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# Close and Connected: The Effects of Proximity and Social Ties on Citizen Opposition to Electricity Transmission Lines

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**Abstract**

To meet reliability and renewable energy goals, new high-voltage transmission line (HVTL) projects are being built in the United States and worldwide. The siting of HVTLs, often considered a locally unwanted land use (LULU), can be difficult due to the negative externalities they create. Based on a survey of 358 residents of Chino Hills, California, we find that respondents' main concerns in regard to an HVTL project were health risks and harm to property values. Regression modeling finds that citizens who live close to the project, and are more connected to each other, are more likely to oppose the project. Psychosocial perceptions of project risks are also an important predictor of opposition. A high level of perceived risk moderates the effects of distance on opposition attitudes and behaviors. Trust in the project sponsor is a significant independent predictor of opposition, and moderates the relationship between distance and opposition.

**Keywords**

high-voltage transmission lines, citizen opposition, energy facilities siting, California, social ties

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## Introduction

Around the world, efforts to reduce air pollution and meet growing demand for electricity are fostering the construction or upgrade of energy infrastructure. Because high-voltage transmission line (HVTL) projects can often take a decade or more to plan, permit, and construct, a lack of electricity transmission capacity has become a major barrier to the development of renewable energy (RE) generation facilities in California and other areas of the United States (Lieb, 2015; Thompson, 2013). Energy infrastructure projects, and especially HVTLs, are contentious and time consuming to site as they create locally intense, negative externalities. Siting energy projects is also difficult because of the complex relationship between individual risk perceptions, social interactions, and the institutional siting process.

To better understand the factors that shape attitudes and behavior toward HVTL projects, we examine a segment of the Tehachapi Renewable Transmission Project (Tehachapi) which runs through the city of Chino Hills, California (California Public Utilities Commission [CPUC], 2007). Tehachapi is a 250-mile-long, 500-kV HVTL built to bring wind and solar power from the rural Tehachapi region to Los Angeles and Riverside Counties. The project was driven by California's Renewable Portfolio Standard (RPS). The state's RPS was established in 2002 and has been updated several times, most recently by California Senate Bill 350, which requires, by the year 2030, that 50% of state power demand be served by renewable sources of electricity (Clean Energy and Pollution Reduction Act of 2015).

The Tehachapi power line project is now famous in California, because, in 2013, the CPUC ordered the segment of the line located in Chino Hills to be placed underground—a reversal of the CPUC's 2009 approval of the project. In explaining the reversal, the CPUC President, who had 4 years earlier approved the overhead HVTL, said, "I went there (Chino Hills) and I saw this and I felt it was wrong, that's really all there was to it. I just felt it was wrong" (Tasci, 2013b). The reversal by the CPUC followed years of lobbying by residents, Hope for the Hills (a local community-based group), and the city of Chino Hills. The CPUC decision required that the project proponent, Southern California Edison (SCE), remove 19 towers that were approximately 60 m in height and that had been constructed on a 3.5-mile-long preexisting right-of-way (Tasci, 2013a). The CPUC required SCE to bury the power line through this area of Chino Hills at an additional cost of US$224 million. The Chino Hills section was energized in December, 2015, signaling completion of the 10-year project (Napoles, 2016). The Tehachapi project offers an exceptional opportunity to analyze the effects of vigorous citizen participation and strongly oppositional attitudes on the infrastructure siting process. Our study uses survey data to develop two dependent variables that measure the attitudes and behaviors of Chino Hills residents regarding Tehachapi.

## Literature Review

The siting process for energy projects is complex. In the popular press, project opponents are often derided as "NIMBYs"—that is, people who want development Not in My Back Yard. But research in the United States on the siting of infrastructure (e.g., Schively, 2007) as well as work by scholars in Europe on wind power (Wolsink, 2000) and on power lines (Cotton & Devine-Wright, 2013; Devine-Wright, 2013) has shown that the NIMBY concept is neither descriptively accurate nor theoretically useful—and thus, we avoid the term and classify these projects as a locally unwanted land use (LULU). We concur with Wüstenhagen, Wolsink, and Bürer (2007) that social acceptance is an important topic for researchers to study. However, their "triangle of social acceptance" framework is optimized for broad societal-scale analysis (Wüstenhagen, Wolsink, & Bürer, 2007, p. 2684), and thus, it is not ideal for studying individual projects.

We instead use a framework advanced by Cain and Nelson (2013) that begins at the project level, and then considers individual, community, and institutional factors. Responding to a call for a more holistic approach to siting infrastructure (Devine-Wright, 2005; McAdam et al., 2010), Cain and Nelson (2013) constructed an interdisciplinary, multi-level framework that includes a psychosocial lens on individual attitudes. That is, a person's attitudes about a given project are shaped not only by the geotechnical realities (e.g., routing and tower height) but also by psychosocial and institutional processes, which together influence everything from how disruptive a proposed project feels to individuals, to how much trust they have in the siting process. In turn, these factors also influence whether a person, either alone or as part of a group, acts to oppose a project.

### *Project-Level Attributes*

At the project level, Cain and Nelson (2013) found that opposition to HVTLs is usually driven by perceptions of negative externalities (hazards) created by high-voltage conductors (the wires) and pylons (the towers; Jay, 2007). The major categories of externalities include harm to property values, aesthetic impacts, and perceived health and safety impacts (Kroll & Priestley, 1992). The property value that impacts thesis, articulated by Schively (2007), is that local opposition is often an entirely "rational" attempt to minimize potential economic harm. Although some researchers have found that HVTLs have little impact on property values (see Jackson & Pitts, 2010), other research has demonstrated that proximity to an HVTL, and especially to towers, can affect property values (for a recent review, see Chalmers & Voorvaart, 2009). Rosiers (2002) found that HVTL towers disproportionately harm more expensive homes, and that impacts are nonlinear.

## *Perceived Distance Links Project and Individual-Level Factors*

The objective risks to health, safety, aesthetics, and property values created by HVTL projects are relatively localized, but how, and at what perceived distance, an individual perceives risks from a project is complex. HVTL towers have a fall line that is limited to their height, and electric and magnetic fields (EMFs) created by HVTLs decay exponentially with distance. At 91 m (300 feet), the EMF from a 500-kV tower falls to near background levels (National Institute of Environmental Health Sciences, National Institutes of Health [NIESH/NIH], 2002). Given these points, distance from an energy project might seem to be the most important factor associated with individual opposition, but empirical research on a range of LULU projects has been mixed (Devine-Wright, 2009). Priestly (1988) found concerns about HVTL health and safety effects from respondents who lived up to 270 m (885 feet) away. A study of wind power in Texas found that respondents who lived closest to a wind farm held the most negative views of the project (Swofford & Slattery, 2010)—but other studies of wind farms have found that those closest tend to hold more favorable attitudes (e.g., Braunholtz, 2003; Krohn & Damborg, 1999; Warren, Lumsden, O'Dowd, & Birnie, 2005). Inconsistent findings between proximity and property values have also been found for pipelines (Hansen, Benson, & Hagen, 2006) and nuclear power in California (Metz & Clark, 1997).

