Does semi-formal credit help to cope with aggregate shocks? Evidence from Roscas and the Indian Ocean Tsunami

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Abstract

We analyze the effects of the 2004 Indian Ocean Tsunami on credit demand in Rotating Savings and Credit Associations (Roscas) in South India. We combine financial data from a semi-formal intermediary with geophysical data on the Tsunami. Exploiting the feature that credit supply in Roscas is fixed on the short term, we estimate the extent to which the price of credit changed in response to this shock. Comparing branches affected and unaffected by the Tsunami before and after the Tsunami hit, we find a significant increase in the interest rate by 5.3 per cent on average in the affected branches. Interest rates increased most dramatically in the first three months after the Tsunami hit and decreased subsequently over the year 2005. We conclude that (i) funds provided by Roscas did play a role for coping with this huge negative shock, (ii) repercussions of the Tsunami in the Rosca credit market were limited in terms of the order of magnitude of effects, and (iii) semi-formal credit and official aid appear to be substitutes as disaster coping mechanisms rather than complements.

Keywords: Natural Disaster, Roscas, Coping Strategies

JEL categories: O16, Q54

1 Introduction

Over the last two decades a body of research on the vulnerability of the poor has accumulated in development economics. Policy makers and researchers alike increasingly recognize that not only the average level of household income at a given point in time, but also the ability or inability to cope with income shocks matters for the welfare of the poor. Townsend's (1994) seminal study on mutual insurance and consumption smoothing in response to income shocks using household survey data has led to further work on particular mechanisms through which households insure or smooth consumption. Both formal and informal credit have been identified as important mechanisms in dealing with idiosyncratic shocks. (e.g. Eswaran & Kotwal (1989); Udry (1990); Udry (1994); Gertler *et al.* (2002); Skoufias (2003)). Further, access to credit has been identified to reduce the use of other coping mechanisms like child labor and reduction of educational attainment of children in the face of negative income shocks (e.g. Jacoby & Skoufias (1997); Beegle *et al.* (2006); Guarcello (2009)).

There is, however, little research on how households cope with large aggregate shocks, like natural disasters, and what role credit plays in this context. A few studies elicit a substitution effect of other coping mechanisms like child labor or educational attainment and credit in the face of aggregate shocks (e.g. Jacoby & Skoufias (1997); Gitter & Barham (2007)). Sawada (2008) finds direct evidence for consumption smoothing after the Kobe earthquake for households having access to credit compared to credit constrained households. Nevertheless, there is little evidence on the direct use of credit as insurance against aggregate shocks in the literature. Notable contributions of Del Ninno *et al.* (2003) and Khandker (2007) are based on the 1998 flood in Bangladesh, and find that household borrowing, especially informal credit and micro credit, played a major role for consumption smoothing in the face of this shock.

Very little continues to be known on the effect of large, aggregate shocks on the markets relevant for households' ability to cope with such risks. Important issues like how effectively credit flows from regions less affected by a natural disaster to more affected regions, or whether – within affected regions – funds flow from less to more affected households, remain largely unexplored. In this paper, we tackle this latter issueby investigating the consequences of the 2004 Tsunami on an important segment of the credit market in South India. Using data from a semi-formal financial intermediary, we estimate the extent to which the price of credit changed in response to the Tsunami hit. As the supply of funds is fixed in the short run in the institution that we study, an increase in the price of credit in locations affected by the Tsunami allows us to conclude that semi-formal credit was indeed a relevant coping mechanism. Second, the longitudinal dimension of our data allows us to identify the dynamics of the role of credit in the aftermath of this large shock.

We use data from 14 branches of a financial company in the Indian state of Tamil Nadu on over 16,000 loans handed out in 2004 and 2005 to address these issues empirically. The financial institution considered are formally organized Roscas (Rotating Savings and Credit Associations) in which individuals get together to borrow and save. Those Roscas are administered by the same financial company in branches in various locations across the state of Tamil Nadu. The interest rate for each loan is determined by concurrent competitive bidding. This feature together with the fixed supply of funds in the short run makes this institution ideal to test for instantaneous changes in credit demand. In this quasi-natural experiment, we use difference-in-difference estimation methods to identify changes in the borrowing interest rate in affected locations relative to unaffected locations around the hit of the Tsunami on December 26, 2004. We use geophysical data by Maheshwari *et al.* (2005) and Narayan *et al.* (2005) to capture the extent of the Tsunami hit. Information on the local severity of the Tsunami from these sources is combined with spatially mapped Rosca data using GIS methods.

We find a significant increase in the interest rate in the affected branches after the Tsunami. In branches classified as affected, interest rates increased by around 5% on average. This translates to an increase of around one percentage point relative to an average borrowing rate of roughly 20%. Accounting for variation in the intensity of the Tsunami we find an increase in the interest rate of around 3% per additional meter of wave height.

We conclude, first, that funds provided by Roscas did play a role for coping with this huge negative shock, second, that the repercussions of the Tsunami in the Rosca credit market were limited in terms of the order of magnitude of effects, and third, that credit demand increased most dramatically right after the shock. This latter observation is in line with qualitative evidence on aid flows and relief programs which are reported to have reached the affected areas with a time lag of several months. In this connection, our results suggest that semi-formal credit and official aid are substitutes as disaster coping mechanisms, rather than complements.

The paper is organized as follows. Section 2 takes a closer look at the functioning of Roscas and the data. In section 3 we describe the identification strategy and estimation approach. The estimation results are presented in section 4. Robustness checks and some extensions of the analysis are considered in section 5. Section 6 concludes.

2 Background and Data Description

Tsunami - Geophysical Data

The December 26, 2004 earthquake in Sumatra, Indonesia, caused Tsunami waves to hit the coast of India. The giant Tsunami waves of 3 to 11 meters in height penetrated inland up to 3 km leading to extensive damage in the states of Andhra Pradesh, Kerala, Tamil Nadu and the Union Territory of Pondicherry on the Indian mainland. The coast of Tamil Nadu was hit especially hard, accounting with 7995 dead people for over 60% of lost lives during the Tsunami in India. 230 villages and 418 kuppams (hamlets) were flattened completely and more than 470,000 people had to evacuate from their homes. Additionally, the Tsunami caused massive destruction to infrastructure, soil quality, and property, like boats and fishing equipment, depleting physical capital and productive assets. Fishery and related activities such as fish marketing, fish transport, fish processing, boat making and repair is an important economic activity along the coast of Tamil Nadu. Fishermen mostly living in huts close to the coast were most severely affected in destruction of livelihood.

Additionally, they suffered from a substantial destruction on production assets with 16,772 boats fully and 19,305 boats partly damaged. Other sources of livelihood along the coast like agriculture and livestock were affected by loss of 16,083 cattle and in storage of agricultural produce as well as soil destruction or salinization of 8460.24 hectares of agricultural land and 669.82 hectares of horticultural land. The total value of damage caused to boats, infrastructure like ports, roads, electricity installations, and water supply, public buildings and soils is estimated at 2,350,950,000,000 Indian Rupees (AsianDevelopmentBank (2005); Maheshwari *et al.* (2005); Narayan *et al.* (2005); Athukorala & Resosudarmo (2005); TamilNaduGovernment (2005)).

The extend of damage varied with Tsunami intensity.[1] The intensity depends on the maximum height of the Tsunami waves which themselves are depending on geographic and geologic conditions. For instance mangrove swamps or the Sri Lankan mainland cushioned the impact of the waves on parts of the Indian coast. Figure 1 shows the Tsunami intensity measured at different geographic points in a survey shortly after the Tsunami. The higher the Tsunami intensity at a geographic site, the more severely is the destruction at the hit location (Papadopoulos & Imamura (2001)). For the Tsunami measures we take data from a survey conducted by the Department of Earthquake Engineering, Indian Institute of Technology, Roorkee. The data set contains geo codes of Tsunami hit locations and measures of the run up height and inundation distance at the Tsunami survey measure points (Maheshwari *et al.* (2005); Narayan *et al.* (2005)). The run up height ranges from

[1] There are different ways to measure the size of a Tsunami aiming at a common scale for Tsunamis like the Richter scale for the quantification of earthquakes. One common measure is the Tsunami intensity depending on the so called run up height. The run up height is the maximum height of the water observed above a reference sea level. A very common definition of the Tsunami intensity is based on Soloviev's (1970) calculations as intensity $i=\log_2(\sqrt{2}*$ run up height) which is also used by the National Geophysical Data Center (NGDC). Another intensity scale was introduced by Shuto (1993) as intensity $i=\log_2$(run up height). Papadopoulos and Imamura (2001) relate Shuto's intensity scale based on physical parameters to their proposed 12 step intensity scale based on observed destruction from a Tsunami. For simplification we apply a small transformation and use the natural log of the run up height as a measure of tsunami intensity in the later analysis.

