Rebounding From Disruptive Events: Business Recovery Following the Northridge Earthquake*

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ABSTRACT

Although the long-term effects of disasters and the factors that affect the ability to recover have received increasing attention from social science researchers, little systematic research has been conducted on the processes and outcomes associated with business disaster recovery. This paper attempts to fill that void by exploring the determinants of recovery within the private sector. We develop a model of business recovery by drawing from existing research on disaster recovery and on organizational survival in non-disaster contexts, and test it using data collected from a stratified random sample of 1110 Los Angeles area firms affected by the 1994 Northridge earthquake. Business size, disruption of business operations due to the earthquake, earthquake shaking intensity, and the utilization of external post-disaster aid are all predictors of business recovery. Size helps businesses weather disaster losses, just as it proves advantageous in non-disaster contexts. How businesses fare following disasters depends not only on direct physical impacts, but also on how disasters subsequently affect business operations as well as on ecological and neighborhood-level impacts. The aid available to businesses following disasters not only doesn't appear to help them recover; it may actually create additional problems, such as higher debt.

INTRODUCTION

Although social scientists have become more interested in the long-term effects of disasters and the factors that affect disaster recovery, there has been relatively little systematic research on recovery processes and outcomes. As a result, the literature is limited and uneven with respect to the research findings and the units of analysis studied. The majority of research on the short- and long-term effects of disasters has focused on families and households (Bolin 1982; Bolin and Bolton 1986; Miller and Nigg 1993). A smaller number of studies have looked at how entire communities recover from disasters (Rubin 1981; Rubin et al. 1985). Other work has attempted to assess the consequences disasters have for local, regional, and national economies (Albala-Bertrand 1993; Cohen 1993, 1995; Friesema et al. 1979; Rossi et al. 1978; West and Lenze 1994; for a review of this literature, see Jones and Chang 1995). However, few studies in the literature have focused on businesses as units of analysis.

This paper attempts to fill that void by focusing on the factors that were related to business recovery following the 1994 Northridge earthquake. That disaster killed 57 people and injured 10,000. The earthquake was the most costly disaster in U.S. history; recent estimates suggest direct losses resulting from the earthquake may reach $40 billion (Tierney 1997a). Damage to businesses was very extensive, particularly in the epicentral area, which was in the San Fernando Valley, and in communities like Santa Monica, which experienced intense shaking during the earthquake.

PREDICTING BUSINESS RECOVERY

The model we use to predict business recovery following the earthquake is based on studies of disaster recovery processes and outcomes for households as well as on the literature on factors

affecting organizational survival in non-disaster contexts. The model estimates the effects of four types of independent and intervening variables--firm characteristics, direct and indirect disaster impacts, loss containment measures, and previous disaster experience--on the well being of businesses, measured 18 months after the earthquake.

Firm Characteristics

The business success and survival literature emphasizes the importance of *firm age and size* as predictors of business success. Studies of organizational age and its impact can be traced to the seminal work of Stinchcombe (1965) who coined the term "liability of newness" to explain the propensity of young or new organizations to fail. New organizations must invest time and effort to establish new roles and socialize members (Stinchcombe 1965). They are also forced to compete with existing firms to secure customers and establish links with other relevant actors. The inability to attract clientele away from established firms is another reason that new organizations fail (Singh and Lumsden 1990). A number of studies support the liability of newness argument (Carroll 1983; Carroll and Delacroix 1982; Carroll and Huo 1986; Freeman et al. 1983), although there is also some evidence that some firms may encounter a "liability of adolescence" (see Aldrich and Auster 1986).

Small size also poses a liability for businesses. Tax laws, government regulation, competition for labor, and the ability to raise capital all favor large organizations. Large firms tend to have more resources and better access to credit, and they benefit more from government programs (Aldrich and Auster 1986). In the disaster area, Alesch et al. (1993) note that small firms seem to be particularly vulnerable to disaster impacts and losses because they tend to have few cash reserves and generally cannot afford to undertake various preparedness and mitigation measures, such as purchasing business interruption and hazard insurance.

