The Micro Analysis of Disaster Relief Programs: Individual Behavior and Design of Aid

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The author was born on April 25th, 1979 in Chiba prefecture, Japan. He graduated from Prefectural Chiba High School in 1998, and started undergraduate program in Economics at Keio University in Tokyo. He wrote a thesis about the decentralization of Japanese local public finance under Haruo Shimada, and graduated with a B.A. in economics from Keio University in 2002. During 2002-2006, he worked at Japan Bank for International Cooperation, the Japanese bilateral aid agency, in charge of official loans to developing countries. He moved to the United States in the summer of 2006. He started doctoral studies in the Department of Economics at Brown University and completed the requirements for his Master's degree in Economics in 2007. He began working on the micro-analysis of disaster-relief efforts in case of the 2004 Indian Ocean tsunami under the guidance of J. Vernon Henderson. Supported by summer field research grant from the Watson Institute for International Studies, he participated in the third round of field survey in Aceh, Indonesia. During 2007-2011, he also worked as a teaching assistant for two undergraduate courses (in environmental economics in developing country, econometrics) and experienced two internship programs at the United Nations Headquarters and the International Monetary Fund. This dissertation represents the culmination of his efforts to complete the requirements for the Degree of Doctor of Philosophy in the Department of Economics at Brown University.

Preface

Earthquakes, storms, and other natural disasters strike in both developed and developing countries. Within the past five years, large-scale natural disasters have occurred in many countries such as China, Haiti and Chile, Indonesia, and Japan. The increasing number of such incidents impels us to devise proactive solutions to managing them. Relief programs for the victims of various natural disasters also increased more than five-fold during the 1990s (Owens, Hoddinott, and Kinsey, 2003). Therefore, designing cost-effective disaster-relief assistance is one of the most important challenges for the international aid community today.

In the immediate aftermath of disasters, aid agencies are expected to play a direct role in reviving the devastated areas. Then, what are the key challenges for international aid communities? My dissertation titled *The Micro Analysis of Disaster Relief Programs* provides micro-evidence for looking at two key issues that have been posed in the literature: (a) who are the beneficiaries of aid programs (Easterly and Pfutze, 2008)? and (b) what are the mechanisms that link foreign aid with economic outcomes (Bourguignon and Sundberg, 2007)?.

In this thesis, I analyze the case of the 2004 Indian Ocean tsunami in Aceh, Indonesia. Using the field survey data collected in Aceh, I examine (a) the allocation process of disaster-relief aid and (b) the impact of this aid on fishing communities in Aceh. My main objective is to identify areas for improvement in aid in order to draw policy lessons for future disaster-relief efforts. In the analysis, I also consider the complementary role of individuals' market transactions in undoing imperfections in the official aid program.

The effectiveness of aid programs depends on how individuals and local government make decisions and utilize the funds given by aid agencies. Using household-level panel data, my study focuses on households' decision-making in the face of the influx of disaster aid. Specifically, I examine households' responses to seeking for aid and their occupational choices in the labor market. I pay close attention to how the design and quality of aid affected the recovery process by altering household decisions and productivity.

Two chapters of this dissertation look primarily at the in-kind aid of boats for the traditional fishing community, and examine how households recovered after the tsunami.

Chapter 1 (*Micro Responses to Disaster Relief Aid*) examines how the recipients of aid boats were selected, and provides a general model incorporating households' responses to aid and the rules used by local leaders for targeting aid. I use the results of this selection rule to derive policy

lesson that mis-matches of the types of aid goods limited the recovery of fishing productivity.

Chapter 2 (*The Impact of Disaster Aid Quality*) examines how households got back to work after the tsunami. From our village-level data, I found that the recovery of the fishing sector was slow compared to the persistent growth in the non-fishing sector. I explain that agencies' provision of poor-quality boats constrained households' job choices and contributed to the sluggish recovery in the fishing sector. I show that the poor quality of aid boats affected the fishing industry in two stages. In the initial stage, the significant number of unusable boats were provided at the village-level. Those who could not get boats from international agencies were constrained by fishing opportunities. In the later stage, many recipients of aid boats learned that their boats fell apart after a year of use. They either switched to employment in the non-fishing sector or self-financed a boat to replace a poor-quality aid boat with a locally produced good boat.

The dissertation provides a general framework for understanding the process of aid allocation and also highlights the importance of the design and quality of aid programs in improving the effectiveness of aid. In addition, Chapter 2 suggests that the promotion of local market transactions can help in mitigating the imperfections of the official aid program.

Although the unique field survey gave me a significant quantity of micro-evidence to tackle key challenges for aid agencies after disasters, my dissertation points out some theoretical and empirical issues that await future work. For example, the welfare analysis of alternative forms of aid is necessary to evaluate the cost-effectiveness of aid programs; I will look at this issue in my future research. It is also important to evaluate how government or aid agencies implement the disaster-relief program.

Finally, I hope that this dissertation will draw some useful lessons for effective reconstruction efforts in disaster-prone countries. In particular, I hope for the prompt and smooth recovery of my home country, Japan, from the series of tragedies in the 2011 Tohoku earthquake and tsunami, which occurred at the final stage of my Ph.D. research at Brown University.

August 2011

Providence, R.I.

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This academic journey could be accomplished thanks to the support of many people. My deepest appreciation goes to my thesis advisor J. Vernon Henderson for spending a lot of time and providing thoughtful guidance at the all stages of my dissertation until today. Vernon gave me an invaluable opportunity to join his project and introduced me how to design and work with field survey data. Besides, he kindly allowed me to explore my academic curiosity in the area of foreign aid using his survey data. I would like to thank my committee members, Andrew D. Foster and Sriniketh N. Nagavarapu. Their advice and insights illuminated my dissertation by introducing me the frontier of development economics. They gave me chances to think about profound questions which are crucial for the re-development after natural disasters.

I was also benefited from the valuable advice from Nathaniel Baum Snow, Blaise Melly, Pedro Dal Bo, Brian Knight, Kaivan Munshi, Oded Galor, Peter Howitt, John Strauss, Robert Townsend, and various conference and seminar participants. I would like to thank Ari Kuncoro, Ifa Isfandiarni, Zakir Machmud, Hamdan Bintara, Tiago Freire, and Yongsuk Lee for working together with the survey data in Aceh team. I also thank the discussions and supports from Kelley Alison Smith and my peer students.

Furthermore, I would like to thank Haruo Shimada, my advisor at Keio, for guiding me to the academic research in economics. I am grateful to my mentor, Dean James F. Campbell, and my English tutors, Betsy Shea-Taylor, Theodore Fraser, and Katrina Avery. Without their supports in the last year of my Ph.D. life, my thesis would have never been accomplished.

I owe a very important debt to my parents, Masaji and Fumiko Nose, my sister Megumi, and my grandmother, Hatsue, all of whom have been my best supporters and have given me much encouragements during my lengthy Ph.D. studies. I dedicate this dissertation to my grandfather, Masao Nose, and maternal grandmother, Noriko Ogawa, who passed away during my Ph.D. study.

Finally, I greatly acknowledge the financial supports from Japan-IMF Scholarship for Advanced Studies in my first two years, GPD Fellowship from the Watson Institute in my third year, the Merit Dissertation Fellowship and G. Nicholas Beckwith Fellowship in my fourth year, and Umezawa-Stoltz Prize from the economics department in 2009. I also acknowledge financial supports from the National Science Foundation (SES 0416840), NIH (R01 HD057188), and supports from the Population Studies Training Center (PSTC) for the Aceh tsunami project.

Toward peaceful world and future

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Chapter 1

Micro Responses to Disaster-relief Aid: Design Problem for Aid Efficacy

1.1 Introduction:

Across the globe, large amounts of aid have been committed to help communities recover from natural disasters. However, the effective allocation of disaster-relief aid poses problems because of (a) the asymmetric information between aid agencies and beneficiaries and (b) the urgency for supporting short-term livelihoods as opposed to focusing on long-term re-development. Because international agencies lack information about local economies, it is difficult to identify the segments of a population that actually need aid. In the aftermath of a disaster, aid agencies usually cannot spend enough time to appropriately design an aid program to guarantee sustainable recovery. For these reasons, it is important to understand the way actual aid beneficiaries are selected and whether aid effectively improves the living standard of its beneficiaries.

I analyze the disaster-relief aid for fishing families in the case of the Indian Ocean tsunami in Aceh, Indonesia. The tsunami happened on 26 December 2004 and resulted in the massive destruction of fishing villages in Aceh. In the affected coastal villages, well over half the population died from the tsunami; in some villages, the survival rate was as low as 10-15%. Fishermen lost their fishing boats, houses, savings, and their families. Following this destructive shock, there was an immediate and overwhelming influx of aid by many agencies. In total, about 7.7 billion dollars have been committed to the efforts, which laid the foundation for the recovery of the affected population (Brookings Institution, 2008). However, only 40% of pre-tsunami boat owners

or captains in our survey received aid boats, which raises the question of whether aid beneficiaries were effectively selected. In addition, a descriptive analysis shows that the fishing output of those who were selected as aid beneficiaries was not as high as the output of those who purchased boats. Besides the allocation problem, this paper further questions the effective design of the disaster-relief program.

To better understand these puzzles, I look at three aspects of the impact of aid: (a) fishermen's ex-ante decisions to apply for aid, (b) decisions by the heads of fishermen's associations regarding allocation of aid, and (c) aid effectiveness in raising fishing production, which is found to be limited due to design problems in fishing boats provided by NGOs.

The first part of this paper examines the self-selection decision between seeking aid and other strategies ex-ante. To understand the decision-making process, I provide a theoretical model which allows for two types of heterogeneities (fish productivity and social capital) and deals with fishermen's expectations for success in getting aid. One would expect that the motivation to apply for aid should be particularly strong under economic hardships after the tsunami. However, the model predicts that some fishermen will not apply for aid. Some will prefer to stop fishing and will seek other job opportunities or will invest their own money to buy new boats[1]. The empirical section then tests the theoretical predictions about self-selection, constructing a structural model to separately estimate the effect of expectation for aid and the returns to productivity and market conditions.

The second part of this paper empirically investigates the allocation process for selecting aid beneficiaries. The self-selection mechanism in the first section identifies the population who sought aid and wanted boats. Amongst those applying for aid, not everyone could receive aid boats. I empirically test which factors significantly affected the decisions of the heads of fishermen's associations choosing who would receive aid boats[2].

Finally, I consider the effectiveness of aid boats in improving fishing production. Although the provision of aid boats gave the opportunity to resume fishing, beneficiaries faced negative shocks from the design problem caused by a one-size-fits-all policy in the provision of aid boats and the high failure rate of the boats. The capacities of new boats provided by NGOs were not necessarily

[1]This type of self-selection is missing in the previous theory (Esteban and Ray, 2006; Epstein and Gang, 2009) and Samaritan's dilemma argument (Pedersen, 2001; Torsvik, 2005) which assumes that agent has strong incentive to participate in an aid program

[2]The value of connection is previously highlighted by Khwaja and Mian (2005) in the Pakistan financial sector context. Connection could also be an important factor to determine aid allocation in Aceh due to the low level of state capacity, stemming from over thirty years of the separatist movement by *GAM (Gerakan Aceh Merdeka)* and the high level of corruption (shown by Olken, 2007; Olken and Barron, 2009).

the same as the types of boats that fishermen operated before the tsunami, and aid beneficiaries faced a significant probability that their boats would fail (i.e, not float) due to poor construction. To my knowledge, Wane (2004) is the only previous study that uses micro (project-level) data to analyze the aid design problem which could affect the quality and the effectiveness of aid. My paper is the first attempt to estimate the design problem of aid on the recipients' productivity using household-level data.

Using unique micro data that was collected in the field, I empirically examine three aspects of disaster-relief aid in Aceh: self-selection, allocation of aid, and aid efficacy on fishing production. First, my structural estimates show that not all fishermen chose to apply for aid, and indeed chose different strategies due to uncertainty of receiving aid and better opportunities outside the fishing sector. Second, as found in other aid programs, those who were socially connected to the heads of fishermen's associations and who also had particular fishing skills were more likely to be chosen to receive aid by these leaders. Finally, I found that in-kind allocation of fishing boats effectively improved fishing outputs of the aid beneficiaries when the design of the new boats was consistent with fishermen's technological capabilities.

As outlined above, this paper studies the micro aspects of aid delivery which supplement and shed new light on the existing literature on aid efficacy. Previous studies have examined the aggregate effects of aid on growth (Burnside and Dollar, 2000; Roodman, 2007) or average treatment effect of development projects (Duflo and Pande, 2007). Although a few experimental research projects such as Kremer and Miguel (2007) discussed aid efficacy through recipients' incentives, no research has evaluated the mechanisms for the impact of an economy-wide disaster relief program. In the context of this study, the tsunami caused random loss of assets and opportunities in fishing households. This then provides an ideal context in which to examine how fishermen with heterogeneous characteristics responded to various opportunities created by subsequent aid.

This paper provides strong policy implications for disaster-relief aid efforts. I point out that inadequate design and monitoring of aid by NGOs significantly reduce the expected performance of their efforts. The results suggests that the provision of more appropriate aid that meets people's diverse needs will improve the impact of aid boats on economic outcomes.

Section 1.2 provides background information and data description. Section 1.3 provides the theoretical model, and Sections 1.4-1.7 carry out empirical analyses. Finally, Section 1.8 presents conclusions.

1.2 Background and Data

1.2.1 Data

The data are drawn from a larger field survey on fishermen and coastal villages in Aceh, Indonesia[3]. The data were gathered at three levels (household, village head, and head's of fishing associations) in 2005, 2007, and 2009. In 2005, information on pre-tsunami household characteristics were also retrospectively collected as well.

For this paper, I only use 342 pre-tsunami fishing families who were previous boat owners or captains, and reside in 71 villages in 12 *kecamatans*[4] 282 fishermen come from Aceh Besar and 60 from Banda Aceh.

The household survey asks pre- and post-tsunami information on boat types, catch, and aid boats; family structure, occupations, debt, earnings, and participation in social activities; emotional trauma suffered by the respondent; and the like. Also, the surveys of village heads and the heads of fishermen's associations gather questions on pre- and post-tsunami information on physical capital (houses, boats, public buildings); detailed information on initial and on-going operations of NGOs, local government and relief agencies; and detailed information on village fishing industries pre- and post-tsunami including questions on marketing, fishing fleet composition, and catch composition. The survey also includes detailed data on foreign aid, such as the number of projects and NGOs working in each village from RAN (Recovery Aceh Nias), a publicly-available dataset.

1.2.2 Disaster-relief Aid in Aceh

General Evidence

There were two main types of post-tsunami aid efforts: (a) fishing boat transfers and (b) reconstruction of housing and public buildings. Both types of projects provided new economic opportunities within the traditional fishing community. I examine two impacts of the aid efforts on households' incentives.

First of all, fishing boats were provided to recover fishing livelihoods. This is grant aid, so no extra cost was necessary to resume fishing. The average size of boats from NGOs was 7 meters. A fishing boat is very valuable asset. The average market price of a 7-meter boat was Rp

[3]The title of the project is "Population and Economic Recovery in Coastal Aceh: Aid and Village Institutions" (principal investigator: J. Vernon Henderson, Brown University/NBER).

[4]In Indonesia, a sub-district (*kecamatan*) is a subdivision of a district (*kabupaten*). Sub-district are divided into villages (*desa*).

15,500,000 (about $1,550) after the tsunami, which is very expensive for fishermen since their average weekly earning was Rp 300,000 (about $30). However, the regional distribution of aid boats was very uneven. This distributional asymmetry was reported in the joint report by the BRR (Executing Agency for the Rehabilitation and Reconstruction of Aceh and Nias) and international donor partners. Figure 1.1 shows the scale of aid (the supply of aid boats over number of fishing captains) based on our fishermen's community survey, which I averaged by *kecamatan*. There were three *kecamatans* in which an excessive number of boats were provided by NGOs, while local needs outstripped total boat supply in most of the *kecamatans*.

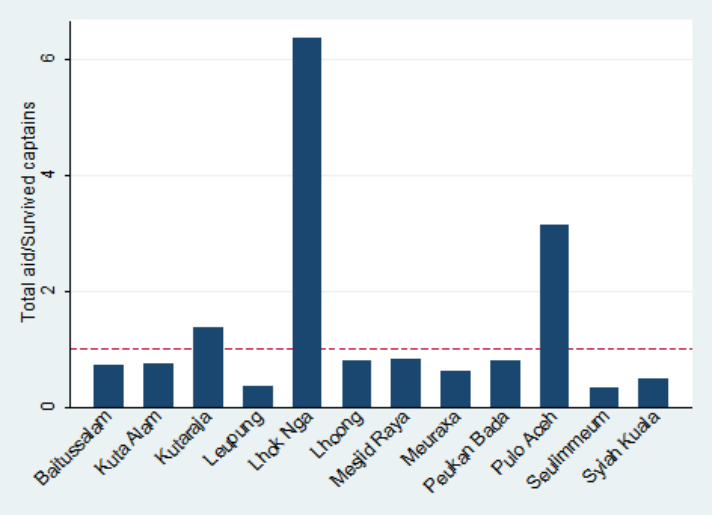


Figure 1.1: Supply of Aid per Local Needs Post-Tsunami

Based on our household-level survey, new boats were provided by NGOs to 88% of households (10% from international governments, 2% from BRR/government). The boats were distributed through a particular intermediary such as a village government or a local fishermen's cooperative association, known as *Panglima Laot* in Aceh's coastal communities.

Second, other relief programs, such as rebuilding destroyed housing and public buildings (including mosques, village halls, fishermen's halls, schools, and health facilities) and the recovery of natural coastal infrastructure such as mangrove, generated labor demands in the form of cash-for-work programs and other market job opportunities. This provided fishermen with alternative employment opportunities outside the traditional fishing sector. The cumulative distribution of the number of NGOs and foreign aid projects in the villages shows that more market opportunities were clustered in urban areas such as Banda Aceh and Aceh Besar than in rural areas such as Aceh Jaya.

The two opposing effects by delivery of aid boats to fish vs. creation of outside job opportunities offers an interesting situation in which to analyze the behavioral response of households.

Eligibility for Aid

Unlike other types of welfare programs, this aid was for immediate livelihood support after a natural disaster rather than financial support earmarked for low-income households. Therefore, there was no established eligibility criteria, like a means test. Those who previously owned boats and lost them were not sure if they could get a new boat, but assumed that they had a claim to receive a replacement boat.

We asked the *Panglima Laot* heads to assess the priority of the groups that could receive aid boats. In 80% of the villages, the highest priority was given to previous boat owners and captains. On the other hand, previous captains who were not owners were less likely to be granted aid boats. This suggests that previous boat ownership was the most important criterion to establish a claim for a replacement boat.

Leaders of local *Panglima Laot* associations were largely responsible for allocating aid boats and were familiar with previous boat owners or captains. Therefore, previous owners were more likely to be listed as candidates for aid boats. In fact, some NGOs (such as the American Red Cross and Mercy Corps) targeted previous owners, since the NGOs had an agenda to replace lost previous boats with new ones.

Type and Quality of Boat

Since this aid was given in the form of in-kind transfers of boats, boat quality is an important determinant of aid effectiveness. As discussed by Thorburn (2009) and Janssen (2005), the quality of fishing boat construction in Aceh was sometimes poor due to inappropriate size, bad-quality materials, lack of equipment, and lack of craftsmanship and technological knowledge. The following sections argue that the type and quality of boats received through NGOs had significant effects on fishermen's productivity.

The fishing boats provided by NGOs have a narrower distribution and were smaller in size and weight. Comparing the size, weight, and engine capacity of boats between the pre-tsunami and post-tsunami periods, I find that pre-tsunami boats were bigger in all aspects. For example, Figure 1.2 plots the distribution of household-level boat length (outliers are trimmed at the 95th percentile), which compares between pre- and post-tsunami boats. The mean difference is significant based

on the mean t-test. Two distributions of boat length are also significantly distinct at the 99% significance level based on the Kolmogorov-Smirnov test. The density of pre-tsunami boat length is visibly distinct in mean and dispersion from that of post-tsunami boats. Provision of smaller fishing boats was a more practical option for NGOs to deliver aid boats quickly. It was also an easier way for NGOs to spend resources to meet their own target numbers of aid boats. The standardized size of boats were equally allocated to households, partly because NGOs could not obtain specific information on local economies in a short time period.

Moreover, the boats provided by aid agencies were often non-operational because they were made from poor materials (such as unseasoned wood or plastic), were improperly designed (i.e, too light weight to fish in the strong wave conditions in the Indian Ocean), or were made by inexperienced boat builders. Most aid boats were quickly built in Banda Aceh, while some donors built boats in Jakarta with insufficient knowledge on the fishing situation in Aceh, which contributed to the poor boat design.

In our survey of fishermen's association heads, they reported the number of non-operational aid boats in 2007 per total number of aid boats. Figure 1.3 is the fraction of non-operational boats in 2007, which are averaged at *kecamatan* level. The figure shows that there were several *kecamatan* (such as Seulimmeum and Meuraxa) where the failure rate of boats was very high. The regions with high failure rate were places where major donors provided many non-operational boats[5]. This quality problem also created uncertainty in that fishermen could not rely on aid boats.