3 to 11 meters averaging 5.8 meters in affected areas considered in our study (Table 1).The sample mean of the run up height corresponds to 2.59 meters. In addition to the physical run up height we use two measures for the Tsunami intensity. The first alternative measure is the wave intensity formed by the natural log of the run up height as $wave\ intensity = \ln(run\ up\ heigth)$. This is comparable to other measures of Tsunami intensity based on physical parameters of the Tsunami. Average wave intensity is 1.65 in affected branches and 0.74 in the whole sample.

The second measure is the damage intensity. We apply the Tsunami intensity mapping in Tamil Nadu from Narayan *et al.* (2006). It is formed according to the 12 step intensity scale by Papadopoulos & Imamura (2001) based on observable destruction caused by a Tsunami. It ranges from an intensity in step 1 "I. Not felt" to "XII. Completely devastating" in step 12.[2] In affected branches the damage intensity ranges from 6.5 corresponding to the category "damaging" to a damage intensity of 10 corresponding to the category "very destructive" on the 12 step intensity scale. The average damage intensity in affected branches is nearly 8 representing the category "heavy damaging". The sample mean of the damage intensity is 3.6.

Chit Fund - Financial Data

We combine the geophysical data with financial data from a semi-formal financial institution in the southern Indian state of Tamil Nadu that organizes Roscas. In a Rosca, or chit fund as they are called in India, a group of people get together regularly to borrow and save. At each meeting, every member of the group contributes a fixed amount to a common pot that is allocated to one of the participants. Every participant receives the pot once during the course of a Rosca. In our study the pot is allocated by an oral ascending bid auction where the highest bidder receives the pot less the winning bid amount. Once a participant

[2] The 12 step Intensity scale is: I) Not felt, II) Scarcely felt, III) Weak, IV) Largely observed, V) Strong, VI) Slightly damaging, VII) Damaging, VIII) Heavy damaging, IX) Destructive, X) Very destructive, XI) Devastating, and XII) Completely Devastating. See Papadopoulos & Imamura (2001).

has received a pot he is ineligible to bid for another. Nevertheless, he continues paying his monthly contributions until the Rosca ends. This is ensured by required provision of guarantors after receiving a pot, commission receipts and legal measures by the Rosca organizer. The bid amount of each auction is distributed among the participants of the Rosca as a dividend. This creates an interest component, where the winner of a pot pays interest for the money he receives and the other participants receive interest for the contribution they save in the respective round.

Example *To illustrate these rules, consider the following three person Rosca which meets once a month and each participant contributes \$10 yielding a pot of \$30. Suppose the winning bid in the first month is \$12. Each participant receives a dividend of \$4. The recipient of the first pot effectively has a net gain of \$12 (i.e. the pot less the bid plus the dividend less the monthly contribution). Suppose that in the second month (when there are two eligible bidders left) the winning bid is \$6. And in the final month, there is only one eligible bidder so that the winning bid is 0. The net gains and contributions are depicted as:*

Month	*1*	*2*	*3*
Winning Bid	*\$12*	*\$6*	*\$0*
Dividend	*\$4*	*\$2*	*\$0*
First Recipient	*\$12*	*-\$8*	*-\$10*
Second Recipient	*-\$6*	*\$16*	*-\$10*
Last Recipient	*-\$6*	*-\$8*	*\$20*

The first recipient is a borrower: he receives \$12 and repays \$8 and \$10 in subsequent months implying a monthly interest rate of 30.5%. The last recipient is a saver: he saves \$6 for 2 months and \$8 for one month and receives \$20 in the last round implying a monthly interest rate of 25%.

Due to the bidding process participants pay a different bid amount to get the pot and hence a different interest rate, depending on their willingness to pay during the auction. We exploit this variation in the bid amount in our empirical analysis.

The data set includes information on over 16,000 auctions from January 2004 to October 2005 of Rosca groups that started before December 2004. Each Rosca is uniquely identified by a group code and a branch code. The auctions within a Rosca are uniquely identified by the round of the Rosca. Generally, a Rosca facilitates borrowing and saving. As shown in the example, the recipient of the first pot is a pure borrower and the recipient of the last pot is a pure saver. For all auctions in between, the participation in the Rosca contains both saving and credit components. The credit component dominates in earlier rounds whereas the saving component dominates in later rounds.

The primary variable of interest in the present study is the bid amount as it proxies the interest component. The pattern of the bid amount differs across rounds. Generally, first rounds of each Rosca produce the highest bid amounts. Early pot winners use the Rosca to obtain funds that they repay by monthly subsequent contributions. Hence, they have a high willingness to pay displayed in high bid amounts. Late pot winners use the Rosca as a savings device. Hence, they want to receive the pot as late as possible to pay minimal bid amounts. Those effects lead to higher winning bids in earlier Rosca rounds and lower winning bids in later rounds. Consequently, bid amounts decrease over the course of the Rosca.

The data we use is from an established Rosca organizer with headquarters in Chennai. This company started its business in Chennai, the state capital located in the Northeast of Tamil Nadu in 1973 and has been expanding gradually since then. The Rosca organizer offers Roscas of different durations and monthly contributions resulting in various values of the pot. This chit value ranges from 10,000 to 1,000,000 Indian Rupees with an average of around 60,000 Indian Rupees (Table 1). The average winning bid in the sample is 13,131 Indian Rupees with a minimum of 500 Indian Rupees and a maximum of 300,000 Indian

Rupees.[3] The relative bid amount defined as the winning bid relative to the respective chit value allows comparison of bids across different denominations. It ranges from 5% to 40% of the chit value with a sample mean of 19.75%. Rosca participants winning the auction have to provide guarantors to secure continued contribution and repayment of the received fund. The number of the so called cosigners ranges from zero to nine with an average of 1.57. Different participants use Roscas as a savings or borrowing device. On the one hand, private individuals, participate in Roscas. On the other hand, financial institutions such as banks participate in Roscas as institutional investors. The fraction of auctions won by institutional investors in the sample is 38%. Rosca funds provided by this organizer are used for productive investments and consumption alike (Klonner & Rai (2006); Klonner (2008)).

3 Identification Strategy and Estimation

For the analysis of the effects of the Tsunami on credit demand we study the relative bid amount in different Rosca groups. First, we divide all auction observations in the sample into auctions taking place before the Tsunami and auctions taking place after the Tsunami on December 26th in 2004. Second, we divide all branches into Tsunami affected and unaffected branches. Overall, we look at 14 branches in the coastal area of Tamil Nadu within a distance of 25 km from the coastline. Five branches are identified as Tsunami affected branches and nine branches are identified as unaffected branches.[4] All branches within a proximity of 5 km to the coastline are classified as affected branches. This definition

[3]A commission of Rs. 500 has to be paid to the chairman of the Rosca at every auction. This poses the bottom line of the winning bid amount. We only consider auctions in which a bidding took place indicated by a winning bid amount higher than the commission. Further, the Indian government imposed a bid ceiling on the winning bid amount of 40% of the chit value. With a maximum chit value of Rs. 1,000,000 the maximum winning bid corresponds to Rs. 400,000.

[4]Affected branches are the branches in Cuddalore, Karaikal, Nagappattinam, Pondicherry, and Tuticorin. Unaffected branches are branches in Chidambaram, Mayiladuthurai, Nagercoil, Pattukkottai, Ramanathapuram, Ramnad, Sirkazhi, Thiruthuraipondi, and Tiruvarur.

avoids any selection issues as the classification solely depends on the branch's distance to the coastline. All branches within a distance of 5 to 25 km from the coastline are classified as unaffected branches. The distances are measured with available geo information on branch locations, coastlines and Tsunami survey points. Third, we combine the geophysical information with the financial data. Every Rosca branch is assigned the run up height, wave intensity and damage intensity measured at its closest Tsunami survey point.

We are interested in the effect of the Tsunami on credit demand across branches. If borrowing serves as a coping mechanism to aggregate shocks, we expect a higher demand for borrowing in affected branches driving up the winning bid in a Rosca. All Rosca groups we are considering in the analysis started before the Tsunami, hence we are looking at the effect of the Tsunami on credit demand conditioned on participation in a Rosca. If Roscas were used to mitigate the aggregate shock of the Tsunami hit, this is reflected in an increased relative bid amount after the Tsunami.

To estimate the increase in credit demand due to the Tsunami we compare the relative winning bids in Tsunami affected and unaffected branches before and after the Tsunami. A simple comparison of means in affected and unaffected branches already leads first indications. Before the Tsunami, the average relative bid amount in affected branches is 21,8%. It decreases to 17.07% after the Tsunami (Table 2). In unaffected branches, the average relative bid amount is 22% before the Tsunami and 15.57% after the Tsunami. Although there is a general decrease over time, the decrease is stronger for unaffected branches (-6.43 percentage points) than for affected branches (-4.73 percentage points).