In one of the few studies to address disaster-related business disruption and recovery, Kroll and associates (1991) found that smaller firms in Oakland and Santa Cruz suffered proportionally greater losses than larger ones as a result of the Loma Prieta earthquake. Larger firms were also more likely than small ones to quickly implement strategies for recovery following the earthquake, largely because they had made plans to do so in advance.

Industrial context or *type of business* is also thought to affect organizational success and survival. Industries vary in their level of competition, technology, and wage structures (Tigges and Green 1994). Firms located in highly competitive and/or low-growth industries, such as the retail and personal service sectors, tend to generate lower earnings (Loscocco and Robinson 1991), increasing their probability of failure (Bruderl et al. 1992; Halliday et al. 1987). Consistent with this idea, there is some evidence that businesses in the trade and service sectors are more vulnerable to disaster impacts (Kroll et al. 1991).

The well-being and resiliency of a business may also be related to whether it is an *individual firm or a franchise or part of a chain.* Branch and franchise establishments have access to more resources, such as credit and national advertising, than do independent firms (Aldrich and Auster 1986; Tigges and Green 1994). Chain businesses may also be able to overcome the liability of newness since they enter into organizational environments with stable affiliations to existing firms that can provide funds and guidance (Bruderl et al. 1992).

Owning, as opposed to leasing, a business property may also be important for business survival following disasters (Durkin 1984). Firms that own their buildings may have better odds of obtaining loans and other aid, since such property can be used as collateral in post-disaster loan arrangements (Dahlhamer 1992). Ownership may be in part a proxy for financial success, since

owning a business property requires more of an investment than leasing. Owners may also have more opportunity than lessees to take actions to reduce disaster losses, such as structurally strengthening or modifying their buildings. Lessees are dependent on building owners to undertake some damage-reduction measures and to make structural repairs in the aftermath of a disaster, which may have consequences both for the damage and disruption they experience when a disaster strikes and for their ability to get back in business quickly.

Finally, business recovery probably hinges in part on *pre-disaster business financial condition.* Durkin (1984), for example, found that businesses that had been marginal or in financial trouble prior to a 1983 California earthquake had difficulty recovering. This finding is consistent with research on households, which indicates that household income is positively associated with recovery (Bolin 1994; Bolin and Bolton 1986; Quarantelli 1991).

Direct and Indirect Disaster Impacts

The well-being of firms in the aftermath of disasters is in part a function of the magnitude of disaster impacts. Other things being equal, we would expect businesses that experienced more disaster-related damage and disruption to be less likely to recover than their less affected counterparts. In this study, we consider five types of impacts: physical damage, loss of utility services, disruption of business operations, business interruption, and earthquake shaking intensity.

The amount of *physical property damage* sustained has been found to have a negative effect on the ability to recover, both for businesses and households (Bolin 1994; Kroll et al. 1991). Recent research following the 1993 Midwest floods also suggests that other disaster impacts such as *loss of utilities* can have serious repercussions for businesses. For example, while four out of ten businesses in Des Moines, Iowa were forced to close for some period of time during the 1993 floods, only 20

percent of the businesses that experienced business interruption did so because of actual physical flooding of the property. More frequently, they had to suspend operations because of loss of water, electricity, sewer and waste water services, and lack of customer and employee access to the business. Utility loss was a much more important cause of business interruption in Des Moines than direct flood damage (Tierney 1994, 1997b; Tierney et al. 1996).

We hypothesize that disaster-induced *business interruption* should also affect recovery outcomes. Businesses forced to close their doors have immediate cash flow problems. Employees lose work, and customers who must go elsewhere for goods and services may not return when the business does reopen (Alesch et al. 1993; Nigg and Tierney 1990).

