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Enterprise Recovery Following Natural Disasters

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Abstract

Using data from surveys of enterprises in Sri Lanka after the December 2004 tsunami, the authors undertake the first microeconomic study of the recovery of the private firms in a developing country following a major natural disaster. Disaster recovery in low-income countries is characterized by the prevalence of relief aid rather than of insurance payments; the data show this distinction has important consequences. The data indicate that aid provided directly to households correlates reasonably well with reported losses of household assets, but is uncorrelated with reported losses of business assets. Business recovery is found to be slower than commonly assumed, with disaster-affected enterprises lagging behind unaffected comparable firms more than three years after the disaster. Using data from random cash grants provided by the project, the paper shows that direct aid is more important in the recovery of enterprises operating in the retail sector than for those operating in the manufacturing and service sectors.

This paper—a product of the Finance and Private Sector Development Team, Development Research Group—is part of a larger effort in the group to study microenterprise dynamics. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at dmckenzie@worldbank.org.

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"What seems more typical are the comments appearing six months to a year after a disaster, expressing surprise at the speed with which the community has recovered, and the prosperity that now reigns."

(Dacy and Kunreuther, 1969)

A series of catastrophic events in recent years has drawn increased attention of both the public and researchers to the plight of those impacted by natural disasters. The number of natural disasters reported by the press and included in the most comprehensive disaster database is increasing. The Intergovernmental Panel on Climate Change (2007) believes that the frequency of natural disasters is "likely" to increase as a consequence of global warming. Some argue that the current increase results from more complete reporting of disasters, and others say that the future trend driven by climate change is uncertain. But there is little disagreement that the impact of natural disasters is felt most severely by households already living on the margins in low-income countries.[1] The death toll from disasters, for example, is typically much higher in low-income countries (Kahn 2005).

There is a large literature on how households in developing countries cope with and respond to disasters and aggregate shocks. (See Skoufias (2003) for an overview.) The poor suffer disproportionately because missing credit and formal insurance markets limit their ability to smooth aggregate shocks. The informal risk-coping strategies that are used to smooth idiosyncratic shocks break down when all members of a risk-sharing group are affected (Morduch, 1999). As a result, transient shocks can have permanent effects, either through a lowered ability of households to provide nutrition or schooling for their children (Maccini and Yang, 2009; Ferreira and Schady, 2009), or through the inability to repurchase productive assets, such as livestock, which are sold to smooth consumption (Carter et al, 2007).

[1] The trend of an increasing number of disasters shown in the EM-DAT data is likely due in part or in whole to a more complete reporting of disasters. (See, for example, the discussion in Strömberg 2007.)

These same market failures that can limit the ability of households to recover quickly from disasters are also likely to inhibit the recovery of microenterprises and small businesses. Yet the existing literature has not looked at the process of enterprise recovery in developing countries, and even in developed countries there are only a handful of qualitative case studies. Until recent disasters such as Hurricane Katrina and the Asian tsunami, the conventional wisdom, reflected in the quote from Dacy and Kunreuther's book, is that the economy recovers surprising quickly.[2] Based in qualitative interviews with small business owners shortly after Hurricane Katrina, Runyan (2006) concludes that insurance is key: firms with insurance quickly replace destroyed assets, but that those without insurance could not, often because business records lost in the flooding and destruction were required to access federal aid. Large government and non-profit aid flows are also common in developing countries after natural disasters. The literature has examined the determinants of how international financial flows such as aid respond to disasters (e.g. Eisensee and Strömberg, 2007; Yang, 2009), but there is little about how and whether this aid reaches enterprise owners.

This paper provides the first microeconomic study of the recovery of the private sector in a developing country following a major natural disaster. We use firm-level panel data gathered from micro enterprises in southern Sri Lanka following the December 2004 Asian tsunami. In addition to surveys, the post-tsunami project involved a field experiment providing grants to randomly selected enterprises. The grants allow us to assess the importance of capital in the recovery process and measure the return to capital immediately following a disaster.

[2] Most of the research by economists examining the aftermath of disasters focuses on short-term recovery process, rather than the longer-term rebuilding process (Okuyama 2003). Analysis of longer term recovery generally uses aggregate data such as building permits (Dacy and Kunreuther 1969). Two exceptions using micro-level data are Smith and McCarty (1996), who analyze the demographic changes in southern Dade Country, Florida following Hurricane Andrew in 1992, and Dolfman et al (2007) who estimate losses in employment and wages in New Orleans following Katrina.

Recovery in low-income countries differs from recovery in high-income countries most notably in the flow of cash to households and enterprises. A large share of households and businesses in high-income countries are covered by insurance against disasters. While about 50 percent of losses resulting from Hurricane Andrew in Florida and the Northridge earthquake in California were covered by insurance, for example, less than 15 percent of the losses resulting from the tsunami were covered (Ferguson 2006). Moreover, insurance coverage in low-income countries is typically limited to the largest enterprises. Few households or small businesses have insurance to cover losses. Relief aid flows serve as a substitute for insurance flows, both in paying for the recovery and in stimulating economic activity. But as our data show, there are important differences between insurance and aid flows. Only a small part of disaster relief aid flows as cash directly to households and small businesses.[3] The larger share of aid comes in kind, with the majority channeled into infrastructure projects. Moreover, aid agencies are seldom in a position to verify actual losses of households or small-scale enterprises. So while insurance payments are closely related to the insured entity's losses, aid payments to individuals, households, or firms may not reflect the actual losses suffered. Where do households and enterprises obtain funds to rebuild? How long does the process of rebuilding take? Our data are uniquely suited to shed light on these questions.

The December 2004 Indian Ocean tsunami produced catastrophic damage along Sri Lanka's eastern and southern coastlines. Official estimates put total deaths in Sri Lanka at more than 35,000. More than half a million people were displaced when their houses were damaged or destroyed. Estimated damage to infrastructure and other assets

[3] See Oxfam (2005) for an argument that cash aid flowing directly to households should be more common following disasters. Harvey (2005) reviews the state of knowledge on cash aid following disasters. These discussions focus largely on household recovery rather than microenterprise recovery. There is also a debate among microfinance practitioners about the role of loan forgiveness in disaster recovery. See Mathison (2003) for a discussion of these issues.

exceeded $1.3 billion, around 7 percent of the country's GDP.[4] The tsunami's impact was concentrated in a narrow strip along the coast, and in the fishing and tourism sectors. Aggregate Sri Lankan GDP fell only by between 0.5 and 1.0 percent (Jayasuriya et al, 2005). But two-thirds of the island's fishing fleet was destroyed (Asian Development Bank et al, 2005), and—in spite of the fact that the arrival of aid workers dampened the blow—hotel bookings fell by 60 percent on Sri Lanka's southern coast in 2005.

The international response to the disaster was rapid and strong. Governments, international NGOs and the international financial institutions committed over $2 billion in relief and recovery funds, of which $1.1 billion had been dispersed and $0.6 billion expended 18 months after the disaster (Government of Sri Lanka, 2006). Of the total aid pledged, $184 million was categorized as "relief" aid. The remainder was for recovery of the housing ($370 million), transportation ($245 million committed), and water ($190 million) infrastructure and for livelihood restoration ($219 million).

Though the prevalence of insurance and aid differs in high- and low-income countries, businesses face a similar set of shocks following a natural disaster regardless of their location. We discuss three factors that typically affect the recovery process and give us reason to believe the findings here would apply more broadly to recovery from other large disasters. First, labor and capital are destroyed. In Sri Lanka, it appears the impact on the capital stock was proportionately larger than the impact on the labor force, almost certainly the usual pattern. Second, demand shifts. In aggregate, the shift will generally be inward. But for some sectors (e.g., construction materials), demand may shift outward. Third, many trading relationships are destroyed, either temporarily or permanently. The time required to re-form relationships depends on the nature of the relationships in a given sector. This effect is analogous to the "disorganization" effects discussed in the

[4] This is the figure reported in the EM-DAT database. An assessment by the Asian Development Bank, World Bank and Japanese Bank for International Cooperation estimated losses of roughly $1.0 billion and replacement costs of $1.5 billion. The Sri Lankan government estimated recovery costs to be $1.8 billion.

literature on transition economies (Blanchard and Kremer 1997; Roland and Verdier, 1999). We use our panel data to examine enterprise recovery from each of these shocks.