It is important to note that a person's perception of distance to an HVTL may differ from what can be measured in a geotechnical fashion (Priestley & Evans, 1996). Perceptions of distance depend on the topography of a site, prior landscape uses, and individual and community perceptions of the place (Devine-Wright, 2013). Baliatsas et al. (2011) found that perceived proximity to power lines was an important predictor of reported nonspecific physical symptoms attributed to EMFs, while actual distance was not.

## *Individual Level: Psychology of Risk Perception*

Researchers have long theorized that how intensely individuals perceived possible risks from a proposed project, as well as what actions they take in response to perceived threats, are shaped by affective, psychological processes (International Electric Transmission Perception Project, 1996; Sandman, Miller, Johnson, & Weinstein, 1993). Variance in individual risk perceptions can be due to the credibility of the information that individuals receive from the news media, friends, family, and other sources (Arlikatti, Lindell, Prater, & Zhang, 2006); whether a person uses experiential or analytical faculties to assess risk (Slovic, Finucane, Peters, & MacGregor, 2004); and degree of numeracy (Peters et al., 2006), among other factors.

Media reports highlighting the potential dangers of EMF exposure have also been found to lead to increased reporting of health effects caused by perceived exposure to EMFs (Witthöft & Rubin, 2013). Psychometric risk analyses suggest a wide variation in HVTL risk perceptions between college students and engineers (Furby, Slovic, Fischhoff, & Gregory, 1988) and the lay public and experts (Slovic, Fischhoff, & Lichtenstein, 1980). In general, the public tends to judge the risk from EMFs as more serious than do engineers and people with technical training (Furby et al., 1988).

### *Individual Level: Political Efficacy*

Individuals' sense of their own political efficacy has also been shown to be an important predictor of citizen opposition behavior vis-à-vis energy projects (Devine-Wright, 2009). This is because people who believe they will have an impact on political outcomes are more likely to engage in lobbying or other actions to influence the process (Nishishba, Nelson, & Shinn, 2005). Citizens tend to engage in participatory actions when they expect the benefits from their participation to exceed the costs (Stürmer & Simon, 2004).

### *Individual Level: Demographic Variables*

In a study of residents' perceptions of a nuclear waste facility in New Mexico, Jenkins-Smith, Silva, Nowlin, and DeLozier (2011) found that residents who are older, male, and wealthier are more likely to be in favor of the project. Devine-Wright (2013) has found that higher levels of education and a longer tenure of residence were both associated with stronger objections to a power line project. Being married has been positively correlated with higher levels of concern about technologies with perceived health risks including nuclear waste (Benford, Moore, & Williams, 1993), but there is mixed evidence for concerns about renewable technologies (Sardianou & Genoudi, 2013).

### *Community Level: How Social Interaction Affects Individual Perception*

Individual risk perceptions are shaped not only by individual affective processes but also by community-level variables and interactions (Devine-Wright, 2009). This is because communication with other people in the community shapes how a person perceives the risks from a project, and whether the participants in the process, and the process itself, can be trusted (Devine-Wright, 2009). In this way, an individual's perception of risks can be amplified through communication networks that increases the salience of a project's perceived negative attributes (Kasperson, Kasperson, Pidgeon, & Slovic, 2003; Kasperson et al., 1988; Renn, 2008).

Other community-level processes also influence individual perceptions and actions. The importance of social ties on civic engagement has a long history of theoretical and empirical support both for community engagement (Putnam, 2001) and democracy (Paxton, 2002). Lewicka (2005) found that neighborhood ties predict civic engagement claiming that "a locally based social network is necessary to help convert emotion into action" (p. 392). More specific to LULU projects, Mannarini, Roccato, Fedi, and Rovere (2009) found that membership in formal networks (i.e., churches) is a significant predictor of opposition to a high-speed rail project in Italy. Tilly (1978) and Kim and Bearman (1997) found that dense social networks increase collective action. Social ties can be stronger in communities with adequate income and low resident turnover (Cattell, 2001; Coleman, 1990).

Social ties can also be strengthened through community-based organizing. McAdam and Boudet (2012) found, when studying site fights in the United States, that in many cases, there was very little organized opposition, but when a community engaged in collective action, it was often able to block the proposed project. Thus, community-based organizations (CBOs) are important for scholars to understand because they are often effective. CBOs usually have the following characteristics: They are based in a geographic area, are driven by volunteers, and focus on a single problem (Florin & Wandersman, 1990). Citizens may be motivated to participate in CBOs because of group-based anger toward projects and project proponents (Stürmer & Simon, 2009).

From this review, we argue that social ties and communication networks are important factors to consider when studying opposition to LULU projects. From an empirical perspective, these networks need to be included to avoid a source of omitted variable bias, which can lead to bias in the regression coefficients that are included in research models, and subsequently invalidate hypothesis testing (Greene, 2011). Because participation in a communication network is typically positively correlated with existing socioeconomic or place attachment variables in these models, and if it is also positively correlated with the outcome variable, then the induced bias is to increase the magnitude of the coefficients for place attachment and socioeconomic variables.

### Institutional Level: Psychosocial Perceptions of the Siting Process

Individual and group perceptions of the siting process itself also affect citizen opposition. Gross (2007) established that if people view the process as unfair, they are more likely to object to the project and join a CBO. Using an empirical study of a case in Wales, UK, Devine-Wright and Howes (2010) found that an individual's level of trust in the actors can substantially influence whether a person accepts a given project. Devine-Wright (2013), studying a power line project in the United Kingdom, shows that the key factors influencing participation are a person's sense that the process is fair (procedural justice), trust in the project sponsor, perception of impacts from the project, and length of residence. The institutional setting can also determine whether CBOs, which aggregate and magnify citizen opposition, are likely to emerge (Abdollahian, Yang, & Nelson, 2013).

### Conditional Effects of Psychosocial Variables

Finally, to explain the complexity of siting processes and to better predict citizen opposition, we posit that individuals' perceptions of risk from a project and trust in the sponsors condition their perceptions of distance to the project. Above, we reference the empirical inconsistencies for the effects of perceived distance on citizen attitudes, and we posit that these empirical anomalies can be partially explained through risk perception and trust as moderating variables. HVTL electrical towers and lines, due to their height and size, are highly salient (Preston, Taylor, & Hodge, 1983). Therefore, we argue that for HVTLs, risk perceptions act as a moderating variable, which is defined as a variable whose value affects the effects of another independent variable (perceived distance) on the outcome variables (opposition attitudes and behaviors; Baron & Kenny, 1986). Figure 1 shows the moderating relationship of trust and risk perceptions on the independent effect of perceived distance on opposition attitudes and behavior. In other words, the extent to which citizens' perceived distance from project is related to their opposition attitudes and behavior will depend on their perceptions of the project risk and their trust in the project sponsors.