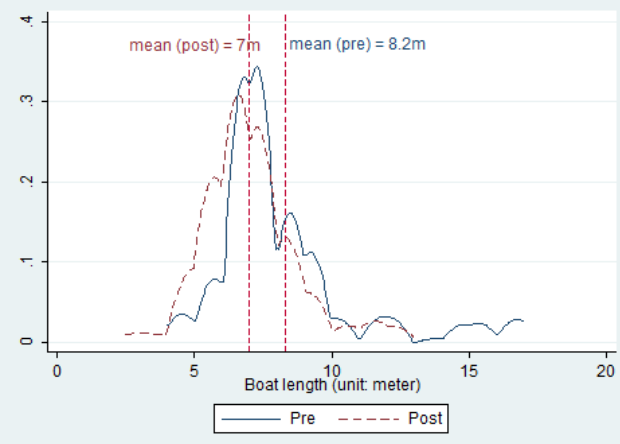


Figure 1.2: Kernel Density of Boat Length

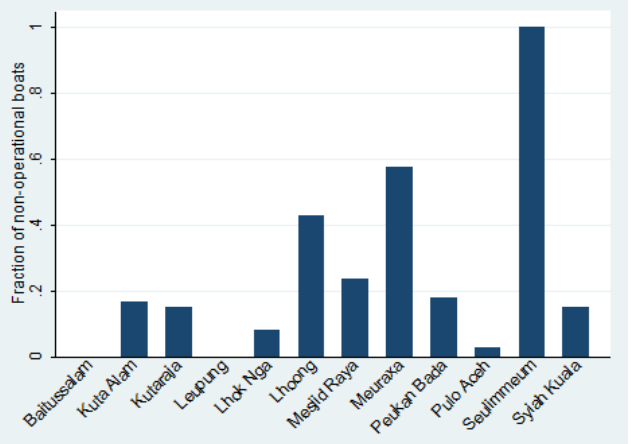


Figure 1.3: Fraction of bad boats by Kecamatan

[5]Based on our survey of the heads of local fishermen's association, boats provided by IMC (International Medical Corps) and Oxfam had such problems.

1.2.3 Household Strategies after Disaster

Figure 1.4 illustrates the choices possible for a single household when the allocation of aid is uncertain. The household takes two issues into consideration: (a) occupational choice (fishing or not) and (b) lobbying for aid or not if he decides to fish[6].

As shown in Figure 1.4, in my sample, 263 households chose to fish ex-ante and 79 chose market jobs. Among 214 households that chose to continue fishing, 214 of them lobbied to obtain a boat from an NGO. Additionally, 49 fishermen decided to purchase their own boats in the private market to be certain of getting new boats. Among 214 lobbyists, only 62% successfully received aid.

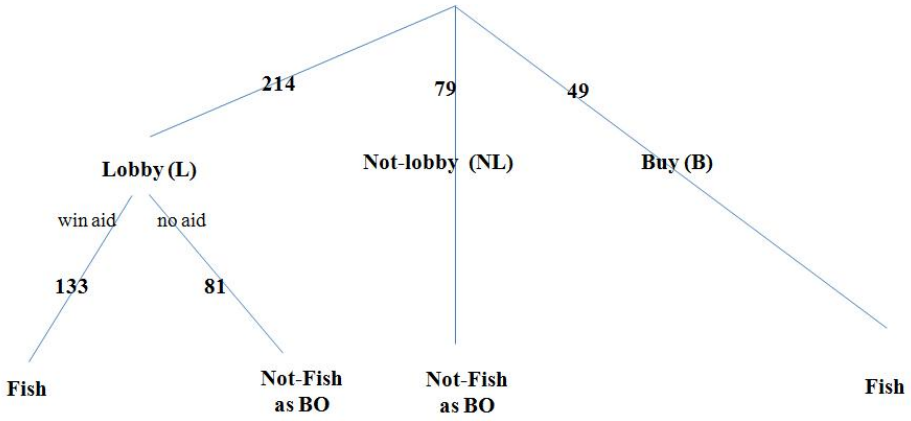


Figure 1.4: Conceptual framework

As the figure shows, not every household applied for boats from NGOs. Although aid was a major source of funding, some villagers self-financed a private boat. Or, they chose to work for other types of occupations. There are at least three reasons why fishermen made such choices.

1. Uncertainty and transaction cost: Lobbying for aid did not guarantee that an applicant could get (appropriate quality of) aid boats. Additionally, the application for an aid boat required transaction costs such as lobbying community leaders, affiliating with relevant social groups and socializing with neighbors, all of which require both time and effort.

2. Social commitment: Lobbying accompanied a strong social commitment to fishing if a family received an aid boat. Among those who failed to get aid boats, there was social pressure

[6]In Aceh, the request for aid occurred through informal networking with the leaders of villages or fishing associations. In our survey, I know whether households requested assistance from heads of villages or fishermen associations to obtain a new boat. I defined *Lobby* as one if households received aid boats by requesting the assistance from the heads of communities. Households who requested aid boats but did not receive boats in 2007 are unsuccessful lobbyists.

that those who *did* receive boats should not then sell these boats, but rather should use them for fishing, as intended. Those selling aid boats faced strong social sanctions from the local fishermen's group.

3. Opportunity cost: Higher wages in reconstruction projects or other market jobs (such as running a small business) induced a household to select out from traditional fishing work.

If a household chose to purchase a new boat in the private market, they needed a source of funding to do so. It was usually the case that such fishermen had informal financial arrangements with friends, relatives or *Toke Bangku*[7], or borrowed from formal credit lines rendered by credit cooperatives. The financial arrangements mitigated the credit constraint. Loans from the credit cooperatives or banks rarely occur since both required interest payments and collateral (ex. land title, savings, insured asset).

1.2.4 Social Networks

When allocating aid boats, social networks functioned as a medium to connect fishermen with village officials. Compared to an urban area like Jakarta, Aceh has stronger social and religious traditions[8].

There are many community groups: both official networks (such as village or fishermen meetings) and informal networks (such as volunteer labor, Koran recitation group, and PKK (women's working group)). Formal meetings are places for developing customary law, solving conflicts, and regulating and sharing fishing resources. Informal networks are spaces where villagers interact with friends and neighbors, and create social connections, ties, and trust in the local community.

Social networks also take the form of rotating savings and credit associations (ROSCAs) called *arisan groups* where villagers deposit a fixed amount of money and winners can receive cash by rotation. The primary purpose is to enable members to buy appliances for use in everyday life (e.g, sewing machines, refrigerators) or to finance social events. Frequent meeting in *arisan groups* also creates a space for socialization and nurture reciprocal exchange (Varadharajan, 2004).

[7] *Toke Bangku* is the middleman that plays an important role in coastal society as a marketing agent and a capital owner. During fish season, the middlemen buy fish from fishermen and sell it either to local fish market or to other place. Most of boat captains sell their fish catch to the middlemen. The middlemen also lend monies to fishermen to meet their various financial needs, such as household's daily consumption, purchasing boat and fishing gears, and the like. Fishermen are closely attached to middlemen due to this informal credit facility and their obligation to sell their catch to the middlemen.

[8] Previous works show the role of social networks in Indonesia and how they have changed in recent years (Geerts, 1962; Miguel, Gertler, and Levine, 2005).

The tsunami destroyed meeting places for these social activities. However, they play an important role and serve an on-going function in fishermen's lives. In the uncertain environment after the tsunami, villagers still needed to rely on reciprocal forms of exchange to deal with poverty under crisis.

1.3 Theory of Responses to Aid

1.3.1 Motivation for the Model:

In this section, I set up the model to help guide the empirical analysis. The model helps us to understand how a fisherman chooses optimal livelihood strategies from the options described above. It also incorporates households' lobbying efforts to influence the intermediary's decision regarding the allocation of aid boats. Aid is not randomly assigned, as stated above, but is targeted to particular groups. A household takes the allocation rule of aid as given, and anticipates the success in getting aid based upon their pre-tsunami fishing skills and social capital. Given their expectations, households consider their optimal responses based upon the return to choosing each strategy net of the unobserved cost of lobbying.

The model identifies the type of people who choose each strategy and highlights the mechanism by which two heterogeneities (fishing productivity and social capital) affect a household's decisions.

1.3.2 The Basic Structure of the Model:

The community was hit by the tsunami and individuals lost their savings and initial assets. The population experienced massive inflows of foreign aid after the disaster.

In this model, each individual lives for two periods. They are endowed with the same temporary income sources (w_0) and one unit of time ($T = 1$). To resume fishing, they need to get a new boat since they lost their old boats. There are two ways to get a new boat: lobbying for getting an aid-funded boat or buying a new one. Lobbying takes place in the first period because villagers start competing for aid right after the tsunami. The investment decision also occurs in the first period to resume fishing in a short time. Because of credit constraints, purchasing a new boat is a very costly option. However, some fishermen may want to buy their own boats to be certain of resuming fishing, due to the uncertain success of lobbying and the delay in receiving aid.

Based on their choices and the outcome of lobbying efforts in the first period, each household makes an occupational choice in the second period.

For simplicity, let us assume that the labor market provides enough market jobs opportunities to absorb potential labor supplies. Based on the comparative advantage, the occupational decision depends on their fishing productivity, which we denote λ where $1 \leq \lambda \leq 2$. The return to fishing is $w\lambda$ and the return to working in wage sectors is y. I assume that $w \geq y > w_0$.

There are three choices at the top part of the tree as shown in Figure 1.4. The three choices are mutually exclusive[9] The first choice is to lobby for aid. If they succeed, fishermen utilize the aid boat and resume fishing[10]. If they fail to get aid, the only choice is to work in wage sectors $(V1)$[11]. Second, if they do not lobby, their choice is to work in wage sectors $(V2)$. Third, they can choose to purchase a boat to fish $(V3)$.

(V1) Lobby, fish if receive aid and not fish if fail to get aid

(V2) Not lobby

(V3) Buy a boat

In the first stage, fishermen make simultaneous decisions on lobby, not-lobby, and buy a boat by anticipating their occupational decisions in the second period.

1.3.3 Expectation on Aid Allocation

When fishermen make a lobbying decision, the probability of getting an aid boat is uncertain. The expected success rate π depends on lobbying efforts e, and whether their social capital s and fishing experience $\bar{\lambda}$ will be targeted by intermediaries that allocate aid boats.

$$\pi = (es)^p(\bar{\lambda})^q \tag{1.1}$$

where $0 \leq e \leq 1$ and $0 \leq s \leq 1$, which ensures that π is bounded between 0 and 1. When the allocation of aid occurs, the intermediary cannot fully observe the distribution of fishing productivity, so he decides the target group based on $\bar{\lambda}$, which takes high value $(\bar{\lambda_H})$ if a fisherman

[9]Realistically, people could choose three strategies sequentially or simultaneously, which could not be empirically tested with the data.

[10]In my another paper ("The Impact of Disaster Aid Quality"), I consider the case that fishermen choose not to utilize aid boats and instead work in wage sectors ex-post. There are social sanctions in the community to not utilizing aid boats as intended, but there were a few households that chose this strategy. In this paper, I take simplifying assumption and consider that people expect to always utilize aid boats ex-ante.

[11]I include those who were fishing as crew in the non-fishing group in the theoretical model.

has particular fishing skill and low value ($\bar{\lambda_L}$) if not. For the analytical solution, let me assume $p = q = \frac{1}{2}$. Based on this assumption, the rationing function has the following property[12].

Property 1 (Success function of aid) *Expected success rate increases if:*

- *A fisherman is socially connected and his fishing skill is targeted by NGOs:* $\frac{\partial \pi}{\partial s} > 0, \frac{\partial \pi}{\partial \bar{\lambda}} > 0$
- *A fisherman makes greater lobbying effort:* $\frac{\partial \pi}{\partial e} > 0, \frac{\partial^2 \pi}{\partial e^2} < 0$

1.3.4 Preference and Budget Constraint:

All fishermen have the same CRRA utility function: $\mathrm{v}(c) = \frac{c^{1-\sigma}}{1-\sigma}$. The utility function is defined in two periods and is additively separable with discount factor r. If they lobby, the second period consumption is uncertain : it is c_2^W if they win the lobbying, and c_2^L if they fail to get boats. If they do not lobby, there is no uncertainty in both periods.

$$U(c_1, c_2) = \mathrm{v}(c_1) + \frac{1}{1+r}\mathrm{E}\mathrm{v}(c_2) = c_1 + \frac{1}{1+r}[\pi c_2^W + (1-\pi)c_2^L]$$

To derive an analytical solution, I assume that people are risk neutral ($\sigma = 0$). Households cannot transfer income to the next period, and they face budget constraints where income is consumed in the same period. The consumption level in the first period depends upon a lobbying and a buying decision, and the main source of income is temporary works available right after the tsunami with wage w_0.

$$c_1 = w_0(1-e) - 1[I=1]\delta B - 1[e>0]F$$

where $1[\cdot]$ is an indicator function and I is one if they buy a boat. If people lobby, they incur a variable time cost of lobbying e as well as a fixed cost F. A fixed cost is required for participating in lobbying. If they do not lobby, they just consume w_0 or decide to buy a boat. If they purchase a boat, they invest fraction δ of the price of new boat B, so they consume $w_0 - \delta B$.

Consumption level in the second period differ by three choices. First of all, there are two cases for lobbyists. If they fail to get boats, there is no choice but to work in wage sectors. If they

[12] q can be negative if a fisherman expects that his fishing skill is not targeted by the intermediary. If q is negative, the effect of $\bar{\lambda}$ on π becomes negative. In that case, $\bar{\lambda}$ enters optimal lobbying effort and critical values (shown later in equation (1.3), (1.5), and (1.6)) in opposite ways. However, this does not contradict the overall framework of the model and the theoretical prediction still holds. Later in the empirical section, we see that q could be positive or negative depending upon the type of fishing productivity (e.g, off-shore fishing skill to catch tuna vs. mechanical abilities which are defined in section 1.4.2.)

succeed in getting boats, they use the boat and fish ($V1$). The second period consumption level is $c^W_{2,L}$ if they win an aid boat and $c^L_{2,L}$ if they lose. Thus, the consumption level is defined as follows:

$$\begin{aligned} c^W_{2,L} &= w\lambda \qquad \text{if lobby and win} \\ c^L_{2,L} &= y \qquad \text{if lobby and lose} \end{aligned}$$

Secondly, non-lobbyists work in wage sectors in the second period. Therefore, the second period consumption level $c_{2,NL}$ is simply defined as follows:

$$c_{2,NL} = y$$

Finally, those who purchased new boats need to pay the price of boat B. A capital market is imperfect, but some fishermen with an informal credit arrangement can borrow fraction δ of B. In that case, they need to repay $(1-\delta)B$ to the lender, which is subtracted from their earnings in the second period where $0 \leq \delta \leq 1$. $\delta = 1$ means that fishermen are fully credit constrained.

$$c_{2,B} = w\lambda - (1-\delta)B$$

In sum, indirect utility functions are defined as follows:

$$\begin{aligned} V1 &= w_0(1-e) - F + \frac{1}{1+r}[\pi(w\lambda) + (1-\pi)y] \\ V2 &= w_0 + \frac{1}{1+r}y \\ V3 &= w_0 - \delta B + \frac{1}{1+r}[w\lambda - (1-\delta)B] \end{aligned} \tag{1.2}$$

1.3.5 Expected Utility Maximization

For lobbyists, the maximization of $V1$ in equation (1.2) subject to $0 \leq e \leq 1$ produces optimal lobbying effort e^* and the accompanying expectation of getting an aid boat π^*.

$$e^* = \Omega(w\lambda - y)^2 s\bar{\lambda}$$

$$\pi^* = \Omega^{\frac{1}{2}}(w\lambda - y)s\bar{\lambda} \tag{1.3}$$

where $\Omega = \frac{1}{4(1+r)^2 w_0^2}$. The optimal lobbying effort is higher for those who have higher fishing

productivity and higher social capital. In the π function, fishing productivity and social capital are complements, which makes unproductive or socially unconnected fishermen exert less lobbying efforts. Equations (1.2) and (1.3) produce indirect utility functions $V1(e^*)$.

An equilibrium strategy is chosen to maximize expected utility. For given fixed parameters $\Theta = (w_0, B, F, w, y, r, \delta, \bar{\lambda})$, fishermen will choose one of the options i depending on two heterogeneities (λ, s) under the following indifference condition:

$$V_i(\lambda, s, \Theta) > V_{-i}(\lambda, s, \Theta) \quad \text{for} \quad i \in \{1, 2, 3\} \tag{1.4}$$

1.3.6 Equilibrium of Self-selection

From equation (1.2), I have the following property of fishermen's indirect utility.

Property 2 (Single-crossing in fishing productivity) *For given s,* $\frac{\partial V2}{\partial \lambda} < \frac{\partial V1}{\partial \lambda} < \frac{\partial V3}{\partial \lambda}$

Property 2 comes from the relative slopes of each indirect utility function. Due to the uncertain success of getting aid, the gradient of indirect utility function with respect to productivity is less steep for $V1$ group than $V3$ group. The least productive fishermen choose $V2$, which has a flat gradient. Most productive fishermen choose to fish by buying a private boat ($V3$).

Next, I characterize households' boundary indifference choices with heterogeneous type of (λ, s). I derive the critical value of social capital $\bar{s}$ such that $V1 = V2 = V3$ where a lobbying choice is strictly dominated by a not-lobbying choice.

$$\bar{s} = \frac{F}{\Omega B^2 (1 + \delta r)^2 \bar{\lambda} w_0^3} \tag{1.5}$$

Keeping other parameters fixed, higher s makes lobbying more likely to be optimal. $\bar{s}$ rises when (a) a fixed cost of lobbying F increases, and (b) the value of aid boats B decreases. This makes a lobbying choice less likely to be optimal.

Similarly, I can analytically solve the critical values of fishing productivity[13]:

$$\begin{aligned}
\tilde{\lambda_{12}} &= \frac{2(1+r)F^{\frac{1}{2}}}{w[w_0 s\bar{\lambda}]^{\frac{1}{2}}} + \frac{y}{w} \\
\tilde{\lambda_{13}} &= \frac{y + \frac{2w_0}{s\bar{\lambda}} - 2[(\frac{w_0}{s\bar{\lambda}})^2 + \frac{w_0(F-B)}{s\bar{\lambda}}]^{\frac{1}{2}}}{w} \\
\tilde{\lambda_{23}} &= \frac{y + (r\delta + 1)B}{w}
\end{aligned} \tag{1.6}$$

[13]Since the expression is complicated, I show the expression assuming that $r = 0$ for $\tilde{\lambda_{13}}$.

where $V1 = V2$ at $\tilde{\lambda_{12}}$ and $V1 = V3$ at $\tilde{\lambda_{13}}$.

Property 3 (Boundary Indifference) *"Border" households between two neighboring choices are indifferent at* $\tilde{\lambda_{12}}$, $\tilde{\lambda_{13}}$, $\tilde{\lambda_{23}}$, *and* $\bar{s}$.

From property 2 and 3, I can characterize each strategy in the (λ, s) plane. An example is shown in Figure 1.5. The shape of all boundary indifference loci in the (λ, s) space is determined by the parameters in Θ.

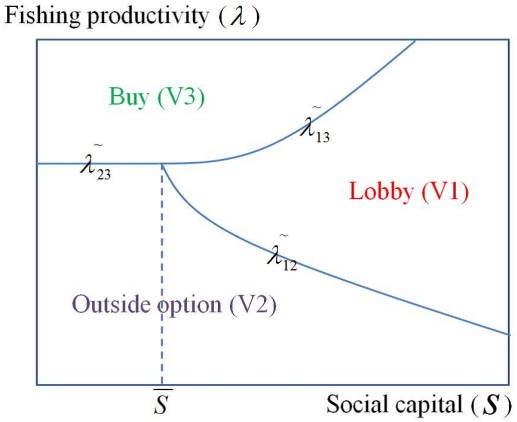


Figure 1.5: Equilibrium strategy

A fisherman's self-selection decision is characterized by the following lemma.

Lemma 1 ***Equilibrium of self-selection***

1. *Lobby (V1) if* $\tilde{\lambda_{12}} < \lambda < \tilde{\lambda_{13}} \cap s > \bar{s}$
2. *Not-lobby (V2) if* $(\lambda < \tilde{\lambda_{23}} \cap s < \bar{s}) \cup (\lambda < \tilde{\lambda_{12}} \cap s > \bar{s})$
3. *Buy (V3) if* $(\lambda > \tilde{\lambda_{23}} \cap s < \bar{s}) \cup (\lambda > \tilde{\lambda_{13}} \cap s > \bar{s})$

Proof: Annex

Figure 1.5 tells us the types of fishermen who choose each strategy. First of all, households that lobby for aid have high social capital and wide range of fishing productivity. Secondly, very productive fishermen alway fish by purchasing their own boats ($V3$). Finally, households take outside job options if both productivity and social capital are low.

1.3.7 Comparative statics (CS)

Lemma 1 shows that different strategies are driven by productivity and social capital. The boundary indifference condition depends on parameters in Θ, which gives two additional predictions.

First of all, relative returns to work in two sectors affect the boundary between outside option and choices of fishing. Higher reservation wage expands the region of $V2$, and makes people more likely to select out from an aid program.

CS 1 (Outside option) *For given w, $\frac{\partial \tilde{\lambda_{12}}}{\partial y} > 0$, $\frac{\partial \tilde{\lambda_{13}}}{\partial y} > 0$, and $\frac{\partial \tilde{\lambda_{23}}}{\partial y} > 0$*

Secondly, if people expect that their previous fishing experience will be favorably treated in the allocation process of aid boats, people with wider range of fishing productivity (especially at the lower ends of the distribution) start lobbying.

CS 2 (Targeting on $\bar{\lambda}$) *If $q > 0$, $\frac{\partial \tilde{\lambda_{12}}}{\partial \bar{\lambda}} < 0$ and $\frac{\partial \bar{s}}{\partial \bar{\lambda}} < 0$. Sign of $\frac{\partial \tilde{\lambda_{13}}}{\partial \bar{\lambda}}$ is indeterminate.*

Finally, the decision to buy a boat from a local workshop will be more difficult when the credit constraint gets more binding.

CS 3 (Credit constraint) *$\frac{\partial \tilde{\lambda_{13}}}{\partial \delta} > 0$, $\frac{\partial \tilde{\lambda_{23}}}{\partial \delta} > 0$, and $\frac{\partial \bar{s}}{\partial \delta} < 0$.*

1.4 Variables and Summary Statistics

Appendix 1.1 and 1.2 provide the summary statistics of key variables and their definitions.

1.4.1 Lobbying

My definition of lobbying is provided in *Footnote 6*. Panel A shows that 63% of households lobbied, 23% chose to work in wage sector, and 14% purchased boats.

In section 1.5, I make the simplification that everyone either lobbies or does not lobby since I cannot observe a continuous lobbying effort.

