

**Perceived Stakeholder Role Relationships and  
Adoption of Seismic Hazard Adjustments<sup>1</sup>**

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*This study examined the relationships among perceived stakeholder characteristics, risk perceptions, respondent characteristics, and self-reported adoption of 16 seismic hazard adjustments by residents in areas of high and medium seismic risk. Seven stakeholder types, ranging from the federal government to the respondents themselves, were rated on three characteristics—seismic hazard knowledge, trustworthiness, and responsibility for taking action to protect households. Respondents rated their hazard knowledge as higher than that of peers, indicating optimistic bias. However, they also rated their hazard knowledge as lower than that of authorities and the news media—confirming that there are limits to optimistic bias. Partial correlation analyses indicated that perceived stakeholder characteristics influenced hazard adjustment by both central and peripheral routes to behavioral change. Paradoxically, respondents' adoption of hazard adjustments was more strongly correlated with the perceived characteristics of peers, even though these were rated lower*

*on hazard knowledge, trustworthiness, and protection responsibility. Although the effects were marginally significant, perceived stakeholder characteristics were related to respondents' characteristics (location, gender, and ethnicity). This suggests risk communicators should consider tailoring their choice of sources as well as the content of their messages to different audience segments.*

**Key words:** Stakeholders, trust, protection responsibility, hazard adjustments, earthquakes

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## Introduction

Environmental hazard managers seek to prepare their communities for disasters by encouraging residents to adopt hazard adjustments (Burton, Kates and White 1978, Mileti 1980). These include *hazard mitigation* measures providing passive protection at the time of disaster impact, *emergency preparedness* measures supporting active response when a disaster strikes, and *recovery preparedness* measures (e.g., hazard insurance) supporting physical reconstruction after disaster (Lindell and Perry 2000). Households' adoption of hazard adjustments has been found to be correlated with disaster experience, risk perception, personality characteristics, demographic characteristics, and economic resources (Lindell and Perry 2000). However, hazards researchers have paid scant attention to risk area residents' relationships with the social sources from which they obtain hazard information. This issue has been addressed in previous research on risk communication, but that research has focused mostly on one attribute (trust) of a limited number of stakeholders (primarily industry, scientists, and the federal government). The present article extends this research by obtaining ratings of seven types of stakeholders ranging from the federal government to the respondents themselves on three key attributes—knowledge, trustworthiness, and protection

responsibility. The relevance of these stakeholders and attributes is tested first by assessing whether the stakeholders differ from each other in predictable ways on the key attributes. Second, additional analyses examine whether any of the stakeholder attributes have a direct effect on household adjustment adoption or affect it indirectly through changes in risk perception. Third, the final analyses examines whether perceived stakeholder attributes are systematically related to respondent characteristics—location, gender, and ethnicity. The discussion of the results addresses their relevance to previous research on *optimistic bias* (Weinstein 1989) and the *Elaboration Likelihood Model* (Petty and Cacioppo 1986). In addition, the discussion addresses the practical value of this study by identifying the stakeholders that are most influential in promoting seismic hazard adjustment and the message recipients that are most receptive to those stakeholders.

### **Seismic Stakeholders and Their Perceived Characteristics**

The first objective of this study is to determine whether the seismic safety stakeholders differ from each other in predictable ways on key attributes. Previous research has distinguished among stakeholders variously characterized as authorities (federal, state, and local government), evaluators (scientists, medical professionals, universities) watchdogs (news media, citizens' and environmental groups), industry/employers, and households (Drabek 1986, Lang and Hallman 2005, Pijawka and Mushkatel 1991). Authorities include federal, state, and local government agencies that vary in their technical knowledge and financial resources. In addition, research on optimistic bias (Weinstein 1989), also known as "comparative optimism" (Klar and Ayal 2004), calls attention to the need for addressing the relationships between households (self and immediate family) and their peers (friends, relatives, neighbors, and coworkers), who are sources of information and social comparison (Turner 1991). Moreover, employers affect household members' safety through hazard adjustments that protect people in the workplace and the news media can put environmental hazards on the public agenda and educate those who do not have direct experience with disasters (Prater and Lindell 2000).

The interrelationships among these stakeholders can be understood in terms of the Godschalk, Parham, Porter, Potapchuk and Schukraft (1994) “onion theory”, in which households (self and family) are located in the center ring, peers (friends, relatives, neighbors, and coworkers) are in the secondary ring, news media are in the tertiary ring, and authorities are in the outermost ring. The interrelationships among stakeholders can be defined by the power they wield over each other’s decisions to take protective actions. Although Godschalk and his colleagues did not specify the nature of these power relations, French and Raven (1959, Raven 1965) provide some insights. Specifically, they posited that power relationships can be defined in terms of six bases of power—reward, coercive, legitimate, referent, expert, and information power. Reward and coercive power are the principal bases of regulatory approaches, but Raven (1993) noted these require continuing surveillance to ensure rewards are received only for compliance and punishment will follow noncompliance. Unfortunately, many state mandates are hampered by a lack of formal reporting or review by state officials, and limited or no penalties for failing to enforce their provisions (Burby, French and Nelson 1998, Nelson and French 2002). Consequently, there is a need to better understand the ways in which households can be influenced by bases of power other than reward and coercion.

French and Raven’s conception of expert (i.e., understanding of cause and effect relationships in the environment) and information (i.e., knowledge about states of the environment) power suggests assessing perceptions of stakeholders’ seismic hazard knowledge. One particularly important consideration is that research on optimistic bias indicates people rate themselves as less likely than average to be affected by hazardous events (Weinstein 1989, Weinstein and Klein 1996) and this effect is most pronounced in situations where they believe they can control the outcomes (Dunning, Heath and Suls 2004). The implication of these findings is that respondents will judge their hazard knowledge to be higher than that of their peers, a proposition recently confirmed by Hatfield and Job (2001). However, government agencies such as the U.S. Geological Survey and Federal Emergency Management Agency generate hazard information and disseminate it

through state and local agencies and the news media. Consequently, ratings of hazard knowledge should be higher for authorities and the news media than for self and family.

**H1a:** Mean ratings of hazard knowledge will be highest for authorities and the news media, next highest for self/family, and lowest for peers.

French and Raven's conception of referent power is defined by a person's sense of shared identity with another (Eagly and Chaiken 1993), which is related to trust in that person. However, trust has been defined in an almost bewildering variety of ways. These include fairness, unbiasedness, willingness to tell the whole story, accuracy, and trustworthiness (Meyer 1988); perceived competence, objectivity, fairness, consistency, and faith (Renn and Levine 1991); commitment, competence, caring, and predictability (Kasperson, Golding and Tuler 1992); trust and confidence (Siegrist, Earle and Gutscher 2003); source credibility and social trust (Frewer, Scholderer and Bredahl 2003); general trust and skepticism (Poortinga and Pidgeon 2003); competence, transparency, public interest, and honesty (Lang and Hallman 2005); ability, integrity, and benevolence (Levin, Whitener and Cross 2006); and honesty, full disclosure, and dedication to duty (Wray, Rivers, Whitworth, Jupka and Clements 2006).

One helpful distinction concerns the difference between source credibility and social trust (Frewer, et al. 2003). *Source credibility* comprises expertise (knowledgeability about the situation) and trustworthiness (honesty and completeness of information communicated about the situation). By contrast, *social trust* is about people's willingness to let expert institutions manage risks. Social trust seems most relevant when an institution controls a hazard (e.g., genetically modified food, nuclear power plants) whereas source credibility is most relevant when that institution provides people with the information they need to decide whether (and how) to manage risks themselves (e.g., earthquake hazard adjustments). Source credibility, also known as interpersonal trust, is relevant

because it has been shown to affect risk perception (Trumbo and McComas 2003).