We begin in Section 2 by discussing the data and examining the sources of funds available to enterprises and households to pay for repair or replacement of lost assets. In Section 3, we use random capital shocks we generated as a part of the project to assess the value of access to liquid capital in the recovery process. We study the timeline of recovery in Section 4, and conclude in Section 5 section with a discussion of policies that might quicken the recovery of microenterprises following a major disaster.

Section 2: Firm Losses and Sources of Recovery Funds

Even in normal circumstances, credit and insurance market failures loom large for business owners in developing countries (e.g. Banerjee and Duflo, 2005). A variety of informal mechanisms have evolved to overcome these market failures, but aggregate shocks such as economic crises and natural disasters can limit the effectiveness of informal financing and risk-coping mechanisms. In particular, group-based informal insurance arrangements are ineffective, as the incomes of a household's risk-pooling partners also fall (Lustig, 2000). Already limited access to formal credit may become even more limited. As a result, it is of interest to ask: What resources do owners of microenterprises and small firms use to replace buildings and equipment that are destroyed or damaged in major disasters? And, how quickly are the enterprise owners able to replace assets lost in the disaster?

The survey data

We provide some answers to these questions using three surveys we conducted with enterprise owners and wage workers along the southern coast of Sri Lanka after the tsunami. Each of the three samples contains information on 400 to 600 individuals: 130 to 200 individuals suffering asset losses from the tsunami, an equal number of individuals

living or working in the nearby neighborhoods but not suffering any asset damage, and an third set of individuals living and working outside the tsunami-affected area. We refer to the first group of individuals as "directly affected," the second as "indirectly affected," and the third as "unaffected." We believe these data are unique in allowing us to examine the recovery process of small scale enterprise in a low-income country.

The first survey is a panel of 618 household enterprises, interviewed quarterly between April 2005 and April 2007, and again in October 2007 and April 2008. The April 2005 baseline survey asked owners which assets were damaged or destroyed by the tsunami, and all waves of the survey ask about the repair or replacement of those assets. The July 2005 survey has questions on grants and loans obtained to replace assets. Enterprises in the panel were also subject to random capital injections in May and November 2005, as described in more detail in Section 3 below. Note that all of the data on asset damage and aid received are self reported. The small scale enterprises and households which comprise the majority of the samples seldom keep written records of assets or business transactions. Thus, while the surveys provide very detailed micro-level data, we have no way to verify any of the responses. We discuss this issue in more detail later in the paper.

In July 2007 we conducted two additional surveys—one with a sample of 456 wage workers and the other with a sample of 424 enterprises with between five and 50 employees. The wage workers all live in the same neighborhoods as the microenterprise owners.[5] Because we did not find enough larger enterprises in these neighborhoods, the enterprise sample was drawn from surrounding areas as well. These surveys asked households and enterprise owners about damage suffered from the tsunami, the extent to which the damaged assets had been replaced or repaired, and the sources of funds used to

[5] Sri Lanka is divided into 25 districts, which are divided further into 324 Divisions. These are further divided into just over 14,000 Grama Nalidaris, or GNs, which are the smallest administrative units. There are about 400 households in a typical GN. The microenterprise sample was drawn from 25 GNs in the districts of Kalutara, Galle and Matara.

pay for those repairs. We asked households and business owners if they received payments from insurance claims or aid in the form of grants, or loans.

Asset recovery

Summary data on the extent of damage, insurance coverage, and aid are shown on Table 1. The reported damages reflect differences in wealth and income among the three samples. The larger firm (SME) owners report losing an average of just over $40,000 in business assets and $6,000 in household assets. Wage workers report household losses averaging $5,000, while the microenterprise owners report losses of $897 in business assets and just over $2,400 in household assets. The table demonstrates the lack of insurance coverage in all three samples. Even among the larger enterprise owners, only 13% of those suffering losses reported having any insurance coverage for business assets, and their policies generally did not cover damage from tsunamis. Those with insurance report that only 7.5 percent of business losses were covered. Similar patterns hold for household assets. Among the larger enterprise owners, only 4.1 percent said they had any insurance on household assets, and only 5.1 percent of household losses were covered. Among wage workers, only one of 153 directly affected by the tsunami report having insurance to cover losses.[6]

Owners and wage workers report receiving more funds from grants than from insurance; more than three-quarters of each group report receiving one or more grants. Loans are less common, especially among the microenterprise owners. Only in the case of wage workers, however, does the average respondent report that grants and loans combined covered as much as half of their losses. For SME owners, where the survey asked how the grants and loans were used, grants were more likely to cover housing

[6] In contrast, 78% of *households* suffering damage from hurricane Andrew in Florida had insurance, and the insured received average payouts of $32,000 (Smith and McCarty, 1996). The percentage of insured was likely higher among businesses. Besides providing funds for the recovery of individuals' assets, the $14 billion dollars of insurance aid following Hurricane Andrew provided a significant boost to the local economy that is lacking in the Sri Lankan case.

losses and loans more likely to cover business losses. For the typical SME owner, grants covered almost one-quarter of housing losses, but less than 2 percent of business losses. Loans covered an additional 13.7 percent of business losses for the SME owners.

In Sri Lanka, cash aid came primarily through four programs. First, the Sri Lankan government paid surviving family members 15,000 Sri Lankan Rupees (LKR, about $150) for each person killed by the tsunami, to offset funeral expenses. Second, the government and the World Bank provided four grants of 5,000 LKR (about US $50) to 220,000 households suffering direct damage from the tsunami.[7] Third, the government provided aid to rebuild houses destroyed by the tsunami. Finally, the government and numerous NGOs sponsored cash-for-work programs, which typically paid workers around 300-350 LKR ($3.00-$3.50) per day to participate in cleanup and rebuilding activities. So while much of the aid came in-kind, there was a significant amount of cash aid provided.

Our April 2005 microenterprise survey indicates that the households of owners received an average of $115 in aid during the first three months of the tsunami, of which $101 came from government programs, $8 from NGOs and $6 from other sources. Table 1 shows that by July 2005, 94 percent of those reporting damage had receive some form of aid. However, the mean aid received ($332 among those receiving something) was less than 10 percent of the reported damage.[8] The grants reported by microenterprise owners cover only a small portion of the losses they incurred. Loans were much less common. Less then 4 percent of microenterprise owners reported receiving loans, and these covered less than 1 percent of losses in aggregate. The data on Table 1 are self reported, and we should be concerned that the reported losses are exaggerated and the reported aid

[7] According to Jayasuriya et al (2005), the number of beneficiaries was reduced from over 800,000 to around 200,000 after the first two payments. The smaller number represents only around 50,000 households.

[8] The enterprises appear to have reported grants provided by our project itself, as described below, so these amounts likely overstate the aid received by typical microenterprises. Those receiving our grants reported cash aid averaging just over $100 more than those not receiving our grants.

understated. However, one measure suggests that the data are not far from reality. The program to replace or repair housing made payments totaling $2,500 per household, almost exactly the same average amount as the grants reported by wage workers. SME owners reported grants averaging around $1,600.

Perhaps the most interesting aspect of the reported aid is the lack of correlation between reported losses and reported grants and loans. For SME owners, where we are able to separate business from household aid, the correlation between the reported loss of household assets and the grants (loans) received is 0.70 (0.27). For business assets, on the other hand, there is essentially no correlation between the reported losses and the (very small level of) grants received; the correlation between losses of business assets and loans to replace those assets is 0.16. For wage workers, the correlation between grants and household losses is 0.31. Finally, for microenterprise owners, there is no correlation between the level of losses on the one hand and grants or loans on the other. So while overall aid flows into Sri Lanka following the tsunami were large, and while at least some aid there flowed directly to households suffering losses, the data suggest that targeting is particularly poor with regard to damage suffered by business owners.

Enterprise recovery

Given the lack of insurance and low aid flows, we find it surprising that owners report the majority of damaged assets had been replaced or repaired by the summer of 2007. Households report having replaced 60% of lost assets, while SME and microenterprise owners report having replaced more than two-thirds of their assets. By April 2008, 75 percent of microenterprise owners reported having replaced all of the housing assets damaged by the tsunami. Where did they obtain funds to repair or replace damaged assets? The survey data allow us to provide some insight on this question, and to say something about the speed of recovery, with regard to the microenterprises.

