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Fertility Response to Natural Disasters

The Case of Three High Mortality Earthquakes

Jocelyn E. Finlay

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Abstract

The event of a natural disaster, and being directly affected by it, brings a large shock to life-cycle outcomes. In addition to the replacement effects of higher fertility following a disaster that caused high mortality, a positive fertility response may be induced as children can be used to supplement household income. This paper analyzes three high mortality earthquakes: Gujarat, India, in 2001; North-West Frontier, Pakistan, in 2005; and Izmit, Turkey, in 1999. There is evidence of a positive fertility response to exposure to these large-scale natural disasters in addition to the response to child mortality. The results in this study are consistent with those of other studies that also find a positive fertility response following exposure to a disaster.

This paper—a product of the Global Facility for Disaster Reduction and Recovery Unit, Sustainable Development Network Vice Presidency—is part of a larger effort in the network to disseminate the emerging findings of the forth coming joint World Bank-UN Assessment of the Economics of Disaster Risk Reduction. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The team leader—Apurva Sanghi—can be contacted at asanghi@worldbank.org, and the author of this paper at jfinlay@hsph.harvard.edu.

Fertility Response to Natural Disasters: The Case of Three High Mortality Earthquakes

Jocelyn E. Finlay[1]

Harvard School of Public Health

Prepared for Global Facility for Disaster Reduction and Recovery at the World Bank[2]

[1] Address for correspondence: Jocelyn Finlay, Center for Population and Development Studies, 9 Bow St, Cambridge, MA 02138 USA. Email: jfinlay@hsph.harvard.edu. Telephone: +1-617-496-8040.

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1. Introduction

The event of a natural disaster can cause large-scale losses to a household. As a result of a natural disaster, households may experience a loss of income, assets, or life. In societies where formal insurance mechanisms are not available, and children have the ability to work to supplement household income, and we may expect that the event of a natural disaster will have a positive effect on fertility. In this paper, I analyze the effect exposure to a natural disaster has on the number of children born into a household.

In a developing country context, children are used to assist the household in smoothing consumption over time (Guarcello, Mealli and Rosati 2002). A fertility response to a large-scale disaster can be motivated by the household's need to use children as a mechanism to compensate for income and asset loss as a result of the disaster. Children can earn income to supplement the support provided by the main income earner of the household, they can provide care for young siblings enabling the parents to participate in the work force, and they can provide care to their old-age parents. Following the experience of a large-scale disaster, households may have the incentive to increase the number of children. A positive fertility response, in addition to the child mortality response, can indicate that these families utilize children to supplement diminished income and asset wealth.

Children can be used as a form of insurance. In a risky environment, where there is a degree of uncertainty over the household's consumption stream, the risk of income loss is insured by having additional children who may be able to support the family when income and consumption needs are compromised. This use of children is in response to risk and uncertainty. Children are used as an insurance mechanism and the decision to have extra children is based on the probability of a catastrophic event occurring and potential loss of income, assets and life. In this paper, however, the fertility response is a response to a shock. Thus the decision for extra children is *ex post* rather than *ex ante* in the case where children are used as insurance. Children can be used to smooth consumption over time in response to risk, in which case the decision to have children will come before the event of a disaster (if it occurs at all). Children can also be used to smooth consumption over time in response to a shock, in which case the decision to have children will come after the event of a disaster.

In the demography literature there are insurance and replacement effects in response to child mortality (Schultz 1997). The insurance mechanism is such that households who live in an environment where the risk of child mortality is high will insure against the probability loss of a child by having more children than desired. The replacement effect is an *ex post* response: following the death of a child another child is born to replace the one who was lost. This of course, relies on the mother being in her fertile years when the loss of the child occurs. The event of a large-scale natural disaster means that among those killed will be children. This shock to human life may induce the replacement effects. In response to an unanticipated natural disaster, fertility will increase due to the replacement effects. In this study, if children are also used as an instrument to smooth household income and consumption over time, we would expect there to be a fertility response in excess of the replacement effects.

The aim of this study is to use the cases of three large-scale natural disasters to test the hypothesis of a positive fertility response that is additional to the child mortality response. In this paper I examine three large disasters: Gujarat, India 2001 earthquake (20,000 killed); North-West Frontier, Pakistan 2005 earthquake (73,338 killed); and Turkey 1999 earthquake in the western region (17,127 killed).

The paper is structured as follows. In the next section background information regarding the previous findings, the conceptual framework, and facts of the earthquakes are given. In section three the data are discussed. In section four the identification strategy is outlined and the estimated model, results and robustness checks are given. In section five, discussion and conclusions are offered. Tables are presented at the back of the paper.

2. Background

The three countries chosen for this case study are chosen for the practical analytical reason of data availability and the scale of the disaster in terms of the number of people killed. The behavioral response to natural disasters is not a new field of study, although it is seldom explored due to the lack of suitable data. In this study, the focus is on the use of children as a form of insurance to smooth life-cycle outcomes over the long term. In this section, clarification over the framework of this analysis is given; differentiating risks from shocks, and the distinction between fertility response to risks, shocks, and mortality.

2.1 Previous Findings

2.1.1 Disasters: Risks and Shocks

Disasters can occur with variation over type, magnitude and location. Often in the study of natural disasters, it is assumed that disasters occur with some degree of anticipation and thus pose risk and uncertainty over future outcomes. Volcanic activity, earthquakes and tsunamis occur along fault lines, bushfires occur in forested areas, floods occur along rivers, and hurricanes occur in the tropics. The elements of a disaster that are random, however, are the exact epicenter of the disaster zone and the magnitude of the event. While households may be able to prepare for small anticipated or seasonal disasters, for example annual flooding levels near the average seasonal mean, large-scale disasters that strike without warning make affected individuals' unprepared for the force that is upon them.

Thus a natural disaster has two elements to it: risk and shock. This risk is associated with your understanding of the probability of a disaster occurring and one would adjust life cycle decisions according to the exposure to the risk. Natural disasters could also impose a shock, and decisions over savings and the number of children, and other life-cycle decisions determined before the disaster may alter decisions over the allocation of resources following the disaster.

Children can supplement depleted household resources as older children can work effectively in either agrarian or newly industrialized zones. Disasters can result in the death or disability of economically active household members, cause damage to farming land, or cause the loss of workplace – each case reduces the income and consumption stream and asset base of the household. With more children available to work or provide care to young and old in times of need, the family can attempt to smooth their consumption and other life-cycle outcomes following a disaster. Thus to supplement income following a negative shock to income and asset wealth as a result of exposure to a natural disaster, there may be an increase in the number of children to ensure that the future income stream is not compromised – conditional on the child bringing great benefit to the household than cost.

In this study, three large-scale earthquakes are the focus. The earthquake in India occurred on January 26, 2001 in Gujarat. According to EM-DAT data (Centre for Research on the Epidemiology of Disasters (CRED) 2008), 20,005 people were killed as a result of this earthquake and nearly 6.5 million people were affected. The earthquake in Pakistan on October 8, 2005 occurred in North West Frontier in the north-west region of the country. It had a devastating effect and killed 73,338 people and 5.1 million people were affected. The earthquake in Turkey hit on August 17, 1999 in Izmit in the western region of the country. It killed 17,127 people and affected 1.3 million people. Each of these earthquakes led to large-scale loss of life and property. Publicity surrounding each of the earthquakes was widespread and images of the damage were televised around the world and remain imprinted in the viewers' minds.