By applying difference-in-difference estimation technique we will estimate in equation (1) whether the lower decrease in affected branches is systematic and can be assigned to the event of the Tsunami.

$$\begin{aligned} relative\_bid\_amount_{bgdr} = {} & \gamma * after_{bgdr} + \delta * affected_b + \beta * affected_b * after_{bgdr} \\ & + x_{dr} + u_{gdr} \end{aligned} \tag{1}$$

The dependent variable is the $relative\_bid\_amount_{bgdr}$ which is the winning bid in round r of Rosca group g with denomination d in branch b. Those four indices uniquely identify each observation. The variable $after_{bgdr}$ represents a time dummy specified as zero for auctions taking place before the Tsunami and as one for observations after the Tsunami. The variable $affected_b$ is capturing the classification of the branch of an observation. It is assigned a value of one for affected branches and zero for unaffected branches. The interaction term $affected_b * after_{bgdr}$ is a combination of the binary branch classification variable and the time dummy. It take a value of one for affected branches after the Tsunami and a value of zero otherwise. As round- and denomination effects are influencing the bid amount in a Rosca, we control for interacted round-denomination fixed effects captured in the matrix x_{dr} in equation (1). To control for any heterogeneity at the branch level standard errors are clustered at the branch level.[5]

The coefficient of interest is β. According to the program evaluation techniques we are applying β is capturing the treatment effect. This is the effect that can solely be assigned to the analyzed event, in our case the Tsunami.

Although the identification of affected branches is independent of branch characteristics the geographic location of a branch might still cause differences in the effect of the Tsunami on credit demand. We need to control for unobserved differences between branches. Inclusion of branch fixed effects δ_b interferes with the identification of affected branches taking place at the branch level. Hence, branch fixed effects replace the binary classification variable $affected_b$ in equation (1). Further, we refine the time at which in an auction took place. The binary variable $after_{bgdr}$ distinguishes between observations before and after the Tsunami. The variables $quarter_{q}\_2004_{bgdr}$ and $quarter_{q}\_2005_{bgdr}$ are stating in which quarter in 2004 or in 2005 the auction happened. The interaction term that is identifying observations in affected branches after the Tsunami is $affected_b * quarter_{q}\_2005_{bgdr}$ for each

[5] The procedure of group assignment is by lists of starting Roscas on which participants sign up for a specific Rosca. The Rosca organizer operates with other enforcement mechanisms than social collateral to enforce repayment (e.g. gurantors to secure the loan, legal procedures, etc.). Hence, it seems unlikely that the residuals are correlated on the Rosca group level. Considering clusters at the branch level is more sensible.

quarter q. Equation (1) changes to

$$\begin{aligned} relative\_bid\_amount_{bgdr} &= \alpha + \sum_{q=1}^{4} \gamma_{1q} * quarter_q\_2004_{bgdr} + \sum_{q=1}^{3} \gamma_{2q} * quarter_q\_2005_{bgdr} \\ &\quad + \delta_b + \sum_{q=1}^{3} \beta_q * affected_b * quarter\_2005_{bgdr} \\ &\quad + x_{dr} + u_{gdr} \end{aligned} \tag{2}$$

In addition to the binary classification of affected and unaffected branches we apply different geophysical measures to account for the different intensity of the Tsunami at different locations. The first measure is the run up height of the Tsunami waves observed at the survey measure point closest to a branch. The continuous variable run_up_b stating the run up height of the waves in affected branch b is replacing the binary classification variable in equation (1) and (2). It is equal to zero in unaffected branches. The equations change to

$$\begin{aligned} relative\_bid\_amount_{bgdr} &= \gamma * after_{bgdr} + \delta * run\_up_b + \beta * run\_up_b * after_{bgdr} \\ &\quad + x_{dr} + u_{gdr} \end{aligned} \tag{3}$$

and

$$\begin{aligned} relative\_bid\_amount_{bgdr} &= \alpha + \sum_{q=1}^{4} \gamma_{1q} * quarter_q\_2004_{bgdr} + \sum_{q=1}^{3} \gamma_{2q} * quarter_q\_2005_{bgdr} \\ &\quad + \delta_b + \sum_{q=1}^{3} \beta_q * run\_up_b * quarter\_2005_{bgdr} \\ &\quad + x_{dr} + u_{gdr} \end{aligned} \tag{4}$$

The second measure of intensity is the wave intensity of the Tsunami. Wave intensity is defined as $wave\_intensity_b = \ln(run\_up_b)$ for affected branches and zero for unaffected branches. The estimation equations are

$$\begin{aligned} relative\_bid\_amount_{bgdr} &= \gamma * after_{bgdr} + \delta * wave\_intensity_b \\ &\quad + \beta * wave\_intensity_b * after_{bgdr} + x_{dr} + u_{gdr} \end{aligned} \tag{5}$$

and

$$relative\_bid\_amount_{bgdr} = \alpha + \sum_{q=1}^{4}\gamma_{1q} * quarter_q\_2004_{bgdr} + \sum_{q=1}^{3}\gamma_{2q} * quarter_q\_2005_{bgdr}$$
$$+\delta_b + \sum_{q=1}^{3}\beta_q * wave\_intensity_b * quarter\_2005_{bgdr}$$
$$+x_{dr} + u_{gdr} \qquad (6)$$

The third measure of intensity is the damage intensity defined by the 12 step intensity scale by Papadopoulos & Imamura (2001). The intensity according to this scale at the Tsunami survey points is taken from Narayan *et al.* (2006). Each affected branch is assigned the damage intensity $damage\_intensity_b$ of its closest survey point. Unaffected branches are assigned a damage intensity of zero. The estimation equations are

$$relative\_bid\_amount_{bgdr} = \gamma * after_{bgdr} + \delta * damage\_intensity_b$$
$$+\beta * damage\_intensity_b * after_{bgdr} + x_{dr} + u_{gdr} \qquad (7)$$

and

$$relative\_bid\_amount_{bgdr} = \alpha + \sum_{q=1}^{4}\gamma_{1q} * quarter_q\_2004_{bgdr} + \sum_{q=1}^{3}\gamma_{2q} * quarter_q\_2005_{bgdr}$$
$$+\delta_b + \sum_{q=1}^{3}\beta_q * damage\_intensity_b * quarter\_2005_{bgdr}$$
$$+x_{dr} + u_{gdr} \qquad (8)$$

In all estimations we control for any heterogeneity at branch level by clustering standard errors at the branch level.

4 Estimation Results

The estimation of equation (1) serves with the simplest specification as a baseline estimation. The dummy variable $after_{bgdr}$ distinguishing observations between before and after the Tsunami shows a significant negative time trend in the relative bid amount (Table 3, column

(1)). The interaction term $affected_b{*}after_{bgdr}$ identifies the effect on the relative bid amount in affected branches after the Tsunami. We observe a positive and significant point estimate of 0.815 percentage points corresponding to an increase in the relative bid amount of around 4% evaluated at the sample mean of the relative bid amount of 19.75%. The percent increase corresponds to an increase in the interest rate implying that the interest rate is higher in affected branches after the Tsunami compared to the interest rate in unaffected areas. Refining the estimation equation by including branch fixed effects and quarterly time effects (equation (2)) supports the findings of the baseline analysis qualitatively. We observe a significant increase of 1.05 percentage points in the relative bid amount in affected branches in the first quarter after the Tsunami (Table 3, column (2)). Evaluated at the sample mean of the relative bid amount this corresponds to a rise of 5.3% of the interest rate. The repercussion of the Tsunami in the first quarter is significant at the 1% level but its magnitude is limited. Further, we notice that this effect fades away in the second and third quarter after the Tsunami. From the significant increase in the interest rate, we conclude that credit demand actually intensified in affected branches in the first quarter after the Tsunami. This pattern supports the idea that borrowing was used to bridge the time lag until emergency relief and aid flows started.

Exploiting the fact that Tsunami impact differed along the coastline, we replace the binary classification in affected and unaffected branches by three different measures for the Tsunami intensity. The first measure is the height of the Tsunami waves. Equation (3) estimates the effects of the run up height on the relative bid amount in affected branches. The coefficient of the interaction term $run\_up_b{*}after_{bgdr}$ shows the effect of the wave height on the interest rate in affected branches after the Tsunami. The significant point estimate of 0.136 confirms that the relative bid amount is increasing in wave height (Table 3, column (3)). Per one percent increase in wave height the relative bid amount increased by 0.68% in affected branches. Equation (4) disentangles the effect over time. After the Tsunami, we observe a point estimate of 0.132 at the 1% significance level in the first quarter, a point estimate of 0.180 at the 5% significance level in the second quarter, and a point estimate of 0.103 at the 10% significance level in the third quarter in affected branches (Table 3, column (4)). Per one percent increase in wave height the relative bid amount increases by 0.5 to 0.9% in affected branches in the three quarters after the Tsunami.