Although trustworthiness clearly is an important stakeholder attribute, previous research provides a somewhat ambiguous basis for specific predictions about differences in stakeholders' perceived trustworthiness. The Godschalk, et al. (1994) onion theory implies trust will be highest in stakeholders that are closest to the respondents (family) and lowest in the stakeholders that are the most remote to the respondents (federal government). Thus, ratings of trustworthiness are expected to be highest for family because family members share a common fate with regard to seismic hazards and, thus, have a powerful incentive to provide accurate information about this hazard. Peers (i.e., friends, relatives, neighbors, and coworkers) are expected to be almost as trustworthy as family members because a high similarity in values is one of the major bases of interpersonal attraction (Berscheid 1985). This value similarity would be expected to lead peers to communicate more honestly about seismic hazards and be perceived as more trustworthy (McGuire 1985).

Trust in more remote stakeholders such as the news media and government is likely to be based on *role-based trust* "predicated on knowledge that a specific person occupies a particular role in the organization rather than specific knowledge about the person's capabilities, dispositions, motives, and intentions" (Kramer 1999, p. 578). Trust in the news media seems to be quite modest, with the Gallup Organization (2003) reporting only a minority of citizens had a "great deal/quite a lot" of confidence in newspapers (33%) and TV news (35%). Moreover, polls show greater confidence in state and local government than in federal government, but the difference is not large (Shaw and Reinhart 2001). For example, one poll showed more respondents had "a great deal/quite a lot" of confidence in local (37%) or state (36%) government than in federal government (26%).

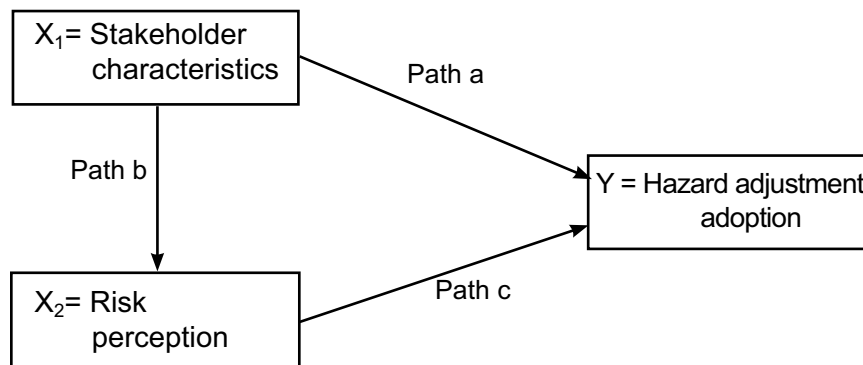
**H1b:** Mean ratings of trustworthiness will be highest for family, next highest for peers, and lowest for news media and authorities.

French and Raven (1959) defined legitimate power by the rights and responsibilities associated with each role in a social network, which raises questions about what households consider to be the responsibility of different stakeholders for protecting them from seismic hazard. This is reinforced by research on stakeholders' perceived *protection responsibility*, which dates from Jackson's (1977, 1981) research that attributed low rates of seismic adjustment adoption to respondents' beliefs that the federal government was the stakeholder most responsible for coping with earthquakes. Much later, Garcia (1989) found respondents had come to believe earthquake preparedness was an individual's responsibility. Her conclusion that a perception of personal protection responsibility leads to a higher level of seismic adjustment adoption is supported by similar findings on tornado adjustment adoption (Mulilis and Duval 1997).

**H1c:** Mean ratings of protection responsibility will be highest for self/family, next highest for authorities, and lowest for news media and peers.

The second objective of this study is to determine whether perceived stakeholder characteristics are systematically related to households' adoption of seismic hazard adjustments. In particular, perceived stakeholder characteristics could affect hazard adjustment adoption in one of two ways, direct or indirect. As Figure 1 indicates, a direct effect occurs if a stakeholder characteristic ( $X_1$ ) influences hazard adjustment adoption ( $Y$ ) through *path a*. This direct influence mechanism is described by Fishbein and Ajzen (1975) as the effect of the subjective norm, by Petty and Cacioppo (1986) as the peripheral route to persuasion, and by Chaiken (1987) as heuristic processing. An indirect effect occurs if perceived stakeholder characteristics change people's risk perceptions ( $X_2$ ) through *path b* and this change, in turn, affects their adoption of hazard adjustments through *path c*. This indirect influence mechanism is described by Fishbein and Ajzen (1975) as the effect of the attitude toward the act, by Petty and Cacioppo (1986) as the central route to persuasion, and by Chaiken (1987) as systematic processing.

**Figure 1. Path analysis of direct and indirect effects of perceived stakeholder characteristics on hazard adjustment adoption**



Paton (2003) proposed that lack of trust in information sources could disrupt the process of hazard adjustment adoption. Lindell and Whitney (2000) found support for a direct effect of perceptions of stakeholder characteristics on the adoption of seismic hazard adjustments. Specifically, two perceived stakeholder characteristics (hazard knowledge and protection responsibility) had significant positive correlations with hazard adjustment intentions and actual adjustment adoption. Unfortunately, their study was limited by a small sample of 168 students from a high seismic risk area. Thus, there is a need to determine if Lindell and Whitney's findings generalize to more demographically diverse samples of respondents from communities having both high and moderate levels of seismic risk.

**H2:** Positive perceptions of stakeholder characteristics will have direct effects on the adoption of seismic hazard adjustments.

The third objective of this study is to identify respondent characteristics that might affect respondents' perceptions of stakeholder characteristics. Location is an obvious correlate of hazard adjustment because regions of the country differ in their hazard exposure, but most of the research on seismic hazard adjustment has been conducted in



California (Lindell and Perry 2000). This state has a very high seismic hazard, so comparisons should be made to an area with a moderate level of hazard, such as Washington state. More specifically, Los Angeles area residents have been acutely aware of their seismic hazard since the 1971 Sylmar earthquake but seismic awareness in the Seattle area was low until the 2001 Nisqually earthquake. The earthquakes in Southern California stimulated households' active information seeking and passive information receipt (Mileti and Darlington 1997, Mileti and Fitzpatrick 1993, Turner, Nigg and Heller-Paz 1986). The difference between Los Angeles and Seattle area residents' disaster experience would be expected to affect respondents' ratings of hazard knowledge but not their ratings of trustworthiness or protection responsibility.

**H3a:** Perceptions of stakeholder hazard knowledge will be significantly higher for respondents in a high seismic risk area than in a moderate seismic risk area.

Gender is a relevant variable because previous research has shown women tend to perceive a variety of risks to be greater than do men (Fothergill 1996). Nonetheless, there is some evidence that they adopt fewer seismic hazard adjustments (Lindell and Prater 2000). One possible explanation for this result is that women have lower levels of perceived protection responsibility but this possibility has not been addressed in previous research. More generally, there is limited research on the degree to which women differ from men in their perceptions of any stakeholders. Major (1999) reported some evidence that, compared to men, women had higher confidence in authorities, news media, and peers but the effects were consistent across samples only for peers. Moreover, the fact that women tend to be more supportive than men for government initiatives for family programs (Atkeson and Rapaport 2003, Shapiro and Mahajan 1986) suggests gender will correlate with ratings of authorities on all three stakeholder attributes.

**H3b:** Females will have significantly higher ratings of authorities' hazard knowledge and trustworthiness, the news media's and peers' trustworthiness, and lower self-ratings of personal protection responsibility.

