric measurements in each age group. Age controls are binary indicators for age-in-months at measurement; cluster level time trends are binary indicators for each cluster in 2012. Migrant household is defined as a household with at least one migrant in the U.S. in three of the four years 2005-08 for children under three years old in 2008 and three of the four years when children three to six years old in 2008. All observations weighted for attrition using inverse probability weights constructed from models predicting re-survey as described in Appendix Note. Standard errors estimated allowing for clustering at the community level in parentheses. *** indicates significance at p<0.01, ** at p<0.05, and * at p<0.10.

Note on attrition weight construction

We calculated inverse probability weights (IPW) separately for the four groups used in the panel cohort analyses, i.e., children under or over three years old in migrant or non-migrant households, using anapproach similar to Molina Millán and Macours (2017). First, we constructed approximately 40 indicators based on the 2008 survey. In addition to the variables in Tables 1a, 1b, 4 and Appendix Table 1, these included further measures of household characteristics (electricity, dirt floor, block walls, metal roof andhome ownership), whether household members were in religious or other (e.g., sports) community groups, and measures that could facilitate recontact, including whether the household address, phone number or a neighbor's name/address had been fully completed. Second, we ran bivariate regressions on an indicator of being interviewed in 2012 for each variable (separately for each age cohort-migration status sample). We retained for potential inclusion in the weight construction all variables significant at10% in any model. Third, we estimated the probability of re-interview in 2012 with this set of baseline predictors for each age cohort-migration sample to calculate separate weights for each group. To accountfor collinearity between predictors, the baseline predictor set was further limited by conducting stepwise selection of variables with backward elimination and using the adjusted R^2 as the information criteria.

Controls for a quadratic of age, municipality fixed effects and an indicator for male child were fixed in the regressions. At each step, the iterative procedure removes from the model the predictor that most improves the information criterion until there is no variable whose removal improves it. We implemented this using 'vselect' in Stata (Lindsey and Sheather 2010). Fourth, using the final model for each subsample, we predicted for each observation the probability of having been re-interviewed and constructed the IPW. Sample weights ranged from 0.78 to 5.56 (25th percentile 1.10, 50th 1.21, 75th 1.36).

References:

Lindsey, C. and S. Sheather. (2010). "Variable selection in linear regression." *The Stata Journal*, 10(4): 650–669.

Molina Millán, T. and K. Macours. 2017. "Attrition in Randomized Control Trials: Using Tracking Information to Correct Bias." *CEPR Discussion Paper No. DP11962*