Among the 204 firms suffering tsunami damage, 168 (82 percent) repaired or replaced some damaged enterprise assets within three months of the tsunami. On average, owners suffering damage reported spending US$111 on enterprise recovery in the three months following the tsunami. Excluding those spending nothing in this period, the average expenditure was $135. While a substantial sum relative to pre-tsunami income levels, the amount represents less than 15 percent of the assets lost or damaged by the tsunami. The largest initial effort went to equipment and working capital: an average of US$39 was spent on equipment, representing 25 percent of the losses in this category. Relative to the losses suffered, the smallest investment was in land and buildings, where owners reported spending US$29 compared with losses of US$362.[9]

What were the sources of funds which enterprises used to replace lost or damaged equipment? On average, just over half of the funds spent in the first three months came from own savings (51 percent). An additional 15 percent were obtained through loans from family members (9 percent) or friends (6 percent). One-fifth of the resources (20 percent) came from grants or loans from tsunami relief agencies. The remaining 14 percent was spread among credit from suppliers (6 percent), loans from microfinance organizations (2 percent), moneylenders (2 percent), banks (less than 1 percent), remittances from relatives abroad (1 percent) and other sources. The largest spenders relied more heavily on loans from family members and credit from suppliers, while those spending the least relied more on own savings. As a percentage of the total amount spent by all 176 entrepreneurs with complete data, own savings represents only 36 percent of expenditures. Loans from family members (13 percent) and friends (20 percent) are together almost as important, and credit from suppliers, at 11 percent of the total funds spent, is also more important than the unweighted averages suggest.

[9] The data on assets lost in this paragraph differ slightly from those reported for microenterprises in Table 1, because the data here come from the baseline survey while those in Table one come from the October 2007 retrospective survey. The two means are actually quite close, however, with owners reporting business losses of $814 in the April 2005 survey and $897 in the October 2007 survey.

Given the breadth of damage in local areas, we might expect those with family and social networks extending outside the direct impact zone to have recovered more quickly, since their networks extend to unaffected areas. The evidence available to us on this, while mixed, is not particularly strong. In the April 2008 survey, we asked entrepreneurs whether their relatives were affected by the tsunami. Questions covered parents, siblings, parents- and siblings-in-law, and adult children who were living at the time of the tsunami. We do not find that those with parents or children who were unaffected by the tsunami spent a larger amount on recovering assets in the months following the tsunami, or that they obtained a larger share of the funds they did spend from family members. We do find that entrepreneurs who lived in a different administrative district (DS Division) at age 12 report using family members as a source for a slightly higher portion of their recovery funds (14 percent vs. 9 percent), but the difference is not significant. Those who lived outside the same DS Division at age 12 also report having spent more to replace and repair assets during the first three months, both at the mean ($185 vs. $102, p=0.12) and the median ($40 vs. $33). These data suggest a surprisingly large contribution to the recovery comes from the owners' savings and loans from family and friends.

Figures 1 and 2 show that enterprises suffering damage had recovered to their pre-tsunami size within about 15 months of the tsunami. The figures show the value of equipment, tools and vehicles used in the enterprise (Figure 1) and profits (Figure 2) across time, as a percentage of the reported values in the month before the tsunami (November 2004). Mean profits of directly affected firms fell to 65 percent of the pre-tsunami level in March 2005 before recovering to 107 percent of the pre-tsunami level by March 2006. Capital stock shows a similar pattern. Both figures compare the directly affected enterprises with the unaffected enterprises.[10] Note that while the affected

[10] We use the set of firms not receiving one of the random grants provided by the project (as discussed below) and reporting profits in all 11 rounds of our panel survey. We trim firms with profits in the top and

enterprises recovered to pre-tsunami levels, the profits and capital stocks of the unaffected firms grew by 30 percent to 50 percent over this same period. Indeed, the affected firms remain smaller in both profits and investment more than three years after the tsunami.

In sum, the data paint a fairly consistent picture of the process of recovery of business assets. The magnitude of the total aid flow to the affected area was roughly comparable to what might be expected following a disaster in the United States. But the flow was of a very different character, with less insurance and more aid. The portion of the aid and insurance flowing directly to households and small scale enterprises appears to be modest compared to the size of the losses incurred. Moreover, while we find some correlation between the magnitude of the aid flows and the magnitude of the losses with respect to losses of household assets, we find no correlation between losses of business assets and aid flows. Consistent with this, the recovery of household assets is complete within three years for a majority of households, while the affected enterprises lag behind a comparable group of unaffected enterprises more than three years after the event.

Section 3: Profitability and the Incentive to Recover Assets

Given the low levels of official aid firms report receiving, we find even the partial recovery of assets surprising. The households of microenterprise owners have low levels of wealth, and few liquid assets. The recovery of the majority of their assets at a time when competing demands for available funds must have been great suggests the microenterprise owners had strong incentives to replace their assets. Did extraordinary opportunities for profit drive enterprise recovery in the tsunami impact zone? We provide

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bottom 1 percent, and then plot an index of mean real profits over the period November 2004 to September 2007. Nominal profits were converted to real profits using the monthly Sri Lanka Consumer's Price Index, available at http://www.statistics.gov.lk/price/slcpi/slcpi_monthly.htm. Annual inflation was 4.0 percent between March 2005 and March 2006, and 18.6 percent between March 2006 and March 2007. Inflation was an additional 10.3 percent in the six months from March 2007 to September 2007.

evidence on this question by providing randomly allocated grants to a portion of microenterprises in a panel survey, as described in more detail below.

A simple framework results in two predictions, which we test with the data. Assume firms have Cobb-Douglas production functions and operate in perfectly competitive output markets. The output of firm i is $Y_i = AK_i^{\alpha} L_i^{(1-\alpha)}$, with K, and L representing capital and labor, and Y representing the output of goods with unit price. Prior to the shock,

$$\alpha A\left(\frac{L_i}{K_i}\right)^{(1-\alpha)} = r_i$$

$$(1-\alpha)A\left(\frac{L_i}{K_i}\right)^{(-\alpha)} = w_i(\bar{w})$$

We allow the opportunity cost of both capital and labor to be firm specific, reflecting less than perfect input markets. Since the enterprises in our sample employ few workers outside the family, $w_i(\bar{w})$ reflects the individual's opportunity cost of time, which depends on the market wage rate, $\bar{w}$.

The tsunami appears to have destroyed a larger share of the capital stock than the labor force. The estimated value of the lost assets was US$1 billion, just over 1 percent of the country's pre-tsunami capital stock. About 35,000 people were killed, less than 0.2 percent of the population.[11] A decrease in capital relative to labor leads to an increase in the returns to capital at the margin, and a decrease in the return to labor at the margin.

But at least three factors might offset this. First, the psychological trauma following the devastation may have increased at least temporarily the opportunity cost of the owner's time. Owners reported (to us and to others) that they did not feel like working in the weeks and months following the event. Second, the tsunami caused shifts in the demand for output produced by the firms. Some evidence suggests that the

[11] Because of the timing of the event and other factors, women were disproportionately likely to be killed. Since women have lower labor force participation rates, the effect on the labor force was likely less than 0.2 percent.

immediate shift was inward. Fishing and tourism are the main industries along the southern Sri Lankan coast. Tourism fell precipitously, replaced partially a few weeks later by the inflow of relief workers. The demand for fish also fell. Much of the initial relief funding came in the form of in-kind aid. After the first few weeks, more of the aid appears to have come in cash or through the purchase and donation of goods produced locally such as fishing boats. Third, the tsunami caused other disruptions in production. Trading relationships were severely disrupted. The businesses of customers or suppliers of firms, particularly those located near the coast, were destroyed and in some cases, their owners were killed or severely injured. In some cases, the entire supply chain was disrupted. This is the case in the coir industry, for example, where the pits used to soak the coconut husks were filled with debris that took many months to clear. Even where alternative suppliers for an input did exist, market frictions might have led to production difficulties in some sectors. The simultaneous severing of many relationships is not unlike the "disorganization" following the breakup of the Soviet Union (see Blanchard and Kremer 1997; Roland and Verdier 1999).

This discussion leads to two testable predictions. First, the disproportionate destruction of capital relative to labor should result in very high returns to capital among firms, at least where demand is restored by aid flows and relief workers. Second, the profitability is likely to be lower for manufacturers than for retailers, because manufacturers rely more on the availability of specific inputs, and generally have more intensive relationships with a smaller number of customers. For the same reasons, manufacturers are likely to recover more slowly.