Finally, ethnicity is a potentially relevant variable because Blacks have been found to have greater immersion in peer networks and more distant relationships with government agencies (Lindell and Perry 2004, pp. 163-169). Similar results have been found in a number of studies on Hispanics (Fothergill, Maestas and Darlington 1999), who noted these patterns may be reinforced by limited English language proficiency. Moreover, Perry and Lindell (1991) found Hispanics in one community most frequently nominated peers and least frequently nominated authorities (police/fire) as the most credible source—although this pattern was reversed on another community. Credibility was defined in this study as reliability and trustworthiness, not hazard knowledge or protection responsibility.

**H3c:** Minorities will have significantly lower ratings of authorities' trustworthiness, and higher ratings of peers' trustworthiness.

## Method

### Respondents

The data reported here are taken from a 1997 survey whose other results were reported by Lindell and Prater (2000, 2002). Three cities in Southern California (Inglewood, Norwalk, and Santa Clarita) and three others in Western Washington (Bremerton, Edmonds, and Renton) were selected because the *County and City Data Book* (U.S. Department of Commerce 1994) showed they are diverse in household ethnicity, education, and income. Moreover, Inglewood and Renton were categorized as leaders in community hazard management, whereas Norwalk and Bremerton were categorized as laggards (May and Birkland 1994). May and Birkland did not classify Santa Clarita and Edmonds, but Santa Clarita was picked because it was struck by the 1994 Northridge earthquake. Edmonds was selected because it had education and income levels that approximated those of Santa Clarita.

Consistent with Dillman's (1978, 1983) procedure, questionnaires were mailed to 300 randomly selected addresses in each city. Those who did not respond within 10 days were sent a second questionnaire and this process was repeated through four mailings. A total of 561 in

the sample of 1800 responded, but four households returned duplicate questionnaires that differed from each other so all four pairs were deleted. This left 553 questionnaires—332 from Western Washington and 221 from Southern California. A total of 174 households no longer at their original addresses, undeliverable, or who returned incomplete questionnaires were deleted, yielding an adjusted response rate of 34% (19% in Inglewood, 23% in Norwalk, 31% in Santa Clarita, 36% in Edmonds, 37% in Renton, 38% in Bremerton). This is low, but lies within the 31-52% range obtained by Mileti and Fitzpatrick (1993). The low response rate might raise questions about sample representativeness and, indeed, comparison of the respondents from each city to the 1994 *County and City Data Book* (U.S. Department of Commerce 1994) showed the sample slightly over-represented males, homeowners, and older residents, and had higher levels of education than the populations from which they were drawn (see Lindell and Prater 2000, for further details). However, over-representation of some demographic categories will produce bias in psychological variables such as perceived stakeholder characteristics only to the degree the latter are correlated with demographic variables, but such correlations are generally low (Lindell and Perry 2000). Moreover, reports by Curtin, Presser and Singer (2000), Keeter, Miller, Groves and Presser (2000), and Lindell and Perry (2000) indicate low response rates do not appear to bias central tendency estimates such as means and proportions. Lindell and Perry (2000) argued that low response rates would affect correlations only if the item variances were severely restricted by a severe over-representation of respondents at one end of the response distribution.

### Measures

The portion of the questionnaire not analyzed previously by Lindell and Prater (2000 2002) included measures of the seven stakeholder types—which were listed as “federal government”, “state government”, “local government”, “newsmedia (paper, TV, radio)”, “your employer”, “friends, relative, neighbors, and coworkers” (summarized below as peers), and “yourself and your immediate family”. In general, each stakeholder type was rated on

three dimensions—hazard knowledge (“each of the following is *knowledgeable about* earthquake hazard”), trustworthiness (“each of the following is *willing to provide you with accurate information about* earthquake hazard”), and protection responsibility (“each of the following is *responsible for protecting you from* earthquake hazard”). The one exception was that “your immediate family” not “yourself and your immediate family” was rated on trustworthiness. The variables were measured on 5-category Likert scales with anchors *Not at all* (= 1) and *Very great extent* (= 5).

Gender was categorized as 0 for males and 1 for females. Ethnicity was dummy coded into three variables—Blacks (= 1), Hispanics (= 1), and Whites (= 1). Risk perception was measured by the respondent’s judgments that an earthquake will occur in the next 10 years that causes a) major damage to property in her/his city, b) major damage to his/her home, c) injury to self or immediate family, d) disruption to his/her job that prevents them from working, and e) disruption to shopping and other daily activities. These five items were measured on 5-category Likert scale with anchors *Not at all likely* (= 1) and *Almost a certainty* (= 5). Item responses were averaged and the resulting scale had an acceptable reliability (Cronbach’s  $\alpha = .88$ ).

Adoption of hazard adjustments was measured by asking the respondent whether he or she had adopted each of 16 different hazard adjustments. These items, drawn from previous research (Lindell 1994, Mileti and Darlington 1995, Mulilis, Duval and Lippa 1990, Russell, Goltz and Bourque 1995, Turner, et al. 1986), fell into one of three categories. Emergency preparedness actions were stocking at least 4 gallons of water and a 4 day supply of dehydrated or canned food and having a transistor radio with spare batteries, a first aid kit, a fire extinguisher, and wrenches to operate utility valves. Hazard mitigation actions were strapping water heaters and tall furniture, installing latches to keep cabinets secured, and purchasing earthquake insurance. Planning activities were developing a household earthquake emergency plan, learning how and where to turn off utility lines, learning the location of nearby medical emergency centers, contacting the Red Cross or government agencies for information about earthquake hazard, attending meetings to learn about earthquake hazard, joining a community organization dealing

with earthquake emergency preparedness, and having written a letter to a newspaper or a governmental official supporting action about earthquake hazard. Respondents' *No* (= 0) or *Yes* (=1) answers to the items were summed to compute an index ranging 0-16. As reported by Lindell and Prater (2000, 2002), the 16 hazard adjustment items formed a scale with acceptable reliability (Cronbach's  $\alpha = .74$ ).

### Analyses

Mean ratings were computed for respondents' perceptions of stakeholder characteristics. Interrater agreement on individual items was also assessed because mean ratings near the midpoint of a rating scale can be quite ambiguous (Lindell and Brandt 1999, 2000). For example a mean rating of  $M = 3.0$  can result if the responses are identical (i.e., all respondents give a rating of 3, so the item variance is zero), uniformly distributed (i.e., an equal number of responses in each of the five categories), or bipolar (i.e., half of the responses are 1 and the remainder are 5). These three patterns have significantly different implications about people's beliefs. Consequently, interrater agreement was assessed using  $r^*_{wg}$ , which is +1.0 (its upper limit) when the item variance is zero, 0 when ratings are uniformly distributed, and -1.0 when the ratings are bipolar (in rare circumstances,  $r^*_{wg} < -1.0$ , see Lindell, Brandt and Whitney 1999).

