EFFECTS OF THE 2001 NISQUALLY EARTHQUAKE ON SMALL BUSINESSES IN WASHINGTON STATE

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EXECUTIVE SUMMARY

The 2001 Nisqually earthquake was a large magnitude (6.8 Mw) quake that yielded relatively mild ground shaking. Yet it was the costliest natural disaster in Washington State history. The fact that a relatively mild earthquake can yield such significant losses may be the most important lesson Nisqually has to offer.

The most common disruptions from the quake were human and yielded hard-to-estimate indirect costs to businesses. Sixty percent of all small businesses reported that employees were distracted and unable to work for a period after the shaking stopped. In thirty percent of firms, at least some employees left work entirely to check on their homes and families.

In the region a whole, excluding the most heavily damaged neighborhoods, approximately 20% of small businesses had direct physical losses. Sixteen percent lost less than $100 but 4% of the region's firms had losses amounting to 1% or more of their annual revenue. Losses were most commonly self-financed. Even the firms with the largest losses were more likely to self-finance than to receive insurance or other aid.

Building damage was the most common and most costly form of direct loss in the quake. Large losses also resulted from damage to inventory and/or to data and records. Retail businesses were the most likely to suffer both building damage and inventory damage. Retail also reported the largest drops in revenue in the quarter following the quake.

In Olympia's Downtown and Seattle's Pioneer Square, two retail neighborhoods where high levels of shake combined with a high proportion of older, nonreinforced masonry buildings, small firms reported notably larger inventory losses, longer closures and greater reductions in revenues than in the region overall.

The largely industrial Harbor Island neighborhood in Seattle experienced the highest level of shake in Nisqually, similar to the shake experienced in heavily damaged areas in the 1994 Northridge California earthquake. Nearly 40% of Harbor Island's firms had direct losses exceeding $20,000. They also suffered high rates of indirect losses in the form of disruptions to operations. Forty percent of the firms with the largest losses reported receiving no insurance or aid.

Following Nisqually, most business owners reported that they recognize that the region is vulnerable to far more serious seismic events. Approximately one-third have taken steps to better prepare for future earthquakes. Training, planning and strapping contents are among the most common new preparations. The firms most likely to add preparations after the quake were *not* the ones that experienced the most damage. Instead, the firms most likely to add mitigations were those that had already taken some precautions *before* the quake. The careful grew more careful.

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1 OVERVIEW

1.1 INTRODUCTION

This study examines the effects on small businesses caused by the Nisqually earthquake that shook the Puget Sound region at 10:55 a.m. on Wednesday, February 28, 2001. The study reports small firms' direct damage and losses, the main disruptions to business revenues and operations, and how businesses coped with these. It also reports some lessons small businesses drew from their experience with the quake, particularly with regard to their propensity to better prepare for future events. It is hoped that these results can help the region's small business owners and public officials make better decisions about preparations for future earthquakes by understanding the effects of this one. Appendix 1 provides a list of web-based resources aimed at helping Puget Sound small businesses better understand and prepare for earthquakes.

1.2 THE NISQUALLY EARTHQUAKE

Nisqually was an unusual earthquake in some important ways. First, it was the only major earthquake in the Puget Sound region in 35 years and the largest in 50 years. Since this is the only personal experience most Puget Sound residents have had with a large earthquake, it looms large in their overall appreciation of earthquake hazards. Second, the moment magnitude of the quake was large (6.8 M_w) but its hypocenter was deep (33 miles). Surface ground motions were consequently milder than for many earthquakes with similar moment magnitudes. Engineers reported that ground shaking did not exceed levels that modern Washington State structures are designed by code to withstand. Also, Nisqually was accompanied by only a few mild aftershocks.

Though Nisqually was mild relative to many 6.8 M_w earthquakes, it still caused significant damage. At $2 billion, the estimated total losses from the quake were greater than for any other natural disaster in the State's history. President Bush declared the region a national disaster area, eligible for federal recovery assistance, the day after the quake. Over 41,000 residents applied for federal disaster aid, three times the rate of application from previous Washington disasters.

It is helpful, in trying to appreciate the significance of Nisqually, to compare it to other past and potential earthquakes. Nisqually is estimated to have caused approximately $305 million in insured losses, $2 billion in total damage, and one heart attack death. California's 1994 Northridge earthquake had a similar moment magnitude (6.7 M_w) but was only 18 kilometers (11 miles) deep, was centered more directly under a major urban settlement and caused ground accelerations 2-3 times higher than any experienced in Nisqually. It also engendered a number of serious aftershocks. Northridge caused over 60 deaths, $15 billion in insured losses and an estimated $40 billion in total losses.

Nisqually does not represent the worst-case earthquakes to which Seattle is vulnerable. The more serious earthquake risks are of two types. Strong, shallow quakes with significant aftershocks, such as occurred in Northridge, may occur along the Seattle fault.

Scientists have so far been unable to determine the recurrence rate for such quakes. The region is also vulnerable to quakes along the Cascadia subduction zone. The U.S. Geological Survey describes subduction quakes as the largest earthquakes in the world. The last Cascadia subduction quake was a devastating magnitude 9 in the year 1700 that involved major land displacement and tsunamis. It is estimated that Cascadia subduction quakes affect the Puget Sound region approximately once every 300 to 600 years.

Earthquakes like Nisqually are to be expected around the Puget Sound approximately once or twice in a lifetime. The fact that the region's most frequent but least severe large earthquakes can yield significant losses may be one of Nisqually's most important lessons. Internationally, it is growing more common for large losses to result from even relatively small earthquakes. Increased urban development in seismically active areas exposes more assets and more people to earthquake risks. The Puget Sound region has been one of the fastest growing in the U.S. in the last few decades. When Nisqually hit, far more assets were exposed to potential damage than in any past quakes.

1.3 THE SMALL BUSINESS STUDIES

Two distinct patterns of small business experience were associated with Nisqually. Therefore, two types of study were conducted, tailored to yield the most complete picture possible of the two different populations:

- *Overall Regional Experience*: To assess experiences across the region generally, a large sample of small business chief executives throughout the region was surveyed by mail in order to assemble a statistically representative overview of the small business experience. Sections 2, 3 and 5 of this report describe results from this survey.
- *Most Seriously Affected Neighborhoods*: The numbers of firms located in the most seriously affected neighborhoods were too small to expect to profile statistically. Instead, in-person structured interviews were conducted where possible and results are presented as a profile of all firms willing to participate. Section 4 presents results from these most affected neighborhoods.

1.4 OVERALL REGIONAL EXPERIENCE

1.4.1 Physical Damage

Approximately twenty percent of small firms outside the most heavily damaged neighborhoods suffered some direct physical losses due to Nisqually. Sixteen percent had less than $100 worth of damage but 2% had losses of over $10,000. Four percent of all firms reported direct quake-related losses that totaled 1% or more of their annual revenue. These figures do not include indirect losses associated with business closure or disruption.

The most common and the most costly damage small businesses suffered was building and equipment damage. Also, firms with building damage were more likely than other firms to suffer related problems such as inventory damage, data losses and productivity disruptions. Structural mitigation, ensuring that older buildings in particular are readied to perform well in earthquakes, remains an important first line of defense against all sorts of earthquake losses. When buildings perform well, repair costs are lower and contents and occupants fare better.

Nisqually also reminds us that it is prudent to prepare for contents damage separate from building preparation. Damage to inventory or stock was the second most common type of damage, affecting approximately half as many small businesses as did building and equipment damage and averaging nearly $2,000 when it occurred.

Finally, data losses were sometimes costly. While data losses were far less common than other physical losses, they were on average more expensive than inventory damage when they did occur. As businesses increasingly rely on their intellectual capital for operational and competitive effectiveness, it will be more important to track and mitigate information losses as well as more traditional categories of building contents.

1.4.2 Direct Loss Recovery

Although 21% of firms held earthquake insurance at the time Nisqually struck, most firms' direct losses from Nisqually were too small to exceed insurance deductibles, which are typically at least 10% of total building or contents value. However, it is worth noting that even the firms with the largest losses commonly did not receive financial assistance. Regionally, more than half of all firms with losses over $10,000 received no federal aid or insurance assistance. Among those firms that both had earthquake insurance and had losses over $10,000, about half received insurance payments or other assistance.

No small firm reported receiving insurance or aid greater than its direct damage costs. In other words, small firms apparently bore all their indirect costs of business disruption and interruption without insurance or aid.

1.4.3 Business Disruption

Sixty percent of small businesses lost productivity because employees were distracted and concerned about their loved ones and homes in the immediate aftermath of the quake. In 30% of firms, employees left work to check on their homes and families. These human disruptions were the most common effects of the quake. Businesses as well as public agencies have a stake in helping employees to prepare themselves, their families and their homes for the uncertain and frightening conditions associated with earthquakes. If employees know what to expect and have a means to ensure remotely that their families are well during a quake, they may be less distressed and less likely to take to the road during the emergency.

In many natural disasters, the most disruptive and long-lived problems faced by small firms result from disruption to community infrastructure or "lifelines" such as water, gas, electricity, communications and transportation. Puget Sounds' small businesses reported little disruption to these key systems from the Nisqually quake.

The weakest lifeline links were communications links. More than a quarter of the region's small businesses found that phone systems, particularly cell phone systems, were not useful for a time. Computer communications were least likely to fail and fastest to recover when they did fail.

1.5 MOST SERIOUSLY AFFECTED INDUSTRY SECTORS

Retail businesses were more likely than other businesses to have damage to both building and inventory. They also suffered the greatest revenue declines attributed to the earthquake. They were more vulnerable than other industries to several effects – such as transportation problems and customers being themselves disrupted – that reduced customers' propensity to buy from them in the quarter following the quake. In short, retail displayed exceptional vulnerability both to direct and indirect losses.

Manufacturing and mining firms were more likely than other types of businesses to report disruptions to operations. Also, their operational disruptions, including closures, productivity losses and interruptions to supply and distribution, tended to last longer than disruptions in other industries. Thus, manufacturing and mining displayed exceptional vulnerability to indirect losses due to quake effects.

