University of Delaware
Disaster Research Center

PRELIMINARY PAPER
#257

BUSINESS DISRUPTION, PREPAREDNESS AND RECOVERY: LESSONS FROM THE NORTHRIDGE EARTHQUAKE

Kathleen J. Tierney
James M. Dahlhamer

1997

Business Disruption, Preparedness and Recovery: Lessons From The Northridge Earthquake

KATHLEEN J. TIERNEY AND JAMES M. DAHLHAMER
DISASTER RESEARCH CENTER
DEPARTMENT OF SOCIOLOGY AND CRIMINAL JUSTICE
UNIVERSITY OF DELAWARE
NEWARK, DE 19716

BACKGROUND

The ways in which private businesses are affected by and attempt to recover from earthquakes and other disasters have seldom been addressed empirically. Research findings on the business impacts of disasters have generally been based on data from individual case studies or from a limited number of firms, rather than on large-scale surveys, and studies have tended to use purposive or convenience samples, rather than systematically selected ones. Over the past few years, however, the Disaster Research Center has been carrying out a program of research on businesses and hazards that has included large-scale studies on such topics as Small Business Administration loan decision making following the Whittier Narrows earthquake (Dahlhamer, 1992); disaster preparedness (Tierney and Dahlhamer, 1995; Dahlhamer and D'Souza, forthcoming, 1997); business impacts and recovery following the 1993 Midwest floods (Tierney, Nigg, and Dahlhamer, 1996); and business vulnerability to disaster-induced lifeline service interruption (Tierney and Nigg, 1995). Because of its scope and severity, the Northridge event provided an opportunity to further explore business vulnerability to disasters and the factors that affect business disaster recovery.

STUDY DESCRIPTION

Eighteen months after the earthquake, the Disaster Research Center conducted a survey addressing the following general research questions: (1) What direct impacts and losses did businesses experience as a result of the earthquake? (2) In what ways did the earthquake affect the operations of the businesses studied--for example, did they experience business interruption, difficulty providing goods and services, or other problems? (3) What earthquake preparedness measures had businesses undertaken prior to the disasters, and what had they done subsequently to prepare? and (4) To what extent had business operations returned to pre-earthquake levels? More broadly, the study's aim was to develop a better understanding of the factors that place businesses at risk in the short and long term and that affect their recovery prospects.

Questionnaires were mailed to a randomly-selected sample of businesses in Los Angeles and Santa Monica in the summer of 1995. The sample was stratified first into high and lower MMI shaking intensity zones, and then further stratified by size and by five broad SIC groupings (wholesale and retail trade; manufacturing and construction; business and professional services; finance insurance, and real estate; and "other" businesses, a category that includes agricultural, mining, and other types of enterprises), in order to represent the population of businesses in the Greater Los Angeles area. The initial sample size for the survey was 4,752; of this number 1,110 businesses returned completed questionnaires, for a response rate of just over 23%. While not ideal, this response rate was acceptable and well within the range typically obtained on business mail surveys.

The survey questionnaire sought information on the following topics: (1) business characteristics (age, number of employees, whether the firm owns its business property, building construction type, etc.); (2) physical damage businesses sustained in the earthquake; (3) the extent and duration of earthquake-induced lifeline service interruption; (4) business interruption, including why businesses closed; (5) business relocation; (6) use of and satisfaction with insurance and governmental disaster assistance programs, as well as use of other

recovery-related resources, such as bank loans and personal savings; (7) pre- and post-earthquake disaster preparedness; and (8) owners' perceptions of the extent to which their business operations had recovered to pre-disaster levels. Selected findings from the study are discussed below.

EARTHQUAKE IMPACTS

Direct physical damage resulting from the earthquake was quite widespread; 57% of the businesses surveyed suffered some degree of damage, with nonstructural and contents damage predominating. Just over one-third of the businesses reported that their buildings had been structurally damaged; for about 13%, the damage was severe enough that the buildings were red- or yellow-tagged.

Lifeline disruption was also extensive. A substantial majority of businesses lost electricity and telephone service, but those outages were generally of short duration. Water, natural gas, and sewer service disruptions were less common. Forty-seven percent of the businesses in the sample suffered both some degree of physical damage and the loss of at least one lifeline as a result of the earthquake. Despite the relatively short time most businesses were without utility services, business owners considered lifeline loss, particularly loss of electricity and telephones, to be quite disruptive to their operations.