While previous analyses have focused on the relationship between damage and recovery (Bolin 1994; Kroll et al. 1991), few have included direct physical measures of disaster severity. This analysis employs data on the *intensity of earthquake ground shaking* (modified Mercalli intensity, or MMI) collected by seismic and geologic researchers during the Northridge earthquake.[1] In our model, we conceptualize ground shaking intensity as a proxy for damage to the general area in which the business is located and to the business site itself. Since many businesses depend on an overall level of commercial traffic, and since high-shaking areas are likely to have higher overall levels of damage, businesses in high shaking intensity zones may have extra disadvantages in trying to recover.

Another measure of indirect disaster impacts not generally employed in analyses of business recovery is the *extent to which a disaster disrupts business operations and interferes with productivity*. Previous research has suggested that such problems as lack of employee and customer access may hamper the ability of firms to recover from disaster (Durkin 1984; Kroll et al. 1991). The measure of disruption we use in the model is based on responses to questionnaire items asking owners

whether or not they encountered the following problems after the earthquake: employees being unable to get to work; damage to their own homes or other properties; loss of customers; difficulties getting supplies/materials needed to run their businesses; difficulties delivering products or services; or difficulty paying their employees. Our assumption is that the larger the number of problems of this kind businesses reported, the poorer their chances of recovering.

Loss Containment Measures

Loss containment measures consist of the steps owners take to reduce the costs associated with disaster impacts. This model assesses the impact of one type of loss containment strategy: the *use of disaster aid and other financial resources* following the earthquake. Previous research on family and household recovery has demonstrated the importance of post-disaster aid for recovery (Bolin 1989, 1994), and we reason that the same is probably true for businesses. The types of aid used by businesses in the sample include insurance, loans from the Small Business Administration, bank loans, help from relatives, and other forms of outside assistance.

Previous Disaster Experience

There is evidence that *previous disaster experience* leads to increased preparedness among private firms (Dahlhamer and D'Souza 1997; Drabek 1994;). Experience with other disasters prior to the earthquake may have led business proprietors to develop business recovery plans, make arrangements to relocate in the event of building damage, or take other steps to cope with disaster-related problems. Owners with disaster experience may also have been more familiar with how to obtain various sources of recovery aid. Thus, we assume that businesses that have previously experienced disasters are more likely to recover.

To summarize, the model we are testing consists of four main components: firm characteristics, direct and indirect disaster impacts, loss containment measures, and previous disaster experience. Business characteristics in the model include type of business; age of the business; number of full-time equivalent employees; whether the business property is owned or leased; financial condition of the business; and risk dispersion.[2] Measures of direct and indirect disaster impacts include whether the business suffered physical damage; the shaking intensity of the earthquake; loss of utilities (electric, phone, water, and sewer); business interruption; and disruption of operations. The loss containment measure considered in the model is utilization of post-disaster aid. The final model component is disaster experience (see Table 1).

TABLE 1 about here

METHODOLOGY

Businesses included in the analysis were selected using a three-stage stratified sampling design, with shaking intensity and type and size of business employed as stratifying variables. In the first stage of the design, Los Angeles area businesses were aggregated into high (Mercalli VIII and IX) and low (Mercalli VI and VII) shaking intensity zip codes. Next, businesses within the high and low MMI zip codes were aggregated by Standard Industrial Codes into five economic sectors: wholesale and retail; manufacturing, construction, and contracting; business and professional services; finance, insurance, and real estate; and "other" businesses, a category that included firms involved in agriculture, forestry, fishing, mining, transportation, communications, and utilities. The final stage

of the design involved the random selection of both small (fewer than 20 employees) and large (20 or more employees) firms in each of the five industrial sectors.

