Typhoons, child mortality, and excess fertility in a disaster-prone country

J.M. Ian Salas*

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Abstract

This paper assesses the extent by which environmental risk shapes fertility behavior in the Philippines, a developing country where typhoons are endemic and formal insurance is limited. Using pregnancy history data from the Demographic and Health Surveys (DHS), it finds that exposure to typhoons induces women to have more pregnancies after the disaster strikes, with a given woman's likelihood of getting pregnant more than tripling after five years. This positive fertility effect is concentrated in rural areas where agriculture is the primary means of livelihood, child labor is prevalent, and people continue working in old age to support their families. A fifth of the resulting pregnancies are lost to miscarriage or abortion, while a sixth die within the first year of life, most of whom are infant boys who are known to be biologically weaker. The bulk of the remaining excess fertility is traced to women who did not have any pregnancy or child loss after the calamity, and whose pregnancy occurred only after having observed the increased fertility and heightened child mortality experienced by members of their community. Estimates imply that women living in highly-agricultural rural areas are expected to have 2%

*David E. Bell Postdoctoral Research Fellow, Harvard Center for Population and Development Studies, 9 Bow St., Cambridge, Massachusetts. I thank Marianne Bitler, David Neumark, Manisha Shah, and conference participants at PacDev for helpful comments and suggestions. Comments welcome at salas@hsph.harvard.edu.

more surviving children on average when their community is directly hit by a typhoon. Census data confirm that these women end up with 3.4% higher completed fertility. These results are consistent with an insurance motive for having children that is salient in less-developed areas and amplified by knock-on child mortality and social network effects.

JEL classification: J13, Q54, Q56

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1 Introduction

It has long been considered that the riskiness of life may be a source of derived demand for children. This underlies the belief that relatively high fertility in rural areas of less developed countries may be due in part to the heightened mortality and variability of income that people living there face. In most of these places, agriculture is the primary means of livelihood, and the availability of mechanisms that can be used to insure against unfavorable events like crop loss is limited. In such an environment, children may be viewed as assets that supplement household income by providing labor services when young and transfers when older. Higher incidence of child mortality may also encourage couples to "hoard" children in anticipation that some would die.

This paper assesses whether this hypothesis is operative in a setting where weather disturbances are common and oftentimes destructive. It asks whether environmental conditions do shape fertility behavior, and in which specific contexts does it matter. In particular, it examines the impact of exposure to typhoons, the term for tropical cyclones in East Asian countries bordering the Pacific Ocean, on the likelihood of pregnancies in the Philippines up to five years after. In addition, it provides an account of related effects on pregnancy termination and child death that may negate or reinforce any effect on fertility.

The paper finds that an area's direct exposure to a typhoon increases the likelihood that a given woman living in that area will conceive three to five years after. This effect is concentrated in rural areas of highly-agricultural provinces, where child labor and continued employment in old age are both high. A fifth of the increase in pregnancies ends up in a miscarriage or abortion, while a sixth die soon after birth. The positive fertility effect is mainly coming from women who did not lose any child during or after the disaster. Since other work has shown that economic conditions in this country significantly worsen many years after a typhoon strikes, this positive fertility response might be driven by an updating of couples' target number of children given the perceived riskier environment.

This paper adds to the scant evidence on fertility responses to background risk. De Vany and Sanchez (1979) showed that the uncertainty of land tenure rights in Mexico brought about higher fertility. Cain (1981) compared villages in India and Bangladesh and argued that the higher levels of risk present in Bangladesh, coupled with the dearth of external sources of assistance and insurance, led to the emergence of much higher fertility in that area. Das Gupta (1995) documented that fertility decline in Punjab coincided with the expansion of irrigation in 1940 and the consequent improvement of both the level and variance of yields. These early papers championed the idea that evaluations of background risk are incorporated in fertility decisions, but a rigorous demonstration of this hypothesis has been lacking until now.

This paper fits in a broader economic literature that looks at demand-side determinants of childbearing, which typically involve relating changes in income, opportunity costs, and modern living standards to movements in fertility trends. The evidence presented in this paper points to the salience of environmental risk in shaping fertility behavior.

The remainder of the paper is organized as follows. In Section 2, I provide a brief background of related work linking natural disasters to fertility, and then discuss typhoons affecting the Philippines. In Section 3, I introduce the datasets I use and the empirical strategy that I employ. I discuss the findings in Section 4, and give concluding remarks in Section 5.

2 Background

2.1 Related work linking natural disasters to fertility

Studies have shown that global mean temperatures have been increasing and are expected to continue rising in the 21st century (IPCC, 2007). This has spurred a wave of research on the effects of climate change on various physical phenomena, which include heightened weather variability that manifests in more frequent and more severe hot days alongside extreme rainfall activity. In turn, these atmospheric changes have been linked to an increase in the intensity of tropical storms and cyclones, and consequently a swelling in their destructive potential (Emanuel, 2005; Knutson et al., 2010). Because of the increasing vulnerability of the population to these extreme weather disturbances, it is important to assess how it will affect various aspects of human well-being.

Recent work has looked at the consequences of weather-induced disasters and hazards on socioeconomic and demographic outcomes. Standard analyses have looked into direct measures of impact such as impaired economic growth, property damage, income losses, and deaths,[1] while there is also a burgeoning body of work that looks at adverse health outcomes.[2] However, there is still little evidence available on fertility effects of extreme weather phenomena. Given that children born after these events will likely face relatively challenging circumstances, one might expect households to reduce or postpone births in response to the calamity. Then again, in risky environments where formal insurance mechanisms are limited and children could supplement household income by working or taking care of younger siblings, disasters could potentially induce more births as a means to smooth consumption over the lifecycle.

Four recent papers have looked into the relationship between natural disasters and fertility, each using various approaches and arriving at different results. Finlay (2009), using difference-in-difference analyses on data from three high-mortality earthquakes from the last decade (involving

[1] See Cavallo and Noy (2010) for a survey; recent rigorous work include Hsiang and Narita (2011), Anttila-Hughes and Hsiang (2012), and Kudamatsu et al. (2011).

[2] These include tropical cyclones' impact on newborns' gestational age and birth weight (Currie and Rossin-Slater, 2012; Simeonova, 2011), children's anthropometric development (Portner, 2010), and infants' fetal distress (Zahran et al., 2010).

Pakistan, India, and Turkey), showed that these large-scale natural disasters induced a positive fertility response that went beyond a child mortality replacement effect. On the contrary, Lin (2010), using long-run historical data for both Italy and Japan's regions, found that natural disasters (earthquakes in Italy and tsunamis in Japan) were associated with reductions in fertility. Portner (2011) also found that hurricane exposure in Guatemala led to decreases in fertility. Meanwhile, Evans, et al. (2010) showed that in the Atlantic and Gulf Coast counties of the U.S., low-severity storm advisories were associated with increases in fertility, while high-severity storm advisories led to decreases in fertility.

These conflicting results underscore the context-specific nature of fertility responses to natural disasters. Negative fertility responses are usually associated with many risk-averse behaviors that follow the experience of a recent calamity (Cameron and Shah, 2012). Some households will actively try to delay births to more benign times. On the other hand, positive fertility responses are associated with replacement motives of lost children and family members, especially after large-scale natural disasters. It could also be related to a "hoarding" motive in response to the perceived likelihood of losing a child (Schultz, 1997). This is especially relevant in settings where child mortality is high, and where children are also valued for the child labor and old-age support that they may be able to provide.

2.2 Typhoons affecting the Philippines

The Philippines is located in an area of Southeast Asia that is subject to recurring typhoons of intense magnitude. An average of 19 typhoons enter its territory every year, about nine of which make landfall. It has been found to have the highest number of intensity-weighted tropical cyclone events per capita of any country in the world (Yang, 2008).

In terms of timing, the country is hit by typhoons most frequently in October to November followed by June to July, a schedule that is consistent with monsoon transition seasons affecting the region. Other months also get their share of typhoon strikes, albeit rarely in February.

The spatial risk of typhoon exposure in the Philippine territory follows a somewhat uniform gradient, where it is at its highest at the northeastern corner and it weakens uniformly while moving into the southern part of the country. However, as Figure 1 illustrates, there is no dominant pattern in the path that each typhoon takes, and its timing, location and intensity cannot be known well in advance.

A recent paper has utilized data generated from a scientific model of weather disturbances to look at mortality outcomes that can be attributed to destructive winds brought by tropical cyclones. Anttila-Hughes and Hsiang (2012) used the maximum wind speed inferred from typhoon wind fields generated from Hsiang's Limited Information Cyclone Reconstruction and Integration for Climate and Economics (LICRICE) model to investigate the direct and indirect economic and human losses that followed typhoons that hit the Philippines from 1979-2008. They find confirmatory household-level evidence that typhoons destroyed durable assets, depressed incomes, and reduced household expenditures in its wake and up to two years after; that this impact was linearly related to a typhoon's intensity; and that female infant mortality substantially increased in the years *after* typhoon exposure. This last result was argued to be a product of worsening economic conditions and a build up of competitive pressures with older siblings (especially brothers) when resources are strained.

It is noteworthy to mention that in areas where exposure to typhoons is common like in the Philippines, it is likely that the population has instituted adaptive responses that try to mitigate the impact of these weather disturbances. Hence, estimates of any effect that are to be obtained should be interpreted as net of any compensating behavior. This stands in sharp contrast to research designs that utilize one-time unanticipated shocks such as earthquakes and volcanic eruptions.

3 Data and empirical strategy

3.1 Typhoon exposure

In order to measure the extent by which typhoons could affect fertility, one first needs to identify episodes of typhoon exposure. I collected information on the path taken by each tropical storm's eye from 1945 to 2010, and its intensity at every turn, from the International Best Track Archive for Climate Stewardship (IBTrACS) database (version 03r06). Since these information on strength and location for each tropical storm are only available at 6-hour intervals, I linearly interpolated the gaps between intervals. I restricted attention to tropical storms in the Western Pacific basin which had maximum sustained winds of at least 64 knots during some part of its lifetime (64 knots is the threshold for designating a tropical storm as a typhoon).

I overlaid this information on the point location of each woman interviewed in the 1993, 1998, 2003, and 2008 Demographic and Health Surveys (DHS) for the Philippines. This geographic location was based on the coordinates of the polygon map centroid corresponding to each woman's province and city/municipality of residence.[3] For each typhoon, I calculated the nearest distance that its' moving eye came to hitting each point during its lifetime, and then classified it as being within 15, 15-30, 30-60, or 60-100 kilometers of a typhoon's eye path at that particular time.[4] I then collapsed this data on each point's exposure to a typhoon by quarter and the specified distance band. For computational simplicity, in cases where there were several typhoon exposures in a given quarter at different distance bands, I assumed that each point was most affected by the typhoon that got closest to it. In effect, I consider each point's nearest exposure to any typhoon each quarter.

A typical typhoon's eye has a radius of 10-20 kilometers (Weatherford and Gray, 1988), and it is known that the eye wall that surrounds a typhoon's eye carries the heaviest rain, strongest winds, and worst turbulence. It is thus expected that the areas directly hit by typhoons will be inflicted the worst damage, and consequently the strongest effect, if any, might appear in the nearest distance bands.

With data on typhoon exposure in hand, I now turn to a discussion of how it was linked to data

[3]Geographic coordinates of survey clusters are available in the 2003 and 2008 DHS, but to maintain uniformity across all four surveys I rely on geographic coordinates that I assign based on province and city/municipality information. The two geographic coordinates differ in that the survey-supplied geographic coordinates are specifically determined for each cluster, and particularly big cities or municipalities may have multiple survey clusters. This does not imply, however, that survey-supplied geographic coordinates are more precise; these coordinates are randomly displaced by up to 10 kilometers in order to protect respondent confidentiality.

[4]Currie and Rossin-Slater (2013) use a distance cutoff of 30 kilometers for typhoon exposure and assess the robustness of their results to using 25, 60, or 75 kilometers instead. I improve on their methodology by distinguishing the effects present in various distance bands up to 100 kilometers.

on conception from a sample of non-moving women in the pooled DHS.

3.2 Sample of non-moving women

Each woman in the pooled DHS sample gave retrospective information on her complete reproductive history. I use this information to construct a quarterly panel of her marital, conception, pregnancy, and pregnancy outcome status.

I also take advantage of information in the DHS on the number of years these women have lived in their latest residence, which is important because I want to assign typhoon exposure correctly based on each woman's city or municipality of current residence. Using this feature of the data, I restrict attention to the sample of women who has lived in their latest residence for the past 10 years and was 20 years old or above at the time of the survey.[5]

Column (2) in Table 1a looks at the characteristics of this sample of non-moving women at the time of the survey. These sample women are 34 years old on average. A third of them have not attended high school,[6] and 79% have been married or in a union. Forty-three percent of them have used modern contraception, with 9% currently ligated, while 45% have never used any form of contraception. Seventy-six percent of them have had a child, with 15% having experienced child death, and 28% having experienced either child death or pregnancy termination. The reported ideal family size is 3.3 on average, which is equivalent to the average number of pregnancies they've had. The average number of live births is 3.0 and the average number of child deaths is 0.2. Finally, a third of these sample women were living in an area classified as urban in 1990, and 30% were living in a province that was considered highly agricultural also in 1990.

I compare this sample of non-moving women to its complement in the full sample in column (3). Because fertility and residential movements have important age gradients, I controlled for age

[5]In the pooled DHS, 62% of women 20-49 years old reported living in their latest residence for the past 10 years. Using this sample of non-moving women is conservative given that women may have moved in the past 10 years but stayed within the same city or municipality, so that they are still suject to the same typhoon exposure. Indeed, data from the 1990 and 2000 Censuses show that around 85% of women 20-49 years old lived in the same city or municipality for the past 10 years.

