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Safety Nets and Natural Disaster Mitigation

Evidence from Cyclone Phailin in Odisha

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Abstract

To what degree can vulnerability to extreme weather events be mitigated by access to a rural livelihoods program, particularly with regard to the impacts on women? This paper addresses this question through a natural experiment arising from two independent but overlapping sources of variation: exposure to a devastating cyclone that occurred in the Bay of Bengal region of India and the staggered rollout of a rural livelihoods intervention. Comparisons from household surveys across communities more or less exposed to the storm before and after the introduction of the program reveal that the storm led to significant reductions in overall household expenditure, and that these reductions were indeed the largest for women, adding to the emerging evidence for the frequently-posed hypothesis that women bear the brunt of the effects of disasters on overall household consumption. Participation in the livelihoods program mitigated some of the reductions in household nonfood expenditure and women's consumption, but not on food expenditure. These results from a densely populated region whose topography makes it particularly vulnerable to storms can inform future policy approaches and aid in modeling the impact of these policies on the effects of climate change.

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Safety Nets and Natural Disaster Mitigation: Evidence from Cyclone Phailin in Odisha

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1 Introduction

This paper examines the effectiveness of a livelihoods program to mitigate the impact of climate-induced extreme weather events. We particularly focus on heteregeneity of reponses on the dimension of gender. Climate change is expected to increase the incidence and intensity of extreme weather events like cyclonic storms (Mendelsohn et al., 2012). While the capacity to avoid and offset the worst effects of such storms, particularly human mortality, is improving, large swaths of the developing world remain vulnerable to sizeable income losses (Intergovernmental Panel on Climate Change, 2014). In addition, much of the policy literature describes women as being particularly vulnerable to the worst insults of climate change (UN Population Fund, 2009; World Health Organization, 2011), but evidence for this hypothesis is nascent (Anttila-Hughes and Hsiang, 2013; Neumayer and Plümper, 2007; Hallegatte et al., 2016), especially with regard to the question of whether safety net programs can lessen the gender gaps resulting from these shocks. The densely populated Bay of Bengal in the North Indian Ocean is uniquely vulnerable to devastation by storms because geographical features translate strong winds into damaging, sometimes catastrophic, storm surge. The region is also home to many of the world's poor (Alam, Hossain and Shafee, 2003), and has long been recognized has having low levels of women's welfare (Hashemi, Schuler and Riley, 1996; Kishor and Gupta, 2004). Modeling the impact of climate change requires understanding the incidence of these storms on household welfare as well as the potential for various policy responses to offset these consequences. Microcredit interventions are a popular poverty alleviation policy tool, particularly in poor countries (Banerjee, Karlan and Zinman, 2015). The most common model of microcredit in India is the Self-Help Group (SHG), which is implemented by the National Rural Livelihoods Mission, a program reaching 600,000 villages across all of the nation's 29 states that has leveraged more than $6 billion dollars over five years (Joshi, Palaniswamy and Rao, 2016). SHGs have a special focus on women's empowerment, strengthening community ties, and increasing collective action (Sanyal, Rao and Majumdar, 2013). They have been found to provide cheap credit and foster women's empowerment, but their impact impact on poverty has been shown to be minimal despite some speculation that they help mitigate risk (Brody et al., 2015). Notwithstanding the lack of evidence on poverty reduction, policymakers believe that SHGs can be used to effectively attenuate the effects of severe weather events (Government of India, 2011).

Cyclone Phailin made landfall in the east Indian state of Odisha on October 11, 2013 (Singh and Jeffries, 2013). It was the strongest tropical storm to hit India in 14 years, indeed stronger than Hurricane Katrina on landfall, with wind velocities of 205-220 kilometers per hour. Phailin led to one of the largest emergency evacuations on record. Over one million people were moved to shelters. 256,000 households experienced partial or severe loss, and 1.3 million hectares of agricultural land (approximately 30% of estimated agricultural land in affected areas) (Singh and Jeffries, 2013). Reconstruction and rehabilitation costs were estimated to have cost $1.45 billion (Singh and Jeffries, 2013).

By coincidence, Phailin-hit areas overlapped with the study districts of a World Bank (WB)-led impact evaluation of a government-run SHG intervention, called Targeted Rural Initiatives for Poverty Termination and Infrastructure (TRIPTI). Using spatial variation in the intensity of the rainfall shock and the staggered rollout of TRIPTI, we conduct a large-scale statistical examination of (1) the negative consumption impacts of Cyclone Phailin, and (2) whether the prior presence of TRIPTI SHGs mitigated covariate risk by improving access to credit and providing a platform for government response. We construct a Geographic Information Systems (GIS)-coded dataset from two sources: the Indian Meteorological Department's (IMD) 1°x1° gridded daily data on rainfall imputed from 6,327 weather stations across India from 1951 to 2013, and the household-level baseline and endline surveys for the impact evaluation of TRIPTI. We exploit spatial variation in the intensity of the rainfall shock experienced by a household in October 2013 as measured by the absolute deviation from the historical average of millimeters of rainfall at the nearest weather station. To these rainfall data, we add data on household expenditures, consumption, credit-seeking, and political engagement from the TRIPTI surveys. The baseline survey for the TRIPTI evaluation was completed in July 2011, two years before Phailin struck, while the endline was completed in August 2014. TRIPTI was assigned to the four least developed blocks (sub-districts) in each of the ten coastal districts in Odisha, which were identified using a development index produced by the Government of India in

1993. The blocks with the next four lowest development scores within each district were chosen as comparison (non-TRIPTI) blocks. We use regression analysis to measure the differential effects of Phailin across TRIPTI and non-TRIPTI areas.

Phailin led to sizeable decreases in total household consumption, as well as a substitution away from purchased food toward the consumption of home-grown stocks. Expenditure on women's goods, a category that includes clothing, shoes, hygiene products, and toiletries purchased for women, sees one of the largest reductions across categories of household expenditure; this finding is among the first concrete pieces of empirical evidence on the disproportionate vulnerability of women to climate change. In contrast, Phailin-hit households spend more on festivals after the storm, and the increase is greatest in magnitude in TRIPTI areas, suggesting that strengthened community ties might be used to leverage social capital in disaster-affected areas. Across the sample, households expand the number of loans taken after Phailin, but this expansion is significantly higher in TRIPTI areas. In non-TRIPTI areas, state-level aid crowds out interactions with village governments, while in TRIPTI areas Phailin-affected populations remain engaged in village politics. In particular, across the sample, households in Phailin-hit areas were more likely to know the name of the Chief Minister, who is the highest ranking political figure in the state. In non-TRIPTI areas, this awareness of the Chief Minister came at the expense of knowledge of the village governance structure, while in TRIPTI areas we see no reduction in engagement with local governance due to Phailin.

The econometric analysis accounts for time invariant characteristics of the households and their location. In addition, the analysis of the effects of exposure to Phailin accounts for spatial autocorrelation common to observations sampled within the same latitude-longitude grid cell. The estimated impact of TRIPTI controls for correlation at the village level, while the estimates of TRIPTI on Phailin exposure account for spatial autocorrelation in the interactions between the latitude-longitude grid cells and villages. The approach used here thus addresses initial differences in the levels of expenditure, credit-seeking behavior or access that coincide with either exposure to Phailin or the presence of TRIPTI; however, it cannot rule out that there were differential trends in these variables arising from sources other than TRIPTI or Phailin. For example, if another weather event between baseline and follow-up surveys affected only Phailin-hit TRIPTI areas but not areas affected by Phailin that were not covered by TRIPTI (or vice-versa), this would lead to spurious findings. We do not have evidence of such differential trends, but cannot fully rule them out. The analysis also only models average impacts of both Phailin and TRIPTI at a relatively coarse spatial scale. This study thus provides suggestive evidence on the impacts of both extreme weather and the safety nets designed to mitigate them.