In collecting data, we used a modified version of Dillman's (1978) "total design method," an approach that is widely used in mail survey research, which consists of a series of mailings and phone calls. Based on our previous experience with mail surveys, the initial mailing was followed by a series of telephone calls to business owners after a reasonable amount of time had passed for questionnaire completion. Postcard and second reminder mailings were eliminated. With an initial sample size of 4,752, mailings for the Northridge survey began in May, 1995, approximately sixteen months after the earthquake. A total of 1110 surveys were received and coded, yielding a 23 percent response rate.

RESULTS

Table 2 provides data on the variables included in the model for the total sample and for both recovered and non-recovered firms. Overall, businesses were generally small but established; the median size was six full-time employees, and the median years in business was 15. At the time of the earthquake, 73 percent of the firms in the sample leased their business properties, and 80 percent were individual, single-location firms. Over 60 percent of the firms were in either the business and professional services (36 percent) or wholesale and retail trade (25 percent) sectors. Finally, the majority of firms (72 percent) in the sample reported they were in sound financial condition at the time of the earthquake.

TABLE 2 about here

Focusing on measures of disaster impacts, 57 percent of the firms in the total sample reported physical damage, and 56 percent were forced to close for some period as a result of the earthquake. The median number of utilities lost when the earthquake struck was two (out of a possible four), with the loss of phones and electricity being the most prevalent. On average, business owners reported functional- or productivity-related problems in two of six areas asked about in the survey, most commonly the inability of employees to get to work after the earthquake and problems owners had with damage to their homes or other property. The majority of business owners (64 percent) reported no other disaster experience prior to the earthquake. Finally, 25 percent of the firms in the total sample used some sort of post-disaster assistance to aid them in the recovery process.

Recovered and worse-off businesses differ in several ways. Non-recovered firms (4.0) are smaller than recovered ones (6.0). They are also more likely to be single-location firms and to be leasing their business properties. A greater percentage of recovered firms are in the manufacturing and construction sector. Recovered firms were more likely to report being in sound financial condition before the earthquake.

Not surprisingly, compared with recovered businesses, a greater percentage of non-recovered firms suffered physical damage and experienced business interruption as a result of the earthquake. They also reported more disruption of their operations than recovered firms, and they were more likely to be located in high shaking intensity zones. Interestingly, worse-off businesses were far more likely to report using external post-disaster aid (45 percent) than the businesses that had recovered (19 percent).

The model is tested using logistic regression techniques, since the dependent variable, business recovery, is dichotomous. "Better off than before the earthquake" and "about the same as before the earthquake" were recoded into recovered (coded 1), with "worse off than before the earthquake" coded as not recovered (0).

Table 3 presents logit coefficients and standard errors for the independent variables predicting recovery.[3] Only one of the business characteristics, number of full-time employees, is related to recovery; larger firms had higher probabilities of recovering than smaller ones. This is consistent with earlier research by Kroll and associates (1991) which found that larger firms had done more to plan for disaster recovery, probably because they could afford to do so. The same factors may be at work for large firms in our analysis. Correlations between size, disaster preparedness, and financial condition at the time of the earthquake indicate that larger firms were significantly more likely to have prepared for an earthquake, and that prior to the disaster they were financially more stable than smaller firms.

TABLE 3 about here

Two measures of disaster impacts, disruption of operations and shaking intensity, are also significantly related to recovery. As expected, the more post-disaster operational problems a business encountered, the lower its probability of recovering. This variable was the strongest predictor of recovery status among the model variables. Again, this finding is consistent with earlier research, which found that problems such as lack of employee and customer access and shipping delays contribute to business losses and impede recovery (Durkin 1984; Kroll et al. 1991).