Other predictions of heterogeneity in the speed of recovery come from the broader development literature. We explore three: education, gender, and the extent to which immediate family members living in other households also were affected by the tsunami. Schultz (1975) argues that education and ability are particularly important in dealing with changes in economic conditions and economic disequilibria. We test to see if education

and other ability measures are associated with more rapid recovery. With respect to gender, the shock to the household may affect household bargaining and the allocation of resources. The recovery of males and females may differ as a result. Finally, gifts or loans from family members may be one source of capital for recovery. These are likely to be most commonly received from parents or adult children. Of course, aid from family members is less likely if family members were also affected by the tsunami.

Using Experimental Data to Identify Returns to Recovery Funds

The suddenness of disasters and logistical issues involved in coordinating the aid response make collecting data for households or enterprises receiving assistance a very difficult and rarely undertaken task. Even where such data are collected, identifying the role of capital in the recovery process is complicated by the presence of a number of unobserved factors which are likely to be correlated with both the speed of capital stock replacement and future profitability. Firms anticipating faster profit recovery may be more inclined to replace capital stock or find it easier to persuade family members to lend them resources. More politically connected firms may be better able to access aid flows. And the direction of causation may flow from profit recovery to capital stock, if firms replace damaged capital by reinvesting profits.

To investigate whether high profits provided an incentive for replacing damaged assets, we carried out an experiment in which firms were randomly given grants of cash or in-kind grants to purchase material or equipment, selected by the owner for the enterprise. We describe in detail the results of the experiment among undamaged firms in de Mel, McKenzie and Woodruff (2008). The experiment gives us a clean measure of the role of capital in the disaster recovery process.

Our baseline survey included 227 enterprises in directly affected areas along the coast. The enterprises were selected with a screening survey administered door-to-door in residential neighborhoods in the districts of Kalutara, Galle and Matara. Our intention

was to draw a sample of enterprises with less than 100,000 LKR (US$1000) in capital stock, excluding land and buildings. A screening survey eliminated enterprises hiring paid employees, those owning a motorized vehicle, and those engaged in professional services, fishing, and agriculture. After reviewing the baseline data, we eliminated 18 of the 227 enterprises either because they exceeded the 100,000 LKR maximum size ceiling we had set, or because a follow-up visit could not verify the existence of the enterprise. The remaining 209 firms constituted the baseline sample. These firms almost evenly split across two broad industry categories, with 107 in manufacturing or services and 102 in retail, and by gender of the owner, with 107 firms owned by females, 98 by males, and 7 jointly owned.

After the baseline survey, we randomly selected some of the enterprises and gave them either 10,000 LKR (about US$100) or 20,000 LKR (about US$200) either in cash or in-kind grants. In the latter case, the items to be purchased were selected by the owner, and purchased by research assistants working for the project. Cash treatments were given without restrictions; recipients were told they could purchase anything they wanted with the cash. The treatment was framed as compensation for participating in the panel survey, and enterprise owners were told that they would be eligible to win the grant only once.

The aim of our experiment was to provide firms with an exogenous shock to capital stock, and to measure the impact of this on business profits. Within the affected zone 120 firms were assigned to treatment (57 percent), with 90 firms assigned to receive treatment after the baseline survey in May 2005 and a further 30 firms assigned to receive treatment after the third survey round in November 2005. This split frontloaded treatments so that more of the randomly allocated aid could reach tsunami victims sooner. The 120 treatments were made up of 77 of the 10,000 LKR treatments (39 cash, 38 in-kind) and 43 of the 20,000 LKR treatments (21 cash, 22 in-kind).

Our initial plan was to survey firms for five quarterly waves only. Receipt of further funding enabled us to continue the panel, with four additional quarterly waves

collected from July 2006 through April 2007, and a tenth and eleventh waves collected in October 2007 and April 2008. In order to compensate firms for the additional burden of staying in the study longer than we had anticipated, we gave 2,500 LKR (~$US25) in cash to each of the remaining untreated firms after round five of the survey.

Attrition in the data is relatively low. Of the 209 baseline firms, 186 report profits in round five and 173 in round 11 (83 percent of the initial sample). However, only 197 firms report profits in the baseline survey, and firms move in and out of the sample. One hundred thirty-five firms report profits in all 11 rounds, and 182 report profits in eight rounds or more. We restrict our analysis to the 200 firms reporting profits in three rounds or more.[12] Appendix 1 compares the characteristics of the treated and untreated firms among these 200. The randomization was done by computer, so any differences can only be due to chance or to the elimination of these nine firms that report less than three waves of profits. The two groups appear to be balanced on the key observable characteristics, but we will also include individual fixed effects to account for any baseline differences in levels remaining.

The Impact of Grants on Profits

We begin by estimating the mean impact of the grants on real profits of tsunami-affected firms, via the following fixed effects regression for firm *i* in period *t*:

$$PROFITS_{i,t} = \alpha + \beta AMOUNT_{i,t} + \sum_{s=2}^{10} \omega_s \delta_s + \mu_i + \varepsilon_{i,t} \qquad (1)$$

Where $AMOUNT_{i,t}$ is an indicator of the amount of treatment received by firm *i* at time *t*, coded in terms of 100 LKR. Firms receiving 2,500 LKR after round 5 will thus have *AMOUNT* of 25 in rounds six through 11 (and 0 before this). The δ_s are wave dummies.

[12] This eliminates six control firms and three firms assigned to receive the 10,000 LKR treatment.

Treatments are coded 0, 100, or 200 in the regressions so the coefficient shows the increase in profits in rupees from a 100 LKR treatment. Thus, the coefficients can be interpreted as the percentage return on the treatment. The interpretation of the coefficients from the regressions merits several comments. First, for all regressions we deflate profits by the all-island consumer price index. Second, since we use the amount of the treatment as the independent variable, we are measuring the intention to treat. As not all of the grants found their way into the enterprise, this may differ from the return to incremental investments. The intention to treat seems the more policy-relevant effect in the disaster recovery context. Third, we pool all waves of the survey, so the coefficient measures an average treatment effect for the three years following the first set of treatments. We find no significant time trend in the treatment effects, justifying the pooling of the data.[13]

The first column of Table 2 shows the effect of the treatment on real profits. A 100 LKR grant increases average monthly profits by 9.90 LKR, representing a 9.9 percent real monthly return on the treatment. The treatment effect is significant at the 5 percent level. In column 2, we trim on extreme changes in profits. We eliminate observations lying above the 99th percentile in either percentage or absolute changes in profits across waves of the sample. We trim the top but not the bottom of the distribution because rapid falls in profits are more likely to be due to owner illness, lack of demand, or other negative shocks that we do not want to trim from the data.[14]

In column 2, we trim observations where profits increased by more than 800 percent or 15,000 LKR from one period to the next. Ideally this trimming should not change the size of the estimated coefficient, but should increase its precision. In fact, we

[13] Returns are slightly higher more than five quarters after treatment, but the difference is not significant at the 0.10 level.

[14] After receiving the data, we asked the survey firm to verify the records for all enterprises showing very large changes from one wave to the next. Several data points were corrected for keypunch errors. The survey firm also confirmed that several cases of large drops in profits were due to negative shocks suffered by the enterprise. Their opinion was that large increases were more likely due to incorrect recording of data in the field. On the basis of this exercise, we trim only the top tail of the data.

see a modest drop in the coefficient, to 8.9 percent, and a drop in the standard error. We trim the remaining regressions reported in the paper in a similar fashion. The treatment effect of 8.9 percent when we trim on changes compares to a treatment effect of 5.4 percent for the indirectly affected and unaffected firms (de Mel, McKenzie and Woodruff, 2008). That is, grants have a far bigger impact on damaged firms, by a margin of half again as much as the effect on undamaged firms.[15]

In column 3 of Table 2 we examine whether the cash and in-kind grants have different effects. A 100 LKH cash grant increases profits by 5.3 LKR, and the in-kind grant by 12.2 LKR. But given the standard errors, we cannot reject equality of the two treatment effects (p=0.211). Therefore, evidence does not strongly support a preference for aid in kind over cash grants in terms of their ability to raise firm profits.