1.6 MOST SERIOUSLY AFFECTED NEIGHBORHOODS

Downtown Olympia and Pioneer Square in Seattle were the most visible areas of concentrated small business damage from Nisqually. Both house mostly small retail and service businesses. In these neighborhoods, over 75% of businesses had to close for a time because of building damage. Closures averaged 2.6 days in Olympia, 4.8 days in Pioneer Square. In the region overall, only 14% of business closed for, on average, 6.2 hours. In both Olympia and Pioneer Square, approximately 40% of businesses suffered inventory losses with median losses of $2,000 and $1,000 respectively. In the region overall, only 8.2% of all businesses and 25.9% of retailers experienced inventory losses, with median losses of $223 for all businesses, $250 for retailers.

Almost 50% of the Olympia firms participating in the study indicated either that their business survival was already threatened because of the direct and indirect costs of the earthquake or they believed that if conditions had persisted another quarter they could have been seriously threatened. Those businesses that were most threatened in Olympia had been either struggling financially or were in debt at the time the earthquake occurred.

Harbor Island is an industrial section of Seattle with a large proportion of small firms. It suffered the most severe level of shaking reported in the earthquake. It was the only neighborhood with a large concentration of small businesses that experienced the level of

shake that was common in the Northridge earthquake. Harbor Island firms were more likely to incur building and equipment damage in excess of $20,000 than they were to have no building damage at all. Sixty-nine percent of firms experienced building losses (median loss $30,900); 54% had inventory losses (median loss: $10,000); and 23% had costly damage to data and records (median loss: $10,000). Productivity disruptions of all sorts were more common and longer in duration than for similar businesses elsewhere in the region.

1.7 PERCEIVED RISK AND MITIGATION

Professionals in public safety and earthquake engineering have expressed concern that Nisqually might have engendered a false sense of security about earthquakes since its moment magnitude was so large yet relatively little damage happened. The concern is that Puget Sound businesses may have become more complacent about preparation and mitigation as a result.

Survey respondents indicated that they were slightly more worried about earthquakes following Nisqually and that they recognize that catastrophic earthquakes are possible in the region. However, they were more likely to conclude that their firms are apparently well prepared for earthquakes (67%) than they were to consider Nisqually a reminder to get better prepared for more serious earthquakes (33%).

Consistent with the attitudes reported above, about one-third of Puget Sound's firms took steps to better prepare for future earthquakes after Nisqually. Most commonly they added disaster planning (10%) and training (11%). A number of firms took even more costly steps. Five percent undertook structural mitigations (e.g., reinforcing, bracing or bolting buildings) and 7% added nonstructural measures like strapping equipment and securing shelves.

The firms that were most likely to add mitigations after the quake were NOT the ones that experienced the most damage. Instead, the firms most likely to add mitigations were the ones that had engaged in some mitigation activities before the quake. In other words, firms that had already taken earthquake precautions were most likely to add still more; firms that had not taken precautions in advance were less likely than their already cautious neighbors to prepare for future events.

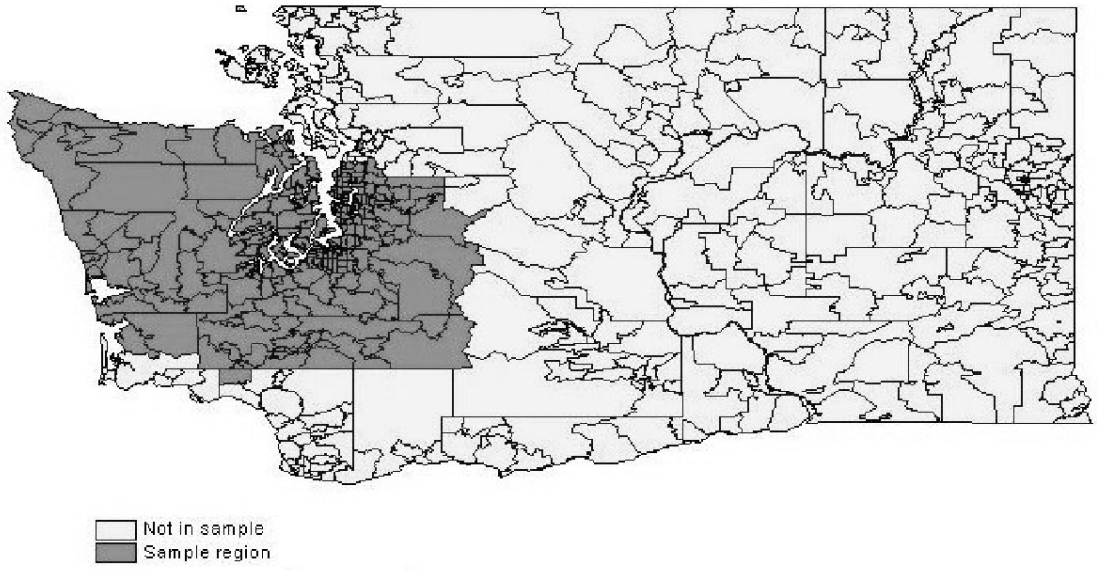
Degree of shake also affected mitigation. Firms in areas that experienced more intense shake levels were more likely to mitigate following Nisqually. Since the locations with the greatest shake are most likely to experience greater shake in certain future earthquakes, this seems an appropriate response.

2 REGIONAL SMALL BUSINESS EXPERIENCE

2.1 SAMPLE AND METHODS

A survey about Nisqually's effects was mailed to 4,000 randomly selected Puget Sound members of the National Federation of Independent Businesses (NFIB) in early winter of 2001, approximately 9 months after the earthquake. The timing of the survey ensured that respondents had time to assess all the effects of the quake, the insurance and other assistance available to them, and the mitigation efforts they chose to adopt as a result of the event. The portion of Washington State surveyed is highlighted on the zip code map in Figure 2.1.

Figure 2.1: Survey region



The survey instrument is shown in Appendix 2. It explores:

- losses and disruptions;
- methods of financing losses;
- earthquake mitigation behaviors before and after Nisqually; and
- attitudes related to perceived earthquake risks and the tendency to mitigate.

Nine hundred seven surveys were returned from small businesses (< 500 employees), a response rate of 23%. Surveys from Olympia, Pioneer Square and Harbor Island were excluded from the regional analysis because these most seriously impacted neighborhoods were studied separately. Their experiences with the earthquake are described in Section 4 of this report. After removing these, the effective sample for the regional analysis was 832.

The survey sample is described in Table 2.1. That table also describes the actual total population of small firms (<500 employees) in the zip codes surveyed. The population data were compiled from the U.S. Census' 1997 Economic Census zip code reports.

Table 2.1: Regional sample and population characteristics

	Sample	Population*
Number of Firms…..……	832	87,439
% Who Own Building……..	54.7%	N/A
% Who Lease Space…….	45.3%	N/A
Industry Sector:		
Agriculture, forestry, fishing…….....	6.3%	0.9%
Finance & insurance…….……	4.5%	5.7%
Manufacturing & mining…….….....	9.9%	4.7%
Real estate, rental, leasing……	2.1%	5.1%
Construction…….	20.4%	11.4%
Transportation & warehousing….……	3.5%	2.3%
Wholesale trade……	5.6%	6.7%
Retail trade……...	18.5%	13.5%
Professional services……	8.6%	11.2%
Non-professional services…….…...	6.1%	9.2%
Business services…….	2.6%	5.1%
Personal services…….	4.6%	9.4%
Other ……...	7.3%	14.9%
Size:		
Fewer than 20 employees…….……	81.6%	86.9%
20 – 500 employees…….	18.3%	13.1%
Average number of employees……	13.1	9.7
Median number of employees……..	5	3.5

The prevalence of firms in certain industries and size categories is somewhat different in the sample than the population as a whole. In order to most accurately describe the earthquake's effects on the region as a whole, the survey results were weighted according to a stratification scheme reflecting proportions of firms of different sizes in different industries. See Appendix 3 for a detailed description of the sample and weighting scheme.

2.2 DIRECT PHYSICAL LOSSES

Twenty percent of the region's small businesses experienced direct losses as a result of physical damage to their businesses during Nisqually. As can be seen in Table 2.2,

* *Source: U.S. Census, 1997 Economic Census zip code reports*

approximately 6.4% had direct physical losses in excess of $1,000; 2% faced losses of $10,000 or more.

Table 2.2: Distribution of levels of loss due to physical damage

Total losses from physical damage	% of firms experiencing
0……..	80.1%
$1 - $100……..……	4.5
$101 - $1,000……..	9.0
$1,001 - $10, 000……	4.4
$10,001 - $20,000…..	1.0
$20,001 +…….	1.0

To gain some perspective on the potential significance of these losses, we assessed physical losses as a percent of annual revenue. Consider that the median profit margin for a Fortune 500 firm in 2001 was only 3.3% of revenues. Consider, further, that a firm's unexpected losses are often paid for out of earnings. Thus, even if losses are a small percentage of annual revenue they may present a challenge for self-financing or may deprive small businesses of a significant portion of their profits.

Table 2.3* reports the average impacts of direct physical losses as a percent of annual revenues. The average loss for those firms that experienced losses amounted to 1.3% of revenue. One firm had losses that amounted to 75% of its annual revenue.

Table 2.3: Average physical damage costs as % of annual revenue

	Total physical damage costs as % of revenue for all firms reporting damage
Average…….	1.3%
Median…….	0.1%
Maximum…….	75%

Table 2.4* shows the distribution of firms' total physical losses as a percentage of annual revenue for those firms that experienced physical damage. For approximately 21% of firms with direct damage (i.e., approximately 4% of the total firms in the region), losses amounted to 1% or more of annual revenue, levels that can be potentially quite difficult to finance. For 1.6% of firms with physical damage (i.e., 0.3% of total firms in the region), direct losses exceeded 15% of annual revenue.

* A number of survey respondents did not report their annual revenue. The estimates in Tables 2.3 and 2.4 are based on the approximately 680 responses which included annual revenues, whereas most results in this study are based on a sample of approximately 830 responses.

Table 2.4: Distribution of physical damage costs as % of annual revenue

Total physical damage costs as % of annual revenue:	% of firms experiencing
< 1%……	79.0%
1-5……	17.4
6-15…..……..…….	2.0
>15……...	1.6

2.3 LOSS RECOVERY

Ninety-six percent of businesses with physical losses did not receive insurance or other aid to help cover their losses. This makes sense given the relatively small size of the average loss and relatively high deductibles carried in earthquake insurance policies. Most Nisqually building losses did not exceed insurance deductibles, which in Washington State are typically at least 10% of total building value.