Shaking intensity was also significantly related to recovery. Businesses in areas that experienced stronger ground motions were significantly less likely to have recovered from the earthquake. High-shaking areas were more prone to a range of earthquake-related problems, including extensive residential and commercial damage and lifeline service disruption. As we discuss in more detail below, even if they didn't sustain direct damage, businesses in the hardest-hit localities faced additional problems that weren't experienced by firms in less-damaged parts of the impact region.[4]

The utilization of external post-disaster aid was also significantly related to recovery status, but not in the expected direction; businesses that used assistance had lower probabilities of recovering. This was somewhat surprising, but a closer examination of the data shows that the heavy users of aid were also those that suffered the most severe damage. In other words, owners who needed outside assistance were worse off to begin with. Furthermore, some business owners utilized U.S. Small Business Administration disaster loans and other governmental and private bank loans as sources of outside aid, and the added indebtedness connected with these loans may actually have hurt these businesses financially. Finally, since businesses were surveyed only 18 months after the earthquake, it may simply have been too early to tell whether the sources of assistance used by business owners would ultimately aid in the recovery process.

Interestingly, physical damage and business interruption were not significantly related to recovery. However, there is evidence that the disruption of operations, use of post-disaster aid, and shaking intensity measures mediated the effects of damage and closure on recovery status. For example, when the model is estimated without those three measures, forced business closure is significantly related to recovery, and damage approaches significance, both in the expected directions.

Businesses that did not experience physical damage and were not forced to close as a result of the earthquake were more likely to have recovered. When either the aid or disruption measure is introduced into the model, the significant effect of business interruption on recovery disappears. Any impacts of temporary closure or physical damage disappear once the effects of shaking intensity, disruption of business operations, and the use of post-disaster aid on recovery are controlled.

While only four of the 16 variables in the model had a significant impact on recovery, the model χ^2 of 116.302, significant at the .0001 level, indicates that the model fits the data well. The pseudo R^2 indicates that 13.7 percent of the variance in recovery is explained by the model variables. Goodness-of-fit can also be assessed by the model's ability to correctly classify cases into the categories of recovered and not recovered. Overall, the model was able to correctly predict the recovery status of 78.7 percent of the firms in the analysis. The model was more successful, however, in correctly classifying those businesses that had recovered, as opposed to those that hadn't. For example, of the 573 recovered firms, the model correctly classified 95.5 percent (547). However, the model correctly classified only 26.9 percent of the firms that had not recovered (50 of 186). This is probably attributable, at least in part, to the discrepancy in sizes of the two categories of recovery. Approximately 75 percent of the firms in the analysis had recovered from the Northridge earthquake. As Hosmer and Lemeshow (1989, p.147) note, classification is "sensitive to the relative sizes of the two component groups and will always favor classification in the larger group, a fact that is also independent of the fit of the model." Nevertheless, our inability to correctly classify non-recovered businesses does suggest the model may be misspecified.

DISCUSSION

The model we developed and tested predicts business recovery well, although a large amount of variance in the dependent variable remains unexplained. Additionally, the classification analysis indicates that the model does much better at predicting recovery than non-recovery.

Three of the four model components are important contributors to our understanding of business recovery. The fact that larger firms fared better following the earthquake than smaller ones is consistent with research on organizational success and survival (Aldrich and Auster 1986). This suggests that factors that contribute to firm viability in normal times play a similar role in the survivability of firms confronted with sudden disruptions in their operations, including disasters. It appears that size helps insulate firms not only from other sudden perturbations in their environments, such as interruption in the flow of supplies or sudden market downturns, but also from the negative effects of disasters.

While business characteristics like size are important, measures of the direct and indirect impacts of disasters are equally important for understanding the recovery outcomes of private firms; both disruption of business operations and earthquake shaking intensity were significant predictors of recovery. The more problems the earthquake caused businesses and business owners--for example, by disrupting customer traffic or making it difficult to ship and receive goods--the more likely they were to have difficulty recovering. That disruption in business operations was the strongest predictor of recovery status suggests the importance of moving away from narrow definitions of disaster effects that only take into account factors like direct physical damage. Some types of physical damage can be dealt with relatively easily--glass can be replaced, for example. Owners may find it much more difficult to cope with downturns in customer volume or lost employee productivity. Similarly, the

Northridge earthquake did major damage to freeways in the Los Angeles area. Recent analyses (Boarnet 1995; Gordon and Richardson 1995) suggest that the transportation problems this damage caused had a major effect on productivity and economic output. Impacts like these are important to consider in assessing how disasters affect business viability and productivity.

