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Nuclear Waste, Public Information and Residential Property Values

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I. Introduction

Since the path breaking works of Lancaster (1969) and Rosen (1974), the hedonic model has been used to implicitly value structural attributes of a house (Kern and Lichtenstein, 1987; Linneman, 1980), fiscal and regulatory characteristics of a community (Stull and Stull, 1991; others) and a wide range of neighborhood factors including crime rates (Clark and Cosgrove, 1990; Thaler, 1979), proximity to employment centers and subcenters (Bender and Hwang, 1985; Herrin and Kern, 1992), and air quality (Ridker and Henning, 1967; Harrison and Rubinfeld, 1978) . The hedonic model has also been used to determine the willingness to pay to avoid proximity to noxious or hazardous activities. For example, Michaels and Smith (1990), McClelland, Schulze and Hurd (1990), and Kohlhase (1991) investigate the influence of proximity to hazardous waste dumps; Nelson (1979) and Morey (1990) examine aircraft noise in the vicinity of airports; Blomquist (1974) studies coal-fired power plants, and Kiel and McClain (1995) consider how proximity to an incinerator effects residential home prices. Finally, the hedonic model has been used to determine whether environmental accidents or natural disasters influence residential home prices. For example, Hays and Downing (1982, 1986) and Nelson (1981) investigated the property value impacts of the 1978 nuclear accident at Three Mile Island, and Bernknopf, Brookshire and Thayer (1990) examine how earthquake and volcano hazard notices affect the perceived market value of properties. The Bernknopf et. al. study is particularly interesting since it not only estimates the property value impacts of hazardous events,

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but also investigates how knowledge about the risks associated with future earthquakes (as conveyed by public notices of earthquake risks which are required at the time of sale) affect the property market.

In this study, we are interested in determining whether public knowledge about nuclear waste storage activities at nuclear power plants has any perceptible effect on the sale price of single-family residential properties. High-level nuclear waste in the form of spent nuclear fuel rods is currently stored in water pools at most of the nation's nuclear power plants. Spent fuel pools were originally intended to allow short term storage of waste before shipment off-site to a waste facility. The U.S. Department of Energy is responsible for siting and constructing high level waste facilities but has experienced massive opposition to it's proposed permanent repository facility at Yucca Mountain in southern Nevada and temporary waste storage facilities elsewhere. There is currently considerable doubt as to whether a permanent facility will ever be constructed. Much of the opposition to nuclear waste facilities is based on heightened perceptions of risk associated with the long term presence of nuclear wasted in a particular location, and the potential effects these adverse perceptions could have on local economic development. A large literature based on the findings of public opinion surveys has also evolved and illustrates the impact nuclear waste facilities have on public perceptions of risk (see for example, Kunreuther, Desvousges, and Slovic, 1988; Slovic, Laymen, Flynn, Chalmers and Gesell, 1991; Erikson, 1994). Delays in the opening of federal waste facilities have burdened spent fuel capacities at many nuclear power plants. As a result, a number of utilities have begun constructing on-site dry storage facilities where the spent fuel rods are moved from the reactor building in large metal containers and stored inside concrete bunkers. These independent spent fuel storage installations (ISFSI's) are intended for temporary waste storage until a federal facility is available.

To test this hypothesis, we examine a sample of properties which were sold within a 25 mile radius of the Rancho Seco nuclear power plant, which is located approximately 25 miles southeast of downtown Sacramento, CA. The Rancho Seco plant which began operation in April 1975, has been idle since June 7, 1989 when the publicly-owned plant was shutdown as a result of the high cost of operating the plant. The plant has stored its high-level radioactive waste in pools of water. In October 1991, the Sacramento Municipal Utility District (SMUD), which owns the plant, applied for a license to construct and operate a dry storage facility as an additional cost saving measure. SMUD officials estimate that they can reduce the cost of storage by nearly $1,000,000 per year if the waste can be placed in dry storage. Although the placement of high-level nuclear waste in dry storage at Rancho Seco does not increase the amount of waste stored at the site, it may be expected to affect the local property market for a number of reasons. First, the application process to the Nuclear Regulatory Commission draws public attention to the fact that high level waste remains at the plant, even though the plant is not operational. Second, the increased media coverage may serve to inform the public about the risks associated with the existence of nuclear waste, or about the risks of transferring the waste from wet storage. Third, some residents may view dry storage to be more or less hazardous than wet storage in pools. Finally, critics of dry storage have argued that it will open the door to the creation of *de facto* permanent waste storage facilities at individual utility sites should DOE fail to successfully site a permanent repository in Nevada or temporary facilities elsewhere. In a review of the literature on residential price effects of nuclear power plants, Fox, Mayo, Hansen and Quindry (1985) conclude that the siting of a temporary waste storage facility in Tennessee is more likely to be capitalized into residential properties if there is an increase in the public's knowledge or understanding of the risks associated with facility. They further contend that "the willingness to pay for distance from the facility" is likely to have significant price effects only for properties within 1 mile of the plant.