2 Cyclone Phailin and Rainfall Data

We measure the intensity of Phailin using data from the Indian Meteorological Department on daily rainfall for all 1°x1° latitude-longitude grids in Odisha from 1951 to 2013. The Indian Meteorological Department (IMD) operates 537 weather stations that measure rainfall over the past 24 hours (ending 8:30 am Indian Standard Time) (Rajeevan et al., 2006). In addition, state governments maintain rain gauges for real-time rainfall monitoring. The IMD collates, cleans and archives these data following protocols established in Rajeevan et al. (2006). The authors note that while 6,327 stations report rainfall data, only 1,803 of them did so at least 90 percent of the time between 1951 and 2003; therefore, the authors interpolated data for the remaining station-year combinations. This interpolation was subsequently updated by the IMD to include later years. Using these data, we first construct historical medians of millimeters of rainfall for each month of the year, which in turn allows us to construct the absolute deviation of rainfall from the historical median for each month from 2009 through 2013. This variable is a measure of departure from the expected volume of rainfall for each month, allowing us to understand the extent to which October 2013, the month of Phailin's impact, represented an adverse weather shock in our sample.[1] Figure 1 shows the deviation of monthly rainfall from the monthly median taken over a five-year time series, averaged over all grid squares covered by the weather station data. This plot confirms that October 2013 was a major rainfall event, and that the only other obvious anomaly picked out by this measure, July 2009,

[1]The interpolated data is provided to us at a monthy scale. Summing rainfall over the month ensures that we capture the full effect of the storm. Taking deviations from historical levels ensures that any seasonally typical rainfall not associated with Phailin is not captured by our measure of shock.

corresponds to another known flooding event (Government of Orissa, 2010).[2] To assess the impact of flooding and storm damage, we will use the spatial variation in the intensity of October 2013 rainfall.[3]

3 Self-Help Groups and the TRIPTI Program

The Odisha Rural Livelihoods Program, TRIPTI, was launched in 2009. The program was funded by the World Bank and implemented by the Government of Odisha. TRIPTI was formed to address high rates of rural poverty in Odisha, with a particular focus on increasing diversification of livelihoods and the reduction of debt. TRIPTI operated in three steps: first, it created village-level SHGs by providing training on the management of group-based lending. Second, these federations were linked with services provided by the public and private sectors[4]. And third, using a participatory identification process and a village census, TRIPTI classified households into one of four categories: (1) extremely poor and vulnerable, (2) poor, (3) manageable, and (4) well-off, and provided grants to the first two categories of households.

The formalized rollout of TRIPTI was designed in conjunction with an impact evaluation in 2011. While this was nominally two years after the initiation of TRIPTI, the project had only started activities in 40 villages (out of an intended 1,020) across all project blocks. As part of the 2011 rollout, TRIPTI aimed to create 30,000 SHGs in 1,010 Gram Panchayats (GPs)[5] By 2015, TRIPTI had been implemented in 38 sub-districts in 10 coastal districts of Orissa. The treatment rule stipulated that the four least developed blocks in each of the

[2]The correlation between the July, 2009 shock and the October, 2013 shock across grid squares is low (-.08).

[3]To the extent that rainfall deviations are correlated with other factors creating damage such as wind or storm surge, this measure captures the effects of these factors as well. If rainfall is uncorrleated with wind or storm surge, these estimates understate the full effect of the storm on well-being. If effects of the storm spill over from areas that received high rainfall to neighboring areas, the impacts will similarly be understated.

[4]SHGs were linked with the Odisha State Seed & Organic Product Certification Agency for certification and the Odisha State Seed Corporation and the Odisha Agro Industries Corporation for seed production and subsidy, while the Animal Husbandry Department subsidized poultry purchases and related inputs. District Industries Centers helped farmers' groups establish linkages with agricultural markets. The state-run Mo-Badi program helped SHGs start kitchen gardens in member households, while the Directorate of Horticulture provided compost facilities to treated households. Many SHGs were also engaged in managing the mid-day meal program.

[5]Gram Panchayats are local government units encompassing an average of eight villages each.

10 targeted districts would receive the intervention and that an objective assignment score would be used to rank and choose these blocks. These assignment scores were calculated as a weighted average of the following variables: (i) the number of households belonging to the two lowest caste categories, Scheduled Castes and Tribes (SCs and STs), (ii) the total number of households, (iii) the number of SHGs that were deemed credit worthy[6] and (iv) a Composite Development Index developed and implemented nationally by the Indian government in 1993. In each district, all blocks were ranked by this score, and the four blocks with the highest score received TRIPTI. The SHGs were rolled out in a staggered manner across GPs, with all villages in the same GP entering the program simultaneously. In each district, the non-program blocks with the four next highest assignment scores were chosen as the control group for the evaluation. The TRIPTI impact evaluation exploits this assignment rule to evaluate TRIPTI by creating groups of communities that are treated by TRIPTI during the study period and groups that were not. To the extent that four blocks with the highest assessment scores not treated have scores that are very similar to those treated, the design approximates a regression discontinuity design. Since we cannot verify the methods of the assessment score, we prefer to interpret this design as a differences-in-differences approach, which accounts for fixed differences between treated and untreated blocks (Joshi, Palaniswamy and Rao, 2016).

3.1 Household Data from Evaluation of TRIPTI

To assess the impact of both the cyclone and TRIPTI on households in Odisha, we use household data from two surveys conducted by the World Bank in support of the impact evaluation of the TRIPTI intervention. In each of the 10 block-pairs selected for the impact evaluation, one treatment block and one control block were randomly sampled for the evaluation, yielding a total sample of 80 GPs. Since all households in treated areas are eligible for treatment, we present Intent-to-Treat estimates for the impact of the program. The baseline survey, conducted between July and October of 2011 included data on 2,875

[6]The rating of SHGs is an exercise that helps establish the SHG's credit-worthiness by comparing repayment rates and attendance to area averages. SHGs that "pass" the rating were deemed credit-worthy for TRIPTI. There are typically three grades, with the highest grades allowing SHGs to access credit directly from banks etc. The rating process is conducted by the state government federation of SHGs.

households from 160 randomly-selected villages, two in each of the 80 selected GPs. The endline, conducted between August and November 2014, revisited 2,874 of the same households from the baseline survey. Both survey rounds collected information on household consumption expenditure following the Indian National Sample Survey consumption module, livelihoods and debt profiles, as well as proxy measures of women's civic engagement and inputs to household decision-making.

In the face of a negative income shock, as likely caused by events like Phailin, households use multiple strategies to cope with shocks to well-being, including relying on government assistance, taking out additional loans, reallocating resources within the household, and drawing down previously-accumulated stocks of food and savings (Gallagher, 2014; Gallagher and Hartley, n.d.; Deryugina, Kawano and Levitt, 2014). Therefore, we focus on borrowing from SHGs and other lenders, home production and consumption of food and non-food items as our key outcomes of interest. These data have several useful features that allow us to understand the effect of both TRIPTI and Cyclone Phailin. The first is the timing. The baseline survey was conducted in July 2011, two years before Phailin made landfall in October 2013. The endline was collected one year later in August 2014. The second key feature is the spatial overlap between villages that received TRIPTI and Phailin's impact zone. As shown in Figure 2, the surveyed communities overlapped significantly with Phailin-hit areas. This allows us to use spatial variation in the rainfall shock as well as the staggered roll-out of TRIPTI to estimate the impact of Phailin. The third advantage is the topical relevance of the survey data, which yields information on precisely the above-mentioned coping strategies used by households to cope with a natural disaster.