Earthquake shaking intensity was also an important predictor of recovery outcomes; businesses located in high shaking intensity zones had lower probabilities of recovering from the earthquake. Shaking intensity was considered a proxy for general commercial disruption in this analysis, and the findings suggest that businesses in high shaking intensity zones had problems recovering because, in addition to experiencing damage and disruption themselves, they also had to deal with neighboring pockets of residential and commercial damage.

Businesses located in areas of intense shaking may be having difficulties recovering due to reduced customer traffic to the general area, damage to surrounding properties, and other factors. In their qualitative study of small businesses in the hardest-hit areas of the San Fernando Valley, Alesch and Holly (1996) found businesses in high-damage areas suffered disproportionately following the earthquake, particularly if they were dependent on a local customer base. Extensive residential damage forced some customers to relocate out of the area, resulting in lost business. Residents who had to invest heavily in repairing and rebuilding their homes suddenly had less discretionary income to spend. Damage to surrounding businesses disrupted customer traffic. Such effects were felt even by businesses that experienced little or no direct earthquake damage.

One of the more unfortunate impacts of the earthquake was that the intense shaking in some areas produced what the media and local officials term "ghost towns"--areas of severe residential and commercial damage in which large numbers of structures were condemned (Los Angeles Times 1994;

Stallings 1996; Tierney 1995). These kinds of neighborhood impacts have obvious implications for the viability of individual business enterprises. While businesses may not suffer direct physical damage, their presence in or near areas of extensive commercial and residential disruption may limit their ability to recover.

These findings suggest the need to look beyond what happens to individual businesses and to begin focusing on disaster-related disruption of neighborhoods and commercial districts. Irrespective of individual levels of damage, firms have more difficulty if they are located in areas where destruction is widespread, indicating that ecological factors play a role in business outcomes.

Finally, the use of post-disaster aid was also a significant predictor of business recovery, but in a counterintuitive way. The literature on household recovery finds that the more aid a household uses, the better its chances for recovery. The opposite was the case for the businesses we studied. There are three likely reasons for the apparent discrepancy. First, as we noted earlier, businesses had to be very badly off before they sought aid following the earthquake. The businesses in our sample, as well as those in another study we conducted recently on the 1993 Midwest floods (Tierney 1997b), showed a great reluctance to use outside aid of any kind, preferring instead to absorb their losses. Seeking outside assistance is thus an indicator of severe loss and disruption for businesses.

The second reason probably lies in the type of aid that is available to businesses following disasters, which primarily consists of loans. While homeowners do apply for Small Business Administration disaster home loans to cover repair and reconstruction costs, households can also benefit from outright grants provided by such agencies as the American Red Cross and the Federal Emergency Management Agency. Businesses have fewer aid options available to them in the aftermath of disasters, and grants to businesses are virtually nonexistent. Few businesses have

earthquake or other types of disaster insurance,[5] so those that formally seek outside funds generally must rely on governmental or bank loans to cover disaster-related losses. Loans, however, bring with them additional indebtedness. Even if income returns to pre-disaster levels, businesses may thus be worse off. In their Northridge business impact study, Alesch and Holly (1996) found many owners who expressed concern about being able to pay back their loans.

It is also possible that the assistance received was insufficient, or that even with outside aid market forces are simply working against some businesses. In contrast with households, where the relationship between recovery assistance and recovery outcomes appears to be positive, the picture seems more complicated for businesses. Owners may have sought aid and put money into replacing inventory and making repairs, only to find that in the meantime their customers had gone elsewhere. Even businesses that received sufficient aid may have suffered because their neighbors hadn't reopened or weren't doing well. If the general economic climate is poor for particular business sectors, disaster assistance isn't likely to change that situation.