Commonly, however, even the firms with the largest direct losses self-financed those losses. The profile of insurance and other aid received by the firms with the largest losses is provided in Table 2.5. Of the businesses with total losses between $10,000 and $20,000, 25% expected insurance help or other aid. Of those with losses above $20,000, less than 40% expected such assistance.

Rates of insurance assistance are also low, in part, because only 21% of small businesses had purchased earthquake insurance before Nisqually hit. Failure to hold insurance is not the complete picture, however. Of those firms that both had earthquake insurance and had losses above $10,000, only half received insurance or other aid. In addition to high deductibles, in these cases there may have been mismatches between policy coverages and the types of damage businesses actually sustained. Also, interviews suggested that some businesses were reluctant to apply for insurance following the quake because they feared their premiums would subsequently rise.

Table 2.5: Total phsical losses and expected assistance

Total direct losses	% of firms experiencing loss	% of those with losses expecting insurance or other aid
1 - $100…….	4.5%	0.0%
$101 - $1,000……	9.0	1.3
$1,001 - $10, 000……..	4.4	2.6
$10,001 - $20,000…….	1.0	25.0
$20,001 - $1,500,000……	1.0	37.5

For those businesses that reported receiving insurance or aid, the assistance reported never exceeded the costs of their direct physical losses. That is, no small business reported receiving assistance with the indirect costs of the quake, such as business interruption.

2.4 TYPES OF PHYSICAL DAMAGE

In order to anticipate what kinds of preparation may be most valuable for future earthquakes, it helps to understand what specific sorts of physical damage were most costly. Table 2.6 shows the distribution of losses from three kinds of damage: Building and Equipment damage, Inventory and Stock damage, and Data and Records damage. Roughly 5% of the region's small businesses experienced more than $1000 in losses due to damage to buildings and equipment; 2% lost more than $1,000 worth of stock and inventory; and about 0.6% lost data and records and incurred more than $1,000 in expenses in order to recover these.

Table 2.6: Distribution of levels of loss due to three kinds of physical damage

Levels of loss	% of firms with losses from damage to:		
	Building and equipment	Inventory and stock	Data and records
0……..	84.9%	91.8%	96.9%
$1 - $100…….……	3.0	2.6	0.5
$101 - $1,000……..….	7.2	3.6	2.0
$1,001 - $10, 000……	3.5	1.6	0.4
$10,001 - $20,000…..	0.7	0.3	0.1
$20,001 +……	0.7	0.1	0.1

As can be seen from Table 2.7, damage to buildings and equipment was the most common type of damage. It also yielded both the largest average losses and the largest maximum losses in the earthquake.

Table 2.7: Profile of physical losses

	Losses from damage to:		
	Building and equip.	Inventory and stock	Data and records
% Firms Damaged	15.1%	8.2%	3.1%
Average…….	$ 15,562	$ 1,824	$ 1,953
Median……..	$ 500	$ 223	$ 500
Maximum……..	$ 1,500,000	$ 40,000	$ 40,000

After building and equipment, inventory losses were the second most common form of physical damage. Building damage tended to be correlated heavily with inventory damage (Spearman correlation coefficient: .385, $p<.001$), suggesting that good structural performance may pay off in terms of lower inventory and stock losses as well lower costs for building repair.

Damage to data and records was quite costly for some firms. The average cost for a firm that had to recover data was higher than average inventory losses. Though data-related losses were less common than building and inventory losses, as more firms grow more

information intensive, it will remain important to assess these costs and associated loss prevention options.

2.5 BUSINESS DISRUPTIONS

2.5.1 Closures

As Table 2.8 shows, approximately 14% of small businesses in the region closed for a time due to Nisqually. Most commonly, firms closed for a matter of a few hours or the remainder of the workday. The average closure was 6.2 hours. The maximum closure reported was 6 days.

Table 2.8: Profile of business closures

	% of firms	Average length	Median length	Maximum length
Closures	13.5%	6.2 hours	4.0 hours	6 days

2.5.2 Lifeline Disruptions

In many natural disasters, disruptions to infrastructure (sometimes called "lifelines") are the major source of extended closures and disruption for most businesses. Nisqually was notable for how well the region's lifelines performed. Gas and water were mostly undisrupted. Electricity failures were somewhat more common. As shown in Table 2.9, disruptions to communication lines were the most common and most long-lasting lifeline failures.

Table 2.9: Disruptions to lifelines

Type of disruption	% of firms with some disruption	% of firms with disruption for more than day of earthquake
Cell phones not fully operational……...	36.3%	1.2%
Main phone system not fully operational……..	25.1	1.7
Computer systems not fully operational…….	13.8	1.0
Electricity disrupted……	11.6	1.2
Gas lines disrupted…….……	1.4	0.2
Water lines disrupted…….…….	1.2	0.5

Disruptions to cell phones were of particular interest in Nisqually. This was the first big earthquake in the U.S. since cell phones have come into common use. Many subscribers were surprised to find themselves unable to send or receive calls when the volume of calls was very high around the time of the quake.

Of the three primary forms of communication available, computer communications were least likely to be disrupted. They were also the most likely to return to full function quickly following disruptions.

2.5.3 Productivity Disruptions

Firms that did not close outright were often still hampered in their operations because of the effects of the quake. The most common disruptions were human. Employees were distracted or left work because of worries about their families and homes. Table 2.10 describes the proportion of firms affected by these productivity disruptions and, for those disrupted, estimated average person-hours lost as a result.

Table 2.10: Productivity disruptions

	% of firms affected	Average estimated person-hours lost
Employees distracted……..	59.9%	29.7
Employees left work……	30.6	23.1
Employees cleaning up after earthquake……	19.6	n/a
Employees doing re-work or data recovery……	5.7	n/a
Employees late to work due to road damage…….	2.9	n/a

Other disruptions to productivity had to do with cleaning up damage caused by the quake or re-doing work that was damaged or lost in the quake. The fact that the region's roads and bridges performed well in the quake is evinced in how few firms reported employees late to work in the days following the quake.

2.5.4 Supply & Distribution Channel Disruptions

Though a particular business may have been not directly hampered by the quake, if their suppliers could not deliver or their distribution channels were disrupted, their business could not function fully. Twelve percent of firms found their delivery channels temporarily disrupted in the wake of the earthquake; slightly fewer (10%) had problems in receiving supplies. Most of these disruptions were resolved by the end of the day (see Table 2.11).

Table 2.11: Supply channel disruptions

	% of firms affected	% experiencing disruption for more than day of earthquake
Could not deliver products/service……...	12.0%	2.2%
Did not receive supplies/materials……	9.7	3.5

2.6 LOSS OF CUSTOMERS

Perhaps the most crucial interdependence for any small business is their dependence on their customers. If customers do not purchase or begin to purchase from someone else, their business is hurt. Vendors' assessments of which earthquake effects reduced their customers' propensity to buy and duration of these disruptions are described in Table 2.12.

Table 2.12: Causes of reduced customers and orders

Causes	Total % of firms	Estimated duration of impact (% of firms)				
		1 day	2-6 days	1-4 weeks	1-3 months	> 3 months
Phone line down……..	13.5%	12.6	0.9	0.0	0.0	0.0
Customers ordering less because of their own disruptions……	9.6	4.3	3.1	1.8	0.2	0.2
Damage to premises…….	6.0	3.4	2.4	0.1	0.1	0.1
Web site down…….	3.7	3.0	0.5	0.2	0.0	0.0
Foot traffic down because of:						
Road/transit problems…..	4.5	3.2	0.4	0.4	0.0	0.5
Nearby businesses whose employees are our customers……..	4.3	2.5	1.4	0.1	0.0	0.3
Neighborhood less attractive……...	1.5	0.9	0.2	0.1	0.0	0.4

2.7 TOTAL REVENUE EFFECTS

Respondents estimated the overall effect of the earthquake on their revenue in the first three months following the event. Table 2.13 shows that about 15% of the region's small businesses believe they lost some revenue due to the earthquake. Another 6.5% felt that their revenues were actually somewhat better because of the quake.

Table 2.13: Estimated revenue effects, 1st quarter following earthquake

	% reporting this level of effect
>25% below normal……..	3.5%
11-25% below normal……	0.9
6-10% below normal……..	4.7
1-5% below normal……	6.3
No impact on revenue……	78.1
1-10% above normal……..	4.9
>10% above normal……	1.6

2.8 RELATIONSHIP BETWEEN SHAKE INTENSITY AND LOSSES

The U.S. Geological Survey's (USGS) Community Internet Intensity Map program* reported the experienced ground shaking from Nisqually for each zip code in the Puget Sound region. The Internet Intensity Map program is based on the Modified Mercalli Intensity Scale shown in Table 2.14.

Table 2.14: Modified Mercalli Intensity Scale

Intensity	Witness Observations
I	Not felt except by a very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Source: USGS Earthquake Hazards Program web site, http://gldss7.cr.usgs.gov/neis/general/handouts/mercalli.html

Not surprisingly, the more intense the shake experienced, the more common are disruptions and losses throughout the region. Severity of losses also tend to be higher as shake intensity increases. Table 2.15, 2.16 and 2.17 show that closures and physical losses generally did increase with shake intensity in the Nisqually quake.

* *http://pasadena.wr.usgs.gov/shake/pnw/html/background.html*

Table 2.15: Profile of closures by shake intensity rating

	entire region	% of firms in zip codes experiencing this shake intensity		
		V or less	VI	VII & VIII
% of business closures ……...	13.9%	0.0%	14.4%	16.9%
Average duration of closure (days)……	0.8	0	0.7	0.9
Median duration of closure (days) …….	0.5	0	0.5	0.5
Maximum duration of closure (days) …	6.0	0	6.0	5.1

Table 2.16: Distribution of levels of total loss by shake intensity rating

	% of firms in entire region	% of firms in zip codes experiencing this shake intensity		
		V or less	VI	VII & VIII
0……	80.1	93.2%	80.2%	73.3%
$1 - $100……..….	4.5	0.0	5.5	4.7
$101 - $1,000……...	9.0	5.4	7.2	14.5
$1,001 - $10, 000…….	4.4	1.4	5.3	4.3
$10,001 - $20,000……	1.0	0.0	0.4	2.4
$20,001 +…….	1.0	0.0	1.5	0.8

Table 2.17: Profile of total losses by shake intensity rating

	entire region	firms in zip codes experiencing this shake intensity		
		V or less	VI	VII & VIII
% of firms damaged……	19.9%	6.8%	19.8%	26.7%
Average……..……..	$ 12,622	$ 1,437	$ 15,042	$ 10,640
Median……..……	$ 500	$ 500	$ 500	$ 419
Maximum…….	$1,502,000	$ 5,000	$1,502,000	$ 825,000

3 INDUSTRY-SPECIFIC IMPACTS

3.1 EFFECTS ACROSS INDUSTRIES

Tables 3.1, 3.2 and 3.3 outline the rates of physical damage and closure and the revenue effects of the earthquake on small businesses by industry. The regional averages all industries is provided at the top of each table for comparison purposes.