### The Current Study

Given the above discussion, and our broader goal of determining the key factors behind opposition to HVTLs, our study has four specific research aims that distinguish it from the bulk of the extant literature: The first is to better understand the relationship between distance and opposition. Distance and

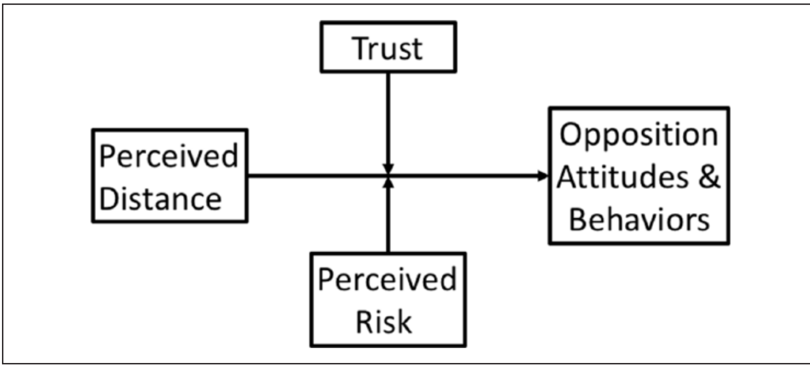


**Figure 1.** Moderating relationship of trust and risk perceptions on the effect of perceived distance on citizen attitudes and behavior.

perceptions of distance have long been theorized to be a key driver of opposition, but empirical research results have been inconsistent. To understand the interactions between factors, our second research objective examines the conditional effects of trust and perceived risks on perceptions of distance to the HVTL. Our third goal is to test whether communication networks influence opposition attitudes and behavior. This is a key factor that has been under studied in existing research, and provides insights into the role of social processes in affecting opposition to LULU projects. Finally, unlike many studies, we measure the impact of the explanatory variables on both attitudes and behaviors.

In the next section, we discuss the geographic site in greater detail; then, in the "Method" section, we describe the study participants and outline our model specification and the creation of scale measures. Our results and discussion then follow.

## Study Context

Our study focuses on Segment 8-1 of the Tehachapi power line, which runs through Chino Hills, a small city located in the southwest corner of San Bernardino County, a suburb of Los Angeles. Although Tehachapi is 402 km in length, the 5.6-km section through residential Chino Hills has generated the most opposition. The city has 76,457 residents on just over 70 km$^2$ of land (U.S. Census, 2014a). Figure 2 shows an aerial image of the study site of Chino Hills, California. The purple outline represents the boundary of the city, which includes a large swathe of forested land that was proposed as an

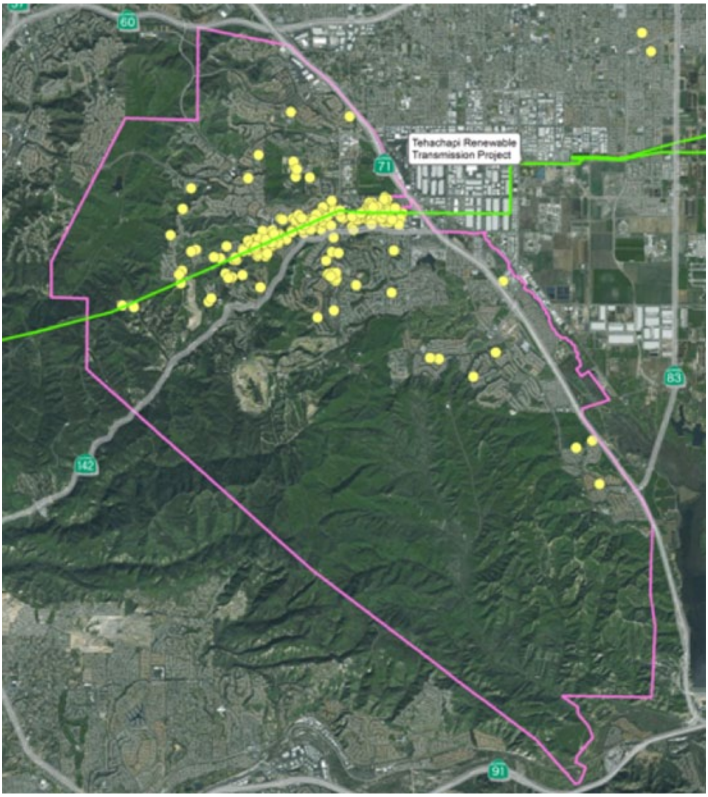


**Figure 2.** Aerial image showing the boundary of Chino Hills, California (purple line), the route of the Tehachapi power line project (green line), and location of citizens who commented on the EIR (yellow dots).
*Source.* Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
*Note.* EIR = Environmental Impact Review.

alternative route for the power line. The power line is indicated by a green line running East–West. The yellow dots show the addresses of citizens who commented on the environmental impact assessment in 2007-2008. Figure 2 shows that most public comments came from residents who live very close to the planned HVTL route.

The Chino Hills segment of the Tehachapi project runs through an existing right-of-way that is approximately 45 m wide with residential development on either side. A right-of-way for a HVTL is a buffer zone where development and usage are limited. California code usually requires at least 30 m (100 feet) from the centerline to the edge on each side of a 500-kV power line (SCE, 2004). In Chino Hills, the right-of-way contained a deactivated transmission line on 30-m-tall towers, but otherwise was largely undeveloped and park-like. This segment called for replacing the old towers and power lines with 60-m-tall tubular-steel structures carrying a double-circuit 500-kV project. Note that the height of the towers relative to the width of the right-of-way implies that a falling tower would impinge approximately 38 (22.5-60) m past the end of the right-of-way.

In 2009, the CPUC, which regulates transmission projects in California, voted to allow the utility to build along the route despite opposition from residents and the city of Chino Hills. The decision galvanized local opposition, led by a CBO called Hope for the Hills. In the ensuing years, Hope for the Hills used a mix of citizen protest, political lobbying, and public communication to persuade the CPUC to reconsider the routing of the HVTL (Tasci, 2012). In July 2013, the CPUC, by a 3-2 vote, reversed their 2009 decision and held that the utility had to remove the 19 towers (which had already been erected) and move the section underground at a cost of US$200 to US$300 million (SCE, 2012).

We selected this case for analysis in 2010 due to the high level of citizen opposition that the project had generated during the impact assessment process. Our survey was completed after the project had been approved, but prior to the CPUC reversal order. Because the CPUC reversal was the result of CBO activities, this case study provides an excellent opportunity to analyze effective citizen opposition.

