A Study of the Impact of a Natural Disaster on Economic Behavior

and Human Capital Across the Life Course

by

Nicholas Shane Ingwersen

Public Policy Studies
Duke University

Date:_______________________
Approved:

____
Elizabeth Frankenberg, Supervisor

____
Duncan Thomas

____
Amar Hamoudi

____
Erica Field

____
Marcos Rangel

Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor
of Philosophy in Public Policy Studies
in the Graduate School
of Duke University

2015

ABSTRACT

A Study of the Impact of a Natural Disaster on Economic Behavior

and Human Capital Across the Life Course

by

Nicholas Shane Ingwersen

Public Policy Studies
Duke University

Date:_______________________
Approved:

____
Elizabeth Frankenberg, Supervisor

____
Duncan Thomas

____
Amar Hamoudi

____
Erica Field

____
Marcos Rangel

An abstract of a dissertation submitted in partial
fulfillment of the requirements for the degree
of Doctor of Philosophy in Public Policy Studies
in the Graduate School of
Duke University

2015

Abstract

How households and individuals respond to adverse and unanticipated shocks is an important concern for both economists and policy makers. This is especially true in developing countries where poverty, weak infrastructure, and a lack of social safety nets often exacerbate the effects of adverse shocks on household welfare. My research addresses these issues in the context of three economic outcomes and behaviors – early life health and the accumulation of human capital, willingness to take on financial risk, and behavior in the labor market. The results of this research project add to our understanding of how life experiences shape individual behavior and how policy can help individuals achieve long-term improvements in the lives following adverse events.

This project focuses on households and individuals affected by a large-scale natural disaster, the 2004 Indian Ocean tsunami. I utilize data from the Study of the Tsunami Aftermath and Recovery (STAR), a unique longitudinal survey of individuals and households living in coastal communities in Aceh and North Sumatra, Indonesia, at the time of the tsunami. The STAR surveys were conducted annually for five years after the disaster and include a wide range of demographic, economic, and health measures.

In the first chapter, Child Height after a Natural Disaster, co-authored with Elizabeth Frankenberg, Duncan Thomas, and Jed Friedman, we investigate the immediate and long-run impacts on child health of in utero exposure to stress induced

by the tsunami. We investigate whether in utero and postnatal shocks affected the growth of children born in the aftermath of the tsunami in the critical first five years of their lives. Although previous studies suggest that in utero exposure to stress and nutrition shocks are related to a number of adverse birth outcomes such as prematurity and lower birth weight, there is little evidence of the impact on linear growth, a strong correlate of later life income. We find evidence that children born 4-6 months after the tsunami experienced reduced growth in the first two years of their lives, with larger growth reductions for more intense exposures. We also find evidence that growth reductions largely disappear by age five. This suggests that significant catch-up growth is possible, particularly in the context of pronounced post-disaster reconstruction and economic rehabilitation.

In the second chapter, The Impact of a Natural Disaster on Observed Risk Aversion, I investigate the short and long-term impacts of the 2004 Indian Ocean tsunami on attitudes toward risk. Attitudes toward risk are important determinants of economic, demographic, and health-related behaviors, but how these attitudes evolve after an event like a natural disaster remains unclear because past research has been confounded by issues of selective exposure, mortality, and migration. My study is the first to directly address these problems by utilizing exogenous variation in exposure to a disruptive event in a sample of individuals that is representative of the population as it existed at the time of the event. In addition, intensive efforts were made to track migrants in the sample population, which is important for this study because migration is common following events like natural disasters and is likely related to attitudes toward risk. I find that physical exposure to the tsunami (e.g., seeing or hearing the tsunami or being caught up in the tsunami) causes significant short-term decreases in observed aversion to risk, especially for the poor, but few longer-term differences. This finding has important implications for the design of effective post-disaster assistance policies. In particular, it implies that post-disaster assistance programs should include aid that is consistent with the observed risk attitudes of the survivors such as job training and capital to start-up businesses.

In the last chapter, Labor Market Outcomes following the 2004 Indian Ocean Tsunami, I investigate how labor market outcomes changed in coastal communities in Aceh and North Sumatra following the tsunami and the post-disaster recovery efforts. Although restoring the livelihoods of survivors of adverse events is critical for their long-term recovery, there is little evidence from developing countries of how labor market outcomes change after such events. Using the STAR data, I find significant and persistent increases in paid employment rates for younger women living in urban communities and increases in retirement for older adults. These changes occur both in communities that were heavily damaged by the tsunami and those that were not, suggesting that disasters may have long-lasting impacts on livelihoods that extend beyond the communities that were directly exposed to the disasters.

Contents

List of Tables

List of Figures

Acknowledgements

This work has benefited enormously from the input of my advisor, Elizabeth Frankenberg, the members of dissertation committee, Duncan Thomas, Amar Hamoudi, Erica Field, and Marcos Rangel, as well as Ryan Brown, Michael Burrows, Gabriela Farfán, Peter Katz, Maria Marta Laurito, Veronica Montalva, Gina Turrini, Andrea Velasquez, John Maluccio, and participants of the Sanford Seminar Series at Duke University; the International Population, Health, and Development Applied Microeconomics Workshop at Duke University; the Sanford Student Graduate Research Workshop at Duke University; the Duke Population Research Institute Demography of Aging Trainee Workshop at Duke University; the 2012 Population Association of America Conference; and the 2013 North East Universities Development Consortium Conference. The project was supported by the National Institute for Child Health and Human Development (R01HD052762, R01HD051970, R03HD071131), the National Institute on Aging (R01AG031266), the National Science Foundation (CMS-0527763), the Fogarty International Center (TW007699), the Hewlett Foundation, the World Bank, the MacArthur Foundation (05-85158-000), and the National Institute on Aging and Duke University Population Research Institute T32 Training Grant.

1. Child Health after a Natural Disaster

1.1 Introduction

The impact of unanticipated shocks on health in very early life and their implications for health in later life is of substantial interest to scientists and policy-makers.. Research in health, psychology, sociology, demography and economics suggests that child birth outcomes are worse when the mother is exposed to hardships during pregnancy. Whether these exposures affect physical health after birth is less clear. We use rich longitudinal survey data collected in Indonesia before and after the 2004 Sumatra-Andaman earthquake and subsequent tsunami to investigate the impact of exposure to a large-scale natural disaster on the linear growth of young children.

Plausible biological pathways link experiences of maternal stress and nutritional adversity *in utero* to adverse birth outcomes. Maternal stress, whether acute or chronic, results in the release of hormones that in high concentrations have been linked to adverse health outcomes, such as premature labor and low birthweight (Beydoun and Saftlas 2008). Evidence from empirical studies is consistent with the theories of biology. Data from women pregnant during the Dutch Hunger Winter suggest that severe restrictions in caloric intake late in pregnancy may result in both low birthweight and short stature as an adult (Stein 1975, Ravelli et al. 1998, Ravelli et al. 1999, Roseboom et al. 2001, Rooij et al. 2010).

Other quasi-experimental studies have investigated the relationship between stressful experiences of the mother during pregnancy and the physical health of offspring. These studies rely on sources of stress that are assumed to be unexpected, such as acts of terror, war or crime (Lauderdale 2006, Camacho 2008, Brown 2014), or natural disasters (Torche 2011), combined with birth records to compare the outcomes at birth of children *in utero* at the time of the event to outcomes of comparison groups of children who were not exposed, either because they were not *in utero* at the time of the event or because their mothers' geographic locations during pregnancy protected them from exposure. While the findings are consistent with biological theory, the magnitude of estimated impacts is generally small and not likely to be clinically relevant.

These studies provide useful insights into the relationship between prenatal maternal stress and child health, but reliance on vital birth records limits the research in two important ways. First, by relying solely on spatial and temporal variation in exposure, the studies cannot account for individual-level differences in intensity of exposure or maternal stress response. Nor do birth records allow the authors to examine the impact of maternal stress on outcomes after birth, so the duration and permanence of impact cannot be assessed. A key challenge in this literature has been identifying *in utero* insults that are both unanticipated and have the potential to affect the health and well-being of pregnant women.

In this study we use survey data designed to study the impact of *in utero* exposure to a natural disaster that is arguable completely unanticipated: the disruption caused by the 2004 Sumatra-Andaman earthquake and tsunami. The Study of the Tsunami Aftermath and Recovery (STAR) collected longitudinal data on individuals before and after the 2004 tsunami in coastal communities in Aceh and North Sumatra, Indonesia. Our outcome is child height measured during the period from around fifteen months of age through sixty months. By tracing linear growth of the same child over time, we are able to assess both the shorter-term impacts of the tsunami-related disruption and subsequent reconstruction as well as the likely longer-term impacts that will follow children into adulthood since linear growth trajectories, and therefore adult stature, are likely determined by 60 months of age. By using individual level survey data with measures of exposure to the tsunami as well as measures of maternal stress response we are able to directly account for individual heterogeneity in the impact on child height.

We find that two years after the disaster, children whose mothers were in the second and possibly third trimesters of pregnancy when the earthquake struck are significantly shorter, given their age, than comparable cohorts of children born three or four years earlier. However, within two or three years, these deficits have completely disappeared. The patterns demonstrate a dose-response relationship with individual-level measures of maternal exposure to the disaster, strengthening the evidence that the disaster is implicated in the reduced linear growth of children. The evidence indicates remarkable resilience in the face of adversity—resilience that may have been strengthened by the massive infusion of assistance to the region after the tsunami. The results leave little doubt that catch-up linear growth after an in utero insult is possible.

The next section describes the existing literature. It is followed by a description of the disaster and its aftermath, an outline of our empirical approach and data, and a discussion of the empirical results.

1.2 Literature

Biological models of the relationship between maternal stress and in utero child health emphasize the body's neuro-endocrine response to stressful events, particularly the production of hormones by the HPA axis (the hypothalamus, the pituitary gland, and the adrenal glands). In response to a stressor, these glands sequentially produce a series of hormones - corticotropin-releasing hormone (CRH) in the hypothalamus, adrenocorticotropin hormone (ACTH) in the pituitary gland, and cortisol in the adrenal glands.

Biopsychosocial models posit that these hormones may trigger premature labor and delivery as well as restrict fetal growth. Controlled studies of animals and observational studies of humans have provided support to these models (a good review can be found in Beydoun and Saftlas 2008). For example, cortisol encourages the production of placental CRH, which in large amounts has been linked with premature labor in primates. Cortisol has also been linked with restricted fetal growth in sheep. Studies of the formerly popular use of glucocorticoids injections in pregnant women (to aid in the development of fetal organs) have found an association between the use of the hormones and incidence of low birthweight.

Recent studies have focused on the potential role of fetal programming, whereby prenatal exposures change physiological development in utero in ways that permanently affect health and well-being. The "Barker hypothesis" draws on the biology of in utero human development and highlights the importance of the specific timing of prenatal insults with respect to their impact on fetal development (Barker 1995). Drawing on this model, Barker linked nutritional insults during the fetal period to low birthweight. An influential body of research exploiting the quasi-experimental design inherent in the Dutch Hunger Winter found evidence of birthweight reductions in children exposed to nutritional restrictions late in the fetal period, though it was unable to separate the effects of pre-natal and post-natal nutritional stress (Stein 1975, Ravelli et al. 1998, Ravelli et al. 1999, Roseboom et al. 2001, Rooij et al. 2010).[1]

An emerging body of research has sought to identify causal mechanisms in a quasi-experimental framework by relating birth outcomes to maternal stress caused by exposure to shocks of different forms. These studies have found that in utero exposure

---

[1] Barker and the Dutch Hunger studies also found evidence of a link between in utero nutritional insults and later life outcomes (e.g.., elevated risk of cardio-vascular disease).

to maternal stress is associated with small reductions in birth weight. Treating the location and timing of landmine explosions in Colombia as random, Camacho (2008) documents a 9 gram reduction in birth weight for children whose mothers were exposed to the stress generated by random landmine explosions in their local area during the child's second trimester. Utilizing an earthquake in Chile, Torche (2011) finds that in utero exposure to the disaster resulted in a 50 gram reduction in birth weight and an increase in the incidence of low birth weights from 4.7 to 6.5%. Work in the United States, using the 9/11 terrorist attacks on New York City and Washington, D.C. as exogenous stressful events have found similar but smaller impacts on birth weight and the likelihood of low birth weight (Lauderdale 2006, Brown 2012).

Scientists and policy makers are interested in the linear growth (growth in height) of young children in part because it is strongly associated with adult height, which in turn is related to socioeconomic outcomes. A number of studies document the strength of the relationship between height achieved in the first 2-3 years of life and height as an adult (Martorell 1995, 1999; Habicht, Martorell, and Rivera 1995; Moore et al. 2001; Shrimpton et al. 2001; Bozzoli, Deaton, and Quintana-Domeque 2009). Research from a controlled experiment found that children potentially exposed to the protein and calorie-rich nutrition intervention in the INCAP study grew more in the first three years of life (but not after) and remained taller years later (Habicht, Martorell, and Rivera 1995). Because adult height is strongly correlated with socio-economic outcomes and health, and with the birth outcomes of the next generation (Strauss and Thomas 1998), linear growth in the first years of life may be an important determinant of well-being across the life course.

Several empirical studies provide recent evidence to this effect. Using longitudinal data of children in rural Zimbabwe and variation in age of exposure to population-level nutrition shocks, Alderman, Hoddinott, and Kinsey (2006) find that children with lower height as pre-schoolers have lower attained grades in school in their adolescence. Similarly Maluccio et al. (2009) find that children potentially exposed in the first 0-3 years of life to a nutrition intervention in rural Guatemala (1969-1977 INCAP study) have higher attained grades in school (for females) and higher verbal and non-verbal test scores as adults. Hoddinott et al. (2008) also find that potentially exposed male children had higher adult wages.

Much less is known about another critical question related to early life health – whether children whose growth is reduced early in childhood can grow at an accelerated pace shortly thereafter, thus making up for lost time. This phenomenon is often referred to as linear "catch-up growth." Laboratory studies of animal growth where nutrient inputs are tightly controlled suggest that animals can experience accelerated growth following periods of restricted nutrition in utero and post-birth if the nutrition environment is improved to "normal" feeding amounts (Hector and Nakagawa 2012).

These findings are supported by early epidemiology studies (reviewed by Martorell, Khan, and Schroeder 1994), which find that children in developing countries who remain in the environments in which they initially experienced relatively slow growth remain short into adulthood; however children who move to environments with higher quality nutrition (i.e., the United States and Sweden) appear to experience faster growth. Adair (1999) analyzes changes over time in the prevalence of stunting in a cohort of children in the Philippines and finds that prevalence decreased significantly between the age of 2 and 8.5 years and between the age of 8.5 and 12 years, which suggests that linear catch-up growth may have occurred for very short children. Her findings are limited by the possibility of selective migration from her sample.

A number of authors have also attempted to identify the existence of linear catch-up growth by simply analyzing the relationship between initial child height and subsequent height (examples include Adair; Hoddinott and Kinsey (2001); Federov and Sahn 2005; Yamano, Alderman, and Christiaensen 2005; Mani 2008; and Handa and Peterman 2012). Most have found that initial height is negatively correlated with subsequent height, but not fully so.

The authors generally interpret the negative correlation as evidence of partial catch-up growth. However, as Hoddinott and Kinsey acknowledge, the fact that no specific negative shock to linear growth marks the likely candidates for catch-up growth means that it is unclear whether the studies are identifying true catch-up growth or simply a process of regression to the mean across a population unaffected by growth restrictions early in life. This problem highlights the need for a study design that exploits an identifiable exogenous shock to linear growth accompanied by multiple subsequent observations on height. This is the approach we take in this study.

1.3 The Sumatra-Andaman earthquake and tsunami

The 2004 Sumatra-Andaman earthquake occurred on December 26, 2004, with an epicenter 100 miles off the west coast of the province of Aceh in Indonesia. The water displaced by the earthquake resulted in a series of tsunamis, the first of which reached the coast of Aceh 15 minutes after the earthquake. The waves ultimately engulfed 800 km of coastline in Aceh, with an average inland reach of some 4-6 kilometers. Mortality was extremely high but was concentrated in a relatively narrow band close to the shore (Frankenberg et al. 2011).

In addition to its death toll, the disaster resulted in massive physical destruction throughout the coastal region. Some 40,000 hectares of agricultural land were affected, with severe losses of crops and livestock (Cossee, Hermes, and Mezhoud 2006). About 40% of the fishing fleet was destroyed, as well as supporting infrastructure such as landing sites, ice plants, and marketplaces. The aquaculture industry was equally hard hit (Cossee, Hermes, and Mezhoud 2006). These losses had immediate and longer-term implications both for livelihoods and for food supply. Water supplies were also disrupted as a result of contaminated wells (estimated at 600,000) and destroyed hand pumps (15,000) (Kohl et al. 2005).

Many survivors experienced various forms of stressors, including life-threatening events, death of kin, friends, and neighbors, and loss of housing and other personal assets, which took a toll on psychosocial health and elevated levels of post-traumatic stress reactivity (Frankenberg et al. 2008). Of critical importance for this paper is the fact that although the impact of the disaster was immense, its effects were not uniformly distributed.

Two features of the tsunami suggest that variation in exposure to disaster-induced stressors was exogenous. First, the tsunami was unanticipated. Tsunamis are rare and the geological evidence indicates that mainland Sumatra was last hit by a tsunami some 600 years ago. As a result, planning for a tsunami is unlikely to have played a significant role in household or formal sector behavior in Aceh and North Sumatra prior to 2004. Moreover, no warning system for tsunamis was in place prior to the disaster, so selective exposure as a result of anticipation of the tsunami is unlikely.

Second, local variation in the intensity of exposure to the tsunami (and tsunami-induced stressors) was arguably random. The force and extent of inundation from the tsunami was a function of a number of geographic factors, including distance to the coast, elevation, slope, the shape of the coast, and the presence of rivers or canals (Ramakrishnan et al. 2005). As a result, otherwise similar mothers and children differed in the intensity of their exposure to tsunami-induced stressors for reasons likely uncorrelated with child health.

Assistance in the first few weeks of the tsunami was limited and food prices rose rapidly (ACF 2005). Communities that had been spared the tsunami's full effects tried to absorb the hundreds of thousands of displaced survivors. The destruction to roads and bridges meant that food assistance to many communities could be provided only by military helicopter drop. By February rice prices in Banda Aceh had risen some 25% (WFP 2005).

The World Food Programme estimated that some 770,000 individuals needed regular rations, the distribution of which began in mid-January via ships, landing craft, aircraft, and helicopters. The goal was to provide sufficient supplies for 2,100 calorie per day diet, in the form of rice, canned fish, noodles, biscuits, and fortified vegetable oil, but it was several months before the system was regularized, and not until April that over 700,000 beneficiaries were estimated to have been reached. Getting food to individuals in private homes proved more difficult than reaching IDPs in camps. Meanwhile, rapid assessment surveys in January and February revealed high levels of malnutrition, micronutrient deficiencies, and illness among children under five and women, leading the UN Standing Committee on Nutrition to describe the nutrition situation as "precarious" (United Nations, 2005). Supplementary feeding programs for children and pregnant and lactating women did not begin even on a pilot basis until April and May of 2005.

Eventually aid did begin to flow into impacted communities, form sources ranging from the Indonesian government to foreign governments and multilateral agencies, international and domestic NGOs, and individual donations. Assistance came in a variety of forms, including cash, clothing, food, and housing, and infrastructure reconstruction. Previous work suggests that the initial aid was heavily targeted to households from communities with high amounts of physical damage and to households that lost assets such as houses and farm and business equipment, but that over time relatively undamaged communities received assistance as well (Frankenberg et al. 2009b). These findings suggest that over time the nutrition environment stabilized and eventually improved, which in turn may have encouraged linear catch-up growth.

1.4 Data and methods

1.4.1 Data

The data for this study are drawn from the Study of the Tsunami Aftermath and Recovery (STAR), a longitudinal survey of 26,919 baseline individuals in 6,490 households in tsunami affected and unaffected areas of Aceh and North Sumatra. Baseline data was collected by Statistics Indonesia (BPS) as part of their annual population representative cross-sectional Socioeconomic Survey (SUSENAS) prior to the tsunami from January to May 2004. SUSENAS is considered to be a high quality dataset and is widely cited in the literature. The STAR surveys collect demographic, health, and economic data at the community, household, and individual level, including information on household expenditures, assets, and socio-economic characteristics as well as measurements of individual physical and psychological health and exposure to the disaster.

Five follow-up surveys were conducted annually beginning in May 2005, five months after the tsunami. The first survey (STAR1) was conducted on a sample of SUSENAS households in 11 districts in Aceh and 2 districts in North Sumatra, covering 407 enumeration areas in 369 villages. Districts were chosen to include both areas affected by the tsunami and areas not directly affected by the tsunami, which serve as comparison areas.

All surviving respondents from the baseline who remained on the island of Sumatra or moved to the island of Java (the most populous island in Indonesia) or household members living with baseline respondents were targeted for interview. As a result of these tracking efforts, attrition rates are extremely low. Fully 95% of survivors from the baseline survey have been interviewed at least once in the follow up surveys (Sikoki et al. 2008). In addition, conditional on surviving the disaster attrition from the survey does not appear to be selected on pre-tsunami socio-economic characteristics (Frankenberg et al. 2011).

The STAR survey began collecting anthropometric data in the second follow-up survey (STAR2), 18-29 months after the disaster. From that point, the data were collected in all subsequent waves.[2] Height and weight was recorded for all respondents by trained enumerators using Seca stadiometers and scales, respectively.

The STAR survey also collected many measures of community, household, and individual exposure to the disaster. These measures are essential in investigating a dose-response relationship between disaster exposure and child health. They include measures of the geographic proximity of the mother's pre-disaster community (i.e., distance to the epicenter of the earthquake and distance to the coast), measures of the mother's tsunami-related experiences (e.g., whether she heard/saw the tsunami), and measures of mother's post-traumatic stress reactivity (PTSR). The PTSR questions were created using seven items in the Post-traumatic Stress Disorder (PTSD) Checklist Civilian Version (Weathers et al. 1993) and have been validated as accurate measures of post-traumatic stress with other potential victims of stressful events (Blanchard et al. 1996, Smith et al. 1999). The items are listed in Figure 1.1.

[2] Anthropometry was not collected in the first follow up wave because mounting a large-scale longitudinal survey in the field quickly after a disaster of the magnitude of the earthquake and tsunami is far from straightforward and field conditions for the early STAR surveys were extremely taxing. Attention in the first resurvey focused on finding survivors and tracing those who had been displaced by the earthquake and tsunami as well as those who had chosen to move.

Information collected from each adult (>=15 years years of age) about 7 items from PTSD Checklist Civilian Version.

For each item [A] through [G]

Q1: Since the tsunami, have you ever experienced […]?

If yes,

Q2: During the time you experienced […] most strongly did it occur (1) Rarely (2) Sometimes (3) Often?

Q3: When did […] start?

Q4: Do you still experience […]? (1) No (2) Sometimes (3) Often?

If not still experiencing,

Q5: How long did it last?

Items:

[A]. Repeated, disturbing memories, thoughts, dreams, or experiences of tsunami
[B]. Feeling very upset when something reminded you of tsunami
[C]. Avoiding activities or situations because they reminded you of a stressful experience
[D]. Feeling as if your future will somehow be cut short
[E]. Trouble falling or staying asleep
[F]. Feeling irritable or having angry outbursts
[G]. Being "super-alert" or watchful or on guard

Figure 1.1: Post traumatic stress reactivity index

1.4.2 Methods

The model estimated in the analysis is the following:

$$\theta_{it} = C_{it}\beta + X_{it}\gamma + \varepsilon_{it} \qquad [1]$$

where θ_{it} is the height of child i at time t expressed as a height-for-age z-score relative to the median well-nourished child following the CDC standard growth charts (Kuczmarski et al. 2000). C_{it} is a vector of birth cohorts specified in birth quarters. X_{it} is a vector of controls that absorbs gender differences that are not captured by the growth standards, differences in birth order, as well as the month and year of the interview in each wave (since each survey spanned about 12 months). ε_{it} captures unobserved heterogeneity and is assumed to be uncorrelated with C_{it} and X_{it}. Estimations are performed using linear regressions, and standard errors are clustered at the level of the enumeration area to account for the sampling strategy used in the baseline survey.

This model compares the standardized height of cohorts in utero at the time of the disaster to an omitted cohort that is too old for their growth to have been affected by the disaster and its aftermath. The estimate of interest is β, which represents the difference in average height θ between children in each birth cohort in C and the comparison cohort, conditional on the controls X. The 2002 cohort is used as the comparison cohort because children in this group are too old to be affected by the disaster (they were aged 2-3 at the time of the disaster) but young enough not to have been affected by the 1997 Asian financial crisis (they were born around 5 years after the crisis). Results using the 2001 cohort as the comparison cohort are also reported as a test of the robustness of the primary findings.

The birth cohorts are specified by quarter years in order to identify the timing of prenatal exposure and to account for seasonality. For example, estimates for children born in the first quarter in 2005 are determined in a regression where the reference group is children born in the first quarter in 2002, while estimates for children born in the second quarter in 2005 are determined in a separate but otherwise identical regression in which children born in the second quarter in 2002 serve as the reference group.

Gestational age at the time of the disaster is estimated by placing conception 9 months before the date of birth. While pre-term births likely increased as a result of the tsunami, most of the children born in the first quarter of 2005 would have been in the third trimester at the time of the tsunami. Likewise children born in the second and third quarters of 2005 would have been in the second and first trimesters, respectively.

The analyses are stratified by the survey wave in which the data were collected (i.e., 2006-2007, 2007-2008, 2008-2009, and 2009-2010). The stratification allows examination of the impacts annually over a period of four years, beginning one and half to two and half years after the disaster. Our first cut on evidence of the impact of exposure to the disaster on child health comes from an analysis of the measurements in 2006-2007, which provides a cumulative measure of linear growth in the two years following the tsunami. Under the assumptions that intensity of exposure to the disaster was random and that the reference cohort is too old for its growth to have been affected by the disaster, differences in age-adjusted height between the reference and in utero cohorts should reflect the impact of exposure to the disaster and subsequent responses on the linear growth of the in utero cohort. It should also be noted that since no anthropometric data is available before the first round of height measurements, any prevention of growth loss or catch-up growth that occurred for the in utero cohorts *before* the first round of measurements (perhaps as a result of responses to the disaster) cannot be separately identified. Evidence of catch-up growth is inferred from the progression of the estimated impacts over the subsequent years of measurements. We interpret increases over time in the estimated coefficient for a young cohort relative to the reference cohort as evidence that accelerated linear growth may have occurred for the young cohort over the sample period.

Earlier work shows that where tsunami-related mortality was extremely high, strength was advantageous for survival (Frankenberg et al. 2011). If taller, stronger children were at a survival advantage, the resulting group of survivors will not be representative of the full pre-disaster distribution of nutritional status. To reduce the risk of selective mortality the analysis is restricted to the sample of children born to mothers from pre-disaster communities where the disaster caused no significant mortality. Because the intensity of exposure to the tsunami along the coast varied idiosyncratically in relation to geography and topography (see Section 1.3), outside of the high mortality communities, variation in tsunami exposure is assumed to be random. As a result, exposure to the disaster within the analytic sample is not selective in ways that may bias results.

The analysis is also restricted to a sample of children who were eligible to be measured in STAR2, the first wave with anthropometric measurements. This restriction means that we do not analyze children who are "new to the survey," that is children born after STAR2, or those who became eligible for the survey by moving into a household of a baseline survey member. This restriction reduces the influence of sample composition change on the estimates.

The sample size and height-for-age summary statistics of children who were born between 2000 and 2005 and were eligible to be measured in 2006-07 (STAR2), by birth cohort, are shown in Table 1.1.

Table 1.1: Sample sizes and summary statistics for children eligible for height measurement in 2006-07 (STAR2)

		Low mortality areas	
Birth year	N	Height-for-age (2006-07)	
		Mean	SE
2000	608	-1.86	0.06
2001	551	-1.64	0.06
2002	532	-1.59	0.06
2003	508	-1.70	0.08
2004	508	-1.91	0.08
2005	512	-1.77	0.09
2005Q1	122	-1.83	0.16
2005Q2	138	-2.23	0.16
2005Q3	127	-1.64	0.20
2005Q4	125	-1.12	0.22

Fewer younger children are present than older children, suggesting that overall fertility was declining. Height-for-age is increasing for the cohorts born from 2000 to 2002, possibly due in part to decreasing effects of the 1997 Financial Crisis. They decrease after 2002, possibly due in part to the impact of the disaster. There are 387 children in the sample who were in utero at the time of the disaster (122 born in the first quarter, 138 born in the second quarter, and 127 born in the third quarter). The children born in the second quarter of 2005 are noticeably shorter than other in utero cohorts. Children born in the fourth quarter, who were conceived after the disaster, are noticeably taller than the other 2005 cohorts, which may reflect selective fertility following the disaster.

We begin by presenting results for the average impact of the disaster on the entire analytic sample of children in utero at the time of the disaster using equation 1. We then stratify the analysis by child sex to investigate heterogeneity in the impact of the disaster. To examine evidence for a dose-response relationship, we next stratify by measures of the intensity of exposure to the disaster. Finally, we stratify by measures of pre-disaster socio-economic status in order to investigate more directly whether the general results are driven by likely correlates of pre-existing differences in child health.

1.5 Results

1.5.1 Average effects of in utero exposures and subsequent child height

We begin with an analysis of the average impacts of the disaster on children who were in utero at the time of the disaster (those born in the first, second, and third quarters of 2005). Results for children born in each quarter of 2005 are reported in Table 1.2.

Table 1.2: Height-for-age measures of children born after tsunami by birth cohort

Children born of parents not living in heavily damaged areas pre-tsunami

Birth quarter	Year child measured				Year child measured			
	2006-07	2007-08	2008-09	2009-10	2006-07	2007-08	2008-09	2009-10
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Height-for-age								
By sample								
	A. Eligible to measure in 2006-07				*B. Measured in each wave*			
2005Q1	-0.11	-0.17	0.07	0.42	-0.07	-0.02	0.23	0.21
	(0.20)	(0.19)	(0.19)	(0.17)	(0.30)	(0.23)	(0.25)	(0.26)
2005Q2	-0.79	-0.35	0.12	0.23	-0.61	-0.41	-0.07	0.26
	(0.19)	(0.19)	(0.19)	(0.17)	(0.24)	(0.23)	(0.20)	(0.19)
2005Q3	-0.05	-0.15	-0.12	0.27	-0.61	-0.32	-0.09	0.28
	(0.21)	(0.17)	(0.17)	(0.16)	(0.25)	(0.26)	(0.25)	(0.22)
2005Q4	0.23	-0.42	0.07	0.37	0.54	-0.42	-0.15	0.41
	(0.22)	(0.21)	(0.20)	(0.16)	(0.33)	(0.31)	(0.25)	(0.23)
Sample Size	3922	3907	3928	4301	2309	2309	2309	2309
Height-for-age growth since 2006-07								
By sample								
	C. Eligible to measure in 2006-07				*D. Measured in each wave*			
2005Q1		0.15	0.31	0.37		-0.01	0.29	0.26
		(0.20)	(0.16)	(0.17)		(0.27)	(0.20)	(0.23)
2005Q2		0.44	0.57	0.91		0.28	0.60	0.91
		(0.18)	(0.19)	(0.19)		(0.22)	(0.21)	(0.23)
2005Q3		-0.02	0.16	0.60		0.25	0.49	0.79
		(0.23)	(0.22)	(0.20)		(0.26)	(0.22)	(0.22)
2005Q4		-0.57	-0.22	0.09		-0.90	-0.62	-0.04
		(0.26)	(0.25)	(0.23)		(0.28)	(0.25)	(0.31)
Sample Size		3119	3060	3347		2309	2309	2309
Height-for-age: Other specifications								
Eligible to measure in 2006-07 sample								
	E. Mother Fixed Effects				*F. 2001 Reference Cohort*			
2005Q1	-0.27	-0.41	-0.06	0.55	-0.06	-0.06	0.19	0.57
	(0.24)	(0.22)	(0.22)	(0.20)	(0.18)	(0.19)	(0.19)	(0.16)
2005Q2	-0.35	-0.13	0.52	0.37	-0.39	-0.16	0.29	0.27
	(0.19)	(0.23)	(0.20)	(0.16)	(0.19)	(0.19)	(0.20)	(0.16)
2005Q3	0.23	0.03	-0.10	0.40	-0.25	-0.33	-0.17	0.12
	(0.24)	(0.20)	(0.20)	(0.20)	(0.20)	(0.18)	(0.16)	(0.17)
2005Q4	0.59	-0.37	-0.19	0.31	0.14	-0.30	0.32	0.46
	(0.31)	(0.25)	(0.23)	(0.19)	(0.22)	(0.21)	(0.20)	(0.18)
Sample Size	3837	3824	3842	4222	3922	3907	3928	4301
Effective Size	2644	2643	2652	3006				

Note: Errors clustered at the level of mother's pre-disaster enumeration area.

As shown in column 1 of Panel A, about two years after the tsunami, children who were born in the second quarter of 2005 are 0.79 standard deviations shorter, given age, than children born in the same quarter, but three years earlier, in 2002. A year later, the gap has shrunk to 0.35 standard deviations. Both gaps are different from zero (column 2 marginally so). Five years after the tsunami (column 4), this cohort of children has made up their initial deficit, and in fact are 0.23 standard deviations taller, given age, than the children born in the same quarter in 2002 (this gap is not significantly different from 0). The children born in the other quarters of 2005 do not differ appreciably (or significantly) from the comparable 2002 cohorts, except for the first quarter children, who by 2009-10 are 0.42 standard deviations taller than the reference cohort.

Panel B of Table 1.2 presents results using the sub-sample of children measured in each wave. For this group of children, those born in the third quarter of 2005 are 0.61 standard deviations shorter than their reference group in 2006-07, but make up the difference over time, similar to the pattern observed for the second quarter cohort. This suggests that children born in the third quarter of 2005 may also have been negatively affected by the disaster, although it is difficult to be certain because children in that cohort who attrite from the sample in later waves appear to be healthier and taller in 2006-07 than those that continued to be measured.

Panels C and D present results for individual growth between 2006-07 and for each subsequent year of measurement (again, relative to the 2002 cohort born in the same quarter). The results suggest that the height deficit that is present for the Q2 children in 2006-07 is made up gradually over the three years that follow.

To investigate whether the results are being driven by time-invariant differences across mothers, Panel E of Table 1.2 exploits the presence of siblings in our data and presents results for model [1] including mother fixed effects.[3] The children born in the second quarter are now only 0.35 standard deviations smaller in 2006-07 than their siblings born in 2002—a deficit that is marginally significant. Thus, although the results in the previous panels may partially reflect time-invariant differences between mothers, even controlling those differences, the disaster took a negative toll on the early nutritional status early in life of children born in the second quarter of 2005.

To explore whether the results are affected by the choice of reference cohort, Panel F of Table 1.2 presents results drawing comparisons with children born in the same quarter in 2001, rather than in 2002. The comparison children would have been, on average, age 4 at the time of the tsunami. Our main conclusions are not affected by the choice of comparison cohort.

To wit, two years after the tsunami, children born in the second quarter of 2005 exhibit a significant deficit in linear growth. But by five years after the tsunami, these children have caught up, and are no shorter, given age, than the 2001 and 2002 cohorts.

---

[3] Birth order controls are excluded from these regressions because of their high correlation with the birth cohorts.

Exposure to the tsunami in utero apparently disrupted growth in very early childhood, but the penalty is not permanent, at least as indicated by height for age.

Five years after the tsunami, children who were conceived after the tsunami and born in the fourth quarter of 2005 are also taller for their age than the comparison cohorts. Faster linear growth for the 2005 birth cohort overall may reflect both catch-up growth from an early childhood deficit and the influence of the massive influx of humanitarian aid and the accompanying resources following the tsunami.[4]

Results stratified by gender of the child are reported in Table 1.3. For the cohort born in the second quarter of 2005, the height deficit in 2006-07 is larger for females. But no gender differences exist for that cohort one year later, nor are they present five years after the tsunami. Among those born in the first quarter of 2005, patterns for males and females are somewhat different (relative to the 2002 cohort, males are significantly shorter, given age, three years after the tsunami and roughly the same height five years after the tsunami, whereas females are not shorter initially, and they are in fact taller than the older cohorts five years after the tsunami). Because these gender differences are not apparent when comparisons are drawn with the 2001 cohort (not shown), we do not focus on them.

---

[4] One such program involved distribution of sachets of micronutrient-fortified sprinkles in the second half of 2005 and 2006 (de Pee et al. 2007).