Earthquake damage and utility service interruptions led to various operational problems for businesses. Nearly 60% reported that their employees were unable to get to work for a time as a result of the earthquake. In about half the cases, owners had to turn their attention to damage at their own homes before concentrating on problems at the business. About 40% of businesses in the sample indicated customer traffic declined following the earthquake, and 23% reported difficulties with delivering goods and services.

More than half the businesses in the sample were forced to close for at least some period of time as a result of the earthquake. The median length of time businesses were closed was about two days. The most common reasons for business interruption were the need to clean up damage, loss of electricity, the inability of employees to get to work, loss of telephones, and owners needing to take care of damage at home. In general, small businesses were more vulnerable to business interruption than larger ones; an exception to this pattern was large firms in the finance, insurance, and real estate sector, which also tended to have a high rate of earthquake-induced closure. For a more thorough discussion on the earthquake's effects, including differential impacts by business size and type, see Tierney (1997a; 1997b).

BUSINESS EARTHQUAKE PREPAREDNESS

Very little research has been done on the nature and extent of business preparations for earthquakes and other disasters and on the factors that influence preparedness. Even though some businesses have undertaken extensive planning efforts, existing studies suggest that businesses generally have little interest in mitigation and preparedness. This is particularly true for small firms; in fact, studies consistently find that larger companies are much more likely to prepare for disasters than smaller ones (see, for example, Dahlhamer and D'Souza, forthcoming; Drabek, 1994a; 1994b).

Respondents in the Northridge study were asked whether their businesses had been involved in each of sixteen different preparedness and mitigation activities before the earthquake, since the earthquake, and at both points in time--that is, both before and after the earthquake. The list of items included standard recommended measures such as engaging in emergency response and recovery planning and training, modifying the business property and its contents to make them earthquake resistant, obtaining supplies and resources such as first aid kits and generators for backup emergency power, attending meetings to obtain earthquake safety information, and having the building assessed for structural safety. The measures undertaken most frequently by businesses

before the earthquake included having first aid supplies on hand, learning first aid, attending meetings or obtaining preparedness information, storing water, and talking to employees about earthquake preparedness. After the earthquake, the measures most commonly undertaken were talking to employees about preparedness, bracing shelves and equipment, and attending earthquake-related meetings or obtaining preparedness information.

Although relatively high proportions of businesses engaged in some protective activities, such as having a first aid kit available at the business site, overall businesses in our two study communities were not well-prepared for earthquakes and other disasters. The data also show that their preparedness levels didn't increase appreciably after the earthquake. Of the sixteen preparedness and mitigation measures listed, the median number undertaken by businesses prior to the earthquake was 3.9, and that number rose to only four following the earthquake.

Business size (that is, the number of full-time employees) was the strongest predictor of preparedness prior to the earthquake; larger businesses were generally better-prepared. Older and more financially stable companies were also more likely to prepare. Sectoral differences were also observed; businesses in the manufacturing, service, and FIRE sectors tended to be better prepared than other businesses in the sample.

After the earthquake, larger firms were again more likely than smaller ones to step up their preparedness efforts. Interestingly, so were the businesses that had been better-prepared prior to the earthquake; the more businesses had done to protect themselves before the earthquake occurred, the more likely they were to undertake additional measures afterwards. The earthquake evidently provided more of a stimulus to firms that were already conscious of the need to protect against earthquakes than to their less-well-prepared counterparts. While older firms were more likely to prepare prior to the earthquake, the disaster appeared to stimulate more younger firms to prepare.

Experiencing losses in the earthquake had a positive effect on preparedness levels. The more different types of physical damage businesses experienced and the longer they were closed following the earthquake, the more likely they were to increase their preparedness activities. The two items on the preparedness checklist that showed the greatest improvement following the earthquake were bracing shelves and equipment and having the building housing the business structurally assessed, again suggesting that learning took place as a result of the earthquake. For more detailed analyses and discussions of causal models developed to explain pre- and post-earthquake preparedness, see Dahlhamer and Reshaur (1996).