TRIPTI was not randomly assigned, so one concern in identifying its effect is that households offered the chance to participate in SHGs formed by TRIPTI may differ from those who do not have this opportunity. The project's impact evaluation report studies balance at baseline for key outcomes of interest, a few of which are significantly different (Joshi, Palaniswamy and Rao, 2016). They find that at baseline, 67.8% of households in project areas reported being SHG members compared to 74.3% in non-project areas. In addition, while 35% of households in project areas relied on SHGs for savings, only 31.4% did so in treatment areas. In appendix table A1, we replicate the balance checks comparing TRIPTI and non-TRIPTI communities. Out of the 24 outcomes studied, we find baseline imbalance in three. Households in communities where TRIPTI set up SHGs consumed a higher value of food from home production, were more likely to have a current loan, and were less likely to be famililar with the village government structure before the TRIPTI intervention. This level of imbalance is consistent with what would be expected from randomized treatment assignment. The baseline values of these variables also do not vary systematically in a pattern that would suggest strategic selection of treatment villages.

Previously reported results (Joshi, Palaniswamy and Rao, 2016) show that households in TRIPTI areas were 22 percent more likely to participate in self-help groups, and 7.7 percent more likely to borrow from formal or institutional sources of credit. However, the evidence on household welfare is more mixed: there was no measurable impact on household consumption, but expenditures on healthcare and women's and children's goods increased significantly. While there were few impacts on livelihood strategies in program areas, households in treated areas reported providing two more days labor to the National Rural Employment Guarantee Scheme (NREGS) than households in control areas relative to a baseline level of slightly under two days. This increase in participation in NREGS was driven by women in treated areas. In addition, women's autonomy over their mobility improved in TRIPTI areas, although this effect was driven by women in treated areas being more likely to go to SHGs meetings (17.8 percent) and to the bank (5.3 percent) alone. There were, however, no effects on women's self-reported influence in household decision-making as measured by an index of women's say in (1) the household purchase of durables, (2) goods for her personal consumption, (3) tuition expenses, (4) the household's livelihood strategy, and (5) household decisions regarding political participation. On the other hand, public action seems to have been higher in TRIPTI areas, with women in treated blocks being 5 percent more likely to use Gram Panchayat meetings to raise problems with domestic violence and alcoholism as well as to address any issues with the Public Distribution and Mid-Day Meal Schemes. Finally, an overall index of willingness to act on these problems was higher by 8.1 percentage points while an index of willingness to pursue institutional response to these community problems was 12.8 percentage points higher in treated areas (Joshi, Palaniswamy and Rao, 2016).

4 Methodology

The analytical objectives of this paper are to (1) establish the effects of Phailin on household welfare, and (2) examine the extent to which TRIPTI mitigates the effect of Phailin on household well-being. To this end, we aim to measure the effect of exposure to Phailin, but our primary parameter of interest is the interacted effect of Phailin and TRIPTI. We begin by showing that Phailin represented a significant negative welfare shock to the households in the TRIPTI impact evaluation data.

4.1 Phailin Exposure in TRIPTI Communities

In the endline survey for the TRIPTI evaluation, one year following Phailin's landfall, the household survey module included questions about the household's experience with Phailin. This allows us to document exposure to the storm in our sample and to verify that our measure of exposure to the cyclone is relevant for households in our data. The upper left panel of figure 3 shows the distribution of the rainfall shock in our sample and the proportion of households who reported that their residence was flooded during the week of Phailin. This figure confirms two key facts. First, there is a wide degree of variation in exposure to more or less intense rainfall shocks as measured in the IMD data. The households living in the areas with the biggest deviations from their grid square's median rainfall in October experience rainfall shocks approximately three times greater than the households living in grid squares with the smallest deviations from typical rainfall in October. Second, the darker line indicates that the rainfall shock is tightly related to households' own reports of damaging flooding. In the grid squares experiencing the smallest rainfall shocks, less than 10 percent of households reported that water had entered their house. In the grid squares that experienced the biggest rainfall shocks, this proportion was approximately 25 percent.

Flooding of households is only indicative of damage, and households in our sample may have been affected by consequences of the cyclone other than flooding. To assess whether the rainfall shock identifies these alternative experiences, Figure 3 shows the proportion of households who experienced the following measures according to the rainfall shock in their grid square: received an evacuation notice, left their house for shelter, received any government aid, and received aid for home repairs. These plots confirm that the rainfall shock is a strong predictor of a wide array of self-reported impacts of the storm, and gives us confidence that rainfall shock is a useful summary of the intensity with which households were affected by the storm.

Figure 3 confirms that the households in the TRIPTI evaluation data were affected by Phailin and that there is substantial variation in this sample in the intensity with which these households were affected. But Phailin exposure is not randomly assigned. For example, cyclones tend to be most powerful on landfall and exhaust their strength as they move inland. So we would expect that households in coastal grid squares to be more exposed than those living in grid squares that are far inland. To understand how rainfall shocks may be correlated with characteristics of households, we perform balance tests on Phailin exposure where we test characteristics of households at baseline, prior to Phailin's landfall, between households where the rainfall shock was above or below the median shock. Results are reported in Appendix Table A2. In general, household characteristics were relatively balanced according to Phailin intensity. Important areas where there are differences include that more exposed households consumed more food from home production, were more likely to have taken a loan, and where less likely to have heard of Gram Sabhas, which are open village meetings that are part of the Indian system of village governance.

4.2 Identifying the Effects of Phailin and TRIPTI

Having checked visually that the households in our dataset were indeed affected by the storm, we next proceed to econometrically estimating the impacts of Phailin on household welfare and any mitigating effects of TRIPTI. First, to quantify the effect of Phailin on households' well-being, we estimate the reduced form effect of Phailin on household well-being using the following difference-in-differences specification:

$$Y_{tigj} = \alpha + \beta log(Rain)_g + \gamma Post_t + \delta Post_t * log(Rain)_g + \psi_j + \epsilon_{tigj} \quad (1)$$

where Y_{tij} is a measure of household well-being in year t for household i in district j (like assets, income, or household expenditure). The variable "$log(Rain)_g$" is the natural log of deviations from monthly historical median rainfall for grid square g in October 2013. The variable $Post_t$ indicates that an observation was taken from the endline (2014) survey rather than the baseline (2011) survey. ψ_j is a vector of indicator variables for the administrative block in which household i resides. This is like a difference-in-difference regression of the effect of cyclone intensity on household well-being except that the "cyclone treatment" measure is continuous rather than discrete. The coefficient α is the baseline average value of the outcome Y_{tij} for households in locations where rainfall in October 2013 was exactly the historical average for the month of October for that location. The coefficient β is the difference in the baseline value of Y_{tij} correlated with each additional millimeter of rainfall received in October 2013; this coefficient thus captures starting differences across locations where the Phailin shock was especially intense. If, at baseline, places that were later especially vulnerable to Phailin were different than places that were less vulnerable, the coefficient β would capture these differences. β is thus a measure of the average starting differences between households that were more exposed to the cyclone and those that were less so. The coefficient γ is the change in Y_{tij} in the locations that were not affected by Phailin. The coefficient δ is the primary effect of interest in this specification, and captures the differences in Y_{tij} caused by exposure to greater rainfall from Phailin. A negative sign on δ means that locations exposed to higher rainfall in October 2013 had greater declines (or slower growth) in Y_{tij} than places that had lower rainfall. Because we allow Y_{tij} to vary at baseline according to vulnerability to Phailin (as captured in the coefficient β), this specification also prevents any correlation between the fixed characteristics of households or villages that may be correlated with both Phailin exposure and the outcomes Y_{tij} from contaminating δ. Finally, as in the usual differences-in-differences approach, the causal effect of Phailin is identified by δ if differences in outcomes between more and less affected areas are constant over time for reasons other than the cyclone. In this specification, we cluster standard errors at the rainfall grid level and include block fixed effects. Clustering at the rainfall grid level accounts for the fact that two observations from the same grid are not statistically independent draws from the population of interest.