Table 1.3: Height-for-age measures stratified by gender

Children born after the tsunami of parents not living in heavily damaged areas pre-tsunami

	Year child measured				Year child measured			
Birth quarter	2006-07	2007-08	2008-09	2009-10	2006-07	2007-08	2008-09	2009-10
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
By sex of child								
	Males				*Females*			
2005Q1	-0.36	-0.71	-0.30	-0.09	0.13	0.36	0.47	0.88
	(0.27)	(0.28)	(0.30)	(0.24)	(0.29)	(0.27)	(0.24)	(0.27)
2005Q2	-0.55	-0.41	0.05	0.11	-1.03	-0.27	0.23	0.36
	(0.25)	(0.28)	(0.23)	(0.22)	(0.27)	(0.24)	(0.33)	(0.26)
2005Q3	-0.09	0.04	-0.30	0.18	-0.05	-0.30	0.07	0.31
	(0.32)	(0.27)	(0.25)	(0.23)	(0.30)	(0.25)	(0.25)	(0.23)
2005Q4	0.39	-0.18	0.21	0.33	0.10	-0.70	-0.09	0.47
	(0.32)	(0.26)	(0.25)	(0.23)	(0.30)	(0.33)	(0.32)	(0.26)
Sample Size	2031	2026	2033	2197	1891	1881	1895	2104

Note: Errors clustered at the level of mother's pre-disaster enumeration area. Sample of children eligible to be measured in 2006-07. 2002 reference cohort.

1.5.2 Differential effects within cohort by intensity of maternal exposure

Thus far, we identify the impact of the tsunami by drawing comparisons across different cohorts. In principle, other contemporaneous changes may drive the cohort-specific differences, in which case we may be falsely attributing the differences to the tsunami and its aftermath. We address this concern in this sub-section.

In order to assure that the patterns reflect the impact of the tsunami we turn to a dose-response research design. Specifically, for the 2005 birth cohort, we compare children who were exposed to greater stress in utero to those exposed to less stress (results for all 2005 cohorts can be found in Appendix Table 1.1). We examine four indicators that are related to maternal stress around the time of the tsunami: distance between the community of residence at the time of the event and the earthquake epicenter, whether the child's mother saw or heard the tsunami, whether the child's mother was exposed to traumatic aspects of the tsunami (such as being caught in the water or watching others struggle), and the psycho-social health of the child's mother.

Distance to the epicenter of the earthquake is one indicator of the violence of the shaking that occurred on December 26, 2004. Generally, the greater the distance from the epicenter, the less violent the shaking (although soil type can also play a role). Moreover, the extent of damage depends on the quality of construction as well as on the size and nature of the tremors. We stratify the sample of communities into three approximately equal sized groups: the closest communities (within 130km of the epicenter), the furthest communities (greater than 250km from the epicenter) and those in between.

Results that stratify the location of the mother prior to the tsunami into each of these three groups are reported in Panel A of Table 1.4. The general patterns described above persist. In 2006-07 children born in the second quarter of 2005 are shorter, given age, than their comparable cohorts born in 2002, but by 2009-10, these children have more than made up the deficits. The size of the shorter-term deficit declines as distance from the epicenter of the earthquake increases. Children born to mothers in areas that are within 130km of the epicenter are 1.21 standard deviations shorter than comparable children in the 2002 cohort who were born to mothers living in the same areas. Children born to mothers living further away are 0.45 standard deviations shorter than the 2002 cohort – a difference that is not statistically significant. However, the difference-in-difference between those born to mothers closer and further away from the epicenter, which is about 0.75 standard deviations, is statistically significant. There is no statistical difference in the rate of catch up growth between 2006-7 and 2009-10 across the three locations.

Stratification based on distance to the epicenter separates children by maternal location of residence prior to the tsunami. The remaining stratifications are based on each mother's experience of the tsunami and its aftermath. We stratify by the mother's experience of the disaster. The measures include exposures that are plausibly exogenous and potentially stress-inducing: whether the mother saw or heard the tsunami, whether the mother was swept away in the water, whether the mother sustained injuries in the disaster, whether the mother saw friends or family members in the water, whether the mother waded through the aftermath of the disaster, and whether the mother saw dead bodies. The first set of results is stratified by whether the child's mother saw or heard the tsunami. The second set of results is stratified by whether the child's mother experienced any of the above exposures.

Table 1.4: Height-for-age measures stratified by exposures to disaster

Children born in 2nd or 3rd quarter of 2005 to parents not living in heavily damaged areas pre-tsunami

	Year child measured				Year child measured				Year child measured			
Birth quarter	2006-07	2007-08	2008-09	2009-10	2006-07	2007-08	2008-09	2009-10	2006-07	2007-08	2008-09	2009-10
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
A. By distance to the epicenter of earthquake												
	> 250km				*130-250km*				*< 130km*			
2005Q2	-0.45	-0.44	-0.39	0.00	-0.93	0.07	0.79	0.85	-1.21	-0.43	0.50	0.21
	(0.30)	(0.28)	(0.29)	(0.25)	(0.37)	(0.35)	(0.27)	(0.36)	(0.29)	(0.32)	(0.36)	(0.27)
2005Q3	-0.23	-0.05	-0.15	0.25	-0.37	-0.06	-0.37	0.35	0.36	-0.38	0.06	0.24
	(0.25)	(0.23)	(0.22)	(0.19)	(0.46)	(0.39)	(0.41)	(0.27)	(0.50)	(0.33)	(0.42)	(0.37)
Sample Size	1803	1775	1864	1987	1101	1075	1085	1147	995	1035	952	1142
B. By mother's exposure to traumatic aspects of tsunami: Saw or heard tsunami												
	Not exposed				*Exposed*							
2005Q2	-0.51	0.07	0.49	0.71	-1.03	-0.83	-0.17	-0.21				
	(0.25)	(0.23)	(0.26)	(0.25)	(0.30)	(0.30)	(0.24)	(0.19)				
2005Q3	0.05	-0.07	-0.11	0.14	-0.21	-0.32	-0.29	0.54				
	(0.28)	(0.21)	(0.21)	(0.18)	(0.33)	(0.34)	(0.37)	(0.29)				
Sample Size	2337	2446	2506	2682	1482	1362	1312	1516				
C. By mother's exposure to traumatic aspects of tsunami: Any exposure												
	Not exposed				*Exposed*							
2005Q2	-0.36	0.01	0.24	0.46	-0.94	-0.47	0.15	0.18				
	(0.39)	(0.34)	(0.34)	(0.35)	(0.22)	(0.23)	(0.20)	(0.18)				
2005Q3	-0.55	-0.16	-0.20	0.31	0.25	-0.18	-0.11	0.28				
	(0.30)	(0.29)	(0.27)	(0.22)	(0.27)	(0.24)	(0.25)	(0.22)				
Sample Size	1305	1351	1427	1540	2514	2457	2391	2658				
D. By mother's maximum post-disaster PTSR												
	Low [0-6]				*Medium [7-13]*				*High [14-21]*			
2005Q2	-0.60	-0.26	0.20	0.25	-0.82	-0.32	0.11	0.21	-1.45	-0.75	-0.25	-0.29
	(0.31)	(0.30)	(0.35)	(0.31)	(0.31)	(0.30)	(0.25)	(0.23)	(0.46)	(0.52)	(0.65)	(0.49)
2005Q3	-0.39	-0.11	-0.47	0.04	-0.08	-0.23	0.07	0.39	0.42	0.10	0.02	0.75
	(0.31)	(0.30)	(0.26)	(0.23)	(0.26)	(0.27)	(0.29)	(0.26)	(0.56)	(0.55)	(0.68)	(0.60)
Sample Size	1670	1707	1756	1857	1454	1411	1384	1571	392	381	358	414

Note: Errors clustered at the level of mother's pre-disaster enumeration area. Sample of children eligible to be measured in 2006-07. 2002 reference cohort.

Results stratified by maternal exposures are reported in Panels B and C of Table 1.4. As with the distance from the epicenter, the general patterns hold. In addition, the children born in the second quarter of 2005 to mothers who saw or heard the tsunami are 1.03 standard deviations smaller than the reference cohort two years after the disaster while those born to mothers who did not see or hear the tsunami are only 0.51

standard deviations smaller (the differences are significantly different from one another). Similarly, exposure to any of a number of previously mentioned exposures (including saw or heard the tsunami) is associated with a larger gap in height with the reference cohort (0.94 standard deviations) than being born to a mother who was not exposed (0.36 standard deviations). The evidence using measures of maternal exposure to the disaster is consistent and suggests that the difference in average height of children born in the second quarter of 2005 is related to the mother being exposed in some way to the potentially stressful disaster.

Biological theory posits that it is not exposure to a stressor alone that may harm a child's growth but how the mother's body reacts to the stressor physiologically. Therefore, the second set of results based on mothers' actual experiences during and after the disaster is stratified by the level of stress the mother experienced in the aftermath of the disaster (while the children born in 2005 were in utero). This analysis draws on seven items in the Post Traumatic Stress Disorder (PTSD) Checklist Civilian Version (Weathers et al. 1993) (listed in Figure 1.1). The questions were administered to all survivors age 15 and older in the first STAR resurvey (conducted in 2005-06). For each item, the respondent indicated whether she had experienced the feeling since the tsunami and if so, how frequently when it was most intense, when it began, whether she still experienced it, and with what frequency.

We combine the responses to create an index of Post Traumatic Stress Reactivity (PTSR) that is intended to reflect the stress-response continuum (Ruscio et al. 2002; Forbes et al. 2005). To provide an indicator of the maximum level of PTSR after the event, responses to the questions on whether the respondent ever experienced each of the seven symptom were scored from 0 (no occurrence) to 3 (occurred often when it was experienced most intensely) and summed across those symptoms so that the scale ranges from 0 to 21. Symptoms of post-traumatic stress based on this scale are known to be strongly linked to the degree of one's own exposure to trauma (Brewin et al. 2000; Briere, et al. 2000; Norris et al. 2002; Foa et al. 2006) and the symptoms have been linked to trauma and destruction experienced at a broader level. (Davidson and McFarlene, 2006.) Our earlier work shows that this scale is predicted by a broad set of exposures to the trauma of the tsunami in the STAR sample and has a Cronbach's alpha of 0.88 (Frankenberg et al. 2008).[5]

The median PTSR score is 7, with less than 10% of mothers reporting no symptoms and over 10% reporting a score of 13 or more. Results of models that stratify children into three levels of PTSR are reported in Panel D of Table 1.4. In 2006-07, children born in the second quarter of 2005 to mothers who report higher levels of PTSR

[5] The 7-item check list is also very highly correlated with a longer 30-item scale administered to the same respondents in the second STAR follow-up.

are shorter than those born in 2002 (the difference between the coefficients is nearly 1 standard deviation and is significant). By 2009-10, the deficit has disappeared.

The weight of the evidence points to a significant negative impact on linear growth during the fetal period and/or first two years of life for children who were in utero at the time of the tsunami and born in the second quarter of 2005. It is not possible to determine whether the deficits in 2006-07 reflect reduced fetal growth, reduced linear growth after birth, or a combination of both. We conjecture that both forces are at play since children born in the first quarter of 2005 – the time of greatest exposure to the physical and economic disruption – do not show significant deficits by 2006-07. However, children born in both the first and second quarter of 2005 show significant catch-up growth between 2006-07 and 2009-10, suggesting that the influx of resources that accompanied the humanitarian aid effort contributed to improved child health. Indeed, five years after the tsunami, overall, children in both the first and second quarter 2005 birth cohorts had more than made up this deficit in linear growth. Children whose mothers experienced higher levels of PTSR do not catch up to the same degree, suggesting that catch-up in child growth is a function of economic resources of the family and the psycho-social resources of the mother.

1.5.3 Differential effects within cohort by mother's pre-disaster socio-economic status

The preceding analysis puts the spotlight on factors that reflect mother's experiences at the time of the disaster, either because of the geographic location of their homes or because of their experiences at the time of the disaster and their subsequent mental health. We now stratify the analysis by the socio-economic status of the mother's pre-disaster household. This analysis will provide evidence of whether the patterns simply reflect pre-existing differences in socio-economic status that play out as differences in height once these children are born, rather than an effect of the disaster itself. The analyses are stratified by three different measures of socio-economic status: mother's pre-disaster household per capita expenditure (PCE) and maternal and paternal education.

The results for household PCE are presented in Panel A of Table 1.5. In 2006-07 children born in the second quarter in 2005 to mother's from pre-disaster households with household PCE above the sample median are 1.03 standard deviations smaller than children born in the same quarter in 2002, while children from households with lower PCE are only 0.52 standard deviations smaller. As in our other findings, these differences disappear over time. This suggests that the growth reductions seen in the children born in the second quarter in 2005 was likely driven by exposure to the disaster rather than pre-existing differences due to household resources.[6] This also suggests that the negative impact of the disaster was stronger for children from advantaged

---

[6] There is no evidence to suggest that the findings result from issues with our household PCE measure. In every cohort in the sample born before 2003 (too old for their growth to have been impacted by the disaster) children born to mothers from households with above median PCE are taller on average than children born to mothers from households with below median PCE.

households, relative to what they would have experienced in the absence of the tsunami, than was the case for children from poorer households.

Table 1.5: Height-for-age measures stratified by pre-disaster socio-economic characteristics

Children born in 2nd or 3rd quarter of 2005 to parents not living in heavily damaged areas pre-tsunami

	Year child measured				Year child measured			
Birth quarter	2006-07	2007-08	2008-09	2009-10	2006-07	2007-08	2008-09	2009-10
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
A. By mother's pre-disaster household per capita expenditure								
	Below median				*Above median*			
2005Q2	-0.52	-0.11	0.24	0.35	-1.03	-0.59	0.05	0.12
	(0.27)	(0.33)	(0.35)	(0.27)	(0.25)	(0.21)	(0.20)	(0.19)
2005Q3	-0.29	-0.35	-0.16	0.25	0.18	0.04	-0.15	0.29
	(0.26)	(0.27)	(0.22)	(0.22)	(0.30)	(0.24)	(0.28)	(0.22)
Sample Size	2010	2059	2056	2326	1892	1830	1848	1950
B. By mother's education								
	0-6 years				*7+ years*			
2005Q2	-0.76	-0.18	-0.02	0.63	-0.81	-0.60	0.14	-0.10
	(0.27)	(0.26)	(0.31)	(0.24)	(0.25)	(0.24)	(0.20)	(0.20)
2005Q3	0.16	-0.38	0.09	0.33	-0.16	0.06	-0.24	0.37
	(0.28)	(0.24)	(0.24)	(0.21)	(0.27)	(0.24)	(0.25)	(0.21)
Sample Size	1931	1950	2025	2208	1906	1874	1817	2014
C. By father's education								
	0-6 years				*7+ years*			
2005Q2	-0.75	-0.09	0.25	0.68	-0.83	-0.58	0.09	0.02
	(0.28)	(0.31)	(0.35)	(0.30)	(0.26)	(0.23)	(0.20)	(0.19)
2005Q3	0.10	-0.39	-0.13	0.09	-0.19	0.01	-0.12	0.37
	(0.31)	(0.27)	(0.27)	(0.25)	(0.27)	(0.25)	(0.25)	(0.22)
Sample Size	1611	1643	1677	1837	2141	2100	2082	2300

Note: Errors clustered at the level of mother's pre-disaster enumeration area. Sample of children eligible to be measured in 2006-07. 2002 reference cohort.

The results for maternal education are found in Panel B. In 2006-07 significant height differences are present for children regardless of whether their mothers have more or less than six years of education. However by the next year, the children of less educated mothers appear to catch up and later surpass the older cohort (0.63 standard deviations taller than children born in 2002), while children of more educated mothers do not catch up until 2008-2009. The results for father's education (Panel C) are similar.

For PCE and particularly for parental education, it appears that by 2009-10, children born to parents who were at the more disadvantaged end of the SES spectrum before the tsunami are somewhat more likely to surpass their older counterparts with respect to height for age than are children born to parents who were better off before the tsunami. This pattern may arise because the older children of the better off parents are relatively taller for their age before the tsunami, making it particularly difficult for their younger counterparts to surpass them.

In any event, it does not appear that pre-existing differences in background characteristics explain the results for exposure to the disaster.

6. Conclusions

Drawing on extremely rich longitudinal survey data collected before and after the 2004 Andaman-Sumatra earthquake and tsunami, this research has examined the impact of the upheaval and disruption surrounding a large-scale unanticipated shock in utero and during the first two years on subsequent linear growth. To avoid complicating the interpretation by having to take into account selective maternal and infant survival, we focus on children whose mothers were living in areas that were not heavily damaged by the tsunami and where there was essentially no excess mortality due to the earthquake or tsunami.

The evidence points to substantively large and statistically significant deficits in height, given age, two years after the earthquake. These deficits are larger among children whose mothers were exposed to greater levels of stress (broadly defined) as a result of the disaster. However, five years after the disaster, the children had made up the deficits compared to their older peers whose height was plausibly not affected by the disaster.

Our results have at least two key implications. First, although the evidence suggests that to the extent that birthweight was affected by the earthquake or tsunami, the size of the impact was small (Hamoudi et al. 2012), it would be premature to conclude that there were no impacts on child health, as some of the literature has suggested. Second, while we cannot rule out other potential long-term health deficits caused by the disaster, its aftermath, or catch-up growth itself (e.g., cognitive, metabolic), short-term negative impacts on linear growth apparently did not translate into longer-term negative impacts for height. Rather, the evidence indicates that the post-trauma resource environment (again broadly defined) plays an important role in mitigating the short-term health costs of early life exposures to negative shocks. This is an important result both from the point of view of the scientific evidence and also from a policy point of view. The massive reconstruction effort almost surely played a role in the recovery of linear growth and the evidence from STAR suggests very high levels of resilience and that, in the appropriate environment, there is substantial scope for catch-up growth in the first few years of life.

2. Impact of a Natural Disaster on Observed Risk Aversion

2.1 Introduction

Attitudes toward risk and deferred gratification are thought to be important determinants of many economic behaviors, including running a self-owned business, investing in new productive technologies, and investing in human capital. Determining how these attitudes vary with life experiences is difficult, however, because experiences often result from choices that reflect these underlying attitudes. I exploit an exogenous large-scale shock – a natural disaster – to examine the impact of unanticipated shocks on attitudes toward risk. In doing so, I also provide new evidence on whether large adverse events change the economic risks that exposed individuals choose to assume as they rebuild their livelihoods, and thereby speak to important policy questions regarding aid and reconstruction after such events.

The questions of whether and how attitudes toward risk and deferred gratification (or “time discounting”) change in the aftermath of an adverse event is largely unsettled in the scientific literature. Research from psychology suggests that psychological trauma and symptoms of posttraumatic stress are strongly associated with maladaptive behaviors such as risky sexual practices and substance abuse (Gore-Felton and Koopman 2002, Brady and Donenberg 2006, Pat-Horenczyk et al. 2007, Dell’Osso et al. 2013, Kianpoor and Bakhshani 2012), but it is unclear how these maladaptive behaviors relate to economic behavior.

Recently, researchers have used methods specifically designed to elicit attitudes in the context of financial decisions to investigate how disruptive events affect attitudes toward risk and time discounting. These studies have investigated the impact of exposure to a variety of events, including hurricanes (Eckel, El-Gamal, and Wilson 2009), tsunamis (Callen 2011; Cassar, Healy, and von Kessler 2011), recurring floods and earthquakes (Cameron and Shah 2013), and violent conflicts (Moya 2012, Voors et al. 2012, Kim and Lee 2013, Callen et al. 2014). The findings in these studies are mixed, with some studies finding that exposure to disruptive events leads to an increase in observed aversion to risk (Cassar, Healy, and von Kessler 2011; Moya 2012; Cameron and Shah 2013; Kim and Lee 2013; Callen et al. 2014) and others finding a decrease (Eckel, El-Gamal, and Wilson 2009; Voors et al. 2012). Similarly with time discounting, some studies find that exposure to disruptive events leads to more discounting of the future (i.e., less willingness to defer gratification) (Voors et al. 2012; Cassar, Healy, and von Kessler 2011) and others find that exposure leads to less discounting (Callen 2011).

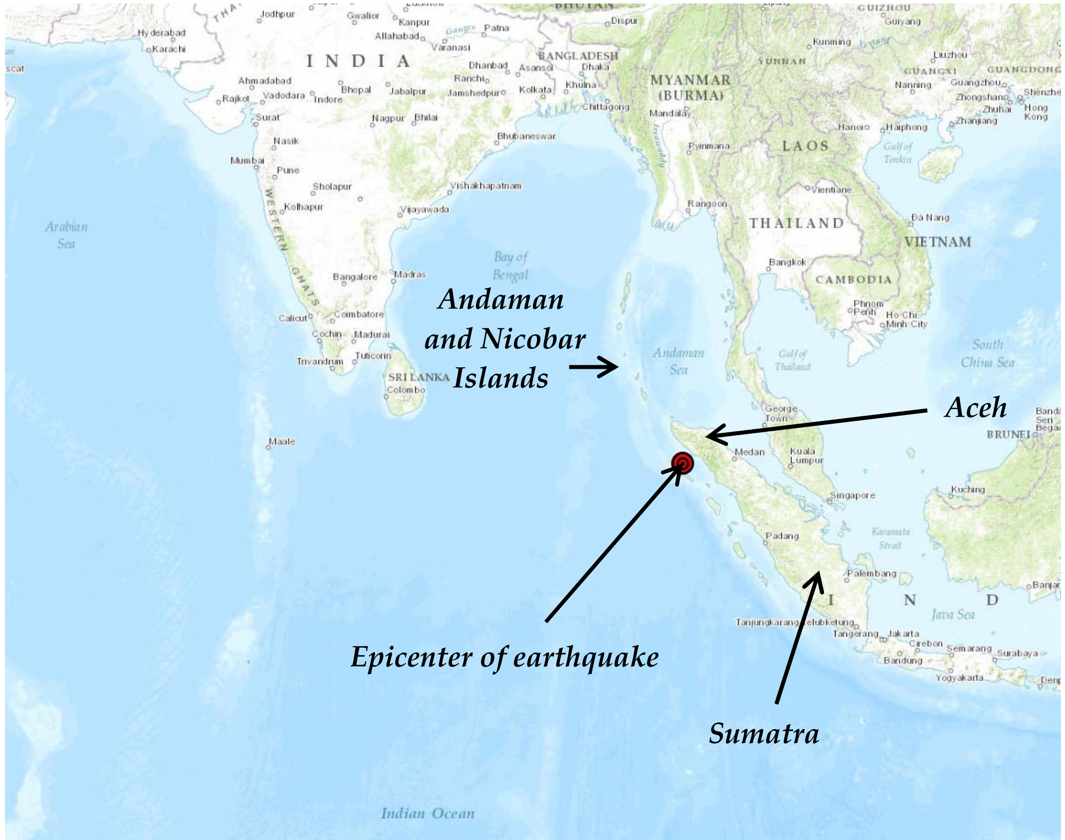
All of these studies have important shortcomings. In many of the previous studies, exposure to adverse events may be selected on characteristics related to attitudes toward risk. For example, periodic floods (Cameron and Shah 2013) and violent conflicts occurring over extended periods of time (Moya 2012, Voors et al. 2012, Kim and Lee 2013, Callen et al. 2014) are arguably predictable, so the degree of exposure may be related to anticipatory behavior related to attitudes toward risk (e.g., migration).

Another concern is that the study samples are not representative of the populations initially exposed to the adverse events. Many of the samples are drawn non-randomly (e.g., Eckel, El-Gamal, and Wilson 2009; Cassar, Healy, and von Kessler 2011), and/or are drawn from post-event populations (e.g., Callen 2011; Cassar, Healy, and von Kessler 2011; Moya 2012; Voors et al. 2012; Cameron and Shah 2013) and therefore cannot fully account for selective migration, which may be correlated with attitudes toward risk. In addition, their results may not be generalizable to broader populations because of high refusal/attrition rates (Callen et al. 2014, Kim and Lee 2013) and/or because only a single member of each household in the sample participated in the study (Moya 2012, Voors et al. 2012, Cameron and Shah 2013).

I address these issues in this study by utilizing arguably exogenous variation in exposure to an unanticipated natural disaster, the 2004 Indian Ocean tsunami, to identify the impact of exposure on attitudes toward risk elicited from a survey instrument that uses hypothetical financial choices. I use longitudinal survey data collected in Indonesia both before and after the disaster (Study of the Tsunami Aftermath and Recovery). The baseline sample is representative of the pre-disaster population and intensive efforts were made to track and interview migrants. The panel design of the data allows an investigation of the both the short and long-term impacts of the disaster, which has not been possible in previous studies. In this study, I focus on the impact of the disaster on attitudes toward risk, and I also present results for the impact on time discounting.

The results suggest that personal physical exposure to the tsunami leads to a significant but temporary decrease in observed risk aversion in the year after the disaster. This is especially true for older and relatively poor individuals. These effects increase with the intensity of exposure, as measured by posttraumatic stress reactively reported by tsunami survivors. In addition, these effects are independent of economic losses captured by the loss of personal assets in the tsunami, which have less consistent impacts on observed risk aversion. Five years after the disaster, however, no evidence of any impacts of exposure to the disaster remain, nor do changes in attitudes toward risk appear to be related to any changes in time discounting.

This paper: (i) discusses the geographic setting of this study, the 2004 Indian Ocean tsunami, and potential ways the disaster could have affected observed attitudes toward risk, (ii) describes the data and the instrument used to elicit attitudes toward risk, (iii) discusses the methods used in the study and the results of the analysis of attitudes toward risk, (iv) presents evidence of changes in time discounting and the relationship between the risk measure and risk-related economic behavior; and (v) concludes with thoughts about the results and their implications for policy-making.



Map courtesy of DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community.

Figure 2.1: Map of 2004 Indian Ocean tsunami

2.2 The Disaster: 2004 Indian Ocean Tsunami

At 8 a.m. on December 26, 2004, an earthquake with an estimated magnitude of 9.1-9.3 on the Richter scale occurred 160 kilometers off of the west coast of the island of Sumatra in Indonesia (see Figure 2.1). The earthquake resulted in a rupture that extended over 1000 kilometers northwest from its epicenter to the Andaman and Nicobar Islands. The sea floor rose suddenly along the rupture, displacing over 25 trillion tons of water and sending out waves of water that radiated away from the rupture at up to 1000 kilometers per hour. As the displaced water approached land, large waves formed in shallower waters and came ashore at heights up to 35 meters in some locations (Tsuji et al. 2005). The tsunami struck coastlines across the Indian Ocean, reaching as far as east Africa some 7-9 hours after the initial earthquake.

Coastal communities near the epicenter of the initial earthquake in the province of Aceh in Indonesia were the most heavily impacted by the tsunami. The first waves struck Aceh less than 20 minutes after the earthquake and caused large amounts of mortality and destruction along the coast. In Aceh, an estimated 4% of the population (170,000 people) died in the tsunami, but there was variation in the extent of mortality across communities, with over 70% of the population killed in some coastal communities.

In addition, damage from the tsunami displaced an estimated 500,000 people and caused $4.5 billion in destruction (roughly the GDP of Aceh in 2003) according to initial estimates (the estimate was later increased to $7.1 billion, Nicol 2013). Of the $4.5 billion in estimated losses, roughly 60% consisted of lost assets and 40% consisted of lost income. Small-scale agricultural production, especially fishing and aquaculture, was badly affected. An estimated 40-60% of coastal aquaculture ponds and 65-70% of fishing capital such as boats and equipment was damaged or lost in the tsunami (Jayasuriya and McCawley 2010). The tsunami was also psychologically traumatic, elevating posttraumatic stress in those that survived the disaster, especially for those who were physically exposed to the tsunami (Frankenberg et al. 2008).

The disaster was followed by an unprecedented influx of domestic and foreign assistance, provided by international governments, Indonesian governmental agencies, NGOs, and local organizations and individuals. The amount of formal assistance delivered far exceeded that of any previous disaster relief effort in a developing country. By the end of 2007, over $7.7 billion was committed for assistance by formal sources for Indonesia alone. Family, friends, and neighbors of survivors also provided substantial assistance, including temporary housing, especially in the aftermath of the tsunami before formal relief efforts were fully in place (Jayasuriya and McCawley 2010).

Early assistance focused largely on emergency relief (e.g., short-term shelter, food, and clean water). In May 2005, under the auspices of the Indonesian Government's Agency for the Rehabilitation and Reconstruction, the assistance effort changed its focus to the reconstruction of housing and infrastructure and the rehabilitation of livelihoods, including programs to restore agricultural and fishing production, promote small businesses, and support cash-for-work and job training programs. These programs likely had large impacts on the socioeconomic livelihoods of survivors (as well as those for whom direct impacts were minimal), so the long-term impacts of the tsunami include the impact of the disaster itself and the impact of the assistance efforts.

Two aspects of the tsunami suggest that it can be treated as a natural experiment for the study of the impact of many types of exposure on attitudes toward risk: The first is that the tsunami was unanticipated by the people living on the coast. Geologic evidence indicates that the last tsunami to strike the island of Sumatra occurred over 600 years ago (Monecke et al. 2008). In fact, only 1% of households interviewed 9-10 months before the disaster as part of the baseline survey used in this study (discussed in Section 2.4.1) reported that their home was in a location that was at high risk of a hurricane or tsunami.[1] As a result, anticipation of a tsunami was not a driver of choice of residential location along the coast of Aceh.

In addition, no tsunami warning system was in place in the Indian Ocean at the time of the tsunami, and the first tsunami waves reached the coast less than 20 minutes after the first earthquake. In fact, the only warning sign that a tsunami was imminent was that the ocean receded just before the arrival of the tsunami, but evidence suggests

---

[1] Households first reported on whether their house was located in a location that was at high risk of a natural disaster. If they reported that it was at high risk, then they specified the type of disaster from a list. Hurricanes and tsunamis were presented together as a single category in the list.

that this warning was not understood by those living on the coast everywhere other than the island of Simuelue, which had experienced a tsunami nearly 100 years before the 2004 disaster (Jayasuriya and McCawley 2010, Yulianto et al. 2010).

The second important aspect is that variation in exposure to the tsunami in coastal areas is plausibly exogenous to attitudes toward risk. Inundation by the tsunami waves was a complex function of the distance to the coast, elevation, slope, water depth, the shape of the coast, and the proximity to rivers and canals (Ramakrishnan et al. 2005). Because the tsunami radiated directly away from the line of the undersea rupture, the size of the tsunami waves that hit a coastal community varied with physical exposure of the coastal area to the rupture (for example, communities on shorelines angled away from the rupture were less exposed than nearby communities on shorelines facing the rupture). These geographic and topographic features are plausibly unrelated to attitudes toward risk at a local level, so variation in exposure caused by these features is likewise unrelated to pre-disaster attitudes toward risk.

One confounding factor for an analysis of a major mortality event like the tsunami is the influence of selective mortality on the population. If the likelihood of survival was related to attitudes toward risk, then selective mortality will confound the analysis by altering the distribution of risk attitudes in the population of survivors. Previous research suggests that mortality in the tsunami was certainly selective in that physical strength was advantageous (hence the greater survival chances of prime-age males), but selection based on other common correlates of attitudes toward risk, such as socioeconomic status, is not present (Frankenberg et al. 2011). Although the evidence suggests that selective mortality is not an important concern for this analysis, I run the analysis separately for areas with and without substantial mortality in order to test for the influence of differential mortality on attitudes toward risk.

2.3. Potential Pathways for Changes in Attitudes Toward Risk

The tsunami and resulting aftermath may have affected attitudes toward risk through a number of plausible pathways. The most direct way is by altering an individual's economic circumstances. Under classic economic models of expected utility with concave utility functions (e.g., von Neumann-Morgenstern) a decrease in wealth is associated with a decrease in absolute risk aversion. Empirical research suggests that observed risk aversion may decline with increased wealth and increase with increased liquidity constraints (Gollier 2000, Guiso and Paiella 2008). After the tsunami, many people lost their wealth and sources of income, which implies that observed risk aversion could increase. However, the disaster was also followed by a large assistance effort that may have increased wealth and eased liquidity constraints, at least in later years, which implies that observed risk aversion could decrease.

In addition, attitudes toward risk may have changed after the tsunami because of changes in perceptions or tastes for risk. Being exposed to a large, destructive natural disaster may have increased survivors' perception of the risks involved in owning assets or earning income near the coast, which could reduce the survivors' willingness to take on those economic activities. The disaster also may have changed perceptions of so called "background risks," which are risks that individuals cannot avoid but are external to the risk involved in a particular decision that individuals are considering. Economic theory cannot clearly predict the relationship between background risk and aversion to other risks, because that relationship depends on the nature of the individual's utility function (Gollier and Pratt 1996, Quiggin 2003), which is supported by the empirical literature (Eeckhoudt, Gollier, and Schlesinger 1996; Guiso and Paiella 2008; Lusk and Coble 2008). It is also possible that exposure to a natural disaster may change observed risk aversion through changes in intrinsic tastes for risk. Economic models of decision-making involving risks allow for individuals to differ in their intrinsic tastes for risk, but the models have traditionally assumed that tastes were set at birth and permanently fixed for each individual and therefore do not provide predictions of the direction or duration of changes that may follow a natural disaster.

In addition to the research discussed in the introduction, there is a large body of empirical research that provides suggestive evidence of how a natural disaster may affect attitudes toward risk. For example, a body of psychology research suggests that individuals exposed to trauma are more prone to behave in risky ways after the trauma with regards to risky sexual practices and substance abuse (Brady and Donenberg 2006, Pat-Horenczyk et al. 2007, Dell'Osso et al. 2013). In addition, studies have found that risk-taking behaviors are associated with experiencing symptoms of posttraumatic stress (Pat-Horenczyk et al. 2007). These findings suggest that observed risk aversion may be lower for individuals exposed to a tsunami, but it is unclear whether decisions regarding non-financial risk-taking behaviors are models for decisions to undertake financial risks, which are the focus of this study.

The field of endocrinology also offers evidence that suggests, for example, that testosterone and stress (specifically the release of the stress hormone cortisol) may be related to observed risk aversion (e.g., Coates and Herbert 2008; van den Bos, Harteveld, and Stoop 2009). In addition, there is evidence that the association between stress and risk aversion may differ for men and women, with men demonstrating significantly less observed risk aversion and women demonstrating more risk aversion while they are experiencing experimentally-induced stress (van den Bos, Harteveld, and Stoop 2009). In the context of the tsunami, these findings suggests that survivors who experienced persistent elevated levels of physiological stress in the aftermath of the disaster may demonstrate different observed risk aversion while their stress is elevated. Although I cannot incorporate experimentally-induced stress in this study, I draw on measures of posttraumatic stress reaction constructed from respondents' reports of symptoms related to posttraumatic stress in the aftermath of the disaster.

2.4. Data and Methods

2.4.1 Survey Data

The data for this study is drawn from the Study of the Tsunami Aftermath and Recovery (STAR), a longitudinal study of households and individuals in Aceh and North Sumatra. The baseline line data was collected by Statistics Indonesia (BPS) as part of their annual cross-sectional Socioeconomic Survey (SUSENAS) in January to May 2004 (7 to 12 months before the disaster). The baseline sample is representative of the pre-disaster population at the district level, which is one administrative level below the province.

The STAR follow-up surveys were first conducted from May 2005 to May 2006 with follow-up surveys conducted annually through May 2009 to May 2010. The baseline communities in STAR were drawn from the sample of communities in the 2004 SUSENAS and include coastal communities with a wide variation in exposure to the tsunami. Survival status was obtained for each individual in the STAR baseline sample. Tsunami-related mortality was 23% in the sample of high mortality communities and < 1% in the sample of low mortality communities (6% in the overall sample). Re-interviews were attempted for all survivors, including all migrants who remained in Aceh and North Sumatra as well as any migrant who moved elsewhere in Sumatra or moved to the island of Java (the most populous island in Indonesia and the site of the national capital, Jakarta). Tracking migrants is especially important in this survey because displacement and migration was common after the tsunami, and it is possible that the decision to migrate is related to attitudes toward risk.

In order to focus on the immediate and long-run impacts of the tsunami on attitudes toward risk, the primary sample for this study is the panel of baseline respondents in STAR with observed risk aversion measured in both the 2005 and 2009 surveys (approximately 1 and 5 years after the disaster). The final analytic sample consists of 11891 individuals – 2837 from high mortality communities and 9054 from low mortality communities. The analytic sample makes up 70% of the 16865 baseline adults who were eligible to be interviewed in both the 2005 and 2009 STAR surveys (67% of eligible individuals in high damage communities and 72% of eligible individuals in low damage communities).[2] Of the eligible baseline individuals, 13427 (80% of eligible baseline adults) were interviewed in 2005 and 14252 (85%) were interviewed in 2009.[3]

---

[2] The number of baseline adults eligible to be measured in 2005 and 2009 excludes all respondents who have died since the baseline survey was conducted in 2004.