1.4.2 Fishing Productivity

In Panel B, I define both binary (variable name starting from "D") and continuous measures of fishing productivity. I use a binary measure when I consider how aid boats were allocated by aid agencies since the agencies could not perfectly observe the distribution of households' fishing

productivity. On the other hand, I use a continuous measure when I examine households' decision-making, since they know their own fishing productivity.

Three main dummy variables capture different types of fishing skills. One is the mechanical ability to operate a boat with a larger size and a higher capacity. As a proxy measure, I use a household's usage of a large boat and usage of a boat with a high engine capacity pre-tsunami. The second measure is about managerial/supervisory skill in fishing with a number of crew members as a team. In our survey in 2005, we asked how many crew members each household worked with before the tsunami. Based on this information, I consider that working with more than five crew members (the typical size of fishing team) requires a particular managerial skill[14]. The third measure is the skill to conduct off-shore fishing as opposed to in-shore fishing. If a household reported the catch of tuna pre-tsunami, I consider that they have ability to catch tuna, which generally involves off-shore fishing ability[15].

1.4.3 Social Capital

I define social capital in two types: *social status* as a previous boat owner and captain and *social connection* based upon participation in an *arisan group* and other variables such as a debt relationship with middlemen. Panel C shows that majority of households (72%) were previous boat owners and captains, 8% were only previous owners, and 20% were only previous captains. Affiliation with an *arisan group* was only 25% and not common in my sample. I should note that these are not perfect proxy variables since they could capture both social connections and credit constraints, but are the only available measures to capture social capital in the data[16].

1.4.4 Other Covariates

Panel D lists the set of control variables. *"Outside option"* is defined by the number of on-going reconstruction projects in villages, which measures the available market job opportunities. The scale of available aid boats (defined as total aid boats divided by surviving captains) varies by villages and is mostly less than one except in some *kecamatans* such as Pulo Aceh and Lhok Nga. There were only 29% of households with high income (weekly earnings greater that Rp 500,000 (about $50)) and 14% of households with high levels of education (above senior high school).

[14]The number of crew members represents labor inputs, but it could represent managerial/organizational quality and are considered one form of fishing productivity in a fishing firm.

[15]Catching tuna requires different equipment (such as heavier jigging line and net) and off-shore fishing and tracking skill, but does not necessarily require a big boat. Hence, two dummy variables are not strongly correlated.

[16]It is difficult to empirically disentangle these two effects, so the results should be interpreted with caution.

1.5 Estimation 1: Households' Self-Selection to Aid

In this section, I consider people's ex-ante behavior of occupational choices and application for aid (vs. purchasing boats in a private market) from the demand side. I estimate parameters using the structural estimation method. Even without direct measures of subjective expectations, the model can separately estimate the parameters on people's expectation for the aid allocation from the parameters on the return to household and village characteristics.

1.5.1 Behavioral Model of Ex-ante Decision:

The allocation of aid was usually conducted through specific intermediaries such as prominent fishermen. The allocation was not random and was not determined by established eligibility criteria, which made fishermen uncertain whether characteristics such as their productivity or social capital would be rewarded by the intermediary or not. Under such uncertainty, households faced competition with neighbors to win the limited resources.

Following equation (1.1), I assume that people formulate their expectations about the likelihood of getting aid boats based on their characteristics ($\bar{\lambda}$ and s). In my estimation, I assume that people compete with other fishermen in the same *kechamatan*[17]. The rationing of aid is determined by the following equation (π), which is standard normally distributed to bound the probability between zero and one:

$$\pi_{ijk} = \Phi(\tilde{a_{0,k}} + a_1 \tilde{s_{ijk}} + a_2 \tilde{\bar{\lambda}_{ijk}}) \tag{1.7}$$

where π_{ijk} is the expected success rate of getting aid for household i in a village j and a *kecamatan* k. For $\bar{\lambda}$, I control for two fishing productivity dummy variables (using a boat with bigger engine capacity, catching tuna pre-tsunami) at the same time.

The intercept $a_{0,k}$ is the inverse of standard normal distribution of the proportion of lobbyists who received aid p_k in each *kecamatan* k (i.e. $\tilde{a_{0,k}} = \Phi^{-1}(p_k)$). This is the average success rate of getting aid and varies by each *kecamatan*. Two characteristics of fishermen (s, $\bar{\lambda}$) in the rationing equation are centered at the mean of each *kecamatan*, i.e, $\tilde{s_{ijk}} = s_{ijk} - E_k(s_{ijk})$ and $\tilde{\bar{\lambda}_{ijk}} = \bar{\lambda_{ijk}} - E_k(\bar{\lambda_{ijk}})$. This specification assumes that the expectation depends on the endowed social capital and fishing experience relative to the *kecamatan* average of other fishermen's characteristics.

Households take the expected rationing process of aid into consideration and choose the best

[17] It would be more realistic to assume that people compete with others at the village level. However, there are not enough observations in my sample to model the competition at the village level.

strategy to maximize their expected utility. As mentioned in section 1.2.3, people's strategy is structured by two considerations: occupational choice and lobbying for aid boats. People could get boats either from the international agencies or from the private market. There are three potential strategies: lobbying (L), not-lobbying (NL), and buying (B).

The empirical model is built on the random utility framework. The model is static. The payoff functions for three strategies are defined in equation (1.8) below. The first equation for V_L represents the payoff when people choose to lobby for aid which involves the uncertainty that they can be rationed from getting aid. In this sense, people's payoff will differ in two states of the world. If they succeed in the competition to obtain aid (state 1), they can fish and fishing productivity λ matters. If the lobbying is unsuccessful (state 2), they will choose to work in non-fishing job opportunities, so the payoff depends on available outside options y and their market skill h. The second equation for V_{NL} represents the payoff when people choose to work in non-fishing jobs from the beginning which shares a similar payoff structure as state 2 in the equation for V_L. Finally, the third equation for V_B represents the payoff for those who choose to buy boats from the private market whose payoff structure is similar to state 1 of equation for V_L. Three equations have different utility levels, so the intercepts ($c_1 \sim c_3$) are distinct. Other covariates X such as access to local boat workshops, high levels of pre-tsunami household income, and a dummy variable of living in Pulo Aceh are included. The unobserved error terms are also different. Based on this, the empirical behavioral model is specified as follows.

$$\begin{aligned} V_{L,ijk} &= \pi_{ij} \underbrace{(c_1 + b_1\lambda_{ij})}_{state1} + (1-\pi_{ij}) \underbrace{(c_2 + b_2 y_j + \tau h_{ij})}_{state2} + \gamma_1 X_{ijk} + \epsilon_{L,ij} \\ V_{NL,ijk} &= c_2 + b_2 y_j + \tau h_{ij} + \gamma_2 X_{ijk} + \epsilon_{NL,ij} \\ V_{B,ijk} &= c_3 + b_1 \lambda_{ij} + \gamma_3 X_{ijk} + \epsilon_{B,ij} \end{aligned} \tag{1.8}$$

where π is defined by equation (1.7). V_{ijk} denotes each payoff for a household i in a village j and in a *kecamatan* k. I estimate the parametric model where the logit error terms are unobserved fixed costs of lobbying ϵ_L (denoted as e and F in theoretical model) for a lobbying choice, unobserved stochastic factors in the non-fishing sector ϵ_{NL} for a non-lobbying choice, and unobserved costs of credit ϵ_B for a buying choice. These logit errors are uncorrelated and are assumed to be independent. In all specifications, I normalize $c_2 = 0$ and $\gamma_2 = 0$.

Under the random utility set-up, structural parameters are estimated by maximizing the log-likelihood function.

$$LL = \sum_i \sum_c D_{c,i} \ln P_{c,ij}$$

where $c \in \{L, NL, B\}$ and $D_{c,i} = 1$ when a household i takes a choice c. $P_{c,ij}$ is the choice probability of three strategies. In the multinomial logit model, logit errors are independent and extreme value distributed. Hence, the probability is defined as $P_{c,ij} = \frac{\exp(V_{c,ij})}{\sum_c \exp(V_{c,ij})}$.

Each parameter is expected to be signed as Table 1.1 for the following reasons.

- The signs of social capital and fishing productivity depend on how people assess the targeting rule of aid. If social capital matters to be eligible for aid, $a_1 > 0$. If people expect that their fishing productivity is expected to be targeted ($q > 0$), $a_2 > 0$. In the opposite situation, $a_2 < 0$.
- If lemma 1 is true, granting aid boats opens fishing opportunities for less productive fishermen while most productive fishermen self-selected into the private boat market because of the uncertainty of the competition in seeking aid. Then, I expect that $b_1 > 0$ and that the covariates in the rationing function π are significant.
- If CS 1 is true, the increase in the labor demand in market opportunities increase the number of those who choose to work in non-fishing jobs. Then, $b_2 > 0$.
- If higher education is necessary for market opportunities, $\tau > 0$.

Table 1.1: Expected signs of structural parameters

Rationing equation		Return equation		
a_1	a_2	b_1	b_2	τ
> 0	?	> 0	> 0	> 0

1.5.2 Result: Determinants of Ex-ante Decisions

The structural estimates of the ex-ante behavioral model in Table 1.3 tells us that there existed a particular self-selection rule as is consistent with my theoretical model.

Panel A: Rationing equation

Estimated coefficients of a_1 and a_2 show two major findings. I examined two social capital measures (pre-tsunami boat owners and captains, participation in an *arisan group*). Both are positively signed, but only the coefficient for pre-tsunami boat owners and captains is significant. This finding means that those who were previous boat owners and captains tended to have higher expectations for aid since they consider that they had a legitimate property claim to receive a replacement boat from an NGO.

Next, a_2 shows how people form their expectations based on whether their previous fishing experience will be targeted for the receipt of aid. As predicted in Table 1.1, the sign depends on the type of fishing experience. They expected less probability of getting aid if their previous fishing boats had bigger engine capacities, but expected higher probability of getting aid if they were catching tuna in the deep sea before the tsunami. People expected that (a) aid agencies allocated boats to those who were using smaller boats before the tsunami due to the redistributive motivation and (b) off-shore fishing of catching tuna will be a more profitable fishing activity because in-shore fishing was fully devastated by the tsunami (loss of mangroves etc).

Panel B: Return equation

In Panel B of Table 1.3, I found the following results.

First of all, the coefficients of fishing productivity (b_1) validates the self-selection behavior as predicted by my theoretical model. I use continuous measures of the log of an engine capacity of pre-tsunami boat (outliers above the 95th percentile of the distribution are trimmed). A positive sign of the variable confirms that more productive fishermen chose to fish using either aid boats or boats they purchased in the private market. In particular, since variables in the rationing equation are found to be significant, the positive sign confirms that the most productive fishermen selected into the private market to purchase a new boat as predicted by my theoretical model.

Also, market skill (τ) is positive and significant, which shows that people with higher education (above senior high school) expected a greater return to working in market opportunities. This is consistent with the fact that more skilled workers were necessary in market opportunities in construction and service sectors.

Secondly, the effect of market opportunities (b_2) is not statistically significant but positively signed. As CS 1 suggests, fishermen had stronger incentives to choose an outside job than applying

for aid boats in places where a large amount of market job opportunities were available in their communities.

Finally, I show the estimates for two covariates (the access to a local boat workshop and a dummy variable for high income pre-tsunami) to test CS 3 about the effects of credit constraints. γ_1 is the estimate specific to a lobbying strategy while γ_3 is specific to a buying strategy (when γ_2 is normalized to be zero). The positive sign of γ_3 for the access to a private boat workshop variable shows that better access to a workshop increases the payoff of the buying strategy. Although not statistically significant, the high income dummy variable is also positively signed for the buying strategy. This implies that people took into account the cost of obtaining a boat from the private market. They were more likely to choose to buy a boat from a local vendor if a boat workshop existed within their villages.

In summary, the structural estimates show a consistent story as the theoretical model predicts fishermen's self-selection decisions.

1.6 Estimation 2 : Intra-village Targeting of Aid:

For those fishermen who self-selected to apply for aid boats, how did aid agencies select the beneficiaries of the aid boats ex-post?

My theoretical model proposes that people expect the allocation rule of aid as defined in equation (1.1). In this section, I estimate the intra-village allocation rule of aid ex-post. I use the sample of only those who self-selected for aid.

In section 1.5, people's expectation of getting aid depends on their social capital (s) and fishing experience ($\bar{\lambda}$). In this section, I estimate the parameters of α_1 (prior fishing experience) and α_2 (return to social capital), and the scale of aid ($\frac{n}{m}$) using the following regression model.

$$AID_{ijk} = 1[\alpha_0 + \alpha_1 \bar{\lambda}_{ijk} + \alpha_2 s_{ijk} + \alpha_3(\frac{n_{jk}}{m_{jk}}) + \kappa_k + \epsilon_{ijk} > 0] \tag{1.9}$$

where AID_{ijk} is one if household i in village j and *kabupaten*[18] k received boat from NGOs, and 0 otherwise. κ is the *kabupaten* fixed-effect.

[18] A district (*kabupaten*) is a political subdivision of a province in Indonesia. Districts are divided into sub-districts (*kecamatan*).

1.6.1 Result of Ex-post Allocation:

Table 1.5 shows marginal effects of a Probit regression on the actual allocation of aid[19]. Standard errors are Huber-White heteroscedasticity robust estimates.

First of all, α_1 tells me whether fishing productivity was the major determinant in allocating aid or not. I tried four alternative fishing productivity measures to check if some particular fishing abilities were targeted by aid agencies or not. In column (1) and (2), I use dummy variables forprevious mechanical fishing ability (using large boats and using high engine capacity boats) as proxies for $\bar{\lambda}$[20]. In column (3), I use the managerial skill to work with many crew members. Throughout column (1)-(3), I separately include a catching tuna dummy to examine whether off-shore fishing activities were differently targeted. Except for the catching tuna dummy, other fishing productivity measures are negatively signed and reduce the likelihood of receiving an aid boat. One interpretation is that aid agencies allocated boats to those fishermen who were using smaller boats with fewer crew members. Because the size of aid boats were relatively small, it is more likely that they were appropriately utilized by people who owned smaller boats before the tsunami. Another interpretation is that agencies had a motive to redistribute boats to households with smaller boats pre-tsunami that were relatively poor.

On the other hand, those who were catching tuna pre-tsunami were more likely to receive aid boats. The marginal effect is large and +14∼16%. The tsunami destroyed mangroves and damaged reefs, which destroyed the in-shore fishing stocks.Since only off-shore fishing continued to be profitable, this positive sign implies that agencies targeted boats to those fishermen who could engage in off-shore fishing.

Secondly, I include both measures about social status (as a previous owner and captain) and social connection (through an *arisan group*) to estimate coefficient of α_2. The table shows that pre-tsunami boat owners and captains were more likely to receive aid boats. The marginal effect of being a boat owner and captain is 16∼17%. Participation in an *arisan group* increased the likelihood of receiving aid by 19∼21%. Conditional on those who applied for aid, a household that had social status and social connections was more likely to be favorably treated in the allocation process of aid boats.

Then, I conducted a robustness check in column (4)-(6). I dropped two *kecamatans*, *Lhok Nga*

[19]I also examined the same regressions using a linear probability model. but the significance level remains unchanged.

[20]I also tried alternative definitions of a large boat dummy by changing the threshold from nine meter (average size) to eight meter or ten meter. In both cases, the coefficients are negative but insignificant.

and *Pulo Aceh*, where an excessive number of aid boats were provided as we saw in Figure 1.1. This dropped 33 households living in these *kecamatans*. The estimated coefficients confirm the robustness of the positive effect of an *arisan group* and the catching tuna dummies. The magnitude of both variables are slightly bigger compared with Table 1.5. By removing two *kecamatans*, I found that the social status as a previous owner and captain also became larger in magnitude, which increases the probability of receiving aid boats by 25∼26%.

In summary, I now have a better idea who became the beneficiaries of aid boats. It is explained by two margins, both supply side (an intermediary's allocation decision of aid) and also demand side (an fisherman's self-selection into lobbying for aid). This provides the selection rule for considering the impact of aid boats on fishing output in the next section.

1.7 Estimation 3 : Impact of Aid Design Problem

As shown in Figure 1.2, aid boats were smaller than boats which were used before the tsunami. Previous chapters show that people can be categorized into three types: lobbying for aid, buying a private boat, and choosing to work for non-fishing job. Did the returns to capital differ by these three types? In particular, under the mis-matching of boat type, did aid boats effectively recover the fishing revenues of aid recipients?

Figure 1.6 shows the non-parametric regression (locally weighted smoothing) of log of fishing revenue in 2007 on the raw difference between post- and pre-tsunami boat engine capacities. The left panel shows the LOWESS estimate for aid recipients, while the right figure is for those who purchased a boat. For aid recipients, the figure shows that the fishing return is maximized at the point where the difference between pre- and post-tsunami engine capacities is zero. As the difference increases in absolute value, the fishing revenue decreased for aid recipients[21]. This is not the case for those who purchased a boat. The right panel shows that the fishing output increases if a fisherman had a new boats with a bigger engine capacity.

Using the empirical results from the previous sections, this section aims to confirm that the effectiveness of aid boats on the fishing output is contingent upon how much the new boats from agencies were consistent with the heterogeneous skill distribution of fishermen in the local economy.

[21]It could be the case that aid boats that were too big or small were poorly constructed, which reduced fishing revenue as the difference of pre- and post-engine capacity increased. I checked whether my mis-matching index and household-level boat quality variable (which takes one if households reported that the boat received from agencies was of poor quality) are positively correlated. I could not find a statistically significant association between two variables.

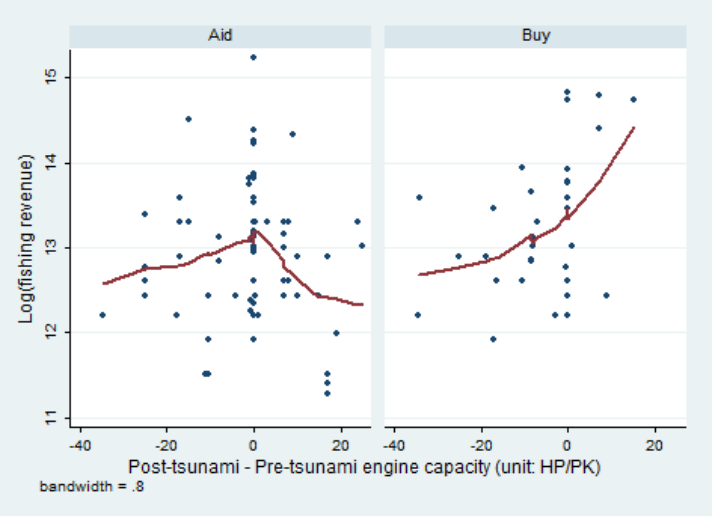


Figure 1.6: Relationship between mis-matching of boat type and fishing revenue

1.7.1 Mis-matching for Aid Boats

Fishing revenue R is determined by fishing productivity λ, the type of current boat K, the vector of household characteristics X, and *kabupaten* fixed effect κ. The *kabupaten* fixed effect controls for the price difference of fishes and unobserved heterogeneities across regions.

$$R_{ijk} = \beta_0 + \beta_1 \lambda_{ijk} + \beta_2 K_{ijk} + \beta_3 X_{ijk} + \kappa_k + \epsilon_{ijk} \tag{1.10}$$

A household uses a boat that was obtained by aid or its own purchase. If a household received an aid boat, the type of boat imposed by agencies may not fit the type of boat they used before the tsunami. As shown in the theoretical model, lobbyists were heterogeneous in fishing productivity. Therefore, the skill of aid recipients is less likely to match the homogeneous type of aid boats.

If a household receives an appropriate type of boat (i.e. $M = 1$, the matching index is defined in section 1.7.2), the return to capital λ_H is higher than the return to aid boats λ_L when aid boats did not fit well with their prior productivity (i.e. $M = 0$). Since households that purchased their own boats could choose a boat that was appropriate to their fishing needs, the return λ_B is at least greater than λ_L. The return to capital K is defined as follows:

$$K_{ijk} = e_{ijk} + \underbrace{A_{ijk}[M_{ijk}\lambda_H + (1 - M_{ijk})\lambda_L]}_{Aid} + \underbrace{(1 - A_{ijk})\lambda_B}_{Buy} \tag{1.11}$$

where e is the common return to physical capital, which is measured by the boat engine capacity

of a current boat. By inserting equation (1.11) into equation (1.10), I get the following empirical model:

$$R_{ijk} = \beta_0 + \beta_1 \lambda_{ijk} + \beta_2 e_{ijk} + \gamma_1 A_{ijk} + \gamma_2 A_{ijk} M_{ijk} + \beta_4 X_{ijk} + \kappa_k + \epsilon_{ijk} \tag{1.12}$$

I use pre-tsunami engine capacity and catching tuna as the proxy variables to measure fishing productivity λ. X includes variables such as age of household head. Relative to my base category of those who purchased a boat, γ_1 is the return to using an aid boat that does not fit a fisherman's skill. γ_2 is the return to using aid-funded boats when the type of boat matches with a fisherman's skill.

I am interested in the sign and magnitude of γ_1 and γ_2. I expect to see the negative sign of γ_1 if aid boats had a quality problem that reduced fishing outputs. I also expect the positive sign of γ_2, which means that an aid boat is effective only when it fits a household's skill (i.e. $M = 1$).

1.7.2 Construction of the Matching Index

A matching index M is a categorical variable. It is constructed by the absolute value of the deviation of pre- and post-tsunami engine capacities. The first measure divides the sample into two groups. If the value of deviation is small, it is a better match.

$$\begin{aligned} M_{ijk,1} &= Match && \text{if 1st half of } |engine_{post} - engine_{pre}| \\ &= Non-match && \text{if 2nd half of } |engine_{post} - engine_{pre}| \end{aligned} \tag{1.13}$$

The second measure divides the sample into three groups (Good, Fair, vs. Bad). In the regression, I include dummy variables for Good and Fair match, omitting Bad match as a reference group.

$$\begin{aligned} M_{ijk,2} &= Good && \text{if 1st tertile of } |engine_{post} - engine_{pre}| \\ &= Fair && \text{if 2nd tertile of } |engine_{post} - engine_{pre}| \\ &= Bad && \text{if 3rd tertile of } |engine_{post} - engine_{pre}| \end{aligned} \tag{1.14}$$

Since I take the absolute value of the deviation of post- and pre-tsunami boat engines, I implicitly assume that positive and negative mis-matching have symmetrically negative impacts on fishing revenue. This assumption is validated based on Figure 1.6. Although the LOWESS estimate for aid recipients shows a slightly sharper decline in the area above zero, the average return declines in an almost symmetric manner in both directions.