Our analysis of business outcomes following disaster is limited in that it focuses primarily on firm-level variables and disaster impacts. Business fates are also tied to more general local, regional, and economic trends that were beyond the scope of the current study. In future analyses, we should be able to explain a greater portion of the variation in recovery by incorporating data on the well-being of different sectors of the Greater Los Angeles economy during the time period in question.

Finally, this analysis compared only two business outcomes, recovery and non-recovery following the earthquake. However, among the businesses that had recovered were a sizeable group, including many businesses in the manufacturing and construction sector, that reported doing better since the earthquake; in some cases, owners attributed business improvement directly to the disaster.

We have recently begun to conduct additional analyses to determine which businesses gained, which lost, and why (Dahlhamer and Tierney 1997).

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NOTES

1. A shaking intensity value, ranging from MMI VI (low) to MMI IX (high), was assigned to each case in the sample based on the highest shaking intensity recorded in the zip code in which the business was located. In the Northridge event, shaking intensities in the impact region ranged from VI to IX.

2. Risks are considered dispersed if the business is a franchise, part of a chain, or has multiple locations, and concentrated if the business is an individual firm. Franchise, chain, and multiple location establishments should be better able than individual firms to spread the risks associated with disasters, and thus should have fewer problems recovering.

3. Initially, the model was estimated with a measure of pre-earthquake preparedness included. However, we decided to remove this variable from the analysis due to a large number of missing observations. Results for the two models were very similar. However, the significant effect of full-time employees did not emerge in the model with preparedness.

4. Since some structures perform better than others when subject to earthquake shaking, we would also expect the type of building in which the business was housed to mediate the effects of shaking intensity on damage and to play some role in explaining the recovery outcomes of businesses. In the survey, business owners were asked to indicate the type of building housing their business. Unfortunately, many owners were unaware of the construction type or simply did not answer the

question, resulting in large levels of missing data, which precluded us from including a measure of the earthquake resistance of structures in the model.

5. Only 20.5 percent of the firms in the sample reported having earthquake insurance at the time of the disaster, and, of those, only 28.0 percent filed an insurance claim after the earthquake. Overall, only 5.5 percent of the firms in the total sample used earthquake insurance to cover disaster-related losses.

TABLE 1. Variable Definitions

Variable	Coding Scheme
Business Characteristics:	
Age of business[a]	Continuous
Number of full-time employees[a] (natural log)	Continuous
Own or lease	0=Lease 1=Own
Risk dispersion	0=Individual firm 1=Franchise/chain/ multiple location
Financial condition	0=Financial trouble/ not doing well 1=Good/excellent financial condition
Wholesale/retail	0=Other 1=Wholesale/retail
Manufacturing/construction	0=Other 1=Manufacturing/ construction
Business/professional services	0=Other 1=Services
Finance/insurance/real estate	0=Other 1=Finance/insurance/ real estate
Direct and Indirect Disaster Impacts:	
Physical damage	0=Yes 1=No
Business interruption	0=Yes 1=No

TABLE 1. (continued)

Variable	Coding Scheme
Loss of utilities	0=Lost no utilities . . 4=Lost all four utilities (electric, phones, water, and sewer)
Disruption of business operations	0=No disruption . . 6=High disruption (Count of operational problems businesses reported as a result of the earthquake.)
Shaking intensity	1=MMI 6 2=MMI 7 3=MMI 8 4=MMI 9
Loss Containment Measures:	
Used external post-disaster aid	0=No 1=Yes
Previous Disaster Experience:	
Disaster experience	0=No 1=Yes
Dependent Variable:	
Recovery	0=Not recovered 1=Recovered

[a]In the logistic regression analysis, the natural log of the number of full-time employees was taken to correct for a non-normal distribution. Outliers were removed from the age of business variable to deal with the same problem.