[3] I analyze the correlates of attrition from the samples measured in 2005 and 2009, measured in 2005, and measured in 2009 (conditional on measurement in 2005). The results are presented in Appendix Table 2.1. Attrition is related to expected correlates of migration (e.g., male, under 30, higher socioeconomic status, lower education) and of being less capable or more unwilling to answer the risk instrument in the survey (e.g.., lower cognition, lower education). In Appendix Table 2.2, I examine the association between attrition in 2009 for respondents measured in 2005 and observed risk aversion in 2005 and whether the individual was physically exposed to the tsunami. Risk aversion measured in 2005 and being physically exposed to the tsunami are not predictive of attrition in 2009 (with the inclusion of individual controls in the case of risk aversion). As a further test of the impact of attrition on the results, I also analyze the impact of the tsunami on risk aversion in 2005 using all respondents measured in 2005 (see results, Section 2.5.1).

The STAR surveys collect individual and household measures of demographics, socioeconomics, physical and economic exposure to the tsunami, and an instrument designed to elicit attitudes toward risk, which is discussed in detail in the next section.

2.4.2 Risk Instrument

In the STAR surveys, an instrument using hypothetical choice tasks was fielded to elicit respondents' attitudes toward risk (similar to those used in Holt and Laury 2002). This type of instrument has been used in many economic studies of attitudes toward risk and has been validated with behavior (Barsky et al. 1997, Bonin et al. 2007, Dohmen et al. 2011, Guiso and Paiella 2008). An example of the risk instrument in STAR is graphically presented in Figure 2.2 (the specific questions used in the instrument for the example is presented in Appendix Figure A.2.1).

In the STAR risk instrument, every adult respondent (those at least 15 years of age at the time of interview) is asked which option they prefer between pairs of hypothetical monthly income streams. For example, in Choice 1 (Figure 2.2), the respondent is asked to choose between a monthly income stream equivalent to $40 USD and an income stream that returns either $80 or $30 with equal likelihood.[4] The hypothetical incomes presented in the instrument were designed to be large enough to

[4] In the STAR surveys, monetary values were presented in Indonesian Rupiah (the local currency), but for ease of interpretation all monetary values in this paper are presented in equivalent $USD ($1 USD ≈ 10,000 Indonesian Rupiah).

be plausible and economically relevant (e.g., the mean monthly per capita expenditure for households in the sample is around $40).

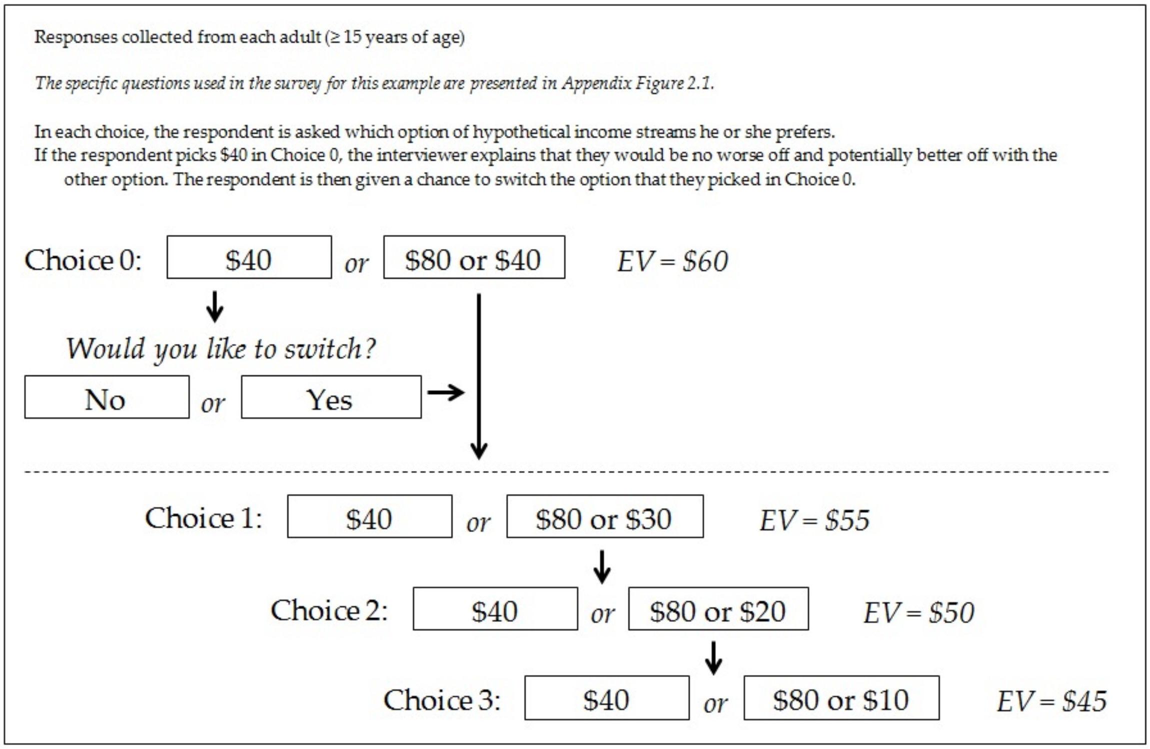


Figure 2.2: Example of STAR risk instrument

The income streams presented in the STAR instrument were designed such that the uncertain option is financially attractive (i.e., has higher expected value) but carries risk (i.e., has a chance of generating less money than the certain option). For example, in Choice 1 the uncertain option has a higher expected value than the certain option ($55 vs. $40) but could result in lower income if the respondent is unlucky (only $30 vs. $40). As a result of this design, respondents who pick the uncertain outcome demonstrate that they are willing to take on more risk than respondents who pick the certain outcome.

In order to more fully differentiate the respondents' relative willingness to assume risk, respondents who pick the uncertain outcome are given another choice involving even more risk. In the example in Figure 2.2, respondents who pick the uncertain option in Choice 1 go on to Choice 2, where the certain option is the same as before ($40) but the uncertain option is now less attractive (i.e., lower expected value – $50) and involves more risk (i.e., $20 < $30 < $40) than in Choice 1. Respondents who pick the uncertain outcome in Choice 2 are given a third choice that involves even more risk, Choice 3. The instrument ends after the third choice.

By design, the choices that respondents make across the instrument indicate their relative willingness to assume risk, at least for the financial options presented in the instrument.[5] Throughout the analysis, I measure relative observed risk aversion in the sample with the implied rank order of risk aversion, which is indicated by the point at which respondents exit the instrument. The rank order ranges from the most risk-averse respondents, who pick the certain option in Choice 1, to the least risk-averse respondents, who pick the uncertain option in Choice 3.

In every STAR survey, each respondent was randomly given one version of the risk instrument chosen from several that present income streams of different magnitudes. This variation was included to allow researchers to test the importance of

---

[5] In order to create a consistent rank order, I assume that respondents who pick a certain option in one choice would consistently pick the certain option in later choices.

the magnitude of the income streams in measured attitudes toward risk. In the 2005 survey, four versions were fielded, with certain income streams of $20, $40 (the example shown in Figure 2.2), $80, and $120. In the 2009 survey, two versions were fielded, with certain options of $30 and $60. Because the distribution of observed risk aversion and my results do not differ systematically by the values of the income streams, I combine the different versions of the instrument and report results for analyses using the rank order measure of relative risk aversion described above.[6]

The instrument was also designed with a baseline choice that is presented to the respondents before the first choice (Choice 0 in Figure 2.2). In this choice, the certain outcome ($40) has no monetary advantage over the uncertain outcome ($80 or $40), so the uncertain outcome carries no risk relative to the certain outcome. In economic decision theory, this condition is known as "first order stochastic dominance." A commonly adopted assumption in decision theory is that if an individual is presented with first order stochastic dominance, they will never prefer the dominated option. Evidence from laboratory studies measuring attitudes toward risk, usually involving undergraduate students in developed countries, has been largely consistent with this assumption (e.g., Loomes and Sugden 1998; Birnbaum, Patton, and Lott 1999; Moffatt and Peters 2001).

---

[6] For example, the distribution of measured risk aversion and results for the primary analysis stratified by the different versions of the risk module are presented in Appendix Table 2.3.

One caveat to this assumption is that individuals may still pick the dominated option, even when do not prefer it, if they do not fully understand the choice. In an effort to reduce the chance that misunderstanding drives the decisions recorded with the baseline choice, the following check is implemented when a respondent picks the dominated option: First, the interviewer explains to the respondent that the uncertain option would always result in an income at least as high as the income in the certain dominated option. Then, the respondent is given an opportunity to switch to the uncertain option. After the baseline choice is complete, the respondents who ultimately pick the uncertain dominating option go on to the other choices (as pictured in Figure 2.2).

The fraction of respondents in the analytic sample who ultimately pick the dominated certain option in the baseline choice is presented in Figure 2.3. Despite the assumption commonly made in decision theory, most respondents in the STAR sample choose the dominated option. In the 2005 survey, over 50% of the sample respondents choose the dominated option. This increases in the 2009 survey to nearly 70% of the respondents. This pattern is not unusual in Indonesia with this type of risk instrument. Similar instruments have been used in the Indonesian Family Life Survey (IFLS), a longitudinal survey representative of 84% of the Indonesian population (which excludes Aceh), and in the Worker Iron Supplementation Evaluation (WISE) survey, a longitudinal survey in a rural village in central Java. The prevalence of respondents picking the dominated option in those surveys is also shown in Figure 2.3. In both IFLS and WISE, over 40% of respondents demonstrate a similar preference for the dominated certain option.

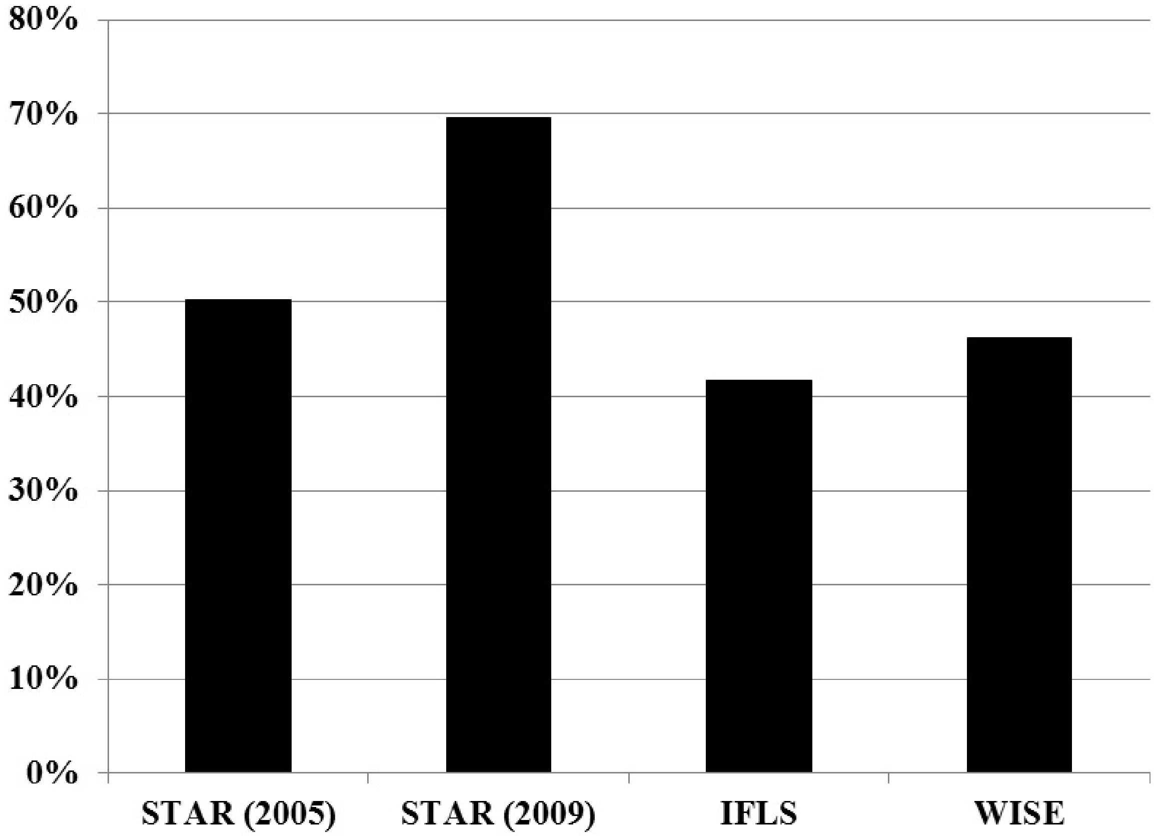


Figure 2.3: Fraction of individuals who pick dominated certain option

Why do so many of the STAR respondents demonstrate a preference for the certain options (what I will refer to as a "certainty preference")? One possibility is that there is a stigma attached to the uncertain option. Aceh has a strongly Islamic culture and gambling is outlawed in the province. However, the choices in the instrument are explicitly framed as income streams in order to reduce any association with gambling. In addition, in IFLS, which includes a measure of respondents' religion, the preference for certainty is not unique to Muslims (see Appendix Table 2.4), which suggests that the result does not arise simply from stigma related to religious convictions.

Although it is possible that the respondents do not understand the options, the survey design directly addresses this. First, the probabilities used in the instrument are set to an equal chance, a cognitively simple probability. Second, the stochastic dominance of the uncertain option is explained to the respondent by the interviewer if the respondent picks the certain option, and the respondent is given the opportunity to switch his or her response. Switching was actually very uncommon (7.3% in the 2005 survey and 2.8% in the 2009 survey), which suggests that incomprehension is unlikely to be an important factor.

Although it is not entirely clear why so many respondents demonstrate a preference for certainty in the sample, it may be the case that the respondents who prefer certainty are in practice more risk-averse in their economic behavior than the respondents who pick the dominating uncertain option. In order to account for this uncertainty, a preference for certainty is categorized in two ways in the analysis: as the most observably risk-averse category and as a separate category rather than as part of the risk aversion continuum.

2.4.3 Methods

I begin the analysis by investigating the short-term impact of exposure to the disaster on attitudes toward risk using observed risk aversion measured in 2005. The measures of observed risk aversion used in the analysis are categorized by the stopping points in the STAR risk instrument with increasing rank order of risk aversion across the categories (i.e., 1 = least risk-averse, 4 = most risk-averse, and 5 = certainty preference).

I use three different measures of observed risk aversion as outcomes for the primary analysis. The first measure is a categorical variable of all responses, which incorporates certainty preference as the most risk-averse category (i.e., risk aversion = {1, 2, 3, 4, 5}). For the other two measures, certainty preference is separated from the other risk aversion categories. The two measures include a binary variable of whether a respondent demonstrates certainty preference (i.e., certainty preference = {0, 1}) and a categorical variable like the first measure, which excludes respondents who demonstrate a certainty preference (i.e., risk aversion = {1, 2, 3, 4}). I estimate ordered logit models for the categorical outcomes, which provide the average impact of exposure across the rank-ordered categories of the risk aversion measure. I estimate a logit model for the binary outcome.

Next, I investigate the duration of the impacts of the tsunami by analyzing how observed risk aversion changes from 2005 to 2009 and how the changes relate to exposure. To do this, I estimate two sets of ordered logit models using the full measure of risk aversion (i.e., including certainty preference). I first estimate models of how risk aversion transitions from 2005 to 2009 for both exposed and unexposed individuals. In the transition models, each individual has two observations: one with risk aversion measured in 2005 and one in 2009. The models include controls for the year of measurement (i.e., an indicator variable for 2009), exposure to the tsunami, and the interaction of exposure with the year of measurement. The 2009 control captures the average change in risk aversion between 2005 and 2009 for individuals who were not directly exposed to the disaster, and the interaction term captures differential changes in risk aversion between 2005 and 2009 for individuals directly exposed to the disaster relative to individuals who were not directly exposed. I also estimate the relationship between exposure and observed risk aversion in 2009 using an ordered logit model (similar to the analysis for risk aversion in 2005 above) to examine whether there are remaining differences in risk aversion between exposed and unexposed individuals in 2009.

The first measure of exposure to the tsunami included in the models is personal physical exposure – a binary measure that indicates whether the respondent experienced at least one of nine unanticipated and largely unavoidable tsunami exposures seen in Figure 2.4. The prevalence of personal physical exposure in the sample is presented in Table 2.1. Physical exposure is fairly common in the overall-sample (49%). The prevalence of physical exposure is much higher in high mortality communities (80%)

than low mortality communities (39%), but a significant percentage of respondents from the low mortality communities were still physically exposed to the tsunami.

Responses collected from each adult (≥ 15 years of age)

At the time of the tsunami did you […]

1. Hear the sound of rushing water?
2. Hear people shouting about the water?
3. See tsunami come ashore?
4. Swept away in the water?
5. Sustain injuries?
6. See family members struggle in the water?
7. See family members disappear?
8. See friends/neighbors struggle in the water?
9. See friends/neighbors disappear?

Figure 2.4: Personal physical exposures to the tsunami

The second measure of exposure to the tsunami included in the analysis is tsunami-induced asset loss, which is a more direct measure of the economic impact of the tsunami. In the STAR surveys, each adult respondent reported on their ownership of a variety of assets and whether they experienced damage or loss of those assets in the tsunami. The assets types in the survey are housing, land, livestock, transportation, furniture/utensils, gold, and cash/bonds/stocks.

For the analysis, I group the asset types together into three broad categories based on the magnitudes of value of the assets and likely differences in the role the assets played in the household. The three categories are housing/land, durables (livestock, transportation, and furniture/utensils), and gold/cash. The measures used in the analysis are binary measures of whether the individual experienced any damage or loss of assets in the tsunami in each category, conditional on ownership (a binary measure of whether an individual did not own assets in each category before the tsunami is also included in the analysis, but the results are not reported). Individuals who owned assets in the same category before the tsunami but did not suffer any damage or loss of those assets in the tsunami make up the comparison group in the regression analysis.

The prevalence of ownership and tsunami-induced asset loss for the three categories of assets is presented in Table 2.1. Ownership of housing/land and durables is common (54% and 67% in the overall sample) and similar in high and low mortality communities, but ownership of liquid assets such as gold and cash is much higher in high mortality communities (46%) than low mortality communities (26%). This suggests that respondents from low mortality communities were poorer on average at the time of the disaster. Losing assets in the tsunami is common for respondents from high mortality communities but much less common for respondents from low mortality communities.

As discussed in Section 2.2, I conduct the analysis separately for individuals from communities with and without significant tsunami-related mortality in order to test for the influence of differential mortality on my estimated results. The standard errors for the estimations (other than the transition models) are clustered at the sampling unit of

Table 2.1: Summary statistics for baseline respondents with risk aversion measured in 2005 and 2009

By mortality in pre-disaster community

	All Communities			High Mortality			Low Mortality		
	N	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*
					Exposures				
Personal physical exposure	11891	0.49		2837	0.80		9054	0.39	
Damage/loss of assets									
Housing and land									
Not damaged	11891	0.35		2837	0.20		9054	0.40	
Damaged	11891	0.18		2837	0.32		9054	0.14	
Did not own	11891	0.46		2837	0.48		9054	0.46	
Durables									
Not damaged	11891	0.47		2837	0.26		9054	0.53	
Damaged	11891	0.20		2837	0.43		9054	0.13	
Did not own	11891	0.33		2837	0.31		9054	0.34	
Gold and cash									
Not damaged	11890	0.25		2836	0.25		9054	0.25	
Damaged	11890	0.06		2836	0.21		9054	0.02	
Did not own	11890	0.69		2836	0.54		9054	0.74	
Max posttraumatic stress *Index: 0-21*	11872	7.3	4.6	2834	9.1	4.8	9038	6.8	4.4
					Individual controls				
Male	11891	0.46		2837	0.50		9054	0.45	
Years of age (2005)	11891	35.2	13.9	2837	35.3	13.8	9054	35.2	13.9
< 20 years		0.15			0.14			0.15	
20-29 years		0.25			0.27			0.25	
30-39 years		0.25			0.25			0.25	
40-49 years		0.19			0.19			0.19	
50-59 years		0.10			0.10			0.10	
60+ years		0.06			0.06			0.06	
Years of education	11891	2.7	1.4	2837	3.0	1.4	9054	2.6	1.4
0 years		0.07			0.05			0.07	
1-5 years		0.13			0.08			0.15	
6 years		0.25			0.23			0.25	
7-9 years		0.22			0.20			0.22	
10-12 years		0.25			0.29			0.23	
13+ years		0.09			0.15			0.07	
Word recall (z-scores)									
1st recall	11640	0.00	1.00	2768	0.08	1.01	8872	-0.03	0.99
2nd recall (later)	11640	0.00	1.00	2768	0.12	1.02	8872	-0.04	0.99
Pre-disaster PCE ($USD)	11891	36.2	26.5	2837	42.4	27.4	9054	34.2	25.9
SES ladder [1-6]	11891	2.6	0.8	2837	2.9	0.8	9054	2.5	0.7
Ladder: 1-2		0.46			0.29			0.51	
Ladder: 3		0.44			0.50			0.43	
Ladder: 4-6		0.10			0.21			0.06	
Urban pre-disaster community	11891	0.30		2837	0.43		9054	0.26	
Distance to the coast (km)	11891	6.6	8.8	2837	3.0	3.7	9054	7.7	9.6
Elevation (m)	11891	28.4	46.9	2837	17.0	32.3	9054	32.0	50.2
Coastal wave height (m)	11891	7.3	4.7	2837	11.7	4.9	9054	5.9	3.7
					Household run business				
HH run business in 2005	5949	0.48		1527	0.42		4421	0.49	
HH run business in 2009	7676	0.48		1925	0.44		5750	0.49	

furniture/utensils. The gold and cash asset category includes gold and cash/bonds/stock. Maximum posttraumatic stress is an index of the frequency of tsunami-induced posttraumatic stress symptoms experienced by the respondent and ranges from 0 to 21 (explained in more detail in Section 6). The unit of observation for Exposures and Individual control measures is the individual. The unit of observation for Household run business measures is the household.

the baseline survey ("enumeration areas"). The sampling units are roughly equivalent to census blocks, from which 16 baseline households per cluster are sampled. The standard errors for the transition models are clustered at individual respondents.

All of the models include controls for individual attributes and for geographic attributes of the pre-disaster community. The individual controls include demographic characteristics (sex, age in 2005), human capital (pre-disaster years of education, measures of cognition using word recall tasks), pre-disaster socioeconomic status ("SES") (per capita household expenditure, self-reported relative SES), whether the individual's pre-disaster community is urban or rural, and the month-year of interview (to control for time effects, given the lengthy nature of the survey process). The self-reported relative SES is measured using a retrospective self-report of the respondent's position on a 6-step ladder representing the range of SES known to the respondent (i.e., 1 represents the poorest individuals and 6 represents the wealthiest individuals).

Three geographic controls of the pre-disaster community are included in the models: elevation, the distance to the coast, and the maximum height of the tsunami waves at the closest point on the coast. These controls are included to account for non-random exposure to the tsunami due to geographic factors (see discussion in Section 2.2).[7] As an additional control for non-random exposure, I also estimate OLS models for

[7] Being physical exposed to the tsunami is predicted by a number of individual characteristics in low mortality communities, including sex, education, SES, and cognition, but only sex and cognition remain significant predictors of exposure with the inclusion of geographic characteristics (see Appendix Table 2.5).

the impact of exposure in 2005 with fixed effects for pre-disaster communities.[8] Because rank order measures of risk aversion are not appropriate for an OLS model, I use three binary measures of risk aversion in 2005 for the community fixed effect models: (i) whether an individual prefers certainty, (ii) whether a respondent prefers certainty or is the next most risk-averse (as opposed to the other risk aversion categories), and (iii) whether a respondent is the next most risk-averse, excluding individuals who prefer certainty.[9]

Descriptive statistics for the individual and geographic controls are presented in Table 2.1. There is evidence that individuals from high and low mortality communities are observably different. High mortality communities have higher pre-disaster SES on average and are more likely to be in urban areas. On average, high mortality communities are also closer to the coast, have lower elevation, and had higher

---

Men are slightly more likely to be exposed than women, which may be because men were marginally more likely to be working out of the house closer to the coast than women. The relationship with cognition is complicated and may be more closely related to the probability of reporting exposure rather than exposure itself. More importantly other individual characteristics, which are related to observed risk aversion (i.e., age, education, SES; see Table 2.2) are no longer significant predictors of exposure. The geographic characteristics themselves are also related to exposure in ways that are consistent with the amount of tsunami inundation in the community (e.g., individuals living closer to the coast were more likely to be exposed) (see Appendix Table 2.6).

[8] In the community fixed effect models, pre-disaster communities are represented by pre-disaster enumeration areas.

[9] The latter two measures are not used as outcomes in the primary analysis, so regression results of logit and OLS models without community fixed effects for those outcomes are presented in an appendix table for comparison.

maximum tsunami wave height at the nearest point on coast, which is consistent with experiencing greater water inundation at the time of the tsunami.

Table 2.2: Relationship between individual characteristics and observed risk aversion

Sample of baseline respondents with risk aversion measured in 2005 and 2009

	2005		*2009*			*2005*		*2009*	
	Risk Averse	Certainty Preference	Risk Averse	Certainty Preference		Risk Averse	Certainty Preference	Risk Averse	Certainty Preference
	Ordered Logit	*Logit*	*Ordered Logit*	*Logit*		*Ordered Logit*	*Logit*	*Ordered Logit*	*Logit*
Male	0.78	0.84	0.79	0.82	Cognition (1st) z-score	0.84	0.82	0.86	0.87
	(-7.79)	(-4.86)	(-5.62)	(-4.49)		(-5.54)	(-5.31)	(-4.21)	(-3.94)
					Cognition (2nd) z-score	1.10	1.12	1.10	1.09
Age: < 20 years	1.02	1.06	1.00	1.00		(3.15)	(3.36)	(2.69)	(2.40)
	(0.36)	(0.84)	(-0.04)	(-0.04)					
Age: 30-39 years	1.02	1.03	0.85	0.87	Pre-tsu PCE: 2nd quartile	0.86	0.81	1.06	1.08
	(0.37)	(0.47)	(-2.99)	(-2.62)		(-2.01)	(-2.54)	(0.76)	(1.04)
Age: 40-49 years	1.16	1.23	0.93	0.95	Pre-tsu PCE: 3rd quartile	0.66	0.62	1.00	1.01
	(2.57)	(3.49)	(-1.14)	(-0.81)		(-4.62)	(-4.91)	(0.04)	(0.19)
Age: 50-59 years	1.10	1.10	1.05	1.06	Pre-tsu PCE: 4th quartile	0.61	0.57	1.06	1.09
	(1.48)	(1.32)	(0.60)	(0.78)		(-5.23)	(-5.28)	(0.67)	(1.01)
Age: 60+ years	1.47	1.43	1.29	1.31					
	(4.68)	(3.95)	(2.62)	(2.71)	Pre-tsu SES ladder: 3	0.77	0.75	1.11	1.13
						(-4.40)	(-4.27)	(2.37)	(2.55)
Education: 0 years	1.46	1.59	1.50	1.51	Pre-tsu SES ladder: 4-6	0.55	0.59	1.05	1.07
	(3.54)	(4.27)	(4.68)	(4.60)		(-6.49)	(-5.37)	(0.52)	(0.76)
Education: 1-5 years	1.14	1.20	0.92	0.95					
	(2.02)	(2.68)	(-1.31)	(-0.88)	Urban pre-disaster communit	0.67	0.72	0.94	0.94
Education: 7-9 years	0.93	0.94	0.98	1.01		(-4.20)	(-3.10)	(-0.84)	(-0.83)
	(-1.40)	(-1.05)	(-0.29)	(0.09)					
Education: 10-12 years	0.76	0.80	0.96	0.98					
	(-4.45)	(-3.30)	(-0.68)	(-0.34)					
Education: 13+ years	0.76	0.79	0.99	1.02					
	(-3.26)	(-2.55)	(-0.09)	(0.28)					
Joint tests (p-values)									
Age	*0.00*	*0.00*	*0.00*	*0.00*	*Cognition*	*0.00*	*0.00*	*0.00*	*0.00*
Education	*0.00*	*0.00*	*0.00*	*0.00*	*Pre-tsu PCE*	*0.00*	*0.00*	*0.79*	*0.58*
					Pre-tsu SES ladder	*0.00*	*0.00*	*0.06*	*0.04*
N	11891								

Note: Odds ratios and z-scores reported. p-values are reported for joint tests of significance of estimated coefficients for measures of age, education, cognition, pre-disaster household per capita expenditure, and pre-disaster socioeconomic ladder. Regressions run separately for each group of individual controls. Standard errors are clustered at the pre-disaster enumeration area. Age 20-29, 6 years of education, first quartile of pre-disaster household per captita expenditure, and pre-disaster socioeconomic ladder = (1 or 2) are omitted.

In Table 2.2, I examine the relationship between attitudes toward risk and the individual and geographic controls in the full analytic sample. Results are reported for an ordered logit model with the rank-order measure of observed risk aversion (including certainty preference) and a logit model with a binary measure of certainty preference measured in 2005 and 2009. I estimate independent regressions for each set of individual and geographic controls. Odds ratios and z-scores are reported. As in most previous studies, men are observably less risk-averse than women. Poorer individuals are more risk-averse than wealthier individuals, which is consistent with economic theory and previous research. Many of the relationships also appear to change over time – for example, with pre-disaster SES – which may be due to differential changes over time across sub-groups or to decreasing relevance of the 2004 measure to individual attitudes in later time periods.

2.5 Results

2.5.1 Evidence of Observed Risk Aversion

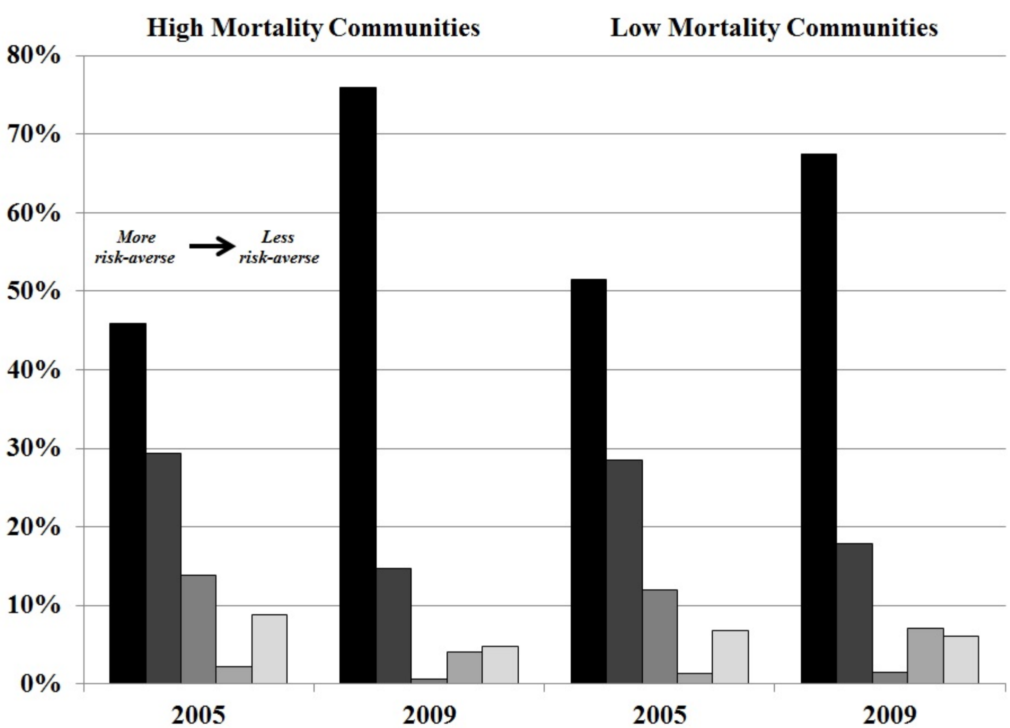


Figure 2.5: Distribution of risk aversion measures from STAR risk instruments

The distributions of the risk aversion measures in high and low mortality communities in 2005 and 2009 are shown in Figure 2.5, with decreasing rank order of risk aversion going from left to right in each distribution. The prevalence of respondents who prefer certainty is high in 2005 and increases in 2009 in both high and low mortality communities. In both 2005 and 2009, the share of respondents in each group generally decreases as risk aversion decreases. There is significant variation in elicited risk aversion across the distributions in both types of communities.

Table 2.3: Transition of observed risk aversion between 2005 and 2009

Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

	2009 Risk Aversion									
	High Mortality Communities					*Low Mortality Communities*				
2005 Risk Aversion	Certainty Preference	Most Risk Averse	More Risk Averse	Less Risk Averse	Least Risk Averse	Certainty Preference	Most Risk Averse	More Risk Averse	Less Risk Averse	Least Risk Averse
Certainty Preference										
N	1,018	180	7	47	52	3,200	822	60	346	236
% of 2005	0.78	0.14	0.01	0.04	0.04	0.69	0.18	0.01	0.07	0.05
Most Risk Averse										
N	628	126	8	32	37	1,744	466	24	166	181
% of 2005	0.76	0.15	0.01	0.04	0.04	0.68	0.18	0.01	0.06	0.07
More Risk Averse										
N	278	66	2	19	29	716	196	13	83	77
% of 2005	0.71	0.17	0.01	0.05	0.07	0.66	0.18	0.01	0.08	0.07
Less Risk Averse										
N	46	7	0	4	3	77	15	5	10	8
% of 2005	0.77	0.12	0.00	0.07	0.05	0.67	0.13	0.04	0.09	0.07
Least Risk Averse										
N	186	36	0	11	15	375	123	25	40	46
% of 2005	0.75	0.15	0.00	0.04	0.06	0.62	0.20	0.04	0.07	0.08
All responses										
N	2,156	415	17	113	136	6,112	1,622	127	645	548
% of 2005	0.76	0.15	0.01	0.04	0.05	0.68	0.18	0.01	0.07	0.06

Correlation: 2005 & 2009	
High mortality	0.05
Low mortality	0.04

Table 2.3 presents the transitions of responses for the risk instruments between 2005 and 2009. There is a large amount of variation in how observed risk aversion changes between 2005 and 2009 in both high and low mortality samples. In addition, the correlation between the measures in 2005 and 2009 is very low – 0.05 in the high mortality sample and 0.04 in the low mortality sample. This implies that the risk aversions measures may be quite noisy, but evidence presented in Table 2.2 and later in Section 2.5.3 (Table 2.11) suggests that the measures of risk aversion capture meaningful aspects of individual attitudes toward risk.

Table 2.4: Impact of exposure to tsunami on observed risk aversion in 2005

Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

	All Communities			*High Mortality Communities*			*Low Mortality Communities*		
	Risk Averse	Certainty Preference	Risk Averse	Risk Averse	Certainty Preference	Risk Averse	Risk Averse	Certainty Preference	Risk Averse
	Ordered Logit	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*
Physical exposure	0.66	0.67	0.79	0.69	0.67	0.94	0.66	0.68	0.79
	(-5.58)	(-4.71)	(-2.63)	(-2.69)	(-2.78)	(-0.27)	(-4.77)	(-3.87)	(-2.34)
Asset damage/loss:									
House and land	0.96	0.95	1.00	0.99	0.95	0.98	0.89	0.90	0.95
	(-0.46)	(-0.58)	(-0.01)	(-0.08)	(-0.34)	(-0.08)	(-1.09)	(-0.93)	(-0.35)
Durables	0.82	0.85	0.87	0.76	0.83	0.72	0.89	0.92	0.94
	(-2.39)	(-1.77)	(-1.31)	(-2.05)	(-1.20)	(-1.54)	(-1.09)	(-0.81)	(-0.49)
Gold and cash	0.99	1.00	0.95	1.08	1.04	1.18	0.75	0.83	0.59
	(-0.12)	(0.02)	(-0.32)	(0.47)	(0.22)	(0.93)	(-1.55)	(-0.84)	(-2.54)
N	11890	11890	5923	2836	2836	1533	9054	9054	4390
Joint tests (p-values)									
Physical exp, assets	*0.00*	*0.00*	*0.02*	*0.02*	*0.04*	*0.36*	*0.00*	*0.00*	*0.00*
Assets	*0.04*	*0.19*	*0.43*	*0.19*	*0.56*	*0.33*	*0.08*	*0.40*	*0.04*

Note: Odds ratios and z-scores reported. p-values are reported for joint tests of significance of estimated coefficients for all measures of exposure (physical exposure and asset loss) and for asset loss measures. "Risk Averse (No CP)" outcome excludes individuals with certainty preference. For each asset category, individuals who owned assets but did not lose assets in the tsunami is the reference group. Regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

Table 2.4 presents the results of regressions of exposure to the tsunami on observed risk aversion in 2005. Both personal physical exposure to the tsunami and experiencing tsunami-induced asset loss are included in the models. Odds ratios and z-scores are reported. The p-values of joint tests of significance are reported for all of the measures of exposure and for the asset damage/loss measures alone.