The second measure is the wave intensity as the logarithmic run up height. The interaction term $wave\_intensity_b * after_{bgdr}$ is measuring the effect of the wave intensity on the interest rate in affected branches. In the simple specification of equation (5) we observe a significant point estimate of 0.524 percentage points (Table 3, column (5)). This implies an increase of 2.65% in the interest rate per additional meter in wave height evaluated at an average borrowing rate of around 20%. The more refined specification of equation (6) with branch fixed effects and quarterly time effects shows that in the first quarter after the Tsunami the relative bid amount increased by 0.575 percentage points at the 1% significance level (Table 3, column (6)). In the second and third quarter there is an increase of 0.651 percentage points and 0.406 percentage points at the 10% significance level. Those estimates correspond to an increase in the interest rate of 2 to 3.3% per additional meter of wave height.

The third measure of Tsunami intensity is the damage intensity based on observed damage caused by the disaster. The estimation of equation (7) considers only a differentiation between observations before and after the shock. The interaction term $damage\_intensity_b * after_{bgdr}$ has a significant estimated coefficient of 0.108. Per percent increase in the damage intensity on the 12 step scale, the relative bid amount is increasing by 0.l08 percent corresponding to a 0.5% increase evaluated at the sample borrowing rate of around 20 % (Table 3, column (7)). After the Tsunami we observe a point estimate of 0.126 at the 1% significance level in the first quarter, a point estimate of 0.130 at the 10% significance level in the second quarter, and a point estimate of 0.0861 at the 10% significance level in the third quarter in affected branches (Table 3, column (8)). Per one percent increase in the damage intensity, the interest rate is increasing by 0.4 to 0.66% in the three quarters after the Tsunami.

In our data we observe an increase in the interest rate in affected branches after the

Tsunami. We reason that credit demand in affected branches actually increased and conclude that borrowing was used as a coping mechanism to deal with negative income shocks caused by the Tsunami. Although the repercussion of the Tsunami is significant its magnitude is limited.

5 Robustness Checks and Extension of the Analysis

Definition of Affected and Unaffected Branches

We define affected branches as all branches within a distance of 5 km from the coastline and unaffected branches as branches located between 5 km and 25 km from the coast. As a robustness check we control for different definitions of affected and unaffected branches.

First, we extend the zone capturing unaffected branches to a distance of 50 km. All branches between 5 km and 50 km are now considered as unaffected branches. We estimate equation (1) and (2) with the extended data on 25 branches divided in 20 unaffected and 5 affected branches.[6] We observe an effect of 0.750 for estimation of equation (1) and an effect of 0.896 for the estimation of equation (2) on the relative bid amount in affected branches for the first quarter after the Tsunami (Table 4, column (1) and (2)). Both point estimates are significant at the 1% level and in the same range as the results from our original estimation. Hence, the results are robust to an extension of the definition of unaffected branches.

Second, we enlarge the definition of affected branches to all branches within a distance of 10 km from the coastline. The unaffected branches are classified as branches between 10 and 25 km from the coast. The 14 branches are equally divided into seven affected and seven unaffected branches.[7] We do not observe any significant effect in the estimation of

[6] The affected branches are Cuddalore, Karaikal, Nagappattinam, Pondicherry, and Tuticorin. The unaffected branches are Chidambaram, Chigleput, Devakottai, Jayamkondam, Karaikkudi, Mannargudi, Mayiladuthurai, Nagercoil, Palayamkottai, Paramakudi, Pattukkottai, Ramanathapuram, Ramnad, Sirkazhi, Thirutuhiraipoondi, Tindivanam, Tirunelveli, Tiruvarur, Villuparam, and Vriddhachalam.

[7] Affected branches are Chidambaram, Cuddalore, Karaikal, Nagappattinam, Nagercoil, Pondicherry, and Tuticorin. Unaffected branches are Mayiladuthurai, Pattukkottai, Ramanathapuram, Ramnad, Sirkazhi,

equation (1) and only a marginally significant positive point estimate for the first quarter after the Tsunami in the estimation of equation (2) (Table 4, column (3) and (4)). Though the sign of the estimated coefficients is correct, they are mostly not significant. We conclude that the effects of the Tsunami were limited to the area very close to the coastline.

Third, we maintain the extended definition of affected branches at a 10 km distance and additionally extend the definition of unaffected branches to a distance between 10 and 50 km. The 25 branches are split up in seven affected and 18 unaffected branches.[8] None of the point estimates measuring the impact of the Tsunami in affected branches is significant. Again we ascribe this to the geographical limitation of the Tsunami impact to locations close to the coastline.

Placebo Experiment

We have to exclude the possibility that the results are driven by time trends unrelated to the Tsunami and estimation problems with difference-in-difference estimation technique in the presence of serial correlation.[9] We conduct a placebo experiment with the same specifications as in the estimation of the quasi-natural experiment by the Tsunami but use a different time period. Instead of a balanced sample with observations of one year before and one year after the Tsunami we shift back the considered time period for one year and use data on observations from 2003 to 2004. The definition of affected and unaffected branches stays the same as in the original analysis namely all branches closer than 5 km to the coastline are classified as affected. We create an artificial event of a "Pseudo-Tsunami" to happen at 26th December 2003 solely by definition of the time dummy $after_{bgdr}$ that

Thiruthuraipondi, and Tiruvarur.

[8] Affected branches are Chidambaram, Cuddalore, Karaikal, Nagappattinam, Nagercoil, Pondicherry, and Tuticorin. Unaffected branches are Chidambaram, Chigleput, Devakottai, Jayamkondam, Karaikkudi, Mannargudi, Mayiladuthurai, Nagercoil, Palayamkottai, Paramakudi, Pattukkottai, Ramanathapuram, Ramnad, Sirkazhi, Thirutuhiraipoondi, Tindivanam, Tirunelveli, Tiruvarur, Villuparam, and Vriddhachalam.

[9] See Bertrand *et al.* (2004) for caveats of difference-in-difference estimation technique in the presence of serial correlation.

divides the sample in observations before and after the shock. This date is exactly one year before the real Indian Ocean Tsunami happened. All observations from 1st January 2003 to 26th December 2003 are classified as "before Pseudo-Tsunami" and all observations from 27th December 2003 to 31st December 2004 classified as "after Pseudo-Tsunami". We apply the same estimation techniques to the data set containing the pseudo event. Since the "Pseudo-Tsunami" is marking an artificial event that did not actually take place we expect to see no effect in the data.

The data set we are using in the placebo experiment contains observations on 18,898 auctions from January 2003 to December 2004 (Table 5). It differs from the originally data set. The chit value ranges from 10,000 to 1,000,000 Indian Rupees with an average of around 57,000 Indian Rupees (Table 5). The average winning bid in the sample is 15,618 Indian Rupees with a minimum of 500 Indian Rupees and a maximum of 400,000 Indian Rupees.[10] The relative bid amount as the winning bid relative to the respective chit value allows comparison of bids across different denominations. It ranges from 5% to 40% of the chit value with a sample mean of 24,42%. The number of cosigners required to secure continued contribution and repayment of the received fund ranges from zero to ten with an average of 1.87. The fraction of auctions won by other financial institutions taking part in the Roscas as institutional investors is 37% in the sample.

The geophysical data used in the placebo experiment is the same as in the original analysis. Due to a different partition of observations in affected and unaffected branches the sample means differ slightly from the 2004-2005 data set. The run up height ranges from 3 to 11 meters averaging 5.69 meters in affected areas considered in our study (Table 5). The sample mean of the run up height corresponds to 2.58 meters. The first intensity measure is the wave intensity. Average wave intensity is 1.63 in affected branches and 0.74 in the whole sample. The second measure is the damage intensity formed according to the 12 step

[10] A commission of Rs. 500 has to be paid to the chairman of the Rosca at every auction. This poses the bottom line of the winning bid amount. Further, the Indian government imposed a bid ceiling on the winning bid amount of 40% of the chit value. With a maximum chit value of Rs. 1,000,000 the maximum winning bid corresponds to Rs. 400,000.

intensity scale by Papadopoulos & Imamura (2001) based on observable destruction caused by a Tsunami. In affected branches the damage intensity ranges from 6.5 corresponding to the category "damaging" to a damage intensity of 10 corresponding to the category "very destructive" on the 12 step intensity scale. The average damage intensity in affected branches is nearly 8 representing the category "heavy damaging". The sample mean of the damage intensity is 3.6.