[6]Note that this educational attainment cutoff is age-accessible even to the youngest women in the sample (a typical high school first-year student is 12 to 13 years old).

and survey fixed effects before making the comparison between the two groups. The data show that in this sample of moving women, 5% less have not attended high school and 7% more have been married or in a union. Four percent more of them have used modern contraception, although the same share have been ligated, while 6% less have never used any form of contraception. Four percent more of them have had a child, with 2% less having experienced child death, and the same share had experienced either child death or pregnancy termination. The reported ideal family size is lower by 0.2 on average, as is the average number of pregnancies and the average number of live births, while the average number of child deaths is lower by 0.02. Finally, 16% more of these moving women are currently living in an area classified as urban in 1990, and 4% less of them are currently living in a province that was considered highly agricultural in 1990.

Overall, these comparisons suggest that the sample of non-moving women that I use is possibly more disadvantaged than the full sample. Thus, one should be careful not to infer effects from the analyses that apply directly to the whole population.[7] From a public policy viewpoint, however, it is important to understand the experience of women who did not move elsewhere in response to exposure to a natural disaster, especially if that choice was not available to them because of their special circumstances.

I partition the sample of non-moving women further into three subsamples based on the woman's residence type in order to understand if different contexts bring about different responses to typhoon exposure. It is natural to separately consider women living in areas classified as urban [U] or rural in 1990, and it is useful to also consider whether the rural residents were located in provinces that were highly-agricultural [RA] or not [R]. As presented in Appendix Table A1, figures from the 1990 Census show that school attendance declines across all school-going age groups as we move from subsample U to R then to RA. A similar pattern is observed for average years of schooling, which extends to the population beyond school-going age. In terms of employment, across all age groups, a higher share of the population works in the RA subsample compared to the other two, and

[7] While I focus on the sample of non-moving women in all the analyses that follow, robustness checks using the full sample (with typhoon exposure assigned on the basis of city or municipality of residence at the time of the survey) produce results that are qualitatively similar, although the estimates seem to be biased towards zero. This attenuation is to be expected given that typhoon exposure is unavoidably measured with error for moving women.

I take note of high employment rates of 20% in the 10-14 age group, 36% in the 15-19 age group, 58% in the 60-64 age group, 51% in the 65-69 age group, and 40% in the 70 or above age group. By construction, most of these workers are engaged in the agricultural sector, but it is still striking to see that a large proportion of workers in each age group, mostly more than 60%, were working in agriculture. This underscores the vulnerability of the RA subsample to environmental shocks and disasters, and also the greater availability of labor market activities for children, teenagers, and seniors.

This pattern of disadvantage, where the RA subsample might be seen as faring worse than the R subsample, which in turn fares worse than the U subsample, is reflected in the sample of non-moving women. Columns (4) to (6) of Table 1a show that a greater share of women from the RA subsample have not attended high school. More of them have also been married or in a union, have had a child, have had a child death, and have had a child death or pregnancy termination. The average ideal family size is higher in the RA subsample, as is the average number of pregnancies, the average number of live births, and the average number of child deaths. In all these comparisons, the U subsample is at the other end of the ordering, while the R subsample is in-between the other two. Interestingly, the three subsamples don't differ in the share who've ever used modern contraception and the share who've never used any contraception, although a smaller share have had ligation in the RA subsample.

Summary statistics for the analysis sample are presented in Table 1b. In the five-year period before the survey, the average quarterly probability of conceiving was 3.1% for the sample of non-moving women, while the average quarterly probability of child death was 0.18% and the average quarterly probability of pregnancy termination was 0.32%.[8] These numbers were higher for the RA subsample at 3.7%, 0.28%, and 0.37%, respectively.

Using the sample of non-moving women allows me to safely merge information on typhoon exposure to each sample woman's residence location. In the ten-year period before the survey, the average quarterly exposure to a typhoon at the nearest distance band of 0-15 kilometers was

[8] Interestingly, the average quarterly probabilities for conception and pregnancy termination were higher for the sample of moving women than for the sample of non-moving women.

1.5% for the sample of non-moving women, while it was 1.3% for the nearest distance band of 15-30 kilometers, 2.0% for the nearest distance band of 30-60 kilometers, and 3.0% for the nearest distance band of 60-100 kilometers.[9] These numbers were a bit lower for the RA subsample at 0.9%, 1.0%, 1.8%, and 2.3%, respectively.

To get a better sense of how prevalent typhoon exposure was in the data, Appendix Table A2 shows how many cities and municipalities were present in the merged dataset, and how many areas were ever exposed to a typhoon in the past 10 years at the specified nearest distance. For the sample of non-moving women in the pooled DHS, 46% were ever hit by a typhoon at less than 15 kilometers, 15% were ever hit at 15-30 kilometers but not nearer, 9% were ever hit at 30-60 kilometers but not nearer, and 3% were ever hit at 60-100 kilometers but not nearer. The corresponding numbers for the RA subsample were at 40%, 13%, 6%, and 3%, respectively. These are quite high incidence levels at the area level that is not quite as apparent at the individual level in the quarterly probabilities of typhoon exposure shown in Table 1b.

3.3 Estimation

To ascertain the fertility response to typhoon exposure, I estimate the following linear probability regression:

$$P(Conceive)_{i\bar{j}t} = \alpha + \sum_{s=-8}^{20} \left(\sum_{k} \beta_{sk} Typhoon_{\bar{j},t-s,k} \right) + \phi_i + \tau_t + W_{it}' \psi + \varepsilon_{i\bar{j}t}, \quad (1)$$

where i indexes each woman, $\bar{j}$ refers to the woman's city or municipality of residence (where the overbar makes it clear that I observe these women in only one location, their latest residence), t indexes time incremented in quarters, and k is composed of four categories of nearest typhoon exposure: within 15, 15-30, 30-60, or 60-100 kilometers. The main outcome of interest is the

[9] There is no corresponding information on typhoon exposure for the sample of moving women precisely because their residential history is not known. What can be said about their location, though, is that if they lived in their latest residence for the past 10 years, they would have been more likely to be exposed to typhoons at 0-15 and 60-100 kilometers, and less likely to be exposed to typhoons at 30-60 kilometers, than the sample of non-moving women.

quarterly probability of conceiving,[10] and the main independent variable is typhoon exposure in the current quarter and up to 5 years behind. This distributed lag specification allows for dynamic adjustments in fertility response. I also include leads in typhoon exposure of up to 2 years to confirm that there are no underlying changes in pregnancy risk that predate the arrival of the typhoon.

Positive estimates of β_{sk} will imply that pregnancy risk responded positively to a typhoon exposure at distance band k that occurred s quarters ago. One could sum up the coefficients from β_{0k} to β_{sk} to obtain the cumulative effect of a typhoon exposure at distance band k after s quarters.

While information on historical typhoon paths and intensities are available, each typhoon's emergence and trajectory, with the associated timing, location and intensity, cannot be predicted exactly in advance, even by meteorological experts. Similar to research designs that utilize rainfall shocks, typhoon exposure is considered a random event and hence it is not expected to be related to the error term.

I control for age-related changes in pregnancy risk by including dummies for single-year age in the vector of time-varying woman characteristics W_{it}. I also include a dummy that turns on when a woman could not get pregnant, in particular when she is already pregnant.[11] In one assessment of the potential mechanism pathways for the results, I add an indicator variable that turns on when a woman has her first marriage or union, and another one for the time when she undergoes sterilization.

I rely on time fixed effects τ_t, composed of year fixed effects and quarter fixed effects, to sweep out annual and seasonal trends in pregnancy risk. Finally, I include woman fixed effects ϕ_i so that fixed characteristics of the woman that affect fertility and other life choices are accounted for.[12] In this case, estimation will focus on whether any given woman is more likely to conceive when she

[10]This information was derived from the following: (i) the reported duration and ending month of pregnancy terminations, (ii) the reported duration of current pregnancies, counting backwards from the interview month, and (iii) the reported month of live births and an assumed nine-month pregnancy period except in cases when a preceding birth or pregnancy termination shortens this pregnancy period to less than nine months. Imprecise imputed dates in (i) were dropped.

[11]Since a woman could conceive right after giving birth or a pregnancy termination (as was the case for several sample women), I exclude the quarter when a woman concludes her pregnancy in the infecund period.

[12]This is also tantamount to having area fixed effects since the individual woman fixed effects subsume the aggregate area fixed effects.

was exposed to a typhoon than when she was not. In other words, identification relies on random variations in typhoon exposure for each woman.

Appendix Table A3 provides information on the available identifying information in the sample used. Out of more than 27,000 women in the sample of non-moving women, 39% had been directly hit by a typhoon at least once in the past 10 years. A tenth of the sample had been directly hit more than once. The corresponding numbers for the more than 9,000 women in the RA subsample are 27% and 6%. There is also rich variation in the number of typhoon exposures at the other distance bands.

Since the identifying variation is at the city or municipality level, the standard errors were clustered at the same level in all of the analyses. Observations were weighted by the sampling weights for each woman in the DHS.

4 Results

I now present results from estimating equation 1 on the sample of non-moving women described in the previous section. To save space, I only present the cumulative impacts on pregnancy risk after zero, one, two, three, four, and five years of typhoon exposure in the tables, although all quarters in-between were estimated, as well as all leads up to 2 years. To aid in interpretation, each table is accompanied by a similarly-numbered figure that graphs the estimated cumulative effects over time.

The estimates for each distance band are shown in Table 2. We can see in column (1) and in Panel A of Figure 2 that when a certain area gets directly hit by a typhoon (<15 kilometers), the cumulative probability of conception for a given woman who lives in that area drifts significantly upward to a point estimate of .014 after a year, to .020 after two years, to .035 after three years, to .052 after four years, and to .061 after five years. This result suggests that from an average quarterly probability of conceiving of .031, the likelihood of a pregnancy goes up by twice this amount in five years' time after a close encounter with a typhoon.

In columns (2) to (4), and in Panels (B) to (D) of Figure 2, we can see that pregnancy risk hardly changed for areas that were not directly hit by a typhoon (nearest exposure of 15-30, 30-60, or 60-100 kilometers). There is perhaps a slight tendency for a lower cumulative probability of conception after being exposed to a typhoon at 60-100 kilometers, but this is small and statistically insignificant like the estimates for typhoon exposure at 15-30 and 30-60 kilometers.

Notice that the leads in each panel, shown as instantaneous effects, are small, centered around zero, and statistically insignificant. This is consistent with typhoon exposure being unpredictable.

The fact that significant cumulative effects show up only for areas which were directly hit by a typhoon strongly points to the presence of the typhoon's eye wall in the exposed areas at specific points in time as the reason for the estimated effects on pregnancy risk. In all the analyses that follows, I will focus on what happens when an area is directly hit by a typhoon, although one should keep in mind that typhoon activity in the other distance bands continue to be controlled for in all the regressions.

I now check whether this increase in pregnancy risk after typhoon exposure is broadly-shared across the three subsamples introduced in the previous section: urban areas [U], rural areas in less-agricultural provinces [R], and rural areas in more-agricultural provinces [RA]. I find in Table 3 and Figure 3 that the cumulative effects are strong in the RA subsample, with effects that kick in more than a year after typhoon exposure and reach a statistically-significant cumulative probability of conception of .097 five years after. There is hardly any fertility response in the R subsample. While there is a slight increase in the cumulative probability for the U subsample, it doesn't attain statistical significance. Thus, it appears that much of the fertility response emanates from the RA subsample. In the succeeding analyses, I investigate further the dynamics behind this fertility response in the RA subsample.

To what extent do these results reflect replacement effects of children lost due to typhoon exposure? I now turn to checking if typhoon exposure affects the probability of a pregnancy termination or the death of a child. I implement regressions similar to equation 1, where only the dependent variable is changed, and the already-pregnant dummy is replaced by either a currently-pregnant dummy (when looking at the probability of pregnancy termination) or a set of dummies for parity (when looking at the probability of child death). Before looking at the results, note first that the probability of these events are quite small, so that the estimation will most likely suffer from low power.

In Panel A of Figure 4, I find an immediate increase in the probability of miscarriage, stillbirth, or abotion in the quarter after typhoon exposure, and this increases anew after a year until it reaches statistical significance around two years after typhoon exposure. The cumulative probability continues to drift upward after this time, but bigger standard errors render these estimates insignificant. On the other hand, In Panel B of Figure 4, I find that the cumulative probability of child death picks up three quarters after typhoon exposure, then inches up again after seven quarters. It continues to go up afterwards until it reaches its highest point at four years after the typhoon struck, where it barely attains statistical significance. When child death is differentiated by child's gender, I find that this effect is largely driven by male child deaths, as can be seen in Table 4 and Panel D of Figure 4.

Ninety percent of these deaths came from children who died in their first year of life, with even half of them dying in the first month of life.[13] For pregnancy terminations, three-quarters of these pregnancies were lost in the first trimester of pregnancy. Because male fetuses are known to be biologically weaker than female fetuses, the strong pattern of cumulative effects for male infant deaths and pregnancy terminations (for what might be male fetuses) raises the possibility that a biological mechanism was behind these losses. This could arise from stress due to the deterioration in economic conditions that occurs after being directly hit by a typhoon. This is consistent with the substantial reduction in durable assets, income, and expenditures that families experience in the years following typhoon exposure (Anttila-Hughes and Hsiang, 2012).

The elevated likelihood of child mortality could be interacting with the increase in fertility, and so I proceeded to investigate how the probability of conceiving differed across groups of women with different child mortality[14] experiences. In Table 5 and Figure 5, I split the RA subsample into four groups: those which had no pregnancy termination or child death, those which had a

[13]It is possible that most of these deaths were associated with pre-term births. Data on gestation is not available in the DHS.