Table 3.1: Prevalence of three types of loss from physical damage, by industry

	% of firms with losses from damage to:		
	Building and equipment	Inventory and stock	Data and records
All industries……	15.1%	8.2%	3.1%
Agriculture, forestry, fishing……	12.5	0.0	0.0
Finance & insurance…….	16.7	0.0	6.4
Manufacturing & mining…….	16.2	8.1	8.3
Real estate, rental, leasing……	19.5	4.9	4.9
Construction…….	12.6	5.2	3.1
Transportation & warehousing….	17.6	5.6	0.0
Wholesale trade……...	14.8	9.4	3.8
Retail trade……..…	22.1	25.9	4.4
Professional services……	19.8	3.2	3.2
Non-professional services……	6.8	8.2	4.1
Business services……..	19.5	10.0	0.0
Personal services……..	12.8	6.3	0.0
Other ……	9.2	1.7	1.7

Table 3.1 shows that retail suffered the highest rates of damage to buildings and the highest rates of inventory losses. Retail was, quite simply, the industry most prone to physical losses in the earthquake. Retailers were also the most likely to report reduced revenue following the quake (see Table 3.3 below). The effects of the quake on retail are therefore explored in some detail below, in Section 3.2.1.

Real estate, rental and leasing firms also experienced exceptional rates of building damage losses. This higher rate of building damage per firm reflects the fact that firms in this industry often own more than one building and so each firm is more likely to have at least one building damaged.

Table 3.2: Business closures, by industry

Industry	% of firms closed	Mean # of days firms closed
All industries…….	13.5%	0.78
Agriculture, forestry, fishing……	0.0	0.0
Finance & insurance…….	10.6	0.9
Manufacturing & mining…….….	37.8	0.8
Real estate, rental, leasing……	25.0	0.9
Construction…….	13.4	0.6
Transportation & warehousing….	11.1	0.5
Wholesale trade……...	15.1	1.3
Retail trade……..…	13.3	1.0
Professional services…….	12.6	0.6
Non-professional services…….	12.5	0.5
Business services……..	9.5	0.4
Personal services……..	8.9	0.6
Other ……	10.1	1.0

Manufacturing and mining experienced by far the highest rates of business closure in the earthquake, per Table 3.2. Closures represent lost production time and hence increased costs in these industries. The experience of the manufacturing and mining sector is explored in more detail in section 3.2.2. Real estate, rental and leasing firms were also more likely than most firms to close for a time when the event occurred.

Disaster researchers have at times explored the question of whether disaster-related revenue losses may be offset by increased revenues related to repair and recovery from the event. While our results do not allow us to assess this question in detail, the patterns of revenue changes across industries suggests that certain industries experienced earthquake-related revenue gains while others did not.

Table 3.3 below shows that construction firms were more likely to experience revenue gains than losses as a result of the earthquake. Eight percent of constructions firms experienced decreased revenue in the quarter following the quake while 15% experienced increases.

Finance and insurance also experienced increased revenue more commonly than decreased. It is common that demand for insurance increases following an earthquake or natural disaster.

By contrast, there were three industries in which no firm reported increased revenues following the quake. Manufacturing & mining, transportation & warehousing and real estate, rental & leasing firms experienced either no change or a decline in revenues.

Table 3.3: Total revenue effects, by industry

Industry	% of firms with estimated revenue impact				
	> 10% below normal	1-10% below normal	No impact on revenue	1-10% above normal	> 10% above normal
All industries…….	4.4%	11.0%	78.1%	4.9%	1.6%
Agriculture, forestry, fishing……			100.0		
Finance & insurance…….	4.3	4.3	78.7	12.8	
Manufacturing & mining…….	2.7	10.8	86.5		
Real estate, rental, leasing……		12.2	87.8		
Construction…….	4.1	4.1	76.3	10.3	5.2
Transportation & warehousing….	5.3	15.8	78.9		
Wholesale trade……...	1.9	14.8	77.8	5.6	
Retail trade……..…	6.4	21.8	67.3	4.5	
Professional services…….	2.1	9.4	76.0	7.3	5.2
Non-professional services…….	1.4	11.3	85.9	1.4	
Business services……..	7.3	4.9	80.5	7.3	
Personal services……..	2.6	15.8	73.7	5.3	2.6
Other ……	10.8	8.3	79.3	1.7	

3.1 RETAIL

Table 3.4 outlines the frequency of retail losses and their magnitude in comparison to average losses for all industries. Retail firms were far more likely to suffer building damage as well as losses from damage to inventory and stock than were firms in other industries.

Average losses in retail were also higher than for all industries. The higher rates and average levels of inventory loss are partly attributable to the fact that retail firms have a higher portion of their assets invested in inventory than many other kinds of business. This does not account for the higher rates and costs of building damage, however.

An analysis of the geographic dispersal of retail firms was conducted to determine whether the higher damage rates occurred because retail firms were more concentrated in areas that experienced more intense shake. They were not. We examined whether retailers had done less mitigation in advance of the quake than had other types of business. Overall, they had adopted mitigations at least as commonly as firms in most other industries. So far, our results do not offer an explanation as to why retail suffered exceptional rates of building damage.

Table 3.4: Profile of retail vs. all industry losses

	% of firms with losses	Mean	Median
Building & equipment losses:			
All industries……	15.1%	$15,562	$ 500
Retail Trade……..	22.1	$65,762	$ 549
Stock & inventory:			
All industries…….	8.2	$ 1,834	$ 223
Retail Trade……...	25.9	$ 2,236	$ 250

In addition to direct physical losses, retail reported more dramatic reductions in revenue following the quake than did other industries. Reasons for reduced customer activity in retail and the duration of disruptions compared with the averages for all industries are provided in Table 3.5. Puget Sound's small retailers believe that their building damage partially accounted for their reduced customer flows. In addition, they reported more loss of customers due to road and transit problems, to damage to neighboring buildings, to damage in their area more generally, and to damage to disruptions to nearby firms whose employees patronized them than did other industries.

Table 3.5: Causes of reduced customers and orders, retail vs. all industries

Cause of reduced customers or orders	% of firms disrupted	% of firms by estimated duration of impact			
		1 day	2-6 days	1-4 weeks	> 4 weeks
Damage to buildings:					
All industries…….	6.0%	3.4%	2.4%	0.1%	0.2%
Retail trade……	14.3	7.1	4.5	0.9	1.8
Customers disrupted:					
All industries…….	10.6	4.3	3.1	1.8	0.4
Retail trade……	18.9	8.1	7.2	2.7	0.9
Road/transit problems:					
All industries…….	4.5	3.2	0.4	0.4	0.5
Retail trade……	11.7	9.0	0.9	0.9	0.9
Damage in area:					
All industries…….	1.5	0.9	0.2	0.1	0.4
Retail trade……	4.6	4.6	0.0	0.0	0.0
Damage to local firms whose employees are our customers:					
All industries…….	4.3	2.5	1.4	0.1	0.3
Retail trade……	10.1	6.4	3.7	0.0	0.0

3.2 MANUFACTURING AND MINING

As seen in Table 3.2 above, manufacturing and mining firms were the most likely to close for a time because of the earthquake. Looking more closely, owners of small manufacturing and mining businesses also reported well above-average rates of a number of other forms of operational disruption (see Table 3.6). This was not true for any other industry.

Table 3.6: Disruptions to operations, manufacturing and mining vs. all industries

Cause of disruption	% of firms disrupted	% disrupted 1st day only	% disrupted more than 1st day
Evacuation of buildings:			
All industries…….	30.1%	29.6%	0.5%
Mfg. & mining……..	62.2	62.1	0.1
Computers not fully operational:			
All industries…….	13.8	12.7	1.0
Mfg. & mining……..	35.2	35.1	0.1
Other equipment not fully operational:			
All industries……	8.4	7.5	1.0
Mfg. & mining…….	31.6	28.9	2.6
Did not receive materials/supplies:			
All industries…….	9.7	6.1	3.5
Mfg. & mining……..	27.8	25.0	2.8
Could not deliver products/services:			
All industries……	12.0	9.8	2.2
Mfg. & mining…….	32.4	29.7	2.7

Mining and manufacturing also experienced the highest rates of disruption to employee productivity (see Table 3.7). Overall this sector appears the most vulnerable to disruptions to operations throughout the production chain. Operational disruptions in manufacturing are costly insofar as costs per unit of output increase whenever production lines halt. Fixed costs often accrue though no output is occurring.

Table 3.7: Productivity disruptions, manufacturing and mining

Cause of lost employee productivity	% of firms disrupted	% of firms by avg. time loss per affected employee			
		< 1 hr	1-4 hrs	5-10 hrs	> 10 hours
Left work to go home:					
All industries……..	30.6%	7.2%	14.7%	7.9%	0.9%
Mfg. & mining……	54.1	2.7	27.0	24.3	0.0
Cleanup after quake:					
All industries……..	19.6	10.6	7.1	0.9	1.0
Mfg & mining…….	35.1	16.2	13.5	2.7	2.7
Rework & data recovery:					
All industries……..	5.7	2.0	2.2	0.7	0.9
Mfg. & mining……	11.4	5.7	5.7	0.0	0.0

3.3 TOURISM

Disaster research has in the past noted that tourism is subject to suffer if an area becomes perceived to be dangerous or otherwise undesirable following an event. A phone survey of the convention bureaus in Olympia and Seattle, two Seattle events-management firms, and 15 tourist hotels near Pioneer Square was conducted in June 2001. The hotels reported receiving many phone calls inquiring about local conditions in the days immediately following the quake, but none of the agencies or hotels believed that cancellations had occurred because of it. None believed they had experienced a decrease in bookings after the quake. In the eyes of this industry, Nisqually apparently had no effect other than direct damage to structures and contents.