The results show that personal physical exposure to the tsunami leads to a significant decrease in observed risk aversion in 2005. In both high and low mortality communities, individuals who were physically exposed to the tsunami are significantly less likely to demonstrate certainty preference. There is also a significant decrease in average risk aversion outside of certainty preference in the low mortality sample. These effects are independent of the effect of tsunami-induced asset loss and are unchanged when the measures of asset loss are excluded from the model (see Appendix Table 2.7). The findings are robust to the inclusion of all individuals measured in 2005 (see Appendix Table 2.8).

The evidence of an impact of tsunami-induced asset loss on observed risk aversion in 2005 is weaker. The effect of asset loss is not jointly significant in most models. There is, however, evidence that losing durable goods in the tsunami is associated with a significant reduction in risk aversion for the full sample and for individuals from high damage communities in particular. There is also evidence that losing liquid assets leads to a large and significant decrease in risk aversion outside of certainty preference for individuals in low mortality communities. These effects are robust to the exclusion of physical exposure from the model (see Appendix Table 2.7), and the impact of liquid asset loss is robust to the inclusion of all individuals measured in 2005 (see Appendix Table 2.8).

Table 2.5: Impact of exposure to tsunami on observed risk aversion in 2005 with community fixed effects

Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

	All Communities			*High Mortality Communities*			*Low Mortality Communities*		
	Certainty Preference	CP/Most RA	Most RA (No CP)	Certainty Preference	CP/Most RA	Most RA (No CP)	Certainty Preference	CP/Most RA	Most RA (No CP)
Physical exposure	-0.044	-0.030	-0.019	-0.047	-0.040	-0.023	-0.043	-0.027	-0.012
	(0.017)	(0.015)	(0.024)	(0.032)	(0.032)	(0.049)	(0.019)	(0.016)	(0.026)
Asset damage/loss:									
House and land	-0.014	-0.001	0.010	-0.001	-0.008	-0.024	-0.035	-0.015	0.009
	(0.020)	(0.017)	(0.029)	(0.036)	(0.032)	(0.053)	(0.025)	(0.021)	(0.036)
Durables	-0.023	-0.003	0.009	-0.032	-0.051	-0.081	-0.020	0.021	0.057
	(0.018)	(0.017)	(0.028)	(0.032)	(0.034)	(0.057)	(0.023)	(0.021)	(0.032)
Gold and cash	0.042	-0.007	-0.034	0.052	0.038	0.040	-0.023	-0.086	-0.129
	(0.027)	(0.023)	(0.035)	(0.037)	(0.031)	(0.045)	(0.042)	(0.039)	(0.053)
N	11890	11890	5923	2836	2836	1533	9054	9054	4390
Joint tests (p-values)									
Physical exp, assets	*0.01*	*0.32*	*0.77*	*0.30*	*0.17*	*0.29*	*0.03*	*0.06*	*0.03*
Assets	*0.16*	*0.98*	*0.76*	*0.40*	*0.21*	*0.27*	*0.22*	*0.11*	*0.01*

Note: Estimated coefficients of OLS regressions with community (enumeration area) fixed effects reported. Standard errors reported in parentheses. p-values are reported for joint tests of significance of estimated coefficients for all measures of exposure (physical exposure and asset loss) and for asset loss measures. For each asset category, individuals who owned assets but did not lose assets in the tsunami is the reference group. Regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

To account for any remaining selection in exposure to the tsunami, I now analyze the impact of exposure to the tsunami on observed risk aversion in 2005 using OLS models with pre-disaster community fixed effects. The results are presented in

Table 2.5.[10] Personal physical exposure to the tsunami still results in a significant decrease in the likelihood of demonstrating certainty preference within low mortality communities, but there are no longer significant decreases in risk aversion outside of certainty preference or within high mortality communities. The reduction in estimated impacts may be due to reduced variation in exposure within communities, but the results suggest that the change in certainty preference in low mortality communities is quite robust. The impact of losing liquid assets on observed risk aversion outside of certainty preference is robust to the inclusion of community fixed effects as well.

Table 2.6 presents evidence of how observed risk aversion changed between 2005 and 2009 and the extent to which the impact of exposure to the tsunami continued into 2009. Odds ratios and z-scores are reported. The results show that on average observed risk aversion significantly increased for all individuals between 2005 and 2009 and increased more for individuals were physically exposed to the tsunami and individuals who lost gold and cash (in the full sample). As a result, by 2009 there are no significant differences in risk aversion between individuals who were physically exposed to the tsunami and those who were not. This is true for individuals from both high and low mortality communities. There are also no significant differences in risk aversion in 2009 between individuals who lost each type of asset and those who did not.

---

[10] Results for logit and OLS regressions of the same models without community fixed effects are presented in Appendix Table 2.9.

Table 2.6: Transition of observed risk aversion between 2005 and 2009 by exposure to tsunami

Ordered logit regressions using full rank-order categorical measure of risk aversion
Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

Transition Regressions from 2005 to 2009

	All Communities	High Mortality Communities	Low Mortality Communities
2009	1.85	2.38	1.89
	(8.96)	(4.38)	(8.52)
2009 x Physical exposure	1.48	1.64	1.27
	(6.89)	(3.23)	(3.68)
2009 x Asset damage/loss:			
House and land	0.85	0.76	0.92
	(-1.66)	(-1.32)	(-0.72)
Durables	1.04	1.08	0.85
	(0.39)	(0.43)	(-1.29)
Gold and cash	1.42	1.11	1.39
	(2.68)	(0.54)	(1.24)
N	23780	5672	18108
Joint tests (p-values)			
Physical exp, assets	*0.00*	*0.01*	*0.00*
Assets	*0.02*	*0.59*	*0.10*

Observed Risk Aversion in 2009

	All Communities	High Mortality Communities	Low Mortality Communities
Physical exposure	0.98	0.90	1.00
	(-0.30)	(-0.66)	(-0.08)
Asset damage/loss:			
House and land	1.01	0.93	1.00
	(0.16)	(-0.45)	(0.03)
Durables	0.92	0.80	0.92
	(-0.95)	(-1.25)	(-0.79)
Gold and cash	1.08	1.19	0.96
	(0.73)	(1.18)	(-0.21)
N	11890	2836	9054
Joint tests (p-values)			
Physical exp, assets	*0.72*	*0.33*	*0.79*
Assets	*0.82*	*0.46*	*0.89*

Note: Odds ratios and z-scores reported for ordered logit regressions. p-values are reported for joint tests of significance of estimated coefficients for all measures of exposure (physical exposure and asset loss) and for asset loss measures. For each asset category, individuals who owned assets but did not lose assets in the tsunami is the reference group. All regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, and estimated maximum wave height at nearest point on the coast. In the transtion regressions, each individual has two observations - one with risk aversion measured in 2005 and one measured in 2009. Transition regressions also include controls for physical exposure and asset damage/loss (not reported). Standard errors are clustered at the individual respondent for the transition regressions and at the pre-disaster enumeration area for the 2009 regressions. Month-year controls of interview are excluded from the 2009 regressions due to issues of concavity in the ordered logit estimation, but the results are similar for OLS regressions both with and without the inclusion of month-year of interview controls.

Tables 2.7 and 2.8 present evidence of whether the impact of personal physical exposure on observed risk aversion differed for sub-groups defined by sex, age, and SES. Table 2.7 presents the results of regressions stratified by sex and age at the time of the tsunami. Odds ratios and z-scores reported. The p-values of tests of equality of the estimates across the different sub-groups are also reported. There are no significant differences in the impact of exposure in 2005 between females and males. In addition,

Table 2.7: Impact of exposure to tsunami on observed risk aversion in 2005 – Stratified by sex and age in 2005

Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

	All Communities			*High Mortality Communities*			*Low Mortality Communities*		
	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Certainty Preference	Risk Averse (No CP)
	Ordered Logit	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*
	Stratified by sex								
Physical exposure									
Females	0.64	0.65	0.77	0.73	0.73	0.92	0.63	0.65	0.76
	(-5.00)	(-4.43)	(-2.24)	(-1.62)	(-1.51)	(-0.33)	(-4.33)	(-3.70)	(-2.08)
Males	0.62	0.63	0.78	0.63	0.58	0.92	0.62	0.64	0.79
	(-5.34)	(-4.49)	(-2.31)	(-2.61)	(-2.99)	(-0.28)	(-4.51)	(-3.67)	(-1.90)
Tests of equality (p-values)									
Females vs. Males	*0.74*	*0.76*	*0.94*	*0.51*	*0.36*	*1.00*	*0.88*	*0.89*	*0.82*
	Stratified by age in 2005								
Physical exposure									
< 30 years	0.64	0.63	0.89	0.77	0.72	1.13	0.61	0.62	0.85
	(-4.82)	(-4.44)	(-1.04)	(-1.31)	(-1.70)	(0.40)	(-4.43)	(-3.81)	(-1.26)
30-39 years	0.62	0.61	0.92	0.58	0.46	1.58	0.62	0.63	0.83
	(-4.03)	(-3.83)	(-0.57)	(-1.61)	(-2.34)	(1.07)	(-3.53)	(-3.06)	(-1.07)
40-49 years	0.62	0.65	0.67	0.61	0.57	0.57	0.62	0.66	0.72
	(-4.37)	(-3.36)	(-2.36)	(-1.98)	(-1.79)	(-1.00)	(-3.77)	(-2.87)	(-1.71)
50+ years	0.67	0.71	0.51	0.57	0.70	0.16	0.64	0.68	0.50
	(-2.91)	(-2.35)	(-3.43)	(-1.80)	(-1.00)	(-3.08)	(-2.71)	(-2.25)	(-3.19)
Tests of equality (p-values)									
< 30 years									
30-39 years	*0.81*	*0.76*	*0.84*	*0.89*	*0.91*	*0.92*	*0.89*	*0.91*	*0.92*
40-49 years	*0.78*	*0.80*	*0.15*	*0.93*	*0.70*	*0.42*	*0.93*	*0.70*	*0.42*
50+ years	*0.72*	*0.42*	*0.01*	*0.76*	*0.56*	*0.03*	*0.76*	*0.56*	*0.03*
30-39 years									
40-49 years	*0.99*	*0.62*	*0.16*	*0.96*	*0.81*	*0.55*	*0.96*	*0.81*	*0.55*
50+ years	*0.62*	*0.35*	*0.02*	*0.87*	*0.69*	*0.06*	*0.87*	*0.69*	*0.06*
40-49 years									
50+ years	*0.57*	*0.59*	*0.28*	*0.83*	*0.84*	*0.19*	*0.83*	*0.84*	*0.19*

Note: Independent stratified regressions are estimated for each sub-group. Odds ratios and z-scores reported for personal physical exposure in each stratified regression. p-values are reported for joint tests of equality of estimated coefficients between sub-groups. Regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

Table 2.8: Impact of exposure to tsunami on observed risk aversion in 2005 and transition to 2009 – Stratified by pre-disaster SES ladder

Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

	All Communities				*High Mortality Communities*				*Low Mortality Communities*			
	2005			*2009*	*2005*			*2009*	*2005*			*2009*
	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse
	Ordered Logit	*Logit*	*Ordered Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*
	Impact of personal physical exposure											
Physical exposure												
Low SES [1-2]	0.47	0.49	0.64	0.98	0.59	0.56	0.86	0.90	0.47	0.49	0.62	0.99
	(-6.63)	(-5.66)	(-3.56)	-0.30	(-1.95)	(-2.04)	(-0.34)	-0.41	(-5.91)	(-4.89)	(-3.60)	-0.16
High SES [3-6]	0.76	0.77	0.91	0.98	0.75	0.75	0.89	0.81	0.80	0.82	0.96	1.00
	(-3.11)	(-2.72)	(-0.87)	(-0.20)	(-1.81)	(-1.63)	(-0.55)	(-0.94)	(-2.22)	(-1.75)	(-0.34)	(-0.04)
Tests of equality (p-values)												
Low vs. High SES	*0.00*	*0.00*	*0.00*	*0.94*	*0.28*	*0.34*	*0.83*	*0.94*	*0.00*	*0.01*	*0.00*	*0.94*
	Transition from 2005 to 2009											
Low SES [1-2]												
2009	1.32				1.44				1.30			
	(5.39)				(1.84)				(5.03)			
2009 x Physical exposure	1.81				2.26				1.64			
	(7.24)				(3.49)				(5.37)			
High SES [3-6]												
2009	2.15				3.79				2.03			
	(13.68)				(7.12)				(11.97)			
2009 x Physical exposure	1.32				1.12				1.03			
	(3.76)				(0.56)				(0.28)			
Tests of equality (p-values)												
Low vs. High SES												
2009	*0.00*				*0.00*				*0.00*			
2009 x Physical exposure	*0.03*				*0.06*				*0.00*			

Note: Independent stratified regressions are estimated for each sub-group. Odds ratios and z-scores reported for personal physical exposure in each stratified regression. p-values are reported for joint tests of equality of estimated coefficients between sub-groups. Impact in 2005 regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors for regressions of the impact in 2005 are clustered at the pre-disaster enumeration area. In the transtion regressions, each individual has two observations -- one with risk aversion measured in 2005 and one measured in 2009. Transition regressions include controls for physical exposure, sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, and estimated maximum wave height at nearest point on the coast. Standard errors for transition regressions are clustered at the individual respondent.

the impact of physical exposure does not largely differ by age, except for individuals aged 50 and above in 2005, who experience a larger decrease in risk aversion outside of certainty preference following physical exposure than younger individuals (i.e., under 40 years of age).

Table 2.8 presents the results of regressions of personal physical exposure stratified by pre-disaster SES, specifically self-reported pre-disaster SES ladder. The results show that in low mortality communities, physical exposure leads to a larger increase in risk aversion in 2005 for individuals with low pre-disaster SES (for both certainty preference and risk aversion outside of certainty preference). The results of the transition and 2009 regressions stratified by pre-disaster SES suggest that this difference is temporary. Low SES individuals who were personally physically exposed to the disaster experience a larger increase in risk aversion between 2005 and 2009 relative to unexposed individuals than high SES individuals. As a result, by 2009, there is no difference in risk aversion between exposed and unexposed individuals with either low or high pre-disaster SES.

The results suggest that being exposed to the tsunami has an impact on attitudes toward risk. It is also possible that the impact varies with the intensity of exposure. Directly measuring intensity with the measures of personal physical exposure in Figure 2.4 is difficult because there is no clear way to assign intensity to those measures. Indirectly measuring intensity is possible, however, using the amount of psychological stress individuals experienced because of their exposure to the disaster and its aftermath. The STAR surveys provide an index of the maximum amount of posttraumatic stress the respondent experienced in the aftermath of the disaster.[11] The summary statistics for the index are presented in Table 2.1. The average posttraumatic

---

[11] The index is made up of seven symptoms from the Posttraumatic Stress Disorder Checklist Civilian Version (Weathers et al. 1996) with four possible frequencies of experience (0 – Never, 1 – Rarely, 2 – Sometimes, 3 – Often). The seven frequencies are summed up to form an index that ranges from 0 to 21.

index in the sample is large (7.3) and is larger in high mortality communities (9.1) than in low mortality communities (6.8).

Table 2.9: Relationship of observed risk aversion with posttraumatic stress

Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

	All Communities				*High Mortality Communities*				*Low Mortality Communities*			
	2005			*2009*	*2005*			*2009*	*2005*			*2009*
	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse
	Ordered Logit	*Logit*	*Ordered Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*
Posttraumatic stress index												
1st quintile omitted												
2nd quintile	0.57	0.53	0.85	0.99	0.69	0.69	0.79	1.12	0.57	0.51	0.88	0.98
	(-8.08)	(-7.93)	(-1.60)	(-0.18)	(-2.28)	(-2.06)	(-1.19)	(0.68)	(-7.19)	(-7.21)	(-1.09)	(-0.32)
3rd quintile	0.59	0.55	0.90	0.96	0.48	0.46	0.78	0.96	0.63	0.58	0.97	0.96
	(-6.00)	(-5.99)	(-0.92)	(-0.63)	(-4.08)	(-3.77)	(-1.13)	(-0.20)	(-4.49)	(-4.74)	(-0.21)	(-0.53)
4th quintile	0.74	0.75	0.80	1.01	0.73	0.68	1.00	0.92	0.76	0.78	0.73	1.04
	(-3.65)	(-3.14)	(-1.94)	(0.13)	(-1.69)	(-1.89)	(0.01)	(-0.40)	(-2.91)	(-2.39)	(-2.31)	(0.51)
5th quintile	0.52	0.55	0.63	0.93	0.48	0.43	0.83	0.81	0.55	0.61	0.54	0.99
	(-7.03)	(-5.94)	(-3.83)	(-1.12)	(-3.97)	(-3.97)	(-0.81)	(-1.18)	(-5.42)	(-4.22)	(-4.32)	(-0.15)
N	11872	11872	5913	11872	2834	2834	1533	2834	9038	9038	4380	9038
Joint tests (p-values)												
Posttraumatic stress quintiles	*0.00*	*0.00*	*0.00*	*0.72*	*0.00*	*0.00*	*0.39*	*0.28*	*0.00*	*0.00*	*0.00*	*0.90*

Note: Odds ratios and z-scores reported. p-values are reported for joint tests of significance of estimated coefficients for PTSR index quintiles. The values of the PTSR index quintiles are 1st: 0-3, 2nd: 4-6, 3rd: 7-8, 4th: 9-11, and 5th: 12-21. Regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

Table 2.9 presents the results of regressions of the index of maximum posttraumatic stress on observed risk aversion. In the regressions, the measure of posttraumatic stress is split into five indicator variables for each quintile of the index in the sample. The first quintile (with the lowest amount of posttraumatic stress) is omitted from the regressions. These results should be interpreted with some caution because the amount of posttraumatic stress an individual experiences is the result of both the exogenous intensity of exposure an individual experienced in the tsunami and the individual's endogenous response to that exposure.

The results in Table 2.9 show that individuals who experience maximum posttraumatic stress above the first quintile are significantly less likely to demonstrate certainty preference in 2005. The results also show that experiencing high amounts of maximum posttraumatic stress (i.e., two highest quintiles) is associated with significantly lower risk aversion outside of certainty preference in 2005. In addition, the impact for individuals in the fifth quintile is significantly larger than the impact for individuals in the fourth quintile, which implies a dose-response between intensity of exposure and risk aversion outside of certainty preference. These results suggest that the decrease in observed risk aversion in 2005 seen in previous tables is generally larger with more intense exposure to the tsunami, particularly with the highest intensities. The results of the transition (not reported) and 2009 regressions show that individuals who experience more maximum posttraumatic stress experience a greater increase in risk aversion between 2005 and 2009 than individuals who experience less posttraumatic stress, and by 2009 there are no remaining differences in observed risk aversion.

2.5.2 Evidence of Time Discounting

It is possible that exposure to the disaster changed not only attitudes toward risk but also how individuals relatively value their current wellbeing and their wellbeing in the future (commonly referred to as time discounting). Some previous studies suggest that exposure to a natural disaster (Cassar, Healy, and von Kessler 2011) or violent conflicts (Voors et al. 2012) may increase discounting, but others suggest that exposure may decrease discounting (Callen 2011). STAR includes an instrument used to elicit time discounting, which is similar to the risk instrument (i.e., a series of binary choice tasks involving the timing of receiving hypothetical lottery payments).

Table 2.10 presents the results of ordered logit regressions of observed time discounting on personal physical exposure to the tsunami and tsunami-induced asset loss.[12] The measure used in the analysis is a categorical variable with a rank order of increasing discounting of the future. The results suggest that exposure to the disaster (both personal physical exposure and tsunami-induced asset loss) had no significant effect on how much survivors discount the future.

2.5.3 Relationship with Running a Household Business

Having studied the impact of exposure to a tsunami on observed attitudes toward risk, I also examine whether these attitudes affect real-world decisions and outcomes. To this end, I analyze the relationship between observed risk aversion and running a household business. Running a business is inherently risky and is particularly relevant after a natural disaster in which lost livelihoods are common. Table 2.1 includes the fraction of households running a household business in the sample in 2005 and 2009.[13] A significant fraction of households are running a business in both 2005 (48%) and 2009 (48%).

---

[12] The sample for the time discounting analysis is respondents measured in both 2005 and 2008. The time instrument changed in 2009 such that it is difficult to compare results from 2009 to earlier waves.

[13] Household-run businesses include both non-rice farm businesses and non-farm businesses.

Table 2.10: Impact of exposure to tsunami on observed time discounting in 2005

Sample of baseline respondents with time discounting measured in 2005 and 2008
By mortality in pre-disaster community

	All Communities	High Mortality Communities	Low Mortality Communities
Physical exposure	0.91	0.92	0.88
	(-1.26)	(-0.50)	(-1.55)
Asset damage/loss:			
House and land	0.98	0.89	1.01
	(-0.28)	(-0.72)	(0.10)
Durables	0.89	0.73	0.88
	(-1.21)	(-2.27)	(-1.01)
Gold and cash	1.15	1.32	1.13
	(1.25)	(1.78)	(0.72)
N	11290	2654	8636
Joint tests (p-values)			
Physical exp, assets	*0.31*	*0.10*	*0.35*
Assets	*0.45*	*0.07*	*0.72*

Note: Odds ratios and z-scores reported for ordered logit regressions. p-values are reported for joint tests of significance of estimated coefficients for all measures of exposure (physical exposure and asset loss) and for asset loss measures. For each asset category, individuals who owned assets but did not lose assets in the tsunami is the reference group. Regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

Table 2.11 presents the results of logit regressions of attitudes toward risk on whether the respondent's household is running its own business. Attitudes toward risk are included in the models with indicator variables for each category of the rank order implied by the risk instrument with certainty preference omitted. Odds ratios and z-scores are reported. The p-value of joint tests of significance for the risk aversion parameters and p-values of tests of equality between the risk aversion parameters are also reported.

Although attitudes toward risk may affect the decision to run a business, running a business may in turn change attitudes toward risk, so the results in Table 2.11 are simply suggestive. Information about household businesses was reported by a knowledgeable member of the household (usually the head of the household). Under the assumption that the reporting household member's attitudes toward risk are likely the attitudes most closely aligned to the decision to run a business, the analysis is restricted to those respondents. The results, however, are robust to the inclusion of all remaining household heads.

Table 2.11: Relationship between observed risk aversion and running a household business

Sample of respondents who reported on household economy
For households containing baseline respondent with risk aversion measured in 2005 and 2009

	Estimated Coefficients		Tests of Equality Between Risk Aversion Coefficients: p-values reported					
			2005			2009		
	2005	2009	*Most Risk Averse*	*Next Most RA*	*Next Least RA*	*Most Risk Averse*	*Next Most RA*	*Next Least RA*
Observed risk aversion								
Certainty Preference omitted								
Most Risk Averse	1.04	1.05	*X*			*X*		
	(0.55)	(0.64)						
Next Most RA	1.06	1.12	*0.78*	*X*		*0.75*	*X*	
	(0.58)	(0.46)						
Next Least RA	1.05	1.46	*0.85*	*0.83*	*X*	*0.00*	*0.00*	*X*
	(0.19)	(3.86)						
Least Risk Averse	1.46	1.41	*0.00*	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*
	(3.54)	(3.13)						
N	5887	7173						
Joint tests (p-values)								
Risk aversion	*0.01*	*0.00*						

Note: Odds ratios and z-scores are reported for logit models. p-values are reported for joint tests of significance of estimated coefficients for risk aversion measures and for tests of equality between esimated coefficents for risk avesrion measures. Outcomes are binary indicators of whether respondent's household was running a business at the time of measurement (not including rice farming). Regressions include controls for sex, age, pre-disaster education, word recall (measures of cognition), self-reported SES ladder at time of measurement, urban-rural status of pre-disaster community, and month-year of interview. Standard errors are clustered at the pre-disaster community.

The results show that there is a strong and significant association between observed risk aversion and running a business. In 2005, individuals who are the least risk-averse are significantly more likely than other respondents run a business. Similarly, in 2009, individuals in the two least risk-averse categories are significantly more likely to run a business than either the individuals who prefer certainty or the most risk-averse individuals. These results suggest that there is a meaningful association between measured attitudes toward risk and economic behavior involving risk such as running a business in the sample communities.

2.6 Conclusions

Using exogenous variation in exposure to the 2004 Indian Ocean tsunami among coastal communities in Aceh and North Sumatra, Indonesia, I find strong evidence that on average being physically exposed to the tsunami leads to an increase in observed willingness to assume financial risk in the first year after the disaster. In addition, these impacts operate independently of the impact of asset loss in the tsunami. This suggests that the impact of physical exposure to the tsunami is likely not driven by personal economic loss. The impact does not differ by sex, but evidence suggests that the impact is larger for older individuals (50 years and older) and the poor. There is also some evidence that tsunami-induced asset loss had an impact on observed risk aversion, especially for individuals from low mortality communities who lost liquid assets.

The estimated impacts for certainty preference with physical exposure are very similar to the estimated impacts for risk aversion outside of certainty preference, suggesting that individuals who demonstrate certainty preference may be functionally more risk-averse than other individuals in economically meaningful ways. This is supported by the relationship between observed risk aversion and running a household business, which is consistent with the certainty preference group being the most functionally risk-averse.

The impacts of exposure on attitudes toward risk also appear to be temporary. Between 2005 and 2009, individuals who were physically exposed to the tsunami experience a greater increase in their risk aversion than individuals who were not directly exposed. As a result, four years later there were no longer discernable differences in attitudes between physically exposed and unexposed individuals. There also appears to be no impact of exposure to the disaster on observed time discounting.

Why would the tsunami lead to a temporary decrease in observed risk aversion? Following the discussion in Section 2.3, being exposed to the disaster may have led to temporary changes in perceptions and/or tastes for risk. It is also possible that the assistance that arrived in the aftermath of the disaster directly altered attitudes toward risk (e.g., easing liquidity constraints).

Finally, what do these findings imply for the design of disaster assistance? In the aftermath of a disaster, the first order of business is to provide short-term humanitarian relief to survivors such as temporary housing and clean water. Assistance organizations are quite adept at providing this type relief. What is less understood are the best ways to use post-disaster assistance policy to achieve lasting improvements in the livelihoods of survivors. This is critically important in the context of disasters like the 2004 Indian Ocean tsunami in which the disaster severely disrupted the ability of many survivors to provide for themselves and their families.

This study suggests the presence of a period after a disaster in which many survivors are willing to take on more financial risk. Accordingly, it may be effective to provide them with assistance in forms that are more consistent with their attitudes toward risk. For example, in addition to cash-for-work programs, assistance programs might provide business capital and job training. Designing post-disaster assistance programs that utilize survivors' willingness to take risks may help survivors not only get through the aftermath of a disaster but also improve their lives in ways that may last long after the assistance programs end.

3. Labor Market Outcomes following the 2004 Indian Ocean Tsunami

3.1 Introduction

Large, adverse events like natural disasters and violent conflicts affect hundreds of millions of people every year, often resulting in widespread mortality and destruction. One of the most important consequences of these types of events is their impact on the livelihood of survivors, especially in developing countries where incomes are often extremely low and social safety nets are generally weak or non-existent. Although restoring livelihoods is a central goal of many post-disaster recovery efforts, there is limited empirical evidence from developing countries on how labor market outcomes change following disasters and post-disaster efforts to restore their livelihoods.

There are a large number of studies using aggregate employment data that investigate the impact of natural disasters on employment rates in the United States. These studies find that disasters such as earthquakes, tornados, and hurricanes may reduce overall employment in the short-run and may even increase employment in the long-run (e.g., Ewing, Kruse, and Thompson 2004, 2005). Recent studies have used micro-level data to analyze differential impacts on labor market outcomes of Hurricane Katrina and find that employment rates are lower for people displaced by the hurricane and are lowest for individuals who remained displaced over time (Vigdor 2007,2008; Groen and Polivka 2008a, 2008b; Zissimopoulos and Karoly 2010). These studies also find that the effects on labor market outcomes differed by economic sectors (Vigdor 2007, 2008).

There is some empirical evidence of the effect of disasters and post-disaster relief efforts on labor market outcomes in developing countries, but the evidence is very limited. A qualitative study by Badri et al. (2006) finds evidence of a decrease in agricultural employment of household heads and an increase in female labor force participation in paid work in a rural village in Iran 11 years after a large earthquake. However the sample is very small and is drawn 11 years after the disaster. As a result, the study relies on retrospective measures of pre-disaster outcomes and cannot account for migration that may have occurred since the disaster. Relief organizations also provide limited evidence of changes in aggregate labor market outcomes following disasters, but these reports rarely use measures of pre-disaster outcomes or directly measure the impact on pre-disaster populations.

There is also limited evidence of the impact of violent conflicts on labor market outcomes, which suggests that being displaced by a conflict may have negative effects on labor market outcomes. For example, Kondylis (2010) finds evidence that being displaced by conflict leads to higher rates of unemployment and higher rates of leaving the labor market among people displaced by war in Bosnia-Herzegovina. Calderón-Mejía and Ibáñez (2009) and Bozzoli et al. (2012) find evidence that conflict displacement in Colombia leads to higher rates of employment in the informal sector, especially in self-employment, but also lower wages. However like with natural disasters this literature is limited by a lack of pre-conflict data and uses narrow samples that focus on displaced populations rather than a general population.

I address the limitations in this literature by utilizing panel survey data of people in coastal communities in Indonesia affected by a large-scale natural disaster, the 2004 Indian Ocean tsunami, to investigate how labor market outcomes of the pre-disaster population changed in the years after the disaster. The data I use in this paper comes from the Study of the Tsunami Aftermath and Recovery (STAR). The STAR surveys include a pre-disaster baseline that is representative of the pre-disaster population and include intensive efforts to track migrants in the baseline sample. Measures of labor market outcomes were collected in the pre-disaster baseline and annually for five years after the disaster. As a result, I can directly analyze the effect of the disaster and post-disaster relief efforts on the pre-disaster population both in the short and long term. The survey also includes both communities that were directly and indirectly exposed to the disaster, which allows me to investigate how the disaster and relief effort differentially affected labor market outcomes in areas with varying amounts of disaster exposure.

The 2004 Indian Ocean tsunami is a useful setting for the study of the impact of a large-scale event on labor market outcomes because the disaster was highly disruptive to the livelihoods of survivors. In a survey of survivors who had been displaced by the tsunami conducted two months after the disaster by the International Organization for

Migration, survivors reported that livelihood assistance was their most important remaining need (IOM 2005). In addition, restoring livelihoods was one of the stated goals of the Indonesian government's Agency for the Rehabilitation and Reconstruction in Aceh and Nias (BRR), which coordinated the enormous post-disaster relief effort. There is evidence that the relief efforts did implement projects that may have helped restore livelihoods in the first two years of recovery. For example, lost business capital was replaced or rehabilitated, job training was conducted, and infrastructure was rebuilt, often at higher quality standards than before the disaster (BRR and Partners 2006).

The results of the study suggest that average labor market outcomes of people living in coastal communities in Aceh did change in the aftermath of the disaster. Young women experienced an increase in paid employment and an increased interest in participating in the labor market, while older adults retired from the labor market in greater numbers. These changes appear to reflect long-lasting changes at the population level that continue to persist five years after the disaster. The effects of the disaster and post-disaster recovery are similar in communities that experienced different amounts of physical damage in the tsunami, but the effects do differ greatly between communities in urban and rural areas.

The rest of the paper (i) discusses the geographic setting of this study, the 2004 Indian Ocean tsunami, (ii) describes the data used in this paper, (iii) discusses pre-disaster labor market outcomes in the analytic sample, (iv) presents the results of the changes in labor market outcomes following the disaster, and (v) presents concluding thoughts about the results.

3.2 The 2004 Indian Ocean Tsunami

At 8 a.m. on December 26, 2004, an earthquake with an estimated magnitude of 9.1-9.3 on the Richter scale occurred 160 kilometers off of the west coast of the island of Sumatra in Indonesia. The earthquake resulted in large tsunami waves that came ashore at heights up to 35 meters in some locations (Tsuji et al. 2005). The tsunami struck coastlines across the Indian Ocean, reaching as far as east Africa some 7-9 hours after the initial earthquake.

Coastal communities near the epicenter of the initial earthquake in the province of Aceh in Indonesia were the most heavily impacted by the tsunami. The waves caused large amounts of mortality and destruction along the coast in Aceh. An estimated 4% of the population (170,000 people) died in the tsunami, but there was variation in the extent of mortality across communities, with over 70% of the population killed in some coastal communities. In addition, damage from the tsunami displaced an estimated 500,000 people and caused $4.5 billion in destruction (roughly the GDP of Aceh in 2003) according to initial estimates (the estimate was later increased to $7.1 billion, Nicol 2013). Of the $4.5 billion in estimated losses, roughly 60% consisted of lost assets and 40% consisted of lost income.

An estimated 7% of the population of Aceh lost their primary source of income in the disaster. The most affected sector was small-scale agricultural production, especially fishing and aquaculture. An estimated 40-60% of coastal aquaculture ponds and 65-70% of fishing capital such as boats and equipment was damaged or lost in the tsunami. An estimated 10% of rice fields in the province were also affected, primarily by salinization from sea water, but two-thirds of the affected lands were restored by water from rainfall and irrigation within 5 months (Jayasuriya and McCawley 2010).

The disaster was followed by an enormous influx of domestic and foreign assistance, provided by international governments, Indonesian governmental agencies, NGOs, and local organizations and individuals. The amount of formal assistance delivered far exceeded that of any previous disaster relief effort in a developing country. By the end of 2007, over $7.7 billion was committed for assistance by formal sources for Indonesia alone. Family, friends, and neighbors of survivors also provided substantial assistance, including temporary housing, especially in the aftermath of the tsunami before formal relief efforts were fully in place (Jayasuriya and McCawley 2010).

Early assistance focused largely on emergency relief (e.g., short-term shelter, food, clean water). In May 2005, under the auspices of the Indonesian Government's Agency for the Rehabilitation and Reconstruction in Aceh and Nias (BRR), the focus of the assistance effort changed to the reconstruction of housing and infrastructure and importantly, the rehabilitation of livelihoods. This included programs to restore agricultural and fishing production, to provide credit to small businesses, and to promote employment through cash-for-work and job training programs. BRR reports that two years after the disaster over 80% of fishing boats, 30% of fish ponds, and 70% of farmland lost in the tsunami were replaced or restored. BRR also reports that 7,000 people received skill training and 120,000 people benefitted from cash-for-work programs in the first year after the disaster (BRR and Partners 2006).

3.3 Data

The data for this study is drawn from the Study of the Tsunami Aftermath and Recovery (STAR), a longitudinal study of households and individuals in Aceh and North Sumatra. The baseline line data was collected by Statistics Indonesia (BPS) as part of their annual cross-sectional National Socioeconomic Survey (SUSENAS) in January to May 2004 (7 to 12 months before the disaster). The baseline sample is representative of the pre-disaster population at the district level, which is one administrative level below the province.

The STAR follow-up surveys were first conducted from May 2005 to May 2006 with follow-up surveys conducted annually through May 2009 to May 2010. The baseline communities in STAR were drawn from the sample of communities in the 2004 SUSENAS and include coastal communities with wide variation in exposure to the tsunami. Survival status was obtained for each individual in the STAR baseline sample. Tsunami-related mortality was 6% in the overall sample and 23% in communities that experienced appreciable mortality. Re-interviews were attempted for all survivors, including all migrants who remained in Aceh and North Sumatra as well as any migrant who moved elsewhere in Sumatra or moved to the island of Java (the most populous island in Indonesia and the site of the national capital, Jakarta). Tracking migrants is especially important in this survey because displacement and migration was common after the tsunami, and migration decisions may be related to employment decisions. As a result of the tracking efforts, attrition in the survey is quite low, with 97% of survivors interviewed in at least one of the STAR resurveys.

The STAR surveys collect individual and household measures of demographics, socioeconomics, and labor market outcomes, and community characteristics like whether the community is in an urban or rural area. The surveys also collect measures of exposure to the tsunami, including a categorical measure of physical damage to the community that was created using a combination of satellite imagery, interviews with community heads, and observations by interviewers. For this analysis I will use a binary measure that indicates whether a community sustained heavy physical damage in the tsunami.

The primary sample for this study includes baseline respondents in STAR who were 25 years or older at the time of the baseline survey.[1] [2] The number of sample

[1] The analysis is restricted to individuals aged 25 and above to focus on labor market decisions that occur after schooling is largely completed.

respondents in each survey year is presented in Table 3.1 by sex and age at baseline (2004).[3] There are 12,516 total respondents measured in the baseline sample (6,297 female and 6,219 male). As a result of intensive tracking efforts, attrition (for reasons other than death) is low in each resurvey, particularly in the latest resurvey (2009) which has attrition rates of 5% for women and 6% for men. Attrition is higher on average for younger respondents and males, which likely reflects higher migration rates for those subgroups.