[14]I use child mortality to refer to both pregnancy terminations and child deaths.

pregnancy termination or child death more than 10 years ago (beyond the period I monitor for typhoon exposure), those which had a pregnancy termination in the past 10 years, and those which had a child death in the past 10 years.[15] Because of the smaller sample sizes, the estimation will most likely suffer from loss of power, although one should keep in mind that statistical significance has been demonstrated in the aggregate subsample.

The motivation to replace a terminated pregnancy or lost child will naturally be found only among women in the two groups who've had a recent child mortality experience. There are indeed strong positive cumulative effects on the probability of conceiving after typhoon exposure for these two groups, but a positive effect was also found for the two other groups. In particular, the cumulative probability of conceiving picks up for women with no child mortality experience three years after typhoon exposure (Panel A of Figure 5), while it picks up for women with prior child mortality experience about four years after typhoon exposure (Panel B of Figure 5).

Before this, women with no child mortality experience are slightly less likely to get pregnant. On the other hand, women with prior child mortality experience seem to have an increased chance of getting pregnant in the first year after typhoon exposure. This cumulative probability tapers down to zero in the second year, and briefly goes up in the third year before going back to zero again. There is an indication that this cyclical pattern has stopped with the increase around the fourth year. It is possible that the earlier positive responses were due to these women's heightened sensitivity to shocks, especially because they get reminded about their prior child mortality experience, and the reversals that followed were corrections for not experiencing any pregnancy loss or child death this time around. At any rate, these two groups of women end up with an elevated likelihood of getting pregnant five years after typhoon exposure that are about twice their respective average quarterly probabilities of conception, although the large standard errors render these cumulative effects insignificant.

For women with pregnancy termination in the last 10 years, the cumulative probability of conceiving starts increasing in the third quarter after typhoon exposure, plateaus during the third

[15] There is an overlap of 169 women between the last two groups.

year, and inches up again around the fourth year (Panel C of Figure 5). On the other hand, for women with child death in the last 10 years, the cumulative pregnancy risk starts going up after the first year, and it continues to increase until the fourth year, attaining statistical significance along the way (Panel D of Figure 5). Even though the average quarterly probability of conception is comparatively higher for these two groups (columns (4) and (5) in Table 5), the cumulative effects are strong enough to reach a level after five years that is more than thrice the average, with statistically-significant cumulative impacts for women with recent child death experience.

These results show that the strongest fertility responses in the RA subsample are coming from women with child mortality experience, but it is not yet clear whether this strong fertility response is in fact due to a replacement motive for children. To answer this question, I re-defined the dependent variable so that it distinguishes between conceptions that happened with a history of pregnancy termination or child death in the last five years versus those that happened without such history. The results of this exercise are shown in Table 6 and Figure 6. I find that contrary to expectations, exposure to a typhoon *does not* lead to higher pregnancy risk among those who've had a recent history of child mortality (this history might include pregnancy terminations and child deaths which were induced by the typhoon itself). Instead, I find that typhoon exposure leads to sustained higher pregnancy risk among those who've not had a recent history of pregnancy termination or child death (but who might end up having one afterwards by virtue of membership in this group). These cumulative effects are highly statistically significant.

One chain of causation that these findings support goes from typhoon exposure to increased likelihood of conceiving, then to increased likelihood of pregnancy termination or child death. This is not to say that pregnancy termination or child death did not influence the likelihood of pregnancy directly; what the findings demonstrate is that the *typhoon-induced* increase in pregnancy risk did not seem to pass through the channel of having had a pregnancy termination or child death beforehand (replacement effect), but that some of the typhoon-induced pregnancies may *eventually* be lost or die soon after birth.

While the increase in pregnancy risk for the two groups which did not have recent child mortality experience can be readily treated as constituting excess fertility, an accounting needs to be made for the last two groups to see how the cumulative increase in pregnancy termination or child death stacks up against the cumulative increase in conception. In Table 7, I re-estimate the quarterly probability of pregnancy termination or child death, earlier used in Table 4, for these two groups, and place the estimates alongside the results for the quarterly probability of conception featured in Table 5. After adjusting for differences in timing in Figure 7, i.e. the cumulative probability of pregnancy termination should be shifted leftward by about a quarter, while the cumulative probability of child death should be shifted leftward by about two to three quarters, it appears that there is quite some surplus of pregnancies not ending in termination or child death on average.

It is interesting to note that the late timing of the cumulative increase in pregnancy risk for women with no child mortality experience (it picks up only after three years) suggests that this group could be reacting to the heightened pregnancy risk and child mortality that it observed among its neighbors in the previous years. This is important to note considering that the bulk of the subsample is in this group. This kind of reaction is consistent with a "community rebuilding" motive for having children, much like what Nobles, Frankenberg, and Thomas (2014) found in Indonesia after the 2004 Indian Ocean tsunami.

In order to get a sense of the magnitude of the cumulative effects for the RA subsample, it is useful to conduct a back-of-the-envelope calculation of the excess fertility that is implied by these estimates. Looking at the cumulative effects five years after being directly hit by a typhoon, the .097 increase in the conception rate for the RA subsample could be roughly allocated among the four groups as follows: .042 for the group with no child mortality experience (.06 effect $\times$ .7 share of the sample), .005 for the group with no recent child mortality experience (.05 effect $\times$ .1 share of the sample), .03 for the group with recent pregnancy termination (.3 effect $\times$ .1 share of the sample), and .02 for the group with recent child death (.2 effect $\times$ .1 share of the sample). To get the excess fertility figure, .02 should be shaved off for pregnancy termination (.2 effect $\times$ .1 share of the sample), and .015 for child death (.15 effect $\times$ .1 share of the sample). Thus, the net increase in fertility is .062 (.097 - .035).

From Table 1a, the average quarterly probability of conception in the RA subsample is .037, but when the average quarterly probability of pregnancy termination (.0037) and average quarterly probability of child death (.0028) are both taken into account, the net average quarterly increase in fertility is .0305. The average quarterly probability of typhoon exposure at <15 kilometers is about .01 or 1 in 100 quarters (equivalently 1 in 25 years). This implies that in rural areas of provinces that are highly agricultural, direct exposure to typhoons leads to 2.6% more conceptions (.00097/.037), 5.4% more pregnancy terminations (.0002/.0037), 5.4% more child deaths (.00015/.0028), and consequently 2.0% excess fertility (.00062/.0305) on average.

I explore differences in cumulative impact by parity, age, education, and typhoon intensity in Tables 8a to 8c and Figure 8 for the RA subsample. I found that women who've had no children before hardly changed their fertility behavior after typhoon exposure, while those who've already had one child had the biggest increase in the cumulative probability of conceiving after being exposed to a typhoon. In stark contrast, those who've already had two children, the modal desired number of children in the sample, had reduced likelihood of getting pregnant soon after typhoon exposure, which was seen for only one other group: those who've already had six children. Women of other parities also had increased likelihood of getting pregnant after being exposed to a typhoon.

Looking now at differences by age at the time of survey, I found that women 20-24 years old were significantly less likely to get pregnant in the first two years after typhoon exposure, although this goes back to zero afterwards. This suggests that they are actively trying to postpone a pregnancy right after being exposed to a typhoon. Women 25-29 years old also exhibit the same pattern to a lesser extent, with the added difference that their cumulative probability of conceiving starts to take off two years after typhoon exposure. Women 30-34 and 40-44 years old have rising probabilities of conceiving after typhoon exposure, unlike women 35-39 years old who seem to have hardly any response to typhoon exposure. Women 45-49 years old have progressively increasing likelihood of getting pregnant right after typhoon exposure, which might be related to an upward adjustment in their desired number of children after being exposed to a typhoon.

When I stratify the sample by whether the woman attended high school or not, I find that the positive cumulative effects are higher for those who've attended high school. This suggests that the results are not strongly mediated by educational status, and that the underlying mechanisms do not involve a straightforward difference in behavior along lines of poverty or disadvantage. In addition, when I consider differences of impact by typhoon intensity (Category 2 and above versus Category 1), I find that the fertility response is weaker for more intense typhoons that directly hit a city or municipality. This suggests that the results are not driven merely by typhoon intensity, or that the effects are possibly nonlinear in typhoon intensity such that experiencing more destructive typhoons weakens the motivation to increase fertility.

I also explored the extent by which the results in the RA subsample are driven in part by changes in marital and ligation decisions. Panel A of Appendix Figure A1 shows that there is perhaps a slightly lower likelihood of getting married or getting involved in a union after typhoon exposure, while Panel B shows that there is a higher likelihood for women to get ligated after typhoon exposure. Although both effects are not statistically significant, the results suggest that the positive fertility response that we've seen were not mechanical by-products of an increased likelihood of pairing up after the disaster, or of a reduced capability to conceive due to sterilization. Indeed, Panel C illustrates that incorporating dummies for these decisions would result in a slight increase in the cumulative probability of conceiving after typhoon exposure.

Finally, I examined whether another dataset could provide confirmation of the effects I've found in the DHS. I used the 10% Sample of the 1990 Census[16] to look at the relationship between the mean number of typhoons per year a woman was exposed to since age 14 and the number of children she reported ever giving birth to. In order to safely assign typhoon exposure, I once again relied on the sample of non-moving women for this analysis, this time according to her place of birth, and I collapsed the data at the city or municipality level. For other pertinent details, the reader is invited to consult the notes to Table 9a.

The regression results by subsample and women's age group are presented in Table 9a. Column (1) shows that there is no statistically significant relationship between mean typhoon exposure

[16]This is the only census which asked information on an individual's residence at birth, and a woman's number of children ever born and number of surviving children.

and the number of children ever born in the full sample. When one looks at the three subsamples in columns (2) to (4), however, one would find a positive and significant relationship in the RA subsample which is consistently present in all age groups. There was no consistent pattern of relationships in the other subsamples. Table 9b does the same analysis but looks at the number of children who have died instead. It is reassuring that the same pattern of results holds here.

Figure 9 illustrates the estimated relationships for the number of children ever born by women 45-49 years old, which is an accepted proxy for completed fertility. The estimates imply that in rural areas located in highly-agricultural provinces, close exposure to typhoons over time leads to 3.9% more births (2.36 effect $\times$ .088/5.27), 10.8% more child deaths (0.49 effect $\times$ .088/.4), and thus 3.4% excess fertility (1.87 effect $\times$ .088/4.87) on average.

5 Concluding remarks

The evidence I have presented supports the view that environmental risk is an important determinant of fertility behavior. Exposure to natural disasters, typhoons in particular, seem to shape risk attitudes and may lead some people to revise their demand for children one way or another. In the Philippines, where these weather disturbances are endemic and where formal insurance mechanisms are limited, it appears that typhoons induce women to consider having more children after being exposed to it.

This positive fertility effect is concentrated in rural areas where agriculture is the primary means of livelihood, child labor is prevalent, and people continue working in old age to support their families. It does not seem to be directly tied to the replacement of children or pregnancies lost because of the calamity—most of the effect comes from women who did not have any child mortality experience themselves. The delayed fertility response of these women seems to be a reaction to the increased rates of pregnancy and child mortality that they observed among other members of their community.

These results are consistent with an insurance motive for having children that is salient in less-developed areas and amplified by knock-on child mortality and social network effects. More research needs to be undertaken to fully investigate the mechanism pathways behind these results.