4 MOST SERIOUSLY AFFECTED NEIGHBORHOODS

4.1 THE HARDEST HIT NEIGHBORHOODS

The three areas with the most identifiable, concentrated small business damage from Nisqually were:

- Downtown Olympia;
- Seattle's Pioneer Square section; and
- Seattle's Harbor Island section.

Both Olympia's Downtown and Seattle's Pioneer Square are dominated by small retail and service businesses often housed in old-fashioned, low-rise masonry buildings. Some of this charming architecture failed dramatically during the earthquake. These were the most dramatic building failures of Nisqually, the ones shown repeatedly on newspaper pages and television news programs.

Harbor Island is an industrial/commercial neighborhood near the Port of Seattle. It experienced the highest level of shake reliably reported in Nisqually, level VIII. Harbor Island firms commonly sustained tens of thousands of dollars in damage.

4.2 RETAIL NEIGHBORHOODS: DOWNTOWN OLYMPIA AND PIONEER SQUARE

4.2.1 Samples

The earthquake's most dramatic and concentrated effects on small businesses in Olympia, which is just 11 miles southwest of the earthquake's epicenter, were on the approximately 75 street-level retail businesses in the 6-block downtown core centered on Washington Street and Capitol Way. In-person surveys of the street level businesses were conducted there in June 2001. All street-level businesses were solicited; twenty-eight merchants agreed to participate. They are described in Table 4.1, below.

In-person surveys were also solicited* from the merchants in Seattle's Pioneer Square neighborhood. Virtually all ground-floor businesses and a small set of second-floor businesses were approached. Sixty businesses agreed to participate. Those who agreed to participate are profiled in Table 4.1.

* This work was done by Stephanie Chang and Anthony Falit-Bailimonte of the University of Washington's Department of Geography. We are most appreciative to them for sharing their results.

Table 4.1 : Sample characteristics

	Downtown Olympia	Pioneer Square
Sample Size……	28	60
% Who Own Building…….……	14%	7%
% Who Lease Space……	86%	93%
Industry Sector:		
Retail……..	93%	75%
Service……...	7%	25%
Size:		
Fewer than 20 employees……..	96%	88%
20 or more employees……...	4%	12%
Average number of employees...……	8	8
Median number of employees…….	6	4

4.2.2 Physical Damage

Both Downtown Olympia and Pioneer Square experienced Level VII shake intensity as recorded by the USGS's Community Intensity Internet Map program. Level VII indicates slight damage to well-built, ordinary structures, considerable damage to poorly built ones (see Table 2.14).

Over 40% of the businesses in Downtown Olympia were in buildings that suffered so much damage that they were declared unsafe for a time immediately following the earthquake (see Table 4.2). In Pioneer Square, 32% were in buildings that were declared unsafe for a time.

Table 4.2: Businesses in buildings declared unsafe by inspectors

	Downtown Olympia	Pioneer Square
Red Tag: No Entry…….	32%	12%
Yellow Tag: Limited Entry……...	11%	20%
Not Declared Unsafe……..	57%	68%

In both these districts, only a small proportion of businesses own the building in which they operate: 14% in Olympia; 7% in Pioneer Square. Since the vast majority of the merchants interviewed would not themselves bear the costs of structural and nonstructural building damage, they often did not know the expected costs of repairs. The anecdotal information that was available about building damage costs is as follows:

- Nine Olympia firms reported structural damage to their building but only one knew the costs of that damage; it was $350,000. Four other owners were aware of the costs associated with nonstructural damage to their buildings (e.g., damage to windows, partitions, sprinkler systems). Their nonstructural damage averaged approximately $1,700.

- Of the sixty Pioneer Square businesses interviewed, only seven reported the costs associated with structural or nonstructural damage to their building. Two reported structural damage costs of $400,000 and $1 million respectively. Four reported nonstructural damage of less than $1,000. One reported nonstructural damage of $10,000. The average reported nonstructural damage was $2,400.

All of the firms bore the costs of lost inventory and stock and were able to estimate these losses. The pattern of Olympia and Pioneer Square inventory losses is provided in Table 4.3. In the region as a whole, as reported in Section 2, 8.2% of all businesses and 25.6% of retail businesses experienced inventory losses. Median inventory losses for all industries were $223, for all retail $250. The experience with inventory losses in Olympia and Pioneer Square was notably worse. Approximately 40% of the businesses in these neighborhoods experienced inventory losses with median losses in Downtown Olympia of $2,000 and in Pioneer Square of $1,000.

Table 4.3: Profile of inventory losses

	Downtown Olympia	Pioneer Square
% Firms reporting inventory losses……..	39%	43%
Average……	$ 2,632	$ 48,458
Median……..	$ 2,000	$ 1,000
Maximum…….	$10,000	$1,000,000

Since the average revenue for the Olympia businesses was approximately $707,000 per year, their average inventory losses constitute a bit less than half of one percent of their annual revenue. The largest loss reported was $10,000 and amounted to 4.6% of the annual revenue for that firm. Annual revenue information was not available for the Pioneer Square businesses.

4.2.3 Loss recovery

Table 4.4 outlines reported total losses together with offsetting aid and insurance payments received in Downtown Olympia and Pioneer Square. In Pioneer Square, approximately 30% of the firms with the largest losses (>$10,000) covered those losses without insurance or other aid. Only one firm in Olympia (3.6% of those participating in the study) had losses over $10,000. That firm received no insurance or aid.

Table 4.4: Assistance for physical losses

	Downtown Olympia		Pioneer Square	
Total direct losses	% of firms	% expecting insurance or other aid	% of firms	% expecting insurance or other aid
1 - $500	10.7%	0%	16.7%	0%
$501-$1,000	3.6	0	8.3	0
$1,001 - $5,000	17.8	40	10.0	16.7
$5,001 - $10,000	7.1	0	0	0
$10,001 +	3.6	0	11.7	71.4

4.2.4 Business Disruptions

Ninety-three percent of the Olympia businesses and 75% of the Pioneer Square businesses had to close for a time (see Table 4.5). Regionally, only 14% of businesses closed for, on average, about 6 hours.

The average closure among those firms that eventually reopened was 2.6 days in Olympia, 4.8 days in Pioneer Square. These averages exclude one Olympia firm and two Pioneer Square firms that had not reopened by the time interviews were conducted.

Table 4.5: Profile of business closures

	Downtown Olympia	Pioneer Square
Closed temporarily……..	89.3%	75%
Median length of closure……..	2 days	1 day
Average length of closure…….	2.6 days	4.8 days
Maximum length of closure……..	7 days	30 days
Closed, did not reopen……	3.6%	3.3%
Did not close……..	7.2%	21.7%

Olympia's businesses were asked which earthquake effects were most disruptive to their operations. Results are reported in Table 4.6, below. After structural damage, inventory damage was the most disruptive problem faced by firms. Nonstructural damage to building components was considered next most disruptive.

Table 4.6: Disruptiveness of various types of damage, Olympia

Type of Damage	How disruptive was this damage to normal business operations? (% of firms)			
	not at all	not very	moderately	very
Structural damage to building……	66.7%	11.1%	3.7%	18.5%
Damage to inventory or stock……	39.3	35.7	21.4	3.6
Non-structural damage (windows, partitions, light fixtures, etc.)……	64.3	28.6	3.6	3.6
Damage to equipment (computers, machinery, etc.)……	89.3	10.7	0.0	0.0
Damage to furnishings (desks, cabinets, etc.)……	92.9	3.6	3.6	0.0
Injury to employees……	100.0	0.0	0.0	0.0

4.2.5 Lost Revenue

In addition to direct losses, the earthquake disrupted overall business patterns, in some cases reducing demand, in other cases affecting supply or ability to deliver. Olympia firms' estimates of the effect of the earthquake on their total revenues in the first three months following the earthquake and their expectations about its probable effects for the quarter following that are outlined in Table 4.7. (Similar information is not available for Pioneer Square.)

Three-quarters of the businesses in Olympia believe they lost revenue during the first three months following the quake because of the quake. By contrast, less than one quarter of firms regionally believed that the quake had affected their subsequent revenues. About half of those in Olympia who reported first quarter revenue declines (i.e., 36% of the Olympia businesses) expected that the quake's effects would result in reduced revenue for the second quarter following as well.

Table 4.7: Distribution of various levels of actual and expected earthquake-caused revenue change, Olympia

	% of firms reporting:	
	1st quarter revenue	Expected 2nd quarter revenue
Revenue >25% below normal….	17.9%	3.6%
Revenue 11-15% below normal...	25.0	7.1
Revenue 6-10% below normal….	21.4	17.9
Revenue 1-5% below normal…..	10.7	7.1
No impact on revenue……..	17.9	60.7
Revenue 1-10% above normal….	7.1	3.6
Revenue >10% above normal….	0.0	0.0

4.2.6 Threats to Survival

The Olympia businesses were asked whether the earthquake had seriously threatened their firm's survival. Their assessments are described in Table 4.8. Almost half the firms indicated that the earthquake had caused them some concern about their survival. Four firms felt they were already struggling for survival because of the quake; nine felt they were not currently threatened but indicated that they felt they could have been threatened if the effects of the quake had continued. Asked to estimate what length of continued disruption would have endangered their business, these firms estimated on average that another three months of similar disruption would have done so.

Table 4.8: Threat to business survival from earthquake, Olympia

	%		
Did not lose revenue or incur extra costs as a result of the earthquake	28.6%		
Economic impacts were temporary and minor; business survival would not have been threatened even if impacts had continued	17.9		
Economic impacts were temporary but serious; business survival might have been threatened if impacts had continued for _?_ months.	32.1	←	Average estimate of length that could threaten firm's survival: 3 more months.
Business survival is already threatened by the economic impacts of the earthquake	14.3	←	Among those threatened: two businesses were already marginally viable; a third was heavily leveraged.
No response	7.1		

Three of the four already-threatened Olympia businesses provided detailed explanations as to why their firm was in danger. The fourth did not. For two of the already-threatened firms, the business was already in difficulty when the earthquake happened. The combination of unexpected expenses and decreased revenue strained these firms that were already have trouble making ends meet.