To explore the question of whether TRIPTI mitigates consequences of Phailin exposure for households, we estimate the effect of TRIPTI on Phailin-affected households using the following triple difference specification:

$$\begin{aligned} Y_{tighj} = \alpha + \beta log(Rain)_g + \gamma Post_t + \delta Post_t * log(Rain)_g \\ + \theta TRIPTI_h + \lambda TRIPTI_h * Post_t + \pi TRIPTI_h * log(Rain)_g \\ + \rho TRIPTI_h * Post_t * log(Rain)_g + \psi_j + \epsilon_{tighj} \end{aligned} \quad (2)$$

As in the double difference specifications above, the coefficients α, β, γ, δ, θ, λ and π capture differences in starting values or time trends that are not associated with the combined impact of TRIPTI and Phailin. The vector ψ_j captures fixed differences between administrative blocks. Additionally, in this specification, the effect of living in a TRIPTI-treated village h in a Phailin-hit area is estimated by a triple difference. Specifically, the coefficient ρ is the effect of TRIPTI on the year-to-year change in household welfare, between baseline and endline, across areas with different exposure to absolute deviations in rainfall due to Phailin. For measures where higher (lower) values of Y indicate greater welfare, when ρ is positive (negative), we conclude that the project had a buffering effect on households that were worst-hit by Phailin. In this specification, we cluster standard errors at the grid-village level and include block fixed effects. Grid-village clustering accounts for non-independence of observations from the same village or the same grid square, while allowing for a different correlation structure for different grids in the same village or different villages in the same grid.

5 Results

5.1 Direct Impacts of Phailin

The double difference of Phailin exposure as shown in equation (1) yields evidence of a significant reduction in total household expenditure per capita. Results shown in the upper panel of Table 1 suggest that a doubling in the size of the rainfall shock reduced per capita consumption by a third. This reduction was primarily driven by lower per capita food expenditure (Anttila-Hughes and Hsiang, 2013). Households appeared to switch away from purchased food to home produced food, suggesting that a coping strategy might have included drawing down their stocks of food. While health and education expenditures did not change after Phailin, per capita festival expenditures increased by a magnitude of 8 percent, significant at the 99 percent level of confidence. The increase in festival expenditures is similar in magnitude and significance to a decrease in women's expenditures, suggesting that women are buffering the households after Phailin.

The timing of Phailin relative to our fieldwork allows us to estimate expenditures on festivals both before and after the cyclone. To confirm that this is indeed being driven by Phailin and not an artifact of the data, we can exploit the timing of festivals relative to the survey to conduct a placebo test of sorts by comparing expenditures on festivals prior to Phailin to expenditures on festivals following Phailin. Dussehra was coincident with the start of Phailin, while Diwali was right after. Other festivals followed, including Christmas, then New Year's, then Raja eight months after Phailin's landfall. In results presented in Appendix Table A3, we show that the most-affected areas spent more on Raja and other festivals, suggesting that the increase in per capita festival expenses stems from expenditures on festivals that occurred after Phailin. At least three reasons may explain this increase: that such expenses are a demonstration of gratitude for having survived a traumatic event; households have more disposable income due to the influx of post-Phailin aid; and they are an investment in social capital that may yield future private returns such as lower prices on food or lower interest on loans, as found in previous literature on festival expenditures (Rao, 2001).

The first panel of Table 3 examines the impacts of Phailin on women in further detail. The

National Rural Employment Guarantee Scheme is the world's largest public works program, providing 100 days of paid work to the rural poor. We find that this program appears to have been less accessed in the worst-hit areas. Facing a twice-as-intense rainfall shock led to three fewer days of NREGS-provided work for women. These women were also half as likely to have been aware of the last village council meeting, but more likely to know the Chief Minister's name. Although NREGS is supposed to prevent households from falling into poverty, this finding is indicative that it may fail serve this protective function in the case of consumption shocks arising from extreme weather events.

5.2 Additional Contribution of TRIPTI on Buffering Effects of Phailin: Total Effect of Phailin in Triple Differences

To examine the impact of TRIPTI on Phailin-affected households, we estimate the triple-difference specification presented in equation (3). Table 1 shows that TRIPTI offset the decline in total non-food expenditures after Phailin but had no effect on food expenditure. Non-food items may be easier to finance through credit, thus these markets may have been less affected by Phailin than food markets (Carleton and Hsiang, 2016). Tellingly, the decrease in expenditure on women's goods was primarily observed in non-TRIPTI areas, which may reflect the female empowerment effects of SHG participation (Brody et al., 2015; Sanyal, Rao and Majumdar, 2013; Datta, 2015). While the triple difference estimate is not significant, the estimated effect is approximately half of the double difference estimate for Phailin, suggesting that TRIPTI may have buffered the impacts of Phailin for some women. The effect of Phailin on children's goods is proportionally similar to the effect on women's goods, but we cannot reject the hypothesis of a zero effect on children's expenses. This pair of results is consistent with the finding by Anttila-Hughes and Hsiang (2013) that households reduce investments in human capital and luxury foods, but not non-food expenditure.

Results presented in the lower panel of Table 2 show that the government's response to Phailin suggests that the government used TRIPTI's infrastructure to distribute aid. Estimates show that TRIPTI expanded access to loans; in addition, Phailin and non-Phailin affected areas had similar access to credit. In particular, in Phailin affected areas, TRIPTI households took out a greater number of loans than in non-Phailin areas. The double difference also shows the credit expansion effect of TRIPTI. First time borrowing from SHGs increased in the wake of Phailin, but is not driven by new lending by TRIPTI suggesting that credit may have expanded to meet greater demand for loans after Phailin. In addition to these extensive margin effects on borrowing from SHGs in non-TRIPTI areas, we also find evidence of intensive margin effects (larger sums borrowed) in TRIPTI areas. The estimates also show that although Phailin reduced the amount of borrowing in non-TRIPTI areas, that TRIPTI was able to mitigate this restriction in credit after Phailin. Finally, Table 3 shows that TRIPTI increased awareness of the last village council meeting, offsetting the negative effect of Phailin. This triple interaction is consistent with TRIPTI making it easier to facilitate community meetings in order to provide information about aid programs or indeed to leverage aid.

6 Interpretation and Discussion

Cyclone Phailin significantly reduced consumption expenditures for affected households in Odisha, India. The SHG intervention, TRIPTI, was able to mitigate some of these impacts. Specifically, the ability of Phailin-hit households in TRIPTI areas to increase their consumption of non-food expenditures relative to Phailin-hit non-TRIPTI households implies that SHGs can help rebuild capital assets. However, the effect on food consumption by these households is just as large in TRIPTI areas as in non-TRIPTI areas, suggesting that SHGs are not a substitute for emergency food aid programs. The worst-hit households spend less on women's goods but more on social expenditures, providing concrete evidence that women buffer their households from negative consumption shocks and are likely to be among the most vulnerable to the effects of climate. Results also show that governments can use SHGs to channel financial aid after extreme weather events as post-Phailin borrowing increased to a greater degree in TRIPTI areas, and households stayed engaged with the local governance structure used by TRIPTI whereas in non-TRIPTI areas knowledge of local governance was replaced by increased salience of state-level politics.

One interpretation of our results is that credit options were limited after Phailin, which in turn induced people to turn to SHGs as a source of loans. In non-TRIPTI areas, households that were more affected by Phailin were more likely to take out their first loans from SHGs, while in TRIPTI areas, the worst-hit households took out additional SHG loans. Both results suggest that expansion of credit may have been a response to the damages inflicted by Phailin.