It is worth noting that Chino Hills is a wealthy community, and two thirds of our sample had stated income of US$75,000 or greater. The income in the case study area is approximately 40% greater than the median household income for San Bernardino County (US$54,100 in 2014; U.S. Census, 2014b). The empirical estimates presented below are the independent, or net, effects controlling for income and education.

## Method

### *Participants*

Our dataset consists of residents of Chino Hills who took an online survey between August 2012 and June 2013. We invited three groups of Chino Hills residents to participate in our online survey containing approximately 130 questions. First, we chose citizens who participated in the Environmental

Impact Assessment process and submitted their names as part of the public record ($n = 160$). Next, we used Geographic Information System (GIS) data to match those participants with their closest neighbors who did not participate in the project to develop a spatially valid residential group ($n = 25$). Our second group of residents was an age- and gender-weighted, random sample of Chino Hills citizens drawn from San Bernardino County voter rolls ($n = 173$). To increase participation rates, mailed survey invitations included a US$1 bill, and online invitations noted that completed surveys were entered into a lottery to win a US$100 gift card (with a one in 100 chance of winning). In total, 1,868 people were sent survey invitations, and 358 people responded, giving us a response rate of 19%. Table 1 provides the sample characteristics.

### *Measures*

We developed two dependent variables for our analysis: one that measures attitudes toward Tehachapi and the other that measures behaviors taken by Chino Hills residents to oppose the project.

To measure citizen attitudes, our ordinal dependent variable, *park*, measures responses to the question "Should the Tehachapi Renewable Transmission Project be rerouted through the Chino Hills State Park?" At the time we began our study, this was the main alternative that had been proposed by project opponents (CPUC, 2007). The variable ranges from 1 to 4 (*strongly disagree/disagree*, *neutral*, *agree*, *strongly agree*), with a higher value indicating greater desire to move the project through the park. Due to a low response rate for the Strongly Disagree and Disagree categories (which indicate acceptance of the project), we combined them and confirm that this is statistically appropriate with a Wald test (not shown).

Our second dependent variable, *behavior*, assesses whether an individual claimed to have undertaken one or more of the following actions: gave money to opposition groups, made a formal comment during the Environmental Impact Review (EIR) process, engaged in legal proceedings, or attended a meeting about the project. The higher the value, the more actions a person took to oppose the project. *Behavior* was generated using principal components analysis (PCA). PCA extracts the underlying factor from a panel of related survey questions (Garson, 2013), whose values have been standardized prior to the PCA analysis. In evaluating which variables to keep within our resulting factors, only variables with factor loadings above .40 were retained. See the online appendix for the wording of the questions and the factor loadings.

**Table 1.** Sample Characteristics.

| Value | Frequency | % response chosen |
|---|---|---|
| Married | | |
| 0—Decline to state | 15 | 5.36 |
| 1—Not married | 61 | 21.79 |
| 2—Married | 204 | 72.86 |
| Education | | |
| 1—Less than high school | 0 | 0 |
| 2—High school | 14 | 5.02 |
| 3—Some college | 93 | 33.33 |
| 4—4-year degree | 84 | 30.11 |
| 5—Graduate or professional | 88 | 31.54 |
| Years at address | | |
| 1—Less than 1 year | 16 | 5.56 |
| 2—2 to 3 years | 43 | 14.93 |
| 3—4 to 5 years | 18 | 26.74 |
| 4—More than 5 years | 211 | 73.26 |
| Age | | |
| 1—18 to 24 | 19 | 6.76 |
| 2—25 to 34 | 28 | 9.96 |
| 3—35 to 49 | 86 | 30.60 |
| 4—50 to 64 | 117 | 41.64 |
| 5—65 and up | 31 | 11.03 |
| Income | | |
| 1—US$20,000 or less | 8 | 2.96 |
| 2—US$20,000-US$34,999 | 11 | 4.07 |
| 3—US$35,000-US$49,999 | 12 | 4.44 |
| 4—US$50,000-US$74,999 | 38 | 14.07 |
| 5—US$75,000-US$109,999 | 51 | 18.89 |
| 6—US$110,000-US$149,999 | 58 | 21.48 |
| 7—US$150,000 or more | 92 | 34.07 |
| Perceived distance | | |
| 1—91 m or less | 53 | 15.82 |
| 2—91-365 m | 55 | 16.42 |
| 3—366 m-1.6 km | 59 | 17.61 |
| 4—1.6-3.2 km | 85 | 25.37 |
| 5—More than 3.2 km | 83 | 24.78 |
| Trust in utility | | |
| 1—No trust at all | 159 | 58.46 |
| 2—Only a little trust | 66 | 24.26 |
| 3—Some trust | 37 | 13.60 |
| 4—Has a lot of trust | 10 | 3.68 |
| Political efficacy | | |
| 1—Comments will have no impact | 77 | 24.06 |
| 2—Comments will have a little impact | 117 | 36.56 |
| 3—Comments will have some impact | 97 | 30.31 |
| 4—Comments will have strong impact | 29 | 9.06 |

**Table 2.** Descriptive Statistics.

| Variable | *n* | *M* | *SD* | Minimum | Maximum |
|---|---|---|---|---|---|
| Income | 270 | 5.43 | 1.60 | 1.00 | 7.00 |
| Married | 265 | 1.77 | 0.42 | 1.00 | 2.00 |
| Education | 279 | 3.88 | 0.92 | 2.00 | 5.00 |
| Age | 281 | 3.40 | 1.03 | 1.00 | 5.00 |
| Years at address | 288 | 3.47 | 0.94 | 1.00 | 4.00 |
| Political efficacy | 320 | 2.24 | 0.92 | 1.00 | 4.00 |
| Perceived risk | 324 | 0.00 | 1.00 | −3.24 | 0.89 |
| Perceived distance | 335 | 3.27 | 1.41 | 1.00 | 5.00 |
| Trust in utility | 272 | 1.63 | 0.85 | 1.00 | 4.00 |
| Procedural justice | 302 | 4.08 | 2.04 | 2.00 | 10.00 |
| Communications networks | 292 | 0.00 | 1.00 | −2.95 | 1.83 |
| Reroute through park | 325 | 2.81 | 1.24 | 1.00 | 4.00 |
| Behavior factor | 321 | 0.00 | 1.00 | −0.81 | 1.84 |

Robust standard errors were used in all models because the Breusch Pagan/Cook Weisburg test for heteroskedasticity showed nonconstant error variance (Gujarati & Porter, 2009).

For all the regression models, we included the following key explanatory variables: perceived project risks, perceived distance from project, trust in the project proponent, perceptions of procedural justice, and citizen communication networks. Household income, marital status, education level, age of respondent, and length of time at residence were included as demographic variables. Table 2 shows the descriptive statistics for the variables used in our models.