1.7.3 Estimation Method

In the sample for this estimation, I only observe people who were fishing in 2007. I exclude those households that were fishing through a shared ownership arrangement, and focus on those with a private ownership arrangement.

I first estimate equation (1.12) by OLS. However those who reported fishing output will be a selected sample. As argued in lemma 1, households self-selected into fishing either by lobbying for aid or purchasing boats ex-ante. Therefore, I also report results based on a Type-II Tobit model.

In the selection model, the participation in fishing is estimated by a probit model. The selection equation includes the exclusion restriction, which affects a household's choice on whether to fish, but does not directly affect fishing revenue. Based on CS 1, I use outside job options as the excluded variable which negatively affects a household's decision to fish, but will not have any direct effect on fishing revenue.

The selection equation is defined as follows.

$$F_{ijk} \quad = \quad 1[\theta Z_{ijk} + \eta_{ijk} > 0]$$

where Z includes (λ, X, κ) plus the excluded variables. Error terms are assumed to be jointly normally distributed and homoschedastic.

$$(\epsilon, \eta) \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{pmatrix} \right] \tag{1.15}$$

Among those who are fishing, those who purchased boats ($V3$) have higher fishing productivity than those who received aid boats ($V1$), i.e. $Cov(R, A) < 0$. To deal with the bias due to this correlation, I control for a household's affiliation with an *arisan group* pre-tsunami and the variable of catching tuna, which significantly increase the probability of getting aid as shown in Table 1.5.

Another threat to identification is the potential endogeneity of matching variables. If prominent fishermen selectively allocated boats that were too small or too big to a particular type of people, the variable could be positively correlated with people's characteristics. To test the orthogonality of the matching variable, I check whether the mis-matching is systematically different by several observed attributes (such as (a) pre-tsunami boat length, engine capacity, and (b) pre-tsunami social capital). I do not find any significant differences based on these characteristics. Although I do not have direct evidence, it is also not common that the fishermen's association leader selectively

allocated better-matched boats to those who had better unobserved fishing ability or desire for fishing. Based on these checks, I consider that the endogeneity of M is of less concern.

Estimation Result

Table 1.5 presents the results. Column (1) uses M_1 and column (2) uses M_2 as the matching index. For both column (1) and (2), I present the results using OLS and the Type-II Tobit model.

Based on OLS, the estimates show that the matching index significantly affected the fishing revenue. By including the interaction term of aid and a matching index, I can separately estimate the return to aid boats that fit their skill versus. those that do not fit their skill. The negative effect of γ_1 comes as a result of the mis-matching problem of the type of aid boats to fishermen's skill. On the other hand, the coefficient on the interaction term γ_2 is positive and significant. For aid beneficiaries, receiving boats whose type matches their fishing skills raises the fishing revenue.

In column (2), I present the results using a second measure of matching index M_2. The marginal effects of γ_1 and γ_2 are bigger in magnitude than the results in column (1). Good matching and fair matching improve fishing revenue by a large magnitude relative to poor matching.

Finally, the coefficients of other covariates are signed as I expected. For example, fishing productivity (measured by the log of previous engine capacity) and the type of current boat (measured by the log of current engine capacity) are both positively signed. It is, however, surprising that those who were catching tuna before the tsunami (and therefore were more likely to receive aid boats based on the results in section 1.6) got lower fishing outputs. Older fishermen also had lower fishing outputs than others.

Based on the results using the sample selection model, the positive sign of the correlation term implies that those who reported fish catch ($V1$ and $V3$) had higher fishing productivity than those who chose not to fish ($V2$). It is consistent with ex-ante behavioral estimation results. Due to the positive selection, OLS estimates are overestimated since productive fishermen were more affected by the mis-matching problem. However, even after correcting the selection bias, γ_2 is still significant at 99%.

In sum, these results provide the empirical evidence that the effect of aid on fishing revenue is positive only when the type of aid boats is consistent with the type of boat that fishermen used before the tsunami[22].

[22] One concern with my identification strategy comes from the measurement error of the proxy variable on fishing productivity. Since I am using pre-tsunami boat type as a proxy measure for fishing productivity, there is a concern

1.7.4 Mis-matching for Privately Purchased Boats

In equation (1.12), I assume that the matching of boat type to fishermen's skill was not a problem for the population who purchased a boat. However, this assumption may not be valid if people were credit constrained, which made them unable to buy suitable boats. The problem may also occur if local boat builder could not provide an appropriate quality of boats. This motivates me to incorporate the mis-matching issue for those who purchased boats in a general model as in equation (1.12).

$$K_{ijk} = e_{ijk} + \underbrace{A_{ijk}[M_{ijk}\lambda_H + (1 - M_{ijk})\lambda_L]}_{Aid} + \underbrace{(1 - A_{ijk})[M_{ijk}\lambda_H^{'} + (1 - M_{ijk})\lambda_L^{'}]}_{Buy} \tag{1.18}$$

where λ_H (or λ_L) is the return to using aid boats when the type of new boat does or does not match a fisherman's skill. Similarly, λ'_H (or λ'_L) is the return to using purchased boats when the boat type does or does not match skill level. By inserting equation (1.18) into equation (1.10), I got the following empirical model.

$$R_{ijk} = \beta_0 + \beta_1\lambda_{ijk} + \beta_2 e_{ijk} + \gamma_1 A_{ijk} + \gamma_2 A_{ijk}M_{ijk} + \gamma_3 M_{ijk} + \beta_3 X_{ijk} + \kappa_k + \epsilon_{ijk} \tag{1.19}$$

Equation (1.19) additionally includes the level effect of the matching index M. Therefore, the base category is people who purchased a boat that does not fit their fishing skill. γ_1 is the return to using aid boats relative to purchased boats *when the new boats do not match their fishing skill.* The coefficient γ_3 of this variable examines whether the matching problem also existed for the boats that were purchased in the private market. If the design of the boat was only problematic for aid beneficiaries, I expect to see $\gamma_3 = 0$.

Column (3) of Table 1.5 presents the results. In comparison with column (1), γ_1 is consistently negative even after correcting sample selection bias. The negative estimate implies that aid boats did not significantly improve the fishing revenue compared with the revenue of those who fished

that it captures not only true productivity but also households' income level before the tsunami. To check the robustness of my result, I decompose proxy measure of productivity λ^* into true productivity λ and pre-tsunami income ω.

$$\lambda^*_{ijk} = \lambda_{ijk} + \omega_{ijk} \tag{1.16}$$

I use equation (1.16) in equation (1.12) and in other empirical specifications.

$$\begin{aligned} R_{ijk} &= \beta_0 + \beta_1(\lambda^*_{ijk} - \omega_{ijk}) + \beta_2 e_{ijk} + \gamma_1 A_{ijk} + \gamma_2 A_{ijk}M_{ijk} + \beta_3 X_{ijk} + \epsilon_{ijk} \\ &= \beta_0 + \beta_{11}\lambda^*_{ijk} - \beta_{12}\omega_{ijk} + \beta_2 e_{ijk} + \gamma_1 A_{ijk} + \gamma_2 A_{ijk}M_{ijk} + \beta_3 X_{ijk} + \kappa_k + \epsilon_{ijk} \end{aligned} \tag{1.17}$$

Even when I net out the income level pre-tsunami, the results are similar.

with purchased boats, if the type of new boats did not match with fishermen's skill distribution.

The coefficient of γ_2 is positive and significant even after including the level effect of the matching indices in the regression. As a matching index, I use M_1 in column (3)[23]. The positive estimates show that aid boats could improve fishing revenue when the type of new boats was consistent with a fisherman's skill distribution. This implies that the positive impact of aid boats was larger if fishermen could use new boats that were very similar to their pre-tsunami boats.

Finally, γ_3 is not statistically significant. This suggests that those who purchased boats did not face serious matching problems[24]. Unlike aid boats, it implies that fishing outputs could be larger when the type of new boats was different from the type of previous boats.

To conclude this section, the following table summarizes the estimates for testing aid efficacy. I use the Type-II Tobit estimates in column (3) of Table 1.5.

Table 1.2: Aid efficacy based on sample selection model

	Match	Not match
Aid	**0.654****	-0.088
Buy	-0.085	0

The most striking finding is that aid effectively improves fishing revenue by 65% only when the type of aid boats matched a fisherman's previous boat type. Otherwise, there was zero impact on fishing revenue. This suggests that the design of new boats was the crucial factor in maximizing the effectiveness of this particular form of disaster-relief aid.

1.8 Conclusion

In this paper, I provided two key findings. First of all, I showed that the beneficiaries of disaster-relief aid were determined not only by supply side factors, but also by household-level self-selection. As predicted by the ex-ante behavioral model, households made decisions based upon their fishing productivity and market opportunities in non-fishing jobs along with their expectations of success in obtaining aid. Among those who applied for aid, the beneficiaries were determined by agencies that

[23]The result using M_2 is not reported since there is not enough variation among those who purchased a boat where boat was categorized into Good and Fair match type.

[24]There could be two explanations for this. It could be that those who purchased a boat could get the type of boats they wanted in the local markets, or possibly that the mis-matching of boat type did not have much of an effect because fishermen could handle the problem. Since I am not able to observe the quality of boats sold in the local market, I cannot test which interpretations are correct. However, significantly positive estimate of γ_2 shows that the mis-matching problem was more crucial for aid beneficiaries.

usually favored those with higher social capital and off-shore fishing skill. Secondly, I used unique micro-data and provided empirical evidence that the homogeneous type of fishing boats delivered by international agencies was not consistent with recipients' heterogeneous skill distribution. Together with the problem of poorly-constructed boats, the mis-match of the type of aid boats substantially reduced the fishing revenue of aid beneficiaries.

My findings pose strong policy implications for future disaster-relief aid efforts. First of all, the aid can be more effectively allocated when we understand how aid programs affect households' incentives and micro-level behaviors. It is clear that the improvement of the aid delivery process to recipients (for example by fighting corruption) is important. My paper, however, suggests that alternative aid programs, such as providing non-fishing job opportunities or developing a private boat market, could satisfy people's heterogeneous needs depending on their demographic characteristics. Secondly, it is important to ensure that the design of aid meets specific local factors such as the heterogeneous distribution of fishing productivity. Although international agencies are usually constrained by the urgency of disaster-relief aid and lack knowledge of the local economic conditions, we could improve the consistency of aid if a wider variety of aid program were designed. Alternatively, the development of private market transaction of fishing boats could match people's heterogeneous needs. These measures could potentially improve ex-post fishing output significantly. The cost-effectiveness of such alternative policies will be explored in future research.

Additionally, it will also be interesting to consider how the allocation process could be improved in the disaster-relief context. Using this ex-ante behavioral model, I plan to examine how households' micro responses would change under alternative aid programs. By restricting the estimated coefficients, I could consider the change in the composition of people choosing each strategy in Figure 1.4 under the scenarios where the allocation mechanism (i.e. targeting rule) and the scale of fishing or total aid projects change. This will answer the question of how the livelihood supports and assistance for market development should be optimally designed to improve aid efficacy.

Annex

Proof of Lemma 1

1. As described in Figure 1.5, the set of equilibrium choice can be divided into three cases depending on the value of s: $(V1, V2, V3)$ if $s > \bar{s}$ and $(V2, V3)$ if $s \leq \bar{s}$.

2. For $s > \bar{s}$: From equation (1.2), $\frac{\partial V1}{\partial s} = \frac{(w\lambda - y)^2}{4(1+r)^2 w_0}\bar{\lambda} > 0$ and $\frac{\partial V2}{\partial s} = \frac{\partial V3}{\partial s} = 0$. For critical values of λ, $\frac{\partial \tilde{\lambda_{12}}}{\partial s} < 0$ and $\tilde{\lambda_{13}} > 0$. For any s, perturbing parameters in Θ by ϵ does not change the relative ranking. So, single-crossing property guarantees the same equilibrium ranking for any s.

3. For $s \leq \bar{s}$: If I change s, $\frac{\partial V2}{\partial s} = \frac{\partial V3}{\partial s} = 0$. Similarly, $\frac{\partial \tilde{\lambda_{23}}}{\partial s} = 0$. If $s < \bar{s}$, $V3$ and $V4$ are not influenced by the change in s, so single crossing property ($\frac{\partial V2}{\partial \lambda} < \frac{\partial V3}{\partial \lambda}$) always hold at $\tilde{\lambda_{23}}$, and the same equilibrium ranking holds for any s. ■

Appendix 1.1: Summary Statisitcs

	N	Mean	SD	min	p25	p50	p75	max
A. Outcome variables								
Aid	342	0.404	0.491	0	0	0	1	1
Aid (if lobby)	214	0.621	0.486	0	0	1	1	1
Lobby	342	0.626	0.484	0	0	1	1	1
Buy	342	0.143	0.351	0	0	0	0	1
Fish	342	0.632	0.483	0	0	1	1	1
Fish (if received aid)	138	0.783	0.413	0	1	1	1	1
Log (fish revenue)	177	13.184	0.991	11.290	12.612	13.017	13.710	16.300
B. Fishing productivity								
D_big engine cap._pre	342	0.553	0.498	0	0	1	1	1
D_large boat_pre	342	0.330	0.471	0	0	0	1	1
D_many crew_pre	342	0.158	0.365	0	0	0	0	1
D_tuna_pre	342	0.468	0.500	0	0	0	1	1
Log(engine_pre)	320	3.058	0.479	1.609	2.833	3.178	3.219	3.714
Log(engine_post)	215	2.922	0.604	1.435	2.773	3.178	3.178	4.263
C. Property right								
Boat owner & Captain_pre	342	0.719	0.450	0	0	1	1	1
Boat owner & non-captain_pre	342	0.082	0.275	0	0	0	0	1
Non-boat owner & Captain_pre	342	0.199	0.400	0	0	0	0	1
Social connection								
Arisan group_pre	342	0.246	0.431	0	0	0	0	1
D. Other covariates								
Outside option	324	3.509	0.565	1.792	3.178	3.664	3.932	4.543
Aid boat/Surv. fish captains	308	1.274	2.068	0.022	0.248	0.710	0.982	12
Access to boat workshop	342	0.582	0.494	0	0	1	1	1
High income_pre	341	0.290	0.455	0	0	0	1	1
High education_pre	335	0.143	0.351	0	0	0	0	1

Appendix 1.2 : Variable Definition

	Definition	Source
Aid	Takes 1 if household received a new boat from NGO or government/BRR, and 0 if not in 2007	2007/2009 Fishermen survey
Lobby	Takes 1 if household asked and requested for assistance from village government, prominent fishermen, village or fishermen council members, or Mullah to obtain boat, and 0 if not	2007/2009 Fishermen survey
Buy	Takes 1 if household obtained a new boat by own household money, relative or friend's money, or invest by borrowing from cooperative or other credit sources after the tsunami, and 0 if not	2007 Fishermen survey
Fish	Takes 1 if any household members works for fishing and 0 if not fish in 2007	2007 Fishermen survey
Log(fish revenue)	Log (values of total fishing catch in 2007)	2007 Fishermen survey
Fishing productivity		
D_big engine cap._pre	Takes 1 if boat engine capacity was above 23 HP/PK (average power) pre-tsunami and 0 if not	2005 Fishermen survey
D_large boat_pre	Takes 1 if household had a boat larger than 9 meter (average size) pre-tsunami and 0 if not	2005/2007 Fishermen survey
D_many crew_pre	Takes 1 if household hired more than five crews pre-tsunami and 0 if not	2005 Fishermen survey
D_tuna_pre	Takes 1 if catch positive amount of Tuna pre-tsunami and 0 if not	2005 Fishermen survey
Log (engine_pre)	Log (boat engine capacity pre-tsunami +1), in HP/PK	2005 Fishermen survey
Log (engine_post)	Log (boat engine capacity post-tsunami +1), in HP/PK	2007/2009 Fishermen survey
Property right		
Boat owner and Captain_pre	Takes 1 if household owns boat and was captain pre-tsunami , and 0 if not	2007 Fishermen survey
Arisan group_pre	Takes 1 if wife participated in Arisan group pre-tsunami and 0 if not	2005 Fishermen survey
Other covariates		
Outside option	log(number of total aid project+1)	RAN Database
Aid boats/Surv. Fish captains	Number of boat provided by aid agency by 2007/Number of survived fishing captains	2005 VH and 2007 PL survey
Access to boat workshop	Takes 1 if village had boat building workshop within lagoon	2007 PL survey
High income_pre	Takes 1 if weekly earning is more than Rp500,000 (US$50) pre-tsunami and 0 if not	2005 Fishermen survey
High education_pre	Takes 1 if household head's education level is above senior high school	2005 Fishermen survey

PL=Panglima Laot (Fisherman community), VH=village head

Table 1.3: Structural Estimates of Multinomial Logit

A. Rationing equation				
$\underline{a1}$				
Boat owner & Captain_pre	0.726**		0.872**	
	(0.348)		(0.422)	
Arisan group_pre		0.159		0.311
		(0.433)		(0.532)
$\underline{a2}$				
D_big engine cap_pre	-0.448	-0.562	-0.547	-0.696
	(0.398)	(0.409)	(0.470)	(0.470)
D_tuna_pre	0.590*	0.646*	0.849**	0.913**
	(0.356)	(0.377)	(0.419)	(0.433)
B. Return equation				
Lobby or Buy				
$\underline{b1}$				
Log (engine_pre)	0.855*	0.815*	0.720*	0.701*
	(0.446)	(0.442)	(0.420)	(0.415)
$\underline{\gamma 1}$				
Access to Boat workshop	-0.475	-0.425		
	(0.297)	(0.300)		
High income_pre			-0.243	-0.213
			(0.335)	(0.335)
$\underline{\gamma 3}$				
Access to Boat workshop	1.108**	1.145**		
	(0.544)	(0.544)		
High income_pre			0.136	0.157
			(0.478)	(0.478)
Not lobby				
$\underline{b2}$				
Outside option	0.229	0.136	0.269	0.164
	(0.325)	(0.328)	(0.331)	(0.337)
$\underline{\tau}$				
High education_pre	1.146**	1.303**	1.099*	1.276**
	(0.584)	(0.564)	(0.588)	(0.563)
Observations	278	278	277	277
Log-likelihood	-227.896	-230.220	-232.051	-234.292
Dummy: Pulo Aceh	YES	YES	YES	YES

Note : : *** p<0.01, ** p<0.05, * p<0.1. ; Estimation performed with fminunc procedure in MATLAB.

Table 1.4: Actual Allocation of Aid for Lobbyists

VARIABLES	(1) Aid	(2) Aid	(3) Aid	(4) Aid	(5) Aid	(6) Aid
$\underline{\alpha_1}$						
D_big engine cap_pre	-0.130*			-0.221***		
	(0.0761)			(0.0856)		
D_large boat_pre		-0.0579			-0.0414	
		(0.0822)			(0.0985)	
D_many crew_pre			-0.228**			-0.144
			(0.105)			(0.108)
D_tuna_pre	0.155**	0.139*	0.140*	0.186**	0.153*	0.153*
	(0.0760)	(0.0754)	(0.0761)	(0.0862)	(0.0839)	(0.0840)
$\underline{\alpha_2}$						
Boat owner & captain_pre	0.173*	0.173*	0.155*	0.251***	0.262***	0.247**
	(0.0898)	(0.0903)	(0.0912)	(0.0968)	(0.0957)	(0.0964)
Arisan group_pre	0.192**	0.200***	0.213***	0.200**	0.200**	0.207**
	(0.0774)	(0.0775)	(0.0783)	(0.0897)	(0.0904)	(0.0891)
$\underline{\alpha_3}$						
Aid boat/Surviving fish captains	0.0884***	0.0830***	0.0808***	0.170*	0.136	0.132*
	(0.0307)	(0.0285)	(0.0274)	(0.0901)	(0.0836)	(0.0796)
Observations	194	194	194	160	160	160
Kabupaten FE	YES	YES	YES	YES	YES	YES

Note : *** p<0.01, ** p<0.05, * p<0.1. ; Standard errors are Huber-White heteroscedasticity robust estimates. Estimates are marginal effects of probit regressions. Sample is restricted for those who lobbied for aid in 2007. In column (4)-(6), households in two kecamatans (Lhok Nga and Pulo Aceh) are excluded due to the excess supply of aid boats in these regions.