Interestingly, the preparedness actions businesses took before the earthquake didn't help them avoid damage, lifeline disruption, or business interruption in the Northridge event. There appear to be several reasons why this was the case. First, most businesses had done relatively little to reduce their potential earthquake losses. Second, the steps they had taken, such as keeping first aid kits on hand and storing water and other supplies, were directed more toward life safety than toward reducing physical damage and disruption. Third, planning tended to concentrate more on protecting the business site and employees than on problems originating offsite, such as lifeline failures. In short, generally speaking, what most businesses had done prior to the earthquake was not sufficient to shield them from earthquake-related losses.

POST-EARTHQUAKE RECOVERY

Although the long-term effects of disasters and the factors that affect recovery have been receiving increasing attention from social science researchers, there has been relatively little systematic research on recovery processes and outcomes. The disaster literature is limited and uneven with respect to both research findings and the units of analysis studied. Most recovery studies have focused on families and households (Bolin, 1982;

Bolin and Bolton, 1986). A smaller number, taking the community as the unit of analysis, have examined the factors that influence the course of community recovery (Rubin, 1981; Rubin et al., 1985). A still smaller subset of those studies have attempted to measure the mid- or long-term economic effects of disasters at the community or regional level (West and Lenze, 1994; Gordon et al., 1995; for a review of this literature, see Jones and Chang, 1995). There has been almost no effort to determine how business firms fare in the aftermath of disasters.

To determine the extent to which the earthquake affected business operations over time, we asked owners to indicate whether their businesses were worse off, better off, or about the same as they had been just before the earthquake. Fifty-two per cent of the businesses in the survey rated their well-being as comparable to what it had been prior to the earthquake. The remainder were about evenly split between those that were worse off and those whose business fortunes had improved since the earthquake.

To better understand the factors that influence business recovery, we developed a model incorporating four types of independent variables: (1) business characteristics, including age and size of the business, whether the business property was owned or leased, whether the firm had a single or multiple locations, financial condition prior to the earthquake, and SIC sector; (2) direct and indirect disaster impacts, including whether there was physical damage at the business site, whether the business closed for some period of time, lifeline disruption, disruption of operations, and MMI shaking intensity; (3) use of post-disaster assistance; and (4) previous disaster experience. The dependent variable in the model was conceptualized as dichotomous; businesses were classified as either recovered--that is, in better or the same financial condition as prior to the earthquake--or worse off and hence not recovered.

Using logistic regression, we identified four variables as predictors of post-disaster recovery status. One business characteristic, size, was significantly related to recovery. Larger firms had a higher probability of recovering than smaller ones, possibly because they tended to be better prepared and in better financial condition than smaller businesses prior to the earthquake.

Two impact-related variables had a significant effect on recovery. First, the more types of operational disruption businesses experienced following the earthquake (e.g., difficulty delivering or obtaining supplies, loss of customers, problems with employees getting to work), the more likely they were to report being worse off. This variable--operational disruption--was the strongest predictor of recovery status among the model variables. Second, irrespective of their own individual levels of damage and disruption, businesses that were located in high MMI shaking intensity areas were less likely to recover. High-shaking areas had more extensive residential damage and more pockets of highly concentrated damage, and evidently these kinds of neighborhood- and community-level impacts influenced recovery outcomes for businesses. Physical damage and business interruption, per se, were not related to recovery. Instead, the impact of these variables was mediated by other factors, such as operational disruption and shaking intensity.

The use of various types of post-disaster recovery resources, including government loans, insurance, and bank loans was also a significant predictor of recovery, but not in the expected direction. Surprisingly, non-recovered businesses were more likely than recovered ones to turn to outside sources for assistance. There may be several reasons for this counterintuitive finding. First, our data indicate that the businesses that used more recovery resources that had been harder-hit than other businesses in the first place. Another explanation could be that the resources businesses obtained fell short of what they actually needed, or that the resources didn't arrive in time. Additionally, other research on Northridge business impacts suggests that even though some businesses may have had access to recovery resources, they may still have been unable to cope with post-earthquake problems such as the loss of customers or market share (Alesch and Holly, 1996). Our data also indicate that very few businesses had insurance to cover physical damage or b usiness interruption (21% and 14% of the

sample, respectively) and that many businesses that had insurance coverage didn't use it. Instead, business owners tried to absorb their losses, which may have subsequently had a negative impact on their finances. Finally, the strategies some businesses employed in their efforts to recover, such as taking out loans or using personal savings, may have drained them financially and increased their debt burden, leaving them worse off than before. For more complete analyses and discussions of recovery-related issues, see Dahlhamer and Tierney (1996; 1997).