Our scale measures were created as follows: *Risk* was our perceived risk variable. It was created by applying PCA to 12 questions addressing perceived worries about the Tehachapi power line project. Questions assessed, for example, the "Possibility of wires breaking in an earthquake," the "Possibility of health risks from the tower's electric field," and the risk of "Increased noise from the lines." Other questions assessed concerns about aesthetics and property values. The online appendix details all the questions used to create the factor and provides factor loadings. *Risk* varies from −3.24 to .89, with higher values indicating a higher level of perceived risk. Because the public tends to dread power lines (Furby et al., 1988) and they are associated with several categories of harm (Kroll & Priestley, 1992), we expect to find a positive relationship between perceived risk and opposition.

*Perceived distance* is ordinal and ranges from 1 to 5, with 1 indicating a perceived distance of 91 m (100 yards) or less, and 5 indicating a location of over 3.2 km (2 miles) from the proposed route. We presented survey respondents with a map of the area that depicted the path of the power line and included a distance scale. While viewing this map, the respondents were asked to estimate their distance from the project using the Likert-type scale described above. Following Swofford and Slattery (2010), we expect to find a negative, but conditional, relationship between perceived distance and opposition.

The variable *trust in utility* was included to capture respondents' trust in the project sponsor. Our survey defines trust as "fulfilling of promises and obligations made in the context of siting transmission line projects." *Trust in utility* ranges from 1 to 4 with higher values indicating greater trust. Following Devine-Wright (2013), we focused on trust in the project sponsor. And, based on Devine-Wright (2005, 2013) and related literature, we expect that lower levels of trust will be associated with higher levels of opposition to the project.

To capture the impacts of respondent communication networks, we again made use of PCA to create *communication networks*, which is composed of five questions such as "About how often do you talk to or visit with your immediate neighbors," "How close are the political opinions of your neighbors to your own?" and "How many close friends would you say that you have?" The online appendix provides the questions that compose the factor and the factor loadings. *Communication networks* ranges from −2.95 to 1.83 with higher values corresponding to a higher level of communication and stronger social ties. Because power lines elicit dread (Furby et al., 1988) and because Kasperson and coauthors (1988, 2003) found that communication can amplify risk perception, we expect to find a positive relationship between this variable and opposition.

Our procedural justice variable, *procedural justice*, is an additive index created from two questions, one of which asked the respondent to rate the CPUC's representation of respondent interests, and the other to rate the utility's representation of respondent interests. *Procedural justice* varies from 2 to 10 with a higher value indicating that the respondents believe their interests are being represented in the siting process. Based on work by Gross (2007) and Devine-Wright (2013), we expect that a stronger sense of procedural justice will be associated with less opposition.

*Political efficacy* measures an individual's perception of their political efficacy and was based on responses to the following question: "How much of an impact do you think your comments would have in influencing the location of the Tehachapi Renewable Transmission Project?" *Political efficacy* ranges from 1 to 4 with a higher value indicating a greater sense of personal political efficacy. Based on Nishishba et al. (2005), we expect those with a stronger sense of efficacy to be more involved in opposing the project, and thus, we expect a positive sign for this variable.

The demographic and socioeconomic variables we analyze include income, marital status, education level, age, and time at current residence. Both *income* (1-7) and *education* (2-5) are ordinal variables that were scaled so that higher values indicate greater levels of income or education. Given the disparate effects of projects on property values (see work by Rosiers, 2002) and that opposition can be understood as a response to local harm (Schively, 2007), we expect those with higher incomes to be more opposed to the project. The *married* variable is binary with married respondents indicated by a 1. Given that Benford et al. (1993) found that married people are more resistant to infrastructure perceived as hazardous, we expect that marriage will be associated with greater opposition. Given Devine-Wright's (2013) finding that more educated people and people who have lived at an address for a longer amount of time more strongly opposed HVTL projects, we expect to see the same positive relationship. *Age* is an ordinal variable that ranges from 1 to 5 with greater values indicating older respondents. As Jenkins-Smith et al. (2011) found that older residents are more accepting of hazardous infrastructure, we expect a similar relationship.

## Results

We first analyzed the issues that citizens were most concerned about with regard to Tehachapi. Table 3 shows how frequently a given issue, provided from a list of concerns contained in the survey, ranked as a respondent's top concern. The "possibility of health risks" from the project's "electric field" was the issue most frequently identified as a top concern (by 34% of respondents). Other top issues of concern were "decline in property values" (27%) and "unwanted impacts on landscape (visual impacts)" (11%). Smaller groups choose "unwanted impact to my quality of life" (7%), risks of "towers falling" (7%), or "wires breaking" (4%) during an earthquake as their top concern.

### *Multinomial Logit Results for Attitudes About Moving the Power Line*

Next, we assessed attitudes about what should be done with the project. The results of our multinomial logit regression models are presented in Table 4. All the multinomial logit models had loglikelihood statistics that indicate the

**Table 3.** Respondents' Issues of Concern.

| Issue of greatest concern | % |
|---|---|
| Health risks from tower's electric field | 34 |
| Decline in property values | 27 |
| Unwanted impacts on landscape (visual impacts) | 11 |
| Negative impact to my quality of life | 7 |
| Towers falling in an earthquake | 7 |
| Wires breaking in an earthquake | 4 |
| Damage to the environment | 4 |
| Towers falling during a storm | 2 |
| Unsupervised children's play in the strip of land under the lines | 2 |
| Increased noise | 2 |
| Loss of tranquility | 1 |
| Loss of historic/heritage value of the area | 1 |

*Note.* Due to rounding, percentages may not add up to 100%.

combined effects of the regression coefficients in the model are unlikely to be zero (not shown). We also present McFadden's $R^2$ for the first multinomial logit model, which shows the level of improvement in the full model over the intercept-only model, but we remind readers that this statistic is different from ordinary least square (OLS) $R^2$ statistics.

The multinomial logit estimations in Model 1 show the impact of the explanatory variables on the log of the odds that a respondent will be in one of three response categories (*neutral*, *agree*, *strongly agree*) relative to the base category that combines Strongly Disagree and Disagree. A significant and positive coefficient in the Strongly Agree category means that a one-unit increase in the variable increases the likelihood of a respondent strongly agreeing that the Tehachapi power line should be rerouted. Thus, the results for the Agree and Strongly Agree categories show the impact of the explanatory variables on the likelihood that the respondent opposes the project as originally routed.

Starting with the demographic variables in Model 1, we can see that married people are more likely to agree, and more educated residents are more likely to strongly agree that Tehachapi should be rerouted. We can also see that the longer individuals have lived at their address, the more likely they are to agree or strongly agree with the proposition that the project should be rerouted. Although the sign is in the expected direction for age, the variable is not significant at commonly accepted alpha levels.