II. Theoretical Model

1. A Brief Development of Hedonic Theory

The theory which underlies the hedonic model has been developed extensively elsewhere (Lancaster, 1966; Rosen, 1974; Freeman, 1979) and thus, it is not reproduced in its complete form in this paper[4]. The model may be expressed as a single-stage model, in which implicit prices for structural and neighborhood characteristics are derived from an implicit price function. Alternatively, the model may be extended to two stages, where the implicit prices derived in the first stage are used in the second stage to derive inverse demand functions for those attributes. However, Brown and Rosen (1982), Diamond and Smith (1985), Epple (1987), Bartik (1987) and others have noted serious identification problems associated with the estimation of inverse demand functions from hedonic models. Given that the current data set does not contain sufficient information to circumvent those problems, we focus on a single-stage model in this paper.

The hedonic model views housing as a differentiated bundle of attributes $z=(z_1, z_2, ..., z_n)$ where the vector z represents structural housing characteristics and features of the neighborhood. Assuming (a) perfect information about the bundle of attributes embodied in all properties in the market; (b) zero transactions costs in market trades of the packaged bundle; and (c) a continuous

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[4] Hageman (1981) develops an extensive theoretical model of the impacts of nuclear power plants on residential property markets.

offering of attributes in the real estate market, the interaction between utility-maximizing consumers and cost-minimizing producers will generate an equilibrium price for housing which implicitly prices each attribute in the bundle, $p(z)$. The price function, $p(z)$ is generally assumed to be nonlinear, since a the costs of repackaging a bundle of attributes once a house is built is assumed to be prohibitive. Under these conditions, the implicit price of an attribute can be derived as the partial derivative of the equilibrium price function with respect to that attribute, $p_i(z)=\partial p/\partial z_i$. Given the aforementioned assumptions, $p_i(z)$ is equal to the marginal willingness to pay, for a marginal increment in attribute z_j.

2. *The Role of Information*

Recall that the hedonic model assumes that sellers and buyers have perfect information about the quantities of all characteristics, z, in the housing bundle. In the absence of perfect information, the price function is dependent on the perceived level of attributes, z_*. Thus, the equilibrium price function is also a function of the perceived level of attributes (i.e.,$p(z_*)$). While the perceived level of knowledge about attributes is capitalized in the equilibrium price function, unknown attributes cannot be capitalized. Supposed the perceived level of an attribute (z_{*j}), is a function of an index of public knowledge (α) about the attribute (where $0 \leq \alpha \leq 1$), and the actual level of z_i (i.e., $z_{*j}=f(z_j,\alpha)$. The index is assumed to vary between no information, ($\alpha=0$) and complete information ($\alpha=1$). Thus, if $\alpha=0$ then $z_{*j}=f(z_*,0)=0$. In contrast, if $\alpha=1$ then $z_{*j}=f(z_*,1)=z$. The implicit price for attribute z_i thus depends not only on the attribute level, but also on the level of public information. Against this backdrop, we can evaluate the influence of new public information in the hedonic model. Given that the equilibrium price function is $p(z_*)$, suppose that new information becomes available concerning a particular attribute, z_j. Press coverage that informs the public about the decision to build a dry storage facility should have an effect on the level of the equilibrium price function since $p(z_{*i}(z_i,\alpha))$. Hence, $p_{z*i}=\partial p/\partial z_{*i} * \partial z_{*i}/\partial \alpha$ is nonzero if the attribute matters to local residents (i.e., $\partial p/\partial z_{*i} \neq 0$), and as long as information affects the perceived level of the attribute (i.e., $\partial z_{*i}/\partial \alpha \neq 0$). Note that as the actual information tends towards complete information (i.e., $\alpha \to 1$), then $p_*(z) \to p(z)$. Second, additional information should also have an effect on the implicit price, since anything that shifts the equilibrium price function will also influence the implicit prices that are derived from that function (i.e., $p_{*i}(z_i,\alpha)$). For example, Kiel and McClain (1995) show that the effect of an incinerator plant on residential home prices varies with the phase of the project. In the context of this model, as the project goes from the pre-rumor to the rumor stage, the value of α increases from zero to some positive value. Kiel and McClain find that the equilibrium price surface shifts, and also the implicit value of distance from the plant change with the phase of the project.