CONCLUSIONS AND IMPLICATIONS

Northridge was by no means a catastrophic or even near-catastrophic event. Nevertheless, it was very costly to businesses, not only in direct physical damage, but also in terms of business interruption losses and the operational problems businesses subsequently experienced. These impacts were quite widespread, affecting a large majority of the businesses in the two communities we studied. Recent government estimates place the losses due to direct earthquake damage at approximately $25 billion (Governor's Office of Emergency Services and Federal Emergency Management Agency, 1996), and some researchers believe that overall losses could total as much as $40 billion (Eguchi et al., 1996). One study on Northridge (Gordon et al., 1995) estimated that about 23% of the total losses resulting from the earthquake were attributable to business interruption. These numbers are very sobering, particularly since the Northridge event was a moderate-sized earthquake that did not cause heavy shaking in the central business district of Los Angeles.

Earthquake hazard awareness is high in Southern California, many local governments are well-prepared, and a long-term effort has been made to encourage household and business preparedness. Nevertheless, most businesses in the two communities we studied had done relatively little prior to the earthquake to reduce their potential losses. The firms that did prepare were generally those that were larger, more established, and in better financial condition.

The efforts businesses had made prior to the earthquake don't appear to have had an appreciable effect on the losses and disruption they experienced, largely because businesses hadn't done enough and because planning wasn't directed toward maintaining business functionality. Some businesses stepped up their efforts to prepare after the earthquake, but improvements were small. Four lessons regarding preparedness can be drawn from our findings. First, despite extensive awareness and educational campaigns, businesses are still not convinced of the need to prepare for earthquakes. Second, persuading businesses with few resources to prepare will likely not work in the absence of financial and other incentives. Third, efforts to encourage businesses to reduce losses should stress both mitigation and preparedness at the business site and possible off-site sources of business interruption, such as lifeline failures. And fourth, in order to contain physical and financial losses, businesses will need to go well beyond commonly-recommended preparedness measures, which are necessary but not sufficient to keep businesses operational.

Eighteen months after the earthquake, most businesses were about the same financially as they had been before the quake or were actually in a better position, but one quarter of those surveyed considered themselves worse off. The regional economic climate was undoubtedly an important factor in how businesses fared after the earthquake. However, both the survey and interviews with business owners indicate that the earthquake itself was responsible for much of the variation in recovery outcomes. Our findings suggest that once a vulnerable business--for example, a small business, or one that is not in good financial condition--suffers disaster-related losses, it will be difficult for that business to recover, and the resources available to business owners may not be of much help.

One implication of this research is that business owners have underestimated the financial risks associated with earthquakes and other disasters. One business in four was still suffering the aftereffects of the earthquake at the time of our survey. Given the difficulty of recovering and the likelihood of future earthquakes, businesses should be more concerned than they currently are about the earthquake hazard. Additionally, agencies responsible for reducing earthquake losses should place more emphasis on outreach to the business community.

There are many businesses that understand the threats associated with earthquakes and other disasters and that are making an active effort to deal with those hazards. However, this study, as well as other research conducted by DRC and other investigators (see, for example, Mileti, et al., 1993) using representative samples, indicate that such businesses are atypical. The typical business proprietor is either unaware, unwilling, or unable to invest in preparing for earthquakes. Reaching owners and encouraging them to change their attitudes and behavior is a major challenge.

This research also illustrates the ways in which community-wide mitigation efforts can help businesses when a disaster occurs. If policies are in place to contain physical damage and lifeline failures, businesses will be less vulnerable to interruption and to the kinds of operational difficulties many respondents in our sample reported, such as problems with employees and customers getting access to the business and shipping delays. In our study, businesses in areas where the shaking intensity was highest and the damage was more severe subsequently fared worse than their counterparts in less-damaged areas, again suggesting that if impacts at the broader community level can be reduced, businesses will benefit.