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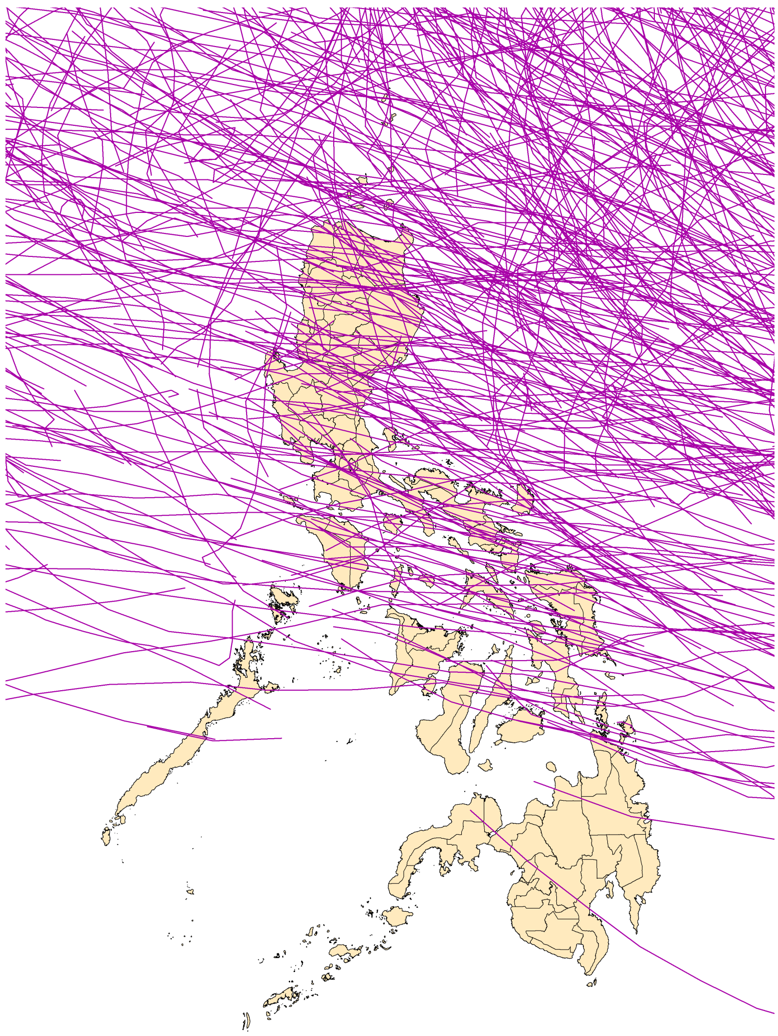
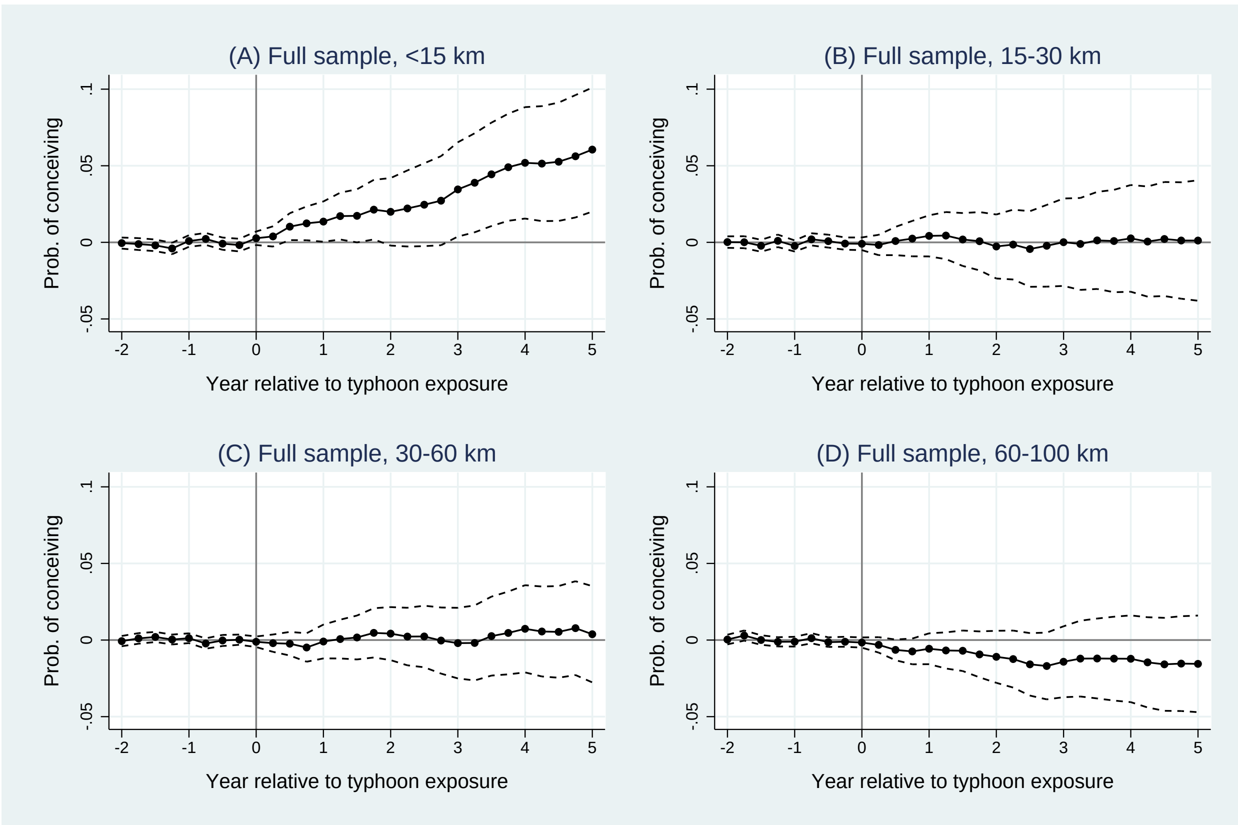
Figure 1: Typhoon tracks through the Philippines from 1958 to 2008



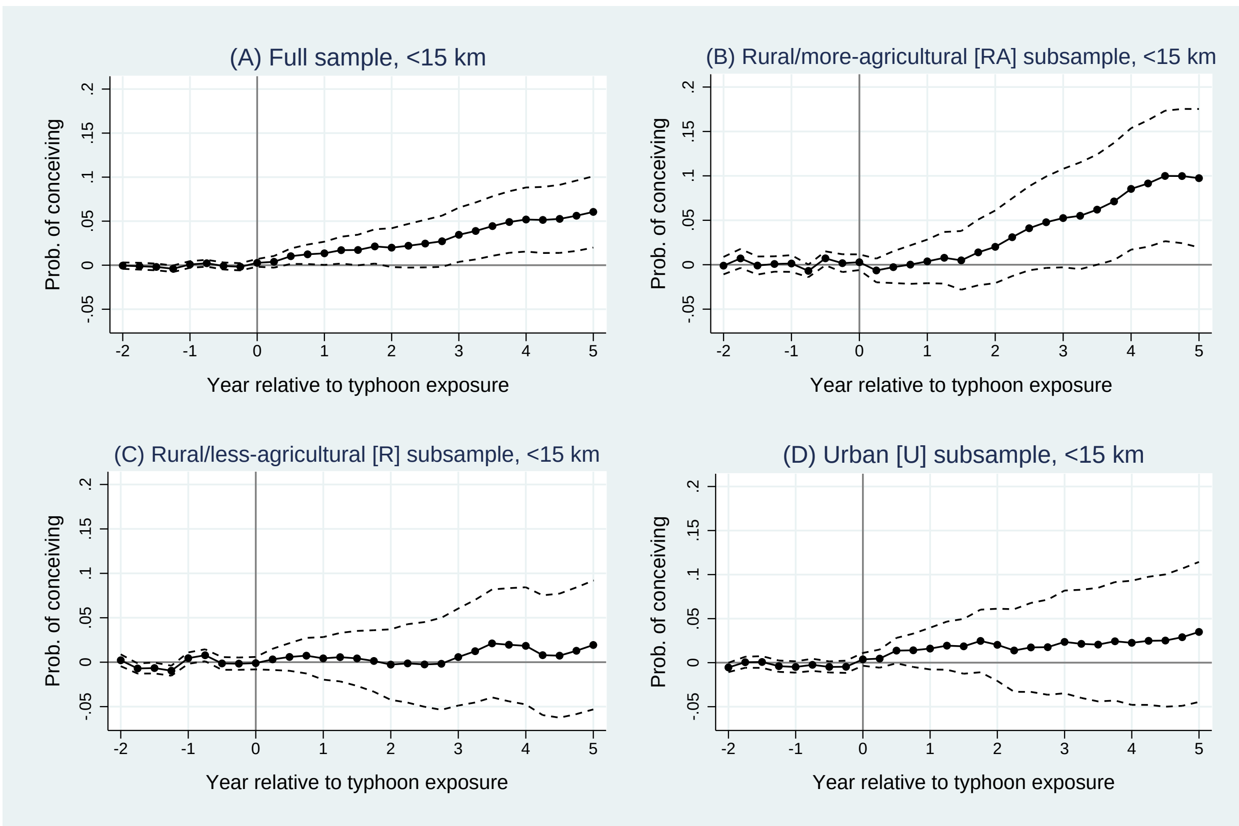
Note: The graph shows the portion of tropical storm tracks that have maximum sustained winds of 64 knots and above, which classifies the storm as a typhoon.

Figure 2: Cumulative impact of typhoon exposure on fertility, full sample



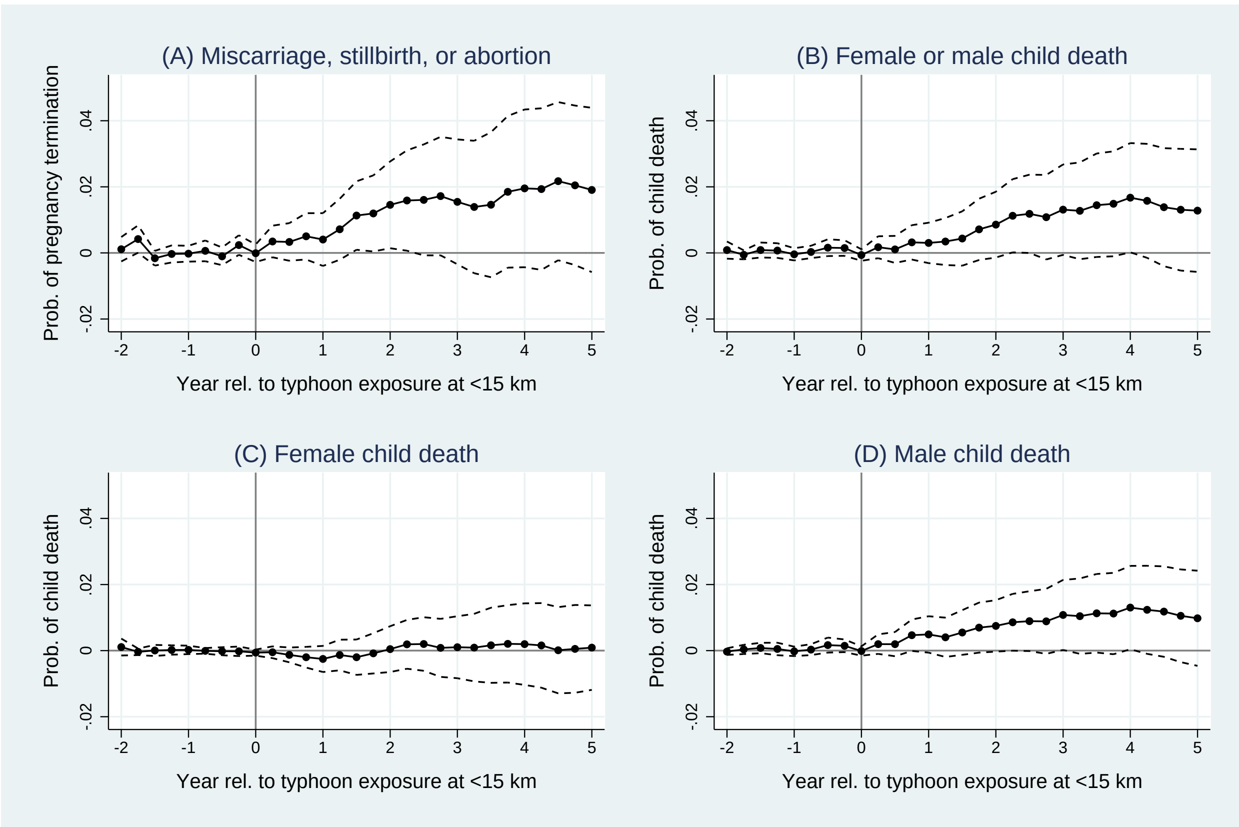
Notes: This figure accompanies Table 2. The graphs show the cumulative probability of conceiving in the periods after typhoon exposure, and the instantaneous probability of conceiving in the periods before typhoon exposure. Typhoon exposure was defined as the presence of a typhoon's eye in the vicinity of a city or municipality in a given quarter, and it was classified according to how close the typhoon approached the city or municipality. The dashed lines show 90% confidence intervals.

Figure 3: Cumulative impact of typhoon exposure on fertility, by subsample



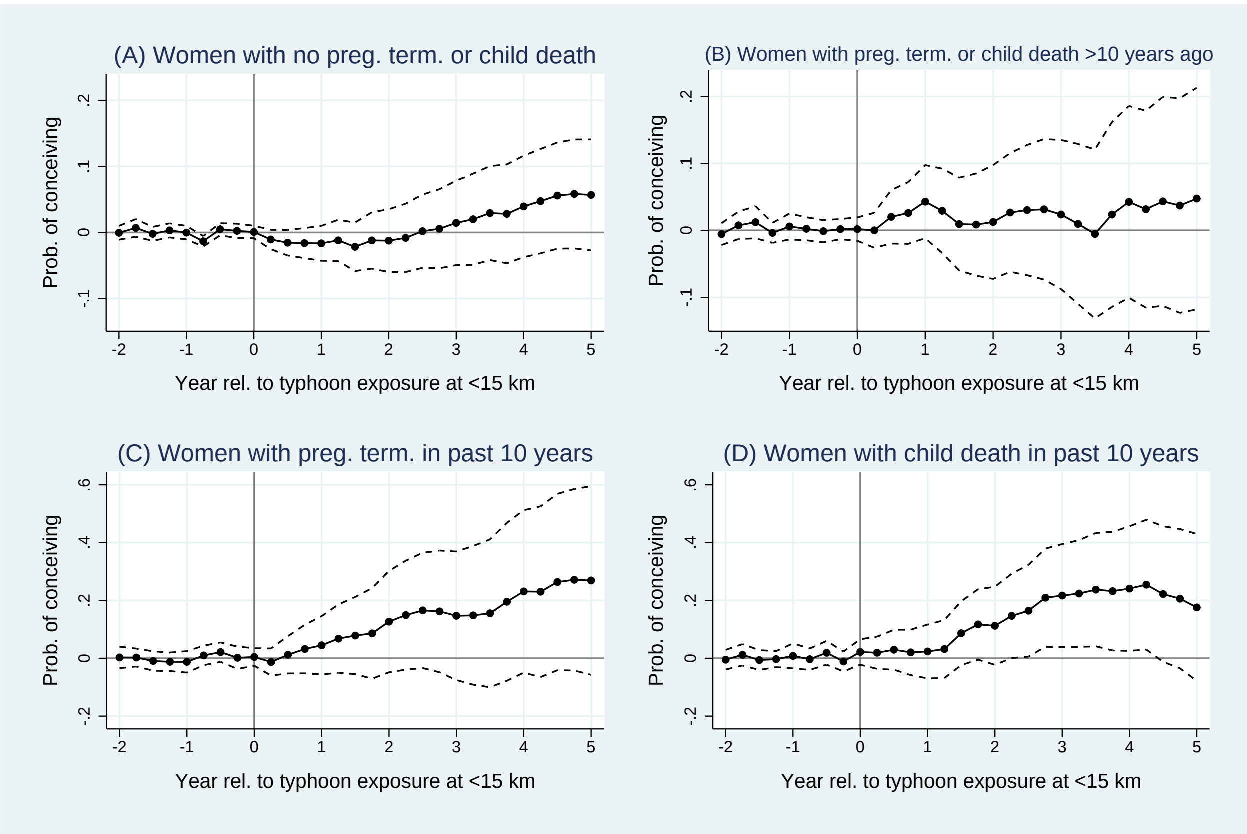
Notes: This figure accompanies Table 3. The graphs show the cumulative probability of conceiving in the periods after typhoon exposure, and the instantaneous probability of conceiving in the periods before typhoon exposure. A city or municipality was considered urban if the majority of its *barangays* (villages) were classified as urban in the 1990 Census, and the province it belonged to was considered highly agricultural if the share of its working-age population (15-59 years old) which reported working in agriculture was above the median (the median was 25%). The dashed lines show 90% confidence intervals.