III. Empirical Model

1. Scope of Study

This paper presents the findings from the first phase of an ongoing study of property value impacts from nuclear power plants. Although we focus on the impacts of the decommissioned Rancho Seco plant, this paper represents only one part of a broader analysis of the impact of nuclear power plants on residential property markets. For example, data have also been assembled for two other plants in California; Diablo Canyon, which is operational and located west of San Luis Obispo, and Humboldt Bay, which is located north of San Francisco in Eureka, CA and which was decommissioned in 1978. In addition, data are currently being collected for nuclear plants in other regions of the country. Subsequent research will focus on comparing and contrasting the findings across sites within and between regions.

2. Model Specification

Applications of the hedonic model have been criticized for focusing extensively on one phenomenon to the exclusion of other salient locational phenomenon. The issue of specification is an important one. For example, a recent paper by Smith and Huang (1993) found that the number of demographic and neighborhood characteristics affected the likelihood of identifying a statistically significant linkage between air quality (specifically particulate matter) and sale prices. If one is to avoid the bias from excluded variables in estimates of the implicit valuation of characteristics of nuclear plants, then other attributes which vary spatially, and which may be correlated with proximity to the plant, need to be included in the model.

The empirical model is estimated separately for each of four separate submarkets, and is broadly defined as follows:

$$\ln RPRICE_k = f(\textit{Structure, Neighborhood, Nuclear})$$

where the real sale price of housing (measured in logarithmic form) in submarket k, is a function of three vectors of determinants: *Structure, Neighborhood,* and *Nuclear*. Property sales data were obtained from TRW REDI-Property and represent individual single-family residential home sales which took place between 1990 and 1994 within 25 miles of the Rancho Seco plant. The period was chosen so that properties sold before and after the announcement of the intention to store waste in ISFSI's are included in the sample. Data are further screened to include only those properties for which sales price and address data are complete[5]. This resulted in a sample of 17,000 observations. Following Michaels and Smith (1990) who show that there are different

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[5] As a result of these screens, all of the properties sold in three nonmetropolitan counties (i.e., Amador, Calaveras, and Stanislaus) to the west, and the southwest of the plant were omitted. In addition, all properties in Yolo county were dropped from the sample, as the closest part of the county is more than 22 miles from the plant.

submarkets operating within the Boston metropolitan area, we define four separate submarkets in the region, classified by the quartiles on the real price variable[6].

a. Use of GIS tools

An important empirical task is to match proximity to these phenomenon to the individual property. To accomplish this, we use Geographic Information System (GIS) software[7]. Since all property sales data have been geocoded, the distance to the closest hazard or annoyance factor can be readily computed so long as the location of the activity can also be geocoded. If hazard data cannot be accurately assigned a lat./long. coordinate, then the characteristics are matched according to other criterion (e.g., by census tract, or zip code).

b. Independent Variables

Complete variable definitions and data sources are defined in Table 1 and descriptive statistics are reported in Table 2. To conserve space, the descriptive statistics are reported on the full sample only. The vector *Structure* contains characteristics of the home. Among the attributes included are the age of the house, the number of bedrooms, the number of full and half baths, the presence of central air conditioning, the number of stories in the structure, the number of fireplaces and the size of the lot on which the house is located.

We include numerous attributes of neighborhoods (i.e., in the *Neighborhood* category) to account for the influence of locational phenomenon on housing markets. These factors include demographic features such as racial and ethnic mix, and poverty levels. Other measures include

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[6] Although Michaels and Smith (1990) use city dummy variables to define their submarkets, we find the price variation with our cities to be unacceptably high. Thus, although we control for the jurisdiction of the property, we define submarkets according to price quartiles rather than the city in which the property is located.