Estimation of equation (1) applying the placebo data yields an insignificant point estimate of the impact on the "Pseudo-Tsunami" on the relative bid amount in affected branches compared to unaffected branches. Also the refined estimation of equation (2) does not yield any significant estimates of an impact in any quarter after the "Pseudo-Tsunami" (Table 6, column (1) and (2)). Beyond the insignificance of the estimates, they all have the wrong sign to show any positive impact. The same holds true for the analysis of the three Tsunami intensity measures. Neither the run up height, nor the wave intensity or the damage intensity show any significant impact of the "Pseudo-Tsunami" in the affected branches (Table 6, column (3)-(8)). We conclude that there can be no effect on the "Pseudo-Tsunami" identified on the relative bid amount that differs for affected and unaffected branches. This is naturally as expected since there was no real event taking place. Nevertheless it gives substantial confidence that the results obtained in the impact evaluation of the real Tsunami hit are not driven by any methodological effects or the general negative time trend in the data.

Structure of the Borrower Pool

There are other aspects which might be driving the results in the impact evaluation. After suffering from material loss in the Tsunami affected branches individuals are less desirable borrowers for the Rosca organizer. To minimize default risk the Rosca organizer could be trying to change the structure of the borrower pool of auction winners. Private persons and financial institutions alike participate in Roscas to invest or obtain funds. Institutional investors such as banks or semi-formal financial companies generally have a lower risk and higher financial power. This allows them to pay higher interest rates and hence crowed out private investors in an auction. Additionally, they are less likely to be affected from Tsunami destruction. Hence, they seem to be more desirable borrowers after the aggregate shock. Consequently, the Rosca organizer could be trying to substitute private investors for institutional ones.

If discouragement of private investors and encouragement of institutional investors as a mean to reduce default risk after the Tsunami is fostered by the Rosca organizer, it will most likely take informal forms. Hence, it is not observed in the data. However, we can observe whether an institutional or a private investor is winning the auction. By forming a binary variable $institutional\_investor_{bgdr}$ that equals zero for private investors and one for institutional investors we can analyze the linear probability of an institutional investor receiving the funds. By applying difference-in-difference technique we test whether institutional investors are more likely to receive the Rosca funds in affected branches than in unaffected branches after the Tsunami. We estimate equations (1) to (8) but use the binary variable for an institutional investor as the dependent variable. For instance, equation (1) and (2) change to

$$\begin{aligned} institutional\_investor_{bgdr} = &\gamma * after_{bgdr} + \delta * affected_b \\ &+ \beta * affected_b * after_{bgdr} + x_{dr} + u_{gdr} \end{aligned} \tag{1b}$$

and

$$\begin{aligned} institutional\_investor_{bgdr} = \alpha &+ \sum_{q=1}^{4} \gamma_{1q} * quarter_q\_2004_{bgdr} + \sum_{q=1}^{3} \gamma_{2q} * quarter_q\_2005_{bgdr} \\ &+ \delta_b + \sum_{q=1}^{3} \beta_q * affected_b * quarter\_2005_{bgdr} \\ &+ x_{dr} + u_{gdr} \end{aligned} \tag{2b}$$

The analysis using a binary classification of affected and unaffected branches shows no significant impact of the Tsunami in affected branches on the probability that an institutional investor is receiving the Rosca funds (Table 7, column (1) and (2)). The same holds true for the three measures of Tsunami intensity, namely the run up height, the wave intensity and the damage intensity (Table 7, column (3) to (8)). We conclude that the observed increase in the interest rate is not driven by a change in the structure of the borrower pool from private to institutional investors.

Other loan characteristics

A way to discourage borrowers from obtaining funds is increasing indirect costs of credit. Generally, upon receiving a pot, borrowers have to provide guarantors, so called cosigners, to secure repayment and continued contributions to the Rosca. The number of cosigners or guarantors required to pledge the reception of the chit value is one measure of such indirect costs. By demanding more cosigners the semi-formal institution studied here can augment such indirect costs and discourage affected individuals from obtaining funds. By applying difference-in-difference technique we test whether the number of required cosigners has increased after the Tsunami in affected areas. We estimate equations (1) to (8) but use the number of cosigners as the dependent variable $cosigners_{bgdr}$. For instance, equation (1) and (2) change to

$$\begin{aligned} cosigners_{bgdr} &= \gamma * after_{bgdr} + \delta * affected_b \\ &\quad + \beta * affected_b * after_{bgdr} + x_{dr} + u_{gdr} \end{aligned} \tag{1c}$$

and

$$\begin{aligned} cosigners_{bgdr} &= \alpha + \sum_{q=1}^{4} \gamma_{1q} * quarter_q\_2004_{bgdr} + \sum_{q=1}^{3} \gamma_{2q} * quarter_q\_2005_{bgdr} \\ &\quad + \delta_b + \sum_{q=1}^{3} \beta_q * affected_b * quarter\_2005_{bgdr} + x_{dr} + u_{gdr} \end{aligned} \tag{2c}$$

The analysis using a binary classification of affected and unaffected branches shows no significant impact of the Tsunami in affected branches on the number of cosigners (Table 8, column (1) and (2)). The same holds true for the three measures of Tsunami intensity, the run up height, the wave intensity and the damage intensity, respectively (Table 8, column

(3) to (8)). We conclude that the observed increase in the interest rate is not driven by a change in required securities to pledge the borrowed funds.

6 Conclusion

In this study, we use geophysical data and detailed financial data from a semi-formal financial institution organizing Roscas in Tamil Nadu to investigate directly changes in credit demand caused by the Indian Ocean Tsunami of 26 December, 2004. A difference-in-difference approach is applied to test for changes in the interest rate in affected branches compared to the unaffected branches after the Tsunami.

We find a positive and significant increase in the relative bid amount in the affected branches after the Tsunami. This corresponds to a 5.3% increment in the interest rate in the first quarter in 2005 that can be attributed to the Tsunami hit reflecting an overall expansion of credit demand in affected branches. Accounting for the treatment intensity measured by run up height and wave intensity we observe a raise in the interest rate in the first quarter after the Tsunami of 0.6% per one percent increase in the wave height and an increase of the interest rate of around 3% per additional meter of wave height.

We conclude that local funds provided by Roscas did play a role in coping with the after-effects of the Tsunami. Although Roscas only pool local resources, they seem to provide insurance against aggregate shocks. Nevertheless, the deployment of Rosca funds is limited in terms of the magnitude of effects. The significant positive effect in the first three months after the Tsunami hit subsequently diminished in later months. This latter observation is in line with qualitative evidence on aid flows and relief programs which are reported to have reached the affected areas with a time lag of several months. In this connection, our results suggest that semi-formal credit and official aid are substitutes as disaster coping mechanisms, rather than complements.

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Figure 1: Tsunami Hit Locations, Rosca Branches and Tsunami Intensity in Tamil Nadu