Figure 4: Cumulative impact of typhoon exposure on child mortality, RA subsample



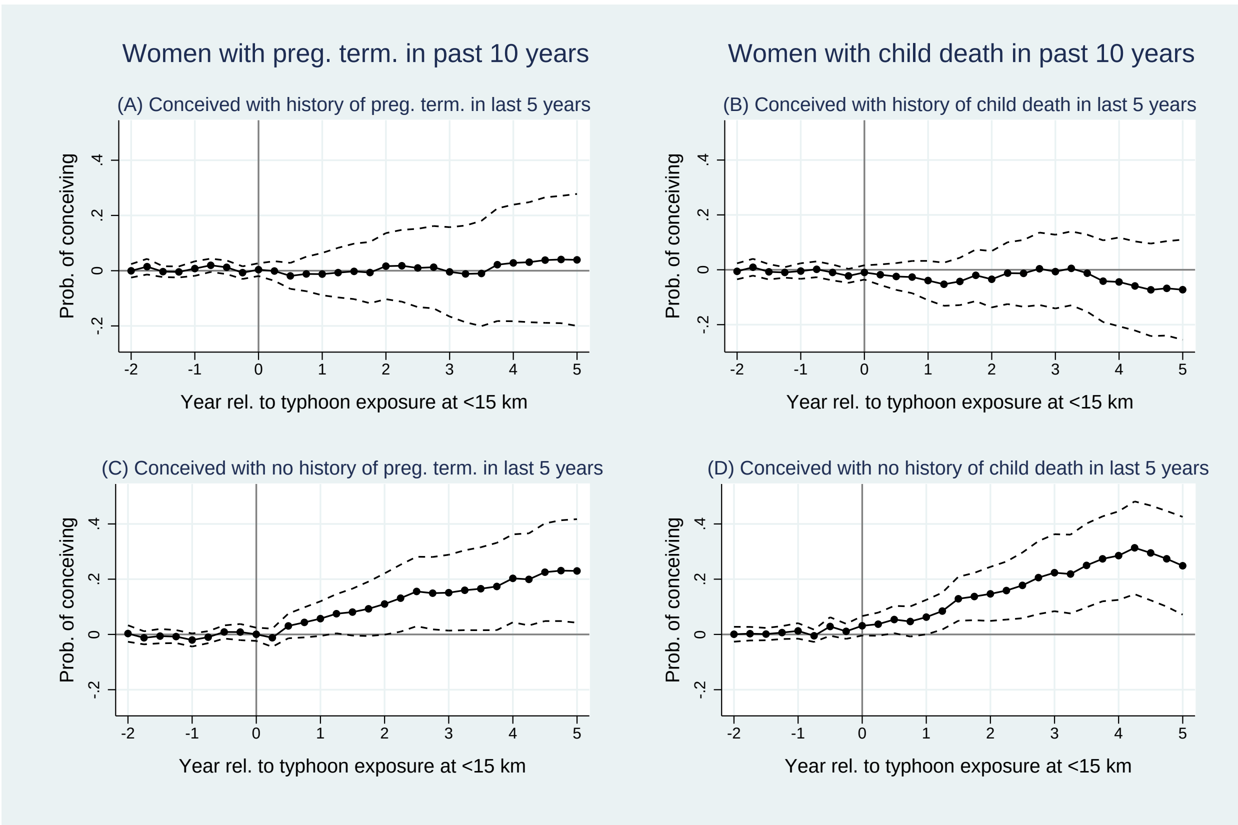
Notes: This figure accompanies Table 4. The graphs show the cumulative probability of pregnancy termination or child death in the periods after typhoon exposure, and the instantaneous probability of pregnancy termination or child death in the periods before typhoon exposure. The dashed lines show 90% confidence intervals.

Figure 5: Cumulative impact of typhoon exposure on fertility by child mortality experience, RA subsample



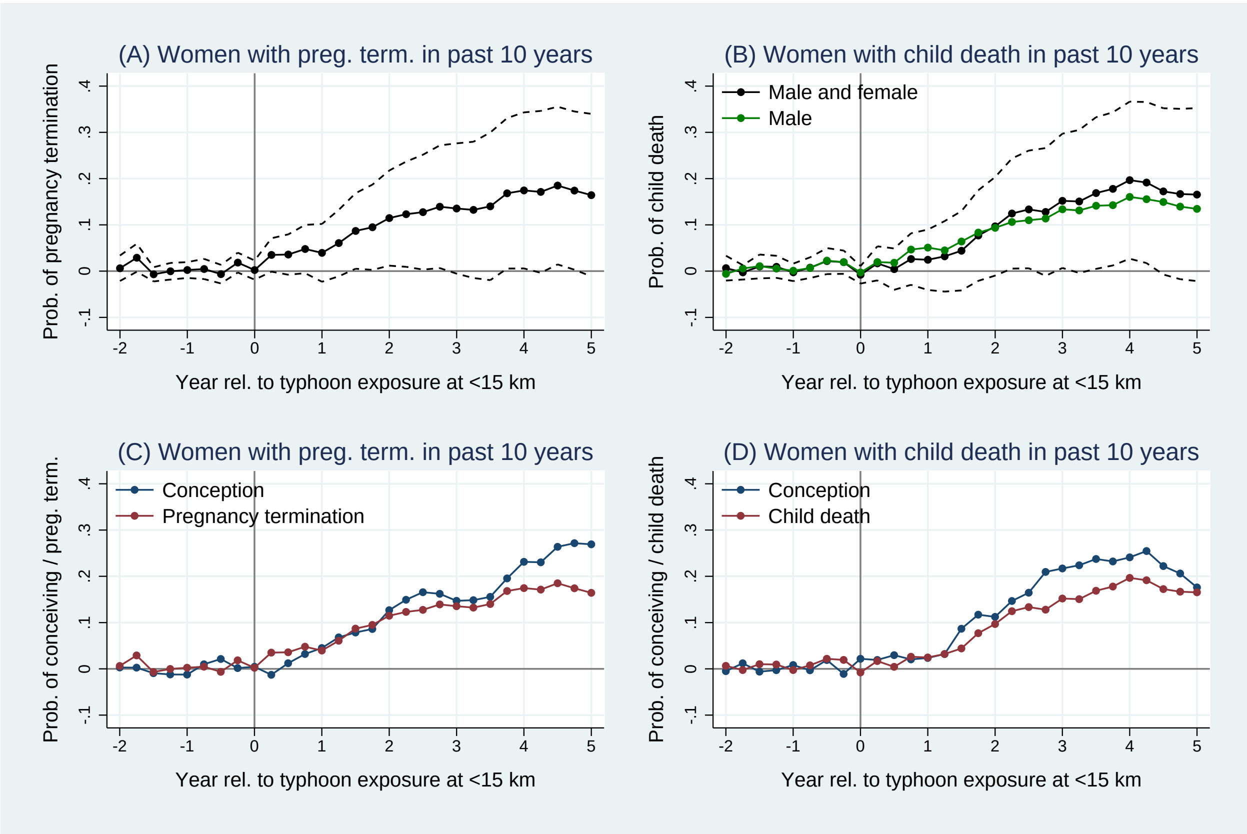
Notes: This figure accompanies Table 5. The graphs show the cumulative probability of conceiving in the periods after typhoon exposure, and the instantaneous probability of conceiving in the periods before typhoon exposure. The dashed lines show 90% confidence intervals.

Figure 6: Cumulative impact of typhoon exposure on fertility by timing of child mortality, RA subsample



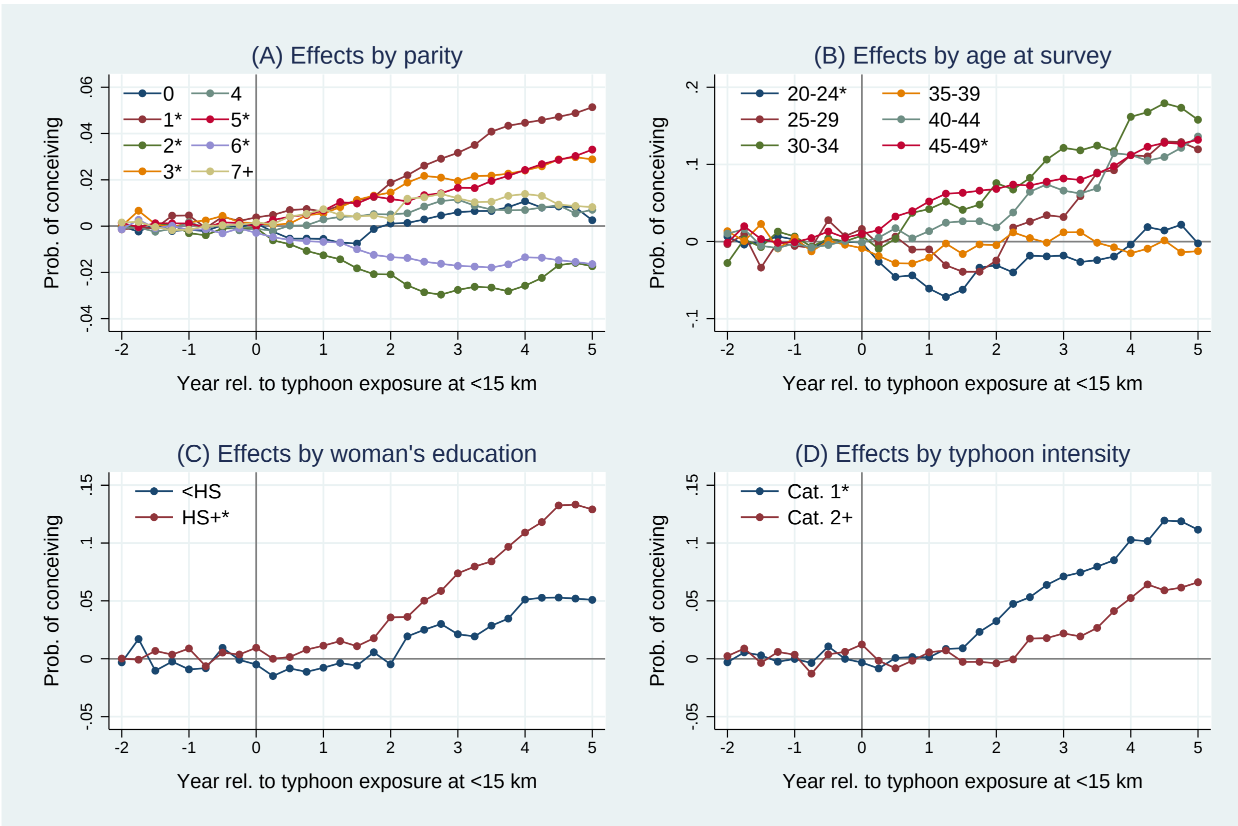
Notes: This figure accompanies Table 6. The graphs show the cumulative probability of conceiving in the periods after typhoon exposure, and the instantaneous probability of conceiving in the periods before typhoon exposure. The dashed lines show 90% confidence intervals.

Figure 7: Cumulative impact of typhoon exposure on excess fertility among women with child mortality, RA subsample



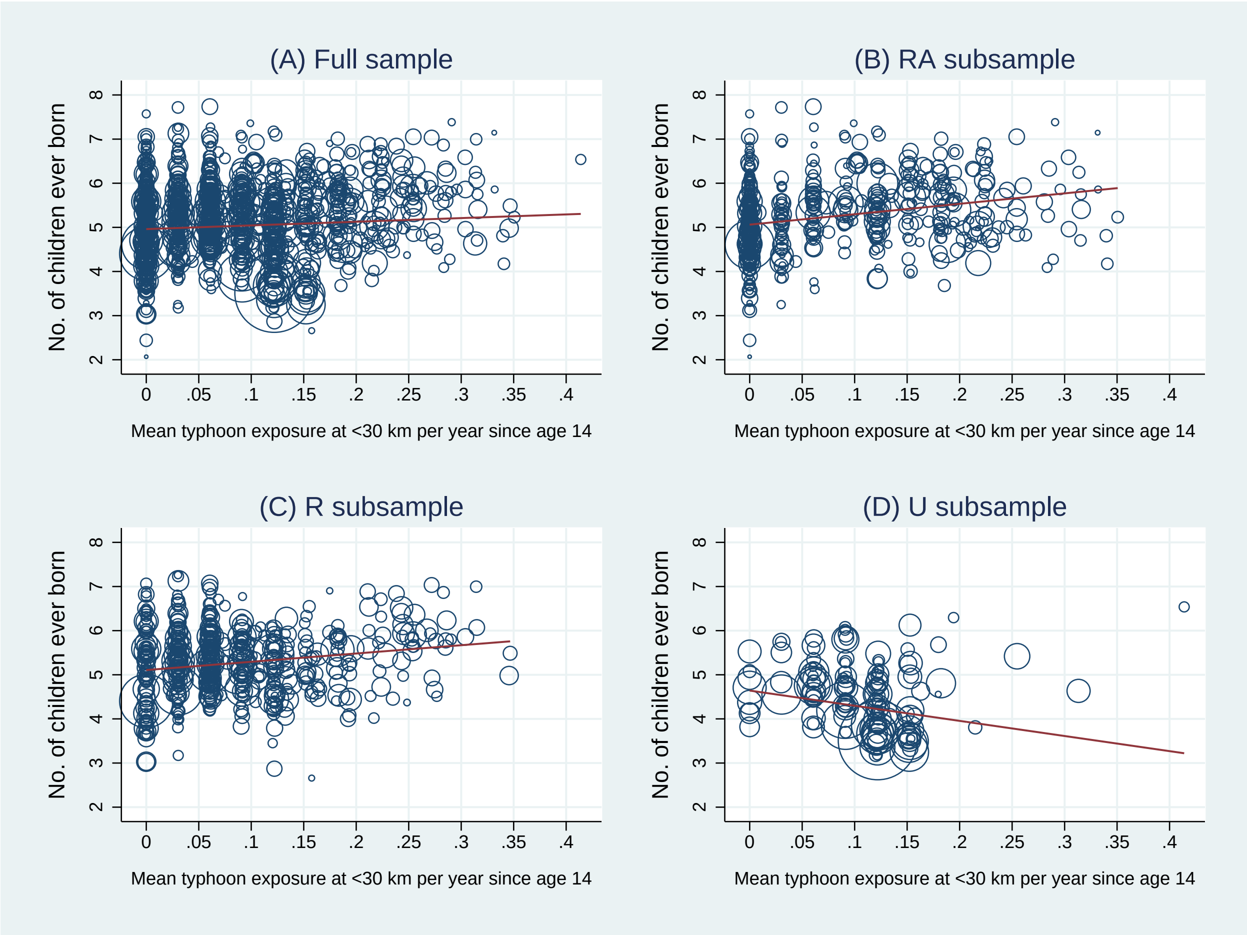
Notes: This figure accompanies Table 7. The graphs show the cumulative probability of pregnancy termination, child death, or conceiving in the periods after typhoon exposure, and the instantaneous probability of pregnancy termination, child death, or conceiving in the periods before typhoon exposure. The dashed lines show 90% confidence intervals.