Table 3.1 also presents descriptive statistics for baseline community characteristics and years of education in the analytic sample. At baseline, roughly a third of the sample live in urban communities, and around a quarter of the sample lived in communities that were heavily damaged by the tsunami. Urban communities were more likely to be heavily damaged by the tsunami than rural communities. The years of education in the sample are fairly low, especially for women, but education increases dramatically with age for both women and men.

---

[2] Analyses are also conducted for a sample of baseline respondents aged 25 year or older at the time of each resurvey in order to analyze changes in population-level distributions of labor market outcomes rather than changes in cohorts of individuals.
[3] Survey years indicate the year that field work began in each STAR survey.

Table 3.1: Descriptive statistics of baseline sample for labor market outcomes analysis

Sample Size and Attrition

	Female						Male					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
	Sample Size											
All Respondents	6297	5274	5101	5038	5008	5162	6219	5262	4980	4921	4915	5037
Age in 2004												
25-39	3230	2746	2670	2665	2678	2802	3008	2565	2469	2474	2506	2629
40-49	1442	1212	1169	1161	1156	1194	1534	1336	1238	1244	1242	1269
50-59	833	695	665	640	631	639	909	767	712	692	695	700
60-69	498	410	393	383	371	372	534	420	395	368	345	326
70+	294	211	204	189	172	155	234	174	166	143	127	113
	Employment Measured? (If Alive)											
All Respondents	1.00	0.93	0.91	0.91	0.91	0.95	1.00	0.92	0.88	0.89	0.90	0.94
Age in 2004												
25-39	0.99	0.92	0.90	0.90	0.90	0.95	0.99	0.90	0.87	0.87	0.89	0.93
40-49	1.00	0.94	0.91	0.91	0.92	0.96	1.00	0.94	0.88	0.90	0.91	0.95
50-59	1.00	0.95	0.93	0.91	0.92	0.95	1.00	0.96	0.91	0.91	0.92	0.96
60-69	1.00	0.94	0.92	0.94	0.92	0.96	1.00	0.94	0.93	0.90	0.91	0.95
70+	0.99	0.93	0.94	0.94	0.95	0.97	0.99	0.94	0.95	0.93	0.93	0.97

Respondent Community Characteristics

	Full Sample	Age in 2004				
		25-39	40-49	50-59	60-69	70+
Urban Community?						
All Respondents	0.32	0.32	0.34	0.33	0.28	0.28
Female	0.32	0.32	0.35	0.33	0.28	0.31
Male	0.33	0.33	0.34	0.33	0.28	0.24
Heavy Tsunami Damage?						
All Respondents	0.24	0.25	0.23	0.24	0.24	0.25
Female	0.24	0.25	0.23	0.25	0.20	0.25
Male	0.25	0.26	0.22	0.24	0.27	0.25
Female						
Rural Community	0.19	0.20	0.19	0.18	0.15	0.16
Urban Community	0.34	0.34	0.30	0.39	0.34	0.44
Male						
Rural Community	0.20	0.21	0.19	0.18	0.22	0.21
Urban Community	0.34	0.35	0.29	0.36	0.39	0.39

Baseline Respondent Education

	Years of Education			
	0-6	7-9	10-12	13+
Female				
All Respondents	0.61	0.14	0.16	0.08
Age in 2004				
25-39	0.45	0.19	0.24	0.11
40-49	0.68	0.12	0.12	0.09
50-59	0.82	0.10	0.06	0.03
60-69	0.91	0.04	0.04	0.01
70+	0.97	0.01	0.01	0.00
Male				
All Respondents	0.48	0.19	0.23	0.10
Age in 2004				
25-39	0.32	0.24	0.33	0.11
40-49	0.54	0.15	0.19	0.12
50-59	0.66	0.14	0.13	0.07
60-69	0.75	0.12	0.09	0.04
70+	0.88	0.08	0.03	0.01

3.4 Baseline Labor Market Outcomes

Table 3.2 presents average labor market outcomes at baseline for the analytic sample. At baseline, female and male respondents have very different labor market outcomes. Male respondents are much more likely to be working than female respondents, and men's primary jobs consist almost entirely of paid work, whereas 20 to 40% of women's primary jobs consist of unpaid work. Women also appear to work fewer hours, conditional on working, and are much more likely to spend time taking care of the household than men. These differences may reflect a variety of economic factors (e.g., labor market opportunities, household division of labor). To account for these baseline differences and the possibility that the disaster and post-disaster recovery effort may have affect women and men differently, I stratify the analysis by the sex of the respondent.

Table 3.2 also presents average baseline labor market outcomes for respondents who were living in urban and rural communities. There are many differences in baseline labor market outcome across rural and urban communities for both women and men. In urban areas, women of all ages and men other than those in their 40s are less likely to be working than in rural areas. Unpaid work is common for women in rural areas but rare for women in urban areas or for men. I do not have data on the industry of respondents' primary jobs at baseline, but the data from the resurveys suggest that around 80-85% of women's unpaid work in rural communities is in the agricultural sector and around 10-

Table 3.2: Baseline labor market outcomes

Sample of baseline respondents

Female

	Time Use				Hours Worked per Week	
	Worked?	Primary Work Paid?	Primary Work Unpaid?	Took Care of Household	Mean	Mean (If Working)
	All Communities					
Age in 2004						
25-39	0.41	0.24	0.16	0.88	13.5	34.2
40-49	0.48	0.33	0.15	0.89	16.4	34.6
50-59	0.42	0.28	0.14	0.82	14.0	34.2
60-69	0.33	0.24	0.09	0.70	9.6	30.0
70+	0.20	0.16	0.04	0.50	5.7	30.3
	Rural Communities					
Age in 2004						
25-39	0.45	0.22	0.23	0.89	14.2	32.9
40-49	0.51	0.29	0.22	0.89	16.5	32.8
50-59	0.48	0.29	0.19	0.79	15.3	32.4
60-69	0.37	0.25	0.11	0.70	10.7	29.7
70+	0.25	0.19	0.06	0.57	7.3	30.3
	Urban Communities					
Age in 2004						
25-39	0.33	0.30	0.03	0.86	11.9	37.7
40-49	0.43	0.40	0.03	0.91	16.2	38.5
50-59	0.28	0.25	0.03	0.88	11.3	40.4
60-69	0.23	0.20	0.03	0.71	6.7	31.2
70+	0.08	0.08	0.00	0.35	2.0	29.8

Male

	Time Use				Hours Worked per Week	
	Worked?	Primary Work Paid?	Primary Work Unpaid?	Took Care of Household	Mean	Mean (If Working)
Age in 2004						
25-39	0.94	0.92	0.01	0.10	39.8	43.4
40-49	0.98	0.93	0.01	0.11	42.2	43.4
50-59	0.92	0.81	0.02	0.09	37.5	41.7
60-69	0.79	0.55	0.02	0.10	30.8	39.7
70+	0.59	0.29	0.02	0.10	20.4	35.6
Age in 2004						
25-39	0.96	0.91	0.05	0.12	38.6	41.2
40-49	0.98	0.97	0.01	0.13	40.1	41.1
50-59	0.96	0.95	0.01	0.11	36.7	39.2
60-69	0.87	0.85	0.01	0.13	32.1	37.9
70+	0.66	0.64	0.02	0.09	22.0	34.0
Age in 2004						
25-39	0.89	0.88	0.02	0.06	42.3	48.0
40-49	0.98	0.97	0.01	0.08	46.3	47.9
50-59	0.84	0.83	0.00	0.06	39.1	47.4
60-69	0.61	0.59	0.02	0.05	27.6	46.2
70+	0.35	0.35	0.00	0.13	15.0	45.7

15% is related to sales (see Appendix Table 3.1). There is also evidence that in urban areas younger people work longer hours than in rural areas. Like before, it is likely that these differences reflect economic factors that differ between urban and rural areas,, so a lot of the analysis will be stratified by whether respondents are living in urban or rural areas to account for these differences and the potential for differential impacts of the disaster and post-disaster recovery on labor market outcomes.[4]

3.5 Results

The analysis begins with changes in the likelihood that respondents are working. Table 3.3 presents the likelihoods for female and male respondents in the analytic sample at the time of each survey. For reach resurvey, I also report the t-statistic of the difference test with the baseline prevalence in brackets below the prevalence for each resurvey year. The results are broken up into five age groups for two measures of respondent age. The first measure is each respondent's age at baseline (in 2004) and captures how the likelihood of working changes for fixed cohorts of respondents. The second measure is each respondent's age at the time of measurement in each survey and captures how the distribution of the likelihood of working across the age groups changes in the overall population.

---

[4] I present results that stratify respondents based on the community they are living in at the time of each resurvey. The results are similar when I stratify by the urban/rural status of the community they were living in in the baseline. These results are presented in Appendix Tables 3.3-3.6.

The results in Table 3.3 show that women who were 25-39 and 40-49 years of age in 2004 were significantly more likely to be employed in 2005 than they were in 2004 and that this increase persists over all of the resurvey years. With age at the time of measurement, the results show a similar increase, which suggests that the changes represent a persistent increase in the likelihood that women below the age of 50 are working in the greater population (as opposed to the changes simply representing changes in cohorts as they age). There is also a significant and persistent decrease in employment for women who were aged 60 and above in 2004.

For men, Table 3.3 shows a persistent increase in employment starting in 2006 for men aged 25-39 in 2004 and a persistent decrease in employment starting in 2005 for men in older cohorts. The results with age at time of measurement show a decrease in employment for men of all ages in 2005, but only appears to persist for men above the age of 60. This suggests that employment in the overall population of men temporarily decreases in the first year after the disaster but only caused a long-term decrease for older men.

Table 3.3 also presents the likelihood of respondents taking care of their households by sex and age (both in 2004 and at the time of measurement). In 2005 there is a large, significant increase in men taking care of the household across all ages, but the increase is temporary and disappears by 2007. There is a large amount of variability after 2005, but there is some evidence of a long-term increase for men age 25-39 and 50-59.

Table 3.3: Rates of working and taking care of household

Sample of baseline respondents
By sex and age of respondent

	Female						Male					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
							Working?					
Age in 2004												
25-39	0.41	0.46	0.49	0.50	0.49	0.56	0.94	0.93	0.95	0.95	0.96	0.96
		[3.93]	[6.54]	[7.01]	[6.29]	[11.82]		[-0.24]	[2.66]	[2.81]	[4.13]	[4.43]
40-49	0.48	0.52	0.54	0.54	0.51	0.56	0.98	0.94	0.95	0.96	0.94	0.96
		[2.00]	[3.18]	[2.94]	[1.35]	[4.22]		[-5.77]	[-3.38]	[-2.74]	[-5.13]	[-2.75]
50-59	0.42	0.37	0.38	0.38	0.35	0.41	0.92	0.82	0.83	0.82	0.83	0.79
		[-1.77]	[-1.44]	[-1.49]	[-2.41]	[-0.15]		[-5.55]	[-4.88]	[-5.50]	[-5.07]	[-7.35]
60-69	0.33	0.20	0.22	0.19	0.18	0.22	0.79	0.58	0.60	0.60	0.58	0.58
		[-4.47]	[-3.74]	[-5.07]	[-5.29]	[-3.71]		[-7.03]	[-6.24]	[-6.18]	[-6.45]	[-6.42]
70+	0.20	0.07	0.11	0.08	0.09	0.08	0.59	0.30	0.33	0.33	0.23	0.28
		[-4.45]	[-2.95]	[-4.03]	[-3.46]	[-3.84]		[-6.01]	[-5.50]	[-5.19]	[-6.95]	[-5.66]
Age at measurement												
25-39	0.41	0.44	0.46	0.47	0.45	0.51	0.94	0.92	0.94	0.93	0.94	0.94
		[2.41]	[4.13]	[4.58]	[3.08]	[8.09]		[-2.51]	[0.26]	[-0.17]	[0.56]	[0.97]
40-49	0.48	0.52	0.56	0.56	0.54	0.60	0.98	0.95	0.96	0.97	0.96	0.97
		[1.88]	[4.07]	[3.97]	[3.27]	[6.36]		[-5.02]	[-2.97]	[-1.63]	[-2.97]	[-1.77]
50-59	0.42	0.42	0.44	0.45	0.45	0.51	0.92	0.85	0.90	0.89	0.90	0.91
		[0.23]	[0.87]	[1.33]	[1.34]	[4.01]		[-4.76]	[-1.50]	[-2.14]	[-1.52]	[-0.62]
60-69	0.33	0.27	0.28	0.29	0.26	0.35	0.79	0.65	0.65	0.70	0.72	0.71
		[-2.00]	[-1.64]	[-1.26]	[-2.35]	[0.64]		[-5.22]	[-4.88]	[-3.27]	[-2.73]	[-3.04]
70+	0.20	0.08	0.13	0.10	0.10	0.11	0.59	0.35	0.41	0.39	0.36	0.42
		[-4.49]	[-2.64]	[-3.91]	[-3.61]	[-3.30]		[-5.20]	[-4.08]	[-4.42]	[-5.21]	[-3.79]
							Taking Care of Household?					
Age in 2004												
25-39	0.88	0.92	0.87	0.86	0.87	0.88	0.10	0.25	0.12	0.07	0.11	0.13
		[5.01]	[-0.55]	[-2.21]	[-0.59]	[-0.06]		[16.92]	[2.28]	[-3.09]	[0.75]	[2.72]
40-49	0.89	0.91	0.85	0.83	0.85	0.86	0.11	0.27	0.13	0.07	0.11	0.12
		[1.36]	[-3.22]	[-4.59]	[-3.27]	[-2.43]		[12.39]	[1.69]	[-3.28]	[-0.03]	[0.95]
50-59	0.82	0.88	0.72	0.75	0.80	0.77	0.09	0.27	0.13	0.08	0.12	0.14
		[2.83]	[-4.42]	[-3.19]	[-1.03]	[-2.02]		[10.88]	[2.54]	[-0.71]	[1.96]	[2.66]
60-69	0.70	0.69	0.52	0.58	0.57	0.58	0.10	0.27	0.10	0.10	0.09	0.12
		[-0.25]	[-5.65]	[-3.69]	[-4.07]	[-3.55]		[7.58]	[-0.28]	[-0.43]	[-0.53]	[0.63]
70+	0.50	0.48	0.27	0.28	0.30	0.28	0.10	0.20	0.07	0.11	0.08	0.14
		[-0.50]	[-5.24]	[-4.98]	[-4.48]	[-4.61]		[3.22]	[-0.80]	[0.40]	[-0.56]	[1.18]
Age at measurement												
25-39	0.88	0.91	0.87	0.85	0.86	0.87	0.10	0.25	0.13	0.08	0.11	0.14
		[3.60]	[-1.30]	[-3.61]	[-2.08]	[-1.37]		[16.53]	[2.96]	[-2.30]	[1.41]	[3.84]
40-49	0.89	0.92	0.87	0.86	0.86	0.86	0.11	0.25	0.13	0.06	0.10	0.12
		[2.36]	[-2.20]	[-2.83]	[-2.73]	[-2.68]		[11.70]	[1.15]	[-4.13]	[-0.73]	[0.36]
50-59	0.82	0.88	0.80	0.79	0.84	0.86	0.09	0.28	0.13	0.09	0.12	0.12
		[3.31]	[-0.96]	[-1.32]	[1.10]	[2.43]		[11.93]	[2.51]	[-0.27]	[1.68]	[2.21]
60-69	0.70	0.76	0.60	0.67	0.72	0.71	0.10	0.28	0.12	0.09	0.13	0.14
		[1.86]	[-3.32]	[-1.13]	[0.83]	[0.49]		[8.19]	[0.78]	[-0.65]	[1.10]	[1.60]
70+	0.50	0.51	0.29	0.33	0.35	0.40	0.10	0.20	0.07	0.10	0.07	0.13
		[0.31]	[-5.48]	[-4.26]	[-3.82]	[-2.54]		[3.45]	[-0.92]	[-0.12]	[-1.19]	[1.11]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

Table 3.4: Joint rates of working and taking care of household

Sample of baseline respondents
By sex and age of respondent in 2004

	Female						Male					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
25-39												
Neither	0.03	0.02	0.01	0.01	0.01	0.01	0.06	0.05	0.04	0.04	0.03	0.03
		[-3.11]	[-3.62]	[-3.84]	[-4.43]	[-4.21]		[-2.13]	[-3.27]	[-3.14]	[-4.57]	[-5.28]
Only Work	0.10	0.06	0.11	0.13	0.12	0.11	0.84	0.70	0.84	0.89	0.86	0.84
		[-4.04]	[2.10]	[3.96]	[2.48]	[1.82]		[-13.92]	[-0.27]	[4.43]	[1.78]	[0.41]
Only HH Care	0.56	0.52	0.49	0.49	0.50	0.43	0.01	0.02	0.01	0.01	0.01	0.01
		[-3.13]	[-5.61]	[-6.03]	[-5.16]	[-10.73]		[4.94]	[0.71]	[0.08]	[0.05]	[0.81]
Both	0.31	0.40	0.38	0.37	0.38	0.45	0.09	0.23	0.11	0.07	0.10	0.12
		[6.58]	[5.41]	[4.72]	[4.91]	[11.01]		[15.98]	[2.14]	[-3.21]	[0.76]	[2.57]
40-49												
Neither	0.01	0.01	0.02	0.02	0.03	0.02	0.01	0.03	0.03	0.03	0.05	0.03
		[0.69]	[2.51]	[2.37]	[3.18]	[1.19]		[2.52]	[2.60]	[2.82]	[4.64]	[2.97]
Only Work	0.10	0.07	0.12	0.14	0.12	0.12	0.87	0.70	0.83	0.90	0.84	0.84
		[-1.75]	[2.35]	[3.87]	[2.10]	[2.08]		[-12.54]	[-2.78]	[1.67]	[-2.17]	[-2.28]
Only HH Care	0.51	0.46	0.43	0.44	0.46	0.42	0.00	0.03	0.01	0.01	0.01	0.01
		[-2.20]	[-3.89]	[-3.62]	[-2.24]	[-4.57]		[6.76]	[2.17]	[0.61]	[2.16]	[0.39]
Both	0.39	0.45	0.42	0.40	0.39	0.44	0.11	0.24	0.12	0.06	0.10	0.12
		[3.15]	[1.72]	[0.51]	[0.02]	[2.95]		[10.58]	[1.03]	[-3.61]	[-0.75]	[0.86]
50-59												
Neither	0.07	0.08	0.14	0.13	0.11	0.14	0.07	0.11	0.14	0.16	0.14	0.19
		[0.65]	[4.51]	[4.03]	[2.47]	[4.61]		[2.63]	[4.01]	[5.24]	[4.01]	[6.75]
Only Work	0.12	0.05	0.14	0.12	0.10	0.08	0.84	0.61	0.73	0.76	0.74	0.68
		[-4.48]	[1.31]	[0.16]	[-1.15]	[-2.03]		[-10.45]	[-5.05]	[-3.47]	[-4.60]	[-7.24]
Only HH Care	0.52	0.55	0.48	0.49	0.54	0.45	0.01	0.06	0.03	0.02	0.03	0.03
		[1.32]	[-1.38]	[-1.04]	[0.83]	[-2.71]		[6.75]	[2.60]	[1.46]	[3.01]	[2.47]
Both	0.30	0.32	0.24	0.26	0.26	0.33	0.08	0.21	0.11	0.06	0.09	0.11
		[1.07]	[-2.42]	[-1.72]	[-1.84]	[1.19]		[8.33]	[1.40]	[-1.56]	[0.54]	[1.60]
60-69												
Neither	0.20	0.27	0.41	0.37	0.36	0.36	0.19	0.31	0.36	0.37	0.37	0.37
		[2.05]	[6.64]	[5.35]	[5.08]	[4.97]		[3.96]	[5.37]	[5.57]	[5.51]	[5.41]
Only Work	0.10	0.04	0.07	0.05	0.07	0.06	0.70	0.42	0.54	0.54	0.54	0.51
		[-3.32]	[-1.35]	[-2.78]	[-1.55]	[-2.35]		[-8.87]	[-4.86]	[-4.95]	[-4.83]	[-5.52]
Only HH Care	0.47	0.53	0.37	0.44	0.46	0.42	0.01	0.11	0.05	0.04	0.05	0.05
		[1.86]	[-3.03]	[-0.71]	[-0.28]	[-1.51]		[7.00]	[2.26]	[1.70]	[2.42]	[2.57]
Both	0.23	0.16	0.15	0.14	0.11	0.17	0.09	0.16	0.05	0.06	0.04	0.07
		[-2.83]	[-3.34]	[-3.89]	[-4.96]	[-2.63]		[3.70]	[-2.15]	[-1.89]	[-2.58]	[-1.28]
70+												
Neither	0.45	0.51	0.69	0.70	0.67	0.69	0.39	0.57	0.63	0.60	0.72	0.62
		[1.42]	[5.51]	[5.65]	[4.84]	[5.14]		[3.83]	[4.83]	[4.13]	[6.28]	[4.15]
Only Work	0.05	0.01	0.04	0.02	0.03	0.03	0.51	0.22	0.30	0.29	0.20	0.24
		[-2.48]	[-0.93]	[-1.98]	[-1.13]	[-1.60]		[-6.39]	[-4.62]	[-4.72]	[-6.36]	[-5.30]
Only HH Care	0.36	0.42	0.20	0.22	0.24	0.23	0.03	0.12	0.05	0.07	0.05	0.10
		[1.60]	[-3.84]	[-3.24]	[-2.77]	[-2.82]		[3.88]	[0.91]	[1.71]	[0.80]	[2.56]
Both	0.14	0.06	0.07	0.06	0.06	0.05	0.07	0.08	0.02	0.04	0.03	0.04
		[-3.54]	[-2.82]	[-3.37]	[-3.27]	[-3.41]		[0.35]	[-2.15]	[-1.30]	[-1.68]	[-1.12]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

I next investigate the decisions to work and to take care of the household jointly. I separate the respondents into four categories: (1) only worked, (2) only took care of the household, (3) both worked and took of the household, and (4) neither activity. The prevalence of each category is presented in Table 3.4 and is stratified by sex and age in 2004. The results indicate that the persistent increase in the prevalence of younger women working after the disaster seen in Table 3.3 primarily consists of an increase in the prevalence of women who both work and take care of the household. There is also a small but significant increase in the prevalence of younger women who only work in 2006 that generally persists over time. For men under the age of 50, the temporary increase in their likelihood of taking care of the household in 2005 primarily consists of men who are both working and taking care of the household. However for men 50 years and older, the increase primarily consists of men who are only taking care of the household. In Table 3.4, there is also a significant increase in 2005 of older adults of both sexes who are neither working nor taking care of the household, but it is unclear whether they are retired from work or simply unemployed.

In Table 3.5, I look more closely at how interest in labor market participation changes after the disaster for respondents who are not working. I separate the respondents into four categories of participation: (1) working, (2) not working but seeking work ("seeking work"), (3) not working or seeking work but would accept a job if offered to them ("not seeking but interested"), and (4) not working or seeking work and would not accept a job if offered to them ("not seeking nor interested"). The results show that the sudden and persistent decrease in employment in 2005 for respondents

Table 3.5: Interest in participation in the labor market

Sample of baseline respondents
By sex and age of respondent in 2004

	Female						Male					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
25-39												
Working	0.41	0.46	0.49	0.50	0.49	0.56	0.94	0.93	0.95	0.95	0.96	0.96
		[3.93]	[6.54]	[7.01]	[6.29]	[11.82]		[-0.24]	[2.66]	[2.81]	[4.13]	[4.43]
Seeking work	0.04	0.05	0.05	0.03	0.03	0.02	0.03	0.04	0.02	0.02	0.02	0.02
		[2.42]	[2.30]	[-0.74]	[-1.69]	[-3.75]		[1.83]	[-1.77]	[-2.79]	[-3.35]	[-3.38]
Not seeking but interested	0.16	0.13	0.10	0.12	0.12	0.11	0.02	0.01	0.01	0.01	0.01	0.00
		[-3.27]	[-6.07]	[-3.96]	[-3.56]	[-4.71]		[-4.51]	[-3.71]	[-3.72]	[-4.10]	[-5.08]
Not seeking nor interested	0.40	0.36	0.35	0.34	0.35	0.30	0.02	0.02	0.02	0.02	0.02	0.02
		[-2.78]	[-3.52]	[-4.28]	[-3.43]	[-7.58]		[1.29]	[0.06]	[0.89]	[-0.33]	[-0.16]
40-49												
Working	0.48	0.52	0.54	0.54	0.51	0.56	0.98	0.94	0.95	0.96	0.94	0.96
		[2.00]	[3.18]	[2.94]	[1.35]	[4.22]		[-5.77]	[-3.38]	[-2.74]	[-5.13]	[-2.75]
Seeking work	0.01	0.04	0.03	0.01	0.02	0.01	0.01	0.03	0.02	0.02	0.02	0.01
		[5.84]	[4.35]	[1.32]	[1.84]	[-0.24]		[4.42]	[2.88]	[2.01]	[2.70]	[0.60]
Not seeking but interested	0.08	0.07	0.06	0.06	0.09	0.06	0.00	0.01	0.00	0.00	0.01	0.01
		[-0.40]	[-2.16]	[-1.44]	[1.40]	[-1.80]		[3.06]	[-0.06]	[0.21]	[2.17]	[1.29]
Not seeking nor interested	0.43	0.37	0.37	0.38	0.38	0.37	0.01	0.03	0.02	0.02	0.03	0.03
		[-3.38]	[-3.26]	[-2.60]	[-2.60]	[-3.31]		[2.71]	[2.29]	[1.99]	[3.71]	[2.63]
50-59												
Working	0.42	0.37	0.38	0.38	0.35	0.41	0.92	0.82	0.83	0.82	0.83	0.79
		[-1.77]	[-1.44]	[-1.49]	[-2.41]	[-0.15]		[-5.55]	[-4.88]	[-5.50]	[-5.07]	[-7.35]
Seeking work	0.01	0.02	0.01	0.00	0.01	0.00	0.00	0.02	0.02	0.02	0.01	0.00
		[2.19]	[-0.26]	[-0.87]	[0.83]	[-0.87]		[2.96]	[2.60]	[2.67]	[2.10]	[-0.15]
Not seeking but interested	0.05	0.05	0.03	0.05	0.04	0.03	0.01	0.03	0.02	0.02	0.01	0.02
		[0.46]	[-1.50]	[0.28]	[-0.27]	[-1.52]		[3.04]	[1.49]	[1.32]	[0.61]	[1.29]
Not seeking nor interested	0.53	0.56	0.58	0.57	0.59	0.56	0.07	0.13	0.13	0.15	0.15	0.20
		[1.15]	[2.06]	[1.51]	[2.33]	[0.91]		[3.97]	[3.92]	[4.63]	[4.60]	[7.48]
60-69												
Working	0.33	0.20	0.22	0.19	0.18	0.22	0.79	0.58	0.60	0.60	0.58	0.58
		[-4.47]	[-3.74]	[-5.07]	[-5.29]	[-3.71]		[-7.03]	[-6.24]	[-6.18]	[-6.45]	[-6.42]
Seeking work	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00
		[0.80]	[0.15]	[0.88]	[-0.55]	[0.18]		[1.35]	[1.41]	[0.74]	[1.55]	[0.00]
Not seeking but interested	0.03	0.02	0.03	0.01	0.03	0.02	0.02	0.02	0.01	0.02	0.03	0.01
		[-0.68]	[-0.07]	[-1.33]	[0.09]	[-1.00]		[0.05]	[-0.71]	[-0.28]	[0.83]	[-1.39]
Not seeking nor interested	0.64	0.77	0.75	0.80	0.80	0.76	0.19	0.40	0.38	0.39	0.39	0.41
		[4.45]	[3.62]	[5.24]	[5.15]	[3.90]		[7.01]	[6.35]	[6.25]	[6.12]	[6.88]
70+												
Working	0.20	0.07	0.11	0.08	0.09	0.08	0.59	0.30	0.33	0.33	0.23	0.28
		[-4.45]	[-2.95]	[-4.03]	[-3.46]	[-3.84]		[-6.01]	[-5.50]	[-5.19]	[-6.95]	[-5.66]
Seeking work	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
		[0.30]	[0.33]	[-0.74]	[-0.72]	[-0.69]		[0.00]	[0.00]	[2.04]	[0.00]	[0.00]
Not seeking but interested	0.04	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.02	0.00
		[-3.30]	[-3.26]	[-3.15]	[-3.01]	[-3.45]		[-0.27]	[0.34]	[1.15]	[0.64]	[-0.73]
Not seeking nor interested	0.76	0.92	0.88	0.92	0.90	0.92	0.41	0.69	0.66	0.64	0.76	0.72
		[5.28]	[3.85]	[5.00]	[4.41]	[4.92]		[6.03]	[5.38]	[4.76]	[6.76]	[5.77]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

who were 60 years and older was matched by an increase in the proportion who are not participating in the labor market and who no interest in joining. This suggests that the large decrease in older adults employment after the disaster was due to respondents retiring from the labor market altogether. On the other hand, for men aged 40 to 59 in 2004 there are significant, temporary increases in all three "not employed" categories in 2005, which suggests that a significant proportion of the men in those cohorts who stopped working maintained an interest in working.

For women below the age of 50, there is evidence of both an increase in employment in 2005 and an increase in interest in participating in the labor market, which is highlighted by a significant and persistent decrease in young women who are out of the labor market and no interest in participating. The effect is particularly striking in the youngest cohort of women, where the percentage of respondents interested in participating in the labor market increases from 60% in 2004 to 70% in 2009.

Table 3.6 presents the likelihood of working in the last week further stratified by two characteristics of the respondent's community: (1) whether the community is in an urban or rural area and (2) whether the community sustained heavy physical damage in the tsunami (as determined by a combination of satellite imagery, interviews with village heads, and interviewer observations; see Section 3.3). These stratifications allow me to identify differential changes in employment across different types of communities.

Table 3.6: Working by tsunami damage, urban/rural status of community

Sample of baseline respondents
By sex and age of respondent in 2004

Female

	Not Heavy Tsunami Damage						Heavy Tsunami Damage					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
Rural Community												
Age in 2004												
25-39	0.45	0.42	0.47	0.49	0.46	0.55	0.42	0.48	0.48	0.47	0.51	0.54
		[-1.99]	[0.66]	[1.83]	[0.34]	[5.87]		[1.61]	[1.46]	[1.35]	[2.33]	[3.24]
40-49	0.51	0.49	0.52	0.50	0.47	0.57	0.49	0.53	0.50	0.49	0.44	0.52
		[-1.09]	[0.08]	[-0.44]	[-1.54]	[2.06]		[0.69]	[0.15]	[0.00]	[-0.71]	[0.53]
50-59	0.48	0.36	0.39	0.40	0.35	0.43	0.51	0.36	0.34	0.36	0.41	0.42
		[-3.45]	[-2.74]	[-2.43]	[-3.67]	[-1.24]		[-1.91]	[-2.11]	[-1.86]	[-1.16]	[-1.14]
60-69	0.36	0.18	0.22	0.19	0.18	0.25	0.42	0.30	0.20	0.20	0.22	0.21
		[-5.22]	[-4.08]	[-4.97]	[-5.23]	[-3.24]		[-1.14]	[-2.24]	[-2.24]	[-2.03]	[-2.16]
70+	0.25	0.07	0.10	0.06	0.08	0.06	0.24	0.12	0.25	0.13	0.36	0.27
		[-5.22]	[-4.43]	[-5.34]	[-4.87]	[-5.27]		[-0.99]	[0.06]	[-0.83]	[0.82]	[0.21]
Urban Community												
Age in 2004												
25-39	0.34	0.53	0.54	0.53	0.56	0.61	0.31	0.56	0.62	0.58	0.53	0.51
		[6.84]	[7.29]	[6.88]	[7.96]	[9.88]		[5.95]	[7.22]	[6.31]	[4.97]	[4.66]
40-49	0.44	0.61	0.63	0.63	0.61	0.60	0.39	0.49	0.53	0.60	0.54	0.44
		[4.20]	[4.83]	[4.80]	[4.16]	[4.05]		[1.48]	[2.00]	[2.93]	[1.98]	[0.66]
50-59	0.33	0.44	0.43	0.37	0.38	0.39	0.20	0.28	0.26	0.28	0.23	0.29
		[1.95]	[1.71]	[0.66]	[0.91]	[1.07]		[1.16]	[0.80]	[1.11]	[0.42]	[1.29]
60-69	0.27	0.24	0.28	0.20	0.17	0.17	0.15	0.25	0.16	0.11	0.13	0.13
		[-0.44]	[0.08]	[-1.11]	[-1.42]	[-1.56]		[1.14]	[0.12]	[-0.41]	[-0.20]	[-0.20]
70+	0.08	0.05	0.13	0.14	0.10	0.12	0.08	0.06	0.07	0.00	0.00	0.00
		[-0.37]	[0.68]	[0.97]	[0.27]	[0.56]		[-0.19]	[-0.05]	[-0.95]	[-0.95]	[-0.95]

Male

	Not Heavy Tsunami Damage						Heavy Tsunami Damage					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
Rural Community												
Age in 2004												
25-39	0.96	0.94	0.96	0.96	0.96	0.97	0.95	0.92	0.95	0.95	0.97	0.96
		[-2.02]	[0.36]	[-0.30]	[0.25]	[1.06]		[-2.00]	[-0.06]	[-0.22]	[1.44]	[0.89]
40-49	0.99	0.94	0.96	0.97	0.95	0.97	0.97	0.89	0.95	0.96	0.95	0.96
		[-4.51]	[-2.22]	[-1.87]	[-4.05]	[-1.42]		[-3.39]	[-1.10]	[-0.43]	[-0.90]	[-0.58]
50-59	0.96	0.82	0.85	0.85	0.85	0.83	0.98	0.84	0.90	0.87	0.88	0.86
		[-6.47]	[-4.92]	[-4.83]	[-4.82]	[-5.71]		[-3.13]	[-1.72]	[-2.41]	[-2.22]	[-2.68]
60-69	0.88	0.62	0.64	0.62	0.61	0.60	0.84	0.60	0.57	0.50	0.55	0.55
		[-6.50]	[-6.01]	[-6.41]	[-6.43]	[-6.50]		[-2.80]	[-3.13]	[-4.00]	[-3.30]	[-3.32]
70+	0.70	0.29	0.38	0.36	0.23	0.29	0.49	0.37	0.35	0.30	0.44	0.47
		[-7.10]	[-5.63]	[-5.56]	[-7.46]	[-6.36]		[-0.84]	[-1.05]	[-1.35]	[-0.33]	[-0.13]
Urban Community												
Age in 2004												
25-39	0.91	0.93	0.94	0.96	0.96	0.95	0.87	0.92	0.92	0.93	0.95	0.95
		[1.38]	[2.59]	[3.59]	[3.52]	[3.49]		[2.15]	[1.93]	[2.22]	[3.21]	[3.00]
40-49	0.98	0.94	0.93	0.94	0.92	0.94	0.97	0.93	0.96	0.97	0.95	0.90
		[-1.98]	[-2.49]	[-2.35]	[-3.38]	[-1.88]		[-1.46]	[-0.57]	[-0.28]	[-0.72]	[-2.40]
50-59	0.84	0.84	0.76	0.74	0.76	0.67	0.83	0.80	0.77	0.74	0.75	0.65
		[-0.07]	[-1.72]	[-2.31]	[-1.84]	[-3.77]		[-0.46]	[-0.76]	[-1.30]	[-1.06]	[-2.45]
60-69	0.67	0.47	0.57	0.53	0.44	0.48	0.51	0.43	0.39	0.67	0.65	0.65
		[-2.58]	[-1.31]	[-1.67]	[-2.70]	[-2.27]		[-0.82]	[-1.14]	[1.38]	[1.25]	[1.25]
70+	0.33	0.36	0.18	0.32	0.12	0.14	0.36	0.18	0.00	0.00	0.00	0.00
		[0.21]	[-1.25]	[-0.14]	[-1.64]	[-1.36]		[-1.43]	[-2.68]	[-2.56]	[-2.56]	[-2.14]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

The results suggest that the changes in employment seen in Table 3.3 for women are quite different in urban and rural communities. The increase in employment for younger women primarily occurs in urban communities, but the decrease in employment for older women primarily occurs in rural communities. These effects largely exist across both low and high damage communities, and these effects appear to be more pronounced in communities that did not experience high physical damage in the tsunami. This suggests that the tsunami and post-disaster recovery changed labor market outcomes for women across all of coastal Aceh, regardless of tsunami exposure.