Table 1.5: Aid Efficacy on Fishing Revenue (Matching problem)

VARIABLES	(1) OLS	(1) MLE	(2) OLS	(2) MLE	(3) OLS	(3) MLE
$\underline{\beta_1}$						
Log (engine_pre)	0.231	0.225	0.261	0.208	0.205	0.211
	(0.163)	(0.144)	(0.174)	(0.150)	(0.177)	(0.147)
D_tuna_pre	-0.113	-0.258	-0.185	-0.326*	-0.109	-0.252
	(0.172)	(0.173)	(0.175)	(0.179)	(0.176)	(0.173)
$\underline{\gamma_1}$						
Aid	-0.579***	-0.0170	-0.723***	-0.158	-0.668***	-0.0880
	(0.182)	(0.223)	(0.198)	(0.223)	(0.249)	(0.288)
$\underline{\gamma_2}$						
Aid × Match	0.502***	0.582***			0.660**	0.654**
	(0.180)	(0.208)			(0.288)	(0.269)
Aid × Good match			0.668***	0.947***		
			(0.217)	(0.331)		
Aid × Fair match			0.648***	0.784***		
			(0.233)	(0.266)		
$\underline{\gamma_3}$						
Match					-0.160	-0.0845
					(0.246)	(0.206)
$\underline{\beta_2}$						
Log (engine_post)	0.393***	0.277**	0.385***	0.227*	0.426***	0.303**
	(0.0996)	(0.117)	(0.0963)	(0.127)	(0.123)	(0.132)
$\underline{\beta_3}$						
Age	-0.0114**	-0.0132*	-0.0124**	-0.0128	-0.0110**	-0.0131*
	(0.00559)	(0.00743)	(0.00553)	(0.00796)	(0.00554)	(0.00734)
Arisan group_pre	-0.0126	0.0552	0.0290	0.0895	0.0140	0.0678
	(0.157)	(0.187)	(0.157)	(0.199)	(0.167)	(0.187)
Constant	11.92***	11.46***	11.80***	11.32***	11.98***	11.52***
	(0.580)	(0.752)	(0.580)	(0.780)	(0.587)	(0.761)
Selection equation						
Outside option		-0.305**		-0.261*		-0.322*
		(0.155)		(0.135)		(0.168)
ρ		0.89		0.956		0.871
		(0.094)		(0.062)		(0.121)
Observations	135	284	135	284	135	284
Kabupaten FE	YES	YES	YES	YES	YES	YES

Note : *** p<0.01, ** p<0.05, * p<0.1. ; Standard errors are Huber-White heteroscedasticity robust estimates.

Chapter 2

The Impact of Disaster Aid Quality: Job Choice after a Natural Disaster

2.1 Introduction:

Helping regions recover from a natural disaster is one of the most challenging tasks that the international aid community faces today. In recent years, numerous natural disasters such as earthquakes, hurricanes, and tsunamis have struck around the world[1]. According to the World Bank (2006), a total of $26,281 million has been committed to 529 disaster assistance programs since 1984. The number of aid projects devoted to disasters has been growing. In the aftermath of such disasters, the resilience of the labor market is crucial for people whose most abundant asset is their labor. Therefore, aid programs which help the labor market recover are the key to the economic rebound of developing regions.

The 2004 Indian Ocean tsunami caused massive devastation in Aceh. It caused an estimated US$4.45 billion in damages, took more than 150,000 lives, and displaced an estimated 700,000 people (Brookings Institution, 2008). Following the tsunami, the region's economy saw a huge influx of humanitarian aid and a reconstruction boom to restore destroyed public infrastructure, funded by the Indonesian government and international agencies[2]. Between 2005 and 2009, aid agencies provided new boats to fishermen in Aceh. However, our village survey in Aceh shows a fall in the number of people working in the fishing industry, accompanied by a persistent increase

[1]Most recent natural disasters include the earthquake and tsunami in the Indian Ocean in 2004, the earthquake in the Sichuan Province of China in 2008, earthquakes in Haiti and Chile in 2009, and the earthquake and tsunami in Japan in 2011.

[2]The aid program was the temporary intervention for five years and mostly completed by April 2010.

in workers in non-fishing occupations (shown later in Figure 2.1). Why was the recovery of the fishing sector slow, while the non-fishing sector continued to expand? After the loss of jobs caused by the tsunami, how did international aid affect the occupational choices of Aceh's fishermen?

The goal of giving boats to the victims of this disaster was to assist the quick recovery of fishermen's livelihoods by replacing lost boats. It is unclear why, despite the assistance program, the fishing industry stagnated. To explain the puzzle, this paper focuses on the impact of one particular feature of the international aid effort - *the poor quality of aid boats* - on a worker's job decisions over time. As summarized in OECD (2011), aid quality and its reliability have been debated among international donors to improve the performance of foreign aid[3]. However, how aid quality matters for economic recovery and the well-being of households after natural disasters was not empirically investigated in the previous literature. I use the unique variation in aid quality available in the field data to answer this question.

I hypothesize that the sluggish recovery of the fishing sector can be largely explained by the effect of the unpredictable *quality* of aid boats on individual job decisions. Previous literature focused on the unpredictable *quantity* of aid inflows, which made long-run career planning difficult (Bulir and Hamann, 2008). Since in-kind support through aid efforts was of imperfect quality, I also hypothesize that the development of private transaction could help fishermen undo the quality problem by self-financing a boat through private market transactions[4].

The paper provides a framework for understanding how the imperfect quality of aid boats interacted with fishing productivity and affected individual-level labor supply behavior. In my framework, the problem of boat quality impacted the labor market in two stages through two different channels. In the initial stage of aid intervention, the provision of unusable boats to villages resulted in the lack of fishing opportunities. This had an adverse equilibrium effect on the compensation for crew, which decreased the supply of fishing workers. In the later stage, information on the actual quality of aid boats was revealed to households. If the boat became unusable in a year, individuals were forced to adjust their job ex-post. A household could also purchase a high-quality boat from private vendors instead of relying on the aid boats, which could be of poor quality.

[3]See the OECD-DAC website on aid effectiveness for details. Increasing the predictability of aid quality requires closer scrutiny to meet the Accra Agenda for Action endorsed in 2008. The Fourth High Level Forum on Aid Effectiveness (HLF-4) in Busan will provide an opportunity for the international community to reach a consensus on how to improve the quality of aid in the future.

[4]In the context of Aceh, a household seeks to utilize local resources, buying boats from the local boat market, and through rental market transactions.

This framework is supported by empirical evidence. As discussed in FAO (2005), a significant number of boats provided by aid agencies were clearly unusable from the beginning. The limited supply of operational aid boats resulted in fewer fishing opportunities. Those who did not receive aid boats competed with other non-owners to be crew, or chose market job opportunities. Many aid boats that were initially usable fell apart within a year and became unusable. Owners of such boats had to decide whether to continue fishing or choose other sectors.

This paper empirically tests two hypotheses by examining labor supply and self-financing behavior over the period of aid intervention. I first divide the sample into boat owners and non-owners in 2007 using 2007 survey. I then compare the effect of village-specific quality of aid boats on fishing decisions between boat owners and non-owners. As expected, fishermen without boats were adversely affected. This paper finds that a 1% increase in bad boats in the village decreases the probability of fishing for non-owners by 47 percentage points, but does not find significant effect for owners' decision. It also finds that the adverse impact of the quality problem was differentially larger for productive fishermen than unproductive fishermen. Using the 2009 survey, I examine whether job switching occurred between 2007 and 2009 after owners discovered that their boats were unusable. I find that fishermen who discovered that their aid boat was unusable were 14% more likely to switch to non-fishing jobs in the later years than those who did not face any quality problem.

I also find that there were fishermen who self-financed own new boat in response to the ex-post individual-specific quality shock. In general, the self-financing strategy became more common choice in 2009 than 2007 as local markets became easier to access in later years. The finding implies that during the recovery process after a disaster, it is important not only to improve the quality of aid intervention, but also to develop local market transactions.

This paper relates to the literature on the adverse impact of a natural disaster on risk-averse agents' labor supply decisions to cope with the shocks (Rose, 2001; Jayachandran, 2006; Mueller and Quisumbing, 2009). This paper focuses on the effect of an in-kind aid program on the local labor market rather than on the impact of a natural shock[5].

The framework of this paper has two unique aspects. First, the effect of aid quality on the labor market worked through two channels: (a) by decreasing fishing opportunities for non-owners during

[5]There are papers which study the economic impact of development programs. For example, Chen, Mu, and Ravallion (2009) examines lasting income gains due to the rural development program in China. However, previous papers on natural disasters usually focus on the exogenous shocks caused by the disaster, and there appears to be less focus on the economic impact of a disaster-relief program.

the initial stage of intervention and (b) by creating an adverse technology shock for boat owners during the later stage of the intervention. The first channel is related to papers on the equilibrium impacts of in-kind transfer programs on the labor market (Cunha, Giorgi, and Jayachandran, 2010; Attanasio, Meghir, and Santiago, 2011) and on consumption (Angelucci and Giorgi, 2009). The second channel relates to the risk-coping strategies of households responding to exogenous shocks such as natural disaster and economic crisis (Skoufias, 2003).

Secondly, the framework I adop allows for two types of adjustment decisions by households in response to the provision of poor-quality boats: (a) switching jobs in the labor market and (b) self-financing a boat through a private market transaction. There are a few papers which study the self-selection decision for higher quality goods[6]. In the context of natural disasters, Smith et al. (2006) examines who moved their residential areas after Hurricane Andrew in the United States. As recent work by Hamory and Miguel (2009) shows, the scarcity of household-level panel data in developing countries makes it difficult to empirically track labor decisions over time. I use the unique household-level panel data we collected in post-tsunami Aceh and examine how aid quality affected job decisions at the two margins over time.

The paper is structured as follows. Section 2.2 provides background information. Section 2.3 presents the theoretical framework and Section 2.4 provides descriptive statistics. The empirical analysis is presented in two parts. Section 2.5 examines job choice in the initial stage. Section 2.6 examines job switching behavior in the later stage. Section 2.7 concludes.

2.2 Background

2.2.1 Data

Data comes from field surveys of fishing families, village heads, and heads of *Panglima Laot* (fisherman associations), which were conducted in 2005, 2007, and 2009. The number of households surveyed in each wave is different.

We surveyed 534 households in 2005 and of those, 366 households were re-surveyed in 2007. The 366 households (called *original sample* hereafter) form the baseline sample. The baseline sample is used to analyze factors affecting initial job decisions in 2007 in Section 2.5.

[6]For example, Jacoby (1997) finds that variation in the quality of an in-kind transfer in Jamaica caused the rich to buy unsubsidized goods in the private market rather than using the school feeding program. The paper assumes that the transaction cost of buying private goods is zero, so it is costless for people to self-select into buying unsubsidized goods. My model generalizes this assumption by considering the transaction cost of buying a boat in a local workshop.

In the second round of the survey in 2007, we added 151 new fishing families to our original sample; these families had never owned a boat before the tsunami[7]. We also added 288 previous owners who were fishermen in 2007. These 288 fishermen lived in the 13 fishing villages in Aceh Jaya (which is the *kecamatan* with heavy devotion to fishing) located beyond the originally surveyed villages. These additional households were chosen randomly from lists provided by the local heads of the fishermen's associations. By construction, these additional sample of 439 households should have been fishing in 2007, but 50 did not report catching fish in 2007. Therefore, I dropped 50 observations, which leaves 389 households in the additional sample. Of the 389 households, we could only follow 244 in 2009. We added these to the 358 households which we could match for all three years, and linked 602 families (called *additional sample* hereafter) between 2007 and 2009. I use this two-year household panel to examine the job switching behaviors from fishing to other sectors in 2009 in Section 2.6.

I mainly use the labor module of the 2007 and 2009 household surveys. The labor section includes information on work activity (e.g, primary vs. secondary jobs, full-time vs. part-time jobs, hours of fishing, and number of fishing trips). I also use modules on family structure and village affairs from the 2005-2009 household surveys.

In this background section, I also use modules in surveys of village heads and heads of fishermen's association. The information includes village economic activities, number of boats and relief agencies, boat aid (including boat quality), current fish marketing system, post-tsunami public investment projects (such as house, infrastructure, school reconstruction) and the like.

2.2.2 Village recovery and labor market developments

The 2004 Indian Ocean tsunami destroyed physical capital (such as fishing boats, infrastructure, and coastal environments) and created a huge loss in human capital. Table 2.1 summarizes basic evidence from surveys of village heads and prominent fishermen. The northwestern regions of Aceh (such as Kuta Raja, Meuraxa, and Syiah Kuala) experienced huge human loss, but quickly recovered in the later years. Notably, population increased rapidly in a few *kecamatans* (such as Baitussalam, Reupung, and Meuraxa)[8].

During the recovery, foreign aid changed the village situation by replacing fishing boats and reconstructing lost physical capital. There were many funds and organizations involved in this

[7] Aid agencies aimed to give these families a chance to be first time boat owners after the tsunami.

[8] In Indonesia, a sub-district (*kecamatan*) is a subdivision of a district (*kabupaten*). Sub-district are divided into villages (*desa*).

historic disaster. Based on the damage assessment from each international agency, the Indonesian government enacted a reconstruction program between 2005 and 2010. The program put more emphasis on sectors such as housing, transportation, health, and education. Following a presidential order, the government established a specialized agency (BRR) for managing and coordinating reconstruction efforts.

Aid efforts proceeded in three steps: (a) an emergency relief phase (0-6 months after the tsunami), (b) a planning and rehabilitation phase (6-12 months after the tsunami), and (c) a reconstruction phase (1-4 years after the tsunami). In the emergency relief stage, agencies administered cash-for-work (CFW) programs and provided living cost allowances to support the unemployed workers right after the shock (see Appendix 2.3 for details). When the emergency relief phase ended, the reconstruction of private housing and public buildings began in 2006.

Village-level evidence

Creating permanent jobs was an important challenge in the aftermath of the natural disaster. I examine how villages recovered employment opportunities during the aid intervention period. Many fishermen had lost their jobs as a result of the tsunami because their boats were destroyed, and the fishing reefs and mangroves were devastated. The underemployment rate went up to about 40% from the pre-tsunami level of 19%. Fishing and aquaculture, the primary industries of coastal villages, were most affected by the tsunami. During the six months after the tsunami, most households worked for CFW programs or were unemployed, which explains the largest share of workers in the "others" job category in 2005 in Figure 2.1.

Between 2007 and 2009, two changes occurred in the village: the fishing sector recovered and the non-fishing sector grew. Figure 2.1 shows the change in the fraction of workers in each of the four sectors. Each bar is the median value of employment shares in each sector from overlap sample of 71 villages, which were surveyed in all three survey rounds. Although the fishing sector recovered from the complete devastation of 2005, by 2009 it had declined.

On the other hand, the non-fishing industry continued to develop during the aid intervention period. Map 2 is a spatial distribution of the aid program by 2007. The map shows that aid boats were concentrated near the urban area in Banda Aceh: Baitussalam, Kuta Alam, Mesjid Raya, Leupung, and Lhok Nga. On the other hand, there were fewer projects implemented in Pulo Aceh (the remote island in Aceh Besar). The major component of aid was to rebuild infrastructure, namely. to reconstruct private houses and public buildings such as hospitals, schools, and mosques.

Reconstruction works were conducted by contractors hired by NGOs and the local government, or by volunteer laborers.

Although I cannot observe how many locals were hired by aid agencies, the number of projects and NGOs capture new job opportunities available for local labors in each village. This should have increased labor demand in the non-fishing sector, and I expect to see higher labor mobility into non-fishing jobs in these areas. Given the concentration of projects in urban areas, households in urban areas should have benefited from better opportunities in aid works.

The slow growth rate of the fishing sector is the motivation for examining household-level job decisions in this paper.

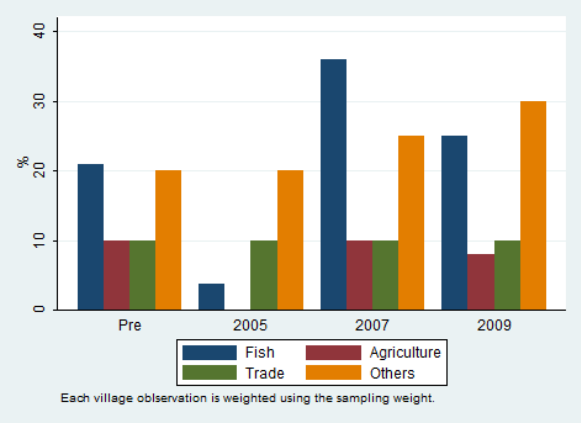


Figure 2.1: Change in occupational structure

Household-level evidence

Table 2.2 comes from the household survey and shows that there was a big shift from being a captain to crew in the fishing sector from 2007 and 2009. The shift implies that fishing opportunities for crew were limited in 2007. The fall in the number of captains in 2009 also implies that some shocks, which were specific to captains, occurred in later years. In this paper, I show that the change in household-level occupational structure can also be explained by the negative impacts of poor-quality aid boats.

Table 2.2 confirms that the distribution of workers became more diverse, and many former fishermen started working in non-fishing jobs. The number of people working in the trading sector and in the service sector increased. There were people who worked in the construction sector (mainly road and house construction) as well. People who worked in non-fishing jobs generally had higher education levels (above senior high school). Trading requires basic knowledge of business

Table 2.2: Breakdown of primary job of household heads

	2007	2009
Fish (Captain)	**381**	**305**
Fish (Crew)	**39**	**82**
Other fishing	3	10
Agriculture	23	50
Construction	25	21
Trade	**58**	**79**
Service sector	**23**	**31**
Unemployed	26	21
	579	599

(Note) Other fishing includes aquaculture and fish processing; trade includes fish related trader, coffee shop, retail shop, restaurant, transportation, and technician (boat builder, mechanics, plumber, electrician, carpenter); service sector includes private service (banker, administrative office), public service (government official, teacher, doctor, police), and manufacturing.

or accounting; these subjects are usually taught above the senior high school level in Indonesia. Higher education with fluency in English helped villagers find a job in the aid business.

2.2.3 Quality problem of aid boats

The problem of boat quality was crucial because fishing was the primary source of income for households. A report by FAO (2005) presented evidence that many aid boats were made of poor-quality wood (the wood was not properly dried), initially unusable (made of plastic), or improperly constructed (inappropriate joint of wood, broken bolt, cheap steel fastening). Occasionally, new fishing boats from donors sank. The poor quality occurred as a result of several factors: lack of quality monitoring by agencies, shortage of qualified boat builders, and a rush of boat orders with unrealistic delivery times[9]).

In our survey of prominent fisherman, we collected information about boat quality by asking about the number of non-operational boats in 2007. Figure 2.2 shows a histogram of the fraction of bad boats allocated by aid agencies and confirms that the quality of aid boats was a major concern in 2007.

Map 1 is a spatial distribution of the quality of aid boats. In the red areas, the quality problem was the most serious than in other areas. As the map shows, villages which experienced quality problem were clustered in specific *kecamatans* such as Jaya, Baitussalam, and Seulimmeum.

[9]FAO reports that it would take a boat builder 12 days to make a boat before the tsunami; the surge in demand for boats after the tsunami required that a boat be completed in one day.

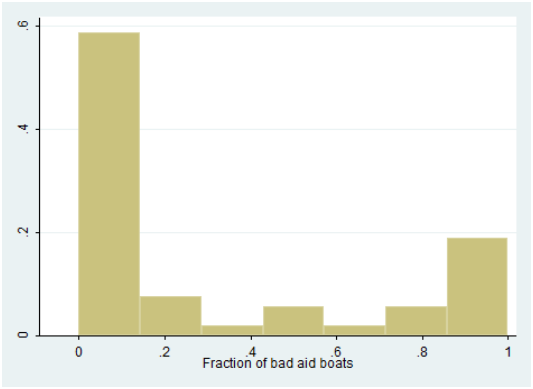


Figure 2.2: Histogram of poor-quality aid boats

Did the quality problem affect the labor market? Figure 2.3 divides villages into two groups: 34 villages had a major quality problem (right panel) and 37 villages had a minor quality problem (left panel). The figure shows the change in the fraction of fishermen separately for the two groups. I define villages as having a major quality problem if over 50% of boats in the village were bad. The figure demonstrates that aid quality had a lasting impact on the recovery pattern of the fishing population[10]. In villages with a major quality problem, fishing did not recover to the pre-tsunami level in 2007, and continued to decline in 2009. On the other hand, in villages with a minor quality problem, the fishing sector recovered to above the pre-tsunami level in 2007, but declined in 2009. This suggests that the aid quality problem arrived in two waves and negatively affected the growth of the fishing sector both in the short-run and in the long-run.

How did aid quality matter for household-level occupational choices? Aid boats were distributed over several years. In 2007, 36% of households in the sample received boats. In some places, a significant number of boats from international agencies were unusable, which limited fishing opportunities and caused people to leave the fishing sector.

Figure 2.4 presents a locally weighted non-parametric regression. It shows the association between the probability of fishing at the household level and the fraction of bad boats in the village in 2007. The line for non-owners slopes downward while the line for owners is somewhat flat[11]. This suggests that non-owners changed jobs because opportunities to work as a fishing captain

[10]In related works in the field of economic geography, wars were found to have no long-run impact on the city growth relative to prewar levels. The finding was reported for Japan after World War II (Davis and Weinstein, 2001), post-war Germany (Brakman et al, 2004), and Vietnam (Miguel and Roland, 2011). Although this paper only covers 5 years, Figure 2.3 suggests that there may be a lasting impact of aid quality on the fishing population. I investigate the mechanism how aid quality impacts on the labor market over time in this paper.

[11]The line for owners becomes slightly upward sloped as the fraction of bad boats increases in the village. This might be because owners include people who purchased a private boat.

were limited when most aid boats were bad. The flat line indicates that the quality problem at the village level did not negatively affect boat owners, who were the early recipients of aid boats or people who self-financed a private boat, because they could fish with the boats they owned. When bad aid boats increases in the village, owners may be willing to fish since hiring crew became cheaper for the excess supply of crew relative to limited demand from owners.

In 2009, even the boats which were initially usable were revealed to fall apart. It takes time for owners to experience and understand the actual quality of a boat. Boat owners made a job decision based on the actual quality of a boat ex-post.