The third business had been stable and profitable for some years when the earthquake struck. It was in the process of expanding and renovating and so had recently taken on debt. The quake caused major damage to building and inventory. Being already leveraged, the owner was unable to bear the costs without loans or grants. He was unable to secure private financing or an emergency government loan at an affordable rate. He has since sold the business to new owners who reopened it in a new location.

4.3 INDUSTRIAL NEIGHBORHOOD: HARBOR ISLAND

4.3.1 Sample

Harbor Island's small business sample differs from Olympia's and Pioneer Square's in three important ways. First, Harbor Island experienced the most intense level of shaking associated with Nisqually, level VIII on the Modified Mercalli Intensity Scale (see Table 2.14). Olympia and Pioneer Square experienced Level VII. Level VIII is associated with movement of heavy furniture, considerable damage to ordinary buildings, and great damage in poorly built ones. Level VIII shake was common in Northridge. In Nisqually, levels VI and VII were common; level VIII was reported only at Harbor Island and Fox Island, which is primarily residential.

Second, Harbor Island is a commercial and industrial neighborhood near the Port of Seattle. It is not a destination for shoppers or tourists, as are Olympia and Pioneer Square. Harbor Island houses mostly manufacturing, construction, warehousing and transportation firms (see Table 4.9).

Finally, Harbor Island's businesses are larger on average than those in Olympia and Pioneer Square. Forty-six percent of Harbor Island small firms have more than 20 employees; in Olympia and Pioneer Square 4% and 12% of firms respectively employ more than 20 people.

Table 4.9: Harbor Island sample characteristics

Sample Size……	13
% Who Own Building……	31%
% Who Lease Space……...	69%
Industry Sector:	
Manufacturing……..	23%
Construction…….	38%
Transportation and Warehousing……	15%
Wholesale Trade……..	15%
Nonprofessional Services…….	8%
Size:	
Fewer than 20 employees…….	54%
20 or more employees……..	46%
Average number of employees……	76
Median number of employees……	15

4.3.2 Physical Damage

Table 4.10 outlines the levels of loss due to physical damage among Harbor Island's small businesses. Building and equipment damage was the most common form of

damage and the most likely to be costly. In this most severely shaken neighborhood, it was more common for firms to suffer building and equipment losses in excess of $20,000 than to suffer no loss at all. In the region overall, approximately 15% of firms reported building losses, 8% had inventory losses and 3% had data losses. From Table 4.10 we can see that the corresponding rates at Harbor Island were 69%, 54% and 33%.

Table 4.10: Distribution of levels of loss due to three kinds of physical damage

	% of firms with losses from damage to:		
	Building and equipment	Inventory and stock	Data and records
0……..	31%	46%	77%
$1 - $100……..…			
$101 - $1,000…….	8	15	8
$1,001 - $10, 000…	23	15	8
$10,001 - $20,000..		8	
$20,001 +……	38	15	8

Table 4.11 profiles average and maximum losses of Harbor Island's small firms. Regional median building, inventory and data losses were $500, $223 and $500.

Table 4.11: Profile of physical losses

	Firms with losses from damage to:		
	Building and equip.	Inventory and stock	Data and records
% of firms with losses	69%	54%	23%
Average	$ 284,350	$ 15,128	$ 70,150
Median	$ 30,900	$ 10,000	$ 10,000
Maximum	$2,300,000	$ 50,000	$ 200,000

4.3.3 Loss Recovery

Table 4.12 outlines the distribution of total costs for damage to buildings and equipment, stock and inventory, and data and records for Harbor Island firms. It also shows how those firms financed these losses. Forty percent of the firms with the largest losses expected no federal aid or insurance.

Table 4.12: Total losses and expected assistance

Total direct losses	% of firms experiencing loss	% of those with losses expecting insurance or other aid
1 - $100…….		
$101 - $1,000……	15.4%	0
$1,001 - $10, 000……..	23.1	0
$10,001 - $20,000…….	7.7	0
$20,001 +……..……	38.5	60%

4.3.4 Business Disruptions

Table 4.13 describes the business closures in Harbor Island. Though the shake was more intense here than in Olympia or Pioneer Square, the rate of closure for these commercial and industrial firms was lower. More than 75% of Olympia and Pioneer Square firms closed for a time; less than 40% closed in Harbor Island.

Table 4.13: Profile of business closures

	% of firms	Median	Average	Maximum
Closed temporarily	38.5%	1 day	1.45 days	3 days

Harbor Island's productivity disruptions are described in Table 4.14. Employees were more commonly distracted and more likely to leave work than were workers in the region overall, where 60% of firms reported distraction and 30% reported employees leaving. Also, in this most severely shaken neighborhood, it was far more common for employees to spend time cleaning up, to spend time doing re-work and to be late to work than in the region generally. The regional rates for those three problems were 19.6%, 5.7% and 2.9% respectively.

Table 4.14: Productivity disruptions

	% of firms affected
Employees distracted……..	83.3%
Employees left work……	66.7
Employees cleaning up after earthquake……	76.9
Employees doing re-work or data recovery……	30.8
Employees late to work due to road damage…….	33.3

Rates of disruption to supply and product deliveries were higher at Harbor Island than in the region overall. Table 4.15 indicates that more than half the firms were unable to deliver product for a time; for 31% of firms, that disruption lasted more than just the day

of the quake. Just under a third were unable to receive supplies for a time. Regionally, 12% of firms had disruptions to their ability to deliver; 9.7% had disruptions in receipt of supplies.

Table 4.15: Supply channel disruptions

	% of firms affected	% experiencing disruption for more than day of earthquake
Could not deliver products/service……..	53.8	30.8
Did not receive supplies/materials……	30.8	30.8

4.3.5 Lost Revenue

The effect of Nisqually on revenues of Harbor Island firms is described in Table 4.16. Revenue losses were more common and larger than for similar industries (i.e., manufacturing and mining, transportation and warehousing, and wholesale trade) in the region generally (compare Table 3.3).

Table 4.16: % Estimated revenue effects, first quarter following earthquake

	1st quarter revenue
Revenue >25% below normal……..	15.4%
Revenue 11-15% below normal…….	
Revenue 6-10% below normal…….	15.4
Revenue 1-5% below normal……..	23.1
No impact on revenue……..	46.2
Revenue 1-10% above normal…….	
Revenue >10% above normal…….	

5 RISK PERCEPTIONS AND MITIGATION ACTIVITY

5.1 PERCEIVED RISK AND WORRY

Nisqually was the first major earthquake in the Puget Sound region since 1965. It is expected that this quake has played an extremely important role in shaping regional perceptions about what earthquakes are like and how important it is to prepare for future quakes. Table 5.1 reports the average rating small business owners gave in response to a set of several questions about earthquake risks. Each question was posed on a 1-7 scale.

Table 5.1: Perceived earthquake risks

	Average rating	Scale
Thinking about the overall effect of the Nisqually earthquake on this region, how serious do you consider it in terms of harm to people?…….	3.7	1=not at all serious 7=extremely serious
AFTER the Nisqually earthquake, are you personally MORE worried or LESS worried about future earthquakes?……..	4.3	1=far less worried 4=no change 7=far more worried
How likely do you think it is that this region will experience an earthquake causing catastrophic levels of harm to people during your lifetime?……	5.0	1=not at all likely 7=extremely likely
BEFORE the Nisqually earthquake, how well prepared for earthquakes was your organization compared to other organizations in this region?……	4.1	1=far less well prepared 7=much better prepared
If this region had an earthquake causing catastrophic levels of harm to people, how likely do you think it is that your business would recover?……	5.1	1=not at all likely 7=extremely likely

These results suggest that Puget Sound's small business owners are aware that Nisqually was not a catastrophic earthquake (seriousness rating of 3.7 out of 7) but that a catastrophic earthquake here is a possibility (likelihood rating of 5 out of 7). On average, they are just a bit more worried about earthquakes following Nisqually than they were before. However, they are not particularly worried that a catastrophic earthquake would threaten the survival of their firm (survival likelihood rating of 5.1 out of 7).

5.2 PERCEPTIONS ABOUT PREPAREDNESS

Given Nisqually's unusual pattern of high moment magnitude without catastrophic levels of ground shake, there has been some concern that it may have promoted complacency about the need to prepare for future earthquakes. Table 5.2 shows that small business

owners were somewhat more likely to conclude from their experience that their firm is already well prepared than to conclude that they ought to get better prepared.

Table 5.2: Judgments about earthquake preparedness

	% responding
Which of the following two statements comes closest to your personal reaction to this earthquake?	
Our organization seems well prepared for earthquakes since we fared pretty well……..	67%
Our organization needs to get better prepared since more serious earthquakes can happen……	33

Closer examination shows that those owners whose firms experienced more serious levels of shake were more likely to conclude that they are well prepared (see Table 5.3). Those who experienced lower levels of shake were more likely to consider the quake a sort of "wake-up call" to get better prepared. Mitigation behaviors were not consistent with these expressed attitudes, however. Section 5.4 below explains that businesses in areas with greater shake actually engaged in more mitigation following the quake than did firms that experienced less shake.

Table 5.3: Judgments about earthquake preparedness by shake intensity level

	Shake level (% of respondents)		
	V or less	VI	VII & VIII
Which of the following two statements comes closest to your personal reaction to this earthquake?			
Our organization seems well prepared for earthquakes since we fared pretty well……	52.2%	64.2%	73.1%
Our organization needs to get better prepared since more serious earthquakes can happen……..	47.8	35.8	26.9

5.3 MITIGATION FOLLOWING NISQUALLY

The proportions of firms that undertook various earthquake mitigations both before and after Nisqually are presented in Table 5.4. The quake did precipitate some increased mitigation. Increased disaster planning and training were the most common new preparations, consistent with the fact that the most common effects of the quake were disruptions related to employees who did not know what to expect or how best to respond.