Data on earthquakes since 1900 (Centre for Research on the Epidemiology of Disasters (CRED) 2008) indicate that India, Pakistan and Turkey are exposed to the risk of the earthquake events. What remains unanticipated is the magnitude of the earthquake and the exact location of the earthquake, and the timing of the event. Studies that consider the fertility response to natural disasters often account for risk (Cain 1981; Cain 1983; Cain 1986; Pörtner 2008): the seasonality of flooding and hurricanes makes the concept of risk the key instrument. In the case of earthquakes, which are neither seasonal nor predictable in magnitude and epicenter, the concept of a shock is the dominant instrument.

In India, according to the EM-DAT data, the 2001 Gujarat earthquake was the largest recorded in terms of casualties since data are available in 1900. The second largest was in 1905 in Kangra, some 1000km north of Gujarat along the Himalya that killed 20,000 people. Gujarat is subject to seismic activity, but it is not along the Himalaya mountain range which is the region most vulnerable to seismic activity. The last large earthquake in Gujarat was in 1956, more than a generation ago, when 113 people died. Thus the force of the earthquake that hit in January 2001 was unanticipated and unprecedented for the Gujarat population.

In Pakistan, the earthquake the struck in the North West Frontier was the largest on record in that country in terms of the number of people killed. The second largest earthquake by this measure was in 1935 in Quetta , 1000km south on a different mountain range to that in the North West. The North West Frontier earthquake had its epicenter in the Himalaya Mountain Range. Unsurprisingly, this region is subject to a lot of seismic activity. But the magnitude of the earthquake on October 8, 2005 was unprecedented in terms of lives lost. Thus while the event of an earthquake may be anticipated to some degree, the magnitude of the Kashmir earthquake had a greater effect on human lives than any experienced in this region before.

In Turkey, the Izmit earthquake was the second largest since 1900 in this country, and the largest was in Erzincan in 1939 (1000km due east of the Izmit earthquake). While there has been seismic activity around Izmit the scale of the earthquake in 1999 was unprecedented.

While each of these countries is clearly subject to seismic activity the timing, exact location, and magnitude were unanticipated, and thus I analyze the event of the earthquakes as an exogenous shock.

2.1.2 Fertility Following a Shock

In the US, there is evidence that following a disaster birth rates increase. Following the Okalahoma bombings Rogers, John and Coleman (2005) find that there was a positive fertility response. Given the site of this disaster, they attributed the increase in fertility to the return to traditional family values. In a developing country context, however, the increase in fertility following a disaster may be attributed to the desire to supplement income, and generate and insurance mechanism against future shocks to income and consumption. The return to family values is also a viable option in the developing country context.

2.1.3 Children as Insurance in Risky Environments

Pörtner (2001) writes in detail about the use of children as insurance in less developed countries. The model developed by Pörtner (2001) incorporates uncertainty over future income, and discusses the benefit children can bring to the household as a substitute for insurance. Children can work at home or provide labor for wages, older children can provide transfers to parents, children expand family ties through marriage, and children can be "sold."

In Pörtner (2008) and Cain (1981; 1983; 1986) children are found to be used as insurance in risky environments. The decision to have extra children is based on the potential need for support during a crisis. Support from family can be relied upon to a greater extent than external assistance during a crisis as informal insurance mechanisms at the village level, and contractual agreements, may break down. The use of extended family, and not just children, is explored by Rosenzweig (1988), who finds that in the event of a shock family ties are called upon *ex post* to assist in smoothing consumption.

2.1.4 A Positive Fertility Response in Addition to the Child Mortality Response

The fertility response to child mortality is either an insurance against expected reduction in family size (an i decision), or a replacement effect in which case additional children are born to replace those who were lost (an *ex post* decision).

The strike of a disaster may insight replacement effects which is consistent with the response to child mortality (Schultz 1997), however, exposure to a disaster may change a household's preference for children through a changed perception of community spirit, or the return the traditional family values (Rogers, John and Coleman 2005). Alternatively, the event of a disaster may insight households to supplement future household income with income from child labor to ensure life-cycle outcomes are smoothed over the lifetime of the parents and thus the demand for children increases.

In this paper, the core question explored is: Does an unanticipated random shock generated by a natural disaster instill a fertility response over and above the mortality effect?

2.2 Conceptual Framework

In this paper I analyze the effect of exposure to a large-scale earthquake on the number of children ever born, and test the hypothesis that exposure to an earthquake will have a positive effect on the number of children ever born in addition to the mortality effect.

In the following I present a model to illustrate why we would expect fertility to increase in an area affected by a natural disaster, relative to those in areas unaffected, over and above the mortality response.

Consider an individual who has utility over consumption in three periods, period 1, 2 and 3, and that utility in the period specific consumption is additively separable and marginal utility of consumption in each period is increasing at a decreasing rate. To illustrate this I adopt the log function for the felicity. Such that the individual maximizes lifetime utility,

$$\begin{aligned} U &= u(c_1) + u(c_2) + u(c_3) \\ U &= \ln(c_1) + \ln(c_2) + \ln(c_3) \end{aligned} \tag{1}$$

For simplicity there is no intertemporal discounting. The individual works and earns an exogenously determined income in periods one, Y_1. In period one she will have n_1 children who provide benefit to the household consumption possibilities of amount w per child but cost k per child to raise. In period one, she will also save an amount s_1 and consume c_1 such as to satisfy the budget constraint in the first period of,

$$Y_1 + (w - k)n_1 = s_1 + c_1 \tag{2}$$

In period two, the individual will work for income Y_2, she will have n_2 children who cost k and provide benefit w, and she will save and amount s_2. Children from period one continue to work and provide benefit to her, but do not impose a cost of care as they are older and able to look after themselves. Savings from period one are brought into period two having earned an interest rate of r. The second period budget constraint such that,

$$Y_2 + (w-k)n_2 + wn_1 + (1+r)s_1 = c_2 + s_2 \tag{3}$$

In period three, the representative individual is dependent on the returns from decisions over the number of children and savings in the previous periods. She will have income from their second period children and savings are brought forward from the second period to cover consumption needs, such that,

$$wn_2 + (1+r)s_2 = c_3 \tag{4}$$

Rearranging (2), (3), and (4), the utility function in (1) can be written as,

$$\begin{aligned} U = & \ln\left\{Y_1 + (w-k)n_1 - s_1\right\} \\ & + \ln\left\{Y_2 + (w-k)n_2 + wn_1 + (1+r)s_1 - s_2\right\} \\ & + \ln\left\{wn_2 + (1+r)s_2\right\} \end{aligned} \tag{5}$$

First order conditions with respect to s_1, s_2, n_1, n_2 are,

$$\begin{aligned} \frac{\partial U}{\partial s_1} &= -u'(c_1) + (1+r)u'(c_2) = 0 \\ \frac{\partial U}{\partial s_2} &= -u'(c_2) + (1+r)u'(c_3) = 0 \\ \frac{\partial U}{\partial n_1} &= (w-k)u'(c_1) + wu'(c_2) = 0 \\ \frac{\partial U}{\partial n_2} &= (w-k)u'(c_2) + wu'(c_3) = 0 \end{aligned} \tag{6}$$

For this paper, I turn particular focus to second period fertility. Continuing with the logarithmic functional form, this implies that from the fourth first order condition in (6) that,

$$\frac{w-k}{Y_2 + (w-k)n_2 + wn_1 + (1+r)s_1 - s_2} = \frac{-w}{wn_2 + (1+r)s_2} \tag{7}$$

Assuming $s_1, s_2, and\ n_1$ are fixed, n_2 can be expressed as the following function,

$$n_2 = \frac{1}{2(w-k)}\left[-Y_2 - (1+r)s_1 - wn_1 - \frac{((w-k)(1+r)-w)}{w}s_2\right] \tag{8}$$

The comparative statics of a change in the number of children born in period two, given exogenous changes in income, asset wealth and number of children are,

$$\frac{\partial n_2}{\partial Y_2} = \frac{-1}{2(w-k)} \quad < 0 \; if \;\; w > k \tag{9}$$

$$\frac{\partial n_2}{\partial s_1} = \frac{-(1+r)}{2(w-k)} \quad < 0 \; if \;\; w > k \tag{10}$$

$$\frac{\partial n_2}{\partial n_1} = \frac{-w}{2(w-k)} \quad < 0 \; if \;\; w > k \tag{11}$$

Notice that fertility increases in the event of a natural disaster if the benefit from the children is higher than the cost of caring for the children. If children are costly to care for, and provide little or no contribution towards household consumption possibilities, then fertility in the second period will fall as a result of exposure to an exogenous shock that reduces income, assets and child survival.