Because extreme weather events are not randomly assigned, no single study can ever rule out that confounding trends led to spurious correlation. However, this context provides a useful example of one policy tool that may be used to improve resilience to extreme weather events. Future research should investigate the ability of social safety nets, including microcredit interventions, at mitigating the impacts of extreme weather events. Such research may include a comparison of the cost-effectiveness of SHGs to other disaster-response programs.

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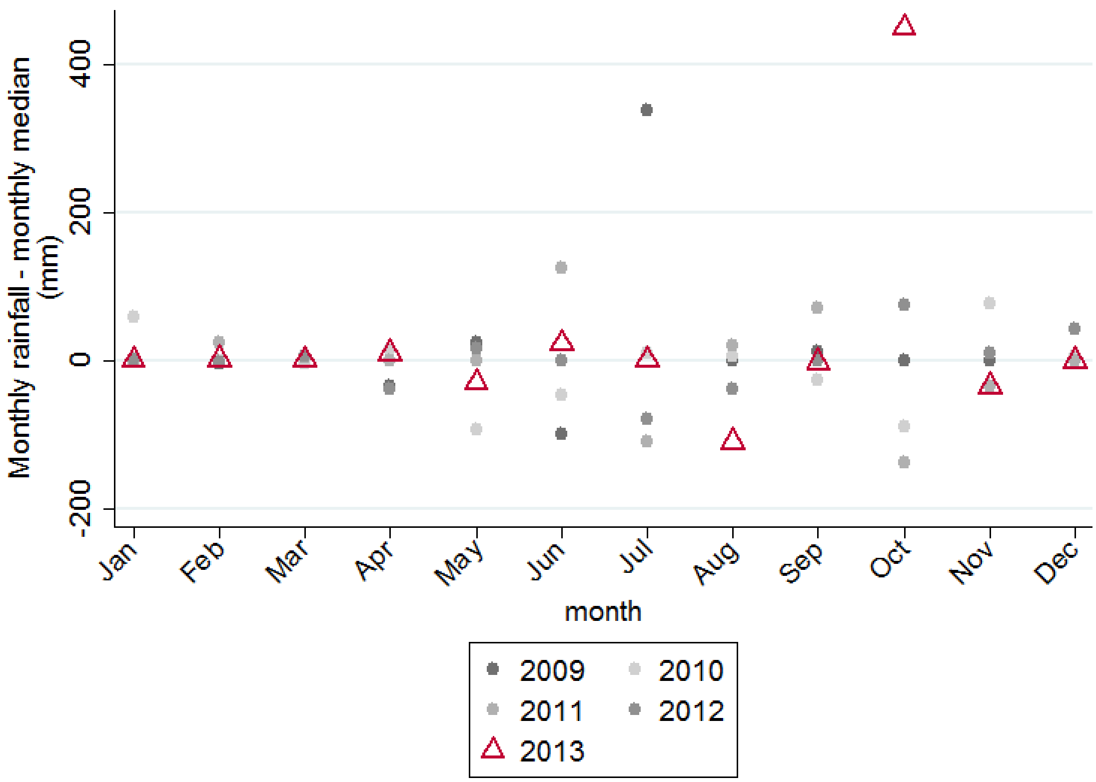
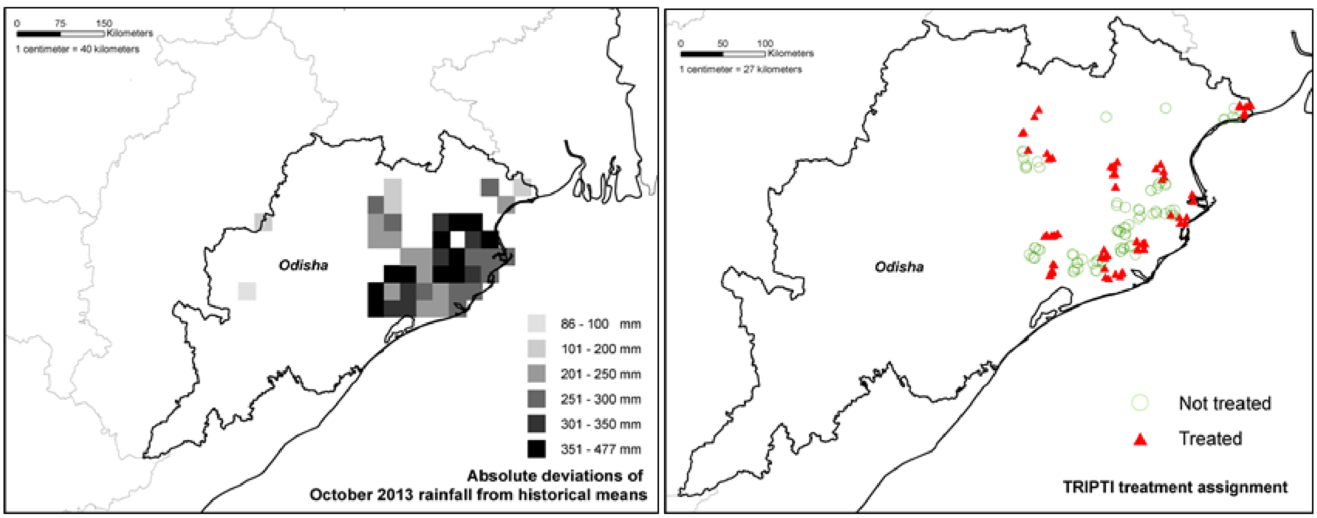
7 Figures and Tables

Figure 1: Rainfall shock caused by Cyclone Phailin



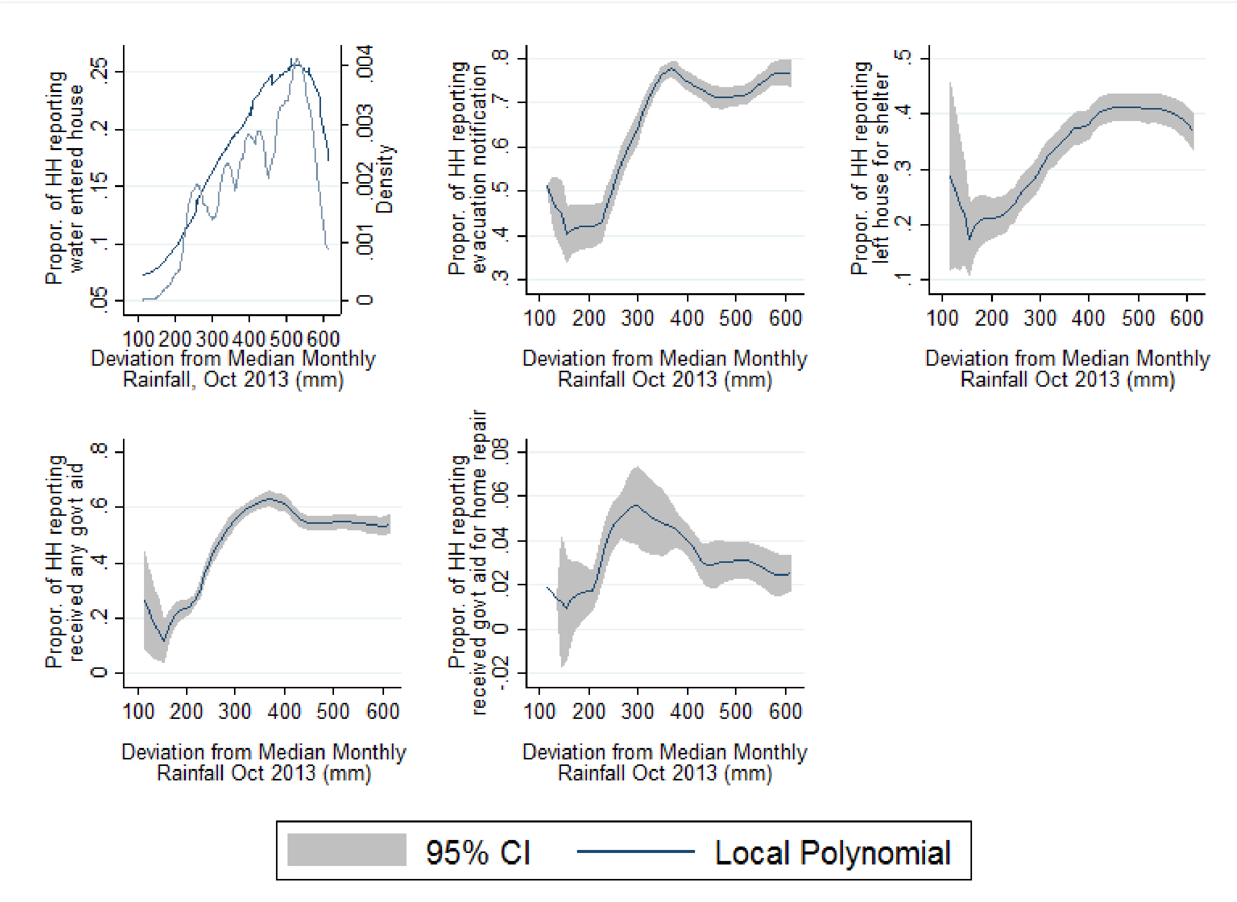
Source: Authors' Calculations from IMD Data