Turning to the results for our key independent variables, the coefficients for *perceived risk* and *perceived distance* are in the theoretically expected

**Table 4.** Multinomial Logit Results for Attitudes About Moving the Power Line.

| | Model 1 | | | Model 2: marginal effects | Model 3 | Model 4 |
|---|---|---|---|---|---|---|
| Variables | Neutral | Agree | Strongly agree | Strongly agree | Strongly agree | Strongly agree |
| Income | −0.100 (0.220) | −0.161 (0.170) | −0.302 (0.166) | −0.0541 (0.0373) | −0.323 (0.166) | −0.277 (0.166) |
| Married | −0.0307 (0.637) | 1.234* (0.578) | −0.0306 (0.598) | −0.145 (0.138) | −0.339 (0.594) | −0.0702 (0.607) |
| Education | −0.630 (0.346) | 0.455 (0.290) | 0.774* (0.310) | 0.148* (0.0637) | 0.849* (0.336) | 0.775* (0.313) |
| Age | −0.262 (0.299) | 0.0926 (0.231) | 0.358 (0.247) | 0.0814 (0.0523) | 0.410 (0.248) | 0.350 (0.246) |
| How long at address | −0.132 (0.219) | 0.550* (0.239) | 0.603* (0.271) | 0.0879 (0.0629) | 0.643* (0.297) | 0.554* (0.269) |
| Political efficacy | 0.0163 (0.404) | 0.111 (0.270) | 0.0246 (0.280) | −0.00667 (0.0548) | 0.0976 (0.285) | 0.0416 (0.281) |
| Perceived risk | 0.0237 (0.323) | 0.217 (0.254) | 0.832* (0.345) | 0.178* (0.0742) | 1.059** (0.364) | 2.785** (1.016) |
| Perceived distance | −0.674* (0.290) | −0.297 (0.195) | −0.637** (0.172) | −0.111** (0.0388) | −1.757** (0.427) | −0.523** (0.180) |
| Trust in utility | −0.283 (0.333) | −0.170 (0.274) | −0.876* (0.356) | −0.190* (0.0780) | −3.850** (1.097) | −0.946** (0.365) |
| Procedural justice | 0.478** (0.170) | −0.0596 (0.132) | −0.0645 (0.127) | −0.0168 (0.0261) | −0.0875 (0.131) | −0.105 (0.132) |
| Communication networks | −0.571 (0.350) | −0.134 (0.274) | 0.581* (0.280) | 0.166** (0.0564) | 0.561 (0.290) | 0.579* (0.279) |
| Perceived Distance × Trust | | | | | 0.793** (0.262) | |
| Perceived Distance × Perceived Risk | | | | | | −0.513* (0.248) |
| Constant | 3.559 (2.005) | −4.025* (2.008) | −0.279 (1.824) | | 3.822 (2.145) | −0.462 (1.862) |
| Observations | 225 | 225 | 225 | 225 | 225 | 225 |
| McFadden's $R^2$ | | .29 | | | | |

*Note.* Robust standard errors in parentheses. Base category indicates Disagreement or Strong Disagreement with proposition to move the TRTP power line through the Chino Hills Park. TRTP = Tehachapi renewable transmission project.
$*p < .05$. $**p < .01$.

direction and significant. Those who perceive the project as most disruptive are strongly in favor of moving Tehachapi. And those respondents who perceive that they live closer to the HVTL (indicated by a negative sign on the *perceived distance* variable) are more likely to be strongly in favor of moving the project.

Looking at the measures of trust and procedural justice, we see that those who lack *trust in utility* are more likely to strongly agree that the project should be moved. We can also see, from the *procedural justice* results, that those who believe the siting process is fair are more likely to hold a neutral view of the project. The positive sign for the *communications network* factor shows that those who communicate more frequently, and believe their views are like their neighbors, are more likely to strongly oppose Tehachapi.

To assess the relative importance of the variables, we estimated their marginal effects in Model 2. In a marginal effects model, the values of the variables are set at the arithmetic mean (for continuous variables) or the most frequently selected response (mode; for categorical variables) in the multinomial logit model. The coefficients in Model 2 reflect the impact of a one-unit increase in the given independent variable on the probability of a respondent moving from the base category (Strongly Disagree/Disagree) to the Strongly Agree category. Starting with the control variables, we see that a one-unit increase in *education* is associated with a .15 increase in the likelihood of a respondent strongly agreeing that Tehachapi should be rerouted. Next, ceteris paribus, increasing *perceived risk* and *communications networks* by one-unit results in a 18% and 17% increase, respectively, in the probability of a Strongly Agree response. In other words, the more strongly individuals perceived that a project will create risks, and the more frequently they communicated with their neighbors, the more likely they were to favor moving the project. Consistent with theory, a one-unit increase in *trust in utility* and a one-unit increase in *perceived distance* are both significantly associated with a decrease in the likelihood of a respondent wanting to reroute the project.

Model 3 is the same as Model 1, but only includes the strongly agree category. Model 3 also includes an interaction between *perceived distance* and *trust in utility*. The interaction term is significant and has a positive sign. Figure 3 shows the marginal effects of the interaction on preferences for rerouting the HVTL. People living closest to the power line and with no trust in the utility are most in favor of moving the power line to an alternative location. From Figure 3, we can see that the effect of perceived distance on opposition is fully moderated by trust in the project proponent. For both sets of respondents, perceived distance matters, but for those with no trust in the utility, opposition is greater and perceived distance attenuates their opposition to a greater degree. This is evident from the difference in the slope of the

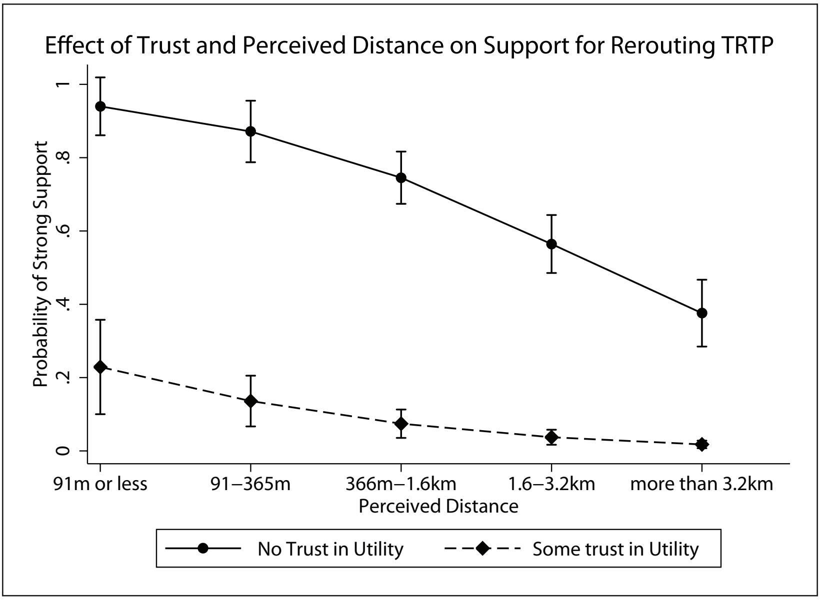


**Figure 3.** Marginal effects of trust and perceived distance on support for rerouting Tehachapi project.
*Note.* TRTP = Tehachapi renewable transmission project.

marginal effect lines for both sets of respondents. Furthermore, as evidenced by the distance between the lines, we can also say that trust, ceteris paribus, reduces the desire to move the project, regardless of perceived distance from the project. Even among those in the closest group (within 91 m of the project), if there is a moderate level of trust, then the desire to move the project is strongly attenuated, holding other variables constant.