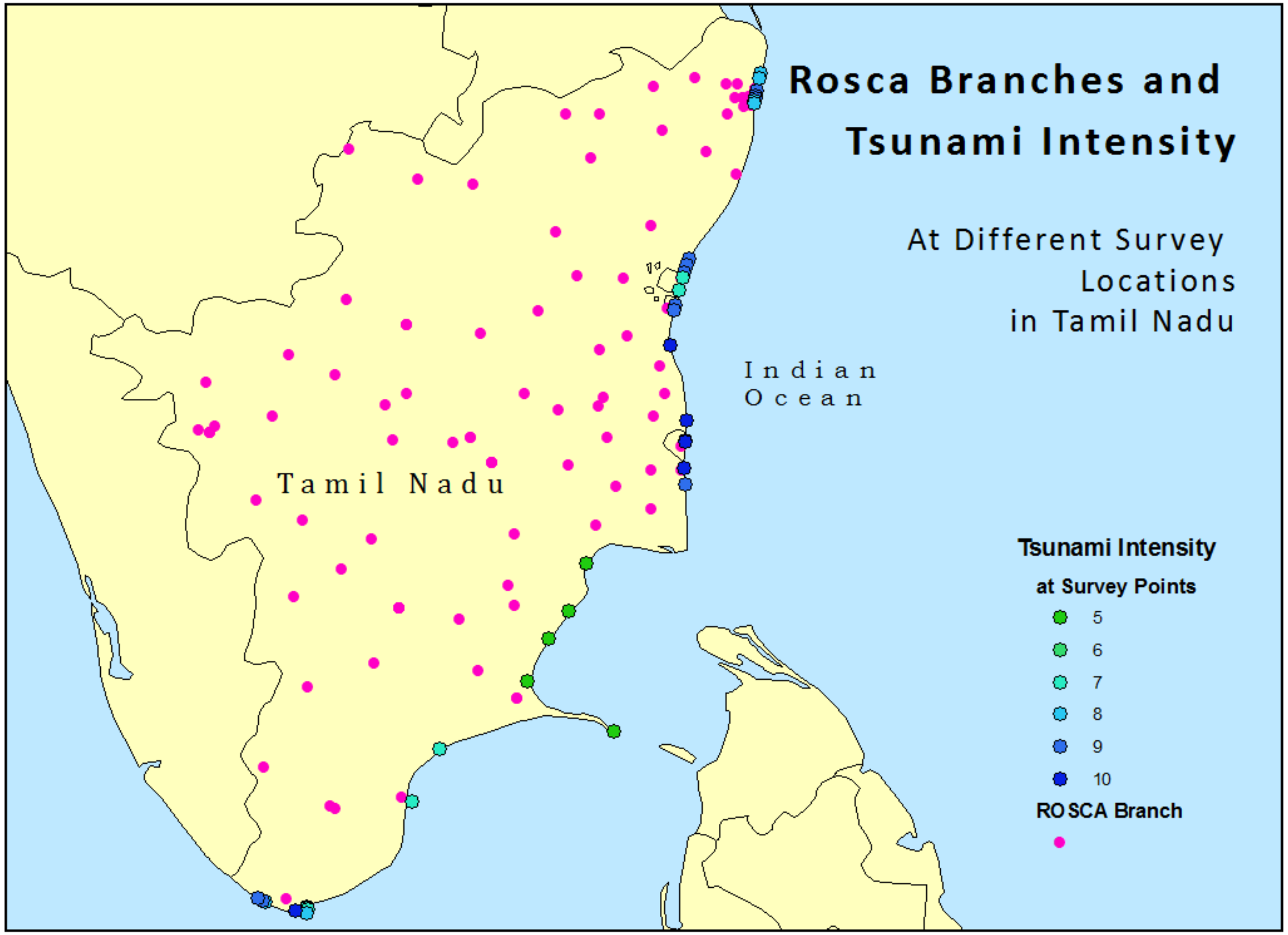

Table 1

Descriptive Statistics of Auctions in 2004-2005

	Mean	Standard Deviation	Minimum	Maximum
All Branches (16,419 Observations)				
Financial Data				
Chit Value (INR)	60,200.99	102,338.30	10,000	1,000,000
Duration in Month	37.22	6.63	25	60
Monthly Contribution	1,608.75	2,642.03	200	30,000
Bid Amount (INR)	13,131.20	26,158.22	520	300,000
Relative Bid Amount	0.1975	0.1087	0.0504	0.4
Number of Cosigners*	1.5662	1.2403	0	9
Institutional Investor Dummy	0.3753	0.4842	0	1
Geophysical Data**				
Run Up Height (meter)	2.5924	3.4390	0	11
Wave Intensity	0.7377	0.8749	0	2.3979
Damage Intensity	3.5683	4.0704	0	10
Unaffected Branches (9,077 Observations)				
Financial Data				
Chit Value (INR)	55,797.07	90,816.60	10,000	1,000,000
Duration in Month	37.25	6.07	25	50
Monthly Contribution	1,498.60	2,364.94	200	25,000
Bid Amount (INR)	12,171.96	24,055.83	520	240,000
Relative Bid Amount	0.1953	0.1079	0.0504	0.4
Number of Cosigners*	1.5907	1.2496	0	7
Institutional Investor Dummy	0.3988	0.4897	0	1
Geophysical Data**				
Run Up Height (meter)	0	0	0	0
Wave Intensity	0	0	0	0
Damage Intensity	0	0	0	0
Affected Branches (7,342 Observations)				
Financial Data				
Chit Value (INR)	65,645.60	114,770.90	10,000	1,000,000
Duration in Month	37.18	7.26	25	60
Monthly Contribution	1,744.93	2,943.30	250	30,000
Bid Amount (INR)	14,317.12	28,501.26	525	300,000
Relative Bid Amount	0.2003	0.1097	0	0
Number of Cosigners*	1.5363	1.2285	0	9
Institutional Investor Dummy	0.3462	0.4758	0	1
Geophysical Data**				
Run Up Height (meter)	5.7974	2.8049	3	11
Wave Intensity	1.6497	0.4552	1.0986	2.3979
Damage Intensity	7.9799	1.3588	6.5	10

Calculations are based on data Rosca auctions from January 2004-October 2005 in Tamil Nadu in branches within 25 km distance of coastline. Only auctions with a bid amount higher than the commission are considered to ensure a bidding process took place. Bid Amount: Winning bid amount of auction. Relative Bid Amount: bid amount as fraction of chit value. Institutional Investor Dummy: 1 if auction is won by an institutional investor, 0 otherwise. Run up height: Maximum height of water observed above a reference sea level (height in meter). Wave intensity=ln(run up height). Damage Intensity by 12 step intensity scale: I) Not felt, II) Scarcely felt, III) Weak, IV) Largely observed, V) Strong, VI) Slightly damaging, VII) Damaging, VIII) Heavy damaging, IX) Destructive, X) Very destructive, XI) Devastating, and XII) Completely Devastating.

*only for groups that reported cosigner data (8,935 auctions, 4,904 in unaffected branches, 4,031 in affected branches).

** based on tsunami survey measure points of the Indian Institute of Technology Roorkee, India for affected branches.

Table 2

Average Relative Bid Amount Before and After the Tsunami

Relative Bid Amount

	Before Tsunami	After Tsunami	Difference	Significance Level of Difference
All Branches	21.90	16.23	-5.67	p<1%
	(0.10922)	(0.1222)	(0.16904)	
Affected Branches	21.80	17.07	-4.73	p<1%
	(0.16661)	(0.18604)	(0.25794)	
Unaffected Branches	22.00	15.57	-6.43	p<1%
	(0.14446)	(0.16103)	(0.22313)	

Dependent variable: relative bid amount. No fixed effects included. All entries times 100, since dependent variable is a fraction (bid amount/ chit value). Standard errors in parenthesis. Observations of auctions from January 2004-October 2005. (1) All branches in Tamil Nadu within a distance of 25 km from coastline. (2) Only affected branches within a distance of 5km from coast line. (3) Unaffected branches within a distance of 5km to 25km from coast line.

Difference-in-Difference-Estimation of the Relative Bid Amount in 2004 and 2005 on Different Tsunami Measures

Tsunami Measure:	Affected Branches		Run Up Height		Wave Intensity		Damage Intensity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	9.20***	37.7***	7.47***	31.4***	7.15***	31.7***	9.23***	37.6***
	(0.325)	(0.416)	(1.14)	(0.608)	(0.965)	(0.565)	(0.317)	(0.403)
Tsunami Measure (Dummy)	-8.21		-0.0635		-0.16		-0.0203	
	(0.618)		(0.104)		(0.403)		(0.0833)	
After Tsunami (Dummy)	-1.70***		-1.69***		-1.73***		-1.73***	
	(0.325)		(0.298)		(0.310)		(0.317)	
Tsunami Measure x After Tsunami	0.815**		0.136***		0.524**		0.108**	
(Dummy)	(0.351)		(0.0418)		(0.187)		(0.0419)	
1. Quarter 2004 (Dummy)		2.32***		2.37***		2.39***		2.37***
		(0.416)		(0.373)		(0.394)		(0.403)
2. Quarter 2004 (Dummy)		2.09***		2.15***		2.16***		2.15***
		(0.538)		(0.488)		(0.511)		(0.523)
3. Quarter 2004 (Dummy)		1.68***		1.73***		1.75***		1.73***
		(0.446)		(0.403)		(0.424)		(0.434)
4. Quarter 2004 (Dummy)		1.25***		1.31***		1.32***		1.30***
		(0.334)		(0.315)		(0.340)		(0.342)
1. Quarter 2005 (Dummy)		0.193		0.376		0.307		0.268
		(0.287)		(0.271)		(0.279)		(0.282)
3. Quarter 2005 (Dummy)		-0.315*		-0.239		-0.259		-0.281*
		(0.154)		(0.159)		(0.162)		(0.158)
Tsunami Measure x 1.Quarter 2005		1.05***		0.132***		0.575***		0.126***
(Dummy)		(0.288)		(0.0380)		(0.160)		(0.0349)
Tsunami Measure x 2.Quarter 2005		0.922		0.180**		0.651*		0.130*
(Dummy)		(0.532)		(0.0725)		(0.314)		(0.0676)
Tsunami Measure x 3.Quarter 2005		0.644		0.103*		0.406*		0.0861*
(Dummy)		(0.403)		(0.0509)		(0.218)		(0.0480)
Observations	16419	16419	16419	16419	16419	16419	16419	16419
R-squared	0.797	0.804	0.797	0.804	0.797	0.804	0.797	0.804
Round-Denomination Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Branch Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes

All coefficients times 100, since they are representing fractions (relative bid amount). Observations from January 2004-October 2005. Dependent Variable: Relative Bid Amount. Affected branches within 5 km distance from coast, unaffected branches within 5 - 25km distance from coast.(1)-(2) Binary classification in affected and unaffected branches, (3)-(4) Run up height, (5)-(6) wave intensity=ln(run up height), (7)-(8) damage intensity by 12 step intensity scale by Papadopoulos and Imamura (2001). Round-Denomination Fixed Effects included in all regressions. Branch Fixed Effects included as indicated. Standard errors clustered at branch level. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4

Difference-in-Difference-Estimation of the Relative Bid Amount in 2004 and 2005 on Different Classifications of Affected and Unaffected Branches

	Affected Branches: 0-5 km Distance Unaffected Branches: 5-50 km Distance		Affected Branches: 0-10 km Distance Unaffected Branches: 10-25 km Distance		Affected Branches: 0-10 km Distance Unaffected Branches: 10-50 km Distance	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	33.1***	8.82***	10.0***	9.81***	34.7***	7.11***
	(0.544)	(0.407)	(-0.00817)	(0.224)	(0.447)	(0.396)
Tsunami Measure (Dummy)	0.0825		0.322		0.316	
	(0.544)		(0.499)		(0.447)	
After Tsunami (Dummy)	-1.70***		-1.44***		-1.45***	
	(0.196)		(0.317)		(0.192)	
Tsunami Measure x After Tsunami (Dummy)	0.750***		0.354		0.288	
	(0.248)		(0.407)		(0.326)	
1. Quarter 2004 (Dummy)		0.632*		1.94***		0.632*
		(0.354)		(0.440)		(0.357)
2. Quarter 2004 (Dummy)		0.434		1.77***		0.433
		(0.346)		(0.520)		(0.345)
3. Quarter 2004 (Dummy)		-0.127		1.33***		-0.115
		(0.277)		(0.389)		(0.277)
4. Quarter 2004 (Dummy)		-0.709**		0.902**		-0.650**
		(0.325)		(0.306)		(0.314)
1. Quarter 2005 (Dummy)		-1.48***		-0.0841		-1.33***
		(0.318)		(0.238)		(0.338)
2. Quarter 2005 (Dummy)		-1.71***				-1.41***
		(0.390)				(0.389)
3. Quarter 2005 (Dummy)		-2.15***		-0.138		-1.70***
		(0.387)		(0.183)		(0.383)
Tsunami Measure x 1.Quarter 2005 (Dummy)		0.896***		0.704*		0.467
		(0.220)		(0.381)		(0.326)
Tsunami Measure x 2.Quarter 2005 (Dummy)		0.835*		0.311		0.253
		(0.434)		(0.530)		(0.441)
Tsunami Measure x 3.Quarter 2005 (Dummy)		0.621**		0.0954		0.143
		(0.278)		(0.405)		(0.309)
Observations	26851	26851	18993	18993	30950	30950
R-squared	0.797	0.804	0.828	0.832	0.827	0.832
Branch Fixed Effects	NO	YES	NO	YES	NO	YES

All coefficients times 100, since they are representing fractions (relative bid amount). Observations from January 2004-October 2005.
Dependent Variable: Relative Bid Amount. Affected branches and unaffected branches as specified in column title. Estimation based on equation (1)-(2) Binary classification in affected and unaffected branches.
Round-Denomination Fixed Effects included in all regressions. Branch Fixed Effects included as indicated.
Standard errors clustered at branch level. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5

Descriptive Statistics of Auctions in 2003-2004

	Mean	Standard Deviation	Minimum	Maximum
All Branches (17,956 Observations)				
Financial Data				
Chit Value (INR)	57,249.94	102,171.30	10,000	1,000,000
Duration in Month	35.96	7.06	25	60
Monthly Contribution	1,593.77	2,779.97	200	30,000
Bid Amount (INR)	15,618.78	31,234.94	520	400,000
Relative Bid Amount	0.2442	0.1120	0.051	0.4
Number of Cosigners*	1.8704	1.2556	0	10
Institutional Investor Dummy	0.3791	0.4852	0	1
Geophysical Data**				
Run Up Height (meter)	2.5705	3.3924	0	11
Wave Intensity	0.7369	0.8669	0	2.3979
Damage Intensity	3.5809	4.0485	0	10
Unaffected Branches (9,846 Observations)				
Financial Data				
Chit Value (INR)	53,265.79	90,883.74	10,000	1,000,000
Duration in Month	36.12	6.55	25	50
Monthly Contribution	1,483.30	2,471.17	200	25,000
Bid Amount (INR)	14,686.54	28,326.97	520	400,000
Relative Bid Amount	0.2450	0.1109	0.051	0.4
Number of Cosigners*	1.9237	1.2538	0	9
Institutional Investor Dummy	0.4057	0.4911	0	1
Geophysical Data**				
Run Up Height (meter)	0	0	0	0
Wave Intensity	0	0	0	0
Damage Intensity	0	0	0	0
Affected Branches (8,110 Observations)				
Financial Data				
Chit Value (INR)	62,086.93	114,206.90	10,000	1,000,000
Duration in Month	35.77	7.63	25	60
Monthly Contribution	1,727.89	3,108.88	250	30,000
Bid Amount (INR)	16,750.58	34,404.79	525	400,000
Relative Bid Amount	0.2431	0.1132	0.051	0.4
Number of Cosigners*	1.8083	1.2549	0	10
Institutional Investor Dummy	0.3469	0.4760	0	1
Geophysical Data**				
Run Up Height (meter)	5.6913	2.7783	3	11
Wave Intensity	1.6316	0.4519	1.0986	2.3979
Damage Intensity	7.9282	1.3495	6.5	10

Calculations are based on data Rosca auctions from January 2003-December 2004 in Tamil Nadu in branches within 25 km distance of coastline. Only auctions with a bid amount higher than the commission are considered to ensure a bidding process took place. Bid Amount: Winning bid amount of auction. Relative Bid Amount: bid amount as fraction of chit value. Institutional Investor Dummy: 1 if auction is won by an institutional investor, 0 otherwise. Run up height: Maximum height of water observed above a reference sea level (height in meter). Wave intensity=ln(run up height). Damage Intensity by 12 step intensity scale: I) Not felt, II) Scarcely felt, III) Weak, IV) Largely observed, V) Strong, VI) Slightly damaging, VII) Damaging, VIII) Heavy damaging, IX) Destructive, X) Very destructive, XI) Devastating, and XII) Completely Devastating.

* only for groups that report cosigner data (10,041 auctions, 5377 in unaffected branches, 4627 in affected branches)

** based on tsunami survey measure points of the Indian Institute of Technology Roorkee, India for affected branches.

Table 6

Placebo Experiment: Estimation of the Relative Bid Amount in 2003 and 2004 on Different Tsunami Measures of "Pseudo-Tsunami"

Tsunami Measure:	**Affected Branches**		**Run Up Height**		**Wave Intensity**		**Damage Intensity**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	6.25***	4.54***	31.4***	10.7***	31.1***	4.53***	31.0***	4.54***
	(0.687)	(0.304)	(1.17)	(0.548)	(0.996)	(0.311)	(0.875)	(0.310)
Tsunami Measure (Dummy)	0.0975		0.00821		0.0465		0.0146	
	(0.530)		(0.0628)		(0.280)		(0.0625)	
After Tsunami (Dummy)	-0.959**		-0.823**		-0.872**		-0.909**	
	(0.354)		(0.341)		(0.355)		(0.356)	
Tsunami Measure x After Tsunami	-0.0499		-0.0623		-0.149		-0.0204	
(Dummy)	(0.457)		(0.0803)		(0.312)		(0.0635)	
1. Quarter 2004 (Dummy)		1.54**		1.54**		1.54**		1.54**
		(0.548)		(0.548)		(0.548)		(0.549)
2. Quarter 2004 (Dummy)		1.91***		1.92***		1.92***		1.91***
		(0.485)		(0.485)		(0.485)		(0.485)
3. Quarter 2004 (Dummy)		1.54***		1.54***		1.54***		1.54***
		(0.493)		(0.493)		(0.493)		(0.493)
4. Quarter 2004 (Dummy)		1.60**		1.60**		1.60**		1.60**
		(0.540)		(0.540)		(0.540)		(0.540)
1. Quarter 2005 (Dummy)		1.11**		1.28***		1.23**		1.19**
		(0.468)		(0.413)		(0.438)		(0.450)
2. Quarter 2005 (Dummy)		1.05*		1.13**		1.12**		1.09**
		(0.486)		(0.463)		(0.480)		(0.486)
3. Quarter 2005 (Dummy)		0.627*		0.620*		0.635*		0.631*
		(0.304)		(0.319)		(0.311)		(0.310)
Tsunami Measure x 1.Quarter 2005		-0.271		-0.116*		-0.339		-0.0574
(Dummy)		(0.435)		(0.0600)		(0.273)		(0.0579)
Tsunami Measure x 2.Quarter 2005		-0.581		-0.135		-0.449		-0.0842
(Dummy)		(0.518)		(0.0803)		(0.336)		(0.0707)
Tsunami Measure x 3.Quarter 2005		-0.389		-0.0652		-0.25		-0.0502
(Dummy)		(0.440)		(0.0638)		(0.259)		(0.0553)
Observations	17956	17956	17956	17956	17956	17956	17956	17956
R-squared	0.791	0.798	0.791	0.798	0.791	0.798	0.791	0.798
Branch Fixed Effects	NO	YES	NO	YES	NO	YES	NO	YES