Figure 2: Overlap in Exposure to Cyclone Phailin and Treatment by TRIPTI



Source: Authors' Calculations from IMD Data and TRIPTI IE Survey Data

Figure 3: Distribution of households experiencing evacuation in our sample



Source: Authors' Calculations from IMD and TRIPTI IE Survey Data

Table 1: The Effects of TRIPTI and Phailin on Per Capita Expenditures

	Total Expenditure	Food	Home Production	Purchased Food	Non-Food	Festivals	Health	Education	Women's Goods	Children's Goods
LN(Rainfall Deviation)	-1398.790	-1066.135	-131.424***	-939.625	-556.111**	-725.319***	-417.692	-4164.835**	-723.671***	-255.020***
	(1082.373)	(1072.164)	(32.396)	(1073.945)	(246.743)	(227.890)	(312.340)	(1654.985)	(259.608)	(96.842)
Post	19254.891***	19874.685***	-720.596***	20590.443***	-675.154	-1686.978***	-521.013	-15741.115	2541.409***	820.558
	(3625.866)	(3578.995)	(121.967)	(3576.005)	(933.767)	(416.025)	(1066.659)	(16452.641)	(918.656)	(565.589)
Post X LN(Rainfall Deviation)	-3439.441***	-3575.257***	122.680***	-3699.893***	162.702	367.069***	74.563	3135.084	-422.415***	-104.219
	(645.155)	(636.553)	(22.186)	(636.023)	(168.928)	(74.272)	(188.180)	(3032.097)	(162.847)	(101.538)
Constant	10168.961*	7860.538	812.590***	7075.055	3820.935***	4341.837***	3215.409*	24432.075***	4791.983***	1613.930***
	(6038.682)	(5981.524)	(181.233)	(5991.504)	(1379.807)	(1280.720)	(1751.285)	(9211.699)	(1454.364)	(541.529)
Total Effect of Phailin	15815.451	16299.427	-597.916	16890.549	-512.452	-1319.910	-446.450	-12606.031	2118.993	716.339
p-value	0.00	0.00	0.00	0.00	0.50	0.00	0.61	0.35	0.01	0.12
TRIPTI village	2179.408	2838.539	-144.441	2997.286	-1021.667	-1230.416***	-2638.238	-14857.354	-879.300	-1078.935**
	(5728.593)	(5609.671)	(125.949)	(5589.350)	(1170.832)	(395.086)	(2294.249)	(9742.777)	(881.190)	(457.417)
LN(Rainfall Deviation)	-1286.942	-1019.102	-115.393***	-909.414	-448.310*	-687.363***	-380.352	-2984.548**	-775.608***	-327.232***
	(1119.341)	(1106.253)	(32.511)	(1107.988)	(261.477)	(227.092)	(363.888)	(1278.726)	(268.385)	(102.377)
Post	19741.189***	19182.441***	-516.012***	19701.043***	1313.702	-1015.484*	283.280	1396.508	3268.860**	731.752
	(4240.514)	(4144.961)	(169.083)	(4138.629)	(1195.649)	(602.011)	(1447.033)	(5709.481)	(1342.122)	(556.431)
TRIPTI X Post	-1681.851	840.148	-413.618*	1231.955	-4291.630**	-1160.976	-1177.214	-34224.221	-1369.706	459.801
	(7501.915)	(7393.084)	(231.397)	(7380.776)	(1836.029)	(791.289)	(2155.450)	(27408.490)	(2004.950)	(1109.501)
TRIPTI X LN(Rainfall Deviation)	-384.082	-502.955	28.108	-533.541	183.066	222.889***	449.380	2693.801	173.212	193.229**
	(1033.872)	(1012.242)	(22.571)	(1008.641)	(209.504)	(70.656)	(404.951)	(1773.382)	(157.245)	(81.966)
Post X LN(Rainfall Deviation)	-3511.005***	-3431.508***	87.884***	-3522.795***	-202.058	246.009**	-93.954	58.672	-554.753**	-97.595
	(761.296)	(744.403)	(30.795)	(743.234)	(213.704)	(106.426)	(255.454)	(1046.710)	(236.293)	(100.365)
TRIPTI X Post X LN(Rainfall Deviation)	269.453	-190.457	69.953*	-256.299	785.571**	208.975	264.793	6140.218	245.368	-64.324
	(1339.757)	(1319.580)	(42.069)	(1317.331)	(332.642)	(141.754)	(382.660)	(5009.890)	(357.278)	(199.444)
Constant	9528.703	7584.552	717.782***	6898.135	3218.046**	4123.533***	3057.043	17750.426**	5049.306***	2018.859***
	(6207.325)	(6133.389)	(181.344)	(6143.147)	(1459.518)	(1278.363)	(2028.791)	(7076.496)	(1500.646)	(570.243)
Total Effect of TRIPTI	2064.780	2145.127	-46.380	2207.446	-53.030	-798.553	-1924.065	-6023.335	-460.721	-950.029
p-value	0.71	0.69	0.72	0.68	0.96	0.05	0.35	0.30	0.52	0.02
Total Effect of Phailin	16499.637	15560.475	-358.175	15921.950	1897.214	-560.500	454.120	7595.398	2959.475	569.833
p-value	0.00	0.00	0.04	0.00	0.12	0.36	0.76	0.13	0.03	0.32
Control (TRIPTI) Observations	2694	2694	2694	2694	2694	2613	2663	2665	2624	2656
Treated (TRIPTI) Observations	2095	2095	2095	2095	2095	2013	2054	2048	2029	2053

Notes: ***sig. at 1%, **sig. at 5%, *sig. at 10%. All specifications include block fixed effects. The top panel includes standard errors clustered at the village; the bottom panel includes standard errors clusters by grid-village.