In period two, the representative individual may be subject to a random shock – exposure to a natural disaster. As a result of being exposed to the natural disaster, her income will be lower, there will be loss of accumulated assets, and there will be child mortality. This implies that while the budget constraint in period two takes the same form as in (3), the levels of the variables will be lowered exogenously and the comparative statics in (9), (10) and (11) imply that fertility in the second period will increase.

In the next sub-sections, I discuss in detail what would motivate an individual to increase fertility following the event of a natural disaster, broadening the interpretation of the model presented in this section.

2.2.1 Explaining the Fertility Increase: Using Children to Smooth Consumption

Children can be a form of insurance. But we think of insurance as a financial instrument that a household would take out *ex ante* based on the probability of an event occurring that has a negative impact on life-cycle outcomes. The justification for children as insurance is elaborate, and even though in this paper I explore the use of children to smooth consumption as an *ex post* decision, the motivation for having children can translate from the risk analysis to the analysis of the response to an exogenous shock.

In the context of a developing country, formal insurance mechanisms are not readily available and there may be use of alternative mechanisms to smooth life-cycle factors in the face of fluctuations in income. The life-cycle factors that could be affected by a large shock such as an earthquake are: consumption; asset accumulation; and family formation. An earthquake can disrupt a household's income stream and thus jeopardize consumption possibilities. Assets such as housing, land, livestock, small business, can be damaged or disappear as a result of the earthquake. Family formation, another life-cycle decision, may also be adversely affected by an earthquake, with mortality of the parents or children bringing differential effects. The loss of the key breadwinner will have obvious repercussions over consumption possibilities of the household; the loss of the key care giver will require a diversification of support for the family unit; and the loss of children may induce a replacement response.

Where formal insurance is available, individuals can make payments on a premium on a regular basis and receive a pay-out when in need to ensure that life-cycle outcomes are smoothed over an adverse shock. In the case of formal insurance, the premium paid is monetary and the pay-out is monetary. This is also the case for some informal insurance mechanisms that operate at the village level.

In the case of consumption and asset loss insurance, we can hypothesize that children can be used as a form of insurance in these cases. The premium cost is the cost of raising the child, and the pay-off comes from the children when needed. Children can supply labor when young (or adult-child labor with intergenerational transfers to elderly parents) to provide for the family unit so that the family does not rely on a sole breadwinner. Children can also provide care to their siblings, and adult children can care for elderly parents. In crude terms, the premium cost of children as insurance is different to the formal and informal insurance mechanisms that involve monetary exchange. Children are multi-use, versatile insurance, thus the cost of raising the child is the premium cost for many forms of insurance: property damage, job loss, consumption, or savings for old-age support. The cost of raising the child may be less than the sum of premiums one would pay for all the types of insurance in the formal or informal monetary insurance markets.

With the notion that children can be a mechanism for insurance, we may hypothesize that in countries or regions that have little access to monetary forms of insurance (formal or informal) then children may be utilized as a form of insurance (Pörtner 2001). Children can be used as a form of insurance, a decision made *ex ante*, but the decision to have more children can also occur *ex post* – both with the goal of smoothing consumption over time.

2.2.2 Explaining the Fertility Increase: Other Possibilities

When conducting this analysis using a difference-in-difference estimation technique, one of the key issues relates to omitted variables. In the reduced form difference-in-difference estimation a positive and significant difference between treatment and control indicates that between the pre- and post-period an event occurred in the treatment area that induced a positive fertility response in the treatment area relative to the control area. This positive and significant fertility response in the treatment area could be due to a shock that affected the treatment but not the control group. Alternatively, it could be due to differential trends between factors in the treatment and control groups.

In the regression analysis we control for education and mortality, consistent with the model developed above (education proxies income and assets), however, there may be other factors that change differentially between treatment and control groups between the pre- and post-periods that insights a positive and significant fertility response in the treatment area. One of the factors that may have varied differentially across treatment and control groups is access to contraception. For example, following the large-scale earthquake, contraceptive access may have become limited relative to what it was before. Thus following the earthquake, the probability of becoming pregnant may have increased. Another option is that if in the event of a high mortality earthquake, loss of a spouse may then encourage remarrying and the new couple has the desire to have children of their own. Another alternative is that there is a return to family values as a result of exposure to the earthquake and this increases a couple's preference for the number of children they desire. All of the above suggestions however are second order to the event of the disaster.

Another possibility is that some other shock affected the treatment area relative to the control area during the same time period. There may have been a policy change in each of the three treatment areas relative to the control areas that had a positive effect on fertility. The likelihood of a policy change in the three affected regions, within the time period in this study, is, however, reasonably low given there are three treatment groups across three countries.

Another possibility is that there is some factor that is changing differentially between the treatment areas and the control areas that affects fertility. I test for the differential trend between treatment and control groups in the included independent variables, but there may be omitted variables that change differentially between treatment and control groups over time. With this is mind, results should be interpreted with caution.

3. Data

The data I use for this investigation is from the Demographic and Health Survey (DHS) (Demographic and Health Surveys 2005). The DHS is a nationally representative (state representative for the case of India) household survey that subsumed the World Fertility Survey. Data are available online free of charge on request to the distributors (Macro International). The survey has been conducted over 76 developing countries since 1985, and there are repeated surveys in most of the countries. The data however are not a panel, but rather a repeated cross section. Following a particular family is not possible, and clusters change between each wave, but we can observe changes in the average behavior at the regional and country level.

To conduct the analysis for this project, I chose to focus on India, Pakistan and Turkey. These three countries satisfied two key criteria for selection: they each had a natural disaster that in terms of the number of people killed were in the global top 20 since 1990 (see Table 1) according to EM-DAT (Centre for Research on the Epidemiology of Disasters (CRED) 2008). Secondly, DHS data were available before and after the earthquakes in each country. In this investigation, the fertility response in addition to the response to mortality is of particular interest. Thus, for there to be a mortality response, high mortality natural disasters must be the focus. The reason for requiring data before and after the natural disaster is to conduct difference-in-difference estimation to observe changes in the average over time of people living in those regions affected by the disasters relative to those living in unaffected regions.

Data for India are taken from the 1998 (International Institute for Population Sciences (IIPS) and ORC Macro 2000) and 2005 (International Institute for Population Sciences (IIPS) and Macro International 2007) surveys, and the earthquake occurred in Gujarat 2001. Data for Pakistan are taken from the 1990 and 2006 surveys, and the earthquake occurred the North West Frontier in 2005. Data for Turkey are taken from the 1998 and 2003 (Hacettepe University Institute of Population Studies 2003) surveys, and the earthquake occurred in Izmit in 1999.