Placebo Experiment: Observations from January 2003-October 2004. All coefficients times 100, since they are representing fractions (relative bid amount). Dependent Variable: Relative Bid Amount. Affected branches within 5 km distance from coast, unaffected branches within 5 - 25km distance from coast.(1)-(2) Binary classification in affected and unaffected branches, (3)-(4) Run up heigth, (5)-(6) wave intensity=ln(run up height), (7)-(8) damage intensity by 12 step intensity scale by Papadopoulos and Imamura (2001). Round-Denomination Fixed Effects included in all regressions. Branch Fixed Effects included as indicated. Standard errors clustered at branch level. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7

Difference-in-Difference-Estimation of the Institutional Investor on Different Tsunami Measures

Tsunami Measure:	Affected Branches		Run Up Height		Wave Intensity		Damage Intensity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.0363	1.144***	0.0309	-0.0205	0.0201	1.111***	0.0421	1.080***
	(0.0347)	(0.0147)	(0.0619)	(0.0276)	(0.0520)	(0.00742)	(0.0462)	(0.0162)
Tsunami Measure (Dummy)	-0.0363		-0.00281		-0.0167		-0.00421	
	(0.0347)		(0.00563)		(0.0221)		(0.00462)	
After Tsunami (Dummy)	-0.00736		-0.0136		-0.0129		-0.0114	
	(0.0163)		(0.0148)		(0.0157)		(0.0159)	
Tsunami Measure x After Tsunami	0.00967		0.00418*		0.0137		0.00238	
(Dummy)	(0.0227)		(0.00221)		(0.0104)		(0.00250)	
1. Quarter 2004 (Dummy)		-0.0360		0.00392		-0.0285		0.000532
		(0.0240)		(0.0289)		(0.0224)		(0.0291)
2. Quarter 2004 (Dummy)		-0.0359*		0.00420		-0.0283		0.000683
		(0.0187)		(0.0274)		(0.0189)		(0.0285)
3. Quarter 2004 (Dummy)		-0.0123		0.0275		-0.00484		0.0242
		(0.0170)		(0.0235)		(0.0175)		(0.0241)
4. Quarter 2004 (Dummy)		0.000568		0.0405*		0.00807		0.0371
		(0.0162)		(0.0209)		(0.0152)		(0.0232)
1. Quarter 2005 (Dummy)		-0.0329**				-0.0315**		
		(0.0140)				(0.0128)		
2. Quarter 2005 (Dummy)				0.0289**				0.0316**
				(0.0126)				(0.0133)
3. Quarter 2005 (Dummy)		-0.0218		0.0149		-0.0180		0.0115
		(0.0175)		(0.0174)		(0.0169)		(0.0184)
Tsunami Measure x 1.Quarter 2005		0.0200		0.00622		0.0205		0.00353
(Dummy)		(0.0342)		(0.00371)		(0.0166)		(0.00386)
Tsunami Measure x 2.Quarter 2005		-0.0275		-0.000392		-0.00634		-0.00204
(Dummy)		(0.0234)		(0.00249)		(0.0123)		(0.00287)
Tsunami Measure x 3.Quarter 2005		0.0150		0.00381		0.0141		0.00278
(Dummy)		(0.0265)		(0.00313)		(0.0135)		(0.00308)
Observations	18993	18993	18993	18993	18993	18993	18993	18993
R-squared	0.284	0.307	0.284	0.307	0.284	0.307	0.284	0.307
Branch Fixed Effects	NO	YES	NO	YES	NO	YES	NO	YES

Observations from January 2004-October 2005. Dependent Variable: Institutional Investor. Affected branches within 5 km distance from coast, unaffected branches within 5 - 25km distance from coast.(1)-(2) Binary classification in affected and unaffected branches, (3)-(4) Run up heigth, (5)-(6) wave intensity=ln(run up height), (7)-(8) damage intensity by 12 step intensity scale by Papadopoulos and Imamura (2001). Round-Denomination Fixed Effects included in all regressions. Branch Fixed Effects included as indicated.

Standard errors clustered at branch level. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 8

Difference-in-Difference-Estimation of the Number of Cosigners on Different Tsunami Measures

Tsunami Measure:	**Affected Branches**		**Run Up Height**		**Wave Intensity**		**Damage Intensity**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	1.106***	0.952***	4.063***	-0.177*	4.089***	-0.115*	3.057***	-0.114*
	(0.0719)	(0.0526)	(0.116)	(0.0846)	(0.109)	(0.0616)	(0.133)	(0.0610)
Tsunami Measure (Dummy)	-0.0744		0.00388		-0.0104		-0.00571	
	(0.0875)		(0.0171)		(0.0666)		(0.0133)	
After Tsunami (Dummy)	-0.0128		0.00458		-0.00169		-0.00603	
	(0.0336)		(0.0310)		(0.0332)		(0.0338)	
Tsunami Measure x After Tsunami	-0.0186		-0.00999		-0.0259		-0.00410	
(Dummy)	(0.0461)		(0.00912)		(0.0347)		(0.00682)	
1. Quarter 2004 (Dummy)		-0.0771		-0.0605		-0.0590		-0.0545
		(0.0630)		(0.0702)		(0.0721)		(0.0735)
2. Quarter 2004 (Dummy)		0.00370		0.0207		0.0221		0.0265
		(0.0480)		(0.0446)		(0.0460)		(0.0467)
3. Quarter 2004 (Dummy)		-0.000321		0.0180		0.0189		0.0230
		(0.0397)		(0.0472)		(0.0511)		(0.0520)
4. Quarter 2004 (Dummy)		-0.0302		-0.0122		-0.0112		-0.00708
		(0.0437)		(0.0533)		(0.0578)		(0.0592)
1. Quarter 2005 (Dummy)		-0.0637		-0.0168		-0.0270		-0.0290
		(0.0372)		(0.0319)		(0.0315)		(0.0319)
2. Quarter 2005 (Dummy)				0.0327		0.0337		0.0334
				(0.0382)		(0.0399)		(0.0401)
3. Quarter 2005 (Dummy)		-0.0326						
		(0.0394)						
Tsunami Measure x 1.Quarter 2005		0.0174		-0.00893		-0.0147		-0.00119
(Dummy)		(0.0714)		(0.0101)		(0.0447)		(0.00918)
Tsunami Measure x 2.Quarter 2005		-0.0991		-0.0227***		-0.0810**		-0.0153*
(Dummy)		(0.0679)		(0.00564)		(0.0303)		(0.00737)
Tsunami Measure x 3.Quarter 2005		-0.0850		-0.0205		-0.0708		-0.0134
(Dummy)		(0.0757)		(0.0120)		(0.0502)		(0.0107)
Observations	10033	10033	10033	10033	10033	10033	10033	10033
R-squared	0.531	0.543	0.530	0.544	0.530	0.544	0.530	0.544
Branch Fixed Effects	NO	YES	NO	YES	NO	YES	NO	YES

Observations from January 2004-October 2005. Dependent Variable: Number of Cosigners. Affected branches within 5 km distance from coast, unaffected branches within 5 - 25km distance from coast.(1)-(2) Binary classification in affected and unaffected branches, (3)-(4) Run up heigth, (5)-(6) wave intensity=ln(run up height), (7)-(8) damage intensity by 12 step intensity scale by Papadopoulos and Imamura (2001). Round-Denomination Fixed Effects included in all regressions. Branch Fixed Effects included as indicated.

Standard errors clustered at branch level. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1