Figure 8: Cumulative impact of typhoon exposure on fertility by parity, age, education, or typhoon intensity, RA subsample



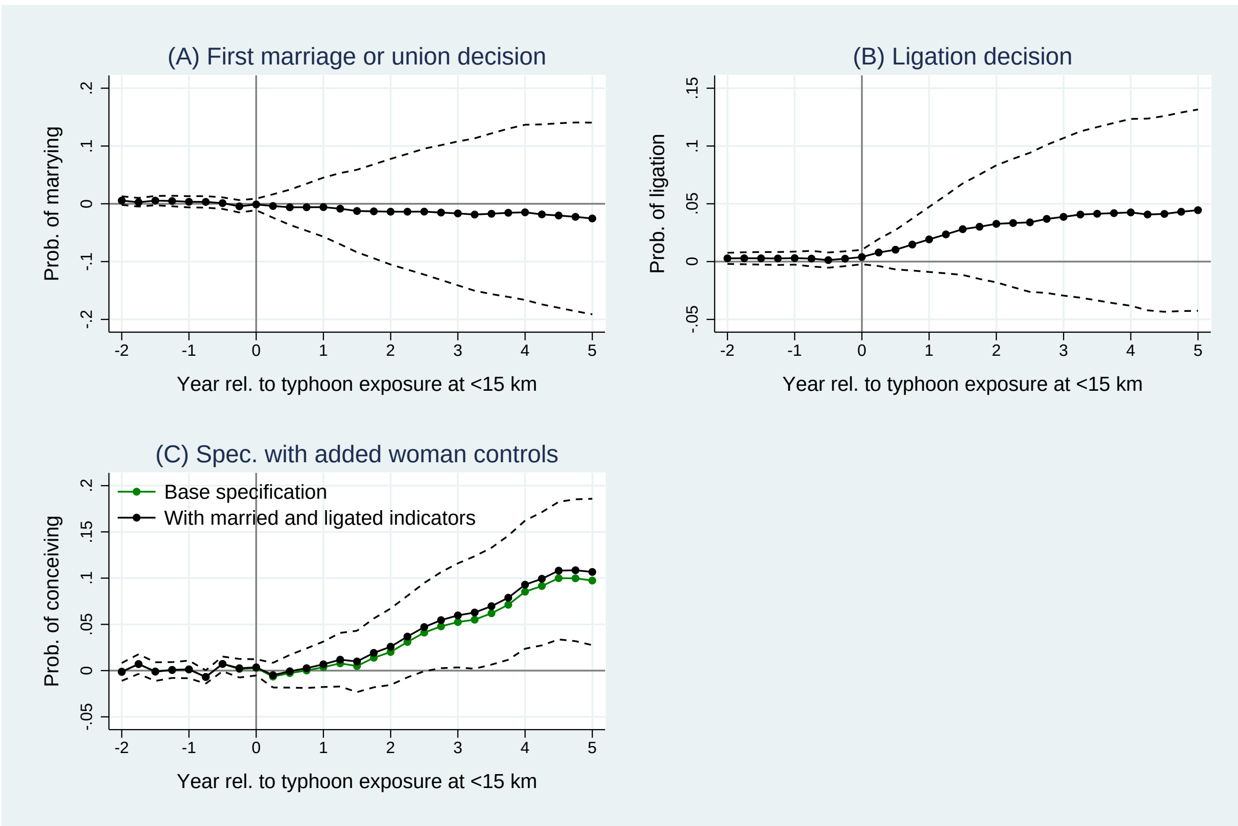
Notes: Panel A in this figure accompanies Table 8a, Panel B accompanies Table 8b, and Panels C and D accompany Table 8c. The graphs show the cumulative probability of conceiving in the periods after typhoon exposure, and the instantaneous probability of conceiving in the periods before typhoon exposure. An asterisk beside the legend name indicates that the corresponding cumulative probability was statistically significant at the .10 level at some point.

Figure 9: Impact of typhoon exposure on cumulative fertility of women 45-49 years old, 1990 Census



Notes: This figure shows the underlying observations for the regressions in Panel D of Table 9a, where each bubble represents a city or municipality. The relative sizes of the bubbles signify the relative weights of sample women across areas. The corresponding regression lines are superimposed in red on each graph. For legibility, a few areas with mean number of children ever born less than two or greater than eight are not shown (they were included in the estimation of the regression lines). See the notes in Table 9a for more details.

Figure A1: Impact of typhoon exposure on first marriage and ligation, RA subsample



Notes: The graphs show the cumulative probability of getting married, getting ligated, or conceiving in the periods after typhoon exposure, and the instantaneous probability of getting married, getting ligated, or conceiving in the periods before typhoon exposure. The dashed lines show 90% confidence intervals.

Table 1a: Summary statistics of sample women from the pooled DHS

	All sample women	Sample of non-moving women	Sample of moving women compared to non-moving women	Sample of non-moving women, partitioned according to residence type: Rural area in more-agri. province [RA]	Rural area in less-agri. province [R] compared to RA	Urban area in any province [U] compared to RA
	(1)	(2)	(3)	(4)	(5)	(6)
Characteristics at time of survey						
Age	32.5	33.8	-	34.1	-	-
	[8.4]	[8.6]		[8.5]		
Latest residence is in an urban area (1990 classification)	0.39	0.33	0.16***	No	No	Yes
	[0.49]	[0.47]	(0.005)			
Latest province is highly agricultural in 1990	0.28	0.30	-0.04***	Yes	No	-
	[0.45]	[0.46]	(0.004)			
Did not attend high school	0.30	0.34	-0.05***	0.45	-0.08***	-0.25***
	[0.46]	[0.47]	(0.004)	[0.50]	(0.007)	(0.007)
Ever married or in a union	0.79	0.79	0.07***	0.84	-0.03***	-0.10***
	[0.41]	[0.41]	(0.004)	[0.37]	(0.005)	(0.005)
Ever had ligation	0.082	0.094	-0.004	0.066	0.035***	0.052***
	[0.274]	[0.292]	(0.003)	[0.248]	(0.004)	(0.004)
Ever used modern contraception	0.43	0.43	0.04***	0.43	0.00	-0.01
	[0.50]	[0.49]	(0.005)	[0.50]	(0.007)	(0.007)
Never used any contraception	0.44	0.45	-0.06***	0.44	-0.00	0.01
	[0.50]	[0.50]	(0.005)	[0.50]	(0.007)	(0.007)
Ideal no. of children	3.2	3.3	-0.2***	3.5	-0.1***	-0.5***
	[1.5]	[1.6]	(0.01)	[1.7]	(0.02)	(0.02)
Parity (no. of births)	2.7	3.0	-0.2***	3.5	-0.4***	-1.0***
	[2.5]	[2.7]	(0.02)	[2.9]	(0.03)	(0.03)
No. of child deaths	0.17	0.20	-0.02***	0.29	-0.08***	-0.15***
	[0.53]	[0.59]	(0.005)	[0.72]	(0.008)	(0.009)
No. of pregnancies	3.0	3.3	-0.2***	3.9	-0.4***	-1.1***
	[2.7]	[2.9]	(0.02)	[3.1]	(0.04)	(0.04)
Ever had a child	0.76	0.76	0.04***	0.82	-0.03***	-0.10***
	[0.43]	[0.42]	(0.004)	[0.39]	(0.005)	(0.006)
Ever had a child death	0.13	0.15	-0.02***	0.20	-0.04***	-0.09***
	[0.33]	[0.35]	(0.003)	[0.40]	(0.005)	(0.005)
Ever had a child death or pregnancy termination	0.26	0.28	0.00	0.34	-0.05***	-0.11***
	[0.44]	[0.45]	(0.004)	[0.47]	(0.006)	(0.007)
No. of women	44,116	27,234	16,882	9,291	10,823	7,120

Notes: The entries denote the mean of the variable for the indicated sample of women in the 1993, 1998, 2003, and 2008 Demographic and Health Surveys (DHS). Standard deviations are reported in brackets. The sample of non-moving women has lived in their latest residence for the past 10 years and was 20 years old or above at the time of the survey. Typhoon exposure is assigned correctly only for this sample of non-moving women, hence it is the sample used in all subsequent analyses. See the notes in Table A3 for details on the classification of cities or municipalities as urban, and the classification of provinces as highly agricultural. Comparisons across subsamples were made after controlling for age and survey fixed effects. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 1b: Summary statistics of the analysis sample from the pooled DHS

	All sample women	Sample of non-moving women	Sample of moving women compared to non-moving women	Sample of non-moving women, partitioned according to residence type		
				Rural area in more-agri. province [RA]	Rural area in less-agri. province [R] compared to RA	Urban area in any province [U] compared to RA
	(1)	(2)	(3)	(4)	(5)	(6)
Time-varying characteristics (quarterly, past 5 years)						
Married or cohabiting	0.73	0.74	0.04***	0.79	-0.03***	-0.10***
	[0.45]	[0.44]	(0.0008)	[0.40]	(0.001)	(0.001)
Ligated	0.069	0.083	-0.006***	0.057	0.033***	0.047***
	[0.254]	[0.275]	(0.0006)	[0.232]	(0.0009)	(0.0009)
Prob. of conception	0.035	0.031	0.006***	0.037	-0.005***	-0.013***
	[0.185]	[0.173]	(0.0004)	[0.189]	(0.0006)	(0.0006)
Prob. of child death	0.0018	0.0018	-0.0001	0.0028	-0.0010***	-0.0017***
	[0.0420]	[0.0428]	(0.00009)	[0.0530]	(0.0001)	(0.0002)
Prob. of pregnancy termination	0.0036	0.0032	0.0010***	0.0037	-0.0003*	-0.0011***
	[0.0599]	[0.0564]	(0.0001)	[0.0607]	(0.0002)	(0.0002)
No. of women-quarters	868,040	535,892	332,148	182,680	212,968	140,244
Nearest exposure to typhoon at latest residence (quarterly, past 10 years)						
<15 km	0.017	0.015	0.003***	0.009	0.003***	0.015***
	[0.128]	[0.123]	(0.0002)	[0.096]	(0.0003)	(0.0003)
15-30 km	0.013	0.013	-0.000	0.010	0.004***	0.006***
	[0.114]	[0.114]	(0.0002)	[0.098]	(0.0003)	(0.0003)
30-60 km	0.019	0.020	-0.002***	0.018	0.006***	-0.000
	[0.136]	[0.140]	(0.0002)	[0.133]	(0.0003)	(0.0003)
60-100 km	0.030	0.030	0.002***	0.023	0.007***	0.012***
	[0.171]	[0.170]	(0.0003)	[0.150]	(0.0004)	(0.0004)
No. of women-quarters	1,750,360	1,080,572	669,788	368,500	429,428	282,644

Notes: The entries denote the mean of the variable for the indicated sample of women in the 1993, 1998, 2003, and 2008 Demographic and Health Surveys (DHS). Standard deviations are reported in brackets. The sample of non-moving women has lived in their latest residence for the past 10 years and was 20 years old or above at the time of the survey. Typhoon exposure is assigned correctly only for this sample of non-moving women, hence it is the sample used in all subsequent analyses. The sample period used was the past five years before the interview date in each survey, with the last quarter taken out because pregnancy status could be undetermined. Typhoon exposure was defined as the presence of a typhoon's eye in the vicinity of a city or municipality in a given quarter, and it was classified according to how close the typhoon approached the city or municipality. See the notes in Table A3 for details on the classification of cities or municipalities as urban, and the classification of provinces as highly agricultural. Comparisons across subsamples were made after controlling for age and time fixed effects. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 2: Impact of typhoon exposure on fertility, full sample