Model 4 examines the interactions between *perceived distance* and *perceived risk*. The negative coefficient for the interaction term shows that risk perceptions moderate the effect of perceived distance on strong attitudes about moving the HVTL. This is something we follow up below in a plot of the interaction effects from the OLS model results.

## OLS Results for Citizen Behavior

Table 5 presents the results from a second set of models estimated using OLS regression. The explanatory variables remain the same, but the dependent variable, created using PCA, now measures the actions a person took to

**Table 5.** OLS Regression Results for Citizen Behavior to Oppose Power Line.

| Variable | Model 5 | Model 6 | Model 7 |
|---|---|---|---|
| Income | −0.0475 (0.0389) | −0.0436 (0.0402) | −0.0318 (0.0386) |
| Married | 0.0831 (0.126) | 0.0463 (0.129) | 0.0686 (0.122) |
| Education | 0.0252 (0.0545) | 0.0202 (0.0542) | 0.0119 (0.0539) |
| Age | 0.0902 (0.0496) | 0.0866 (0.0486) | 0.0747 (0.0482) |
| How long at address | 0.0982* (0.0491) | 0.100* (0.0475) | 0.0766 (0.0475) |
| Political efficacy | 0.122 (0.0660) | 0.137* (0.0662) | 0.145* (0.0651) |
| Perceived risk | 0.0745 (0.0546) | 0.0860 (0.0519) | 0.627** (0.133) |
| Perceived distance | −0.286** (0.0397) | −0.386** (0.0902) | −0.245** (0.0359) |
| Trust in utility | −0.0846 (0.0649) | −0.343 (0.234) | −0.0934 (0.0622) |
| Procedural justice | 0.00910 (0.0278) | 0.00579 (0.0274) | −0.00629 (0.0277) |
| Communication networks | 0.323** (0.0523) | 0.315** (0.0535) | 0.316** (0.0513) |
| Perceived Distance × Trust | | 0.0715 (0.0543) | |
| Perceived Distance × Perceived Risk | | | −0.147** (0.0330) |
| Constant | 0.199 (0.386) | 0.590 (0.491) | 0.125 (0.383) |
| Observations | 225 | 225 | 225 |
| $R^2$ | .549 | .553 | .570 |
| Adjusted $R^2$ | .526 | .528 | .545 |

*Note.* Robust standard errors in parentheses.
* $p < .05$. ** $p < .01$.

oppose the project. The OLS model explains nearly 55% of the variation in opposition behavior. Starting with Model 5, we can see that *how long at address*, *perceived distance*, and *communication networks* are significant at least at the 95% level. The positive sign of *how long at address* indicates that the longer individuals have lived at their address, the greater the array of actions they took to oppose the Tehachapi. The negative sign of *perceived distance* shows that if individuals perceive that they live closer to the power line, they are more likely to take action to oppose the project. The −.28 coefficient for *perceived distance* indicates that for each one-unit increase in our five-item *perceived distance* measure, opposition behavior is expected to decrease by 5.6%.

The positive sign and large coefficient for *communications networks* show that the more frequently individuals communicated with their neighbors and believed their views were aligned with their neighbors, the more likely they were to take action to oppose the project. A one-unit increase in the *communications network* factor is associated with a 6.7% increase in oppositional behaviors.

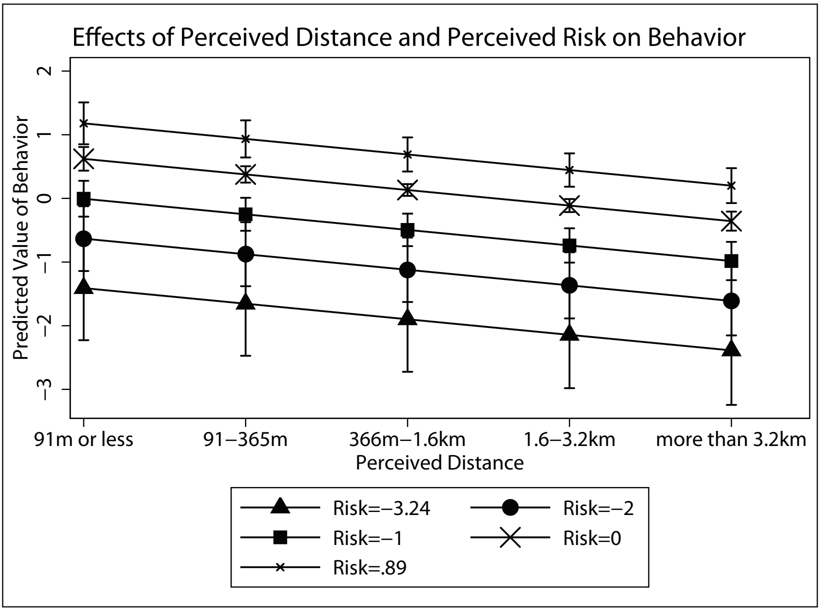


**Figure 4.** Marginal effects of perceived distance on dependent variables at different values of perceived risk.

Model 6 includes an interaction term for *Perceived Distance* × *Trust in Utility* for the opposition behavior factor. Although the sign is in the direction expected by theory, the coefficient is not significant. Model 7 presents an interaction term for *Perceived Distance* × *Perceived Risk*, which is significant and has a negative sign. This supports the findings from Model 4: The effect of perceived distance on behavior decreases as perceived risk increases.