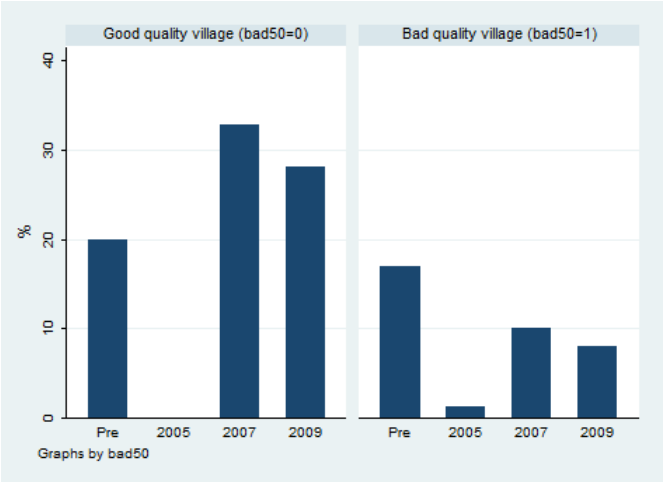


Figure 2.3: Change in fishing sector (Good vs. Bad quality villages)

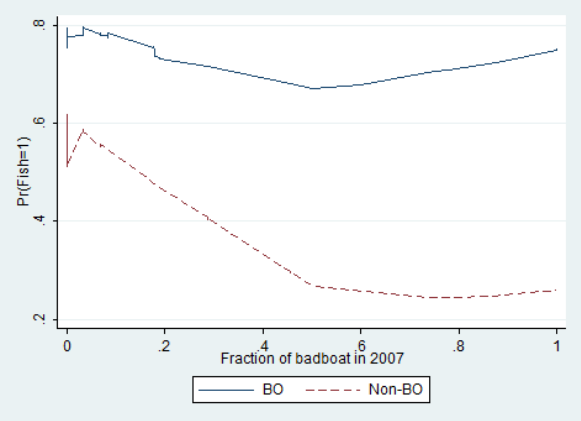


Figure 2.4: Relationship between fish decision and supply of poor-quality boats

2.3 Theoretical framework

In this section, I use a labor demand and supply framework to analyze how the change in the fishing sector came about at the village-level. Figures 2.1 and 2.3 show that the recovery of the fishing industry was slow in both the initial and later stages, especially in places where there was a major quality problem with the quality of aid.

I describe the situation where the provision of poor-quality boats affected the labor market in two stages. First, aid boats could have been unusable in the initial stage. Second, owners of aid boats could have discovered that their boats were unusable in the later stage. Since a boat is an experience good (Nelson, 1970), recipients of aid boats could not have fully predicted the actual quality of aid boats ex-ante. They learned the true quality through their experience on the ocean.

First, I examine the association between village-specific quality shock and fishing decision in the initial stage. Second, I examine whether owners of aid boats switch their jobs or self-finance private boats in response to individual-specific quality shocks in the later stage.

Fishing is conducted in a team which consists of a captain and crew. The captain needs a boat and hires a crew. The fishing market clears when the labor demanded by captains equals the labor supplied by crew. I assume that Aceh is a closed economy right after the tsunami, so the labor market is segmented at each village.

2.3.1 Supply effect in the short-run

In the immediate aftermath of a tsunami, agencies need to quickly deliver boats to households. As a result, many boats are constructed in poor quality (Figure 2.2). When the number of unusable aid boats, B, increases, and there are a total of N aid boats in the village, there are only $N - B$ good aid boats available. Therefore, there are $N - B$ owners of good aid boats and a fixed number of fishermen, X, who purchase private boats and hire crew. If a household owns a boat, it can fish and its fishing decision is unaffected by B.

The fishing production function depends on boat quality Q and the number of crew h: $y = Qf(h)$. Boat owners need to pay each crew member α. Owners maximize profit, written as $\pi = Qf(h) - \alpha h$, by choosing the optimal number of crew h^*. Profit is maximized at the point where the marginal product of labor is equal to the compensation for crew members: $f'(h) = \frac{\alpha}{Q}$. Then, the aggregate labor demand L_D, which is the total job opportunities for non-owners, is

defined as follows:

$$L_D = [(N - B) + X]h^*(\alpha, Q) \tag{2.1}$$

The labor demand curve is downward sloping since $\frac{\partial h^*}{\partial \alpha} < 0$. Those who cannot receive aid may find an opportunity to be crew members. Labor supply L_S depends on the compensation for crew, α.

$$L_S = l(\alpha) \tag{2.2}$$

The labor supply curve is upward sloping since $\frac{\partial l}{\partial \alpha} > 0$. The labor market clears with equilibrium compensation for crew α^* when $L_D = L_S$.

As B increases, the labor demand curve shifts down, which limits fishing opportunities for crew (Figure 2.5). People who do not own a boat need to compete with many other non-owners for limited opportunities to work as crew. This makes people more willing to opt out of fishing and reduces labor supply of crew to L_1.

$$\frac{\partial L_S}{\partial B} < 0 \tag{2.3}$$

I call this the negative *supply effect* of village specific quality problem on the individual labor supply decision.

The magnitude of the negative supply effect will be larger when the compensation wage α stays at the same level, and will reduce labor supply of crew further down to L_2. This is likely when the labor supply adjusts elastically and the supply curve shifts up in response to the increase in B (as shown in Figure 2.5)[12].

Alternatively, when the number of poor-quality boats B increases and the number of owners of good boats decreases in the village, non-owners may try to share limited fishing opportunities with each other. Villagers may share fishing opportunities to mitigate the negative village-specific quality shock, especially if they have stronger motives for mutual assistance. In such as situation, the labor demand curve will not shift down as much when B increases, and I expect that $\frac{\partial L_S}{\partial B} = 0$.

Entire villages are affected by the village-specific quality shock, but who is affected most by the quality shock[13]? I expect that the supply effect is heterogeneous depending on individual fishing

[12]In a different context, Cunha, Giorgi, and Jayachandran (2010) compars the price effects of cash and in-kind transfer programs in Mexican villages (i.e, Programa de Apoyo Alimentario (PAL)). The two programs have opposite price effects on the food market due to the difference in supply elasticities. Difference in price elasticities also has opposite distributional impacts between producers and consumers.

[13]The equilibrium effect of aid programs has been analyzed by previous papers. Angelucci and Giorgi (2009) analyze the effect of Progressa in Mexico. They argue that not only did those eligible for the program benefit, even those ineligible for it indirectly benefited from it.

productivity λ. As discussed by previous papers (Murphy, Shlefer, and Vishny, 1991; Grossman, 2004), productive fishermen are not willing to work as crew if their skill is not be properly rewarded[14]. Based on this theory, I expect that the labor supply curve for productive fishermen is flatter and the intercept is above the labor supply curve for unproductive fishermen (Figure 2.6). I expect that productive fishermen are differentially more likely to opt out of fishing than unproductive fishermen.

$$\left.\frac{\partial L_S}{\partial B}\right|_{\lambda_H} > \left.\frac{\partial L_S}{\partial B}\right|_{\lambda_L} \tag{2.4}$$

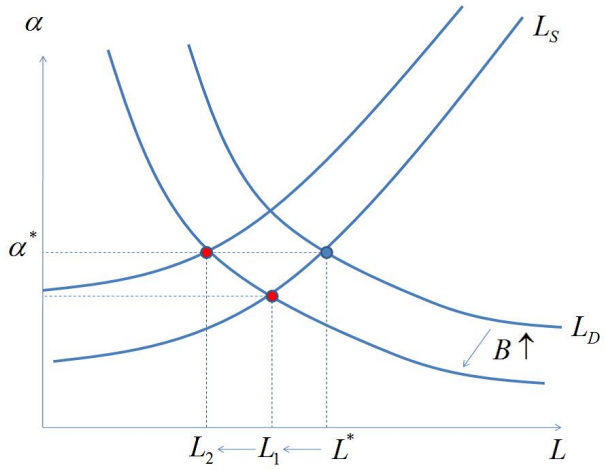


Figure 2.5: Equilibrium effect of aid quality

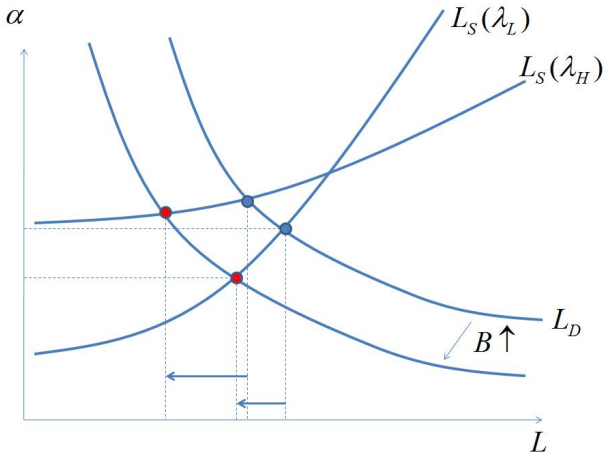


Figure 2.6: Heterogeneous effect by productivity

2.3.2 Realization of actual quality in the later stage

In the later stage of aid intervention, the allocation of boats is complete. In this stage, boats which were usable in the initial stage may fall apart and become unusable. In other words, the quality of boat Q is revealed to be either low or high ($q \in \{q_L, q_H\}$) ex-post. This unpredictable quality shock occurs at the household level, which negatively affects the fishing decision of boat owners. As shown in Appendix 2.1, the number of households that reported a quality problem in 2009 had doubled from 2007. This evidence supports the assumption that actual boat quality could not be fully anticipated when people received boats from aid agencies in 2007.

Given this household-specific quality shock, in the model, owners of aid boats may switch their job from fishing to non-fishing sector in the later stage.

[14]These papers argues that talented agents prefer not to work in a team for two reasons. First, returns by working as crew members are lower compared with their fishing ability because of the imperfect labor contract. Second, the fishing industry is small and fishing jobs are not as attractive as non-fishing jobs.

The empirical sections test the theoretical prediction that there was a negative impact of aid quality on household job choices in the two stages.

2.3.3 Substituting a poor-quality boat through private transactions

Previous paper (Nose, 2011) has suggested that households may have purchased a locally produced private boat rather than relying on aid boats. Households can purchase a boat to cope with the uncertain probability of getting aid or with the uncertain quality of aid boats. If these uncertainties drive the household to self-select into a local market transaction, I also expect the number of people who self-financed a boat, X, to be larger when village-specific poor-quality boats B (in 2007) or individual-specific poor quality q (in 2009) is larger in each period.

$$\frac{\partial X}{\partial B} > 0 \quad \text{if quality matters in 2007} \tag{2.5}$$

$$\frac{\partial X}{\partial q} > 0 \quad \text{if quality matters in 2009} \tag{2.6}$$

In later sections, I empirically test whether fishermen actually self-financed a locally produced boat. After the devastation by the tsunami, the access to local markets should have been limited. I expect people to be less likely to self-finance a boat if the transaction cost I of the private transaction is high.

$$\frac{\partial X}{\partial I} < 0 \tag{2.7}$$

As the economy recovers from the tsunami, I expect I to decrease, which allows more fishermen to self-finance a boat. I also test this prediction in the following section.

2.4 Data and summary statistics:

Summary statistics for the original sample (2005-2007) and the additional sample (2007-2009) are reported in the appendix. There were more fishermen in the additional sample than in the original sample since the additional sample includes new boat owners who were fishing in 2007. Given the sampling scheme of the 2007 survey, there was no job choice for new boat owners, so the original sample of 366 households is used to examine job choice in 2007. In the original sample, people who worked in the fishing sector as a primary job declined from 58% in 2007 to 56% in 2009. If I include those who were fishing as a secondary job, people who reported fish catch declined from 63% in

2007 to 61% in 2009. I use the additional sample to study job switching behaviors from 2007 to 2009 in section 2.6. In the additional sample, the fishing population similarly declined from 70% in 2007 to 64% in 2009.

In the original sample, only 36% of 366 households received a new boat from an NGO in 2007. Since the additional sample covers new boat owners who could get aid boats from NGO, the coverage of aid is at 55%, which is much higher than in the original sample. In this sample, aid beneficiaries increased to 70% between 2007 and 2009. On the other hand, about 11% of households purchased a boat in 2007, which almost tripled to 29% in the additional sample in 2009. The increase was partly explained by the quality issue. Those who received a poor-quality aid boat seemed to buy a new one between 2007 and 2009.

In the original sample, 25% of aid boats were unusable in the village in 2007. At the household level, only 9% actually received poor-quality aid boats by 2007. Although the failure rate of aid boats was high at the village level in 2007, it was very low at the household level. This statistical gap arose because village leaders did not distribute unusable boats to households. By 2009, the fraction of households whose aid boats became unusable jumped up to 19%. The failure rate almost doubled at the household level as they learned that boats which were initially usable broke down by 2009. The quality issue was found to be especially serious in the Jaya area (shown in the lower panel of Table 2.1).

The table also shows household demographic attributes. Only 15% of people in the original sample had above senior high school education. Even after the tsunami, 20% of people were still obliged to repay their debts to *Toke Bangku*[15]. Since people lost most of their assets, their net wealth became negative if they held debt. Even if their net wealth was negative, fishermen who owed debts to middlemen needed to clear the debt by continuing fishing transactions with the middlemen. Such an informal credit contract constrained people in the fishing sector. In order to control the effect of a credit constraint on job choice, I use a dummy variable which equals one if people owned any other type of debt; the dummy shows that 14% of households owned debt in the original sample.

Finally, the average weekly earning for 570 fishermen was 436,579 Indonesia Rupiah, with a

[15] *Toke Bangku* is the middleman that plays an important role in coastal society as a marketing agent and a capital owner. During fish season, the middlemen buy fish from fishermen and sell it either to local fish market or to other place. Most of boat captains sell their fish catch to the middlemen. The middlemen also lend monies to fishermen to meet their various financial needs, such as household's daily consumption, purchasing boat and fishing gears, and the like. Fishermen are closely attached to middlemen due to this informal credit facility and their obligation to sell their catch to the middlemen.

large standard deviation. In the additional sample, 17% of fishermen lived in Banda Aceh, 13% in Aceh Jaya, and the remaining 70% in Aceh Besar.

2.5 Estimation 1: Short-run supply effect

This section estimates equation (2.8) to examine the supply effect of aid quality on the probability of choosing to be a fisherman in 2007:

$$P(y_{07,ivk} = Fish) = \Phi(\beta_0 + \beta_1 B_{iv} + \beta_2 \lambda_{iv} + \beta_3 w_v + \beta_4 X_{iv} + \mu_k) \tag{2.8}$$

where y_{07} equals one if household i in village v in *kabupaten* k chose to fish in 2007, and zero otherwise. B is the fraction of bad boats provided by NGOs in each village between 2005 and 2007. Among other covariates, λ is fishing productivity and w is a reservation wage. The length of a pre-tsunami boat, which captures the technological ability to operate a large boat, is used as a productivity measure. Since the reservation wage cannot be directly observed, the log of number of NGOs doing aid works is used as a proxy measure. X is other covariates, including pre-tsunami debt obligations to middlemen, other types of private pre-tsunami debt, the taste for fishing (which is captured by pre-tsunami boat owner and captain status), and higher education level of household heads (above senior high school). The regression also includes a *kabupaten* fixed effect, μ, to purge *kabupaten*-specific unobserved characteristics (such as the tradition of fishing, and cultural or social characteristics).

To account for seasonal working patterns (e.g., fishing in the peak season and farming in the slack season), all regressions include dummy variables for the months of interviews.

I divide the whole sample into boat owners and non-boat owners in 2007, and estimate equation (2.8) separately by boat ownership status. From theoretical predictions in equation (2.3), I expect $\beta_1 < 0$ for non-owners only.

The fraction of bad aid boats is randomly distributed across villages within each *kabupaten*. This helps identify the village-specific quality effect on fishing decision. The Huber-White robust standard error is used to allow for heteroschedasticity in all regressions in the following sections.

Results are reported in Table 2.6.

2.5.1 Basic results

Owners in 2007

By 2007, 49% of households had a boat. Boat owners in 2007 include the recipients of aid boats as well as people who self-financed a boat in the local market. Among boat owners, 74% chose to fish in 2007 and their decision was not significantly affected by the fraction of poor-quality boats at the village level as shown in column (1). These people already owned a fishing boat and did not concern the possibility that their boats could potentially become not usable in the later stage.

The high utilization rate of aid boats is also explained by the social imperative that those who received aid boats should work with them. Since boats are a valuable asset for fishermen, recipients of aid boats sometimes faced strong social envy from other villagers as we found in the field study. There was strong social pressure to use the boats to catch fish and not sell them in the secondary market.

The positive estimate of pre-tsunami debt to the middlemen implies that fishermen could not exit from the fishing sector if they owed a contractual obligation to repay debt to the *Toke Bangku*. Since debts need to be paid back by fish, defaulted fishermen were required to continue fishing with boats given from aid agencies[16].

Non-owners in 2007

The poor quality of aid boats did matter for non-boat owners. As described in the model, there were two ways that non-owners could fish: by working as a crew or by self-financing a private boat and fishing as an owner.

In column (2) of Table 2.6, a unit increase in the fraction of bad boats reduces the probability of fishing by 36.3 percentage points. An increase in the supply of bad aid boats decreases the number of owners of aid boats who hired crew. It can be seen that as job opportunities to work as crew became more limited, the excess supply of crew creates downward pressure of the compensation for crew. If crew cannot share the limited fishing opportunities, non-owners had stronger incentives to choose not to fish.

In column (3), I add the number of surviving captains after the tsunami since it captures labor demand for crew from captains. As expected, the variable is positively signed. The negative effect

[16]This type of interlinkage between borrower (in my case, fishermen) and lender (*Toke Bangku*) through informal trade-credit arrangement are widespread for agricultural economies in many low-income countries (Bell, 1988). When borrowers default on their contractual obligations, lenders have various options such as bonding labor and extracting resources of borrowers.

of bad quality becomes larger in magnitude (-46.9%) and is still significant at 99%.

In column (4), I replace the continuous quality measure with two dummy variables: one dummy equals one if there were no bad boats in the village and the other dummy is one if more than 50% were of poor quality. There may be non-linearity in the effect of aid quality, and the negative marginal effect could become larger in magnitude when the fraction of bad boat is above 0.5. The result shows that the marginal effect of a dummy of the fraction bad boats>0.5 is -26.8% (significant at 90%). It confirms that the negative impact of aid quality on fishing decision was larger if the majority of aid boats were of poor quality. On the other hand, a dummy of the fraction of bad boats=0 is insignificant.

As a robustness check, I drop unemployed people from the sample in column (5). The negative effect is -49.6 percentage points (significant at 99%). In column (6), I changed the definition of the outcome variable. In this specification, fishing does not have to be a primary occupation. As long as any family member is engaged in fishing, households are defined as fishermen since they continued some fishing activities. Even when I use this outcome variable, the village-level quality variable has a large negative marginal effect of -47.4% and is significant at 99%. Finally, I replace the fraction of bad aid boats with the logs of number of good and bad aid boats in column (7). Even in this specification, 1% increase in number of bad aid boats reduces the probability of fishing by 19.4% (significant at 99%).

The number of NGOs variable is negatively signed, and the effect is statistically significant. As NGOs become more concentrated, more people get a chance to work for aid agencies in the non-fishing sector. The negative sign on the *other debt* variable also indicates that financing fishing activity was harder if non-owners had debt.

2.5.2 Effect of aid quality on compensation for crew members

My theoretical model considers the situation where a village-specific quality shock shifts the labor demand curve down, which could reduce the equilibrium compensation for crew members. When the compensation for crew does not change in response to the shock, the theory predicts that the labor supply is more elastic, which leads to a further fall in crew employments to L_2 in the equilibrium.

In our survey, we asked fishermen leaders about the average compensation (in Indonesian Rupiah) to each crew member in 2009. Unfortunately, we did not collect compensation data in 2007. Assuming that compensation stayed at a similar level between 2007 and 2009, I regress the log

of compensation for crew in 2007 on two village-level variables: total aid boats per captains and fraction of bad aid boats in 2007 by OLS.

$$\ln(wage_{vk}) = \beta_1 \times Supply_{vk} + \beta_2 \times Quality_{vk} + \mu_k \tag{2.9}$$

where v denotes village and k denotes *kecamatan*. I control for *kecamatan* fixed effects μ_k to account for the regional differences in compensation for crew. The result is reported in Table 2.3.

Table 2.3: Equilibrium wage effect of aid quality

	Ln(wage for crew)
Aid boats/Surv. fish captains	0.045**
	(0.023)
Fraction of bad aid boats in 07	0.154
	(0.210)
Observation	80
Kechamatan FE	YES

(Note) *** p<0.01, ** p<0.05, * p<0.1.; OLS regression for 80 villages, where 602 fishermen lived. Standard errors in parenthesis are clustered at the village level.

The increased supply of boats from NGOs increased labor demand from boat owners much faster than the increase in the supply of crew. This led to a higher level of equilibrium compensation for crew in 2007.

On the other hand, the increase in the fraction of bad aid boats did not have a significant impact on compensation for crew. This implies that the labor supply of crew was elastic, and non-owners could make adjustments by finding new jobs when the village-specific quality shock B increased (as shown in Table 2.6). This led to a further fall in fishing employment, keeping the compensation for crew a similar level in equilibrium.

2.5.3 Alternative story: forward-looking effect of the quality of aid boats

Does the negative estimate of β_1 in equation (2.8) mean the supply effect? There is an alternative story for interpreting this. That is to say, non-owners in 2007 might have expected a higher likelihood of receiving a bad boat if many aid boats delivered by 2007 were of poor quality. Since the size of village was quite small, they could see the quality of neighbors' aid boats. If there was social learning that many boats were of poor quality, this could have reduced the expected return

to fishing and made people more likely to choose non-fishing job[17],

To know whether people's expectations of aid were affected by village-level boat quality, I estimate the probability of lobbying for aid[18] conditional on the quality variable. The coefficient is -0.022, but is not statistically significant. This suggests that poor boat quality affected the fishing decision by limiting the supply of good boats, but did not change expectations of the quality of boats in the future. I do not find evidence that villagers planed on future quality in 2007 and optimized their job decisions from 2007.

2.5.4 Heterogeneous response by fishing productivity

This section analyzes who was affected by the quality of aid boats. Equation (2.4) in the theory section implies that productive fishermen should be differentially more affected by the quality problem.

I estimate differences in the supply effect of aid quality between productive and unproductive fishermen. I use two fishing productivity measures: length and engine capacity of pre-tsunami boats[19]. I use the sample of non-boat owners and add an interaction term of village-level quality with fishing productivity measures.