Table 2: The Effects of TRIPTI and Phailin on Household Borrowing

	Any Current Loan	Total Number of Current Loans	Total Amount Currently Borrowed	Any Current Loans from an SHG
Post	-0.124	-0.291	75645.547	-0.299
	(0.696)	(2.932)	(63629.029)	(0.187)
LN(Rainfall Deviation)	-0.038	0.077	-10845.947	-0.015
	(0.092)	(0.506)	(11328.846)	(0.039)
Post X LN(Rainfall Deviation)	0.049	0.089	-10606.043	0.057*
	(0.122)	(0.521)	(11279.328)	(0.033)
Constant	0.831	1.304	81984.901	0.165
	(0.519)	(2.845)	(63425.972)	(0.221)
Total Effect of Phailin	-0.074	-0.202	65039.503	-0.242
p-value	(0.90)	(0.93)	(0.22)	(0.12)
TRIPTI village	-0.674	0.072	63209.621	0.214
	(0.765)	(2.838)	(52984.540)	(0.495)
Post	-0.223	4.287**	113704.287*	-0.623***
	(0.471)	(1.732)	(65476.226)	(0.223)
LN(Rainfall Deviation)	-0.059	0.297	-7253.530	-0.020
	(0.096)	(0.414)	(11358.829)	(0.041)
TRIPTI X Post	0.431	-10.405***	-112395.327	0.667**
	(0.952)	(3.271)	(110989.166)	(0.309)
TRIPTI X LN(Rainfall Deviation)	0.117	-0.007	-11522.355	-0.035
	(0.135)	(0.505)	(9436.419)	(0.088)
Post X LN(Rainfall Deviation)	0.062	-0.737**	-18299.386	0.113***
	(0.084)	(0.302)	(11518.075)	(0.039)
TRIPTI X Post x LN(Rainfall Deviation)	-0.066	1.872***	21853.711	-0.117**
	(0.167)	(0.586)	(19678.155)	(0.055)
Constant	0.957*	0.064	62499.853	0.187
	(0.540)	(2.328)	(63782.764)	(0.234)
Total Effect of TRIPTI	-0.623	1.937	73540.977	0.062
p-value	0.39	0.45	0.14	0.89
Total Effect of Phailin	-0.228	5.423	117258.612	-0.627
p-value	0.65	0.00	0.08	0.01
Control (TRIPTI) Observations	2736	2189	2732	2736
Treated (TRIPTI) Observations	2116	1741	2114	2116

Notes: ***sig. at 1%, **sig. at 5%, *sig. at 10%. All specifications include block fixed effects. The top panel includes standard errors clustered at the village; the bottom panel includes standard errors clusters by grid-village.

Table 3: The Effects of TRIPTI and Phailin on Women's Civic Engagement

	Days Worked under NREGA	Days of Paid Work under NREGA	Knows the Name of the Chief Minister	Has Heard of Village Meeting (Gram Sabha)	Attended the Last Village Meeting	Voted in the Last Village Council (Gram Panchayat) Election
LN(Rainfall Deviation)	2.543	1.561	-0.159*	0.117	0.022	-0.012
	(1.864)	(2.011)	(0.086)	(0.082)	(0.041)	(0.033)
Post	8.031	21.060**	-0.825**	1.670***	0.116	-0.238
	(6.635)	(7.928)	(0.312)	(0.470)	(0.176)	(0.178)
Post X LN(Rainfall Deviation)	-1.306	-3.563**	0.171***	-0.274***	-0.016	0.038
	(1.179)	(1.391)	(0.056)	(0.085)	(0.032)	(0.032)
Constant	-13.385	-7.450	1.332***	-0.527	-0.108	1.008***
	(10.431)	(11.266)	(0.484)	(0.460)	(0.228)	(0.186)
Total Effect of Phailin	6.725	17.497	-0.654	1.396	0.100	-0.201
p-value	0.22	0.01	0.01	0.00	0.49	0.17
TRIPTI village	-0.441	3.604	-1.552**	0.020	0.064	0.183
	(10.882)	(13.251)	(0.718)	(0.492)	(0.191)	(0.247)
LN(Rainfall Deviation)	2.626	1.756	-0.191**	0.142*	0.021	-0.006
	(2.333)	(2.570)	(0.086)	(0.077)	(0.034)	(0.038)
Post	7.718	21.150*	-0.547	2.263***	0.069	-0.183
	(6.907)	(10.991)	(0.447)	(0.490)	(0.176)	(0.183)
TRIPTI X Post	0.327	-1.876	-0.062	-1.382**	0.079	-0.189
	(13.537)	(20.318)	(0.608)	(0.633)	(0.311)	(0.310)
TRIPTI X LN(Rainfall Deviation)	0.127	-0.599	0.280**	-0.008	-0.013	-0.035
	(1.922)	(2.345)	(0.128)	(0.090)	(0.035)	(0.045)
Post X LN(Rainfall Deviation)	-1.448	-3.746*	0.129	-0.384***	-0.008	0.029
	(1.215)	(1.900)	(0.078)	(0.087)	(0.032)	(0.033)
Treat X Post X LN(Rainfall Deviation)	0.300	0.636	-0.005	0.257**	-0.014	0.031
	(2.413)	(3.562)	(0.107)	(0.114)	(0.056)	(0.056)
Constant	-13.908	-8.601	1.507***	-0.657	-0.099	0.982***
	(13.090)	(14.422)	(0.485)	(0.434)	(0.192)	(0.214)
Total Effect of TRIPTI	-0.013	3.640	-1.277	0.268	0.037	0.179
p-value	1.00	0.77	0.04	0.53	0.82	0.44
Total Effect of Phailin	6.570	18.040	-0.423	2.136	0.048	-0.122
p-value	0.37	0.12	0.35	0.00	0.80	0.52
Control (TRIPTI) Observations	2713	2713	2713	2713	2713	2713
Treated (TRIPTI) Observations	2085	2085	2085	2085	2085	2085

Notes: ***sig. at 1%, **sig. at 5%, *sig. at 10%. All specifications include block fixed effects. The top panel includes standard errors clustered at the village; the bottom panel includes standard errors clusters by grid-village.

8 Appendix

Table A1: Baseline Balance in TRIPTI Treatment Assignment

	(1) Non-TRIPTI		(2) TRIPTI		T-test Difference
Variable	N	Mean/SE	N	Mean/SE	(1)-(2)
Total Expenditure Per Capita (Rs.)	1547	2388.851 (325.133)	998	2413.096 (388.437)	-24.245
Total Food Expenditure Per Capita (Rs.)	1569	1895.222 (308.292)	1029	1913.821 (360.493)	-18.599
Value of Home Produced Food Per Capita (Rs.)	1569	72.357 (6.998)	1029	85.047 (10.859)	-12.689**
Expenditure on Food from Market Per Capita (Rs.)	1569	1822.599 (305.772)	1029	1828.222 (356.660)	-5.623
Expenditure on Non-Food Per Capita (Rs.)	1547	466.677 (27.930)	998	439.827 (26.371)	26.850
Ann. Expenditure on All Festivals (Rs.)	1547	285.033 (21.370)	998	269.097 (34.483)	15.936
Expenditure on Raja (Rs.)	1550	69.180 (7.714)	1009	62.113 (8.186)	7.067
Expenditure on Dusshera (Rs.)	1558	39.780 (2.708)	1011	38.966 (3.890)	0.815
Expenditure on Diwali (Rs.)	1556	27.011 (2.617)	1011	24.117 (2.120)	2.894
Expenditure on Other Festivals (Rs.)	1571	145.960 (15.417)	1009	140.740 (31.537)	5.220
Expenditure on Health (Rs.)	1547	915.824 (77.989)	998	843.024 (106.668)	72.800
Expenditure on Education (Rs.)	1547	1188.440 (100.814)	998	1116.090 (149.312)	72.350
Expenditure on Women's Goods (Rs.)	1525	726.989 (34.164)	993	760.123 (61.126)	-33.134
Expenditure on Children's Goods (Rs.)	1547	199.398 (20.081)	998	167.150 (14.816)	32.248*
=1 Any Loan	1608	0.618 (0.038)	1050	0.614 (0.058)	0.004
Number of Loans	1066	1.687 (0.082)	677	1.873 (0.154)	-0.186
Total Value of Loans (Rs.)	1608	22822.886 (2203.956)	1050	18626.689 (2585.603)	4196.197*
=1 Any Loan from an SHG	1608	0.069 (0.010)	1050	0.104 (0.027)	-0.035*
Days Worked Under NREGA	1586	0.793 (0.273)	1019	1.055 (0.413)	-0.262
Days of Paid Work Under NREGA	1586	1.255 (0.343)	1019	1.473 (0.621)	-0.218
=1 Knows the Name of Chief Minister	1586	0.433 (0.022)	1019	0.459 (0.028)	-0.027
=1 Has Heard of the Gram Sabha	1586	0.146 (0.024)	1019	0.102 (0.025)	0.044**
=1 Attended the Last Village Meeting	1586	0.016 (0.004)	1019	0.018 (0.005)	-0.002
=1 Voted in Last Village Council	1586	0.945 (0.006)	1019	0.940 (0.009)	0.004