Figure 4 shows the marginal effects of perceived distance on predicted values of the dependent variable at different values of perceived risk. Two points emerge from a review of this figure: First, the closer the respondent lived to the project, the greater the impact *perceived risk* has on predicting opposition behavior. For example, the confidence interval for the predicted value of the behavioral variable at a perceived risk of 1 (top line) and a distance of 91 m does not overlap with the confidence interval for perceived risk of 1 at >3.2 km. Although the slopes of the perceived risk groups are parallel (as required in OLS), predicted opposition behavior is greatest for those in close proximity to the project. Second, recall from Table 2 that the "average" resident's perceived risk factor score is 0. Looking at the line indicating *perceived risk* = 0 in Figure 4 (indicated with X-like symbols), we can see that

**Table 6.** Relative Importance of Variables in (a) Multinomial Logit Attitudes and (b) OLS Behavior Models.

| | Dominance weight | Standardized weight | Ranking |
|---|---|---|---|
| a. Move to park | | | |
| Income | 0.0018 | 0.0046 | 11 |
| Married | 0.0159 | 0.0414 | 8 |
| Education | 0.0106 | 0.0277 | 9 |
| Age | 0.0178 | 0.0464 | 7 |
| Years at address | 0.0436 | 0.1135 | 5 |
| Political efficacy | 0.0087 | 0.0226 | 10 |
| Perceived risk | 0.0565 | 0.1471 | 4 |
| Perceived distance | 0.0814 | 0.2118 | 1 |
| Trust utility | 0.0588 | 0.1531 | 3 |
| Procedural justice | 0.0256 | 0.0667 | 6 |
| Communication networks | 0.0635 | 0.1651 | 2 |
| b. OLS Behavior | | | |
| Income | 0.0023 | 0.0042 | 10 |
| Married | 0.0188 | 0.0343 | 8 |
| Education | 0.0016 | 0.0028 | 11 |
| Age | 0.0202 | 0.0367 | 7 |
| Years at address | 0.0298 | 0.0543 | 6 |
| Political efficacy | 0.0335 | 0.0611 | 5 |
| Perceived risk | 0.0548 | 0.0998 | 3 |
| Perceived distance | 0.1919 | 0.3496 | 1 |
| Trust utility | 0.0434 | 0.0791 | 4 |
| Procedural justice | 0.0157 | 0.0285 | 9 |
| Communication networks | 0.137 | 0.2496 | 2 |

*Note.* OLS = ordinary least square.

predicted opposition levels for citizens with a stronger perception of risks (the top line) are significantly higher at all perceived distances except the closest category, where the confidence intervals overlap.

### *General Dominance Analysis of Relative Importance of Explanatory Variables*

To assess the relative importance of the explanatory variables, Table 6 shows a general dominance analysis of the $p = 11$ variables in Models 1 and 5. The dominance analysis is equivalent to Shapley Decomposition techniques

(Budescu, 1993). The dominance analysis creates two-variable (pair) submodels and then compares all $2^{p-1}$ pairs of independent variables to see which contribute more to the model fit. Table 6 shows that *perceived distance*, strength of *communications networks*, and *trust in utility* are the most important predictors for oppositional attitudes. Table 6 also shows that *perceived distance*, strength of *communications networks*, and *perceived risk* are the most important predictors for oppositional behavior. Trust is more important than perceived risk in the attitudes outcome, but risk is more important than trust for the behavior outcome.

## Discussion

Based on a survey of residents of suburban Chino Hills, we can say that their top concerns in regard to the Tehachapi power line project were potential health impacts and harm to property values. Our findings support Elliott and Wadley's (2012) qualitative work, which found that health impacts from EMFs were the top concern for residents of Queensland, Australia. However, our findings differ somewhat from Devine-Wright (2013) who found the aesthetic impacts of HVTLs were the most important project-related factor in the largely rural area of the United Kingdom he studied.

One of the strongest empirical findings of our study was the effect of perceived distance on opposition attitudes and behavior. If residents perceive that they are closer to the power line, they are far more likely to hold a negative sentiment about the project, and they are more likely to act to oppose the project. These effects are substantive and significant, and independent of potentially confounding factors such as strength of communication networks and tenure at address.

The regression results also show that perceived risk is a substantive predictor of opposition attitudes (Models 1 and 2). Furthermore, perceived risk moderates the effect of perceived distance in predicting attitudes and behavior (Models 4 and 7). In other words, the impact of perceived distance on both action and attitudes is contingent on the risks citizens associate with the project. This supports Devine-Wright's (2013) claim that project-level variables exhibit contingent effects. Perceived distance, or space, matters, but the effect of perceived distance on citizens' actions and attitudes depends on the risks they associate with the project.

Our finding that the strength of communication networks is associated with negative project sentiment, and is one of the substantive drivers of citizen opposition, supports previous literature on the importance of social ties (Devine-Wright, 2013; Klandermans, 1997), and gives added weight to the argument that individual knowledge is created through social interactions and communication networks (Devine-Wright & Howes, 2010; Kasperson et al., 2003).

We also find evidence that perceptions of the siting process and the project sponsor have an important effect on attitudes toward the project. Although more trust in the project sponsor was negatively associated with a desire to move the project, its effect on behavior was not significant (although the sign is in the expected direction). Trust also moderates the relationship between perceived distance and opposition attitudes. As shown in Figure 3, higher levels of trust substantially attenuate the impact of perceived distance on opposition. Contrary to industry opinion, building trust is important not only for citizens who are proximate to the project but also for those who live further away. More distant citizens with low trust are also likely to be strongly opposed to the project.

Although our measure of *procedural justice* was only significant in Model 1, which estimates the effects of the independent variables on attitudes toward the power line, the substantial coefficient and low $p$ value ($p < .01$) of the variable for the Neutral category do provide support for theoretical work by Gross (2007): Respondents who believe that the siting process is fair are more likely to hold a neutral attitude toward rerouting Tehachapi. Given how controversial the project was within the city, this result shows that efforts to ensure that the process is fair are important.

Any case-based research project faces limits in generalizability. Although many power line projects are built on existing right-of-ways, the segment of Tehachapi that ran through Chino Hills was particularly close to residences. In addition, given that our study's sample is high-income, high-education, long-tenured, and suburban, it would be useful for future studies to look at other projects and locations to further test our findings. Future studies could also look more closely at the conditional effects of trust and perceived risk on opposition attitudes and behaviors, and track changes over time.

## Conclusion

The primary goals of this study were to better understand the factors associated with opposition to an especially contentious power line project located in Southern California. Given the importance of HVTLs to RE and electricity reliability goals, and that the Tehachapi project was very time consuming and expensive to complete, a better understanding of citizen opposition should be applied to improve the siting process. Existing research is often too narrow in scope, and lacks appropriate consideration of social ties and perceived distance, which makes it difficult to assess the relative importance of different factors to a siting decision.

Our results provide quantitative evidence regarding the perception of risks associated with HVTLs. Given that concerns over impacts from EMF were paramount, planners should route projects to minimize EMF exposure and ensure a sufficient buffer between high-voltage power lines and residences. Our study also provides theoretical and empirical support for the role of risk perception in moderating the effect of perceived distance on opposition to infrastructure projects. Although citizens might be close to a project, their perception of risks from the project is also important in predicting whether they oppose it or not. Our general dominance results (Table 5) show that citizens that were close and connected were most likely to oppose the project. Our findings are important as we empirically estimate the effects of citizen perceived distance on opposition attitudes and behaviors.

Our work also adds empirical evidence to the importance of procedural justice to the siting process. If people believe that the siting process is fair, they are more likely to accept the placement of a project that is perceived as risky. Perceptions of trust and fairness also moderate the effect of perceived distance on opposition attitudes. Given the importance of power line infrastructure to future RE development, proponents and researchers should pay greater attention to these psychosocial and process-related factors.

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