As the data for each of the countries are not a panel, we cannot observe changes in behavior at the household level and rely on changes in the regional average over time. There are a number of issues that come about because of this, each of which ameliorates the effect of the earthquake on the observed behavioral response. The response to the earthquake may not be limited to those who were directly affected by it, and thus there are spillovers into the control groups (regions other than those affected by the earthquake). If there is a response in the control group, then in the difference-in-difference estimation the change in fertility over time in the treatment group compared to the control group may appear to be smaller than what it actually is in response to the earthquake. The second issue that arises from not having a household panel survey is that out-migration following the earthquake may induce a selection bias: those household with preferences for large families before the earthquake remain in the treatment area and those with smaller families have the capability to move away from the affected region. This then means that when the post earthquake data are observed the regional average family size for the affected area is larger as the smaller families moved away from the treatment area. To control for this in a robustness check, the sample is limited to respondents who have never moved. The third issue to recognize is the dampening effects emergency foreign aid may have on a household's behavioral response. While this is a welcome response for those people affected by the disaster, it distorts household decisions that may include a fertility response.

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4. Identification

For this investigation, to observe changes in fertility preferences following the event of exposure to a large-scale natural disaster a difference-in-difference estimation technique is used. The change in the difference between treatment and control averages is identified using this strategy. With adequate control variables, we can attribute any change in the difference between treatment and control groups to the shock (that is, the earthquakes) experienced by the treatment groups.

As the dataset was not generated for the specific purpose of analyzing the fertility response to the earthquakes[3] other variables must be controlled for to isolate other factors that may have changed differentially between the treatment and control groups over time. In addition to controlling for these variables (education of the mother and father, age at first birth, age of the mother, urban/rural place of residence, number of children who have died), a robustness check is also conducted. These controls are interacted with the difference-in-difference dummy variables to see if there is a placebo response and differences in fertility may be generated by differences in another variable (e.g. education of the mother) that is different over time across the treatment and control group.

4.1 Equation for Estimation

From equation (8), the number of children born is a function of income, assets, the number of children who survived from the previous period, and a contemporaneous residual. An exogenous shock, that is the event of an earthquake, will reduce income, assets and the number of children and increase the number of children born after the earthquake as illustrated in (9), (10), and (11).

To analyze the effect of the shock on the number of children born, consider the difference-in-difference approach where the difference across time between the treatment and control groups is compared.

[3] Indeed, if the earthquake is a random unanticipated shock conducting a purpose built survey would imply that this assumption is violated as the location and timing of the earthquake would be known to the survey designers.

$$N_{irt} = \beta_1 post_t + \beta_2 near_r + \beta_3 post_t * near_r + X'\beta + \varepsilon_{irt} \quad (12)$$

Where N_{irt} is the number of children woman *i* in region *r* has ever had at time *t*. The difference-in-difference dummies are $post_t$ which is equal to one in the time period after the earthquake and is equal to zero before the earthquake. The value of the dummy variable is common across all women and regions within a time period. The dummy variable labeled $near_r$ is equal to one if the region was affected by the earthquake (Gujarat for India, North West Frontier (North) for Pakistan, and Izmit (West) for Turkey) and zero otherwise. The value of this dummy is common across time. The interaction term, $post_t * near_r$ hosts the coefficient of interest, and informs us of any difference between the treatment and control groups in the number of children born that is attributable to the earthquake.

The vector of controls is taken from equation (8). Changes in income, assets the number of children who survived from the first period are control variables derived from the model. One of the objectives of this paper is to isolate the fertility response following a natural disaster from the mortality response, thus, the key control variable is the number of children of mother *i* who have died. The coefficient on this variable should be positive and significant, consistent with replacement effects (Schultz 1997). Income and assets are proxied for using education of the husband. There are other socio-economic factors that we may expect to affect the number of children a woman has. Women who have attained higher levels of education may have fewer children as the opportunity cost of having an extra child may be higher if she is earning a skilled wage in the workforce (other reasons as well such as a greater understanding of reproductive health if she has access and the capability to read information, moreover if she is educated she may value her children's education and thus employ the quality/quantity tradeoff with fewer more highly educated children). Living in an urban area, may imply fewer children ever born as space may be limited and childcare more difficult compared to a rural setting where the work (on the farm) and childcare duties can be conducted jointly. In addition to these socio-economic variables, demographic variables such as the age of the mother and the mother's age at first birth are controlled for.

In conducting a difference-in-difference estimation, we may be concerned that other factors may change differentially between the treatment and control groups over time. In which case, it would be these other factors driving the results of interest, and not the exogenous shock of the earthquake. To control for this, the difference-in-difference dummies are interacted with the control variables that vary across time to test whether these variables vary differential in treatment and control area. In this case, the following equation is estimated,

$$\begin{aligned} N_{irt} &= \beta_1 post_t + \beta_2 near_r + \beta_3 post_t * near_r + X'\beta \\ &+ \beta_{10} post_t * x_{irt} + \beta_{11} near_r * x_{irt} + \beta_{12} post_t * near_r * x_{irt} + \varepsilon_{irt} \end{aligned} \quad (13)$$

The x_{irt} is either the number of children born, education of the mother, age of the mother, age at first birth, urban, or the education of the father. If coefficient β_{12} is significant, then this implies that that particular variable changes differentially between the treatment and control groups over time, and this would contaminate the estimated coefficient of β_3 in equation (12).

The a list of control variables, including regional fixed effects, can never be definitive, and thus the risk of omitted variables means that the difference-in-difference parameter is picking up another factor that changed differentially between treatment and control groups over the same period. To rule out this possibility, a further test is conducted. The core regression in equation (12) is run for a randomly selected group of regions (one region per country) to be the treatment groups and the remainder to be the control groups.

4.2 Results

In Table 2 the pre-shock summary by treatment status statistics are presented. In the total sample across the three countries, we see that before each country's respective earthquake, the average age of the respondent was 31 years. The average number of children who died per woman is 0.36 on average, but with the stratification by urban/rural we see that the number of children who died per woman is 0.42 in rural areas and 0.24 in urban areas. The average number of years of education of the women surveyed is 3.9 years. In rural areas it is lower at 2.6 years on average and in urban areas it is 6.2 years. The education of the husband is higher than that of the women on average, with 6.4 years as the total average, and 5.3 years in rural areas and 8.5 years in urban areas. The age at first birth is 19.3 years on average.

The pre-shock summary statistics for each of the countries is reported in Table 2. For many of the variables there is a significant difference between the treatment and control groups. These variables are controlled for in the regression analysis, and thus differences in variables in the pre-disaster period (and any subsequent difference in the changes over time) are accounted for. Variation in the pre-shock summary statistics may raise doubt with regard to what the difference-in-difference dummies are picking up. Changes in education, age at first birth, or other time varying factors that may change differentially between the treatment and control groups may contaminate the effect of the earthquake on the number of children born. To check this concern, in Table 5 time variant variables are interacted with the difference-in-difference dummy variables. Further discussion on this is to follow, but the results indicate that there were no differential changes in education, age, age at first birth, father's education and urban living, between the treatment and control groups. Thus while the treatment and control groups many differ over some of the control variables in the pre-shock period (as shown in Table 2), these socio-economic and demographic factors do not change differentially over the treatment and control groups over time.

In Table 3 the difference-in-difference reduced form estimation results of the impact of the earthquake on the number of children ever born are presented. In the first set of reduced form regressions (the total sample), the results indicate that the average number of children born to a woman has declined over time in both the treatment and control groups. However, in the total sample, we see that the decline in the number of children is greater in the control group than in the treatment group.

The positive difference-in-difference coefficient in the reduced form regression analysis in Table 3 implies that some factor (potentially the earthquake, but without sufficient controls we cannot yet make this assertion) has had a positive effect on fertility so that the difference between the treatment and control has widened over time.