Notes: The value displayed for t-tests are the differences in the means across the groups. Standard errors are clustered at variable cluster. Fixed effects using variable district code are included in all estimation regressions. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table A2: Baseline Balance in Phailin-affected Villages

Variable	(1) Above Median Rainfall N	(1) Above Median Rainfall Mean/SE	(2) Below Median Rainfall N	(2) Below Median Rainfall Mean/SE	T-test Difference (1)-(2)
Total Expenditure Per Capita (Rs.)	1313	1942.842	1232	2883.823	-940.980
		(343.162)		(485.942)	
Total Food Expenditure Per Capita (Rs.)	1333	1476.075	1265	2352.030	-875.955
		(342.222)		(449.203)	
Value of Home Produced Food Per Capita (Rs.)	1333	91.315	1265	62.702	28.613**
		(10.437)		(8.816)	
Expenditure on Food from Market Per Capita (Rs.)	1333	1384.527	1265	2288.794	-904.267
		(336.570)		(444.159)	
Expenditure on Non-Food Per Capita (Rs.)	1313	444.284	1232	468.792	-24.509
		(21.661)		(35.316)	
Ann. Expenditure on All Festivals (Rs.)	1313	276.914	1232	280.778	-3.864
		(22.019)		(32.352)	
Expenditure on Raja (Rs.)	1313	61.014	1246	72.062	-11.048
		(9.123)		(9.906)	
Expenditure on Dusshera (Rs.)	1313	40.965	1256	37.887	3.078
		(3.563)		(3.216)	
Expenditure on Diwali (Rs.)	1313	26.978	1254	24.713	2.265
		(2.814)		(2.621)	
Expenditure on Other Festivals (Rs.)	1313	147.866	1267	139.828	8.038
		(19.639)		(22.878)	
Expenditure on Health (Rs.)	1313	947.955	1232	822.608	125.346
		(123.038)		(76.363)	
Expenditure on Education (Rs.)	1313	1138.219	1232	1183.355	-45.136
		(121.474)		(119.718)	
Expenditure on Women's Goods (Rs.)	1308	732.250	1210	748.494	-16.244
		(60.193)		(43.814)	
Expenditure on Children's Goods (Rs.)	1313	195.522	1232	177.407	18.115
		(25.606)		(14.646)	
=1 Any Loan	1333	0.680	1325	0.553	0.126*
		(0.054)		(0.048)	
Number of Loans	952	1.661	791	1.877	-0.217
		(0.106)		(0.174)	
Total Value of Loans (Rs.)	1333	22224.246	1325	20099.851	2124.395
		(2841.853)		(2384.584)	
=1 Any Loan from an SHG	1333	0.104	1325	0.062	0.042
		(0.023)		(0.014)	
Days Worked Under NREGA	1313	1.023	1292	0.766	0.257
		(0.376)		(0.321)	
Days of Paid Work Under NREGA	1313	1.716	1292	0.959	0.757
		(0.627)		(0.322)	
=1 Knows the Name of Chief Minister	1313	0.450	1292	0.436	0.014
		(0.034)		(0.025)	
=1 Has Heard of the Gram Sabha	1313	0.079	1292	0.179	-0.100***
		(0.023)		(0.025)	
=1 Attended the Last Village Meeting	1313	0.012	1292	0.021	-0.009
		(0.004)		(0.005)	
=1 Voted in Last Village Council	1313	0.939	1292	0.947	-0.008
		(0.009)		(0.007)	

Notes: The value displayed for t-tests are the differences in the means across the groups. Standard errors are clustered at variable cluster. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table A3: The Effects of TRIPTI and Phailin on Per Capita Festival Expenses

	All Festivals	Raja 2014	Dussehra 2013	Diwali 2013	Other Festivals in 2013-14
LN(Rainfall Deviation)	-725.319***	-174.666***	-149.025	-88.479**	-469.477**
	(227.890)	(52.231)	(95.075)	(40.886)	(189.413)
Post X LN(Rainfall Deviation)	367.069***	147.423***	10.402	-3.745	263.843***
	(74.272)	(32.513)	(31.705)	(15.966)	(50.473)
Post	-1686.978***	-633.470***	-5.614	79.249	-1334.495***
	(416.025)	(180.691)	(178.844)	(89.434)	(283.216)
Constant	4341.837***	1044.327***	873.986	521.283**	2773.214***
	(1280.720)	(292.301)	(532.243)	(228.860)	(1066.677)
Total Effect of Phailin	-1319.910	-486.047	4.788	75.504	-1070.651
p-value	0.00	0.00	0.97	0.30	0.00
TRIPTI village	-1230.416***	-38.981	-167.377**	-51.023	-814.885***
	(395.086)	(184.592)	(82.718)	(61.979)	(261.173)
LN(Rainfall Deviation)	-687.363***	-105.767**	-118.101	-84.817**	-523.525***
	(227.092)	(52.343)	(83.281)	(35.893)	(194.181)
Post	-1015.484*	-235.836	208.497	208.199	-1255.236***
	(602.011)	(249.196)	(299.899)	(139.753)	(377.733)
TRIPTI X Post	-1160.976	-877.194**	-425.494	-279.728	36.967
	(791.289)	(354.103)	(331.372)	(173.041)	(540.113)
TRIPTI X LN(Rainfall Deviation)	222.889***	4.837	30.406**	9.838	149.941***
	(70.656)	(32.998)	(14.761)	(11.133)	(46.805)
Post X LN(Rainfall Deviation)	246.009**	79.146*	-25.883	-27.275	244.174***
	(106.426)	(44.504)	(52.837)	(24.789)	(66.375)
TRIPTI X Post X LN(Rainfall Deviation)	208.975	152.036**	72.135	50.785	2.981
	(141.754)	(63.760)	(58.710)	(30.899)	(96.977)
Constant	4123.533***	662.797**	699.604	499.338**	3067.600***
	(1278.363)	(292.322)	(465.941)	(200.733)	(1096.344)
Total Effect of TRIPTI	-798.553	117.892	-64.835	9.600	-661.963
p-value	0.05	0.52	0.47	0.87	0.02
Total Effect of Phailin	-560.500	-4.654	254.748	231.709	-1008.081
p-value	0.36	0.99	0.40	0.10	0.01
Control (TRIPTI) Observations	2613	2673	2679	2677	2645
Treated (TRIPTI) Observations	2013	2067	2068	2071	2025

Notes: ***sig. at 1%, **sig. at 5%, *sig. at 10%. All specifications include block fixed effects. The top panel includes standard errors clustered at the village; the bottom panel includes standard errors clusters by grid-village.