Table 5.4: Firms' mitigations before and after Nisqually

	Preparedness before earthquake (%)	Additional efforts initiated after event (%)
Store First Aid supplies in building	57%	7%
Store computer data files (backups) off-site	37	7
Purchase business interruption insurance	28	3
Train employees in emergency response	26	11
Develop a disaster plan	24	10
Redundancy (e.g., backup machines, extra inventory, emergency generator, etc.)	23	4
Purchase earthquake insurance	21	2
Stockpile emergency supplies (e.g., spare parts, fuel, water, food, etc.)	21	6
Non-structural mitigation (e.g., strapping shelves & equipment)	16	7
Store copies of critical contracts and documents off-site	15	4
Practice a disaster plan	13	7
Structural mitigation (e.g., reinforcing, bracing, bolting, etc., of building)	13	5
Have engineer perform structural assessment of building	6	6
Arrange with other organizations for mutual aid (e.g., sharing personnel, facilities, etc.)	5	2
Seek additional information about disaster planning & recovery	5	6
Increase % of supplies from non-local suppliers (i.e., less dependent on local suppliers)	2	1
Increase % of sales to non-local customers (i.e., less dependent on local customers)	2	1

The average numbers of mitigations before and after the quake are outlined in Table 5.5. Companies on average added one mitigation but it was not the case that most firms added some protection or other. Instead, a little more than a third of firms added several mitigations (on average, each added 2.6) while the others reported no new efforts.

Table 5.5: Profile of mitigations before and after Nisqually

	Mitigations before	Mitigations after
Average number of mitigations……..	3.3	0.9
% of firms mitigating……..	75.2%	34.4%

The best predictor of which businesses would add mitigations after the quake was the level of preparedness they had established before the quake (see Table 5.6). Firms that had mitigated before were more likely to add more preparations than were firms that had not mitigated before Nisqually.

Table 5.6: Mitigations by firms that had NOT mitigated before vs. those that HAD mitigated before

Preparedness activities undertaken	% of those who did NOT mitigate before who mitigate after	% of those who DID mitigate before who mitigate after
Purchase earthquake insurance…….	1.1%	4.8%
Purchase business interruption insurance ……	2.2	4.8
Structural mitigation (e.g., reinforcing, bracing, bolting, etc., of building)…….	4.2	9.5
Non-structural mitigation (e.g., strapping shelves & equipment)…….…..	6.5	11.9
Develop a disaster plan…….	10.8	9.3
Practice a disaster plan……..	7.5	6.8
Train employees in emergency response……..	10.2	14.5
Store First Aid supplies in building……..	6.0	8.2
Redundancy (e.g., backup machines, extra inventory, emergency generator, etc.)……..	3.2	6.7
Stockpile emergency supplies (e.g., spare parts, fuel, water, food, etc.)…….	5.2	8.2
Store computer data files (backups) off-site……	5.1	9.1
Store copies of critical contracts and documents off-site.	4.1	5.8
Arrange with other organizations for mutual aid (e.g., sharing personnel, facilities, etc.)……	1.2	11.4
Increase % of supplies from non-local suppliers (i.e., less dependent on local suppliers)……...	0.9	4.8
Increase % of sales to non-local customers (i.e., less dependent on local customers)……	0.7	4.8
Have engineer perform structural assessment of building	5.1	14.5
Seek additional information about disaster planning & recovery……...	5.4	19.1

5.4 MITIGATION AND SHAKE INTENSITY

It was reported in Section 5.2 that firms in areas with lower levels of shake were more likely to conclude that they need to get their firms better prepared for future earthquakes; firms that experienced more intense shaking were more likely to conclude that their firm is already well prepared. Actual mitigation behaviors are not consistent with these attitudes. Firms in zip codes with the most intense levels of shake, VII and VIII, actually added more mitigations of nearly every type after Nisqually than those who experienced level VI or less (see Table 5.7).

Table 5.7: Mitigations added after the earthquake, by shake intensity

Post-mitigation activity	% post-mitigating			
	Total region	V or less	VI	VII & VIII
Purchase earthquake insurance	2.2%	0.0%	2.5%	2.6%
Purchase business interruption insurance	2.2	1.4	2.9	1.9
Structural mitigation	4.3	0.0	4.6	5.3
Non-structural mitigation	6.7	0.0	6.5	8.3
Develop a disaster plan	11.3	9.5	12.6	10.9
Practice a disaster plan	7.6	2.7	9.0	8.2
Train employees in emergency response	10.9	4.1	11.9	12.0
Store First Aid supplies in building	8.2	5.4	9.4	7.9
Redundancy	3.9	2.7	3.8	4.9
Stockpile emergency supplies	6.3	2.7	6.7	7.1
Store computer data files (backups) off-site	6.8	2.7	6.7	9.4
Store copies of critical contracts/documents off-site	4.0	1.4	3.3	6.0
Arrange with other organizations for mutual aid	1.4	1.4	1.3	1.9
Increase % of supplies from non-local suppliers	1.2	1.4	0.8	1.5
Increase % of sales to non-local customers	0.6	0.4	0.7	0.4
Have engineer perform structural assessment of bldg	4.6	2.7	5.4	4.1
Seek more info about disaster planning & recovery	5.7	2.7	5.9	7.5

APPENDIX 1: EARTHQUAKE PREPAREDNESS RESOURCES FOR PUGET SOUND SMALL BUSINESSES

Cascadia Region Earthquake Working Group
Earthquake mitigation for businesses: http://www.crew.org/mitigation/busmit.html

Institute for Home and Business Safety
Business protection program: http://www.ibhs.org/business_protection/

King County Emergency Management
Earthquake web site: http://www.metrokc.gov/prepare/hiva/earthquakes.htm

Seattle Emergency Management Office
Earthquake web site:
http://www.cityofseattle.net/emergency_mgt/hazards/earthquakes.htm
Project Impact web site:
http://www.cityofseattle.net/projectimpact/pages/businesses/businesses.htm

Federal Emergency Management Agency
Library on preparation and prevention:
http://www.fema.gov/library/prepandprev.shtm#mit

U.S. Small Business Administration
Disaster assistance web site: http://www.sba.gov/disaster/

APPENDIX 2: THE SURVEY INSTRUMENT

UNIVERSITY OF WASHINGTON
NISQUALLY EARTHQUAKE IMPACTS QUESTIONNAIRE
Please place a check mark, circle or write in the appropriate answers.

1. Was your business closed for any period of time for some earthquake-related reason?
   _____ No
   _____ Yes. Closed for _____ (hours? days?).

2. Did you experience any of the following disruptions to your normal business operations as a result of the earthquake? (place a check in the boxes that best estimate the duration of your disruptions) Note to help you estimate: the earthquake occurred at 10:54 am on February 28.

Cause of disruption	Estimated duration of disruption							
	No disruption	< 2 hours (over by 1 pm on 2/28)	most of 1st day (over by 5 pm on 2/28)	part of 2nd day (over by 5 pm on 3/1)	3 - 6 days	1 – 2 weeks	3-4 weeks	> 1 month
Evacuation of building								
Main phone system not fully operational								
Cell phones not fully operational								
Computer systems not fully operational								
Other important equipment not fully operational								
Water lines disrupted								
Gas lines disrupted								
Electricity disrupted								
Did not receive supplies/materials								
Could not deliver products/services								

3. Did you lose employee productivity as a result of the earthquake? (Please indicate number of employees disrupted and the average time lost. For example, if 2 employees spent 5 hours each on data recovery, this is 2 employees, 5 hours.)

Cause of disruption	Estimated # employees affected	Estimated average time lost per affected employee						
		No disruption	< 1 hour	1-4 hours	5-10 hours	11-20 hours	21-40 hours	> 40 hours
Employees left work to care for homes & families	_____							
Employees temporarily distracted/less productive	_____							
Employees cleaning up after earthquake	_____							
Employees late for work due to damaged roads	_____							
Employees doing re-work or data recovery	_____							

4. What is your best estimate of your total costs to repair or replace buildings and equipment damaged as a result of the earthquake? (do not adjust for insurance or grants in aid) $ _____(approximate)

5. What is your best estimate of your total costs to repair or replace stock and inventory damaged as a result of the earthquake? (do not adjust for insurance or grants in aid) $ _____(approximate)

6. What is your best estimate of your total costs to repair or replace data and records damaged as a result of the earthquake? (do not adjust for insurance or grants in aid) $ _____(approximate)

7. Did you experience a reduction in customers or orders as a result of the earthquake? (Indicate the approximate duration with a check mark.)

Cause of reduced customers/orders	Estimated duration of impact					
	No disruption	1 day	2 – 6 days	1 - 4 weeks	between 1-3 months	> 3 months
Fewer customers because of damage to my building or premises						
Smaller/fewer orders from large customer(s) who suffered disruptions						
Could not receive orders because web site was not working						
Could not receive orders because phone lines were not working						
Foot traffic in neighborhood declined because of:						
Disruptions to roads and transit systems						

Neighborhood considered generally less attractive by potential customers						
Disruptions to nearby businesses whose employees are our customers						

8. What is your best estimate of the earthquake's impact on your total revenue in the 3 months following the event? (Circle ONE number.)

More than 25% below normal	11-25% below normal	6-10% below normal	1-5% below normal	No impact on revenue	1-10% above normal	More than 10% above normal
1	2	3	4	5	6	7

9. Do you expect to receive insurance payments or grants-in-aid to help cover any of the costs described above?
_____ No _____ Yes. I expect to receive approximately $_____ in assistance/insurance.

10. Please check all the preparedness activities undertaken by your firm before the earthquake and those you have initiated following the event.	Preparedness before earthquake (check ALL that apply)	Efforts initiated following the event (check All that apply)
Purchase earthquake insurance		
Purchase business interruption insurance		
Structural mitigation (e.g., reinforcing, bracing, bolting, etc., of building)		
Non-structural mitigation (e.g., strapping shelves & equipment)		
Develop a disaster plan		
Practice a disaster plan		
Train employees in emergency response		
Store First Aid supplies in building		
Redundancy (e.g., backup machines, extra inventory, emergency generator, etc.)		
Stockpile emergency supplies (e.g., spare parts, fuel, water, food, etc.)		
Store computer data files (backups) off-site		
Store copies of critical contracts and documents off-site		
Arrange with other organizations for mutual aid (e.g., sharing personnel, facilities, etc.)		
Increase % of supplies from non-local suppliers (i.e., less dependent on local suppliers)		
Increase % of sales to non-local customers (i.e., less dependent on local customers)		
Have engineer perform structural assessment of building		
Seek additional information about disaster planning & recovery		

11. Is your business planning to undertake additional preparedness activities in the future?
_____ No
_____ Yes. Nature of activities: _____

12. Have you previously experienced business disruption due to natural disaster, fire, or major accident?
_____ No (skip to question #14)
_____ Yes. Nature of disruption: _____

13. Did you have insurance coverage for these earlier events? _____ No _____ Yes

14. Which of the following two statements comes closest to your personal reaction to this earthquake?
_____ It taught me that earthquakes are powerful and sudden and potentially quite destructive.
_____ It taught me that earthquakes need not be too destructive, depending on the nature of the quake and the geology of your location.