In Table 4a and Table 4b the main regression results are presented. Regional fixed effects are controlled for in each of the regressions. Observing the coefficient on 'post' the regression results indicate that the number of children ever born has declined between the two periods. With the full controls in column (8) of Table 4a we see that the total number of children born is higher in the treatment group. In column (8), we also see that even after controlling for other explanatory variables, the event of the earthquakes in the three countries has had a positive effect on the average total number of children in the treatment group compared to the control group (coefficient on post*near is 0.08). If we feel confident that sufficient controls have been included in the regression analysis, and we can attribute any remaining change in the number of children born to the event of the earthquake, then the coefficient of 0.08 indicates that the earthquakes had a positive and significant effect on the number of children ever born, albeit it a modest marginal effect. Viewing across columns in Table 4, we see that the introduction of each control lowers the marginal effect on the post*near variable.

The controls are all highly significant. The number of children who have died has a positive effect on the number of children born consistent with replacement theory. In column (8) with full controls, we see that this marginal effect of 0.8 implies that replacement is slightly less than one for one. The age of the mother has a positive effect on the number of children ever born, with a coefficient of around 0.1 this indicates that over a 30 year fertile life (age 15-45) a woman would have 3 children if age were the only factor influencing fertility. The number of years of schooling of the mother has a negative effect on the number of children ever born. Fewer children are born in urban areas. The coefficient on father's education is negative. If father's education adequately proxies household income, then the decline in income leading to an increase in fertility is consistent with the theory.

In this investigation, one of the key insights is to isolate a fertility response to the earthquake that is additional to a mortality effect. Thus, to ensure that the mortality response does not change differentially over the treatment and control groups, the number of children who have died is interacted with the difference-in-difference variables. In column (8) with the full set of controls we see that the marginal effect of number of children who have died is not different across the treatment and control groups over time.

In Table 4b, column (8) from Table 4a is presented again to serve as a point of reference. In columns (9), (11) and (12), the results for the individual countries are presented. From column (9) we see that in India there was no differential fertility response in Gujarat relative to the rest of India following the earthquake in Gujarat. In Pakistan (column (11)) and in Turkey (column (12)), however, we see that there was a positive fertility response following the event of the earthquake in addition to the response to child mortality. For both countries, the response to child mortality is close to one (0.77 children for every child who died in Pakistan, and one for one in Turkey) and that in the treatment areas there was a positive fertility response in addition to the mortality response of around 0.2 children.

In the whole sample (column (8)) we may be concerned that the differential fertility response is driven by migration effects. For example, following a disaster, it may be that individuals with smaller families have a higher propensity to move away from the affected region than larger families. Quite simply, smaller families take up less space, and friends and relatives in other parts of the country are more easily able to assist a smaller family than a larger one. To overcome this issue using the DHS, I utilize information on the length of time the respondent has been living in the same village or city. With a sample of individuals who have always lived in the same village or city, I run the same analysis as that in column (8). As data on length of stay in the same village or city does not exist for Pakistan, the analysis is conducted for India (column (10)) and Turkey (column (13)). This restriction of the sample, however, is not a perfect control for migration. Individuals who moved as a result of the earthquake are excluded from the sample. The benefit of this sample restriction however, is that we are comparing like with like across treatment and control and within this sub-sample migration is not an issue.

Taking Turkey as the example, column (13), we see that for the sample of individuals who have always lived in the same place, there is a positive fertility response in addition to the fertility response to mortality. The coefficient measuring this response, post*near, is larger for the sample that has never moved than for the whole sample (0.214 in column (12) for the whole sample, compared to 0.293 in column (13) for the sample who have never moved).

In Table 4a and Table 4b the potential for differential effects of the number of children who have died over the treatment and control groups over time were ruled out (insignificance of post*near*dead in columns (7) and (8). The same concern may exist for other control variables. In Table 5 time variant variables are interacted with the difference-in-difference dummy variables. We see that for each of the control variables interacted with the difference-in-difference dummy variables that none of the variables change differentially between the treatment and control groups over time.

In the difference-in-difference estimation, the regions that are affected by the three earthquakes are assigned as the treatment groups, and other regions are control groups. After taking into account various control variables, education of the mother and father and age at first birth for example, differences in the number of children born between the two regions is attributed to the incidence of the earthquake. The incidence of the earthquake in the treatment areas is unique to those treatment regions, and the resultant fertility response exhibited as a result of being exposed to the earthquake should be unique. If, for example, the treatment region is randomly assigned to any region (other than the true treatment region) then we should not observe a differential fertility response in that region relative to the remaining regions. In Figure 1, the t-statistics of the post*near variable are given for all the regressions with every possible combination of “treatment” regions. In 19 percent of the regressions, the co-efficient on post*near is statistically significant at the 5 percent level. Thus with 81 percent confidence, the regression analysis reported in Table 4a and Table 4b, can be attributed to the incidence of the earthquakes in Gujarat, North West Frontier and Izmit.

5. Discussion and Conclusion

In this paper I have explored the hypothesis that there is a positive fertility response to exposure to natural disasters in addition to the child mortality response. Children can be used to smooth consumption over time. Once children have grown they can work to supplement the income of the main breadwinner, they can provide care to siblings, and when older they can make intergenerational transfers to their elderly parents and provide them with care. The event of an earthquake can make individuals exposed to the disaster realize the vulnerability of their life-cycle outcomes, and they can elect to increase their family size as a mechanism to smooth consumption over time. If indeed this is the reason for the increase in children, then the parents are not myopic in their decision making. The children must mature and reach an age (around seven) when they can be relied on to provide for the family unit in some way.

The results found in this paper, that is the increase in fertility following a negative shock to income, assets and child survival, are consistent with other studies of exogenous shocks (Rosenzweig 1988; Rogers, John and Coleman 2005), but inconsistent with others Pörtner (2008). The role of children as an insurance mechanism in an environment subject to risk and uncertainty over income and consumption is well explored as discussed above. The use of children to smooth consumption following an exogenous negative shock is consistent with this insurance literature – only that the decision to have children is *ex post* rather than *ex ante*.

In this paper, I found the fertility response to exposure to natural disasters to be positive and significant. This response is additional to the response to child mortality – the well known replacement effect. In the data, we observe a positive response to child mortality just under a one-for-one replacement, and in areas affected by the earthquake there is an additional positive fertility response. If we are convinced that there are adequate controls in the regression analysis with regional fixed effects and other socio-economic and demographic variables influencing the number of children born to a woman, then the results suggest that exposure to an earthquake does induce a positive fertility response over and above the mortality response.

Using data that is not purposefully built for the question at hand will always introduce irregularities into the analysis. The timing of the response is an issue that I have not been able to properly reconcile. Each of the three disasters occur within a different lead and lag to the before and after surveys. While discounting the years following the disaster may be one approach, the degree of discounting is unknown and thus has been excluded. The second issue that cannot be properly dealt with in this data set is that of migration. In the robustness checks the sample is restricted to people who have never moved, but this does not capture individuals who moved as a result of the disaster.

The rise in fertility following exposure to a natural disaster found in this paper, coupled with results found by Baez and Santos (2007), which indicates that childhood outcomes over education, nutrition, and child labor worsen, implies that there will be more children under relatively worse conditions following the event of the disaster. With lower investments in children following a disaster, this may weaken the capability of using children as an insurance mechanism over the long run. With lower education attainment following the disaster (Baez and Santos 2007), for example, the children will grow up to earn a lower wage. Thus their income earning capabilities will be lower, and if the children were had with the idea of supporting the family or supplementing the main breadwinner then the probability of achieving this goal is lower. The results imply that helping communities subject to natural disasters to gain access to alternative forms of insurance could have positive implications for childhood outcomes.

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Appendix 1: Tables

Table 1: Top 20 Natural Disasters since 1990 by number of people killed.