Column 4 of Table 2 examines whether firm owners adjusted their labor hours in response to the treatment. *A priori,* the direction of any effect is unclear – repaired capital stock may allow owners to produce more, and hence increase complementary labor inputs, or may enable owners to substitute capital for labor, leading them to work less. The results in Table 2 show no strong effect in either direction. The point estimates suggest that owners reduce labor hours by 0.3 hours per week as a result of the treatment, and we cannot reject that the change in labor hours is zero. Thus, any effect on profits would appear to be attributable to the injection of capital rather than any associated changes in labor input.

[15] Note, however, that the standard errors are large enough that we cannot reject that the treatment effect for tsunami-affected enterprises is equal to that of unaffected enterprises, despite the large difference in point estimates. Table III, column 6 of De Mel et al. 2008 is the only part of that paper which involves the tsunami-affected firms: it reports a treatment effect of 9.08 percent for the tsunami-affected firms using only nine waves instead of the 11 waves of data here. The paper then refers to the current paper for analysis.

Demand, market friction, or production complementarity?

There are several dimensions along which we might expect to find heterogeneity in the post-disaster returns to capital. The tsunami resulted in the closure of many businesses on a temporary or (in the case of death) permanent basis. Where enterprises purchase from or sell to only a few trading partners, replacing these relationships might be expected to take time. Second, demand shocks may vary with the product of the enterprise. McKenzie (2006) shows that one way credit-constrained consumers respond to aggregate shocks is to cut back on their purchases of semi-durables to a much larger extent than would be predicted just from the income effect. As a consequence, we would expect demand to recover much more quickly in retail sales, and less quickly in manufacturing, as consumers shift their expenditure patterns to protect food consumption. Third, production assets may have stronger complementarity in manufacturing than in retail. Owners may need to replace all of their capital stock before they can produce. Retailers, on the other hand, may be able to sell goods even without assets such as display cases, refrigerators, and so forth. Finally, supply chains may have been disrupted. Manufacturers of products made from coconut husks (coir), for example, reported finding supplies difficult, as the lagoons used to process the husks took many weeks or months to clean. Without a supply of inputs, replacing machinery may be irrelevant.

We investigate how the impact of the grants varies across sectors, and by the importance of individual customer and supplier relationship. We do this by estimating the following fixed effects regression in which the treatment variable and wave dummies are each interacted with sector or trading partner characteristics of the firm:

$$PROFITS_{i,t} = \alpha + \beta AMOUNT_{i,t} + \phi AMOUNT_{i,t} * X_i + \sum_{s=2}^{10} \omega_s \delta_s + \sum_{s=2}^{10} \eta_s \delta_s * X_i + \mu_i + \varepsilon_{i,t} \quad (2)$$

where X_i indicated the sector, the presence of a trading partner buying more than 25 percent of output or supplying more than 25 percent of inputs, or some other characteristic of the enterprise or owner.

The results by broad sector and trading partners are shown on Table 3. We show results with the sample trimmed at the 99th percentile on percentage and absolute changes in profits, but the results are very similar without trimming. We find very significant differences in the impact of the grant on manufacturing firms compared to retail firms. Column 1 shows that the mean effect for retail firms is to increase real monthly profits by 19.6 LKR for every 100 LKR received, equivalent to a 19.6 percent monthly return on the grant. In contrast, the interaction of amount with the manufacturing dummy is significant, large, and negative. Adding the interaction effect to the amount coefficient results in mean treatment effect which is slightly negative, and not significantly different from zero for manufacturing. The grant therefore had a large effect on retail, and no average effect on manufacturing. This is strikingly different from the results of applying the treatment to indirectly affected and unaffected firms, where there is no significant interaction with manufacturing.[16] It therefore appears that after the tsunami a lack of capital was not the main barrier to recovery of manufacturing, but that capital did significantly impact on the recovery of retail.

Given the sample size, we are unable to say why capital is more important for retailers than for manufacturers. We suspect the explanation varies with the nature of the product. Both enterprise owners and NGOs told us, for example, that lack of inputs was the main constraint in the coir industry. The primary customers for producers of lace are tourists, so in that sector, a lack of demand may haven been the critical factor. Given our sample of about 100 manufacturers in the directly affected area, we are unable to

[16] In particular, when we trim on changes in profits, the coefficient on retail*amount is 6.43 (s.e. 3.08) and the coefficient on manufacturing*amount is 4.08 (s.e. 2.80) when we estimate equation (4) for firms not damaged by the tsunami. The difference is insignificant (p=0.57).

differentiate between these explanations. We can say that we find no evidence that returns are lower among firms with suppliers or customers who account for a large share of trade. In Columns 2 and 3 of Table 3, we interact the treatment amount with a variable indicating the enterprise has a single customer accounting for at least 25 percent of sales (Column 2) or one supplier accounting for at least 25 percent of input purchases (Column 3). Neither interaction is significant, suggesting that friction in trading relationships is not a cause of slow recovery. However, we take even this limited evidence with a grain of salt. The questions on which these variables are based were asked at the time of the baseline survey. As such, they reflect the situation after the tsunami rather than before.

Other Dimensions of Heterogeneity

Appendix 1 compares the characteristics of manufacturing and retail firms in our sample. The manufacturing firms are more likely to be run by females, have lower profits before the tsunami, and are more reliant on a single customer and a single supplier of inputs. They sell to far fewer customers per day, on average. The three largest sub-industries within our manufacturing sample among directly affected firms are sewing clothes, spinning lace, and making food such as string hoppers (Sri Lankan rice noodles which are a dietary staple). These are all industries dominated by female owners. With the exception of food preparation, all other products made by the manufacturing firms are semi-durables, for which demand is likely to recover more slowly. Furthermore, a greater reliance on a major customer and/or a major supplier increases the likelihood that a disruption in this relationship as a result of the tsunami will have a large effect on the firm.

In de Mel, McKenzie, and Woodruff (2008, 2009) we find that returns are significantly lower in enterprises owned by females than in enterprises owned by males. Indeed, we cannot rule out the possibility that the overall mean effect of the treatment is zero for female owners. In the tsunami-affected zone, however, we find no significant

difference between returns in male- and female-owned enterprises. Column 4 Table 3 suggests the mean female effect is about 70 percent of the male effect. We posit that the difference reflects the value of capital in recovery compared with the value of capital in expansion. In the directly affected area, the grants helped owners return their business to their pre-tsunami size. In the unaffected areas, the grants allowed owners to expand their businesses. The higher returns for females in the directly affected area suggests that recovering the enterprise is as valuable for females for males, while the low returns for females in unaffected areas suggests that expanding the businesses from the steady state size may not be profitable.

An additional hypothesis is that recovery may be faster for more educated, able business owners. Schultz (1975) has argued that an important role of education is providing the ability to deal with changes in economic conditions and economic disequilibria. Column 5 of Table 3 shows that the treatment has a positive, but insignificant interaction with the years of education of the firm owner. The point estimate is positive and similar in size to the significant coefficient found among indirectly affected and unaffected firms (de Mel, McKenzie and Woodruff, 2008). The results are therefore consistent with the view that among small firms, more able firm owners are further away from their optimal capital stock level (even prior to the disaster), and hence have higher returns to capital. They do not suggest that human capital can serve as a substitute for physical capital in the recovery process – which would require a negative interaction between the grant and human capital.

Finally, we asked owners if they had parents or adult children who were not affected by the tsunami. Unaffected family members might serve as an alternative source of aid in the absence of insurance or grants tied directly to losses. Though we did not find that those with unaffected family members received larger loans from family members, we did find that those with parents or adult children who were unaffected by the tsunami had lower returns from the treatments. Indeed, the results suggest that those with both

adult children and parents who were untouched by the tsunami had zero returns to the treatment. Though we did not stratify the treatment on this variable, the results are consistent with social networks being an important source of recovery funds. Those without family networks in the position to provide help after the disaster have particularly high-valued uses for recovery funds.