For men the results in Table 3.6 similarly suggest that the changes seen in Table 2 are largely divided by whether the respondent's community is urban or rural. For example, the temporary decrease in employment in 2005 for men of all ages and the persistent decrease for older men primarily occur in rural communities, but there is still evidence of long-term decline in employment for older men in urban communities that were not heavily damaged. There is also evidence of a long-term increase in employment for the youngest cohort of men in urban areas regardless of tsunami damage.

I next present evidence of how hours worked in a normal week changed after the disaster. The results are stratified by sex, age in 2004, and urban/rural status of the community and are presented in Table 3.7. Results are presented for two measures of hours worked: (1) the mean hours worked and (2) the mean hours worked for

Table 3.7: Hours worked in a normal week

Sample of baseline respondents
By sex, age of respondent in 2004, and urban/rural status of community

Female

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
	Mean											
Age in 2004												
25-39	14.2	14.8	17.0	17.8	16.1	19.9	11.9	20.9	21.5	21.5	22.1	23.4
		[0.96]	[4.30]	[5.47]	[2.88]	[8.84]		[8.02]	[8.48]	[8.45]	[8.97]	[10.28]
40-49	16.5	17.4	18.4	17.9	16.4	19.9	16.2	22.6	22.7	23.7	23.9	22.6
		[0.89]	[1.93]	[1.41]	[-0.15]	[3.37]		[3.95]	[3.94]	[4.58]	[4.64]	[3.93]
50-59	15.3	12.7	13.4	13.2	10.9	14.3	11.3	14.2	11.8	13.8	11.4	13.4
		[-2.16]	[-1.54]	[-1.68]	[-3.57]	[-0.81]		[1.46]	[0.22]	[1.24]	[0.02]	[1.03]
60-69	10.7	6.5	8.1	5.7	5.6	7.5	6.7	7.5	7.6	4.4	3.4	4.0
		[-3.54]	[-2.15]	[-4.17]	[-4.23]	[-2.67]		[0.43]	[0.48]	[-1.17]	[-1.65]	[-1.38]
70+	7.3	1.6	3.0	1.4	2.3	1.8	2.0	0.5	1.7	2.5	1.1	2.6
		[-5.68]	[-4.26]	[-5.67]	[-4.68]	[-4.99]		[-1.29]	[-0.20]	[0.46]	[-0.70]	[0.47]
	Mean (Conditional on Working)											
Age in 2004												
25-39	32.9	36.1	36.9	37.4	35.5	36.5	37.7	41.1	39.9	40.0	40.3	40.2
		[4.06]	[5.23]	[5.95]	[3.43]	[4.99]		[2.37]	[1.55]	[1.64]	[1.85]	[1.84]
40-49	32.8	36.1	36.3	36.3	35.3	35.7	38.5	39.4	38.4	39.3	40.5	40.1
		[3.04]	[3.25]	[3.26]	[2.28]	[2.77]		[0.49]	[-0.06]	[0.43]	[1.11]	[0.90]
50-59	32.4	35.7	35.3	33.9	30.5	33.5	40.4	36.7	32.6	40.8	34.8	37.6
		[2.20]	[1.94]	[0.99]	[-1.17]	[0.77]		[-1.12]	[-2.26]	[0.12]	[-1.57]	[-0.82]
60-69	29.7	36.1	38.1	30.1	31.8	30.9	31.2	31.9	30.5	25.0	22.5	27.2
		[2.57]	[3.57]	[0.15]	[0.83]	[0.50]		[0.14]	[-0.14]	[-1.08]	[-1.40]	[-0.65]
70+	30.3	22.4	26.4	22.7	25.3	24.3	29.8	8.0	15.8	22.8	14.7	30.3
		[-1.89]	[-1.13]	[-1.67]	[-1.25]	[-1.31]		[-2.71]	[-2.03]	[-1.02]	[-1.88]	[0.06]

Male

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
	Mean											
Age in 2004												
25-39	38.6	42.1	44.1	44.3	43.1	44.0	42.3	46.9	45.8	47.4	48.3	47.6
		[5.95]	[9.27]	[9.59]	[7.66]	[9.28]		[4.62]	[3.52]	[5.03]	[5.80]	[5.24]
40-49	40.1	41.4	42.5	43.5	41.0	41.6	46.3	46.9	45.7	45.4	43.9	43.5
		[1.72]	[3.07]	[4.42]	[1.13]	[1.95]		[0.41]	[-0.45]	[-0.63]	[-1.72]	[-1.98]
50-59	36.7	33.2	36.3	35.9	34.9	33.6	39.1	39.0	34.9	34.2	34.4	30.4
		[-3.03]	[-0.39]	[-0.69]	[-1.55]	[-2.57]		[-0.07]	[-1.76]	[-2.05]	[-1.95]	[-3.70]
60-69	32.1	23.7	23.2	23.8	21.8	22.1	27.6	19.2	23.1	26.1	22.3	23.2
		[-5.18]	[-5.44]	[-5.02]	[-6.13]	[-5.81]		[-2.58]	[-1.34]	[-0.40]	[-1.46]	[-1.22]
70+	22.0	9.9	11.9	13.2	9.6	11.6	15.0	10.2	4.3	7.7	2.2	4.7
		[-5.60]	[-4.64]	[-3.88]	[-5.26]	[-4.27]		[-1.28]	[-2.67]	[-1.74]	[-2.96]	[-2.15]
	Mean (Conditional on Working)											
Age in 2004												
25-39	41.2	45.3	46.3	46.6	44.9	45.7	48.0	51.6	49.2	50.2	50.8	50.0
		[7.85]	[9.71]	[10.41]	[7.09]	[8.81]		[4.20]	[1.46]	[2.58]	[3.19]	[2.33]
40-49	41.1	44.6	44.3	45.2	43.3	43.0	47.9	50.4	48.9	48.2	47.9	46.6
		[5.06]	[4.66]	[5.96]	[3.19]	[2.81]		[2.07]	[0.86]	[0.27]	[0.02]	[-1.07]
50-59	39.2	40.8	42.3	42.2	40.8	40.2	47.4	47.3	46.2	46.5	46.1	45.8
		[1.64]	[3.22]	[3.03]	[1.69]	[1.07]		[-0.08]	[-0.61]	[-0.46]	[-0.63]	[-0.79]
60-69	37.9	38.8	36.9	40.0	36.1	37.2	46.2	44.0	46.1	45.2	44.6	43.2
		[0.69]	[-0.71]	[1.58]	[-1.27]	[-0.48]		[-0.71]	[-0.04]	[-0.31]	[-0.48]	[-0.93]
70+	34.0	33.3	32.9	37.3	36.1	36.5	45.7	33.1	33.0	34.5	28.0	45.0
		[-0.26]	[-0.43]	[1.17]	[0.64]	[0.78]		[-1.94]	[-1.32]	[-1.36]	[-1.36]	[-0.06]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

respondents who work (i.e., hours are greater than zero). The results indicate that in rural areas the average hours worked for respondents below 50 years of age who work (i.e., conditional mean) increased in 2005 and persisted through 2009. There is also an increase in the unconditional averages, but it is less consistent over time for respondents in their 40s. The average number of hours declines for older women and men in rural areas, but there is no change for the conditional average, which suggests that the hour change is driven by respondents who stopped working. In urban areas, there is a significant and persistent increase in both conditional and unconditional hours worked for men below 40 years of age, which suggests that younger men in urban areas were both more likely to work after the disaster (see Table 3.6) and to work more hours.

The results in Table 3.6 provide strong evidence that employment increases significantly for young women after the disaster and that the speed of the increase differs in urban and rural areas – it occurred within the first year in urban areas but more slowly in rural areas. However it is also possible that this increase differs across other subgroups of women. In Table 3.8, I investigate whether the increases differs by levels of human capital, an important determinant of labor market outcomes. Table 3.8 presents the likelihood of working for women below the age of 50 in 2004 stratified by urban/rural status of their community and by their years of education.[5] The results

---

[5] The years of education are at the time of measurement, but the results are the same when using years of education in 2004.

indicate that in urban areas employment increases significantly in 2005 and persists to 2009 for all levels of education. In rural areas, employment also increases significantly in 2005 and persists through 2009 for college educated women, but there is no significant increase in employment until 2009 for women with less than college education.

Table 3.8: Working by years of education for younger females

Sample of female baseline respondents aged 25-49 in 2004
By sex, age of respondent in 2004, and urban/rural status of community

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
						0-6 Years						
Age in 2004												
25-39	0.46	0.43	0.45	0.48	0.46	0.54	0.28	0.48	0.46	0.45	0.45	0.52
		[-1.37]	[-0.15]	[0.93]	[0.08]	[4.02]		[3.98]	[3.48]	[3.34]	[3.26]	[4.71]
40-49	0.50	0.47	0.50	0.48	0.44	0.54	0.35	0.49	0.54	0.59	0.55	0.52
		[-1.05]	[0.15]	[-0.51]	[-2.04]	[1.70]		[2.57]	[3.63]	[4.57]	[3.76]	[3.18]
						7-9 Years						
Age in 2004												
25-39	0.40	0.36	0.38	0.42	0.37	0.50	0.21	0.45	0.47	0.40	0.43	0.49
		[-1.40]	[-0.60]	[0.41]	[-0.85]	[2.90]		[4.39]	[4.67]	[3.45]	[3.89]	[5.12]
40-49	0.42	0.38	0.36	0.37	0.42	0.43	0.36	0.55	0.51	0.51	0.49	0.46
		[-0.57]	[-0.69]	[-0.61]	[-0.11]	[0.04]		[2.60]	[2.00]	[1.98]	[1.82]	[1.35]
						10-12 Years						
Age in 2004												
25-39	0.40	0.38	0.46	0.42	0.43	0.49	0.27	0.44	0.51	0.48	0.47	0.52
		[-0.40]	[1.53]	[0.48]	[0.72]	[2.44]		[4.83]	[6.57]	[5.67]	[5.49]	[6.75]
40-49	0.45	0.61	0.53	0.53	0.50	0.67	0.36	0.46	0.58	0.53	0.48	0.48
		[1.58]	[0.78]	[0.79]	[0.45]	[2.17]		[1.39]	[2.85]	[2.22]	[1.54]	[1.58]
						13+ Years						
Age in 2004												
25-39	0.64	0.73	0.83	0.84	0.85	0.86	0.57	0.81	0.80	0.84	0.86	0.82
		[1.99]	[4.14]	[4.48]	[4.70]	[4.93]		[5.78]	[5.68]	[6.62]	[7.10]	[6.08]
40-49	0.95	0.97	0.95	1.00	1.00	1.00	0.80	0.96	0.95	0.98	0.94	0.94
		[0.51]	[-0.19]	[1.39]	[1.42]	[1.42]		[3.60]	[3.30]	[3.99]	[3.00]	[3.07]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

In Table 3.9, I present evidence of how employment in paid and unpaid work changed after the disaster. At baseline, most unpaid work is conducted by women in rural areas. However in 2005 there is a significant decrease in employment in unpaid work for all women in rural areas along with a significant increase in employment in paid work for women below 50 years of age. As a result, although there is no significant change in overall employment for younger women in rural areas in 2005 (see Table 3.6), there is a significant shift in their employment from unpaid to paid work. In addition, the prevalence of unpaid work for younger women increases after 2005 while their prevalence of paid work remains fairly constant. As a result, the late increase in the total employment of young, rural women appears to consist of an increase in unpaid work. There also appears to be a significant but smaller decrease in unpaid work for young men (25-39 years) in 2005 in both urban and rural areas that coincides with a persistent increase in employment in paid work.

3.6 Conclusions

Using unique longitudinal data of people from coastal communities in Aceh, Indonesia, I find evidence that the 2004 Indian Ocean tsunami and the subsequent post-disaster relief efforts had significant effects on the labor market outcomes of the people living in Aceh. I find strong evidence of lasting increase in the employment rate of women under the age of 50, which occurred shortly after the disaster in urban communities and persisted over time. The increase in employment was experienced by women with all levels of education, although college educated women maintained higher employment rates than less educated women. I also find evidence of a persistent increase in the proportion of young women who are interested in working, suggesting

Table 3.9: Paid vs. unpaid work

Sample of baseline respondents
By sex, age of respondent in 2004, and urban/rural status of community

Female

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
	Main Job in Last Week was for Pay?											
Age in 2004												
25-39	0.22	0.34	0.33	0.35	0.34	0.37	0.30	0.50	0.52	0.50	0.51	0.55
		[8.35]	[7.29]	[8.71]	[8.26]	[10.06]		[8.64]	[9.45]	[8.81]	[8.89]	[11.05]
40-49	0.29	0.38	0.38	0.35	0.33	0.37	0.40	0.55	0.56	0.57	0.54	0.52
		[3.90]	[4.13]	[2.70]	[2.01]	[3.50]		[4.31]	[4.53]	[5.01]	[3.96]	[3.42]
50-59	0.29	0.31	0.31	0.28	0.28	0.34	0.25	0.35	0.33	0.31	0.29	0.30
		[0.79]	[0.73]	[-0.48]	[-0.28]	[1.61]		[2.36]	[1.89]	[1.26]	[0.95]	[1.20]
60-69	0.25	0.17	0.18	0.15	0.16	0.20	0.20	0.22	0.24	0.15	0.14	0.16
		[-2.79]	[-2.41]	[-3.27]	[-3.15]	[-1.87]		[0.47]	[0.70]	[-0.87]	[-1.07]	[-0.76]
70+	0.19	0.08	0.09	0.06	0.09	0.07	0.08	0.06	0.09	0.11	0.07	0.09
		[-3.64]	[-3.05]	[-4.17]	[-2.98]	[-3.62]		[-0.43]	[0.20]	[0.68]	[-0.07]	[0.16]
	Main Job in Last Week was Unpaid?											
Age in 2004												
25-39	0.23	0.09	0.14	0.14	0.13	0.19	0.03	0.04	0.04	0.04	0.05	0.03
		[-12.55]	[-7.72]	[-8.10]	[-8.97]	[-3.66]		[0.96]	[1.51]	[1.03]	[1.68]	[0.25]
40-49	0.22	0.11	0.13	0.15	0.14	0.19	0.03	0.03	0.05	0.05	0.05	0.05
		[-6.16]	[-5.12]	[-4.00]	[-4.85]	[-1.55]		[0.55]	[1.92]	[1.69]	[1.92]	[1.72]
50-59	0.19	0.05	0.07	0.11	0.08	0.10	0.03	0.04	0.04	0.04	0.04	0.06
		[-7.69]	[-6.60]	[-4.12]	[-6.02]	[-5.09]		[0.63]	[0.74]	[0.48]	[0.79]	[1.56]
60-69	0.11	0.02	0.04	0.03	0.02	0.04	0.03	0.02	0.01	0.02	0.01	0.00
		[-5.63]	[-4.81]	[-4.89]	[-5.44]	[-4.18]		[-0.47]	[-0.91]	[-0.28]	[-0.84]	[-1.56]
70+	0.06	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00
		[-3.94]	[-2.67]	[-2.93]	[-3.25]	[-3.12]		[0.00]	[2.12]	[0.00]	[0.00]	[0.00]

Male

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
	Main Job in Last Week was for Pay?											
Age in 2004												
25-39	0.91	0.92	0.94	0.94	0.95	0.96	0.88	0.92	0.93	0.94	0.95	0.95
		[2.23]	[4.43]	[4.01]	[5.91]	[6.35]		[3.14]	[3.83]	[4.75]	[5.53]	[5.76]
40-49	0.97	0.93	0.95	0.94	0.94	0.97	0.97	0.93	0.93	0.94	0.92	0.93
		[-4.12]	[-1.81]	[-2.74]	[-3.05]	[-0.17]		[-2.50]	[-2.77]	[-1.90]	[-3.30]	[-2.70]
50-59	0.95	0.81	0.84	0.82	0.84	0.83	0.83	0.81	0.76	0.72	0.75	0.66
		[-7.03]	[-5.41]	[-6.14]	[-5.29]	[-5.67]		[-0.68]	[-2.00]	[-2.90]	[-2.12]	[-4.58]
60-69	0.85	0.60	0.62	0.58	0.59	0.57	0.59	0.43	0.49	0.58	0.51	0.51
		[-7.19]	[-6.45]	[-7.48]	[-7.16]	[-7.37]		[-2.59]	[-1.53]	[-0.18]	[-1.10]	[-1.12]
70+	0.64	0.29	0.36	0.35	0.26	0.32	0.35	0.28	0.13	0.22	0.08	0.11
		[-6.60]	[-5.36]	[-5.16]	[-6.48]	[-5.40]		[-0.74]	[-2.34]	[-1.28]	[-2.68]	[-2.20]
	Main Job in Last Week was Unpaid?											
Age in 2004												
25-39	0.05	0.01	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.00
		[-7.84]	[-7.32]	[-7.55]	[-9.04]	[-9.14]		[-2.10]	[-1.67]	[-1.57]	[-2.45]	[-3.42]
40-49	0.01	0.01	0.01	0.03	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01
		[-1.50]	[-0.69]	[2.32]	[-0.98]	[-2.41]		[0.63]	[1.25]	[-0.50]	[0.43]	[0.39]
50-59	0.01	0.01	0.02	0.03	0.02	0.00	0.00	0.02	0.01	0.02	0.01	0.01
		[0.42]	[1.03]	[2.71]	[0.57]	[-0.99]		[1.68]	[0.77]	[1.33]	[0.21]	[0.73]
60-69	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.03	0.01	0.00	0.00	0.03
		[0.69]	[-0.68]	[0.44]	[0.20]	[0.73]		[0.48]	[-0.59]	[-1.16]	[-1.16]	[0.30]
70+	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
		[-0.18]	[-0.18]	[-1.47]	[-1.41]	[-1.38]		[1.71]	[0.00]	[0.00]	[0.00]	[0.00]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

that the disaster and post-disaster recovery may have opened up work opportunities for young women in urban areas that were not available to them before.

For young women in rural communities, I find evidence of a shift in work from unpaid, mostly agricultural labor to paid labor in the first year after the disaster. Over time young women increase their participation in unpaid labor but not at the expense of their gains in paid labor, which remains stable over time and significantly higher than pre-disaster levels. In particular, the evidence suggests that college educated women in rural areas experienced a lasting increase in their employment rate after the disaster. There is also evidence that the disaster and post-disaster relief efforts increased the number of hours worked by young women in rural areas and younger men in both urban and rural areas.

There is evidence of a significant drop in employment rates for older adults (60 years and above for women and 50 years and above for men) in the year after the disaster, particularly in rural communities, and of a matching increase in retirement from the labor market for all but the 50-59 cohort of men. The decrease in employment changed the long-term distribution of employment for older adults at the population level, which suggests that the changes may be permanent. Importantly the changes at the population level are smaller than those within the 2004 cohorts, which suggest that the disaster both sped up the retirement of older people who were likely to retire in the near future anyway and altered the long-term employment rates of older adults at the population level.

I also investigated changes in the rates of respondents taking care of the household, an alternative productive activity for respondents' time. The evidence suggests that the increase in younger women's employment consisted mostly of an increase in the prevalence of women who spend their time both working and taking care of the household (as opposed to only working). I also found a significant but increase in the prevalence of men taking care of the household in the first year after the disaster, but afterward the rates return roughly to pre-disaster levels.

Overall the analysis suggests that the 2004 Indian Ocean tsunami and post-disaster recovery efforts likely did have a large and often persistent effect on the labor market outcomes of the people living in coastal communities in Aceh. Young women in Aceh are working in paid jobs and are interested in working in greater numbers than before the disaster, which may have long-lasting consequences to household dynamics and bargaining. Older adults have decreased their rates of employment, which may be related to changes in the employment environment or to an improvement in financial resources in family networks, which allows the older adults to stop working if they so desire. This question may be better answered by a future investigation into changes in household resources and transfers to and from households with older adults in them after the disaster.

Another important finding in the analysis is that labor market outcomes changed in both communities that were heavily damaged in the tsunami and those that were not. In addition, the changes often occurred earlier and were more pronounced in the communities that were not heavily damaged. This suggests that contrary to the focus of previous studies on this topic, the effects of large-scale disasters and post-disaster relief efforts on labor market outcomes are not limited to the people and communities that are directly exposed to the disaster. This highlights the importance of conducting research with data that includes people with a wide range of exposure to adverse events in order to get a fuller picture of the impact of an event like a natural disaster.

Appendix: Chapter 1

Appendix Table 1.1: Height-for-age measures stratified by exposures to disaster (all in utero cohorts)

Children born in 2nd or 3rd quarter of 2005 to parents not living in heavily damaged areas pre-tsunami

	Year child measured				Year child measured				Year child measured			
Birth quarter	2006-07	2007-08	2008-09	2009-10	2006-07	2007-08	2008-09	2009-10	2006-07	2007-08	2008-09	2009-10
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
A. By distance to the epicenter of earthquake												
	> 250km				*130-250km*				*< 130km*			
2005Q1	-0.45	0.07	-0.14	0.23	0.20	0.01	0.38	0.74	0.03	-1.10	-0.23	0.27
	(0.24)	(0.29)	(0.26)	(0.24)	(0.42)	(0.36)	(0.39)	(0.32)	(0.42)	(0.33)	(0.37)	(0.37)
2005Q2	-0.45	-0.44	-0.39	0.00	-0.93	0.07	0.79	0.85	-1.21	-0.43	0.50	0.21
	(0.30)	(0.28)	(0.29)	(0.25)	(0.37)	(0.35)	(0.27)	(0.36)	(0.29)	(0.32)	(0.36)	(0.27)
2005Q3	-0.23	-0.05	-0.15	0.25	-0.37	-0.06	-0.37	0.35	0.36	-0.38	0.06	0.24
	(0.25)	(0.23)	(0.22)	(0.19)	(0.46)	(0.39)	(0.41)	(0.27)	(0.50)	(0.33)	(0.42)	(0.37)
2005Q4	0.03	-0.80	-0.24	0.16	-0.04	-0.33	-0.10	0.63	0.83	0.37	0.92	0.49
	(0.32)	(0.29)	(0.30)	(0.24)	(0.43)	(0.34)	(0.38)	(0.30)	(0.48)	(0.47)	(0.33)	(0.34)
Sample Size	1803	1775	1864	1987	1101	1075	1085	1147	995	1035	952	1142
B. By mother's disaster experience: Saw/heard tsunami												
	Not exposed				*Exposed*							
2005Q1	-0.01	-0.32	0.31	0.47	-0.21	0.01	-0.38	0.36				
	(0.25)	(0.24)	(0.22)	(0.25)	(0.31)	(0.35)	(0.34)	(0.25)				
2005Q2	-0.51	0.07	0.49	0.71	-1.03	-0.83	-0.17	-0.21				
	(0.25)	(0.23)	(0.26)	(0.25)	(0.30)	(0.30)	(0.24)	(0.19)				
2005Q3	0.05	-0.07	-0.11	0.14	-0.21	-0.32	-0.29	0.54				
	(0.28)	(0.21)	(0.21)	(0.18)	(0.33)	(0.34)	(0.37)	(0.29)				
2005Q4	0.55	-0.14	0.18	0.34	-0.07	-0.71	-0.12	0.44				
	(0.29)	(0.25)	(0.23)	(0.21)	(0.32)	(0.33)	(0.33)	(0.27)				
Sample Size	2337	2446	2506	2682	1482	1362	1312	1516				
C. By mother's disaster experience: Any exposure												
	Not exposed				*Exposed*							
2005Q1	0.09	-0.25	0.25	0.37	-0.18	-0.15	-0.04	0.44				
	(0.33)	(0.35)	(0.30)	(0.30)	(0.25)	(0.24)	(0.23)	(0.22)				
2005Q2	-0.36	0.01	0.24	0.46	-0.94	-0.47	0.15	0.18				
	(0.39)	(0.34)	(0.34)	(0.35)	(0.22)	(0.23)	(0.20)	(0.18)				
2005Q3	-0.55	-0.16	-0.20	0.31	0.25	-0.18	-0.11	0.28				
	(0.30)	(0.29)	(0.27)	(0.22)	(0.27)	(0.24)	(0.25)	(0.22)				
2005Q4	0.44	-0.15	-0.12	0.48	0.19	-0.49	0.18	0.35				
	(0.42)	(0.34)	(0.33)	(0.27)	(0.25)	(0.25)	(0.25)	(0.21)				
Sample Size	1305	1351	1427	1540	2514	2457	2391	2658				
D. By mother's maximum post-disaster PTSR												
	Low [0-6]				*Medium [7-13]*				*High [14-21]*			
2005Q2	-0.04	-0.60	0.02	0.44	0.27	0.30	0.12	0.38	-1.03	-0.66	-0.11	0.50
	(0.25)	(0.29)	(0.30)	(0.27)	(0.38)	(0.33)	(0.25)	(0.28)	(0.77)	(0.62)	(1.05)	(0.75)
2005Q2	-0.60	-0.26	0.20	0.25	-0.82	-0.32	0.11	0.21	-1.45	-0.75	-0.25	-0.29
	(0.31)	(0.30)	(0.35)	(0.31)	(0.31)	(0.30)	(0.25)	(0.23)	(0.46)	(0.52)	(0.65)	(0.49)
2005Q3	-0.39	-0.11	-0.47	0.04	-0.08	-0.23	0.07	0.39	0.42	0.10	0.02	0.75
	(0.31)	(0.30)	(0.26)	(0.23)	(0.26)	(0.27)	(0.29)	(0.26)	(0.56)	(0.55)	(0.68)	(0.60)
2005Q3	0.34	-0.27	-0.02	0.50	0.37	-0.42	0.35	0.00	0.72	0.09	0.35	0.76
	(0.39)	(0.35)	(0.31)	(0.28)	(0.33)	(0.33)	(0.34)	(0.28)	(0.63)	(0.47)	(0.49)	(0.45)
Sample Size	1670	1707	1756	1857	1454	1411	1384	1571	392	381	358	414

Note: Errors clustered at the level of mother's pre-disaster enumeration area. Sample of children eligible to be measured in 2006-07. 2002 reference cohort.

Appendix: Chapter 2

This is an example of the risk instrument presented to respondents in the STAR surveys.
This example corresponds to the graphical example presented in Figure 2.2.
The income streams have been converted from the original Indonesian Rupiah to US dollars for ease of interpretation.

SI01. Suppose you are offered two ways to earn income. With option 1, you are guaranteed an income of $20 per month. With option 2, you have an equal chance of earning either the same income, $20, or, if you are lucky, $40, which is more. Which option will you choose?

1. $20 → *SI02*   2. $40 or $20 → *SI03*

SI02. Are you sure? In option 2 you will get at least $20 per month and you may get $40. In option 1 you will always get $20.

1. Still picks option 1 → *EXIT*   2. Switches to option 2 → *SI03*

SI03. Now, in option 2 you have an equal chance of receiving either $40 or $15, depending on how lucky you are. Option 1 guarantees you an income of $20 per month. Which option will you choose?

1. $20 → *EXIT*   2. $40 or $15 → *SI04*

SI04. Now, in option 2 you have an equal chance of receiving either $40 or $10, depending on how lucky you are. Option 1 guarantees you an income of $20 per month. Which option will you choose?

1. $20 → *EXIT*   2. $40 or $10 → *SI05*

SI05. Now, in option 2 you have an equal chance of receiving either $40 or $5, depending on how lucky you are. Option 1 guarantees you an income of $20 per month. Which option will you choose?

Appendix Figure 2.1: Example of STAR risk instrument as presented in the survey

Appendix Table 2.1: Relationship between attrition from analytic samples and individual characteristics

Sample of respondents eligible to be measured in 2005 and 2009

	All Communities			High Mortality Communities			Low Mortality Communities		
Eligible sample:	All Eligible Adults		Measured in 2005	All Eligible Adults		Measured in 2005	All Eligible Adults		Measured in 2005
Analytic sample:	*Measured in 2005 & 2009*	*Measured in 2005*	*Measured in 2009*	*Measured in 2005 & 2009*	*Measured in 2005*	*Measured in 2009*	*Measured in 2005 & 2009*	*Measured in 2005*	*Measured in 2009*
Male	0.094	0.060	0.045	0.077	0.040	0.048	0.098	0.065	0.044
	(0.007)	(0.007)	(0.005)	(0.014)	(0.013)	(0.010)	(0.008)	(0.008)	(0.005)
Age: < 20 years	-0.003	-0.020	0.013	0.001	-0.011	0.011	-0.003	-0.022	0.013
	(0.011)	(0.011)	(0.007)	(0.022)	(0.019)	(0.016)	(0.013)	(0.013)	(0.008)
Age: 30-39 years	-0.096	-0.082	-0.026	-0.073	-0.062	-0.022	-0.103	-0.088	-0.027
	(0.009)	(0.008)	(0.006)	(0.016)	(0.018)	(0.012)	(0.010)	(0.010)	(0.007)
Age: 40-49 years	-0.132	-0.114	-0.031	-0.128	-0.119	-0.021	-0.132	-0.112	-0.035
	(0.010)	(0.009)	(0.007)	(0.019)	(0.018)	(0.016)	(0.012)	(0.011)	(0.008)
Age: 50-59 years	-0.110	-0.099	-0.022	-0.080	-0.077	-0.013	-0.119	-0.106	-0.024
	(0.013)	(0.011)	(0.010)	(0.027)	(0.020)	(0.023)	(0.015)	(0.013)	(0.011)
Age: 60+ years	-0.034	-0.002	-0.022	-0.036	-0.012	-0.017	-0.032	0.001	-0.023
	(0.016)	(0.017)	(0.012)	(0.030)	(0.031)	(0.022)	(0.019)	(0.020)	(0.014)
Education: 0 years	0.058	0.061	-0.005	0.030	0.038	-0.023	0.065	0.068	-0.002
	(0.015)	(0.015)	(0.014)	(0.041)	(0.035)	(0.034)	(0.017)	(0.016)	(0.015)
Education: 1-5 years	0.017	0.034	-0.017	0.006	0.011	-0.011	0.019	0.039	-0.019
	(0.012)	(0.011)	(0.008)	(0.026)	(0.024)	(0.018)	(0.013)	(0.012)	(0.009)
Education: 7-9 years	-0.011	-0.017	0.003	0.018	-0.006	0.025	-0.019	-0.020	-0.004
	(0.010)	(0.009)	(0.007)	(0.021)	(0.021)	(0.015)	(0.011)	(0.010)	(0.007)
Education: 10-12 years	-0.008	-0.017	0.004	0.008	-0.007	0.015	-0.013	-0.021	0.001
	(0.011)	(0.011)	(0.007)	(0.021)	(0.021)	(0.015)	(0.013)	(0.013)	(0.008)
Education: 13+ years	0.002	-0.022	0.015	0.046	0.000	0.051	-0.020	-0.033	-0.002
	(0.014)	(0.014)	(0.009)	(0.026)	(0.025)	(0.019)	(0.017)	(0.016)	(0.011)
Cog missing?	0.588	0.029	0.711	0.589	0.010	0.720	0.587	0.035	0.708
	(0.014)	(0.013)	(0.017)	(0.028)	(0.024)	(0.030)	(0.016)	(0.015)	(0.021)
Cognition (1st) z-score	-0.024	-0.009	-0.016	-0.020	0.007	-0.031	-0.025	-0.014	-0.011
	(0.006)	(0.005)	(0.005)	(0.012)	(0.010)	(0.008)	(0.007)	(0.006)	(0.005)
Cognition (2nd) z-score	0.001	0.004	-0.003	0.002	-0.004	0.007	0.000	0.007	-0.006
	(0.006)	(0.005)	(0.004)	(0.012)	(0.011)	(0.008)	(0.007)	(0.006)	(0.005)
Pre-tsu PCE: 2nd quartile	-0.007	-0.005	-0.001	-0.023	-0.030	0.005	-0.003	0.000	-0.002
	(0.010)	(0.010)	(0.007)	(0.022)	(0.024)	(0.014)	(0.012)	(0.011)	(0.008)
Pre-tsu PCE: 3rd quartile	0.005	0.001	0.004	-0.027	-0.045	0.010	0.011	0.011	0.004
	(0.012)	(0.012)	(0.007)	(0.028)	(0.030)	(0.013)	(0.014)	(0.014)	(0.008)
Pre-tsu PCE: 4th quartile	-0.009	-0.015	0.004	-0.040	-0.046	0.006	-0.001	-0.007	0.005
	(0.013)	(0.013)	(0.008)	(0.029)	(0.030)	(0.016)	(0.014)	(0.014)	(0.009)
SES ladder missing?	0.174	0.773	0.212	0.170	0.793	0.184	0.175	0.766	0.219
	(0.014)	(0.014)	(0.018)	(0.023)	(0.024)	(0.030)	(0.017)	(0.017)	(0.023)
Pre-tsu SES ladder: 3	0.032	0.036	0.001	-0.016	-0.011	-0.004	0.041	0.045	0.003
	(0.008)	(0.009)	(0.005)	(0.020)	(0.021)	(0.014)	(0.010)	(0.010)	(0.006)
Pre-tsu SES ladder: 4-6	0.055	0.037	0.025	-0.021	-0.039	0.017	0.092	0.074	0.030
	(0.015)	(0.014)	(0.009)	(0.026)	(0.025)	(0.016)	(0.020)	(0.019)	(0.012)
Urban pre-disaster community	0.030	0.008	0.026	0.003	-0.026	0.022	0.037	0.017	0.028
	(0.012)	(0.012)	(0.007)	(0.023)	(0.026)	(0.014)	(0.014)	(0.013)	(0.008)
N	16865	16865	13427	16865	16865	13427	16865	16865	13427

Note: Estimated coeffient and standard errors of OLS regressions reported. Standard errors are clustered at the pre-disaster enumeration area. Age 20-29, 6 years of education, first quartile of pre-disaster household per captita expenditure, and pre-disaster SES ladder = (1 or 2) are omitted for individual controls.

Appendix Table 2.2: Relationship between attrition from sample measured in 2009 and observed risk aversion in 2005, physical exposure

Sample of baseline respondents measured in 2005

	All Communities		High Mortality Communities		Low Mortality Communities	
	No Controls	With Individual and Geographic Controls	No Controls	With Individual and Geographic Controls	No Controls	With Individual and Geographic Controls
			Observed risk aversion in 2005			
Risk Aversion						
Certainty Preference omitted						
Most Risk Averse	-0.003	-0.004	0.012	0.002	-0.008	-0.008
	(0.007)	(0.005)	(0.017)	(0.012)	(0.008)	(0.006)
More Risk Averse	-0.003	-0.010	0.023	0.011	-0.014	-0.017
	(0.011)	(0.007)	(0.021)	(0.012)	(0.012)	(0.008)
Less Risk Averse	0.004	-0.015	0.048	-0.009	-0.022	-0.016
	(0.023)	(0.016)	(0.043)	(0.024)	(0.025)	(0.021)
Least Risk Averse	0.050	-0.002	0.046	0.005	0.050	-0.005
	(0.014)	(0.009)	(0.024)	(0.017)	(0.018)	(0.010)
N	13427	13427	3264	3264	10163	10163
Joint tests (p-values)						
Risk aversion	*0.01*	*0.57*	*0.32*	*0.87*	*0.02*	*0.24*
			Personal physical exposure to tsunami			
Personal physical exposure	0.012	-0.005	-0.011	-0.025	0.009	-0.002
	(0.008)	(0.006)	(0.020)	(0.015)	(0.009)	(0.006)
N	13427	13427	3264	3264	10163	10163

Note: Estimated coeffient and standard errors of OLS regressions reported. Standard errors are clustered at the pre-disaster enumeration area. Certainty preference is omitted. Individual and geographic controls include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, and estimated maximum wave height at nearest point on the coast.