Start Date	End Date	Country	Type of Disater	Number Killed	Total Affected	Estimated Damage, US$ milllion
26/12/2004	26/12/2004	Indonesia	Wave / Surge	165,708	532,898	4,452
29/04/1991	10/5/1991	Bangladesh	Wind Storm	138,866	15,438,849	1,780
8/10/2005	**8/10/2005**	**Pakistan**	**Earthquake**	**73,338**	**5,128,000**	**5,200**
21/06/1990	21/06/1990	Iran Islam Rep	Earthquake	40,000	710,000	8,000
26/12/2004	26/12/2004	Sri Lanka	Wave / Surge	35,399	1,019,306	1,317
15/12/1999	20/12/1999	Venezuela	Flood	30,000	483,635	3,160
26/12/2003	26/12/2003	Iran Islam Rep	Earthquake	26,796	267,628	500
16/07/2003	15/08/2003	Italy	Extreme Temperature	20,089		4,400
26/01/2001	**26/01/2001**	**India**	**Earthquake**	**20,005**	**6,321,812**	**2,623**
1/8/2003	20/08/2003	France	Extreme Temperature	19,490		4,400
17/08/1999	**17/08/1999**	**Turkey**	**Earthquake**	**17,127**	**1,358,953**	**20,000**
26/12/2004	26/12/2004	India	Wave / Surge	16,389	654,512	1,023
1/8/2003	11/8/2003	Spain	Extreme Temperature	15,090		880
25/10/1998	8/11/1998	Honduras	Wind Storm	14,600	2,112,000	3,794
28/10/1999	30/10/1999	India	Wind Storm	9,843	12,628,312	2,500
29/09/1993	29/09/1993	India	Earthquake	9,748	30,000	280
00/08/2003	00/08/2003	Germany	Extreme Temperature	9,355		1,650
26/12/2004	26/12/2004	Thailand	Wave / Surge	8,345	67,007	1,000
18/08/1991	18/08/1991	Peru	Epidemic	8,000		
6/5/1991	6/5/1991	Nigeria	Epidemic	7,289	10,000	

Source: EM-DAT, http://www.emdat.be/

Table 2: Pre-shock summary statistics by treatment status

	Total				Rural				Urban			
	Total	Treatment	Control	Difference	Total	Treatment	Control	Difference	Total	Treatment	Control	Difference
Age	31.180	31.284	31.172	0.112	30.728	31.024	30.710	0.313	32.013	31.535	32.069	-0.534***
	0.027	0.103	0.028	0.104	0.034	0.146	0.035	0.148	0.045	0.145	0.047	0.146
	105,490	7,680	97,810		68,349	3,773	64,576		37,141	3,907	33,234	
Dead	0.360	0.318	0.363	-0.044***	0.422	0.382	0.424	-0.0420***	0.245	0.257	0.243	0.013
	0.003	0.008	0.003	0.010	0.003	0.013	0.003	0.015	0.003	0.011	0.004	0.011
	105,490	7,680	97,810		68,349	3,773	64,576		37,141	3,907	33,234	
Education	3.904	4.327	3.871	0.456***	2.633	2.762	2.625	0.136**	6.243	5.838	6.290	-0.453***
	0.014	0.053	0.015	0.055	0.015	0.062	0.015	0.064	0.026	0.079	0.028	0.086
	105,450	7,679	97,771		68,327	3,772	64,555		37,123	3,907	33,216	
Husband's education	6.397	6.497	6.389	0.108*	5.297	5.151	5.305	-0.153*	8.484	7.876	8.551	-0.675***
	0.016	0.058	0.016	0.062	0.018	0.076	0.019	0.081	0.027	0.083	0.028	0.089
	102,797	7,125	95,672		67,318	3,605	63,713		35,479	3,520	31,959	
Urban	0.352	0.509	0.340	0.169***								
	0.001	0.006	0.002	0.006								
	105,490	7,680	97,810									
Age at first birth	19.323	19.903	19.280	0.624***	18.841	19.391	18.809	0.581***	20.227	20.435	20.204	0.230***
	0.012	0.046	0.012	0.047	0.014	0.062	0.014	0.061	0.022	0.067	0.023	0.073
	92,355	6,373	85,982		60,243	3,243	57,000		32,112	3,130	28,982	

	India				India Rural				India Urban			
	Total	Treatment	Control	Difference	Total	Treatment	Control	Difference	Total	Treatment	Control	Difference
Age	31.364	31.957	31.338	0.619***	30.806	31.268	30.790	0.479**	32.602	32.866	32.585	0.281
	0.029	0.141	0.030	0.144	0.035	0.188	0.036	0.192	0.050	0.211	0.052	0.213
	90,303	3,845	86,458		62,248	2,188	60,060		28,055	1,657	26,398	
Dead	0.365	0.355	0.366	-0.011	0.425	0.423	0.425	-0.002	0.232	0.264	0.230	0.034**
	0.003	0.012	0.003	0.013	0.004	0.017	0.004	0.019	0.004	0.016	0.004	0.016
	90,303	3,845	86,458		62,248	2,188	60,060		28,055	1,657	26,398	
Education	3.896	4.461	3.871	0.590***	2.657	2.839	2.650	0.189**	6.647	6.602	6.650	-0.048
	0.016	0.080	0.016	0.077	0.015	0.086	0.016	0.084	0.031	0.129	0.032	0.131
	90,265	3,844	86,421		62,228	2,187	60,041		28,037	1,657	26,380	
Husband's education	6.478	6.945	6.457	0.488***	5.394	5.506	5.390	0.115	8.884	8.847	8.886	-0.039
	0.017	0.081	0.017	0.084	0.019	0.098	0.019	0.103	0.030	0.121	0.031	0.126
	90,086	3,843	86,243		62,117	2,187	59,930		27,969	1,656	26,313	
Urban	0.311	0.431	0.305	0.126***								
	0.002	0.008	0.002	0.008								
	90,303	3,845	86,458									
Age at first birth	19.205	19.436	19.195	0.241***	18.741	18.803	18.738	0.065	20.223	20.278	20.220	0.057
	0.013	0.055	0.013	0.062	0.014	0.069	0.014	0.076	0.024	0.086	0.025	0.103
	80,872	3,443	77,429		55,560	1,966	53,594		25,312	1,477	23,835	

continued…

Table 2 continued…

	Pakistan				Pakistan Rural				Pakistan Urban			
	Total	Treatment	Control	Difference	Total	Treatment	Control	Difference	Total	Treatment	Control	Difference
Age	31.270	31.250	31.276	-0.026	30.906	30.690	30.992	-0.302	31.616	31.936	31.526	0.410
	0.103	0.211	0.119	0.238	0.151	0.287	0.178	0.336	0.141	0.310	0.159	0.340
	6,611	1,665	4,946		3,227	916	2,311		3,384	749	2,635	
Dead	0.480	0.453	0.489	-0.036	0.505	0.442	0.530	-0.088**	0.457	0.467	0.454	0.014
	0.012	0.023	0.014	0.028	0.018	0.031	0.022	0.040	0.017	0.033	0.019	0.040
	6,611	1,665	4,946		3,227	916	2,311		3,384	749	2,635	
Education	1.807	1.213	2.007	-0.794***	0.518	0.456	0.542	-0.086	3.036	2.139	3.291	-1.152***
	0.045	0.076	0.054	0.103	0.032	0.059	0.038	0.071	0.077	0.147	0.088	0.183
	6,609	1,665	4,944		3,225	916	2,309		3,384	749	2,635	
Husband's education	4.745	4.785	4.732	0.053	3.167	3.827	2.904	0.923***	6.256	5.962	6.339	-0.377*
	0.063	0.128	0.073	0.146	0.075	0.157	0.084	0.166	0.094	0.203	0.106	0.226
	6,576	1,659	4,917		3,216	915	2,301		3,360	744	2,616	
Urban	0.512	0.450	0.533	-0.083***								
	0.006	0.012	0.007	0.014								
	6,611	1,665	4,946									
Age at first birth	19.897	19.910	19.892	0.017	19.952	19.964	19.947	0.017	19.845	19.845	19.845	0.000
	0.054	0.113	0.062	0.126	0.080	0.152	0.094	0.178	0.074	0.169	0.082	0.179
	5,905	1,472	4,433		2,845	800	2,045		3,060	672	2,388	