15. Which of the following two statements comes closest to your personal reaction to this earthquake?
_____ Our organization seems well prepared for earthquakes since we fared pretty well.
_____ Our organization needs to get better prepared since more serious earthquakes can happen.

16. Which of the following two statements do you think reflects how most other business leaders in the region reacted to this earthquake?
_____ It taught them that earthquakes are powerful and sudden and potentially quite destructive.
_____ It taught them that earthquakes need not be too destructive, depending on the nature of the quake and the geology of your location.

On the following questions, please circle the number that best reflects your opinion/impression.

17. BEFORE the Nisqually earthquake, how well prepared for earthquakes was your organization compared to other organizations in this region?	Far less well prepared 1	2	3	Average 4	5	6	Much better prepared 7
18. Thinking about the overall effect of the Nisqually Earthquake on this region, how serious do you consider it in terms of harm to people?	Not at all serious 1	2	3	4	5	6	Extremely serious 7
19. AFTER the Nisqually earthquake, are you personally MORE worried or LESS worried about future earthquakes?	Far less worried 1	2	3	No change 4	5	6	Far more worried 7
20. How likely do you think it is that this region will experience an earthquake causing catastrophic levels of harm to people during your lifetime?	Not at all Likely 1	2	3	4	5	6	Extremely likely 7
21. If this region had an earthquake causing catastrophic levels of harm to people, how likely do you think it is that your business would recover and continue operating?	1	2	3	4	5	6	7
22. Government warnings about possible natural disasters tend to be:	Overly optimistic 1	2	3	Mostly accurate 4	5	6	Overly pessimistic 7
23. Media reports about possible natural disasters tend to be:	1	2	3	4	5	6	7
24. Structural mitigation for earthquakes (e.g., reinforcing, bracing or bolting a building) tends to be:	Extremely ineffective 1	2	3	4	5	6	Extremely effective 7
25. After an earthquake, businesses that had earthquake insurance generally receive reasonable payments from insurers.	Strongly disagree 1	2	3	4	5	6	Strongly agree 7
26. After an earthquake, adequate financial assistance for recovery will be available through government sources.	1	2	3	4	5	6	7

27. The following questions which have been found to be related to risk perceptions and behaviors in other studies. These will help us relate our findings to these other studies and so will allow us to draw more complete conclusions.

	Strongly disagree						Strongly agree
One should live one's life independently of others as much as possible	1	2	3	4	5	6	7
I would rather struggle through a personal problem by myself than discuss it with my friends.	1	2	3	4	5	6	7
I would help within my means if a relative told me that he (she) is in financial difficulty.	1	2	3	4	5	6	7
I like to live close to my good friends.	1	2	3	4	5	6	7
I tend to do my own thing and most people in my family do the same.	1	2	3	4	5	6	7
One does better working alone than in a group.	1	2	3	4	5	6	7
I enjoy talking to neighbors everyday.	1	2	3	4	5	6	7
When faced with a difficult personal problem it is better to decide yourself rather than follow the advice of others.	1	2	3	4	5	6	7
Even if a child won the Nobel prize the parents should not feel honored in any way.	1	2	3	4	5	6	7
Children should not feel honored even if the father were praised and given an award by government.	1	2	3	4	5	6	7
Aging parents should live at home with their children.	1	2	3	4	5	6	7
Children should live at home with parents until they get married.	1	2	3	4	5	6	7
There is not much my company can do to lessen the effects of a major earthquake on us.	1	2	3	4	5	6	7
Safety and risk avoidance are often discussed in our company.	1	2	3	4	5	6	7

28. In what industry sector does your business generate most of its sales or revenues? (check ONLY ONE)

___ Agriculture, Forestry, & Fishing
___ Manufacturing & Mining
___ Construction
___ Wholesale Trade
___ Health, Education, & Social Services
___ Finance & Insurance
___ Real Estate, Rental & Leasing
___ Transportation & Warehousing
___ Retail Trade
___ Information (e.g., publishing, data processing, software, website development, broadcasting, telecommunications, etc.)
___ Professional Services (e.g., accounting, legal, science/engineering, consulting, etc.)
___ Non-professional Services (e.g., lodging, food service, recreation, entertainment, etc.)
___ Business Services (e.g., administrative services, facilities support, mail, employment agencies, etc.)
___ Personal Services (e.g., laundries, beauty shops, child care, etc.)
___ Other. Please describe _____

29. Do you Own _____ or Lease _____ the main building in which your business operates?

30. What is the zip code of your main business building? _____

31. Form of business: _____ Proprietorship _____ Partnership _____ Corporation _____ Sub-S Corporation

32. In what year was your business founded? _____

33. What is your position or relationship with the business? (check ALL that apply)
_____ Owner _____ CEO _____ Manager/executive. Please identify your position/title _____

34. Is the current CEO the founder of your business? _____ No _____ Yes (skip to question #36)

35. If the current CEO is NOT the founder, was the prior CEO a relative of the current CEO? _____ No _____ Yes

36. Approximately what percentage of the ownership of your business is held by the following owner categories?
_____ % owned by the CEO
_____ % owned by members of the CEO's family
_____ % owned by the largest investor and that person's family (other than the CEO and his/her family)

37. How many people are employed in your business (not counting yourself)?
_____ # full-time employees _____ # part-time employees

38. How many of the CEO's relatives are employed in your business?
_____ # CEO's relatives who are full-time employees _____ # CEO's relatives who are part-time employees

39. What were your gross sales or revenues over the last fiscal year? $_____(approximate)

40. What is your year of birth? _____

41. Sex: _____ Male _____ Female

Again, thank you for your assistance with this study. Please return the questionnaire to:

NFIB Education Forum
Earthquake Survey
1201 "F" St., NW
Washington D.C. 20004

APPENDIX 3: WEIGHTING OF REGIONAL SAMPLE

The National Federation of Independent Business (NFIB) is a national association of more than 600,000 small businesses located throughout the United States. A sample of 4,000 was randomly selected from the list of NFIB members located in Washington State zip codes affected by the Nisqually earthquake. A mail survey of these members yielded 907 responses (22.7%). The frequency distributions of responses by industry category and firm size appear in Tables A2.1 and A2.2, respectively. In both tables, the frequency distribution of the population of Puget Sound small businesses is also reported. The population statistics are compiled from the U.S. Census, 1997 Economic Census zip code reports, and include all businesses in the designated zip codes that have less than 500 employees. Neither the population statistics nor the sample statistics include data from zip codes 98501 (downtown Olympia), 98134 (Harbor Island in Seattle), and 98104 (Pioneer Square in Seattle), as analyses of these areas are reported separately.

Table A2.1: Relative frequencies of industry categories for population and sample

Industry	Population	Sample
Agriculture, forestry, fishing	0.9%	6.3%
Finance & insurance	5.7%	4.5%
Manufacturing & mining	4.7%	9.9%
Real estate, rental, leasing	5.1%	2.1%
Construction	11.4%	20.4%
Transportation & warehousing	2.3%	3.5%
Wholesale Trade	6.7%	5.6%
Retail Trade	13.5%	18.5%
Professional services	11.2%	8.6%
Non-professional services	9.2%	6.1%
Business services	5.1%	2.6%
Personal services	9.4%	4.6%
Other	14.9%	7.3%
Total	100.0%	100.0%
Number of small firms	87,439*	832*

* does not include data from downtown Olympia, Pioneer Square or Harbor Island (zip codes 98501, 98104, and 98134)

Comparison of the population and sample frequency distributions in Table A2.1 reveals that firms in the agriculture, manufacturing, construction, and retail industries are over-represented in the sample, whereas firms in the real estate and services industries are under-represented. A similar comparison in Table A2.2 shows that the sample represents the population fairly well with respect to firm size, although the smallest firms are slightly under-represented.

Table A2.2: Relative frequencies of firm size categories for population and sample

Size of firm	Population	Sample
0 to 4.5 employees	55.2%	49.1%
5 to 19.5 employees	31.7%	32.5%
20 to 49.5 employees	8.4%	12.5%
50 to 99.5 employees	2.8%	3.4%
100 or more employees	1.9%	2.4%
Total	100.0%	100.0%
Number of small firms	87439*	832*

* does not include data from downtown Olympia, Pioneer Square or Harbor Island (zip codes 98501, 98104, and 98134)

Given that an individual's survey responses may be influenced by industry membership and/or firm size, and that some industry and firm size categories are over-represented in the sample, a direct extrapolation of the survey results could produce a misleading picture of the earthquake's overall impact on the population of small businesses in the Puget Sound region. For example, if construction firms are more likely than firms in other industries to suffer particular kinds of disruption, then the over-representation of construction firms in the sample would yield an exaggerated estimate of the disruption experienced by all firms in the region.

To correct for this possibility, the survey data were "weighted" according to the following arithmetic scheme. First, the relative frequency of each industry – firm size category, a matrix of 75 cells (5 size categories by 15 industry categories), was computed for the population. For example, retail firms employing 5 to 19.5 people comprise 5.63% of the total population of small firms in the Puget Sound region. The same computations were performed to generate relative frequencies for each industry – firm size category in the sample (6.33% of firms in the sample are retailers with 5 to 19.5 employees). Second, a ratio of the population matrix to the sample matrix was computed. A value less than 1.0 in a particular cell of this ratio matrix indicates that firms in that industry – firm size category are over-represented in the sample whereas a value greater than 1.0 in a cell of the ratio matrix indicates that firms in that industry – firm size category are under-represented in the sample. Third, each data point in the sample was weighted by the ratio value associated with its industry – firm size category. Given this weighting scheme, when descriptive statistics for the sample are computed, each retailer with 5 to 19.5 employees is counted as 0.89 retailers. Similarly, each professional services firm employing 0 to 4.5 people is counted as 1.52 firms because that category is under-represented in the sample. As a result, the reported statistics provide more accurate estimates of the characteristics of the population.