Appendix Table 2.3: Distribution of observed risk aversion and impact of exposure to tsunami on observed risk aversion in 2005

Stratified by modules of risk aversion instrument in STAR with increasing size of hypothetical income streams

Sample of baseline respondents from all pre-disaster communities with risk aversion measured in 2005 and 2009

Distribution of Measured Risk Aversion (%)

	Module 1 ($20/$30)		*Module 2 ($40/$60)*		*Module 3 ($80)*	*Module 4 ($120)*
	2005	*2009*	*2005*	*2009*	*2005*	*2005*
Risk Aversion						
Certainty Preference	0.49	0.70	0.50	0.70	0.50	0.52
Most Risk Averse	0.29	0.17	0.28	0.18	0.29	0.29
More Risk Averse	0.13	0.01	0.13	0.01	0.12	0.11
Less Risk Averse	0.02	0.06	0.01	0.06	0.01	0.02
Least Risk Averse	0.07	0.06	0.08	0.05	0.07	0.06

Impact of Exposure on Observed Risk Aversion in 2005

	Module 1 ($20)			*Module 2 ($40)*			*Module 3 ($80)*			*Module 4 ($120)*		
	Risk Averse	Certainty Preference	Risk Averse	Risk Averse	Certainty Preference	Risk Averse	Risk Averse	Certainty Preference	Risk Averse	Risk Averse	Certainty Preference	Risk Averse
	Ordered Logit	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*
Physical exposure	0.60	0.61	0.72	0.72	0.73	0.87	0.66	0.68	0.79	0.64	0.63	0.76
	(-4.72)	(-4.00)	(-2.00)	(-2.99)	(-2.59)	(-0.89)	(-3.78)	(-3.12)	(-1.64)	(-4.06)	(-3.81)	(-1.63)
Asset damage/loss:												
House and land	0.86	0.84	0.96	0.86	0.81	1.06	1.15	1.14	1.10	1.01	1.05	0.92
	(-0.95)	(-1.01)	(-0.19)	(-1.13)	(-1.36)	(0.29)	(0.91)	(0.80)	(0.43)	(0.08)	(0.33)	(-0.40)
Durables	0.86	0.87	0.95	0.78	0.81	0.78	0.80	0.81	0.89	0.83	0.90	0.80
	(-0.98)	(-0.83)	(-0.24)	(-1.90)	(-1.46)	(-1.38)	(-1.53)	(-1.32)	(-0.62)	(-1.25)	(-0.74)	(-1.02)
Gold and cash	0.89	0.98	0.75	1.29	1.16	1.70	0.92	1.16	0.50	0.87	0.70	1.52
	(-0.59)	(-0.09)	(-1.12)	(1.25)	(0.68)	(1.77)	(-0.45)	(0.70)	(-2.80)	(-0.79)	(-1.66)	(1.66)
N	2967	2967	1521	2924	2924	1471	3022	3022	1510	2977	2977	1421

Note: Odds ratios and z-scores reported. Dollar amounts listed with modules are the certain options for each choice in each module. For each asset category, individuals who owned assets but did not lose assets in the tsunami is the reference group. Regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

Appendix Table 2.4: Religion and certainty preference in the Indonesian Family Life Survey

Sample of respondents measured in 2007 Indonesian Family Life Survey (IFLS 4)

	Prevalence in Sample		*OLS Regression*
	N	%	Certainty Preference
Certainty preference	12049	0.42	
Self-identified religion			
Muslim	25841	0.89	*Omitted*
Catholic	443	0.02	-0.04
			(0.02)
Protestant	1133	0.04	0.06
			(0.01)
Hindu	1384	0.05	0.03
			(0.01)
Buddhist	85	0.00	-0.20
			(0.05)
N	28886		28886

Note: OLS coefficents and standard errors reported for OLS regression. Konghucu and "Not Applicable" religious groups dropped from analysis due to small sample sizes (2 and 5 respondents, respectively).

Appendix Table 2.5: Relationship between physical exposure to tsunami and individual and geographic characteristics

Sample of respondents eligible to be measured in 2005 and 2009

	All Communities		High Mortality Communities		Low Mortality Communities	
	Without Geographic Controls	*With Geographic Controls*	*Without Geographic Controls*	*With Geographic Controls*	*Without Geographic Controls*	*With Geographic Controls*
Male	0.033	0.026	0.022	0.013	0.021	0.027
	(0.009)	(0.008)	(0.015)	(0.012)	(0.010)	(0.009)
Age: < 20 years	-0.039	-0.029	-0.011	0.021	-0.039	-0.039
	(0.016)	(0.014)	(0.024)	(0.021)	(0.019)	(0.017)
Age: 30-39 years	0.004	-0.016	0.052	0.031	-0.005	-0.024
	(0.014)	(0.012)	(0.023)	(0.019)	(0.016)	(0.014)
Age: 40-49 years	0.002	-0.029	0.028	0.011	0.004	-0.029
	(0.017)	(0.014)	(0.026)	(0.022)	(0.019)	(0.016)
Age: 50-59 years	-0.019	-0.030	0.056	0.058	-0.028	-0.051
	(0.021)	(0.018)	(0.031)	(0.026)	(0.023)	(0.020)
Age: 60+ years	0.012	-0.023	0.073	0.012	-0.002	-0.030
	(0.026)	(0.021)	(0.050)	(0.034)	(0.029)	(0.024)
Education: 0 years	-0.160	-0.044	-0.230	-0.021	-0.140	-0.042
	(0.025)	(0.019)	(0.070)	(0.044)	(0.025)	(0.020)
Education: 1-5 years	-0.108	-0.030	-0.116	-0.030	-0.080	-0.026
	(0.019)	(0.014)	(0.045)	(0.026)	(0.020)	(0.016)
Education: 7-9 years	0.006	0.003	0.020	0.007	0.013	0.004
	(0.017)	(0.013)	(0.024)	(0.019)	(0.019)	(0.015)
Education: 10-12 years	-0.010	-0.001	-0.009	0.010	-0.001	0.002
	(0.020)	(0.014)	(0.029)	(0.020)	(0.023)	(0.017)
Education: 13+ years	-0.014	0.004	0.005	0.018	-0.025	-0.005
	(0.027)	(0.022)	(0.040)	(0.026)	(0.030)	(0.027)
Cog missing?	0.078	0.023	0.044	0.032	0.068	0.020
	(0.034)	(0.031)	(0.062)	(0.042)	(0.040)	(0.039)
Cognition (1st) z-score	-0.003	0.004	-0.010	-0.012	0.017	0.014
	(0.009)	(0.007)	(0.016)	(0.012)	(0.010)	(0.008)
Cognition (2nd) z-score	-0.009	-0.018	-0.006	-0.007	-0.022	-0.023
	(0.008)	(0.006)	(0.014)	(0.011)	(0.009)	(0.007)
Pre-tsu PCE: 2nd quartile	0.025	0.017	0.120	0.064	-0.009	-0.001
	(0.024)	(0.017)	(0.049)	(0.031)	(0.024)	(0.019)
Pre-tsu PCE: 3rd quartile	0.100	0.058	0.149	0.096	0.067	0.037
	(0.030)	(0.021)	(0.055)	(0.037)	(0.033)	(0.022)
Pre-tsu PCE: 4th quartile	0.110	0.062	0.100	0.070	0.088	0.039
	(0.037)	(0.025)	(0.056)	(0.041)	(0.043)	(0.029)
Pre-tsu SES ladder: 3	0.101	0.035	0.118	0.033	0.053	0.028
	(0.019)	(0.015)	(0.031)	(0.022)	(0.021)	(0.016)
Pre-tsu SES ladder: 4-6	0.235	0.082	0.192	0.080	0.082	0.041
	(0.029)	(0.023)	(0.038)	(0.027)	(0.034)	(0.032)
Urban pre-disaster community	0.170	0.026	0.051	-0.002	0.183	0.010
	(0.038)	(0.031)	(0.040)	(0.037)	(0.044)	(0.041)
N	11891	11891	2837	2837	9054	9054
Joint tests (p-values)						
Age	*0.10*	*0.31*	*0.19*	*0.14*	*0.13*	*0.08*
Education	*0.00*	*0.18*	*0.02*	*0.74*	*0.00*	*0.35*
Cognition	*0.26*	*0.00*	*0.39*	*0.10*	*0.05*	*0.01*
Pre-tsu PCE	*0.00*	*0.02*	*0.03*	*0.06*	*0.01*	*0.17*
Pre-tsu SES ladder	*0.00*	*0.00*	*0.00*	*0.01*	*0.02*	*0.22*

Note: Estimated coeffients and standard errors of OLS regressions reported. Standard errors are clustered at the pre-disaster enumeration area. Age 20-29, 6 years of education, first quartile of pre-disaster household per captita expenditure, and pre-disaster SES ladder = (1 or 2) are omitted for individual controls. The regressions "without geographic controls" include only individual controls. The regressions "with geographic controls" include both individual controls and geographic controls -- distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast. Estimated coeffients for geographic controls in the "All Communities" regression are reported in Appendix Table 6.

Appendix Table 2.6: Relationship between physical exposure to tsunami-related geographic characteristics

Sample of respondents eligible to be measured in 2005 and 2009
Estimates for OLS regression including all individual controls in Appendix Table 5 and geographic controls listed below

		All Communities			
Distance to the coast (km)		Elevation (m)		Coastal wave height (m)	
1st decile omitted		*1st decile omitted*		*1st decile omitted*	
2nd decile	0.079	2nd decile	0.020	2nd decile	0.004
	(0.061)		(0.049)		(0.075)
3rd decile	0.041	3rd decile	0.023	3rd decile	-0.038
	(0.061)		(0.061)		(0.073)
4th decile	-0.062	4th decile	0.002	4th decile	0.198
	(0.053)		(0.054)		(0.058)
5th decile	-0.189	5th decile	-0.087	5th decile	0.227
	(0.058)		(0.060)		(0.061)
6th decile	-0.181	6th decile	-0.075	6th decile	-0.106
	(0.059)		(0.056)		(0.067)
7th decile	-0.192	7th decile	-0.204	7th decile	0.182
	(0.062)		(0.060)		(0.062)
8th decile	-0.362	8th decile	-0.192	8th decile	0.266
	(0.063)		(0.062)		(0.059)
9th decile	-0.468	9th decile	-0.202	9th decile	0.316
	(0.063)		(0.059)		(0.063)
10th decile	-0.534	10th decile	-0.187	10th decile	0.367
	(0.064)		(0.062)		(0.052)
Joint tests (p-values)					
Distance to the coast	*0.00*				
Elevation	*0.00*				
Coastal wave height	*0.00*				
N	11891				

Note: Estimated coeffients and standard errors of an OLS regression reported. Standard errors are clustered at the pre-disaster enumeration area. The regression includes both individual controls (see Appendix Table 5) -- sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community -- and geographic controls -- distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast. The 1st decile (as distributed across all communities) is omitted for each set of geographic controls.

Appendix Table 2.7: Impact of exposure to tsunami on observed risk aversion in 2005 – personal physical exposure and asset damage loss run in separate models

Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

	All Communities			*High Mortality Communities*			*Low Mortality Communities*		
	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Certainty Preference	Risk Averse (No CP)
	Ordered Logit	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*
	Experienced personal physical exposure to tsunami								
Physical exposure	0.63	0.64	0.78	0.67	0.65	0.91	0.63	0.65	0.77
	(-6.19)	(-5.25)	(-2.81)	(-2.85)	(-2.95)	(-0.43)	(-5.29)	(-4.31)	(-2.61)
N	11891	11891	5923	2837	2837	1533	9054	9054	4390
	Experienced tsunami-induced asset damage/loss								
Asset damage/loss:									
House and land	0.94	0.92	0.98	0.98	0.94	0.98	0.87	0.88	0.93
	(-0.73)	(-0.87)	(-0.13)	(-0.16)	(-0.41)	(-0.08)	(-1.27)	(-1.17)	(-0.46)
Durables	0.79	0.83	0.86	0.73	0.79	0.71	0.87	0.89	0.93
	(-2.79)	(-2.13)	(-1.46)	(-2.35)	(-1.49)	(-1.61)	(-1.34)	(-1.03)	(-0.56)
Gold and cash	0.96	0.97	0.94	1.07	1.03	1.18	0.71	0.79	0.57
	(-0.36)	(-0.20)	(-0.43)	(0.43)	(0.16)	(0.92)	(-1.80)	(-1.07)	(-2.73)
N	11890	11890	5923	2836	2836	1533	9054	9054	4390
Joint tests (p-values)									
Assets	*0.01*	*0.05*	*0.26*	*0.09*	*0.36*	*0.28*	*0.02*	*0.19*	*0.02*

Note: Odds ratios and z-scores reported. p-values are reported for joint tests of significance of estimated coefficients for for asset loss measures. For each asset category, individuals who owned assets but did not lose assets in the tsunami is the reference group. Regressions include controls for sex, age at time of the disaster, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

Appendix Table 2.8: Impact of exposure to tsunami on observed risk aversion in 2005 – all respondents with risk aversion measured in 2005

Sample of baseline respondents with risk aversion measured in 2005
By mortality in pre-disaster community

	All Communities			*High Mortality Communities*			*Low Mortality Communities*		
	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Certainty Preference	Risk Averse (No CP)	Risk Averse	Certainty Preference	Risk Averse (No CP)
	Ordered Logit	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*	*Ordered Logit*	*Logit*	*Ordered Logit*
Physical exposure	0.65	0.67	0.77	0.65	0.63	0.89	0.66	0.68	0.77
	(-5.65)	(-4.80)	(-3.09)	(-3.22)	(-3.33)	(-0.59)	(-4.73)	(-3.85)	(-2.74)
Asset damage/loss:									
House and land	0.95	0.93	1.01	1.01	0.99	0.95	0.87	0.87	0.96
	(-0.66)	(-0.77)	(0.08)	(0.10)	(-0.05)	(-0.30)	(-1.45)	(-1.29)	(-0.27)
Durables	0.86	0.89	0.88	0.79	0.85	0.73	0.93	0.96	0.96
	(-1.89)	(-1.29)	(-1.21)	(-1.80)	(-1.03)	(-1.56)	(-0.66)	(-0.42)	(-0.33)
Gold and cash	0.95	0.96	0.95	0.98	0.96	1.12	0.76	0.81	0.63
	(-0.48)	(-0.33)	(-0.40)	(-0.10)	(-0.22)	(0.70)	(-1.67)	(-1.02)	(-2.14)
N	13426	13426	6708	3263	3263	1784	10163	10163	4924
Joint tests (p-values)									
Physical exp, assets	*0.08*	*0.29*	*0.49*	*0.28*	*0.71*	*0.32*	*0.06*	*0.31*	*0.13*
Assets	*0.00*	*0.00*	*0.01*	*0.00*	*0.01*	*0.23*	*0.00*	*0.00*	*0.00*

Note: Odds ratios and z-scores reported. p-values are reported for joint tests of significance of estimated coefficients for all measures of exposure (physical exposure and asset loss) and for asset loss measures. "Risk Averse (No CP)" outcome excludes individuals with certainty preference. For each asset category, individuals who owned assets but did not lose assets in the tsunami is the reference group. Regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

Appendix Table 2.9: Impact of exposure to tsunami on observed risk aversion in 2005 – logit and OLS results without pre-disaster community fixed effects

Sample of baseline respondents with risk aversion measured in 2005 and 2009
By mortality in pre-disaster community

	Logit			*OLS*			*OLS (Community FE)*		
	Certainty Preference	CP/Most RA	Most RA (No CP)	Certainty Preference	CP/Most RA	Most RA (No CP)	Certainty Preference	CP/Most RA	Most RA (No CP)
					All communities				
Physical exposure	0.67	0.63	0.79	-0.091	-0.070	-0.048	-0.044	-0.030	-0.019
	(-4.71)	(-5.32)	(-2.45)	(0.019)	(0.013)	(0.021)	(0.017)	(0.015)	(0.024)
Asset damage/loss:									
House and land	0.95	0.96	0.99	-0.011	-0.002	-0.002	-0.014	-0.001	0.010
	(-0.58)	(-0.39)	(-0.10)	(0.021)	(0.017)	(0.028)	(0.020)	(0.017)	(0.029)
Durables	0.85	0.86	0.93	-0.035	-0.025	-0.017	-0.023	-0.003	0.009
	(-1.77)	(-1.56)	(-0.64)	(0.020)	(0.017)	(0.026)	(0.018)	(0.017)	(0.028)
Gold and cash	1.00	1.09	1.07	-0.001	0.013	0.013	0.042	-0.007	-0.034
	(0.02)	(0.73)	(0.43)	(0.029)	(0.023)	(0.034)	(0.027)	(0.023)	(0.035)
N	11890	11890	5923	11890	11890	5923	11890	11890	5923
					High mortality communities				
Physical exposure	0.67	0.69	0.88	-0.085	-0.054	-0.027	-0.047	-0.040	-0.023
	(-2.78)	(-1.90)	(-0.57)	(0.031)	(0.029)	(0.048)	(0.032)	(0.032)	(0.049)
Asset damage/loss:									
House and land	0.95	0.92	0.94	-0.012	-0.003	-0.011	-0.001	-0.008	-0.024
	(-0.34)	(-0.44)	(-0.29)	(0.036)	(0.031)	(0.048)	(0.036)	(0.032)	(0.053)
Durables	0.83	0.67	0.67	-0.042	-0.071	-0.094	-0.032	-0.051	-0.081
	(-1.20)	(-2.17)	(-1.73)	(0.034)	(0.033)	(0.054)	(0.032)	(0.034)	(0.057)
Gold and cash	1.04	1.26	1.36	0.007	0.043	0.072	0.052	0.038	0.040
	(0.22)	(1.40)	(1.66)	(0.039)	(0.032)	(0.044)	(0.037)	(0.031)	(0.045)
N	2836	2836	1533	2836	2836	1533	2836	2836	1533
					Low mortality communities				
Physical exposure	0.68	0.63	0.80	-0.084	-0.070	-0.046	-0.043	-0.027	-0.012
	(-3.87)	(-4.65)	(-2.09)	(0.022)	(0.015)	(0.023)	(0.019)	(0.016)	(0.026)
Asset damage/loss:									
House and land	0.90	0.89	0.91	-0.022	-0.017	-0.023	-0.035	-0.015	0.009
	(-0.93)	(-0.89)	(-0.59)	(0.025)	(0.021)	(0.037)	(0.025)	(0.021)	(0.036)
Durables	0.92	0.98	1.06	-0.021	-0.003	0.014	-0.020	0.021	0.057
	(-0.81)	(-0.20)	(0.44)	(0.024)	(0.021)	(0.031)	(0.023)	(0.021)	(0.032)
Gold and cash	0.83	0.65	0.59	-0.042	-0.089	-0.123	-0.023	-0.086	-0.129
	(-0.84)	(-2.26)	(-2.38)	(0.045)	(0.040)	(0.052)	(0.042)	(0.039)	(0.053)
N	9054	9054	4390	9054	9054	4390	9054	9054	4390

Note: Odds ratios and z-scores reported for logit regressions. Estimated coefficients and standard errors reported for OLS regressions. For each asset category, individuals who owned assets but did not lose assets in the tsunami is the reference group. Regressions include controls for sex, age at measurement in 2005, pre-disaster education, word recall (measures of cognition), pre-disaster household per capita expenditure, pre-disaster self-reported SES ladder, urban-rural status of pre-disaster community, distance of pre-disaster community to the coast, elevation of pre-disaster community, estimated maximum wave height at nearest point on the coast, and month-year of interview. Standard errors are clustered at the pre-disaster enumeration area.

Appendix: Chapter 3

Appendix Table 3.1: Industry of primary job of female respondents by pre-tsunami urban-rural status of community

Sample of female baseline respondents who have worked in last week

By sex, age of respondent in 2004, pre-tsunami urban/rural status of community, and whether job is paid or unpaid

	Rural Communities										Urban Communities									
	Paid Work					Unpaid Work					Paid Work					Unpaid Work				
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
25-39																				
Professional/Technical	0.18	0.21	0.21	0.22	0.20	0.00	0.00	0.00	0.00	0.00	0.25	0.26	0.28	0.29	0.27	0.00	0.00	0.00	0.00	0.00
Administrative/Managerial	0.01	0.02	0.02	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.06	0.04	0.05	0.03	0.04	0.00	0.00	0.00	0.06	0.03
Clerical	0.02	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.13	0.11	0.10	0.14	0.11	0.00	0.00	0.00	0.00	0.03
Sales Work	0.21	0.25	0.24	0.23	0.25	0.14	0.11	0.14	0.12	0.14	0.30	0.34	0.35	0.31	0.32	0.75	0.76	0.70	0.69	0.61
Service Work	0.08	0.06	0.07	0.09	0.08	0.00	0.01	0.00	0.01	0.00	0.14	0.11	0.10	0.10	0.13	0.09	0.00	0.03	0.08	0.03
Agricultural	0.35	0.30	0.27	0.29	0.30	0.85	0.84	0.80	0.84	0.83	0.02	0.05	0.03	0.04	0.05	0.13	0.06	0.18	0.11	0.27
Production	0.14	0.13	0.16	0.13	0.13	0.01	0.03	0.05	0.02	0.02	0.09	0.08	0.08	0.09	0.08	0.03	0.18	0.09	0.06	0.03
40-49																				
Professional/Technical	0.13	0.13	0.15	0.16	0.15	0.00	0.00	0.00	0.00	0.00	0.29	0.27	0.27	0.30	0.27	0.00	0.00	0.00	0.00	0.00
Administrative/Managerial	0.03	0.02	0.02	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.04	0.03	0.03	0.00	0.00	0.00	0.00	0.00
Clerical	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.06	0.07	0.06	0.06	0.05	0.00	0.06	0.00	0.00	0.00
Sales Work	0.15	0.16	0.20	0.18	0.17	0.06	0.07	0.10	0.11	0.06	0.36	0.38	0.35	0.37	0.39	0.93	0.67	0.71	0.72	0.82
Service Work	0.04	0.05	0.06	0.05	0.05	0.01	0.00	0.01	0.02	0.01	0.11	0.13	0.18	0.14	0.12	0.07	0.00	0.00	0.17	0.12
Agricultural	0.50	0.45	0.39	0.40	0.45	0.90	0.91	0.84	0.85	0.91	0.04	0.03	0.03	0.04	0.07	0.00	0.17	0.06	0.11	0.00
Production	0.14	0.18	0.15	0.17	0.13	0.02	0.02	0.05	0.02	0.01	0.10	0.07	0.08	0.05	0.05	0.00	0.11	0.24	0.00	0.06
50-59																				
Professional/Technical	0.06	0.07	0.07	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.18	0.18	0.18	0.12	0.15	0.00	0.00	0.00	0.00	0.00
Administrative/Managerial	0.01	0.01	0.02	0.04	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clerical	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.00	0.00
Sales Work	0.17	0.14	0.20	0.17	0.18	0.12	0.09	0.13	0.14	0.05	0.49	0.38	0.47	0.48	0.42	0.63	0.63	0.67	0.71	0.36
Service Work	0.06	0.03	0.05	0.05	0.05	0.00	0.00	0.02	0.00	0.00	0.13	0.13	0.11	0.12	0.15	0.00	0.00	0.00	0.00	0.00
Agricultural	0.58	0.55	0.52	0.52	0.68	0.88	0.91	0.75	0.83	0.93	0.08	0.11	0.11	0.18	0.10	0.13	0.25	0.17	0.14	0.36
Production	0.12	0.21	0.12	0.18	0.08	0.00	0.00	0.08	0.03	0.02	0.12	0.18	0.09	0.06	0.13	0.25	0.13	0.17	0.14	0.27
60-69																				
Professional/Technical	0.04	0.09	0.04	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.10	0.06	0.08	0.20	0.00	0.00	0.00	0.00	1.00	0.00
Administrative/Managerial	0.00	0.02	0.04	0.00	0.04	0.00	0.00	0.00	0.00	0.08	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clerical	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sales Work	0.22	0.16	0.13	0.18	0.07	0.14	0.18	0.30	0.00	0.00	0.50	0.56	0.31	0.30	0.22	0.50	0.00	0.50	0.00	0.00
Service Work	0.06	0.00	0.00	0.02	0.04	0.00	0.00	0.00	0.14	0.00	0.15	0.06	0.15	0.30	0.44	0.50	1.00	0.00	0.00	0.00
Agricultural	0.51	0.57	0.56	0.58	0.64	0.71	0.82	0.60	0.71	0.92	0.00	0.17	0.23	0.10	0.22	0.00	0.00	0.50	0.00	1.00
Production	0.18	0.17	0.22	0.16	0.20	0.14	0.00	0.10	0.14	0.00	0.25	0.06	0.23	0.10	0.11	0.00	0.00	0.00	0.00	0.00
70+																				
Professional/Technical	0.18	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Administrative/Managerial	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clerical	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sales Work	0.09	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.50	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Service Work	0.00	0.00	0.29	0.18	0.13	0.00	0.00	0.00	0.00	0.00	0.33	0.50	0.20	0.33	0.67	0.00	0.00	0.00	0.00	0.00
Agricultural	0.27	0.64	0.29	0.55	0.25	0.00	0.67	1.00	1.00	1.00	0.00	0.00	0.20	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Production	0.45	0.36	0.14	0.18	0.50	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.60	0.33	0.33	0.00	0.00	0.00	0.00	0.00

Appendix Table 3.2: Industry of primary job of male respondents by pre-tsunami urban-rural status of community

Sample of male baseline respondents who have worked in last week
By sex, age of respondent in 2004, pre-tsunami urban/rural status of community, and whether job is paid or unpaid

	Rural Communities										Urban Communities									
	Paid Work					Unpaid Work					Paid Work					Unpaid Work				
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
25-39																				
Professional/Technical	0.05	0.05	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.09	0.08	0.11	0.10	0.08	0.17	0.00	0.00	0.00	0.00
Administrative/Managerial	0.02	0.02	0.04	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.06	0.04	0.03	0.03	0.04	0.00	0.00	0.00	0.00	0.00
Clerical	0.03	0.04	0.03	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.09	0.13	0.10	0.10	0.11	0.00	0.00	0.00	0.00	0.00
Sales Work	0.12	0.11	0.13	0.12	0.12	0.23	0.04	0.14	0.00	0.11	0.16	0.16	0.16	0.15	0.18	0.67	0.57	0.71	0.50	0.00
Service Work	0.03	0.02	0.02	0.02	0.02	0.00	0.00	0.04	0.00	0.00	0.09	0.07	0.06	0.08	0.06	0.00	0.00	0.14	0.25	0.00
Agricultural	0.47	0.44	0.39	0.43	0.45	0.73	0.86	0.68	0.82	0.83	0.13	0.14	0.14	0.13	0.14	0.17	0.29	0.14	0.25	0.00
Production	0.29	0.33	0.33	0.31	0.29	0.04	0.11	0.14	0.18	0.06	0.39	0.38	0.40	0.40	0.38	0.00	0.14	0.00	0.00	1.00
40-49																				
Professional/Technical	0.06	0.06	0.06	0.05	0.06	0.00	0.00	0.00	0.00	0.00	0.10	0.12	0.10	0.09	0.11	0.00	0.00	0.00	0.00	0.00
Administrative/Managerial	0.02	0.03	0.05	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.08	0.05	0.04	0.06	0.06	0.00	0.00	0.00	0.00	0.00
Clerical	0.03	0.03	0.04	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.11	0.15	0.15	0.16	0.16	0.00	0.00	0.00	0.00	0.00
Sales Work	0.12	0.12	0.12	0.13	0.12	0.17	0.11	0.05	0.14	0.50	0.19	0.17	0.18	0.14	0.17	1.00	0.80	0.00	1.00	0.67
Service Work	0.03	0.02	0.02	0.02	0.02	0.00	0.00	0.05	0.00	0.00	0.07	0.08	0.05	0.09	0.07	0.00	0.00	0.00	0.00	0.00
Agricultural	0.52	0.50	0.49	0.51	0.53	0.50	0.78	0.82	0.86	0.50	0.13	0.12	0.15	0.12	0.13	0.00	0.00	0.00	0.00	0.00
Production	0.22	0.25	0.22	0.22	0.20	0.33	0.11	0.09	0.00	0.00	0.29	0.30	0.31	0.33	0.29	0.00	0.20	1.00	0.00	0.33
50-59																				
Professional/Technical	0.04	0.02	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.10	0.06	0.12	0.09	0.05	0.25	0.00	0.00	0.00	0.00
Administrative/Managerial	0.01	0.02	0.04	0.02	0.04	0.00	0.00	0.00	0.13	0.00	0.12	0.06	0.04	0.07	0.05	0.00	0.00	0.00	0.00	0.00
Clerical	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.04	0.04	0.05	0.00	0.50	0.00	0.00	0.00
Sales Work	0.12	0.13	0.12	0.13	0.12	0.13	0.20	0.20	0.38	0.50	0.25	0.24	0.25	0.24	0.29	0.50	0.00	0.75	1.00	1.00
Service Work	0.03	0.03	0.02	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.04	0.03	0.06	0.00	0.00	0.00	0.00	0.00
Agricultural	0.61	0.61	0.61	0.64	0.68	0.63	0.80	0.73	0.50	0.50	0.14	0.17	0.18	0.23	0.19	0.00	0.00	0.25	0.00	0.00
Production	0.17	0.19	0.17	0.15	0.12	0.25	0.00	0.07	0.00	0.00	0.29	0.33	0.32	0.30	0.31	0.25	0.50	0.00	0.00	0.00
60-69																				
Professional/Technical	0.01	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Administrative/Managerial	0.01	0.03	0.04	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.05	0.02	0.05	0.00	0.00	0.00	0.00	0.00
Clerical	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.05	0.10	0.00	0.00	0.00	0.00	0.00
Sales Work	0.09	0.08	0.10	0.07	0.09	0.00	0.50	0.00	0.25	0.40	0.35	0.44	0.41	0.43	0.49	0.67	1.00	0.00	0.00	1.00
Service Work	0.02	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.12	0.08	0.07	0.07	0.02	0.00	0.00	0.00	0.00	0.00
Agricultural	0.75	0.69	0.70	0.72	0.77	0.83	0.50	0.80	0.75	0.60	0.10	0.17	0.20	0.17	0.15	0.33	0.00	0.00	0.00	0.00
Production	0.12	0.14	0.10	0.13	0.08	0.17	0.00	0.20	0.00	0.00	0.37	0.21	0.20	0.21	0.20	0.00	0.00	0.00	0.00	0.00
70+																				
Professional/Technical	0.05	0.02	0.05	0.04	0.03	0.00	0.50	0.00	0.00	0.00	0.08	0.00	0.17	0.50	0.50	0.00	0.00	0.00	0.00	0.00
Administrative/Managerial	0.03	0.06	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.08	0.25	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clerical	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sales Work	0.16	0.13	0.13	0.15	0.07	0.00	0.50	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Service Work	0.00	0.02	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agricultural	0.65	0.72	0.75	0.63	0.70	1.00	0.00	0.00	0.00	0.00	0.25	0.75	0.33	0.50	0.50	0.00	0.00	0.00	0.00	0.00
Production	0.11	0.04	0.05	0.19	0.07	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix Table 3.3: Working by tsunami damage and pre-tsunami urban/rural status of community

Sample of baseline respondents
By sex and age of respondent in 2004

Female

	Not Heavy Tsunami Damage						Heavy Tsunami Damage					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
						Rural Community						
Age in 2004												
25-39	0.45	0.42	0.47	0.48	0.46	0.56	0.42	0.47	0.49	0.47	0.50	0.55
		[-1.83]	[0.63]	[1.59]	[0.21]	[6.05]		[1.18]	[1.83]	[1.23]	[2.09]	[3.45]
40-49	0.51	0.49	0.51	0.50	0.47	0.57	0.49	0.51	0.50	0.50	0.45	0.53
		[-1.07]	[0.00]	[-0.39]	[-1.51]	[1.97]		[0.38]	[0.15]	[0.23]	[-0.58]	[0.69]
50-59	0.48	0.37	0.39	0.39	0.35	0.44	0.51	0.35	0.33	0.35	0.39	0.40
		[-3.34]	[-2.58]	[-2.44]	[-3.62]	[-1.16]		[-1.91]	[-2.22]	[-1.91]	[-1.40]	[-1.27]
60-69	0.36	0.18	0.23	0.19	0.17	0.24	0.42	0.31	0.24	0.19	0.24	0.23
		[-5.06]	[-3.86]	[-4.90]	[-5.27]	[-3.34]		[-1.02]	[-1.82]	[-2.26]	[-1.73]	[-1.86]
70+	0.25	0.07	0.10	0.06	0.07	0.06	0.24	0.12	0.25	0.14	0.36	0.30
		[-5.10]	[-4.33]	[-5.35]	[-4.89]	[-5.25]		[-0.98]	[0.06]	[-0.73]	[0.82]	[0.38]
						Urban Community						
Age in 2004												
25-39	0.34	0.51	0.54	0.54	0.57	0.60	0.31	0.57	0.59	0.58	0.53	0.50
		[6.44]	[7.31]	[7.29]	[8.14]	[9.58]		[6.38]	[6.69]	[6.37]	[5.33]	[4.70]
40-49	0.44	0.60	0.63	0.63	0.60	0.60	0.39	0.52	0.53	0.58	0.52	0.43
		[4.08]	[4.88]	[4.71]	[4.11]	[4.20]		[1.85]	[2.00]	[2.64]	[1.80]	[0.56]
50-59	0.33	0.43	0.41	0.37	0.38	0.38	0.20	0.29	0.27	0.29	0.25	0.31
		[1.74]	[1.46]	[0.70]	[0.85]	[0.93]		[1.31]	[1.03]	[1.22]	[0.66]	[1.45]
60-69	0.27	0.23	0.25	0.19	0.18	0.18	0.15	0.23	0.10	0.14	0.11	0.11
		[-0.74]	[-0.38]	[-1.25]	[-1.33]	[-1.34]		[0.90]	[-0.49]	[-0.10]	[-0.43]	[-0.43]
70+	0.08	0.05	0.11	0.15	0.10	0.12	0.08	0.06	0.07	0.00	0.00	0.00
		[-0.47]	[0.55]	[1.04]	[0.31]	[0.57]		[-0.19]	[-0.05]	[-1.00]	[-0.96]	[-1.00]

Male

	Not Heavy Tsunami Damage						Heavy Tsunami Damage					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
						Rural Community						
Age in 2004												
25-39	0.96	0.95	0.96	0.96	0.96	0.97	0.95	0.93	0.96	0.95	0.97	0.96
		[-1.55]	[0.28]	[-0.16]	[0.26]	[1.39]		[-1.53]	[0.41]	[-0.01]	[1.35]	[0.81]
40-49	0.99	0.94	0.97	0.97	0.95	0.97	0.97	0.89	0.95	0.95	0.94	0.96
		[-4.50]	[-2.10]	[-2.04]	[-4.10]	[-1.46]		[-3.35]	[-0.81]	[-0.78]	[-1.55]	[-0.72]
50-59	0.96	0.82	0.86	0.85	0.85	0.83	0.98	0.86	0.89	0.87	0.88	0.88
		[-6.17]	[-4.68]	[-4.75]	[-4.81]	[-5.77]		[-2.64]	[-2.06]	[-2.45]	[-2.34]	[-2.31]
60-69	0.88	0.62	0.64	0.62	0.61	0.60	0.84	0.56	0.61	0.55	0.59	0.58
		[-6.45]	[-5.91]	[-6.40]	[-6.50]	[-6.54]		[-3.30]	[-2.64]	[-3.31]	[-2.90]	[-2.90]
70+	0.70	0.29	0.38	0.36	0.23	0.29	0.49	0.35	0.35	0.30	0.41	0.47
		[-7.13]	[-5.56]	[-5.56]	[-7.46]	[-6.36]		[-0.99]	[-1.05]	[-1.35]	[-0.51]	[-0.13]
						Urban Community						
Age in 2004												
25-39	0.91	0.92	0.94	0.95	0.96	0.95	0.87	0.91	0.91	0.93	0.96	0.95
		[0.85]	[2.63]	[3.29]	[3.45]	[3.04]		[1.84]	[1.82]	[2.33]	[3.73]	[3.55]
40-49	0.98	0.94	0.93	0.94	0.92	0.95	0.97	0.94	0.95	0.98	0.98	0.92
		[-1.99]	[-2.62]	[-2.10]	[-3.27]	[-1.79]		[-1.48]	[-0.93]	[0.19]	[0.19]	[-2.12]
50-59	0.84	0.82	0.75	0.74	0.76	0.68	0.83	0.77	0.79	0.74	0.76	0.66
		[-0.50]	[-1.95]	[-2.34]	[-1.85]	[-3.70]		[-0.83]	[-0.49]	[-1.30]	[-0.87]	[-2.51]
60-69	0.67	0.49	0.57	0.54	0.47	0.49	0.51	0.46	0.33	0.57	0.59	0.59
		[-2.45]	[-1.34]	[-1.56]	[-2.40]	[-2.17]		[-0.47]	[-1.66]	[0.52]	[0.73]	[0.73]
70+	0.33	0.37	0.17	0.32	0.12	0.14	0.36	0.20	0.00	0.00	0.00	0.00
		[0.30]	[-1.33]	[-0.14]	[-1.64]	[-1.36]		[-1.23]	[-2.63]	[-2.53]	[-2.40]	[-2.10]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

Appendix Table 3.4: Hours worked in normal week by pre-tsunami urban/rural status of community

Sample of baseline respondents
By sex, age of respondent in 2004, and pre-tsunami urban/rural status of community