In Table 2.7, column (1) uses the log of pre-tsunami boat length and column (2) uses the log of pre-tsunami engine capacity as productivity measures. In column (1), the marginal effect of the interaction term is -1.086 (significant at 95%). Since the average of the log of boat length is 2.237, the total negative effect of the fraction of bad aid boats is 1.897-1.086×2.237=-0.532. As the fraction of bad aid boats increases, people who used larger boats pre-tsunami are 85% less likely to choose fishing. Similarly in column (2), the marginal effect of the interaction term is -0.651 (significant at 95%). Since the average of the log of engine capacity is 3.170, the total negative effect of bad aid boats is 1.391-0.651×3.170=-0.673. This result confirms that productive fishermen were differentially more affected by the supply effect of aid quality based on the alternative productivity measure.

As discussed in the theory section, the negative supply effect matters more for productive fishermen because they did not want to work as crew when fishing opportunities were limited in

[17]There is a rich literature in development economics that studies the role of social learning in acquiring information for optimal decisions (Foster and Rosenzweig, 1995; Munshi, 2004; and Conley and Udry, 2010).

[18]I use the same variable defined in Nose (2011). *Lobby* is a dummy variable which equals one if households received aid boats by requesting the assistance from the heads of villages or fishermen associations to obtain a new boat.

[19]Households are defined as productive if they worked with bigger boats before the tsunami, even if they worked as crew.

the village. Being a crew will not give them sufficient compensation to reward their productivity if profit is not properly shared within the team based on their fishing ability[20].

The differential effect is graphically shown in Figure 2.7. It shows that as the supply of bad aid boats increases, the probability of fishing goes down much faster for the high productivity group than for the low productivity group or for boat owners. The difference in marginal effects between the productive and unproductive groups becomes larger when more than half the aid boats are in poor quality. As a result, the average productivity level is lower in the villages with major quality problem than the villages with minor quality problem.

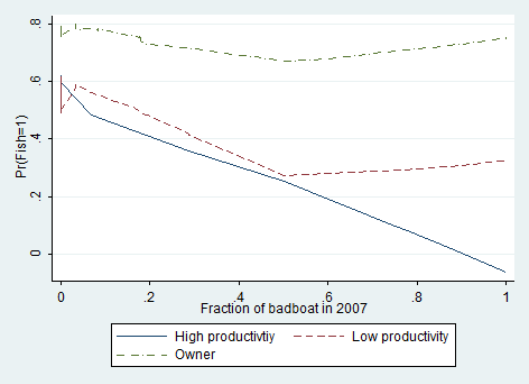


Figure 2.7: Relationship between fish decision and quality by fishing productivity

2.5.5 Self-financing a private boat in 2007

Table 2.8 examines whether people had an incentive to invest in a boat sold in the local boat market. Based on the equation (2.5), the theory predicts that fishermen might substitute poor-quality aid boats with a locally produced good boats in 2007. Equation (2.7) predicts that households should have a stronger incentive to self-finance a boat if the transaction cost I is low.

Column (1) shows that the decision to buy a boat was not statistically related to the village-specific failure rate of aid boats in 2007. This means that people's expectations of aid quality were the same across villages in 2007. On the other hand, the total number of aid boats per boat captain variable was -2.5% (significant at 99%). This means that self-financing was more likely if the total supply of aid boats was limited in 2007.

Other variables are signed as expected. A positive estimate of the previous large boat dummy

[20] Alternatively, productive fishermen were differentially more affected by boat quality simply because they had better outside options in their village since they also had higher education. Although it is hard to distinguish between the two interpretations, I consider it more likely that productive fishermen simply did not want to work as crew.

indicates that productive fishermen had a stronger incentive to self-finance a locally produced boat. The negative coefficients on the log of distance to Banda Aceh implies the buying a boat was an easier option near urban areas where many market opportunities were available and the transaction cost was low.

In column (2), the interaction term of the quality variable and fishing productivity are added. The interaction term is not significant, implying that even productive fishermen were not induced to self-finance a boat as the number of bad aid boats increased.

Next, I examined whether credit or other household characteristics affected the decision to self-finance. However, whether or not households had a saving account in village credit institutions (credit union, bank) pre-tsunami did not significantly affect the buying decision (therefore, it is not reported in the table). In column (3), I included a dummy variable which equals one if a household head had a position in the village government, fishermen's association, or religious group before the tsunami. It increases the probability of self-financing by 14.9% (significant at 95%). The result implies that those who had higher political status had a better access to the boat market to purchase a boat in 2007.

As a final test, I investigated whether the price of a boat affected the self-financing decision. I simply included the log of the average price of boats at the village level as a right hand side variable in column (4). The result shows that the decision was not significantly affected by the price, keeping the estimates of other covariates unchanged.

2.6 Estimation 2: Ex-post quality shock to owners

2.6.1 Evidence of job switching

This section analyzes job switching behavior after people discovered actual boat quality. Table 2.4 shows a cross tabulation which describes the pattern of people's career transition[21].

Table 2.4: Transition matrix of occupations

	Fish in 09	Not fish in 09	
Fish in 07	**314**	**106**	**420**
Not fish in 07	73	109	182
	387	215	602

[21]In the data, their primary jobs in 2007 and 2009 are observed, but people's entire career history (how frequently people changed jobs between 2007 and 2009) is not observable. Therefore, the paper focuses on job transition between two time points in 2007 and 2009.

Several factors affect the job switching decision. First, non-boat owners in 2007 may have chosen to start fishing if they got an aid boat by 2009. Second, those who became owners of aid boats by 2009 would have to decide whether or not to fish after discovering the actual quality of aid boats ex-post. Therefore, I expect that receipt of poor-quality aid boats additionally reduced fishermen in 2009, unless they could self-finance a private boat.

The change in village market conditions was also an important determinant of the job switching decision. The data tells us that rebuilding infrastructure improved marketing channels of fish across villages. For example, exporting fish to other areas wase more popular in 2009 than in 2007. Although we cannot directly observe market transactions of fish, our survey collected information on the locations of major retail markets for fish. The following table shows the average score of the importance of each market location. The score ranges from 0 (least important) to 4 (most important). The table shows that market transactions with different lagoons or places further away from own community became more important in 2009. Exporting fish outside Aceh (such as to Medan) or other countries gained importance. I control for this change in the market conditions by including a *kabupaten* dummy in the regression.

Table 2.5: Importance of selling market of fish

	2007	2009
Within the village	3.13	2.16
Other village in the same lagoon	2.66	2.53
Other village in the nearest lagoon	**1.74**	**1.92**
Further away (Medan, Banda Aceh, Melaboh, Malaysia etc)	**1.46**	**1.74**

(Note) Based on the field survey of heads of *Panglima Laot* in 2007 and 2009. Scores are computed after excluding missing observations.

The regression model for the job switching decision is defined as follows.

$$P(y_{09,ivk} = Fish | y_{07,ivk} = Fish) = \Phi(\beta_0 + \beta_1 q_{iv} + \beta_2 \lambda_{iv} + \beta_3 X_{iv} + \mu_k) \tag{2.10}$$

where q is the actual quality of aid boats; it equals one if the boat was discovered to be unusable and 0 otherwise. I am interested in the effect of q. If owners of aid boats learned that the actual quality of their boats was poor between 2007 and 2009, owners were obliged to switch out from fishing. Then, I expect to see $\beta_1 < 0$. λ is a household head's fishing productivity, measured by pre-tsunami boat length. X includes variables such as household head's education level and the

percentage of fishermen in each village. If there are more fishermen in the village, the fish market is bigger and more opportunities are available. Banda Aceh and Aceh Jaya dummies μ control for the *kabupaten*-specific factors such as market environment and unobserved regional differences (e.g., the strength of fishing culture, the stock of fish species).

As in equation (2.10), I estimate the fishing decision in 2009 conditional on those who were fishing in 2007. To identify the effect of actual boat quality on job choice, it is important to identify the groups which suffered from the aid quality problem. In column (1) and (2) of Table 2.9, I do not separate each group. In columns (3) and (4), I estimate the same model for two different samples: boat owners in 2007 (in column (3)) and owners of aid boats in 2007 (in column (4)). The realization of actual quality should matter for those who received aid boats from NGOs by 2009.

In the estimation, actual boat quality is assumed to be exogenously determined at the household level. Endogeneity is less of a concern since boats were not selectively assigned to households based on the quality. When aid agencies (or the intermediary such as a fisherman leader) allocated boats to people, they believed that the boats would match well with the local environment: they did not expect the boats to fail in a year or so. Households also did not anticipate actual boat quality when they lobbied for aid (as shown in Nose (2011)). Therefore, actual boat quality q is uncorrelated with error term.

2.6.2 Result

In column (1) of Table 2.9, receiving a bad quality aid boat reduced the probability of fishing by 20%. After adding *kabupaten* dummies in column (2), the magnitude diminishes to -12.2% since the poor quality variable and the Aceh Jaya dummy are positively correlated (visually shown in Map 1). However, the effect is still statistically significant at 95%. This implies that people changed jobs at the extensive margin if they actually received a poor-quality boats.

In column (3)-(5), I use the same model as in column (2). Column (3) shows estimates for boat owners in 2007. The quality variable is negative and the effect becomes -14.2%. In column (4), the sample is restricted to those who received aid boats by 2007. As expected, the negative effect increased in magnitude to -14.9%.

Column (5) includes a dummy variable of new boat owners to correct some bias by mixing the samples of previous and new owners. The new boat owner dummy is negatively signed, which implies that first time boat owners were less likely to continue fishing in 2009. Even in this

specification, the quality effect is -12.6% and remains significant at 95%.

There are some other variables which matter for the job switching decision. Those who were boat owners and captains before the tsunami had a stronger taste for fishing, and were more likely to continue fishing in 2009. The marginal effect is large. The positive coefficient on percentage of fishermen in the same village captures the positive externality of working with more fishermen. Since fishermen work in a team, it shows a positive spill-over effect among them as interaction in a fishing team increased. Finally, those living in Banda Aceh were much more likely to fish in 2009. This reflects evidence that Banda Aceh had a more open fishing market, and actively exported fish with higher profits.

In addition, I checked a different type of quality concern: the matching problem of aid boats. Did people switch jobs if the new boat did not match their previous boat, or did they learn how to use the mis-matched boat? In column (6), I added two mis-matching indexes: (a) *D_not exact match*, which is one if people received a new boat from NGOs whose type was different from the boat they used before the tsunami, and (b) $|Diff\_length|$, which is the absolute difference in boat lengths between the pre-tsunami boat and the new boat[22]. Both variables are insignificant. This suggests that people continued fishing although the type of new boat was different from what they actually wanted. As shown in Nose (2011), the mis-match in boat type temporarily reduced fishing revenues in 2007. However, it did not make fishermen switch to a non-fishing job. The situation was different when the boat was of poor quality and did not operate at all. Although the poor quality problem forced people to stop fishing, people could adjust a mis-matched boat as they learned how to operate it by 2009.

2.6.3 Self-financing a private boat in 2009

If people discovered that their boat was of poor quality, did they buy a locally produced boat to continue fishing in 2009 as predicted in equation (2.6)? In the summary statistics, the proportion of people who purchased a boat almost tripled from 11% in 2007 to 29% in 2009. I expect the coefficient of having a bad boat in 2009 to be positive and significant if people self-financed a boat in the local market, and buy a good boat to undo the quality shock.

The result is shown in Table 2.10. Having a bad boat increases the probability of self-financing a boat by about 13% (significant at 95%). The result also shows that previous boat owner and

[22]Pre-tsunami boat length is used to construct a matching index in this chapter since we collected this information from an additional 244 households. We asked previous owners about the engine capacity of their previous boat, but did not collect this information from households which were added in 2007 and 2009 surveys.

captains, and those who lived near Banda Aceh were more likely to buy a boat. The negative coefficient of the log of distance to Banda Aceh became larger in magnitude in 2009 compared with 2007. This implies that the transaction cost of purchasing a boat in a local workshop became lower near Banda Aceh in 2009.

In column (2), I divide the sample into those who received aid boats by 2009 and those did not, and separately run a regression to estimate the self-financing decision. Since the quality problem is related only to aid boats, I expect recipients of aid boats to purchase a boat if the quality was poor. On the other hand, non-recipients might also need to buy a boat if they wanted to fish in 2009. For this group, it is the credit constraint rather than the quality of aid that should have been the major problem. The results are consistent with these stories. Estimates show that getting a poor-quality boat increased the probability of buying a boat by 18% (significant at 99%) for the first group. For the second group, what matters the most is whether they were rich enough to buy a boat. The marginal effect of high income dummy in 2007 is 46.7% (significant at 99%).

In column (3), I examine whether self-financing behavior differs with accessibility to credit unions: accessibility to a credit union would imply a lower transaction cost I in the theoretical model. For this purpose, I divide the whole sample based on the existence of credit unions in 2007. The estimate shows that households living in villages with credit unions in 2007 were differentially more likely to self-finance a boat when their aid boats were of poor quality.

In column (4), the sample is restricted to 178 non-owners in 2007. 24% of them got aid, and 33% of those new aid recipients faced a quality problem. The estimate shows a statistically zero effect of boat quality. Richer households and previous boat owners and captains, who had strong taste for fishing, were more likely to self-finance a boat by 2009.

These results suggest that private resources available in the local economy helped recipients of aid boats undo the poor quality of boats by self-financing a local one in 2009. However, credit and access to local boat workshops were the key constraints for self-financing a boat in 2009.

Assuming that aid cannot perfectly satisfy local economic needs[23], an alternative policy for promoting local market transactions would be a cost-effective policy to satisfy local demand for good-quality boats and improve aid efficacy[24].

[23]It is a difficult task to perfectly satisfy aid quality because disaster-aid must be delivered quickly with imperfect knowledge of local economic conditions.

[24]An alternative solution may include providing insurance or public guarantees for the quality of aid boats, or developing local workshops and market transactions. Examining which kinds of alternative policies are relevant and whether such policies function properly in a post-disaster context is outside the scope of this paper; it is an important direction for my future research.

2.7 Conclusion

Using a unique household level panel dataset, this paper quantifies the impact of poor-quality aid on the recovery of the fishing sector in post-tsunami Aceh. I show that poor-quality aid boats had a large and persistent negative impact on the fishing industry by constraining households' job choices throughout the aid intervention period. The negative quality shock was shown to arrive in two stages, which explains why the fishing sector stagnated despite a large influx of boats from aid agencies.

I also highlighted two important findings. First, in the initial stage, productive fishermen were more affected than unproductive fishermen by the village-specific quality problem; this reduced average productivity in the fishing sector. Second, this paper highlights the complementary role played by a household's self-financing strategy. In other words, households purchased locally produced private boats to replace poor-quality aid boats after discovering the actual quality. Productive fishermen had a stronger motivation for self-financing a boat, especially when the transaction cost of purchasing a boat in the local boat market decreased.

This paper provides new insights into the existing literature of natural disasters. First, the quality problem was the unpredictable shock to households; it negatively and persistently affected their job decision over the course of the aid intervention period. The ways in which aid quality affected households differed by their productivity and the type of quality problem; either the aid boat was unusable or mis-matched to the owner's skill. Productive fishermen were differentially more affected by the quality problem because they preferred not to work as crew for a lower return. Second, to cope with the quality problem, owners of aid boats demanded better boats through local markets as local market transactions developed. This implies that not only improving the quality of aid intervention is important, but developing local market transactions is also important during the recovery process.

This paper provides the mechanism of aid impact on the labor market. However, it does not explore the welfare consequences of the disaster-relief program. The welfare consequences are ambiguous, and are left for future research.

Appendix 2.1: Summary statistics

Variables	N	Mean	S.D.	N	Mean	S.D.
	Original sample			Additional sample		
Fish in 07	366	0.577	0.495	602	0.698	0.460
Fish in 09	366	0.563	0.497	602	0.643	0.480
Report catch in 07	366	0.631	0.483	602	0.756	0.430
Report catch in 09	366	0.609	0.489	602	0.701	0.458
Aid in 07	366	0.358	0.480	602	0.545	0.498
Aid in 09				602	0.696	0.460
Buy in 07	366	0.137	0.344	602	0.111	0.315
Buy in 09				602	0.286	0.452
Boat owner in 07	366	0.492	0.501	602	0.664	0.473
Boat owner in 09				602	0.470	0.500
Fraction of bad aid boats in 07	330	0.251	0.388			
D_bad boats=0	330	0.615	0.487			
D_bad boats>0.5	330	0.230	0.422			
D_have a bad aid boat in 07				602	0.090	0.286
D_have a bad aid boat in 09				602	0.191	0.393
Boat owner and captain_pre	366	0.699	0.459	602	0.855	0.352
D_large boat_pre	366	0.336	0.473	602	0.317	0.466
D_big engine_pre	366	0.557	0.497	602	0.743	0.438
Log (boat length_pre)	366	2.237	0.330			
Log (engine cap_pre)	363	3.170	0.652			
Higher education	359	0.148	0.355	565	0.156	0.363
D_debt to Toke Bangku	366	0.199	0.400			
D_other debt	366	0.137	0.344			
High income in 07				570	0.249	0.433
D_political position_pre	366	0.148	0.355			
Aid boats/Survived fishing captains in 07	330	1.257	2.034			
Log (number of NGO in 07)	345	2.701	0.529	569	2.547	0.559
Number of captains in 05	325	22.987	19.207			
D_Banda Aceh	348	0.187	0.390	570	0.167	0.373
D_Aceh Jaya				570	0.132	0.338
% fishing population in 07				526	0.270	0.273
Log (price of boat in 07)	331	16.763	1.008			
Credit union in village in 07				562	0.326	0.469

Appendix 2.2: Variable Definition

	Definition	Source
Fish in 07/09	Takes 1 if households' primary occupation was fishing in 2007/2009, and 0 if not	2007/2009 Fishermen survey
Report catch in 07/09	Takes 1 if any family members worked for fishing and reported some fish catch in 2007/2009, and 0 if not	2007/2009 Fishermen survey
Aid in 07	Takes 1 if household received a new boat from NGO or government/BRR, and 0 if not in 2007	2007 Fishermen survey
Buy in 07	Takes 1 if household obtained a new boat by own household money, relative or friend's money, or invest by borrowing from cooperative or other credit sources after the tsunami, and 0 if not	2007 Fishermen survey
Boat owner in 07/09	Takes 1 if household owns boat pre-tsunami , and 0 if not	2007 Fishermen survey
Bad boat		
Fraction of bad aid boats in 07	Proportion of bad aid boats within village by 2007, calculated by "number of not operational boat/number of boat received by aid"	2007 PL survey
D_have a bad aid boat in07/09	Takes 1 if boats given by aid agencies to household were in poor quality in 07/09, and 0 if not	2007/09 Fishermen survey
Fishing productivity		
Boat owner and captain_pre	Takes 1 if household head was boat owner and captain pre-tsunami , and 0 if not	2005/07/09 Fishermen survey
D_large boat_pre	Takes 1 if household had a boat larger than 9 meter (average size) pre-tsunami and 0 if not	2005 Fishermen survey
D_big engine cap_pre	Takes 1 if boat engine capacity was above 23 HP/PK (average power) pre-tsunami and 0 if not	2005 Fishermen survey
Other covariates		
High education pre/in 07	Takes 1 if household head graduated from senior high shool pre-tsunami/in 2007, and 0 if not	2005/07 Fishermen survey
D_debt to Toke Bangku	Takes 1 if household had traditional debt to Toke Bangku (still obliged to repay) and 0 if not.	2005 Fishermen survey
D_other debt	Takes 1 if household had debt to Muge/other creditors and 0 if not.	2005 Fishermen survey
High income in 07	Takes 1 if weekly earning is more than Rp 500,000 (US $50) in 2007 and 0 if not	2007 Fishermen survey
D_political position_pre	Takes 1 if household head held any kind of political position (such as head of village/fishermen association, council member of village or fishermen cooperative, or Mosque etc) in the village pre-tsunami, and 0 if not	2007 Fishermen survey
Aid boats/Surv. fish captains	Number of boats provided by aid agencies by 2007/Number of survived fishing captains	2005 VH and 2007 PL survey
Log (number of NGO in 07)	Number of aid agencies operating in the village in 2007	RAN dataset
Number of captains in 05	Number of people working as a boat captain in the village in 2005	2005 village survey
% fish population in 07	The percentage of works in the fishing sector in 2007	2007 VH survey
Log (price of boat in 07)	Log of the average price of any type of boat in the village in 2007	2007 Fishermen survey
Credit union in village in 07	Takes 1 if there existed credit unions in the village in 2007 and 0 if not	2007 VH survey

PL=Panglima Laot (Fisherman community), VH=village head

Appendix 2.3: Temporary jobs in the emergency phase

Aid efforts started by providing immediate life saving supports (such as living cost allowances for poor families), as well as CFW programs in the first six months after the tsunami. As summarized by Doocy, Gabriel et al. (2006), the CFW program was implemented on a large-scale in many tsunami-affected villages. It started from areas near Banda Aceh within two weeks of the tsunami, and soon spread to outlying areas, reaching its peak intensity during the first three to four months of 2005. By the end of 2005, the CFW program was completed in Aceh.

The CFW program provides immediate employment opportunities for fishermen who lost their fishing boats by the tsunami. Oxfam, Mercy Corp, and USAID provided CFW programs. The typical types of work was labor intensive, such as clearing rubbles, dead body and so on. The average time wage was about Rp. 35,000. In the original sample, 64% of total households participated in the CFW program. Living cost allowances were paid in the first five months. The average amount of allowances per month was Rp. 90,000 in January 2005, Rp. 50,000 in February, and the amount decreased in later months.

As shown in the following table, households with social contacts with neighbors through the participation in an *arisan group* and living near Banda Aceh were more likely to participate in the CFW program.

	CFW
Family size post-tsunami	-0.004
	(0.011)
D_arisan group_pre	0.105*
	(0.059)
Log (distance to BA)	-0.171***
	(0.056)
D_physical reaction (insomnia) in 05	-0.107
	(0.082)
Lived in Barrack in 05	0.109*
	(0.057)
Observation	348
Kabupaten FE	YES

(Note) Estimates are the marginal effect of Probit model.