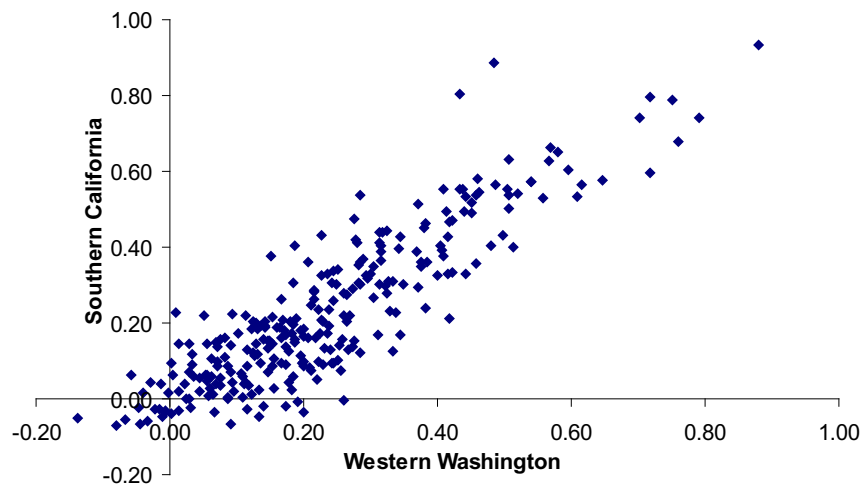
## Results

### Homogeneity of Intercorrelations

Hazard knowledge, trustworthiness, protection responsibility, gender, ethnicity, risk perception, and hazard adjustment adoption scores were initially correlated separately for the California and Washington samples because a preliminary test indicated the covariance matrices were not equal (Box's  $M = 341.34$ ,  $F_{231, 418642} = 1.40$ ). Given the large number of degrees of freedom, this test has the power to detect trivial levels of heterogeneity, so a graphical test was performed. Following Gnanadesikan (1977, see Lindell and Perry 1990 for an example), the equivalence of the patterns of intercorrelations among the perceived stakeholder characteristics within each of these two states was assessed

by taking the obtained value of each correlation for respondents from California and plotting it against the corresponding value of that correlation for respondents from Washington. For example, one data point is defined by plotting the value of the correlation between federal hazard knowledge and state hazard knowledge for the Southern California sample on the  $x$ -axis and the corresponding value of the correlation between federal hazard knowledge and state hazard knowledge for the Washington sample on the  $y$ -axis. Thus, the total number of data points is equal to the distinct correlation coefficients in the correlation matrix for each sample— $k(k-1)/2 = 21(20)/2 = 210$ . Figure 2 shows the cross-plot of interitem correlations for California and Washington respondents is approximately linear and has no obvious outliers, indicating a similar overall pattern of intercorrelations among the perceived stakeholder characteristics in the two states. Consequently, tests of H2 and H4 were conducted by pooling the correlation matrixes for the two states. It is important to note that finding the matrixes of inter-item correlations for the two states are equal does not imply that the vectors of item means are also equal for the two states. This is tested in H3.

**Figure 2. Cross-plot of interitem correlations for Washington and California respondents**



**Table 1. Means (M), standard deviations (SD), interrater agreement values (r\*wg), and intercorrelations (rij) among variables.**

Variable	M	SD	r* <sub>wg</sub>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1. FedKn	3.46	1.03	.49	—																									
2. StaKn	3.64	.98	.51	.72	—																								
3. LocKn	3.49	1.05	.48	.48	.73	—																							
4. MedKn	3.39	1.07	.46	.38	.51	.56	—																						
5. EmpKn	3.09	1.21	.39	.30	.38	.47	.43	—																					
6. PeerKn	2.91	.98	.51	.20	.35	.47	.45	.52	—																				
7. SelKn	3.40	1.05	.48	.10	.24	.42	.37	.46	.62	—																			
8. FedTr	3.24	1.10	.45	.60	.45	.30	.33	.26	.18	.14	—																		
9. StaTr	3.52	1.02	.49	.47	.59	.47	.41	.28	.27	.24	.77	—																	
10. LocTr	3.46	1.06	.47	.36	.49	.61	.48	.33	.37	.32	.59	.76	—																
11. MedTr	3.53	1.12	.44	.29	.38	.37	.62	.28	.32	.26	.43	.53	.56	—															
12. EmpTr	3.08	1.31	.35	.24	.28	.30	.35	.67	.39	.34	.36	.37	.37	.39	—														
13. PeerTr	2.98	1.15	.43	.17	.23	.28	.32	.35	.52	.37	.28	.33	.40	.40	.56	—													
14. SelTr	3.30	1.25	.38	.13	.20	.28	.25	.35	.48	.53	.23	.29	.41	.33	.49	.75	—												
15. FedRe	3.12	2.12	-.06	.14	.09	.06	.09	.05	-.02	-.02	.12	.06	.04	.05	.07	.06	.03	—											
16. StaRe	3.31	1.32	.34	.18	.22	.17	.16	.05	.03	.06	.19	.22	.18	.17	.13	.16	.12	.57	—										
17. LocRe	3.36	1.35	.33	.15	.22	.21	.19	.11	.07	.10	.12	.18	.22	.18	.15	.17	.13	.51	.90	—									
18. MedRe	2.75	1.32	.34	.08	.12	.10	.27	.06	.06	.06	.05	.08	.07	.25	.12	.17	.12	.34	.54	.57	—								
19. EmpRe	2.94	1.37	.31	.15	.19	.21	.24	.34	.20	.24	.11	.11	.14	.19	.42	.28	.27	.31	.49	.52	.42	—							
20. PeerRe	2.48	1.23	.38	.02	.08	.20	.18	.20	.31	.26	.00	-.01	.07	.10	.22	.35	.31	.20	.29	.33	.46	.52	—						
21. SelRe	4.08	1.26	.37	.06	.14	.18	.18	.15	.24	.28	.09	.16	.17	.16	.19	.24	.31	.09	.16	.16	.16	.31	.31	—					
22. Gender	.41	.49	-	.02	.06	.13	.19	.05	.07	.06	-.01	.03	.03	.13	.03	.07	.01	.14	.16	.16	.22	.18	.19	.08	—				
23. Black	.05	.22	-	.04	.00	.02	-.01	-.03	-.02	-.06	.02	.03	.04	.01	-.03	.02	.01	.04	.04	.04	.06	-.03	.07	.01	.06	—			
24. Hispanic	.08	.28	-	-.01	-.01	.02	.11	.06	.03	.00	.00	-.02	.01	.06	-.01	.00	-.03	.05	.08	.10	.09	.04	.05	-.06	.00	-.07	—		
25. White	.70	.46	-	.02	.03	-.02	-.04	-.01	-.04	.00	.02	.04	-.01	-.04	.03	.01	.01	-.04	-.05	-.07	-.10	.02	-.10	.03	.02	-.36	-.47	—	
26. RiskPer	2.84	.91	-	.00	.06	.20	.18	.18	.18	.24	-.02	-.01	.10	.12	.14	.10	.12	.14	.09	.15	.11	.15	.21	.08	.23	.07	.16	-.06	—
27. HazAd	8.04	3.03	-	-.05	.01	.12	.05	.24	.25	.39	-.08	.01	.09	.03	.18	.12	.22	-.03	-.05	-.02	-.02	.10	.08	.12	-.10	-.05	-.06	.07	.10

Note: Respondents from Western Washington (332) and Southern California (221) combined. N for individual correlations ranges from 476 to 537 because of missing data.

<sup>a</sup>r > .11 are significant at p < .01. <sup>b</sup>.09 ≤ r < .11 are significant at p ≤ .05.