Profitability and investment

If profitability is higher in retail, we should expect to find that retailers invest a larger share of the grants than manufactures. Table 4 presents evidence weakly consistent with this expectation. We regress capital stock reported in each wave of the survey against the treatment amount and the treatment amount interacted with a variable indication the firm is a manufacturer. The regressions also include firm and wave fixed effects, and wave / manufacturing interaction effects. The regression is trimmed on the absolute and percentage change in reported profits. Retailers appear to invest all of the grant in the enterprise. A 10,000 LKR grant is associated with an increase in the average retailer's capital stock of 10,600 LKR. Manufacturers appear to invest a lower portion of the grant in their business, about 6,400 LKR of a 10,000 LKR grant. Thus, the investments behavior of manufacturers appears consistent with lower returns in the manufacturing sector.

Section 4: The Speed of Recovery

The high returns to capital in the recovery zone provide a strong incentive for reinvesting capital. If investment is in fact responding to that profit incentive, then we should find that retailers recover their capital stock, sales and profits more rapidly than manufacturers, even absent grants provided by the experiment. In this section, we examine this correspondence. In particular, we are interested in the question: Do

untreated manufacturers recover more slowly than untreated retailers? That is, is the behavior of the treated firms consistent with the data from the untreated sample?

Before looking at the microenterprise panel data, we note that the SME sample includes both retailers and manufacturers. There are relatively few retailers among the larger enterprises. The sample includes only 28 retailers (including hotels and restaurants) that were damaged by the tsunami. But these retailers had replaced 78 percent of their assets on average (85 percent at the median), compared with 64 percent (60 percent at the median) among the manufacturers. The difference in means is significant at the .05 level, in spite of the small sample size. On the other hand, we find no significant difference between retailers and manufacturers with respect to replacing household assets. By the summer of 2007, larger retailers had replaced 71 percent of the household assets damaged in the tsunami, compared with 67 percent for manufacturers. These data suggest that manufacturers had as many resources available to them as retailers for use in replacing household assets. These data are thus consistent with retailers having stronger incentives to replace or repair business assets.

We do not have good measures of inventories prior to the tsunami. This is a concern, because a larger share of retailers' investment is made in inventories. Admittedly, even our measures of profits and sales are retrospective. However, leaving aside concerns about deliberate misreporting, we believe these are likely to more accurately reflect the pre-tsunami situation. Using the untreated part of the microenterprise sample, we now examine the characteristics of firms that recovered more quickly. We estimate the following random effects model for log real profits for untreated firm *i* in time period *t=2,…,11*:

$$\ln\left(PROFITS_{i,t}\right) = \alpha + \beta' X_i + \theta_1 \ln\left(PROFITS_{i,March2005}\right) + \theta_2 \ln\left(PROFITS_{i,November2004}\right) + \sum_{t=3}^{11} \pi_t \delta_t + \mu_i + \varepsilon_{i,t} \quad (3)$$

where X_i is a vector of baseline characteristics of the owner and the firm, $PROFITS_{i,March\ 2005}$ and $PROFITS_{i,November\ 2004}$ are the firm's profits in March 2005 and November 2004 respectively, the δ_t are wave effects, and μ_i is a firm random effect. We estimate this for the unbalanced sample of untreated firms experiencing business damage. This gives 702 observations on 80 firms. Since real profits are expressed in logs, the vector of coefficients β multiplied by 100 can be interpreted as the percentage growth in profits associated with a one unit change in X_i. It is likely that the association with X_i will vary from quarter to quarter, in which case β is giving the average effect of X_i over the three years post-tsunami studied.

The choice of variables to include in X_i in equation (3) is guided by several competing hypotheses about the factors that might be most strongly linked to the speed of enterprise recovery. Schooling and gender were discussed above. We also include variables indicating the age of the owner and enterprise and the marital status of the owner. We have shown that access to capital may be important, at least for retailers. Since the tsunami destroyed physical capital of the business, access to credit is likely to be one determinant of how quickly firms can replace this capital and recover. Our baseline survey asks whether firms have ever had a loan from a private bank, government bank, microfinance program, or government program. This category includes 30 percent of untreated firms with business damage. However, 26 percent of firms still had outstanding loans dating from before the tsunami, for which payments generally continued to be paid. Previous use of credit may therefore not be a very good indicator of the ability to raise new capital after the tsunami.

Another characteristic that might affect a firm's recovery is its formality status. A firm's registration (in our case with the Pradeshiya Saba (municipal organization) or District Secretariat) arguably offers a potential advantage by establishing a record of the firm's existence prior to the disaster, and providing some basic information on its sales

and assets. Also, formalization enables firms better access to credit, according to often heard claims. However, in our discussions with NGOs and government officials working on tsunami recovery programs, registration of the firm apparently was not used to identify firms as potential aid recipients, as a precondition for loans, or for verification of pre-tsunami asset levels. We therefore expect to see no significant effect of formalization on recovery, but include this variable as a check of the formality hypothesis.

Table 5 reports the results of estimating equation (3). Column 1 shows our base specification. Baseline and pre-tsunami profits are positively and significantly associated with profits in latter waves of the panel. Conditional on these, we see that profit recovery in the absence of the capital provided by our grants is slower for manufacturing firms, female-owned firms, and firms located closer to the coast. The speed of recovery is not significantly associated with the owner's education, age, or marital status, or the age of the enterprise. We also find no evidence that formally registered firms recover more quickly. There is a sizeable positive point estimate on having previously had a loan, consistent with greater access to capital aiding recovery. However, the standard errors are large, so we cannot reject zero effect.

Columns 2 and 3 control for whether the firm has a major supplier or major customer accounting for 25 percent or more of inputs or sales respectively. We see a strong negative and significant effect of having a major customer. Firms with a major customer average 33 percent less profit growth over this period. Overall, the recovery of profits among the untreated sample suggests a consistent with the experimental results. Manufacturers appear to recover more slowly than retailers.

Section 5: Conclusions

In large, well-publicized disasters affecting low-income countries, the flow of relief and recovery aid is often very large. This paper uses data from surveys of private enterprises and households in Sri Lanka in an attempt to understand how that aid might

be more effectively administered. We find that the aid flow to households for the purpose of recovering household assets damaged by the tsunami was large and positively correlated with the damage suffered by the household. In contrast, the aid flow to enterprises was small and not well correlated with reported damage.

In spite of the lack of aid flowing to businesses, enterprises reported having replaced or repaired two-thirds of the damaged assets 30 months after the tsunami, our findings show. Surprisingly, among the smallest enterprises, the majority of the funds used to pay for recovery came from personal savings or from loans or gifts from family members and friends. Recovery aid and formal loans were a less important source of finance for recovery. We find this surprising because these households are generally thought to be the most capital constrained. Nonetheless, despite this partial recovery of capital stock, tsunami-affected firms still had lower profits and capital stock three years after the tsunami than similar firms not damaged by the tsunami, suggesting the recovery process is slower than often assumed.

Using the random allocation of cash grants to enterprises, we find that returns to capital among retailers in the recovery zone are very large—much larger than in inland areas less affected by the tsunami. But among manufacturers, the incremental capital provided by the grants did not result in higher profits. The high returns, of course, provided an incentive to invest in the enterprises during the recovery period. The data also show that the recovery was more rapid among those operating in the retail sector than among those in manufacturing or services.

We believe that many of the findings from the tsunami experience would apply more broadly to the recovery of firms from other disasters, especially those arising from infrequent natural phenomena such as tsunamis and earthquakes. Arguably, firms may take more ex ante actions when exposed to more frequent natural disasters such as hurricanes. But even where disasters are recurrent, the majority of microenterprises are likely to be uninsured. The general pattern of large aid flows and poor targeting toward

business recovery seems generalizable, as does the change in demand and supply chain disruption leading to faster recovery for retail than manufacturing.

We interpret the data as supporting the use of cash grants in disaster recovery, but only in limited cases. Grants to firms in retail trade stimulate more rapid recovery of these enterprises. The data also support a greater use of cash aid in household recovery. The spending by households in local shops provides a stimulus that is lacking with in-kind aid. Finally, we believe the experiment has demonstrated the ability of random grants to generate knowledge about how to increase the speed with which small enterprises recover. If global warming leads to more frequent and more severe water-related disasters, as climate change experts predict, this knowledge will be increasingly valuable in hastening recovery from the growing devastation.