TABLE 2. Descriptive Characteristics of Model Variables

Variable	Total Sample	Recovered	Not Recovered
Business Characteristics:			
Age of business			
Mean:	20.7	20.7	19.5
Median:	15.0	15.0	15.0
	(N=1035)	(N=768)	(N=238)
Number of full-time employees			
Mean:	40.4	36.5	56.0
Median:	6.0	6.0	4.0
	(N=1059)	(N=787)	(N=241)
Percent own business property	27.5	29.0	22.4
	(N=1100)	(N=818)	(N=245)
Risk dispersion			
% Individual firm	79.7	79.3	82.2
% Franchise/chain/ multiple location	20.3	20.7	17.8
	(N=1016)	(N=749)	(N=236)
Financial condition			
% Financial trouble	3.4	2.2	7.5
% Not doing well	24.5	23.6	27.4
% Good fin. cond.	48.3	49.2	45.2
% Excellent financial condition	23.8	25.0	19.9
	(N=1048)	(N=805)	(N=241)
Percent wholesale/ retail firms	25.1	22.8	31.3
	(N=1110)	(N=824)	(N=249)
Percent manufacturing/ construction firms	13.6	16.0	6.8
	(N=1110)	(N=824)	(N=249)

TABLE 2. (continued)

Variable	Total Sample	Recovered	Not Recovered
Percent business and professional service firms	36.1 (N=1110)	36.9 (N=824)	34.1 (N=249)
Percent finance/insurance/ real estate firms	13.0 (N=1110)	11.5 (N=824)	17.7 (N=249)
Direct and Indirect Disaster Impacts:			
Percent with physical damage	57.2 (N=1096)	54.2 (N=813)	68.4 (N=247)
Percent interruption/ closure	55.9 (N=1106)	51.3 (N=823)	71.3 (N=247)
Loss of utilities			
Mean # lost (out of four):	1.4	1.3	1.7
Median # lost:	2.0	1.0	2.0
	(N=1045)	(N=779)	(N=232)
Disruption of business operations			
Mean # of problems encountered (out of six):	1.9	1.7	2.7
Median # of problems:	2.0	2.0	2.0
	(N=1093)	(N=814)	(N=245)
Shaking intensity			
% MMI 6	5.7	6.9	2.0
% MMI 7	33.6	35.3	26.5
% MMI 8	54.3	53.0	59.4
% MMI 9	6.4	4.7	12.0
	(N=1110)	(N=824)	(N=249)

TABLE 2. (continued)

Variable	Total Sample	Recovered	Not Recovered
Loss Containment Measures:			
Percent used post-disaster aid	24.8 (N=1015)	18.5 (N=761)	44.8 (N=239)
Previous Disaster Experience:			
Percent of owners with disaster experience	36.0 (N=1078)	34.2 (N=810)	43.4 (N=244)

TABLE 3. Logistic Regression Coefficients and Standard Errors for the Independent Variables Predicting the Occurrence of Recovery (N=759)

Independent Variable	Logit Coefficients	Standard Errors
Business Characteristics:		
Age of business	-.007	.006
Full-time employees (ln)	.276**	.090
Own or lease	.183	.229
Risk dispersion	.197	.261
Financial condition	.240	.202
Wholesale/retail	-.309	.341
Manufacturing/construction	.633	.442
Services	.226	.340
Finance/insurance/real estate	-.646	.379
Direct and Indirect Disaster Impacts:		
Physical damage	.073	.225
Business interruption	-.063	.233
Loss of utilities	.112	.095
Disruption of operations	-.327***	.071
Shaking intensity	-.424**	.160

TABLE 3. (continued)

Independent Variable	Logit Coefficients	Standard Errors
Loss Containment Measures:		
Post-disaster aid	-.819***	.217
Previous Disaster Experience:		
Disaster experience	-.269	.195
Model χ^2	116.302***	
Pseudo R^2	.137	

*$p<.05$ **$p<.01$ ***$p<.001$