Table 2.1: Summary of village recovery by kecamatans

kecamatan	Number of village	Number of NGO	Number of aid projects	Aid boats/previous captains	Fraction of bad aid boats
Baitussalam	5	19.2	43.2	0.50	0.20
Jaya	12	8.7	31.5	0.77	0.58
Kuta Alam	1	26.0	61.0	0.75	0.17
Kuta Raja	2	15.5	33.0	2.73	0.38
Leupung	4	16.5	42.5	3.72	0.00
Lhok Nga	8	16.6	41.1	5.38	0.04
Lhoong	15	10.8	37.1	1.49	0.32
Mesjid Raya	12	18.8	49.1	0.98	0.24
Meuraxa	7	11.8	26.0	0.56	0.31
Peukan Bada	11	10.7	23.7	2.07	0.33
Pulo Aceh	16	5.5	16.0	2.59	0.12
Seulimmeum	5	4.4	11.4	0.36	0.80
Syiah Kuala	2	14.5	34.0	0.62	0.23
	100				

(Source) Summary statistics are calculated for 100 villages (overlap sample of 2005, 2007, and 2009 surveys). Data comes from the surveys of village head, prominent fishermen, and RAN database.

Table 2.6: Fishing decision in 2007

	Owners	Non-owners					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Fish in 07	Fish in 07	Fish in 07	Fish in 07	Fish in 07	Report catch in 07	Report catch in 07
Fraction of bad aid boats	-0.149	-0.363***	-0.469***		-0.496***	-0.474***	
	(0.119)	(0.111)	(0.123)		(0.129)	(0.123)	
D_bad boat=0				0.149			
				(0.161)			
D_bad boat>0.5				-0.268*			
				(0.159)			
Log (number of good aid boats by 07)							0.0308
							(0.0330)
Log (number of bad aid boats by 07)							-0.194***
							(0.0447)
D_large boat_pre	-0.0305	-0.0190	0.0169	0.0201	0.0498	-0.0261	-0.0249
	(0.0791)	(0.0878)	(0.0908)	(0.0914)	(0.0970)	(0.0911)	(0.0938)
Boat owner and captain_pre	0.00652	-0.00561	-0.0342	-0.0326	-0.0360	-0.0553	-0.0396
	(0.0926)	(0.0867)	(0.0884)	(0.0886)	(0.0915)	(0.0882)	(0.0896)
Log (number of NGO in 07)	-0.0860	-0.152	-0.289***	-0.273**	-0.288**	-0.270**	-0.283***
	(0.0736)	(0.0951)	(0.109)	(0.108)	(0.114)	(0.107)	(0.107)
D_debt to Toke Bangku	0.239***	0.124	0.0913	0.0765	0.0936	0.118	0.0183
	(0.0666)	(0.119)	(0.131)	(0.135)	(0.137)	(0.131)	(0.123)
D_other debt	-0.0792	-0.147	-0.188*	-0.188*	-0.154	-0.200*	-0.215**
	(0.123)	(0.112)	(0.108)	(0.110)	(0.121)	(0.108)	(0.107)
High education_pre	-0.154	-0.0889	-0.131	-0.118	-0.163	-0.139	-0.122
	(0.125)	(0.117)	(0.112)	(0.115)	(0.119)	(0.112)	(0.113)
Number of captains in 05			0.00575**	0.00526*	0.00587**	0.00554**	0.00790***
			(0.00265)	(0.00309)	(0.00280)	(0.00265)	(0.00266)
Observations	156	165	162	162	152	162	161
Mean of dependent variable	0.737	0.442	0.451	0.451	0.480	0.457	0.453
Specification					Drop unemployed		
Seasonality	X	X	X	X	X	X	X
Kabupaten fixed effect	X	X	X	X	X	X	X

Standard errors are Huber-White heteroscedasticity robust estimates.
*** p<0.01, ** p<0.05, * p<0.1
All estimates are marginal effect of probit model.

Table 2.7: Heterogeneity by fishing productivity (for non-owners)

VARIABLES	(1) Fish in 07	(2) Fish in 07
Fraction of bad aid boats	1.897*	1.391*
	(1.093)	(0.802)
Fraction of bad * Log (boat length_pre)	-1.086**	
	(0.511)	
Log (boat length_pre)	0.283**	
	(0.138)	
Fraction of bad * Log (engine cap_pre)		-0.651**
		(0.279)
Log (big engine cap_pre)		0.0758
		(0.0686)
Boat owner and captain_pre	0.00818	-0.0168
	(0.0919)	(0.0897)
Log (number of NGO in 07)	-0.281**	-0.255**
	(0.110)	(0.108)
D_debt to Toke Bangku	0.0492	0.0799
	(0.137)	(0.132)
D_other debt	-0.167	-0.180*
	(0.108)	(0.105)
High education_pre	-0.135	-0.130
	(0.111)	(0.114)
Number of captains in 05	0.00653**	0.00638**
	(0.00265)	(0.00261)
Observations	162	162
Mean of dependent variable	0.451	
Seasonality	X	X
Kabupaten fixed effect	X	X

Standard errors are Huber-White heteroscedasticity robust estimates.
*** p<0.01, ** p<0.05, * p<0.1
All estimates are marginal effect of probit model

Table 2.8: Self-financing decision in 2007

VARIABLES	(1) Buy in 07	(2) Buy in 07	(3) Buy in 07	(4) Buy in 07
Fraction of bad aid boats	-0.0198	0.00247	0.0178	-0.0262
	(0.0488)	(0.0558)	(0.0545)	(0.0627)
D_large boat_pre	0.0565	0.0735	0.0647	0.0884
	(0.0434)	(0.0503)	(0.0486)	(0.0575)
Fraction of bad boats * D_large boat_pre		-0.0936	-0.106	-0.103
		(0.128)	(0.129)	(0.130)
Boat owner and captain_pre	0.0334	0.0350	0.0145	0.0230
	(0.0393)	(0.0395)	(0.0404)	(0.0435)
Log (number of NGO in 07)	-0.0800**	-0.0789**	-0.0826**	-0.0854**
	(0.0362)	(0.0362)	(0.0351)	(0.0378)
Log (distance to BA)	-0.0465*	-0.0474*	-0.0573**	-0.0417
	(0.0251)	(0.0248)	(0.0243)	(0.0266)
D_political position_pre			0.149**	
			(0.0664)	
Log (price of boat in 07)				-0.0151
				(0.0242)
Aid boats/survived fish captains	-0.0254***	-0.0244***	-0.0277**	-0.0253***
	(0.00971)	(0.00937)	(0.0108)	(0.00967)
Observations	327	327	327	306
Mean of dependent variable	0.14	0.141	0.141	0.147

Standard errors are Huber-White heteroscedasticity robust estimates.
*** p<0.01, ** p<0.05, * p<0.1
All estimates are marginal effect of probit model

Table 2.9: Job switching decision (for fisherman in 07)

VARIABLES	(1) Fish in 09	(2) Fish in 09	(3) Fish in 09	(4) Fish in 09	(5) Fish in 09	(6) Fish09
Aid in 09	0.117*	0.143**	0.154		0.207***	
	(0.0699)	(0.0728)	(0.109)		(0.0767)	
D_have a bad aid boat in 09	-0.201***	-0.122**	-0.142**	-0.149**	-0.126**	-0.151**
	(0.0634)	(0.0613)	(0.0675)	(0.0706)	(0.0631)	(0.0713)
D_not exact match						0.0592
						(0.0794)
|Diff_length|						-0.0225
						(0.0165)
D_large boat_pre	0.0284	0.0469	0.0269	-0.00873	0.0457	0.0835
	(0.0496)	(0.0483)	(0.0568)	(0.0643)	(0.0479)	(0.0797)
Boat owner & captain_pre	0.107**	0.127***	0.187***	0.210***	-0.0491	0.185***
	(0.0466)	(0.0466)	(0.0537)	(0.0584)	(0.0675)	(0.0598)
High education_07	-0.129*	-0.180**	-0.132	-0.0766	-0.201**	-0.0938
	(0.0775)	(0.0845)	(0.0988)	(0.103)	(0.0857)	(0.107)
% fish population	0.103	0.0927	0.127	0.170	0.125	0.109
	(0.0777)	(0.0767)	(0.0938)	(0.107)	(0.0778)	(0.108)
D_Banda Aceh		0.156***	0.177***	0.145**	0.191***	0.134*
		(0.0499)	(0.0548)	(0.0709)	(0.0415)	(0.0733)
D_Aceh Jaya		-0.264***	-0.281***	-0.283***	-0.236***	-0.289***
		(0.0818)	(0.0887)	(0.0927)	(0.0829)	(0.0957)
D_new boat owner					-0.291***	
					(0.0951)	
Observations	374	374	303	250	374	232
Sample	Total	Total	BO in 07=1	Aid in 07=1	Total	Aid in 07=1
Seasonality	X	X	X	X	X	X

Standard errors are Huber-White heteroscedasticity robust estimates.
*** p<0.01, ** p<0.05, * p<0.1
All estimates are marginal effect of probit model.

Table 2.10: Self-financing decision in 2009

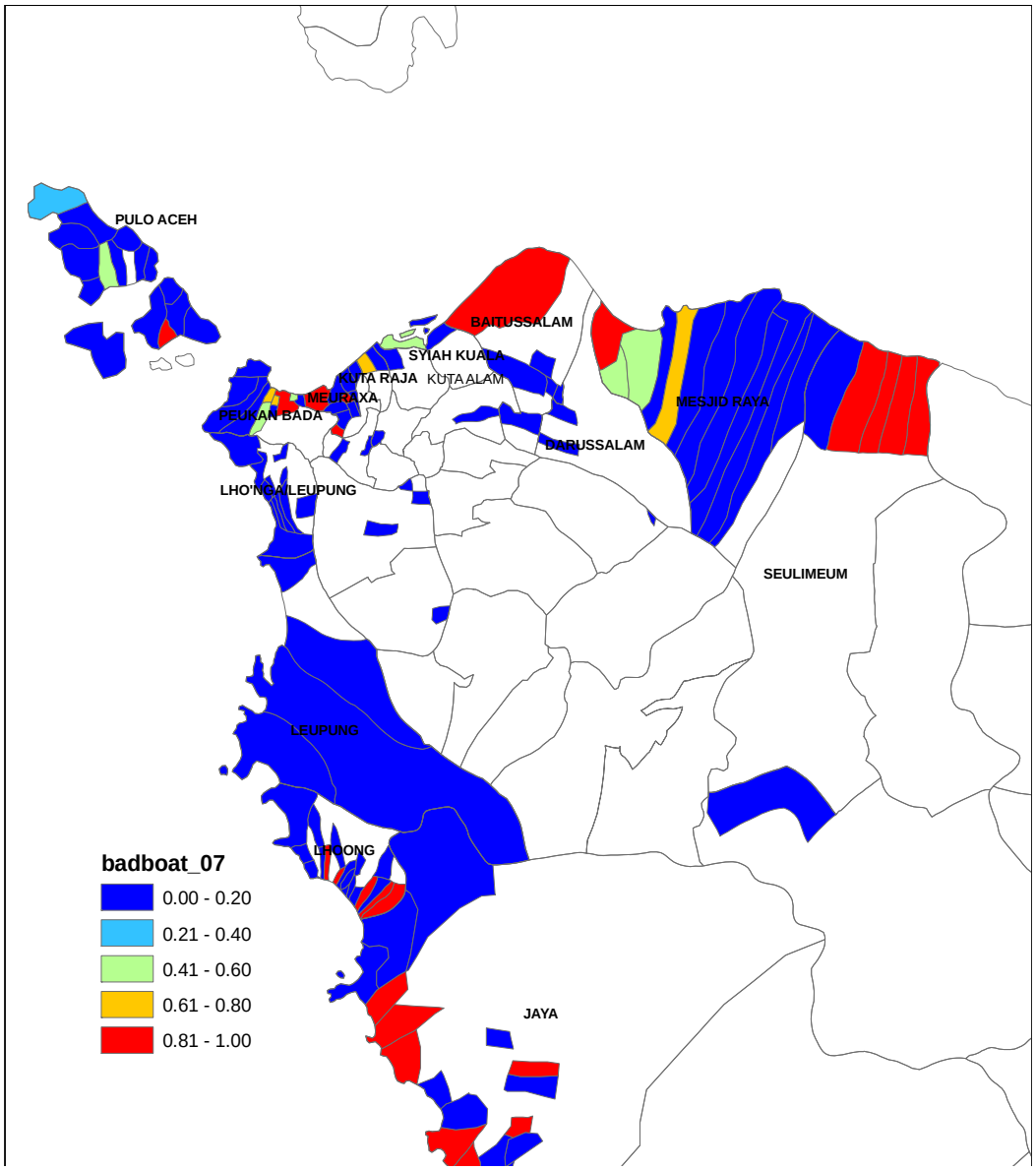
VARIABLES	(1) Buy in 09	(2) Buy in 09		(3) Buy in 09		(4) Buy in 09
D_have a bad aid boat in 09	0.133**	0.176***		0.292**	0.0675	0.115
	(0.0634)	(0.0627)		(0.121)	(0.0748)	(0.108)
D_large boat_pre	0.0543	0.0350	0.0103	0.154	0.0564	0.0559
	(0.0532)	(0.0579)	(0.130)	(0.101)	(0.0676)	(0.0630)
Boat owner and captain_pre	0.125***	0.112**	0.152	0.173**	0.0870	0.138***
	(0.0466)	(0.0490)	(0.125)	(0.0844)	(0.0581)	(0.0522)
High income in 07	0.0787	0.0194	0.467***	0.210*	0.0232	0.171*
	(0.0601)	(0.0586)	(0.117)	(0.127)	(0.0701)	(0.102)
Log (distance to BA)	-0.0960***	-0.0963**	-0.0418	-0.0518	-0.113***	-0.0241
	(0.0354)	(0.0385)	(0.0818)	(0.0692)	(0.0411)	(0.0326)
D_Aceh Jaya	0.0569	0.141		-0.0919	0.140	
	(0.0888)	(0.0947)		(0.172)	(0.106)	
Observations	398	327	70	125	267	178
Specification	Total	Aid in 09=1	Aid in 09=0	Credit union in 07=1	Credit union in 07=0	BO in 07=0
Mean of dependent variable	0.31	0.27	0.5	0.29	0.32	0.157

Standard errors are Huber-White heteroscedasticity robust estimates.

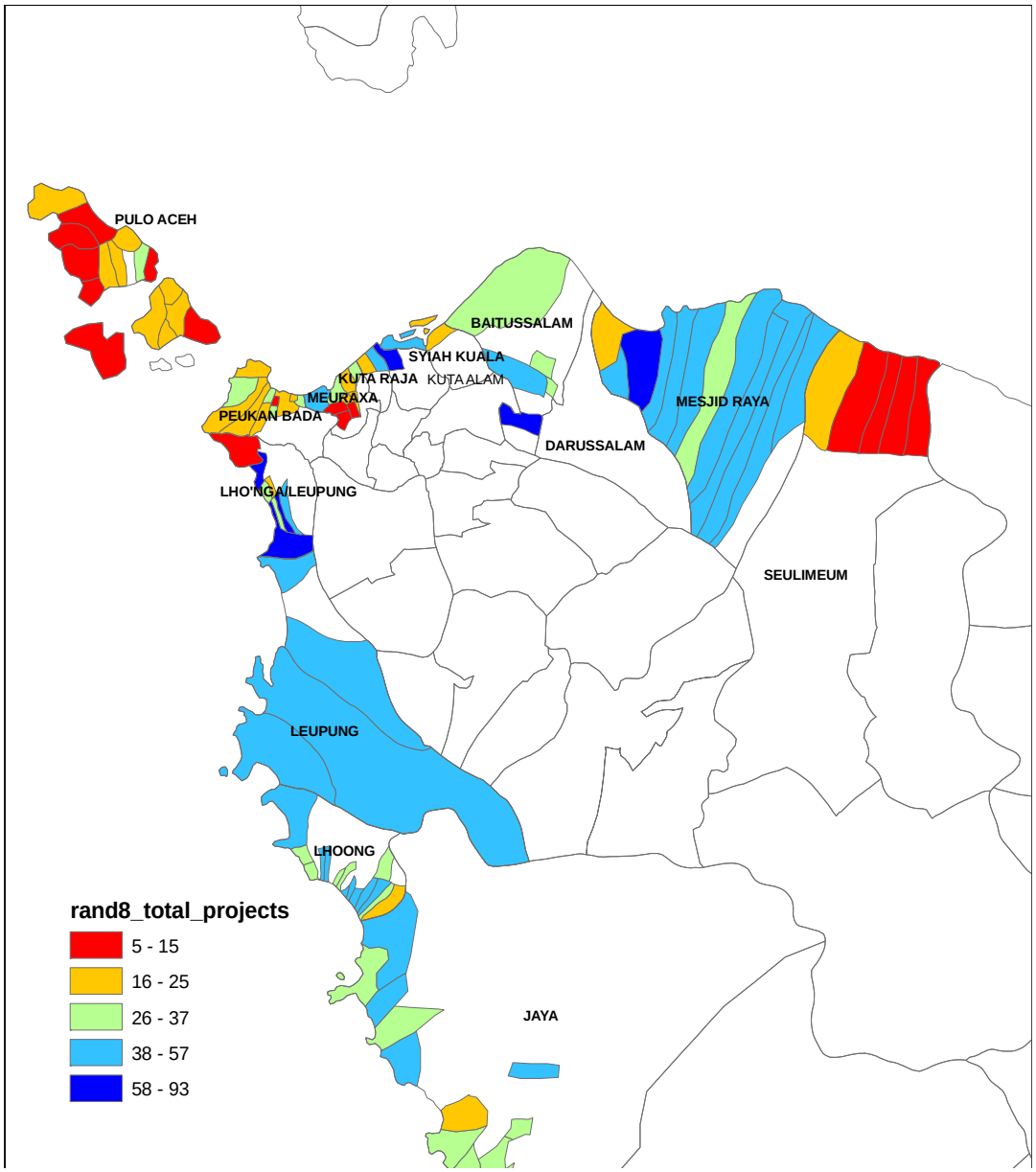
*** p<0.01, ** p<0.05, * p<0.1

Column (2) breaks the sample by whether or not to receive aid boats by 2009. Column (3) breaks the sample by the existence of village credit institution in 2007.

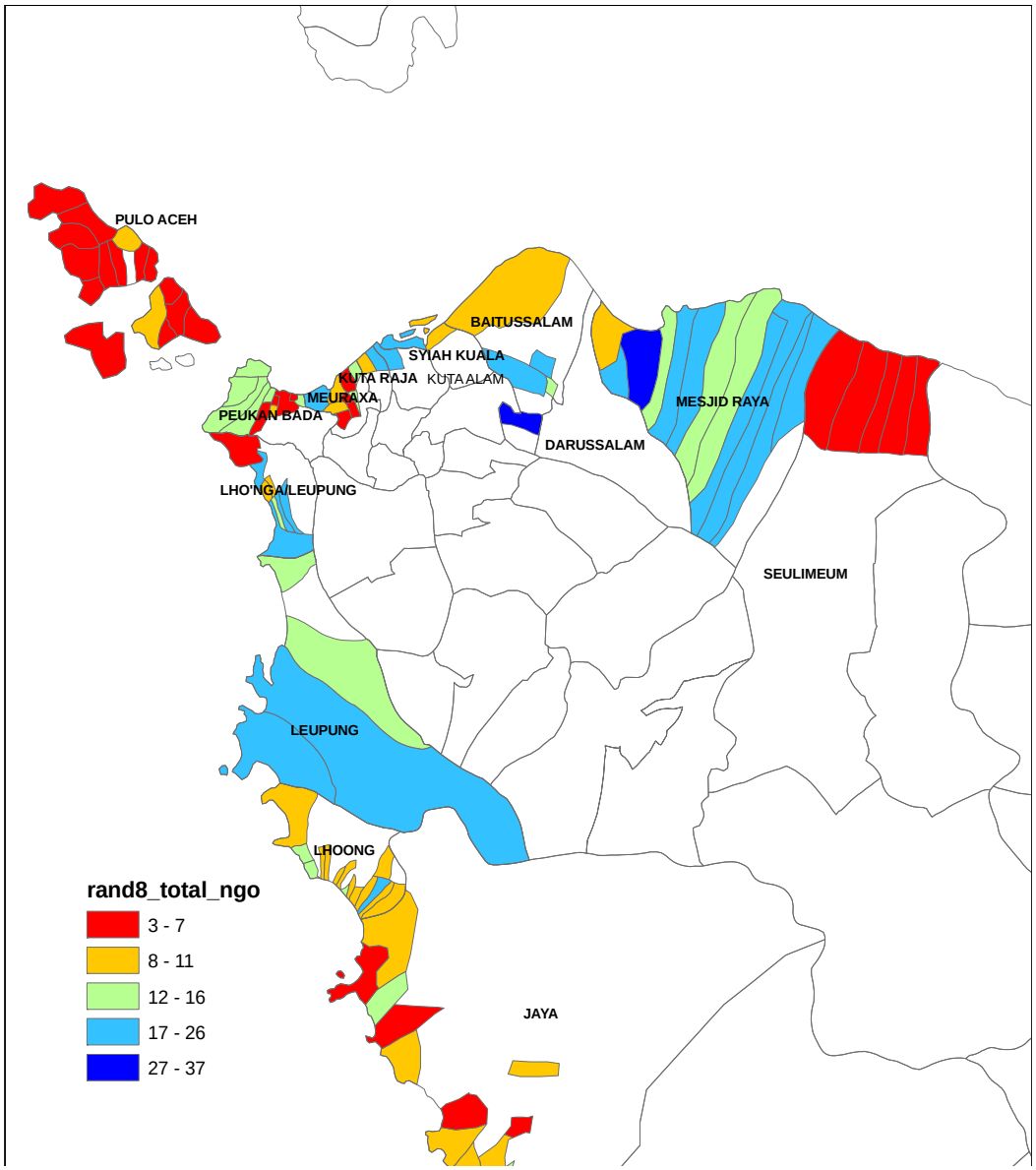
Map 1: Spatial Concentration of Bad boats in 2007



Map 2: Spatial Concentration of Aid Activities



Spatial Concentration of operating NGO



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