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Table 1
Sources of Recovery Funds for Small Businesses and Households

	SME owners		Wage workers	Panel of microenterprises (1)		
	Business	Household	Household	Business		Household
Number suffering damage	139	97	153	197		176
Mean damage (USD at 100Rs/$)	$40,200	$6,282	$5,079	$897	(2)	$2,421
% of those with loss covered by insurance	12.9%	4.1%	0.7%	0.0%		0.0%
Mean % of losses paid by insurance (conditional on being insured)	7.5%	5.1%	33.3%	NA		NA
% of total losses covered by insurance	1.7%	0.2%	0.2%	0.0%		0.0%
% receiving grant for repair	23.7%	75.3%	86.4%		94.4%	
% receiving loan for repair	25.9%	9.3%	20.5%		3.5%	
Mean aid received from government / NGOs (3)	$2,101	$2,068	$1,361		$332	
Mean loan received from government or banks (3)	$21,215	$3,122	$1,738		$496	
Mean % losses covered by grants	1.2%	24.8%	48.9%		20.8%	
Mean % of losses covered by loans	13.7%	4.6%	25.3%		0.4%	
Correlation of losses and aid received	0.02	0.70	0.31		-0.02	
Correlation of losses and loans received	0.16	0.27	-0.07		0.09	
% of all losses covered by insurance, grants or loans	16.9%	30.2%	30.4%		21.3%	
% of losses replaced/repaired by July/Oct 2007	67.8%	68.4%	60.6%	72.3%		64.5%

(1) Information on losses and insurance from October 2007 survey. Information on aid and loans from July 2005 survey.
(2) Data from the October 2007 survey. Similar questions asked in the April 2005 survey yielded very similar losses for enterprise assets ($814), but losses of just under $900 for household assets.
(3) Mean conditional on reporting some aid.

Table 2: Effect of Grants on Profits Among Damaged Firms
Dependent Variable: Real Profits

	Real Profits			Own hours
	(1)	(2)	(3)	(4)
Amount	9.90**	8.96**		-0.324
	(4.25)	(3.89)		(1.84)
Cash Amount			5.27	
			(4.30)	
Equipment Amount			12.21**	
			(5.04)	
Trimming	No	Yes	Yes	Yes
Observations	2024	1993	1587	2095
Number of firms	200	200	172	200

Notes: Fixed effects estimation, estimated over 11 waves for firms reporting profits in 3 or more waves.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
All regressions also include wave effects.
Trimmed samples delete the top 1% of percentage and absolute changes in profits from one wave to the next.

Table 3: Heterogeneity in Treatment Effects

	(1)	(2)	(3)	(4)	(5)	(6)
Amount	19.6***	14.53	12.88	10.17*	8.79**	19.91***
	(6.16)	(15.7)	(11.61)	(6.14)	(3.74)	(6.75)
Amount*Manufacturing	-22.1**					
	(6.85)					
Amount*MajorCustomer		-3.28				
		(8.71)				
Amount*MajorSupplier			-2.66			
			(7.76)			
Amount*Female				-3.19		
				(7.70)		
Amount*Years Education					1.69	
					(1.08)	
Parents / children						-9.77**
unaffected by tsunami						(4.39)
Observations	1993	1993	1993	1925	1993	1790
Number of firms	200	200	200	193	200	172

Notes: Fixed effects estimation, estimated over 11 waves for firms reporting profits in 3 or more waves.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
All regressions include wave effects and interactions of waves and variable shown.
Trimmed samples delete the top 1% of percentage and absolute changes in profits from one wave to the next.

Table 4: Treatment and capital stock

	(1)
Amount	10638***
	(5831)
Amount*Manufacturing	-4175*
	(6910)
Observations	1857
Number of firms	200

Notes: Fixed effects estimation, estimated over 11 waves for firms reporting profits in 3 or more waves.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Which Damaged Firms Recovered Fastest?
Dependent Variable: Log Real Profits

	(1)	(2)	(3)
Manufacturing dummy	-0.286*	-0.254*	-0.266*
	(0.147)	(0.150)	(0.145)
Female owner	-0.663***	-0.636***	-0.619***
	(0.164)	(0.165)	(0.162)
Years of education of owner	0.00305	-3.02e-05	-0.00301
	(0.0291)	(0.0292)	(0.0288)
Age of owner	-0.00707	-0.00750	-0.00664
	(0.00734)	(0.00733)	(0.00723)
Owner is married	0.0925	0.102	0.0985
	(0.183)	(0.183)	(0.180)
Business<=3 years old	0.0468	0.0197	0.0294
	(0.154)	(0.156)	(0.152)
Firm had a loan at baseline	0.230	0.200	0.179
	(0.158)	(0.161)	(0.158)
Firm is registered	-0.0546	-0.0351	-0.0917
	(0.190)	(0.191)	(0.188)
Log March 2005 profits	0.245**	0.232**	0.245**
	(0.101)	(0.101)	(0.0990)
Log November 2004 profits	0.216*	0.243**	0.217*
	(0.113)	(0.116)	(0.111)
Log distance to the coast	0.212**	0.230**	0.239***
	(0.0898)	(0.0914)	(0.0893)
The firm has a major supplier		-0.146	
		(0.147)	
The firm has a major customer			-0.326**
			(0.152)
Observations	702	702	702
Number of firms	80	80	80

Notes: Random effects estimation on untreated firms suffering business damage, estimated over waves 2 to 11.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Regression also contains wave effects.

Figure 1

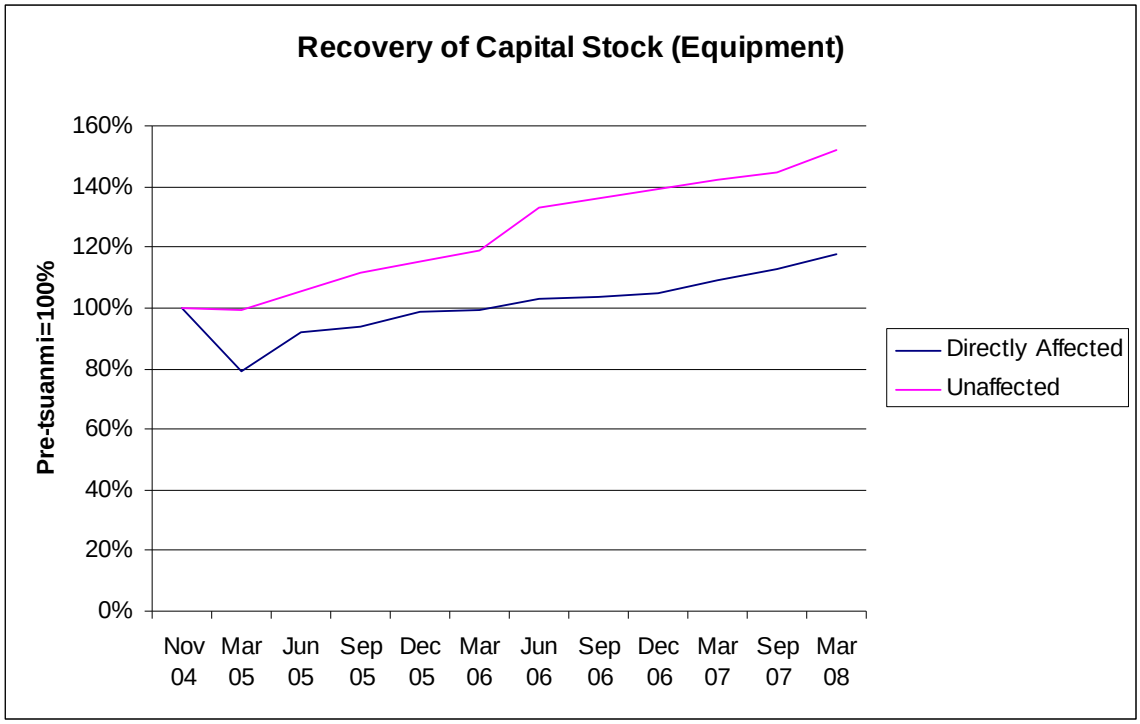
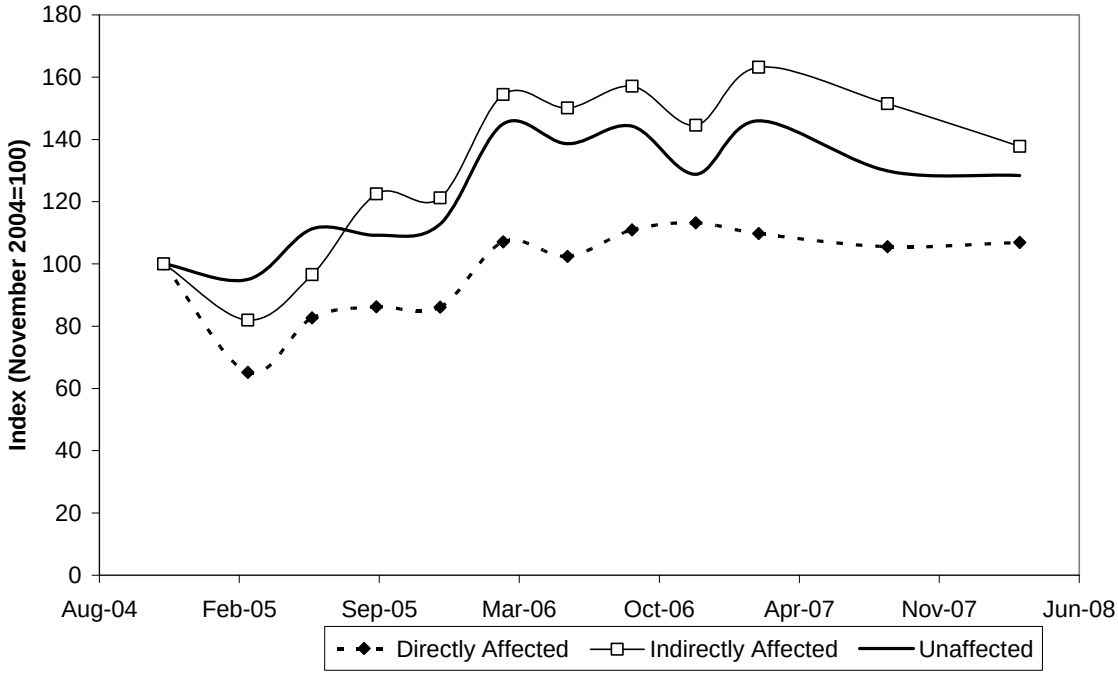