	Dep. variable: Quarterly probability of conception			
	Nearest exposure to typhoon:			
	<15 km	15-30 km	30-60 km	60-100 km
	(1)	(2)	(3)	(4)
Mean of dep. variable	0.031			
Cumulative impact of typhoon exposure:				
Current quarter	0.003	-0.001	-0.001	-0.002
	(0.003)	(0.003)	(0.002)	(0.002)
After 1 year	0.014*	0.004	-0.001	-0.006
	(0.008)	(0.008)	(0.007)	(0.006)
After 2 years	0.020	-0.003	0.004	-0.011
	(0.013)	(0.013)	(0.011)	(0.010)
After 3 years	0.035*	0.000	-0.002	-0.014
	(0.019)	(0.017)	(0.014)	(0.014)
After 4 years	0.052**	0.003	0.007	-0.012
	(0.022)	(0.021)	(0.017)	(0.017)
After 5 years	0.061**	0.001	0.004	-0.016
	(0.025)	(0.024)	(0.019)	(0.019)
Woman fixed effects	Yes (27,234 women)			
Year and quarter fixed effects	Yes (5 years, 4 quarters)			
R-squared	0.087			
No. of women-quarters	535,892			

Notes: All the estimates in the table are from the same least squares regression. Standard errors (reported in parentheses) were clustered by city or municipality. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is already pregnant and thus cannot conceive. See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regression, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Figure 2 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 3: Impact of typhoon exposure on fertility, by subsample

	Dep. variable: Quarterly probability of conception			
		Subsample		
	Full sample	Rural area in more-agri. province [RA]	Rural area in less-agri. province [R]	Urban area in any province [U]
	(1)	(2)	(3)	(4)
Mean of dep. variable	0.031	0.037	0.032	0.024
Cumulative impact of typhoon exposure at <15 km:				
Current quarter	0.003	0.003	-0.001	0.004
	(0.003)	(0.005)	(0.004)	(0.004)
After 1 year	0.014*	0.004	0.004	0.016
	(0.008)	(0.015)	(0.015)	(0.014)
After 2 years	0.020	0.020	-0.003	0.020
	(0.013)	(0.025)	(0.024)	(0.025)
After 3 years	0.035*	0.053	0.006	0.024
	(0.019)	(0.034)	(0.033)	(0.035)
After 4 years	0.052**	0.085**	0.018	0.023
	(0.022)	(0.042)	(0.040)	(0.043)
After 5 years	0.061**	0.097**	0.019	0.035
	(0.025)	(0.047)	(0.044)	(0.048)
Woman fixed effects	27,234	9,291	10,823	7,120
Year and quarter fixed effects	Yes	Yes	Yes	Yes
R-squared	0.087	0.085	0.086	0.090
No. of women-quarters	535,892	182,680	212,968	140,244

Notes: The estimates in each column are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by city or municipality. Regressions include controls for typhoon exposure at 15-30, 30-60, and 60-100 kilometers. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is already pregnant and thus cannot conceive. See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regressions, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Figure 3 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 4: Impact of typhoon exposure on child mortality, RA subsample

	Dep. variable: Quarterly probability of:			
	Pregnancy termination	Child death		
		Female or male	Female	Male
	(1)	(2)	(3)	(4)
Mean of dep. variable	0.0037	0.0028	0.0012	0.0017
Cumulative impact of typhoon exposure at <15 km:				
Current quarter	-0.0001	-0.0006	-0.0006	-0.0001
	(0.0016)	(0.0011)	(0.0006)	(0.0009)
After 1 year	0.0041	0.0030	-0.0025	0.0049
	(0.0049)	(0.0037)	(0.0024)	(0.0033)
After 2 years	0.0146*	0.0086	0.0005	0.0075
	(0.0080)	(0.0060)	(0.0042)	(0.0047)
After 3 years	0.0155	0.0131	0.0010	0.0108*
	(0.0115)	(0.0083)	(0.0057)	(0.0064)
After 4 years	0.0195	0.0167*	0.0020	0.0130*
	(0.0145)	(0.0100)	(0.0075)	(0.0077)
After 5 years	0.0191	0.0128	0.0009	0.0098
	(0.0151)	(0.0113)	(0.0078)	(0.0088)
Woman fixed effects	9,291	9,291	9,291	9,291
Year and quarter fixed effects	Yes	Yes	Yes	Yes
R-squared	0.079	0.066	0.061	0.058
No. of women-quarters	182,680	182,680	182,680	182,680

Notes: The estimates in each column are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by city or municipality. Regressions include controls for typhoon exposure at 15-30, 30-60, and 60-100 kilometers. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is pregnant and thus can experience a pregnancy termination in column (1), or dummies for parity (number of previous births) in columns (2)-(4). See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regressions, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Figure 4 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 5: Impact of typhoon exposure on fertility by child mortality experience, RA subsample

	Dep. variable: Quarterly probability of conception				
		Woman's child mortality experience			
	All women	Had no pregnancy termination or child death	Had pregnancy termination or child death more than 10 years ago	Had pregnancy termination in the past 10 years	Had child death in the past 10 years
	(1)	(2)	(3)	(4)	(5)
Mean of dep. variable	0.037	0.030	0.021	0.078	0.066
Cumulative impact of typhoon exposure at <15 km:					
Current quarter	0.003	0.001	0.002	0.005	0.022
	(0.005)	(0.006)	(0.011)	(0.018)	(0.027)
After 1 year	0.004	-0.016	0.043	0.045	0.024
	(0.015)	(0.016)	(0.033)	(0.061)	(0.057)
After 2 years	0.020	-0.012	0.013	0.127	0.112
	(0.025)	(0.029)	(0.052)	(0.106)	(0.082)
After 3 years	0.053	0.015	0.024	0.147	0.217**
	(0.034)	(0.039)	(0.068)	(0.135)	(0.108)
After 4 years	0.085**	0.039	0.043	0.231	0.241*
	(0.042)	(0.047)	(0.087)	(0.171)	(0.131)
After 5 years	0.097**	0.057	0.048	0.269	0.176
	(0.047)	(0.051)	(0.101)	(0.198)	(0.154)
Woman fixed effects	9,291	6,119	1,270	1,104	967
Year and quarter fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.085	0.079	0.088	0.081	0.090
No. of women-quarters	182,680	120,248	24,964	21,725	19,076

Notes: The estimates in each column are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by city or municipality. Regressions include controls for typhoon exposure at 15-30, 30-60, and 60-100 kilometers. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is already pregnant and thus cannot conceive. See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regressions, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Figure 5 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 6: Impact of typhoon exposure on fertility by timing of child mortality, RA subsample

	Women with pregnancy termination in the past 10 years		Women with child death in the past 10 years	
	Dep. variable: Quarterly probability of conception with:			
	history of pregnancy termination in last 5 years?		history of child death in last 5 years?	
	Yes	No	Yes	No
	(1)	(2)	(3)	(4)
Mean of dep. variable	0.039	0.039	0.035	0.031
Cumulative impact of typhoon exposure at <15 km:				
Current quarter	0.004	0.001	-0.01	0.031
	(0.014)	(0.015)	(0.016)	(0.021)
After 1 year	-0.012	0.057	-0.039	0.063*
	(0.047)	(0.038	(0.044)	(0.038)
After 2 years	0.017	0.110	-0.034	0.147**
	(0.073)	(0.067)	(0.062)	(0.059)
After 3 years	-0.004	0.151*	-0.007	0.224***
	(0.098)	(0.083)	(0.082)	(0.085)
After 4 years	0.028	0.203**	-0.044	0.285***
	(0.128)	(0.097)	(0.098)	(0.097)
After 5 years	0.039	0.230**	-0.073	0.249**
	(0.145)	(0.114)	(0.111)	(0.108)
Woman fixed effects	1,104	1,104	967	967
Year and quarter fixed effects	Yes	Yes	Yes	Yes
R-squared	0.078	0.063	0.084	0.081
No. of women-quarters	21,725	21,725	19,076	19,076

Notes: The estimates in each column are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by city or municipality. Regressions include controls for typhoon exposure at 15-30, 30-60, and 60-100 kilometers. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is already pregnant and thus cannot conceive. See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regressions, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Figure 6 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 7: Impact of typhoon exposure on excess fertility among women with child mortality, RA subsample

	Women with pregnancy termination in the past 10 years		Women with child death in the past 10 years		
	Dep. variable: Quarterly probability of:				
	Conception	Pregnancy termination	Conception	Child death	Male child death
	(1)	(2)	(3)	(4)	(5)
Mean of dep. variable	0.078	0.031	0.066	0.027	0.016
Cumulative impact of typhoon exposure at <15 km:					
Current quarter	0.005	0.002	0.022	-0.008	-0.003
	(0.018)	(0.013)	(0.027)	(0.012)	(0.010)
After 1 year	0.045	0.04	0.024	0.025	0.051
	(0.061)	(0.038)	(0.057)	(0.040)	(0.035)
After 2 years	0.127	0.115*	0.112	0.097	0.094*
	(0.106)	(0.063)	(0.082)	(0.065)	(0.050)
After 3 years	0.147	0.135	0.217**	0.152*	0.134**
	(0.135)	(0.086)	(0.108)	(0.088)	(0.067)
After 4 years	0.231	0.175*	0.241*	0.197*	0.160**
	(0.171)	(0.103)	(0.131)	(0.103)	(0.075)
After 5 years	0.269	0.164	0.176	0.165	0.135
	(0.198)	(0.107)	(0.154)	(0.114)	(0.085)
Woman fixed effects	1,104	1,104	967	967	967
Year and quarter fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.081	0.084	0.090	0.063	0.061
No. of women-quarters	21,725	21,725	19,076	19,076	19,076

Notes: The estimates in each column are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by city or municipality. Regressions include controls for typhoon exposure at 15-30, 30-60, and 60-100 kilometers. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is already pregnant and thus cannot conceive in columns (1) and (3), a dummy that turns on when a woman is pregnant and thus can experience a pregnancy termination in column (2), or dummies for parity (number of previous births) in columns (4) and (5). See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regressions, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Figure 7 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 8a: Impact of typhoon exposure on fertility by parity, RA subsample

	Dep. variable: Quarterly probability of conception with no. of previous births:								
	Any	0	1	2	3	4	5	6	7+
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mean of dep. variable	0.0369	0.0060	0.0057	0.0050	0.0045	0.0041	0.0035	0.0027	0.0053
Cumulative impact of typhoon exposure at <15 km:									
Current quarter	0.003	0.001	0.004	-0.001	0.001	-0.001	-0.000	-0.003***	0.002
	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
After 1 year	0.004	-0.006	0.006	-0.013**	0.005	0.003	0.007	-0.007*	0.007
	(0.015)	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)	(0.004)	(0.005)
After 2 years	0.020	0.001	0.019	-0.021**	0.015*	0.005	0.012	-0.013**	0.003
	(0.025)	(0.011)	(0.012)	(0.009)	(0.009)	(0.010)	(0.008)	(0.006)	(0.008)
After 3 years	0.053	0.006	0.032*	-0.028**	0.019*	0.011	0.017	-0.017**	0.012
	(0.034)	(0.015)	(0.017)	(0.012)	(0.011)	(0.012)	(0.012)	(0.008)	(0.011)
After 4 years	0.085**	0.011	0.045**	-0.026*	0.024*	0.007	0.024*	-0.013	0.014
	(0.042)	(0.018)	(0.021)	(0.015)	(0.014)	(0.015)	(0.015)	(0.010)	(0.014)
After 5 years	0.097**	0.003	0.051**	-0.017	0.029*	0.007	0.033*	-0.016	0.008
	(0.047)	(0.020)	(0.022)	(0.018)	(0.015)	(0.016)	(0.017)	(0.012)	(0.016)
Woman fixed effects	9,291	9,291	9,291	9,291	9,291	9,291	9,291	9,291	9,291
Year and quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.085	0.058	0.055	0.056	0.054	0.056	0.055	0.056	0.091
No. of women-quarters	182,680	182,680	182,680	182,680	182,680	182,680	182,680	182,680	182,680

Notes: The estimates in each column are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by city or municipality. Regressions include controls for typhoon exposure at 15-30, 30-60, and 60-100 kilometers. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is already pregnant and thus cannot conceive. See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regressions, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Panel A of Figure 8 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 8b: Impact of typhoon exposure on fertility by age, RA subsample

	Dep. variable: Quarterly probability of conception						
	Age at time of survey						
	20-49	20-24	25-29	30-34	35-39	40-44	45-49
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mean of dep. variable	0.037	0.037	0.057	0.051	0.042	0.025	0.008
Cumulative impact of typhoon exposure at <15 km:							
Current quarter	0.003	-0.001	0.016	0.008	-0.009	-0.001	0.010
	(0.005)	(0.011)	(0.018)	(0.017)	(0.013)	(0.010)	(0.009)
After 1 year	0.004	-0.061	-0.010	0.042	-0.021	0.014	0.052**
	(0.015)	(0.042)	(0.048)	(0.050)	(0.034)	(0.027)	(0.020)
After 2 years	0.020	-0.031	-0.025	0.076	-0.005	0.018	0.068**
	(0.025)	(0.074)	(0.083)	(0.081)	(0.055)	(0.047)	(0.028)
After 3 years	0.053	-0.018	0.032	0.121	0.012	0.066	0.082**
	(0.034)	(0.096)	(0.111)	(0.111)	(0.076)	(0.063)	(0.037)
After 4 years	0.085**	-0.004	0.112	0.162	-0.015	0.112	0.112**
	(0.042)	(0.115)	(0.129)	(0.136)	(0.091)	(0.081)	(0.051)
After 5 years	0.097**	-0.002	0.120	0.158	-0.012	0.136	0.132**
	(0.047)	(0.133)	(0.143)	(0.148)	(0.117)	(0.090)	(0.059)
Woman fixed effects	9,291	1,552	1,454	1,541	1,778	1,553	1,413
Year and quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.085	0.097	0.080	0.076	0.081	0.086	0.079
No. of women-quarters	182,680	30,500	28,612	30,307	34,944	30,539	27,778

Notes: The estimates in each column are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by city or municipality. Regressions include controls for typhoon exposure at 15-30, 30-60, and 60-100 kilometers. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is already pregnant and thus cannot conceive. See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regressions, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Panel B of Figure 8 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 8c: Impact of typhoon exposure on fertility by education or by typhoon intensity, RA subsample