Fed = Federal government, Sta = State government, Loc = Local government, Med = News media, Emp = Employer, Sel = Self/family, Gender = Female, Kn = Knowledge, Tr = trust, Re = responsibility,

Black = African American ethnicity, Hispanic = Hispanic ethnicity, White = Caucasian, RisPer = Risk perception, HazAd = Seismic hazard adjustments adopted,

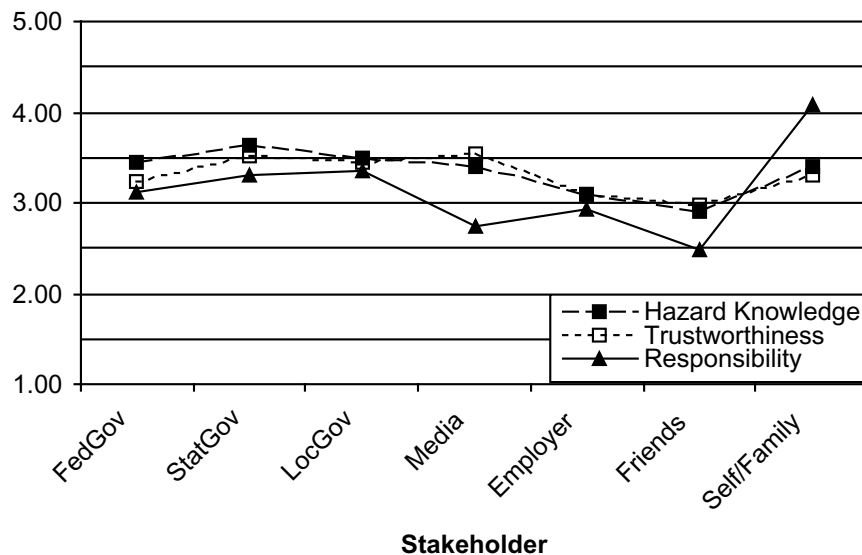
The resulting correlation matrix (see Table 1) reveals high intercorrelations among stakeholders with respect to each of the characteristics (i.e., Variables 1-7, 8-14, and 15-21 all have statistically significant positive correlations). In addition, 35 of the 49 correlations of stakeholder knowledge with stakeholder responsibility are significantly positive, as are 37 of the 49 correlations of stakeholder trustworthiness with stakeholder responsibility. The number of significant correlations (221 of 276 = 80%) substantially exceeds the number expected by the experiment-wise error rate (1% of 276 = 3). This large number of significant correlations might seem to indicate that the perceived stakeholder characteristics should be combined into a single scale. However, the magnitudes of the correlations of hazard knowledge and trustworthiness with protection responsibility are quite low and those of stakeholder characteristics with gender, ethnicity, risk perception, and hazard adjustment adoption are inconsistent with summing either by stakeholder (across characteristics) or by characteristic (across stakeholders).

### **Perceived Hazard Knowledge, Trustworthiness, and Responsibility**

Figure 3 shows a plot of mean ratings for perceived hazard knowledge, trustworthiness, and protection responsibility across the seven stakeholder types. Interrater agreement on stakeholder hazard knowledge was moderately high across all items (average  $r^*_{wg} = .47$ ), although there was slightly less agreement on employers' knowledge ( $r^*_{wg} = .39$ ) than on other stakeholders. To test H1a (Mean ratings of hazard knowledge will be highest for authorities and the news media, next highest for self/family, and lowest for peers), ratings of federal, state, and local government, and news media were averaged, as were those for employer and peers. In support of the hypothesis, the mean ratings for authorities and media are significantly larger than those for self/family ( $t_{518} = 2.15, p = .032$ ). The difference is relatively small, as indicated by Cohen's (1988) standardized difference  $d = .09$ . Also as predicted, the mean ratings for self/family are significantly higher than those for peers ( $t_{474} = 10.14, p < .0001, d = .39$ ).



**Figure 3. Mean ratings of perceived hazard knowledge, trustworthiness, and protection responsibility across seven stakeholders.**



Levels of interrater agreement across all trustworthiness items are slightly lower than the corresponding levels for hazard knowledge (average  $r^*_{wg} = .43$ ), with the lowest level of agreement being found on employer trustworthiness ( $r^*_{wg} = .35$ ). Contrary to H1b (Mean ratings of trustworthiness will be highest for family, next highest for peers, and lowest for authorities), trustworthiness ratings for family are significantly smaller (rather than larger, as predicted) than for authorities and media ( $t_{515} = -2.48, p < .0001, d = -.12$ ). Also contrary to H1b, authorities and media are rated significantly higher than peers ( $t_{465} = 8.21, p < .0001, d = -.39$ ).

Interrater agreement across all protection responsibility items is substantially lower than for the other two perceived stakeholder characteristics (average  $r^*_{wg} = .30$ ). In particular, there is no agreement in respondents' ratings of the federal government's protection responsibility ( $r^*_{wg} = .06$ ). Consistent with H1c (Mean ratings of protection responsibility will be highest for self/family, next highest for authorities, and lowest for news media and peers), the ratings for

self/family are significantly higher than those for authorities and media ( $t_{522} = 14.10, p < .0001, d = .80$ ). Moreover, ratings for authorities and media are significantly higher than those for peers ( $t_{465} = 7.95, p < .0001, d = .35$ ).

H2 (Respondents' perceptions of stakeholder characteristics will have direct effects on their adoption of seismic hazard adjustments) was partially supported by the finding that 10 of the 21 perceived stakeholder characteristics had significant correlations with hazard adjustment adoption. However, risk perception also had a statistically significant correlation with hazard adjustment ( $r = .10$ ). Consequently, the data were analyzed further to determine whether the correlation of perceived stakeholder characteristics with hazard adjustment adoption was a spurious effect resulting from the correlations between risk perception and perceived stakeholder characteristics. The correlation between perceived stakeholder characteristics and hazard adjustment could be classified as spurious if the *partial correlations* of perceived stakeholder characteristics with hazard adjustment adoption were statistically nonsignificant when each of the 21 items measuring stakeholder characteristics were held constant. As Table 2 indicates, 9 of the 21 values for the partial correlation,  $r_{1Y.2}$  (where  $X_1$  is the stakeholder characteristic,  $X_2$  is risk perception, and  $Y$  is hazard adjustment adoption), were statistically significant. These results suggest stakeholder characteristics might have a direct effect on hazard adjustment adoption that is independent of risk perception. To test whether stakeholder characteristics might also have an indirect (i.e., mediation) effect on hazard adjustment adoption through risk perception requires both a statistically significant correlation of the relevant stakeholder characteristic with risk perception *and also* a statistically significant correlation of risk perception with hazard adjustment adoption (James and Brett 1984). As Table 2 indicates, 8 of the 21 stakeholder characteristics showed evidence consistent with an indirect effect of stakeholder characteristics on hazard adjustment adoption through risk perception. Another three stakeholder characteristics showed evidence supportive of joint effects of stakeholder characteristics and risk perception on hazard adjustment adoption. That is, there was evidence suggesting that each variable had an effect on hazard adjustment that was independent of the other. Finally,

four perceived stakeholder characteristics had no evidence of effects on hazard adjustment adoption—either directly or indirectly through risk perception.

**Table 2. Partial correlations of risk perception and perceived stakeholder characteristics with hazard adjustment adoption.**

	$r_{12}$	$r_{1Y}$	$r_{2Y}$	$r_{1Y-2}$	$r_{2Y-1}$	Effect of perceived stakeholder characteristics
<i>Hazard Knowledge</i>						
Federal Knowledge	.00	-.05	.10*	-.05	.10*	None
State Knowledge	.06	.01	.10*	.00	.10*	None
Local Knowledge	.20**	.12**	.10*	.10*	.08	Direct
Media Knowledge	.18**	.05	.10*	.03	.09*	Indirect
Employer Knowledge	.18**	.24**	.10*	.23**	.06	Direct
Peer Knowledge	.18**	.25**	.10*	.24**	.06	Direct
Self/Family Knowledge	.24**	.39**	.10*	.38**	.01	Direct
<i>Trustworthiness</i>						
Federal Trust	-.02	-.08	.10*	-.08	.10*	None
State Trust	-.01	.01	.10*	.01	.10*	None
Local Trust	.10*	.09*	.10*	.08	.09*	Indirect
Media Trust	.12**	.03	.10*	.02	.10*	Indirect
Employer Trust	.14**	.18**	.10*	.17**	.08	Direct
Peer Trust	.10*	.12**	.10*	.11*	.09*	Joint
Family Trust	.12**	.22**	.10*	.21**	.07	Direct
<i>Protection Responsibility</i>						
Federal Responsibility	.14**	-.03	.10*	-.04	.11*	Indirect
State Responsibility	.09*	-.05	.10*	-.06	.10*	Indirect
Local Responsibility	.15**	-.02	.10*	-.04	.10*	Indirect
Media Responsibility	.11*	-.02	.10*	-.03	.10*	Indirect
Employer Responsibility	.15**	.10*	.10*	.09*	.09*	Joint
Peer Responsibility	.21**	.08	.10*	.06	.09*	Indirect
Self/Family Responsibility	.08	.12**	.10*	.11*	.09*	Joint