Conversely, when local governments and other entities (e.g., special districts and lifeline service providers) weigh alternative mitigation strategies, they should take into account the likely effects these measures will have on business continuity and viability. For example, the fact that most lifeline systems performed well in the earthquake helped to contain business losses. Lifeline-related problems were a main source of business interruption in the Northridge earthquake, and had those outages lasted longer, losses would have escalated. Gordon et al. (1995) estimated that just over one-fourth of the business interruption losses resulting from the earthquake were the result of transportation system damage. More extensive damage to roads and highways would have made those losses more severe. The costs of mitigation must be judged in light of the benefits it can bring in reducing business disruption.

Another case DRC recently studied, the 1993 Midwest floods, illustrates this same point. Because the Des Moines water works was flooded, over 250,000 customers in that community were without water for 11 days. Approximately 80% of Des Moines businesses lost water, and nearly half were forced to close. The direct damage to the water works totalled about $14 million, while business interruption losses were estimated at $200 million. Because of this experience, the city has moved to implement measures to protect the water supply against disaster-related damage and avoid these kinds of losses in the future. (For more information on Des Moines and related cases, see Federal Emergency Management Agency, 1997).

The issue of whether earthquakes and other disasters produce negative, positive, or negligible economic outcomes has long been a topic of debate (see, for example, National Research Council, 1992). Research suggests that depending on whether the focus is on the individual business, the community, the region, or the nation, impacts may well differ. Cochrane's recent analyses (1997) show, for example, that under our present system of insurance and disaster relief, a New Madrid earthquake will likely have a positive effect on the regional economy (largely because of the stimulus provided by reconstruction), but a negative impact nationally. Similarly, the economic effects of disasters are likely to be different moving from larger to smaller levels of aggregation. While there is evidence to suggest that regional economies in the U. S. are robust enough to absorb the short-term disruption disasters produce, our research indicates that many businesses are considerably less resilient.

REFERENCES

Alesch, Daniel J. and James N. Holly, (1996). "How to Survive the Next Natural Disasters: Lessons for Small Business From Northridge Victims and Survivors." Paper presented at Pan-Pacific Hazards '96, Vancouver, B. C., July 31- Aug. 2.

Bolin, Robert C., (1982). Long-Term Family Recovery From Disaster. Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado.

Bolin, Robert C. and Patricia Bolton, (1986). Race, Religion, and Ethnicity in Disaster Recovery. Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado.

Cochrane, Hal, (1997). "Economic Impacts of a Midwestern Earthquake." NCEER Bulletin, Vol. 11, No. 1 (January).

Dahlhamer, James M., (1992). Small Business and the Whittier Narrows Earthquake: Loan Request Outcomes in the U. S. Small Business Administration Disaster Loan Program for Businesses. Newark, DE: Master's thesis, Department of Sociology, Disaster Research Center, University of Delaware.

Dahlhamer, James M. and Melvin D'Souza, (forthcoming, 1997). "Determinants of Business Disaster Preparedness in Two U. S. Metropolitan Areas. International Journal of Mass Emergencies and Disasters.

Dahlhamer, James M. and Lisa Reshaur, (1996). "Businesses and the 1994 Northridge Earthquake: An Analysis of Pre- and Post-Disaster Preparedness." Newark, DE: Disaster Research Center, University of Delaware. Preliminary paper no. 240.

Dahlhamer, James M. and Kathleen J. Tierney, (1996). "Rebounding from Disruptive Events: Business Recovery Following the Northridge Earthquake." Newark, DE: Disaster Research Center, University of Delaware. Preliminary paper no. 242.

Dahlhamer, James M. and Kathleen J. Tierney, (1997). "Winners and Losers: Predicting Business Disaster Recovery Outcomes Following the Northridge Earthquake." Paper presented at the annual meeting of the American Sociological Association, Toronto, Canada, August 9-13.

Drabek, Thomas E., (1994a). "New Study Shows that Growing Tourist Industry Is Inadequately Prepared for Emergencies." Hazard Technology Vol. 14.

Drabek, Thomas E., (1994b). Disaster Evacuation and the Tourist Industry. Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado.