	Dep. variable: Quarterly probability of conception				
		Education		Typhoon intensity	
	All	Did not attend high school	Attended high school or higher	Category 1	Category 2 or higher
	(1)	(2)	(3)	(4)	(5)
Mean of dep. variable	0.037	0.043	0.032	0.037	
Cumulative impact of typhoon exposure at <15 km:					
Current quarter	0.003	-0.005	0.010	-0.003	0.012
	(0.005)	(0.008)	(0.007)	(0.006)	(0.010)
After 1 year	0.004	-0.008	0.011	0.001	0.006
	(0.015)	(0.025)	(0.019)	(0.021)	(0.021)
After 2 years	0.020	-0.005	0.036	0.033	-0.004
	(0.025)	(0.042)	(0.032)	(0.033)	(0.036)
After 3 years	0.053	0.021	0.074*	0.071	0.022
	(0.034)	(0.056)	(0.044)	(0.043)	(0.047)
After 4 years	0.085**	0.051	0.109**	0.103*	0.053
	(0.042)	(0.066)	(0.055)	(0.055)	(0.057)
After 5 years	0.097**	0.051	0.129**	0.112*	0.066
	(0.047)	(0.073)	(0.063)	(0.060)	(0.068)
Woman fixed effects	9,291	4,185	5,106	9,291	
Year and quarter fixed effects	Yes	Yes	Yes	Yes	
R-squared	0.085	0.085	0.085	0.085	
No. of women-quarters	182,680	82,339	100,341	182,680	

Notes: The estimates in columns (1)-(3) are from separate least squares regressions, while the estimates in columns (4) and (5) are from the same least squares regression. Standard errors (reported in parentheses) were clustered by city or municipality. Regressions include controls for typhoon exposure at 15-30, 30-60, and 60-100 kilometers. Other controls included were dummies for single-year age, and a dummy that turns on when a woman is already pregnant and thus cannot conceive. See the notes in Table 1b for details on the sample used and how typhoon exposure was defined. Quarterly lags in typhoon exposure of up to 20 quarters were included in the regressions, as well as leads of up to 8 quarters. The cumulative impact after n years sums up the estimates from $n \times 4$ quarters behind up to the current quarter; see Panels C and D of Figure 8 for the complete impact trajectory. Observations were weighted using the sampling weights in the DHS.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 9a: Impact of typhoon exposure on cumulative fertility of non-moving women since birth, 1990 Census

	Full sample of ever-married women	Subsample: Rural area in more-agri. province [RA]	Subsample: Rural area in less-agri. province [R]	Subsample: Urban area in any province [U]
	Dep. variable: No. of children ever born			
	(1)	(2)	(3)	(4)
	A. Women 15-24 years old			
Mean of dep. variable	1.36	1.42	1.38	1.22
Mean no. of typhoons at <30 km per year since age 14	0.04	0.15**	-0.11	0.21
	(0.078)	(0.071)	(0.12)	(0.16)
R-squared	0.0010	0.013	0.011	0.019
	B. Women 25-34 years old			
Mean of dep. variable	2.87	3.12	2.98	2.42
Mean no. of typhoons at <30 km per year since age 14	0.44	0.91**	-0.07	1.16
	(0.33)	(0.38)	(0.45)	(0.79)
R-squared	0.0069	0.043	0.00045	0.039
	C. Women 35-44 years old			
Mean of dep. variable	4.33	4.74	4.52	3.56
Mean no. of typhoons at <30 km per year since age 14	-0.14	1.86***	0.78	-2.06
	(0.90)	(0.68)	(0.97)	(1.36)
R-squared	0.00021	0.070	0.014	0.044
	D. Women 45-49 years old			
Mean of dep. variable	5.04	5.27	5.26	4.27
Mean no. of typhoons at <30 km per year since age 14	0.83	2.36***	1.88	-3.43*
	(0.95)	(0.84)	(1.17)	(2.02)
R-squared	0.0055	0.076	0.038	0.056
Mean of indep. variable for:				
Women 15-24 years old	0.101	0.088	0.125	0.080
Women 25-34 years old	0.080	0.067	0.096	0.073
Women 35-44 years old	0.094	0.083	0.091	0.112
Women 45-49 years old	0.090	0.088	0.084	0.107
No. of cities and municipalities	1,164	490	529	145

Notes: The estimates in each cell are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by province. The sample of non-moving women from the 10% Sample of the 1990 Census has lived in their city or municipality of residence since birth. Only ever-married women 15-49 years old were asked about the number of children they have had and the number who have died. Typhoon exposure was measured as the mean number of typhoons per year each woman was exposed to since she was 14 years old up until 1989. Municipalities with population under 20,000 were lumped together in the data and could only be assigned to the province's GIS centroid. To provide a more accurate measure of actual exposure for these municipalities, the distance threshold used for determining typhoon exposure was expanded to 30 kilometers (the average province has a land area of 3,900 square kilometers, which would have a radius of 35 kilometers if laid out in a circle). Data was collapsed to the average value at the city or municipality level. See the notes in Table A3 for details on the classification of cities or municipalities as urban, and the classification of provinces as highly agricultural. See Figure 9 for the scatterplot of observations that underlie the regressions for women 45-49 years old in Panel D. Observations were weighted using the sampling weights in the 1990 Census.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 9b: Impact of typhoon exposure on cumulative child mortality of non-moving women since birth, 1990 Census

	Full sample of ever-married women	Subsample: Rural area in more-agri. province [RA]	Subsample: Rural area in less-agri. province [R]	Subsample: Urban area in any province [U]
	Dep. variable: No. of children who have died			
	(1)	(2)	(3)	(4)
	A. Women 15-24 years old			
Mean of dep. variable	0.04	0.05	0.04	0.03
Mean no. of typhoons at <30 km	-0.00	0.01	-0.01	0.01
per year since age 14	(0.011)	(0.020)	(0.014)	(0.017)
R-squared	0.000010	0.0023	0.0037	0.00094
	B. Women 25-34 years old			
Mean of dep. variable	0.11	0.14	0.11	0.07
Mean no. of typhoons at <30 km	0.02	0.19**	-0.06	0.07
per year since age 14	(0.053)	(0.079)	(0.070)	(0.074)
R-squared	0.00069	0.032	0.0076	0.0092
	C. Women 35-44 years old			
Mean of dep. variable	0.22	0.30	0.23	0.13
Mean no. of typhoons at <30 km	-0.02	0.38**	-0.00	-0.28
per year since age 14	(0.14)	(0.17)	(0.17)	(0.21)
R-squared	0.00012	0.039	0.0000021	0.038
	D. Women 45-49 years old			
Mean of dep. variable	0.33	0.40	0.34	0.21
Mean no. of typhoons at <30 km	0.07	0.49**	0.04	-0.59
per year since age 14	(0.18)	(0.22)	(0.22)	(0.40)
R-squared	0.00066	0.035	0.00021	0.038
Mean of indep. variable for:				
Women 15-24 years old	0.101	0.088	0.125	0.080
Women 25-34 years old	0.080	0.067	0.096	0.073
Women 35-44 years old	0.094	0.083	0.091	0.112
Women 45-49 years old	0.090	0.088	0.084	0.107
No. of cities and municipalities	1,164	490	529	145

Notes: The estimates in each cell are from separate least squares regressions. Standard errors (reported in parentheses) were clustered by province. The sample of non-moving women from the 10% Sample of the 1990 Census has lived in their city or municipality of residence since birth. Only ever-married women 15-49 years old were asked about the number of children they have had and the number who have died. Typhoon exposure was measured as the mean number of typhoons per year each woman was exposed to since she was 14 years old up until 1989. Municipalities with population under 20,000 were lumped together in the data and could only be assigned to the province's GIS centroid. To provide a more accurate measure of actual exposure for these municipalities, the distance threshold used for determining typhoon exposure was expanded to 30 kilometers (the average province has a land area of 3,900 square kilometers, which would have a radius of 35 kilometers if laid out in a circle). Data was collapsed to the average value at the city or municipality level. See the notes in Table A3 for details on the classification of cities or municipalities as urban, and the classification of provinces as highly agricultural. Observations were weighted using the sampling weights in the 1990 Census.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table A1: Differences in education and employment across subsamples by age, 1990 Census

	Subsample			Subsample		
	Rural area in more-agri. province [RA]	Rural area in less-agri. province [R]	Urban area in any province [U]	Rural area in more-agri. province [RA]	Rural area in less-agri. province [R]	Urban area in any province [U]
Age group	(1)	(2)	(3)	(4)	(5)	(6)
	A. Attended school last year			B. Years of schooling		
5-9 years old	0.46	0.52	0.64	0.8	0.9	1.0
	[0.50]	[0.50]	[0.48]	[1.1]	[1.1]	[1.2]
10-14 years old	0.84	0.87	0.92	4.4	4.7	5.3
	[0.37]	[0.34]	[0.28]	[2.0]	[2.0]	[1.8]
15-19 years old	0.54	0.57	0.64	7.1	7.8	8.9
	[0.50]	[0.49]	[0.48]	[3.0]	[2.9]	[2.5]
20-24 years old	0.20	0.20	0.25	7.8	8.6	10.2
	[0.40]	[0.40]	[0.43]	[3.6]	[3.5]	[3.0]
15-59 years old	-	-	-	6.9	7.6	9.5
				[3.7]	[3.6]	[3.3]
60-64 years old	-	-	-	4.5	5.0	7.5
				[3.7]	[3.8]	[4.2]
65-69 years old	-	-	-	3.8	4.2	6.8
				[3.5]	[3.5]	[4.2]
70 years old or above	-	-	-	3.2	3.4	5.9
				[3.3]	[3.3]	[4.3]
	C. Currently working			D. Working in agriculture		
10-14 years old	0.20	0.14	0.18	0.11	0.04	0.00
	[0.40]	[0.35]	[0.38]	[0.31]	[0.18]	[0.07]
15-19 years old	0.36	0.27	0.29	0.24	0.11	0.02
	[0.48]	[0.44]	[0.46]	[0.42]	[0.32]	[0.14]
20-24 years old	0.50	0.44	0.49	0.31	0.18	0.03
	[0.50]	[0.50]	[0.50]	[0.46]	[0.39]	[0.18]
15-59 years old	0.54	0.48	0.54	0.34	0.21	0.04
	[0.50]	[0.50]	[0.50]	[0.47]	[0.41]	[0.20]
60-64 years old	0.58	0.49	0.47	0.42	0.29	0.08
	[0.49]	[0.50]	[0.50]	[0.49]	[0.45]	[0.26]
65-69 years old	0.51	0.43	0.37	0.39	0.28	0.07
	[0.50]	[0.50]	[0.48]	[0.49]	[0.45]	[0.26]
70 years old or above	0.40	0.33	0.28	0.30	0.21	0.06
	[0.49]	[0.47]	[0.45]	[0.46]	[0.41]	[0.24]
No. of individuals	1,917,710	2,354,311	1,741,892	1,917,710	2,354,311	1,741,892

Notes: The entries denote the mean of the variable for the indicated age group of individuals interviewed in the 10% Sample of the 1990 Census. Standard deviations are reported in brackets. The city or municipality of residence was considered urban if the majority of its *barangays* (villages) were classified as urban. The urban classification of each *barangay* was based on population density, existence of a street pattern, and presence of establishments and facilities for basic services. Provinces were considered highly agricultural if the share of its working-age population (15-59 years old) which reported working in agriculture was above the median (the median was 25%). The reference period for the employment figures is the past week. Observations were weighted using the sampling weights in the 1990 Census.

Table A2: Typhoon exposure of sample areas in the pooled DHS

Survey	No. of cities and municipalities (1)	Share ever exposed to a typhoon in the past 10 years at specified nearest distance <15 km (2)	15-30 km (3)	30-60 km (4)	60-100 km (5)
	A. Sample of non-moving women				
Pooled DHS	1,140	0.46	0.15	0.09	0.03
1993 DHS	538	0.37	0.21	0.14	0.03
1998 DHS	549	0.46	0.14	0.08	0.02
2003 DHS	485	0.35	0.18	0.15	0.04
2008 DHS	493	0.35	0.14	0.08	0.05
	B. Sample of non-moving women residing in a rural area in a more-agricultural province [RA]				
Pooled DHS	501	0.40	0.13	0.06	0.03
1993 DHS	227	0.33	0.18	0.09	0.04
1998 DHS	238	0.34	0.14	0.05	0.02
2003 DHS	200	0.24	0.16	0.14	0.05
2008 DHS	192	0.28	0.11	0.04	0.04

Notes: The sample of non-moving women has lived in their latest residence for the past 10 years and was 20 years old or above at the time of the survey. The nearest distance of a typhoon's eye to each city or municipality was computed using interpolated typhoon path coordinates from IBTRACS and the coordinates of each city or municipality's GIS centroid.

Table A3: Distribution of typhoon exposure among sample women in the pooled DHS

No. of quarters	Share of sample with no. of typhoon exposures at specified nearest distance: <15 km (1)	15-30 km (2)	30-60 km (3)	60-100 km (4)
	A. Sample of non-moving women			
Zero	0.61	0.63	0.51	0.43
One	0.27	0.28	0.28	0.24
Two	0.10	0.07	0.14	0.19
Three or more	0.03	0.02	0.07	0.14
	B. Sample of non-moving women residing in a rural area in a more-agricultural province [RA]			
Zero	0.73	0.71	0.61	0.58
One	0.20	0.23	0.18	0.14
Two	0.05	0.05	0.14	0.14
Three or more	0.01	0.01	0.08	0.15

Notes: Each entry denotes the share of sample women observed in the data with the indicated quarterly frequency of typhoon exposure at the specified nearest distance over the past 10 years. Each column sums up to unity.