**Note:** X1 = Stakeholder Characteristic, X2 = Risk Perception, Y = Hazard Adjustment Adoption

H3a (Perceptions of stakeholder hazard knowledge will be significantly higher for respondents in a high seismic risk area than in a moderate seismic risk area) was tested using a MANOVA that revealed a significant overall effect (Wilk's  $\Lambda = .87$ ,  $F_{21, 416} = 2.94$ ,  $p < .0001$ ), Consistent with the hypothesis, Table 3 shows Californians gave consistently higher ratings than Washingtonians to stakeholders' hazard knowledge on all seven stakeholders except the federal government.

Although Hypothesis 3a made no specific predictions about stakeholder trustworthiness, Californians gave significantly higher ratings than Washingtonians on four of the seven stakeholders—local government, employers, peers, and family. Similarly, though there were no specific predictions about protection responsibility, California residents gave higher protection responsibility ratings than Washington residents to local government and peers.

**Table 3. Mean ratings for perceived stakeholder characteristics in California and Washington**

Variables	Univariate results <sup>a</sup>				Multivariate results <sup>b</sup>		
	California		Washington		F	Significance	Partial $\eta$
	Mean	SD	Mean	SD			
<i>Knowledgeable</i>							
FedKn	3.48	1.07	3.44	1.00	.40	.529	.03
StaKn	3.87	.99	3.49	.94	9.14	.003	.14
LocKn	3.81	.96	3.28	1.05	22.87	.0001	.22
MedKn	3.56	1.10	3.28	1.04	5.74	.017	.11
EmpKn	3.37	1.21	2.90	1.18	13.52	.0001	.17
FrdKn	3.16	1.03	2.75	.91	17.10	.0001	.19
SelKn	3.57	1.07	3.29	1.02	9.60	.002	.15
<i>Trustworthy</i>							
FedTr	3.19	1.16	3.28	1.07	1.43	.232	.05
StaTr	3.59	1.06	3.48	1.00	.46	.498	.03
LocTr	3.63	1.07	3.34	1.04	6.15	.013	.12
MedTr	3.64	1.11	3.46	1.11	2.32	.129	.07
EmpTr	3.23	1.36	2.99	1.27	5.58	.019	.11
FrdTr	3.13	1.16	2.89	1.13	5.47	.020	.11
SelTr	3.45	1.23	3.20	1.25	4.90	.027	.10
<i>Responsible</i>							
FedRe	3.15	1.37	3.10	2.48	2.45	.118	.08
StaRe	3.43	1.36	3.24	1.29	3.10	.079	.08
LocRe	3.53	1.40	3.24	1.30	6.42	.012	.12
MedRe	2.72	1.33	2.76	1.31	.24	.623	.03
EmpRe	2.98	1.41	2.90	1.35	.56	.454	.03
FrdRe	2.66	1.27	2.37	1.20	5.18	.023	.11
SelRe	4.13	1.23	4.04	1.29	.78	.379	.04

<sup>a</sup> N = 221 (California) and 332 (Washington) in univariate tests.

<sup>b</sup> N = 173 (California) and 265 (Washington) in multivariate tests due to missing data.

In weak support for H3b (Females will have significantly higher ratings of authorities' hazard knowledge and trustworthiness, the newsmedia's and peers' trustworthiness, and lower self-ratings of personal protection responsibility), Table 1 shows the only authority to which female respondents gave significantly higher ratings of hazard knowledge or trustworthiness was local government hazard knowledge ( $r = .13$ ). Moreover, although females gave significantly higher ratings of trustworthiness ( $r = .19$ ) to the news media, this was not true for peers. Finally, contrary to H3b, (female) gender has a nonsignificant correlation for self/family protection responsibility ( $r = .08$ ). Although not predicted, females have significantly higher ratings of news media hazard knowledge ( $r = .13$ ) and protection responsibility for all six stakeholders other than self/family (average  $r = .18$ ).

Finally, contrary to H3c (Minorities will have significantly lower ratings of authorities' and the news media's trustworthiness, and higher ratings of peers' trustworthiness), Table 1 shows Black ethnicity had no significant correlations with any of the perceived stakeholder characteristics and Hispanic ethnicity was significantly correlated only with media knowledge—and that correlation was positive, not negative. Although not predicted, Hispanic ethnicity was also significantly positively correlated with local government and media protection responsibility and White ethnicity was negatively correlated with news media and peer responsibility. However, these correlations should be interpreted cautiously because the number of significant correlations with ethnicity ( $6/63 = 9.5\%$ ) was only slightly higher than chance expectations.

## Discussion

As summarized in Table 4, the results of this study support H1a, H1c, and H3a; partially support H2 and H3b; and contradict H1b and H3c. Regarding Hypothesis 1, one important finding is that respondents considered themselves to be more knowledgeable about seismic hazard than their peers (i.e., employers and peers), but not authorities and the news media. This perception of superiority over peers is consistent with previous research on optimistic bias, which has concluded that

people are motivated to believe they are better able to control their vulnerability to hazards (Dunning, et al. 2004, Weinstein and Klein 1996). In particular, it replicates the finding that people believe they are more knowledgeable than their peers (Hatfield and Job 2001). The present results support the conclusion that people “maintain the most favorable self-concepts possible within the bounds of believability (Alicke, Vredenberg, Hiatt and Govorun 2001, p. 9). That is, however much people might distort their beliefs about peers to maintain self-esteem, they do not distort reality severely enough to assert the superiority of their hazard knowledge over authorities and the news media. Moreover, this finding of limits to optimistic bias is broadly consistent with the results of Spittal, McClure, Siegert, and Walkey (2005), who reported that their respondents reported less harm from an earthquake to themselves than to an acquaintance by expected more property damage for themselves than for an acquaintance. Paradoxically, even though respondents considered themselves and their families to be superior to peers, it was the perceived knowledge and trustworthiness of their peers—not of authorities and news media—that correlated significantly with respondents’ risk perception and hazard adjustment adoption. Thus, even though peers are presumed to know less (and be less trustworthy), the more peers are assumed to know (and the more trustworthy they are perceived to be) the greater are the respondents’ risk perceptions and the more hazard adjustments they adopt.

It is hardly surprising that respondents rated authorities and the news media as (slightly) more knowledgeable than themselves and their families because, as noted earlier, authorities and the news media have more direct contact with the scientists who are the ultimate sources of this information. However, it is quite surprising to find that authorities and the news media are considered to be more trustworthy than peers. After all, people can discontinue relationships with peers and employers if they consider the latter untrustworthy. It is even more remarkable that authorities were rated as more trustworthy than family (recall that the family only, not self and family, was rated with respect to trustworthiness).