	Turkey				Turkey Rural				Turkey Urban			
	Total	Treatment	Control	Difference	Total	Treatment	Control	Difference	Total	Treatment	Control	Difference
Age	29.175	30.117	28.855	1.262	28.822	30.682	28.258	2.424***	29.352	29.865	29.169	0.697**
	0.105	0.207	0.121	1.262	0.186	0.380	0.211	0.437	0.127	0.246	0.148	0.287
	8,576	2,170	6,406		2,874	669	2,205		5,702	1,501	4,201	
Dead	0.207	0.151	0.226	-0.075***	0.260	0.166	0.288	-0.122***	0.181	0.144	0.194	-0.050***
	0.007	0.011	0.008	0.016	0.014	0.021	0.017	0.032	0.008	0.013	0.010	0.018
	8,576	2,170	6,406		2,874	669	2,205		5,702	1,501	4,201	
Education	5.601	6.478	5.303	1.175***	4.492	5.667	4.136	1.531***	6.159	6.840	5.916	0.924***
	0.043	0.081	0.050	0.098	0.059	0.115	0.067	0.138	0.056	0.104	0.066	0.126
	8,576	2,170	6,406		2,874	669	2,205		5,702	1,501	4,201	
Husband's education	6.977	7.187	6.902	0.285**	5.687	6.020	5.574	0.446***	7.594	7.711	7.551	0.160
	0.051	0.096	0.059	0.115	0.070	0.144	0.079	0.160	0.065	0.120	0.077	0.146
	6,135	1,623	4,512		1,985	503	1,482		4,150	1,120	3,030	
Urban	0.665	0.692	0.656	0.036***								
	0.005	0.010	0.006	0.012								
	8,576	2,170	6,406									
Age at first birth	20.423	21.001	20.219	0.783***	20.143	20.851	19.895	0.956***	20.561	21.074	20.378	0.696***
	0.051	0.099	0.059	0.116	0.086	0.159	0.101	0.195	0.063	0.125	0.073	0.144
	5,578	1,458	4,120		1,838	477	1,361		3,740	981	2,759	

Table 3: Difference-in-difference reduced form estimation of the impact of the earthquake on the number of children ever born

Total

	Before	After	Difference
Treatments	2.812	2.594	-0.218
	0.026	0.025	0.037
Controls	2.990	2.213	-0.777
	0.007	0.006	0.009
D at a point in time	-0.178	0.381	
	0.026	0.025	
D-D	0.560***		
	(0.036)		
Observations	247,973		

Rural

	Before	After	Difference
Treatments	3.078	2.918	-0.160
	0.039	0.041	0.056
Controls	3.130	2.440	-0.690
	0.009	0.009	0.012
D at a point in time	-0.052	0.478	
	0.038	0.039	
D-D	0.530***		
	(0.054)		
Observations	144,065		

Urban

	Before	After	Difference
Treatments	2.555	2.307	-0.247
	0.036	0.031	0.047
Controls	2.718	1.951	-0.767
	0.011	0.008	0.014
D at a point in time	-0.164	0.356	
	0.036	0.031	
D-D	0.520***		
	(0.047)		
Observations	103,908		

India

	Before	After	Difference
Treatments	2.859	2.111	-0.748
	0.031	0.031	0.044
Controls	2.983	2.063	-0.920
	0.007	0.006	0.009
D at a point in time	-0.124	0.048	
	0.035	0.034	
D-D	0.172***		
	(0.049)		
Observations	214,688		

India Rural

	Before	After	Difference
Treatments	3.057	2.308	-0.750
	0.043	0.043	0.061
Controls	3.122	2.296	-0.826
	0.009	0.009	0.012
D at a point in time	-0.064	0.012	
	0.048	0.048	
D-D	0.0765		
	(0.068)		
Observations	129,672		

India Urban

	Before	After	Difference
Treatments	2.597	1.847	-0.750
	0.043	0.042	0.060
Controls	2.667	1.789	-0.878
	0.011	0.008	0.014
D at a point in time	-0.070	0.059	
	0.047	0.047	
D-D	0.128*		
	(0.066)		
Observations	85,016		

Pakistan

	Before	After	Difference
Treatments	4.150	4.090	-0.059
	0.073	0.069	0.100
Controls	4.137	3.852	-0.285
	0.042	0.032	0.052
D at a point in time	0.013	0.239	
	0.084	0.074	
D-D	0.226**		
	(0.11)		
Observations	16,634		

Pakistan Rural

	Before	After	Difference
Treatments	4.009	4.160	0.152
	0.100	0.085	0.131
Controls	4.056	3.930	-0.126
	0.062	0.042	0.075
D at a point in time	-0.048	0.230	
	0.116	0.095	
D-D	0.278*		
	(0.15)		
Observations	9,420		

Pakistan Urban

	Before	After	Difference
Treatments	4.322	3.952	-0.370
	0.107	0.116	0.158
Controls	4.207	3.730	-0.477
	0.057	0.047	0.073
D at a point in time	0.115	0.222	
	0.121	0.118	
D-D	0.108		
	(0.17)		
Observations	7,214		

Turkey

	Before	After	Difference
Treatments	1.701	2.171	0.470
	0.038	0.032	0.049
Controls	2.201	3.026	0.825
	0.031	0.031	0.044
D at a point in time	-0.500	-0.855	
	0.057	0.053	
D-D	-0.355***		
	(0.078)		
Observations	16,651		

Turkey Rural

	Before	After	Difference
Treatments	1.871	2.256	0.384
	0.071	0.075	0.112
Controls	2.383	3.608	1.225
	0.058	0.066	0.088
D at a point in time	-0.511	-1.352	
	0.113	0.151	
D-D	-0.841***		
	(0.19)		
Observations	4,973		

Turkey Urban

	Before	After	Difference
Treatments	1.626	2.156	0.531
	0.044	0.035	0.055
Controls	2.105	2.771	0.665
	0.036	0.033	0.049
D at a point in time	-0.480	-0.615	
	0.065	0.053	
D-D	-0.135		
	(0.084)		
Observations	11,678		

Table 4a: Regression results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: Number of children ever born								
Post	-0.777***	-0.540***	-0.403***	-0.226***	-0.249***	-0.133***	-0.146***	-0.146***
	(0.017)	(0.012)	(0.014)	(0.011)	(0.0100)	(0.010)	(0.010)	(0.010)
Near	-0.178***	-0.103**	-0.134***	-0.0922***	-0.416***	1.659***	1.647***	1.674***
	(0.056)	(0.044)	(0.047)	(0.034)	(0.038)	(0.051)	(0.052)	(0.052)
Post * near	0.560***	0.468***	0.279***	0.165***	0.158***	0.0760**	0.0749**	0.0803**
	(0.076)	(0.061)	(0.063)	(0.046)	(0.033)	(0.035)	(0.035)	(0.035)
Number of children ever died		1.689***	1.290***	1.131***	1.088***	0.889***	0.873***	0.864***
		(0.0079)	(0.0070)	(0.0061)	(0.0058)	(0.0053)	(0.0070)	(0.0070)
Age of mother			0.118***	0.112***	0.115***	0.107***	0.107***	0.107***
			(0.00059)	(0.00055)	(0.00055)	(0.00067)	(0.00067)	(0.00067)
Number of years of schooling of the mother				-0.106***	-0.0896***	-0.0514***	-0.0513***	-0.0380***
				(0.00082)	(0.00081)	(0.00089)	(0.00088)	(0.00097)
Urban dummy					-0.0665***	-0.0865***	-0.0866***	-0.0731***
					(0.0098)	(0.011)	(0.011)	(0.011)
Age at first birth						-0.137***	-0.137***	-0.137***
						(0.0011)	(0.0011)	(0.0011)
Number of years of schooling of the father								-0.0200***
								(0.00090)
Post*number of children ever died							0.0345***	0.0341***
							(0.011)	(0.011)
Near*number of children ever died							0.0190	0.0187
							(0.031)	(0.031)
Post*near*number of children ever died							0.0125	0.00479
							(0.047)	(0.046)
Regional fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Countries within sample	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey
Observations	247,973	247,973	247,973	247,921	247,921	193,076	193,076	191,910
R-squared	0.03	0.32	0.54	0.59	0.61	0.59	0.59	0.59