Eguchi, Ronald T., James D. Goltz, Craig E. Taylor, Stephanie E. Chang, et al. (1996). "Analyzing Economic Impacts and Recovery from urban Earthquakes: The Northridge Earthquake as an Economic Event: Direct Capital Losses." Paper presented at the Earthquake Engineering Research Institute Conference on the Northridge Earthquake: Analyzing Economic Impacts and Recovery from Urban Earthquakes--Issues for Policymakers. Pasadena, CA, October 10-11.

Federal Emergency Management Agency, (1997). Report on Costs and Benefits of Natural Hazard Mitigation. Washington, D. C.: Mitigation Directorate, Federal Emergency Management Agency

Gordon, Peter and Henry W. Richardson, with Bill Davis, Chris Steins, et al. (1995). The Business Interruption Effects of the Northridge Earthquake. Los Angeles: Lusk Center Research Institute, School of Urban and Regional Planning, University of Southern California.

Governor's Office of Emergency Services and Federal Emergency Management Agency, (1996). "Fact Sheet: Two-Year Anniversary Northridge Earthquake Statistical Recap." Pasadena, CA: Federal/State Coordinating Office.

Jones, Barclay G. and Stephanie E. Chang, (1995). "Economic Aspects of Urban Vulnerability and Disaster Mitigation." In Franklin Y. Cheng and M.-S. Sheu (Eds.) Urban Disaster Mitigation: The Role of Engineering and Technology. Tarrytown, NY: Elsevier Science Ltd.

Mileti, Dennis S., Joanne D. Darlington, Colleen Fitzpatrick, and Paul W. O'Brien, (1993). Communicating Earthquake Risk: Societal Responses to Revised Probabilities in the Bay Area. Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado.

National Research Council, (1992). The Economic Consequences of a Catastrophic Earthquake: Proceedings of a Forum, August 1 & 2, 1990. Washintgon, D. C.: National Academy Press.

Rubin, Claire, (1981). Long-term Recovery From Natural Disasters: A Comparative Analysis of Six Local Experiences. Columbus, OH: Academy for Contemporary Problems.

Rubin, Claire, with Marvin D. Saperstein, and Daniel G. Barbee, (1985). Community Recovery From a Major Natural Disaster. Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado.

Tierney, Kathleen J., (1997a). "Impacts of Recent Disasters on Businesses: the 1993 Midwest Floods and the 1994 Northridge Earthquake." In Barclay G. Jones (Ed.) Economic Consequences of Earthquakes: Preparing for the Unexpected. Buffalo, NY: National Center for Earthquake Engineering Research, SUNY--Buffalo. Report No. NCEER-SP-0001.

Tierney, Kathleen J., (1997b). "Business Impacts of the Northridge Earthquake." Journal of Contingencies and Crisis Management, Vol. 5, No. 2, June.

Tierney, Kathleen J. and James M. Dahlhamer, (1995). "Earthquake Vulnerability and Emergency Preparedness Among Businesses in Memphis/Shelby County, Tennessee. Newark, DE: Disaster Research Center, University of Delaware. DRC Preliminary Paper No. 233.

Tierney, Kathleen J. and Joanne M. Nigg, (1995). "Business Vulnerability to Disaster-Related Lifeline Disruption." In Proceedings of the Fourth U.S. Conference on Lifeline Earthquake Engineering. New York: American Society of Civil Engineering, Technical Council on Lifeline Earthquake Engineering.

Tierney, Kathleen J., Joanne M. Nigg, and James M. Dahlhamer, (1996). "The Impact of the 1993 Midwest Floods: Business Vulnerability and Disruption in Des Moines." In Richard T. Sylves and William T. Waugh, Jr. (Eds.) Disaster Management in the U. S. and Canada, 2nd Edition. Springfield, MA: Charles C. Thomas.

West, Carol T. and Donald G. Lenze, (1994). "Modeling the Regional Impact of Natural Disaster and Recovery: A General Framework and an Application to Hurricane Andrew." International Regional

ACKNOWLEDGMENT

This research was supported by the National Center for Earthquake Engineering Research, NCEER Grant No. 93-6303. The findings and conclusions contained in this paper are those of the authors.