**Table 4. Summary of support for hypotheses**

Hypothesis	Statement	Support
1a	Mean ratings of hazard knowledge will be highest for authorities and the news media, next highest for self/family, and lowest for peers.	Supported
1b	Mean ratings of trustworthiness will be highest for family, next highest for peers, and lowest for news media and authorities.	Not supported
1c	Mean ratings of protection responsibility will be highest for self/family, next highest for authorities, and lowest for news media and peers.	Supported
2	Perceptions of stakeholder characteristics will have direct effects on the adoption of seismic hazard adjustments.	Partially supported
3a	Perceptions of stakeholder hazard knowledge will be significantly higher for respondents in a high seismic risk area than in a moderate seismic risk area.	Supported
3b	Females will have significantly higher ratings of authorities' hazard knowledge and trustworthiness, the news media's and peers' trustworthiness, and lower self-ratings of personal protection responsibility.	Partially supported
3c	Minorities will have significantly lower ratings of authorities' trustworthiness, and higher ratings of peers' trustworthiness.	Not supported

Role based trust in authorities seems an inadequate explanation because public opinion polls have consistently revealed a lack of trust in institutions, especially government. However, these poll questions address generalized mistrust in general institutions, not mistrust about specific domains. For example, the Gallup Organization's (2003) findings revealed people had much more confidence in police (61%) than in local (37%), state (36%), or federal (26%) government—of which the police are a part. Similarly, there was much higher confidence in the Presidency (55%) than in Congress (29%) or the federal government in general. The present study's findings indicate responses to domain-specific questions about hazard knowledge, trustworthiness, and protection responsibility about stakeholders can differ from responses to nonspecific questions about stakeholders just as responses to role-specific questions (e.g., police vs. local government) differ from nonspecific questions.

Regarding Hypothesis 2, the finding that perceived stakeholder characteristics have significant bivariate and partial correlations with hazard adjustment adoption indicates perceived stakeholder characteristics can affect hazard adjustment adoption directly (via the peripheral route, Petty and Cacioppo 1986) as well as indirectly (via the central route). This finding, which is similar to Gladwin, Gladwin and Peacock's (2001) results for responses to hurricane evacuation warnings, poses an interesting challenge because it means researchers must identify the conditions under which direct or indirect effects should be expected. This is not likely to be easy because Table 3 shows no consistent pattern of direct or indirect effects as a function of either stakeholder or characteristic. The strongest pattern is for direct effects to be found for employers, peers, and self/family, but even this is limited to hazard knowledge and trustworthiness.

In addition, researchers must identify the bases from which the stakeholder characteristics themselves are inferred. Lindell and Perry (1992) characterized risk area residents' bases for judging risk communicators' credibility as credentials, treatment by other information sources, and past history of job performance. This typology is compatible with Kramer's (1999) typology of bases for trust within organizations as dispositional, history-based ("past history of job performance"), third party-referenced ("treatment by other information sources"), categorical, role-based ("credentials"), or rule-based. The pattern of correlations among the perceived stakeholder characteristics in Table 1 suggests the bases for perceptions of stakeholders' hazard knowledge will be similar to those for trustworthiness, but different from those for protection responsibility. Specifically, respondents' perceptions of stakeholders' hazard knowledge have an average  $r = .59$  with the corresponding ratings of trustworthiness, which suggests knowledge and trustworthiness are perceived as being roughly equivalent—especially because the ratings of the two dimensions have nearly identical means. One might argue that hazard knowledge and trustworthiness are correlated by halo error—which is an “unrealistically large within-rater correlations between different performance dimensions” (Viswesvaran, Schmidt and Ones 2005, p. 109). Cooper (1981) asserted halo error can occur if respondents



perceive one salient dimension and generalize their ratings on this dimension to other dimensions. Halo error seems especially likely to occur when respondents are asked to provide opinions about issues that they have not previously thought about. Thus, respondents' ratings on the non-salient dimensions are likely to be pseudo-attitudes constructed at the time of questionnaire administration (Graeff 2003, Lindell and Perry 1990, Schuman and Kalton 1985). However, there is no obvious explanation why halo error would affect the correlations between hazard knowledge and trustworthiness much more than the correlations of these two perceived stakeholder characteristics with protection responsibility. Thus, the correlations between hazard knowledge and trustworthiness are more likely to arise because they were derived from same types of bases as those described by Kramer (1999)—dispositional, history-based, third party-referenced, categorical, role-based, and rule-based. Indeed, future studies might profitably consider expertise and trustworthiness to be indicators of a higher-order construct of credibility.

The correlations in Table 1 make it clear that the respondents perceived protection responsibility as distinctly different from hazard knowledge and trustworthiness. The correlations of protection responsibility with these characteristics are much lower (average  $r = .25$  and  $.27$ , respectively) than with each other (average  $r = .59$ ) and protection responsibility has a different pattern of means in Figure 3. In addition, protection responsibility has distinctive correlations with gender in Table 1. Thus, the bases for judging protection responsibility must be different from the ones used to judge hazard knowledge and trustworthiness. Interestingly, respondents' low level of agreement on federal protection responsibility, as indicated by the low  $r^*_{wg}$  value in Table 1, suggests beliefs about protection responsibility might be related to respondents' political orientations. Unfortunately, no data on political party affiliation are available to test this proposition.

Regarding Hypothesis 3a, the finding that perceptions of seismic hazard knowledge are significantly higher for respondents in a high risk area (California) than those in a moderate risk area (Washington) is significant because California residents believed all stakeholders *within* their state were relatively knowledgeable about seismic hazard

(recall that there were no significant differences between California and Washington residents regarding federal hazard knowledge). However, it is unclear why Californians have greater confidence than Washingtonians in the trustworthiness of local government, employers, peers, and family. It might be that decades of earthquake advisories, confirmed by numerous earthquakes, has created a generalized sense of confidence in the trustworthiness of all local sources of seismic hazard information. It is similarly unclear why Californians consider local government and peers, but not employers and self/family, as more responsible for their safety. An explanation of these findings is most likely to emerge from further research that includes technological hazards such as toxic chemicals, where it will be possible to assess respondents' perceptions of facility operators' hazard knowledge, trustworthiness, and protection responsibility.

Although gender differences in perceived stakeholder characteristics were found, some of them were not the ones that were predicted. Females did have slightly greater confidence in the trustworthiness of the news media, as predicted. Contrary to predictions, however, they did not have greater confidence in authorities' or peers' trustworthiness or in authorities' hazard knowledge. The conflict with Major's (1999) findings might be attributable to the fact that she collected her data during the period of the Iben Browning earthquake prediction. The dynamics of that evolving situation might have altered stakeholder perceptions in ways that differ from other situations.

Most notably, women had more nearly equal attributions of protection responsibility than did men. These results for protection responsibility might be related to gender effects in the broader political arena. Specifically, women tend to be more supportive than men for government initiatives for family programs (Atkeson and Rapaport 2003, Shapiro and Mahajan 1986), they might be more supportive than men of a broad range of collective (rather than individual) actions (Mulilis 1999). Alternatively, women may perceive a greater need for protection in general, or their lower level of adoption of hazard adjustments may be related to (lack of) control over enough financial resources to achieve protection from seismic hazard (Lindell and Prater 2000). To address these questions, future research should more

carefully examine whether there are gender differences in perceptions of individual hazard adjustments. This could reveal if, for example, there are gender differences in the perceived efficacy, cost, time and effort requirements, requirements for special tools and equipment, or other hazard adjustment attributes.