Notes:
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Post is the year after the earthquake; near is the region in which the earthquake occurred.
Clusters are unique across countries and within countries across years.
Regions are unique within a country and consistent across time within a country.
Regional fixed effects are controlled for in each regression.
Clusting of the standard errors at the cluster level.

Table 4b: Regression results

	(8)	(9)	(10)	(11)	(12)	(13)
Sample	India, Pakistan, Turkey	India	India, Never Moved	Pakistan	Turkey	Turkey, Never Moved
Dependent variable: Number of children ever born						
Post	-0.146***	-0.0510***	-0.142***	-0.232***	-0.184***	-0.232***
	(0.010)	(0.013)	(0.024)	(0.043)	(0.042)	(0.059)
Near	1.674***	1.033***	0.234***	2.142***	2.410***	-0.589***
	(0.052)	(0.052)	(0.081)	(0.093)	(0.085)	(0.094)
Post * near	0.0803**	-0.0920	0.0221	0.184**	0.214***	0.293***
	(0.035)	(0.057)	(0.12)	(0.082)	(0.061)	(0.10)
Number of children ever died	0.864***	0.908***	0.872***	0.777***	1.078***	1.085***
	(0.0070)	(0.0075)	(0.023)	(0.027)	(0.041)	(0.072)
Age of mother	0.107***	0.112***	0.0953***	0.209***	0.100***	0.105***
	(0.00067)	(0.00067)	(0.0014)	(0.0024)	(0.0024)	(0.0036)
Number of years of schooling of the mother	-0.0380***	-0.0487***	-0.0302***	-0.0422***	-0.0819***	-0.0794***
	(0.00097)	(0.0011)	(0.0023)	(0.0039)	(0.0040)	(0.0080)
Urban dummy	-0.0731***	-0.0563***	-0.0941***	-0.0384	-0.193***	-0.322***
	(0.011)	(0.014)	(0.024)	(0.035)	(0.043)	(0.059)
Age at first birth	-0.137***	-0.0771***	-0.124***	-0.226***	-0.129***	-0.122***
	(0.0011)	(0.0016)	(0.0023)	(0.0040)	(0.0037)	(0.0063)
Number of years of schooling of the father	-0.0200***	-0.0148***	-0.0164***	-0.0115***	-0.0375***	-0.0364***
	(0.00090)	(0.00098)	(0.0022)	(0.0032)	(0.0038)	(0.0069)
Post*number of children ever died	0.0341***	-0.0251**	-0.0172	-0.0365	0.181***	0.176*
	(0.011)	(0.012)	(0.029)	(0.036)	(0.059)	(0.10)
Near*number of children ever died	0.0187	-0.160***	-0.0357	0.0341	-0.0660	-0.329**
	(0.031)	(0.031)	(0.097)	(0.065)	(0.087)	(0.15)
Post*near*number of children ever died	0.00479	0.0709	-0.0326	-0.0333	-0.261**	0.00598
	(0.046)	(0.059)	(0.20)	(0.086)	(0.12)	(0.27)
Regional fixed effects	yes	yes	yes	yes	yes	yes
Countries within sample	India, Pakistan, Turkey	India	India	Pakistan	Turkey	Turkey
Observations	191,910	164,367	29,231	14,637	12,906	3,981
R-squared	0.59	0.88	0.53	0.90	0.89	0.65

Notes:
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Post is the year after the earthquake; near is the region in which the earthquake occurred.
Clusters are unique across countries and within countries across years.
Regions are unique within a country and consistent across time within a country.
Regional fixed effects are controlled for in each regression.
Clusting of the standard errors at the cluster level.

Table 5: Robustness check – differential trends between treatment and control

Interaction variable: x	(1) Number of children ever died	(2) Age of mother	(3) Number of years of schooling of the mother	(4) Urban dummy	(5) Age at first birth	(6) Number of years of schooling of the father
Dependent variable: Number of children ever born						
Post	-0.146***	0.338***	-0.112***	-0.0899***	-0.173***	-0.0829***
	(0.010)	(0.036)	(0.015)	(0.013)	(0.042)	(0.017)
Near	1.674***	1.712***	1.693***	1.665***	1.843***	1.717***
	(0.052)	(0.14)	(0.054)	(0.056)	(0.12)	(0.057)
Post * near	0.0803**	-0.203	0.111**	0.0794	0.136	0.109*
	(0.035)	(0.17)	(0.052)	(0.054)	(0.16)	(0.063)
Number of children ever died	0.864***	0.878***	0.881***	0.880***	0.880***	0.881***
	(0.0070)	(0.0053)	(0.0053)	(0.0053)	(0.0053)	(0.0053)
Age of mother	0.107***	0.115***	0.107***	0.107***	0.107***	0.107***
	(0.00067)	(0.00094)	(0.00067)	(0.00067)	(0.00067)	(0.00067)
Number of years of schooling of the mother	-0.0380***	-0.0386***	-0.0342***	-0.0381***	-0.0382***	-0.0380***
	(0.00097)	(0.00097)	(0.0013)	(0.00097)	(0.00097)	(0.00097)
Urban dummy	-0.0731***	-0.0731***	-0.0737***	-0.0132	-0.0731***	-0.0736***
	(0.011)	(0.011)	(0.011)	(0.016)	(0.011)	(0.011)
Age at first birth	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***
	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0015)	(0.0011)
Number of years of schooling of the father	-0.0200***	-0.0197***	-0.0201***	-0.0201***	-0.0200***	-0.0155***
	(0.00090)	(0.00090)	(0.00090)	(0.00090)	(0.00090)	(0.0012)
Post*x	0.0341***	-0.0144***	-0.00538***	-0.111***	0.00198	-0.00771***
	(0.011)	(0.0012)	(0.0017)	(0.020)	(0.0019)	(0.0016)
Near*x	0.0187	-0.000919	-0.0111**	0.00751	-0.00805	-0.00672
	(0.031)	(0.0041)	(0.0045)	(0.050)	(0.0055)	(0.0045)
Post*near*x	0.00479	0.00864	-0.00569	0.0234	-0.00271	-0.00375
	(0.046)	(0.0055)	(0.0061)	(0.070)	(0.0073)	(0.0062)
Regional fixed effects	yes	yes	yes	yes	yes	yes
Countries within sample	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey	India, Pakistan, Turkey
Observations	191910	191910	191910	191910	191910	191910
R-squared	0.59	0.59	0.59	0.59	0.59	0.59

Notes:
Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Post is the year after the earthquake; near is the region in which the earthquake occurred.
Clusters are unique across countries and within countries across years.
Regions are unique within a country and consistent across time within a country.
Regional fixed effects are controlled for in each regression.
Clusting of the standard errors at the cluster level.

Figure 1: Robustness check: Randomizing the placement of the earthquake – t-statistic on the D-D variable, post*near