Female

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
						Mean						
Age in 2004												
25-39	14.2	14.9	17.0	17.6	16.0	20.2	11.9	20.3	21.3	21.7	22.0	22.5
		[1.04]	[4.24]	[5.24]	[2.70]	[9.19]		[7.72]	[8.49]	[8.76]	[9.11]	[9.76]
40-49	16.5	17.1	18.3	17.9	16.3	19.8	16.2	22.9	22.8	23.7	23.8	22.7
		[0.61]	[1.79]	[1.44]	[-0.16]	[3.27]		[4.16]	[4.03]	[4.51]	[4.57]	[4.02]
50-59	15.3	12.9	13.5	13.2	11.0	14.5	11.3	13.7	11.8	13.9	11.1	13.0
		[-1.99]	[-1.49]	[-1.71]	[-3.48]	[-0.66]		[1.25]	[0.24]	[1.31]	[-0.09]	[0.83]
60-69	10.7	6.8	8.4	5.6	5.5	7.3	6.7	6.5	6.7	4.6	3.5	4.5
		[-3.25]	[-1.90]	[-4.19]	[-4.21]	[-2.75]		[-0.10]	[-0.01]	[-1.10]	[-1.65]	[-1.14]
70+	7.3	1.6	3.1	1.4	2.3	1.8	2.0	0.4	1.6	2.5	1.1	2.5
		[-5.58]	[-4.16]	[-5.65]	[-4.69]	[-4.95]		[-1.36]	[-0.30]	[0.46]	[-0.68]	[0.42]
						Mean (Conditional on Working)						
Age in 2004												
25-39	32.9	36.3	36.8	37.5	35.5	36.8	37.7	40.5	40.0	39.8	40.1	39.6
		[4.22]	[5.03]	[5.95]	[3.37]	[5.26]		[1.99]	[1.68]	[1.52]	[1.73]	[1.37]
40-49	32.8	35.5	36.0	36.1	35.2	35.5	38.5	40.2	38.7	39.6	40.8	40.3
		[2.50]	[3.04]	[3.12]	[2.16]	[2.63]		[0.97]	[0.14]	[0.63]	[1.23]	[1.01]
50-59	32.4	36.1	35.2	33.8	30.9	33.9	40.4	35.9	33.2	40.8	33.8	36.6
		[2.39]	[1.82]	[0.96]	[-0.94]	[1.01]		[-1.40]	[-2.15]	[0.10]	[-1.89]	[-1.13]
60-69	29.7	36.7	37.6	29.8	31.7	30.5	31.2	30.2	31.2	26.3	23.3	29.5
		[2.80]	[3.39]	[0.01]	[0.75]	[0.33]		[-0.20]	[0.00]	[-0.86]	[-1.31]	[-0.28]
70+	30.3	22.4	26.4	22.7	25.3	24.3	29.8	8.0	15.8	22.8	14.7	30.3
		[-1.89]	[-1.13]	[-1.67]	[-1.25]	[-1.31]		[-2.71]	[-2.03]	[-1.02]	[-1.88]	[0.06]

Male

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
						Mean						
Age in 2004												
25-39	38.6	42.2	44.0	44.2	43.1	44.0	42.3	46.4	46.0	47.4	48.1	47.3
		[6.09]	[9.13]	[9.53]	[7.53]	[9.21]		[4.18]	[3.66]	[5.06]	[5.73]	[5.04]
40-49	40.1	41.3	42.7	43.5	40.8	41.6	46.3	46.8	45.1	45.5	44.2	43.5
		[1.50]	[3.33]	[4.29]	[0.84]	[1.87]		[0.39]	[-0.92]	[-0.61]	[-1.54]	[-2.10]
50-59	36.7	33.6	36.4	36.0	35.0	33.7	39.1	37.5	34.7	34.0	34.2	30.3
		[-2.61]	[-0.31]	[-0.61]	[-1.47]	[-2.52]		[-0.74]	[-1.88]	[-2.16]	[-2.07]	[-3.77]
60-69	32.1	23.2	23.4	24.0	21.9	22.4	27.6	20.8	22.6	25.3	21.9	22.1
		[-5.49]	[-5.33]	[-4.88]	[-6.04]	[-5.61]		[-2.12]	[-1.49]	[-0.66]	[-1.61]	[-1.53]
70+	22.0	9.6	12.0	13.2	9.5	11.6	15.0	11.0	4.1	7.7	2.3	4.7
		[-5.70]	[-4.60]	[-3.89]	[-5.33]	[-4.28]		[-1.07]	[-2.72]	[-1.73]	[-2.88]	[-2.14]
						Mean (Conditional on Working)						
Age in 2004												
25-39	41.2	45.2	46.1	46.5	44.8	45.5	48.0	51.3	49.5	50.4	50.6	49.9
		[7.66]	[9.36]	[10.14]	[6.91]	[8.45]		[4.00]	[1.78]	[2.81]	[3.02]	[2.29]
40-49	41.1	44.5	44.5	45.3	43.2	43.0	47.9	50.2	48.4	47.9	47.7	46.3
		[4.82]	[4.84]	[6.00]	[3.06]	[2.78]		[2.02]	[0.46]	[0.00]	[-0.12]	[-1.35]
50-59	39.2	40.8	42.3	42.2	40.9	40.2	47.4	46.8	46.1	46.3	45.6	45.6
		[1.69]	[3.17]	[3.03]	[1.79]	[1.05]		[-0.34]	[-0.70]	[-0.58]	[-0.92]	[-0.89]
60-69	37.9	38.3	36.7	39.8	36.1	37.5	46.2	45.1	46.6	45.8	43.8	42.2
		[0.35]	[-0.88]	[1.39]	[-1.22]	[-0.29]		[-0.38]	[0.11]	[-0.14]	[-0.75]	[-1.24]
70+	34.0	33.0	32.9	37.3	36.1	36.5	45.7	33.8	33.0	34.5	28.0	45.0
		[-0.34]	[-0.43]	[1.17]	[0.64]	[0.78]		[-1.90]	[-1.33]	[-1.37]	[-1.37]	[-0.06]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

Appendix Table 3.5: Working by years of education for younger female respondents by pre-tsunami urban/rural status of community

Sample of female baseline respondents aged 25-49 in 2004
By sex, age of respondent in 2004, and pre-tsunami urban/rural status of community

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
0-6 Years												
Age in 2004												
25-39	0.46	0.43	0.45	0.47	0.46	0.54	0.28	0.50	0.47	0.46	0.46	0.49
		[-1.51]	[-0.27]	[0.85]	[-0.03]	[4.25]		[4.34]	[3.82]	[3.56]	[3.61]	[4.21]
40-49	0.50	0.47	0.50	0.48	0.44	0.54	0.35	0.49	0.55	0.58	0.54	0.52
		[-1.07]	[0.12]	[-0.42]	[-1.97]	[1.68]		[2.64]	[3.70]	[4.38]	[3.57]	[3.25]
7-9 Years												
Age in 2004												
25-39	0.40	0.36	0.39	0.41	0.37	0.51	0.21	0.44	0.45	0.41	0.45	0.47
		[-1.29]	[-0.47]	[0.33]	[-1.05]	[3.15]		[4.18]	[4.43]	[3.66]	[4.27]	[4.72]
40-49	0.42	0.36	0.36	0.41	0.42	0.42	0.36	0.55	0.51	0.48	0.49	0.46
		[-0.74]	[-0.74]	[-0.19]	[-0.02]	[-0.07]		[2.68]	[2.02]	[1.63]	[1.74]	[1.45]
10-12 Years												
Age in 2004												
25-39	0.40	0.39	0.47	0.41	0.43	0.51	0.27	0.43	0.49	0.49	0.47	0.50
		[-0.21]	[1.91]	[0.27]	[0.81]	[2.77]		[4.64]	[6.19]	[5.87]	[5.41]	[6.48]
40-49	0.45	0.58	0.53	0.50	0.50	0.68	0.36	0.49	0.57	0.55	0.48	0.48
		[1.23]	[0.78]	[0.46]	[0.45]	[2.22]		[1.78]	[2.84]	[2.48]	[1.52]	[1.60]
13+ Years												
Age in 2004												
25-39	0.64	0.75	0.83	0.83	0.85	0.85	0.57	0.79	0.81	0.85	0.87	0.82
		[2.40]	[4.01]	[4.15]	[4.47]	[4.64]		[5.38]	[5.81]	[6.94]	[7.33]	[6.45]
40-49	0.95	0.97	0.97	1.00	1.00	1.00	0.80	0.96	0.94	0.98	0.94	0.94
		[0.62]	[0.56]	[1.55]	[1.56]	[1.57]		[3.50]	[3.03]	[3.90]	[2.99]	[3.03]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

Appendix Table 3.6: Paid vs. unpaid work by pre-tsunami urban/rural status of community

Sample of baseline respondents

By sex, age of respondent in 2004, and pre-tsunami urban/rural status of community

Female

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
	Main Job in Last Week was for Pay?											
Age in 2004												
25-39	0.22	0.34	0.33	0.34	0.34	0.37	0.30	0.49	0.51	0.51	0.51	0.53
		[8.10]	[7.18]	[8.40]	[7.87]	[10.21]		[8.58]	[9.29]	[9.10]	[9.17]	[10.40]
40-49	0.29	0.37	0.38	0.35	0.33	0.36	0.40	0.55	0.56	0.57	0.53	0.52
		[3.73]	[3.88]	[2.78]	[2.05]	[3.31]		[4.34]	[4.71]	[4.89]	[3.84]	[3.58]
50-59	0.29	0.31	0.31	0.27	0.28	0.34	0.25	0.35	0.33	0.31	0.30	0.30
		[0.74]	[0.75]	[-0.55]	[-0.42]	[1.63]		[2.38]	[1.85]	[1.36]	[1.18]	[1.17]
60-69	0.25	0.18	0.19	0.15	0.16	0.20	0.20	0.21	0.20	0.15	0.14	0.15
		[-2.59]	[-2.07]	[-3.23]	[-3.11]	[-1.79]		[0.12]	[0.04]	[-0.93]	[-1.12]	[-0.89]
70+	0.19	0.08	0.10	0.06	0.09	0.07	0.08	0.05	0.08	0.11	0.08	0.08
		[-3.54]	[-2.96]	[-4.15]	[-3.00]	[-3.58]		[-0.53]	[0.10]	[0.69]	[-0.04]	[0.12]
	Main Job in Last Week was Unpaid?											
Age in 2004												
25-39	0.23	0.09	0.14	0.14	0.13	0.19	0.03	0.04	0.04	0.04	0.05	0.04
		[-12.17]	[-7.38]	[-8.00]	[-8.72]	[-3.44]		[0.79]	[1.28]	[1.30]	[1.70]	[0.92]
40-49	0.22	0.12	0.14	0.15	0.14	0.20	0.03	0.03	0.05	0.05	0.05	0.05
		[-6.01]	[-4.86]	[-3.90]	[-4.76]	[-1.33]		[0.63]	[1.63]	[1.51]	[1.91]	[1.48]
50-59	0.19	0.05	0.07	0.12	0.08	0.10	0.03	0.04	0.04	0.04	0.04	0.06
		[-7.38]	[-6.37]	[-4.02]	[-5.79]	[-5.03]		[0.41]	[0.61]	[0.45]	[0.47]	[1.59]
60-69	0.11	0.02	0.04	0.03	0.02	0.04	0.03	0.02	0.01	0.02	0.01	0.01
		[-5.60]	[-4.76]	[-4.89]	[-5.44]	[-4.35]		[-0.50]	[-0.93]	[-0.28]	[-0.83]	[-0.89]
70+	0.06	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00
		[-3.89]	[-2.62]	[-2.92]	[-3.24]	[-3.09]		[0.00]	[2.06]	[0.00]	[0.00]	[0.00]

Male

	Rural Communities						Urban Communities					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
	Main Job in Last Week was for Pay?											
Age in 2004												
25-39	0.91	0.93	0.94	0.94	0.95	0.96	0.88	0.91	0.93	0.94	0.95	0.95
		[2.71]	[4.53]	[4.20]	[5.82]	[6.50]		[2.59]	[3.76]	[4.51]	[5.73]	[5.67]
40-49	0.97	0.93	0.95	0.94	0.94	0.97	0.97	0.93	0.92	0.95	0.92	0.93
		[-4.16]	[-1.63]	[-3.03]	[-3.27]	[-0.26]		[-2.47]	[-3.02]	[-1.48]	[-2.96]	[-2.48]
50-59	0.95	0.81	0.84	0.82	0.84	0.83	0.83	0.79	0.75	0.72	0.76	0.66
		[-6.63]	[-5.31]	[-6.00]	[-5.32]	[-5.61]		[-1.19]	[-2.06]	[-3.05]	[-2.04]	[-4.55]
60-69	0.85	0.59	0.63	0.59	0.59	0.58	0.59	0.45	0.48	0.55	0.51	0.50
		[-7.36]	[-6.19]	[-7.21]	[-7.07]	[-7.25]		[-2.22]	[-1.78]	[-0.56]	[-1.14]	[-1.30]
70+	0.64	0.28	0.36	0.35	0.26	0.32	0.35	0.30	0.13	0.22	0.08	0.11
		[-6.70]	[-5.30]	[-5.17]	[-6.55]	[-5.41]		[-0.53]	[-2.40]	[-1.27]	[-2.59]	[-2.18]
	Main Job in Last Week was Unpaid?											
Age in 2004												
25-39	0.05	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.00
		[-7.58]	[-7.15]	[-7.39]	[-8.82]	[-8.85]		[-2.32]	[-1.81]	[-1.70]	[-2.64]	[-3.64]
40-49	0.01	0.01	0.01	0.03	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01
		[-1.45]	[-0.65]	[2.40]	[-1.16]	[-2.37]		[0.54]	[1.18]	[-0.52]	[0.79]	[0.30]
50-59	0.01	0.02	0.02	0.03	0.02	0.00	0.00	0.02	0.01	0.02	0.01	0.01
		[0.49]	[1.08]	[2.50]	[0.59]	[-0.98]		[1.53]	[0.71]	[1.80]	[0.19]	[0.69]
60-69	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.03	0.01	0.00	0.00	0.02
		[0.71]	[-0.65]	[0.49]	[0.23]	[0.74]		[0.42]	[-0.66]	[-1.23]	[-1.22]	[0.28]
70+	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
		[-0.17]	[-0.17]	[-1.47]	[-1.42]	[-1.38]		[1.68]	[0.00]	[0.00]	[0.00]	[0.00]

Note: t-statistics are reported in brackets for tests of difference between each survey year and 2004.

References

Action Contre La Faim (ACF) (2005). Preliminary Analysis on the Food Aid response to the tsunami crisis. Indonesia - Aceh Province. March. Manuscript.

Adair, L.S. (1999) Filipino children exhibit catch-up growth between ages 2 and 11. *Journal of Nutrition*, 129, 1140-1148.

Alderman, Harold, John Hoddinott, and Bill Kinsey. (2006). Long term consequences of early childhood malnutrition. *Oxford Economic Papers*, 58, 450-474.

Badri, S. Ali, Ali Asgary, A.R. Eftekhari, and Jason Levy (2006). Post-disaster resettlement, development and change: a case study of the 1990 Manjil earthquake in Iran. *Disasters*, 30(4), 451-468.

Barker, D.J.P. (1995). Fetal origins of coronary heart disease. *BMJ*, 311, 171-174.

Barsky, Robert B., F. Thomas Juster, Miles S. Kimball, and Matthew D. Shapiro (1997). Preference Parameters and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study. *Quarterly Journal of Economics*, 112(2), 537–579.

Beydoun, H. and A. Saftlas (2008). Physical and mental health outcomes of prenatal maternal stress in human and animal studies: a review of recent evidence. *Paediatric and Perinatal Epidemiology*, 22, 438-466.

Birnbaum, Michael H., Jamie N. Patton, and Mellisa K. Lott (1999). Evidence against Rank-Dependent Utility Theories: Tests of Cumulative Independence, Interval Independence, Stochastic Dominance, and Transitivity. *Organizational Behavior and Human Decision Processes*, 77(1), 44-83.

Blanchard, E.B., J. Jones-Alexander, T.C. Buckley, and C.A. Forneris (1996). Psychometric properties of the PTSD checklist (PCL). *Behavior Research and Therapy*, 34, 669-673.

Bonin, Holger, Thomas Dohmen, Armin Falk, David Huffman, and Uwe Sunde (2007). Cross-sectional Earnings Risk and Occupational Sorting: The Role of Risk Attitudes. *Labour Economics*, 14(6), 926–937.

Bozzoli, Carlos, Tilman Brück, and Nina Wald (2012). Self-employment and Conflict in Colombia. *Journal of Conflict Resolution*, 57(1), 117-142.

Bozzoli, Carlos, Angus Deaton, and Climent Quintana-Domeque (2009). Adult Height and Childhood Disease. *Demography*, Nov 2009, 46(4), 647-669.

Brady, Sonya S. and Geri R. Donenberg (2006). Mechanisms Linking Violence Exposure to Health Risk Behavior in Adolescence: Motivation to Cope and Sensation Seeking. *Journal of the American Academy of Child and Adolescent Psychiatry*, 45(6), 673-680.

Brewin, C.R., B. Andrews, and J.D. Valentine (2000). Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *Journal of Consulting and Clinical Psychology*, 68, 748-766.

Briere J., and D. Elliott (2000). Prevalence, characteristics, and long-term sequelae of natural disaster exposure in the general population. *Journal of Traumatic Stress*, 13, 661-679.

Brown, Ryan (2012). The Intergenerational Impact of Terror: Does the 9/11 Tragedy Reverberate into the Outcomes of the Next Generation? Working Paper, April 2012.

BRR and Partners (2006). Aceh and Nias Two Years After the Tsunami: 2006 Progress Report.

Calderón-Mejía, V. and A. Ibáñez (2009). Labor Market Effects of Migration-Related Supply Shocks: Evidence from Internal Refugees in Colombia. Documentos CEDE No. 2009-14, Universidad de los Andes, Bogotá, Colombia.

Callen, Michael (2011). Catastrophes and Time Preference: Evidence from the Indian Ocean Earthquake. Working Paper, September 2011.

Callen, Michael, Mohammad Isaqzadeh, James D. Long, and Charles Sprenger (2014). Violence and Risk Preference: Experimental Evidence from Afghanistan. *The American Economic Review*, 104(1), 123-148.

Camacho, A. (2008). Stress and Birth Weight: Evidence from Terror Attacks. *American Economic Review, Papers and Proceedings*, 98(2), 511-515.

Cameron, Lisa and Manisha Shah (2013). Risk-taking Behavior in the Wake of Natural Disasters. *NBER Working Paper Series*, Working Paper 19534, October 2013.

Cassar, Alessandra, Andrew Healy, and Carl von Kessler (2011). Trust, Risk, and Time Preferences after a Natural Disaster: Experimental Evidence from Thailand. Working Paper, June 20, 2011.

Coates, J. M. and J. Herbert (2008). Endogenous Steroids and Financial Risk Taking on a London Trading Floor. *Proceedings of the National Academy of Sciences*, 105(16), 6167-6172.

Cossee, O., R. Hermes, and S. Mezhoud (2006). Real Time Evaluation of the FAO Emergency and Rehabilitation Operations in Response to the Indian Ocean Earthquake and Tsunami. Report of the Second Mission.

Davidson J.R.T., and A.C. McFarlene (2006). The extent and impact of mental health problems after disaster. *Journal of Clinical Psychology*, 67(suppl 2), 9-14.

de Pee, Saskia, Regina Moench-Pfanner, Elviyanti Martini, Stanley H. Zlotkin, Ian Darnton-Hill, and Martin W. Bloem (2007). Home fortification in emergency response and transition programming: Experiences in Aceh and Nias, Indonesia. *Food and Nutrition Bulletin*, 28(2), 189-197.

Dell'Osso, Liliana, Claudia Carmassi, Paolo Stratta, Gabrielle Massimetti, Kareen K. Akiskal, Hagop S. Akiskal, Icro Maremmani, and Alessandro Rossi (2013). Gender Differences in the Relationship Between Maladaptive Behaviors and Posttraumatic Stress Disorder. A study on 900 L'Aquila 2009 earthquake survivors. *Frontiers in Psychiatry*, 3(111), 1-7.

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, and Gert G. Wagner (2011). Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences. *Journal of the European Economic Association*, 9(3), 522-550.

Eckel, Catherine C., Mahmoud A. El-Gamal, and Rick K. Wilson (2009). Risk Loving after the Storm: A Bayesian-Network Study of Hurricane Katrina Evacuees. *Journal of Economic Behavior & Organization*, 69(2), 110-124.

Eeckhoudt, Louis, Christian Gollier, and Harris Schlesinger (1996). Changes in Background Risk and Risk Taking Behavior. *Econometrica*, 64(3), 683-689.

Ewing, Bradley T., Jamie B. Kruse, and Mark A. Thompson (2004). Employment Dynamics and Nashville Tornado. *The Journal of Regional Analysis & Policy*, 34(2), 47-60.

Ewing, Bradley T., Jamie B. Kruse, and Mark A. Thompson (2005). Empirical Examination of the Corpus Christi Unemployment Rate and Hurricane Bret. *Natural Hazards Review*, 6(4), 191-196.

Federov, Leonid and David E. Sahn (2005). Socioeconomic Determinants of Children's Health in Russia: A Longitudinal Study. *Economic Development and Cultural Change*, 53(2), 479-500.

Foa, E.B., D.J. Stein, and A.C. McFarlene (2006). Symptomatology and psychopathology of mental health problems after disaster. *Journal of Clinical Psychiatry*, 67(suppl 2), 15-25.

Forbes, D., N. Haslam, B.J. Williams, and M. Creamer (2005). Testing the Latent Structure of Posttraumatic Stress Disorder: A Taxometric Study of Combat Veterans. *Journal of Traumatic Stress*, 18(6), 647-656.

Frankenberg, Elizabeth, Jed Friedman, Thomas Gillespie, Nicholas Ingwersen, Robert Pynoos, Iip Umar Rifai, Bondan Sikoki, Alan Steinberg, Cecep Sumantri, Wayan Suriastini, and Duncan Thomas (2008). Mental Health in Sumatra after the Tsunami. *American Journal of Public Health*, 98(9), 1671-1677.

Frankenberg, Elizabeth, Thomas Gillespie, Samuel Preston, Bondan Sikoki, and Duncan Thomas (2011). Mortality, the Family and the Indian Ocean Tsunami. *The Economic Journal*, 121(554), F162-F182.

Gollier, Christian (2000). *The Economics of Risk and Time*, Cambridge, MA: MIT Press.

Gollier, Christian and John W. Pratt (1996). Risk Vulnerability and the Tempering Effect of Background Risk. *Econometrica*, 64(5), 1109-1123.

Gore-Felton, Cheryl and Cheryl Koopman (2002). Traumatic Experiences: Harbinger of Risk Behavior Among HIV-Positive Adults. *Journal of Trauma & Dissociation*, 3(4), 121-135.

Groen, Jeffrey, and Anne Polivka (2008a). The Effect of Hurricane Katrina on the Labor Market Outcomes of Evacuees. *The American Economic Review*, 98(2), 43-48.

Groen, Jeffrey, and Anne Polivka (2008b). Hurricane Katrina Evacuees: Who They Are, Where They Are, and How They Are Faring. *Monthly Labor Review*, 131(3), 32-51.

Guiso, Luigi and Monica Paiella (2008). Risk Aversion, Wealth, and Background Risk. *Journal of the European Economic Association*, 6(6), 1109-1150.

Hamoudi, Amar, Elizabeth Frankenberg, and Cecep S. Sumantri (2012). Impact of the December 2004 Tsunami on Birth Outcomes in Aceh, Indonesia. Paper presented at the Population Association of America 2012 Annual Meeting, San Fransisco, CA.

Handa, Sudhanshu and Amber Peterman (2012). Is there Catch-Up Growth? Evidence from Three Continents. Working Paper.

Hector, Katie L. and Shinichi Nakagawa (2012). Quantitative analysis of compensatory and catch-up growth in diverse taxa. *Journal of Animal Ecology*, 81(3), 583-593.

Hoddinott, John and Bill Kinsey (2001). Child growth in the time of drought. *Oxford Bulletin of Economics and Statistics*, 63(4), 409-436.

Hoddinott, John, John A. Maluccio, Jere R. Behrman, Rafael Flores, and Bill Kinsey (2008). Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *Lancet*, 371, 411-416.

Holt, Charles A. and Susan K. Laury (2002). Risk Aversion and Incentive Effects. *The American Economic Review*, 92(5), 1644-1655.

Inter-Agency Rapid Health Assessment (2005). Inter-Agency Rapid Health Assessment: West Aceh, Indonesia Earthquake and Tsunami Response – End of Mission Report. Jan 13-19, 2005.

International Organization for Migration (IOM) (2005). Settlement and Livelihood Needs and Aspirations Assessment of Disaster-affected and Host Communities in Nanggroe Aceh Darussalam.

Jayasuriya, Sisira and Peter McCawley (2010). *The Asian Tsunami: Aid and Reconstruction after a Disaster,* Cheltenham, UK: Asian Development Bank Institute and Edward Elgar Publishing.

Kianpoor, Mohsen and Nour-Mohammad Bakhshani (2012). Trauma, Dissociation, and High-Risk Behaviors. *International Journal of High Risk Behaviors & Addiction*, 1(1), 9-13.

Kim, Young-Il and Jungmin Lee (2013). The Long-Run Impact of Traumatic Experience on Risk Aversion. Working Paper, July 2013.

Kohl, Patrice A., Ann P. O'Rourke, Dana L. Schmidman, Wendy A. Dopkin, Marvin L. Birnbaum (2005). The Sumatra-Andaman Earthquake and Tsunami of 2004: The Hazards, Events, and Damage. *Prehospital and Disaster Medicine*, 20(6), 356–363.

Kondylis, Florence (2010). Conflict displacement and labor market outcomes in post-war Bosnia and Herzegovina. *Journal of Development Economics*, 93(2010), 234-248.

Kuczmarski, R.J., C.L. Ogden, L.M. Grummer-Strawn, K.M. Flegal, S.S. Guo, R. Wei, A. Mei, L.R. Curtin, A.F. Roche, and C.L. Johnson (2000). CDC growth charts: United States. *Advance Data*, 2000(314), 1-27.

Lauderdale, D. (2006). Birth outcomes for Arabic-named women before and after September 11. *Demography*, 43(1), 185-201.

Loomes, Graham and Robert Sugden (1998). Testing Different Stochastic Specifications of Risky Choice. *Economica*, 65(260), 581-598.

Lusk, Jayson L. and Keith H. Coble (2008) Risk Aversion in the Presence of Background Risk: Evidence from an Economic Experiment. In: James C. Cox, Glenn W. Harrison (Eds.), *Risk Aversion in Experiments (Research in Experimental Economics)*, Volume 12, Emerald Group Publishing Limited: 315-340.

Maluccio, J., J. Hoddinott, J. Behrman, A. Quisumbing, R. Martorell, and A. Stein (2009). The impact of nutrition during early childhood on education among Guatemalan adults. *Economic Journal*, April 2009, 119(537), 734-763.

Mani, Subha (2008). Is there Complete, Partial, or No Recovery from Childhood Malnutrition? – Empirical Evidence from Indonesia. October 8, 2012. Working Paper.

Martorell, Reynaldo (1995). Results and Implications of the INCAP Follow-up Study. *The Journal of Nutrition*, Apr 1995, 125(4), 1127S-1138S.

Martorell, Reynaldo (1999). The Nature of child malnutrition and its long-term implications. *Food and Nutrition Bulletin*, 20(3), 288-292.

Moffatt, Peter G. and Simon A. Peters (2001). Testing for the Presence of a Tremble in Economic Experiments. *Experimental Economics*, 4(3), 221-228.

Monecke, Katrin, Willi Finger, David Klarer, Widjo Kongko, Brian G. McAdoo, Andrew L. Moore, and Sam U. Sudrajat (2008). A 1,000-year Sediment Record of Tsunami Recurrence in Northern Sumatra. *Nature*, 455(30 October 2008), 1232-1234.

Moore, S.R., A.A.M. Lima, M.R. Conaway, J.B. Schorling, A.M. Soares, and R.L. Guerrant (2001). Early childhood diarrhea and helminthiases associate with long-term linear growth faltering. *International Journal of Epidemiology*, 2001, 30, 1457-1464.

Moya, Andrés (2012). Violence, Mental Trauma and Induced Changes in Risk Attitudes among the Displaced Population in Colombia. Working paper, June 2012.

Murthy, K.S.R. (2005). First oceanographic expedition to survey the impact of the Sumatra earthquake and the tsunami of 26 December 2004. *Current Science*, 88(7), 1038-1039.

NASA (2005). (http:/www.nasa.gov/home/hqnews/2005/jan/HQ_05011_earthquake.html).

Nicol, Bill (2013). *Tsunami Chronicles: Adventures in Disaster Management*, CreateSpace Independent Publishing Platform.

Norris, Fran H., Matthew J. Friedman, Patricia J. Watson, Christopher M. Byrne, Eolia Diaz, and Krzysztof Kaniasty (2002). 60,000 Disaster Victims Speak: Part I. An Empirical Review of the Empirical Literature, 1981-2001. *Psychiatry*, 65(3), 207-239.

Pat-Horenczyk, Ruth, Osnat Peled, Tomer Miron, Daniel Brom, Yael Villa, and Claude M. Chemtob (2007). Risk-Taking Behaviors Among Israeli Adolescents Exposed to Recurrent Terrorism: Provoking Danger Under Continuous Threat? *American Journal of Psychiatry*, 164(1), 66-72.

Quiggin, John (2003). Background Risk in Generalized Expected Utility Theory. *Economic Theory*, 22(3), 607-611.

Ramakrishnan, D., S.K. Ghosh, V.K.M. Raja, R. Vinu Chandran, and A. Jeyram (2005). Trails of the Killer Tsunami: A Preliminary Assessment using Satellite Remote Sensing Technique. *Current Science*, 88(5), 709-711.

Ravelli, A.C.J., van der Meulen, Jan H.P., Michels, R.P.J., Osmond, C., Barker, D., Hales, C.N. and Bleker, O.P. (1998). Glucose tolerance in adults after prenatal exposure to famine. *Lancet*, 351, 173-177.

Ravelli, A.C.J., Jan H.P. van der Meulen, C. Osmond, D. Barker, and O.P. Bleker (1999). Obesity at the age of 50 years in men and women exposed to famine prenatally. *American Journal of Clinical Nutrition*, 70, 811-816.

Rooij, W.H., J.E. Yonker, R.C. Painter, and T.J. Roseboom (2010). Prenatal under-nutrition and cognitive function in late adulthood. *Proceedings of the National Academy of Sciences*, 107, 16881-86.

Roseboom, Tessa J., Jan H.P. van der Meulen, Clive Osmond, David J. Barker, and Otto P. Blecker (2001). Adult survival after prenatal exposure to the Dutch famine 1944-1945. *Paedeatric and Perinatal Epidemiology*, 15, 220-225.

Ruscio A.J., J. Ruscio, and T.M. Keane (2002). The Latent Structure of Posttraumatic Stress Disorder: A Taxometric Investigation of Reactions to Extreme Stress. *Journal of Abnormal Psychology*, 3(2), 290-301.

Shrimpton R., C. Victora, M. de Onis, R. Costa Lima, M. Blössner, and G. Clugston (2001). Worldwide Timing of Growth Faltering: Implications for Nutritional Interventions. *Pediatrics*, 107(5), e75-81.

Sikoki, Bondan, Cecep Sumantri, and Wayan Suriastini (2008). Methods of Tracking the Displaced: A Lesson from the Study of the Tsunami Aftermath and Recovery. Paper presented at the Population Association of America 2008 Annual Meeting, New Orleans, LA.

Smith M.Y., W. Redd, K. DuHamel, S. Vickberg, and P. Ricketts (1999). Validation of the PTSD Checklist-Civilian Version in Survivors of Bone Marrow Transplantation. *Journal of Traumatic Stress*, 12(3), 485-493.

Stein, Z., M. Susser, G. Saenger, and F. Marolla (1975). *Famine and human development: The Dutch hunger winter of 1944-45*, Oxford: Oxford University Press.

Strauss, John and Duncan Thomas (1998). Health, Nutrition, and Economic Development. *Journal of Economic Literature*, June 1998, 36, 766-817.

Torche, F. (2011). The effect of maternal stress on birth outcomes: exploiting a natural experiment. *Demography*, 48, 1473-1491.

Tsuji, Yoshinobu, Hideo Matsutomi, Yuichiro Tanioka, Yuichi Nishimura, Tsutomu Sakakiyama, Takanobu Kamataki, Yoshikane Murakami, Andy Moore, and Guy Gelfenbanm (2005). Distribution of the Tsunami Heights of the 2004 Sumatera Tsunami in Banda Aceh measured by the Tsunami Survey Team (The Head: Dr. Tsuji). http://www.eri.u-tokyo.ac.jp/namegaya/sumatera/surveylog/eindex.htm. Captured on September 27, 2014.

van den Bos, Ruud, Marlies Harteveld, and Hein Stoop (2009). Stress and Decision-making in Humans: Performance is Related to Cortisol Reactivity, Albeit Differently in Men and Women. *Psychoneuroendrocrinology*, 34(10), 1449-1458.

Vigdor, Jacob (2007). The Katrina Effect: Was There a Bright Side to the Evacuation of Greater New Orleans? *The B.E. Journal of Economic Analysis and Policy: Advances*, 7(1), Article 64.

Vigdor, Jacob (2008). The Economic Aftermath of Hurricane Katrina. *Journal of Economic Perspectives*, 22(4), 135-154.

Voors, Maarten J., Eleonora E.M. Nillesen, Philip Verwimp, Erwin H. Bulte, Robert Lensink, and Daan P. Van Soest (2012). Violent Conflict and Behavior: A Field Experiment in Burundi. *The American Economic Review*, 102(2), 941-964.

Weathers F.W., B.T. Litz, D.S. Herman, J.A. Huska, and T.M. Keane (1993). The PTSD checklist: reliability, validity, & diagnostic utility. Paper presented at the 1993 Annual Meeting of the International Society for Traumatic Stress Studies, San Antonio, TX.

Weathers, Frank W., Brett T. Litz, Terence M. Keane, Debra S. Herman, Howard R. Steinberg, Jennifer A. Huska, and Helena C. Kraemer (1996). The Utility of the SCL-90-R for the Diagnosis of War-Zone Related Posttraumatic Stress Disorder. *Journal of Traumatic Stress*, 9(1), 111-128.

World Bank (2005). Indonesia: Preliminary Damage and Loss Assessment. The December 26, 2004 Disaster. Mimeo.

World Food Programme (WFP) (2005). A Report from the Office of Evaluation. Full Report of the 'Real Time' Evaluation of WFP's Response to the Indian Ocean Tsunami. Rome, Sept 2005. Ref OEDE/2005/3

Yamano, Takashi, Harold Alderman, and Luc Christiaensen. (2005). Child Growth, Shocks, and Food Aid in Rural Ethiopia. *American Journal of Agricultural Economics*, May 2005, 82(2), 273-288.

Yulianto, Eko, Fauzi Kusmayanto, Nandang Supriyatna, and Mohammad Dirhamsyah (2010). Where the First Wave Arrives in Minutes: Indonesian Lessons on Surviving Tsunamis near Their Sources. *United Nations Educational, Scientific and Cultural Organization: Intergovernmental Oceanographic Commission (UNESCO/IOC), IOC Brochure 2010-4*. Adapted by Brian F. Atwater, Eko

Yulianto, and Ardito M. Kodijat. http://iotic.ioc-unesco.org/images/xplod/resources/material/tsunami_arrives_in_minutes.pdf

Zissimopoulos, Julie and Lynn A. Karoly (2010). Employment and Self-employment in the Wake of Hurricane Katrina. *Demography*, 47(2), 345-367.

Biography

Nicholas Shane Ingwersen was born on February 14, 1981 in Seattle, WA. He attended the University of California Los Angeles for his undergraduate studies where he graduate Summa Cum Laude and earned a BA in Economics in 2003. He earned a MA in Public Policy from the Sanford School of Public Policy at Duke University in 2011 and will earn a PhD in Public Policy from Sanford in May 2015. While studying at Sanford, he has been awarded the James B. Duke Fellowship in 2009 and a T32 Training Grant in the Social, Medical, and Economic Demography of Aging from the National Institute on Aging/National Institutes of Health in 2011, 2012, 2013, and 2014.

His research is the result of ten years of involvement and investment in the collection of two large-scale household and individual longitudinal surveys in Indonesia with Professors Elizabeth Frankenberg and Duncan Thomas, the Worker Iron Supplementation Evaluation (WISE) and the Survey of the Study of the Tsunami Aftermath and Recovery (STAR). He is a co-author with Professors Frankenberg and Thomas as well as other collaborators on the STAR project on one published article, "Mental Health in Sumatra After the Tsunami" published in the American Journal of Public Health, vol. 98, no. 9, September 2008.