Recovery of Capital Stock (Equipment)
Pre-tsuanmi=100%
160%
140%
120%
100%
80%
60%
40%
20%
0%
Nov 04
Mar 05
Jun 05
Sep 05
Dec 05
Mar 06
Jun 06
Sep 06
Dec 06
Mar 07
Sep 07
Mar 08
Directly Affected
Unaffected

Figure 2: Mean Profits for Untreated Firms by Tsunami Exposure



Appendix 1: Subsample Comparisons

Table A1.1: Comparison of Treated and Untreated Firms

	Never Treated	Treated	p-value
Proportion female	0.51	0.54	0.710
November 2004 profits	5029	6748	0.056
Log November 2004 profits	8.15	8.33	0.224
March 2005 profits	3260	3454	0.754
Log March 2005 profits	7.64	7.70	0.660
Education years	9.89	10.03	0.694
Age of owner	41.05	42.59	0.318
Asset Index	-0.45	-0.30	0.621
Previously had a loan	0.31	0.19	0.041
Proportion in manufacturing	0.55	0.48	0.294
Proportion married	0.84	0.85	0.958
Log distance to coast	5.60	5.53	0.317
Proportion of firms aged<=3 years	0.22	0.21	0.842
Sample size	83	117	

Table A1.2: Comparison of Manufacturing and Retail Firms

	Manufacturing	Retail	p-value
Proportion female	0.59	0.46	0.054
November 2004 profits	5065	6897	0.031
Log November 2004 profits	8.03	8.48	0.001
March 2005 profits	2733	3958	0.035
Education years	10.11	9.67	0.211
Asset index	-0.45	-0.48	0.908
Has a major supplier	0.69	0.57	0.066
Has a major customer	0.42	0.21	0.000
Daily number of customers (March 05)	7.88	26.74	0.000
Percent of customers in same GN	72.52	75.78	0.484
Percent of inputs outside DS	22.15	21.01	0.824
Sample size	107	102	

Appendix 2: Suitability of the Inland firms as a comparison sample.

The strongest predictor of whether or not a firm was damaged by the tsunami is, not surprisingly, how close it was located to the coastline. Table A2.1 shows the proportion of firms in our sample that experienced asset damage from the tsunami, by distance from the coastline. Three-quarters of firms located within 250 meters of the shoreline experienced damage, compared to 37 percent of firms located 500 to 750 meters, and almost no firms claim to have experienced damage if located more than 750 meters from the shoreline. In some areas, the shape of the coastline mitigated the impact of the tsunami, while in others, the tsunami caused a surge in rivers linked to the coast, resulting in more damage slightly inland.

Did the characteristics of damaged enterprises differ systematically from undamaged enterprises located similar distances from the shoreline? This question is especially relevant for defining an appropriate comparison group against which to measure recovery. If the affected firms are substantially different from unaffected firms, the latter group will not be a relevant comparison group. We ran probit regressions on the likelihood a microenterprise suffered some damage as a function of owner, firm, and location characteristics. The results, shown in Table A2.2, indicate that enterprises with more educated owners, those with higher levels of pre-tsunami profits and those which had operated for more than three years were somewhat more likely to have suffered damage.[17] But we find no association between tsunami damage and the age, marital status, and gender of the firm owner, nor with the industry or legal status of the firm. In general, the characteristics of affected and unaffected enterprises appear to be similar enough to use the latter as a comparison sample for the former.

Microenterprises in our sample were grouped into three groups: directly affected, meaning they had suffered asset damage from the tsunami; indirectly affected, which are firms in the same geographic areas as the directly affected, which didn't suffer damage; and unaffected, which were firms located further inland in the same districts. The median distance to the coastline is 261 meters for directly affected firms, 495 meters for indirectly affected firms, and 7.2 kilometers for unaffected firms.

[17] These results thus suggest that it is not the case that richer firms owned by more able owners were able to avoid damage by virtue of better construction of premises.

Table A2.1: Proportion of Firms Reporting Business Damage by Distance from the Coastline

Distance from Coast (metres)	Proportion reporting damage	# Obs
<=150m	0.649	37
151 to 250m	0.779	95
251 to 500m	0.604	149
501 to 750m	0.367	60
751 to 1000m	0.040	25
1001 to 1500m	0.000	70
1501 to 2000m	0.000	18
2001 to 2500m	0.042	24
2501 or more metres	0.028	106

Note: proportions are of firms reporting profits in three or more waves of the survey

Table A2.2: Which businesses close to the shore were more likely to suffer damage?
Marginal effects from probit regression for firms within 750 metres of the shore
Dependent variable: Suffered business damage

	(1)	(2)	(3)	(4)
Within 250 metres	0.341***	0.347***	0.358***	0.333***
	(0.067)	(0.067)	(0.067)	(0.070)
Within 500 metres	0.222***	0.196***	0.201***	0.170**
	(0.073)	(0.074)	(0.075)	(0.077)
Firm is registered	0.0813	0.0648	0.0531	0.0287
	(0.062)	(0.064)	(0.065)	(0.066)
Female owner	-0.0831	0.00437	0.0165	0.0211
	(0.056)	(0.063)	(0.064)	(0.066)
Business is 3 years or less in age	-0.143**	-0.141**	-0.141**	-0.163**
	(0.068)	(0.069)	(0.069)	(0.073)
Age of entrepreneur	0.000327	0.00136	0.00182	0.00158
	(0.0029)	(0.0029)	(0.0029)	(0.0030)
Dummy for married	0.121	0.147*	0.130	0.138*
	(0.078)	(0.079)	(0.080)	(0.082)
Years of education of entrepreneur	0.0268**	0.0221*	0.0218*	0.0194
	(0.011)	(0.011)	(0.011)	(0.012)
Manufacturing	-0.0207	0.0241	0.0454	0.0350
	(0.059)	(0.061)	(0.063)	(0.070)
Log (pre-tsunami profits)		0.109***	0.0664	0.0676
		(0.032)	(0.043)	(0.044)
Log (pre-tsunami sales)			0.0562	0.0581
			(0.039)	(0.040)
Digitspan recall				0.0174
				(0.026)
House has a dirt floor				0.0448
				(0.077)
House has brick walls				0.0706
				(0.061)
Business operated out of home				-0.0288
				(0.072)
Observations	331	331	331	316

Standard errors in parentheses
* significant at 5%; ** significant at 1%