The slight tendency of Hispanics to view local government and the media as more responsible for seismic protection is consistent with previous findings that Hispanics tend to be more fatalistic about seismic protection (Turner, et al. 1986) and, thus, have higher risk perceptions. In this case, the data seem to indicate that powerful others—either instead of or in addition to blind fate—determine seismic hazard vulnerability. Conversely, Whites had a slight tendency to hold the news media and peers less responsible for their seismic safety. Nonetheless, these ethnicity effects were weak and need to be replicated in future research.

It is important to acknowledge that this study has its limitations. First, in assessing risk perceptions, respondents were asked about the potential for personal consequences occurring “within the next ten years”. It is possible that this time frame for earthquake occurrence might have had an effect on the results but there is little consistency among researchers in this regard. Time intervals have been as short as the “next five months” and as long as the next 20 years (e.g., Lehman and Taylor 1988) and many studies ask only for a probability rating without specifying any time interval. In any event, the range of time intervals in risk perception surveys is significantly smaller than the 30 year time interval often referenced by geoscientists (see, for example, <http://pubs.usgs.gov/fs/1999/fs152-99>). It seems likely that shorter intervals would produce lower probability estimates and longer intervals would produce higher probability estimates, but it a change in the overall probability levels would not be expected to affect the correlation of risk perceptions with hazard adjustment adoption unless the probability estimates were all so low (a “floor effect” or high “ceiling effect” that there was a substantial reduction in the variances of the ratings on the risk dimensions. Nonetheless, future research should examine the possibility of other effects of specified time interval for earthquake occurrence.

Second, the response rate was low (34%), which raises questions about the generalizability of the results. Despite the representation of both sexes, a wide range of ages, education, income, ethnicities and home ownership arrangements, the respondents' demographic characteristics did not exactly mirror the population from which they were drawn (compared with 1990 census data for the study communities). However, biases were found in only a few variables and even those were not large (Lindell and Prater 2000). The biases tended to be similar in the two states suggesting there is no net effect on differences between states in mean responses. Moreover, as noted earlier, correlation coefficients are resistant to mean bias so tests of the other hypotheses can be taken at face value.

Third, this study, like all cross-sectional designs, has limited ability to make conclusive causal inferences. In particular, Weinstein and Nicolich (1993) have demonstrated that correlations between risk perception and hazard adjustment adoption can be ambiguous when tested with cross-sectional data. In this study, women had higher risk perception than men but lower levels of hazard adjustment adoption, suggesting they would be motivated to do still more to protect themselves. By contrast, Major (1999) found women had lower risk perception but higher hazard adjustment, suggesting they believed they had done all they needed to protect themselves. To resolve conflicting results such as these, longitudinal studies are needed. Hence, future research should analyze data collected at multiple points in time to gauge the stability of the effects of perceived stakeholder characteristics, risk perceptions, location, and gender on the adoption of seismic hazard adjustments.

Despite its weaknesses, this study has two important theoretical implications. First, this research integrates research on the degree to which hazards are known to science and to those exposed (Slovic 1987, 1992) with the findings of research on optimistic bias (Rothman, Klein and Weinstein 1996, Weinstein 1989, Weinstein and Klein 1996). In the context of the present research, hazard knowledge by authorities is a reasonable proxy for risks known to science, whereas hazard knowledge by self/family and peers is equivalent to risks known to those exposed. From this perspective, the present research

extends the work of Slovic and his colleagues by examining the level of hazard knowledge by societal stakeholders intermediate between scientists and those exposed. It also extends Slovic's work by examining stakeholders' relative levels of trustworthiness and protection responsibility, neither of which dimensions is addressed within the framework described by Slovic (1987, 1992). These data on hazard knowledge support Lindell and Whitney's (2000) conclusion that research on optimistic bias is more informative if it includes a variety of stakeholders and Rothman, Klein and Weinstein's (1996) conclusion that optimistic bias results from underestimating (some) others' abilities rather than overestimating one's own.

Second, this study also provides partial support for the Godschalk, et al. (1994) onion theory. Specifically, the ratings of family's, peers', and employers' hazard knowledge and trustworthiness had much higher correlations with hazard adjustment adoption than did ratings of government or the news media. Moreover, Table 1 also supports the onion theory with a noticeable *simplex* pattern of decreasing correlations with increasing distance from the main diagonal for each of the stakeholder attributes (Guttman 1955). For example, the correlations for hazard knowledge on the first off-diagonal ( $r_{12}$ ,  $r_{23}$ ,  $r_{34}$ , ...  $r_{67}$ ) are greater than those on the second off-diagonal ( $r_{13}$ ,  $r_{24}$ ,  $r_{35}$ , ...  $r_{57}$ ), and so on to the sixth off-diagonal (which consists only of  $r_{17}$ ). This simplex pattern for hazard knowledge (similar patterns can be seen for trustworthiness and protection responsibility) suggests the psychological ordering of the stakeholders in terms of increasing distance from self/family to federal government forms a continuum having the same rank order as is listed in the table. Although the simplex pattern to the correlations is consistent with the onion theory, it might be a methodological artifact—adjacent items in a questionnaire tend to be correlated even if they have little theoretical commonality.

However, none of the respondents' mean ratings on the three perceived stakeholder characteristics conformed to the ordering predicted by the onion theory. Specifically, peers were lower than authorities and the news media in perceived protection responsibility, trustworthiness, and hazard knowledge. The rank ordering of the

stakeholders was the same for hazard knowledge and trustworthiness but different for protection responsibility. These results suggest that further research is needed to understand how people view their relationships to other stakeholders.

In addition, this study has two significant practical implications. First, the results identify ways in which local emergency managers can increase households' seismic hazard adjustment adoption. Specifically, respondents agreed significantly in their perceptions about the government agencies, especially state government, being most knowledgeable and trustworthy despite self/family having the most responsibility for personal safety. Thus, seismic hazard managers should provide more hazard information, especially information that personalizes the risk (Mileti and Peek 2000) and accurately describes the characteristics of alternative hazard adjustments (Lindell and Prater 2002). Of course, this means that, to preserve their credibility, all government scientific and mission agencies with responsibility for a given hazard must harmonize their data collection and analysis, as well as their information dissemination to the news media and the public (Paton, Johnston, Houghton, Flin, Ronan and Scott 1999).

Paradoxically, the data revealed respondents' lack confidence in the hazard knowledge and trustworthiness of their peers even though these are the stakeholders whose hazard knowledge and trustworthiness was most strongly correlated with hazard adjustment adoption. This implies that, to increase people's hazard adjustment adoption, one should try to increase their peers' perceived hazard knowledge and trustworthiness. One way to achieve this objective would be to increase hazard knowledge through community hazard awareness programs. Program participants' hazard knowledge could be increased and their belief in earthquake myths could be dispelled using an "earthquake myths vs. facts" format (Whitney, Lindell and Nguyen 2004). In addition, emergency managers could "certify" participants' increased hazard knowledge and encourage them to engage in discussions or visible hazard adjustments that reveal their hazard knowledge to their peers. Ultimately, increasing peers' beliefs about the participants' hazard knowledge would increase those peers' levels of hazard adjustment.

Second, there were a few marginally significant ethnic differences in respondents' perceptions of knowledge and trustworthiness, which suggests hazard managers might consider using different information sources for some ethnic groups. Alternatively, they should be aware of the ways in which specific groups perceive them so they can better understand their audiences' reactions. Similar implications follow from the gender differences in perceptions of knowledge and trustworthiness. The principal gender difference, perceived protection responsibility, suggests hazard managers use a gendered perspective to hazard adjustment adoption (Fothergill 1996). This will enable them to effect greater improvements in seismic hazard adjustment adoption by using *gender mainstreaming* (Graham 2001)—that is, targeting female population segments with specific messages about sustainable hazard reduction programs.

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