[7] PC-based GIS software packages from MapInfo and Scan/US have been used in this project.

the occupancy rate of housing units in the neighborhood, the average travel time in neighborhood, and the property tax rate on the home. Noxious activity in the community is proxied by several measures including proximity to interstate highways, airports, railroads, Superfund sites, manufacturing firms on the Toxic Release Inventory, hazardous waste disposal sites, and correctional facilities. Earthquake risks are also quantified. Unfortunately, data on school quality and other public services was not available in geocoded form. Therefore, to proxy such factors, we include dummy variables for the city or town in which the household is located.

c. Modeling Public Information

The goal of this study is to determine the extent to which the equilibrium price function $\partial p(z_{*i}(z_i,\alpha))/\partial\alpha$, and also $\partial p_{*i}(z_i,\alpha)/\partial\alpha$ are nonzero. To do so requires that public information, α, be measured. We examine the number of articles about Rancho Seco, which appeared in the local newspaper (the Sacramento Bee) within 60 days of the sale of the property. Over the 5 year period, there were 62 articles or editorials which were written about the plant. Although other media outlets (e.g., television, radio, national newspapers) exist, we chose to focus on press coverage in the dominant local newspaper for several reasons. First, any public information on the Rancho Seco plant which appears in national media outlets is also likely to be reported in the local media. Thus, local coverage actually proxies national coverage as well. The converse is obviously not true. Issues that are reported in the local media, in most cases do not find their way into national media outlets. Second, it is a relatively easy task to determine readership of local newspapers. The same cannot be said for the audiences of local television and radio stations. Third, even if estimates of audience size and geographic range could be obtained for television and radio markets, individual stations do not typically keep the transcripts of news reports in a readily accessible format. Thus, assembling data for all media outlets was not possible, and we use local newspaper coverage as a proxy for the level of public information about the activities at the plant.

The specifications explored in this paper are designed answer the following three questions:

1. Do housing prices change with distance from the Rancho Seco plant (i.e., is there a housing price gradient), and has the shape of the gradient changed over time?

2. Has the number of newspaper articles written about Rancho Seco in the two months prior to the home sale affected the sale price, and has that relationship changed over time?

3. Is there an interaction between the number of articles written and the distance of the property from the Rancho Seco plant, and has that relationship changed over time.

To investigate these questions, the elements of the *Nuclear* vector are measured using three different specifications. The simplest specification addresses the first question by including the distance from the reactor. To allow for differential effects of distance over time, the variable is interacted with the year in which the home sold. Note that since the announcement took place in October 1991, all properties sold in 1992 or later are post-announcement sales. A second specification addresses question #2 above. The level of media coverage on Rancho Seco in the local newspaper (i.e., the Sacramento Bee) in the period just prior to the sale is proxied by the number of articles which appeared within the period of 120 days and 45 days prior to the sale. We reason that articles appearing within 45 days of closing will not have an influence on the offered price, since the typical period between an accepted offer and closing is 4-6 weeks. Again, this measure is interacted with the year in which the property is sold so that differential impacts over time can be measured. The final question is investigated by weighting (i.e., dividing) the media coverage measure in the second specification by distance of the property to the Rancho Seco plant. Again, this measure is also interacted with dummy variables for the year of the sale.

IV. Empirical Findings

Given that there are a total of 12 regression models estimated (i.e., 3 models for each submarket), we economize on space by reporting the findings on variables in the *Structure* and *Neighborhood* characteristics for the first model only. The findings on the variables in the *Nuclear* category are then reported for all three models. The regression coefficients on the control variables are quite robust, and varied little across specifications. It should be noted that the findings on control variables are insensitive to the specification of the public information variables. Before discussing the regression findings which are reported in Table 3, several points need to be made. First, we screened out properties which sold for less than $20,000 (in real terms) on the possibility that these are not arms-length transactions. In addition, one property reported a price in excess of $100 million, and it too was dropped from the sample. Data were also screened when there were missing data on the latitude or longitude of the property. Third, a zero-order missing data approach was used when independent variables in the *Structure* category were missing from the TRW-REDI Property data. The approach is applied separately to each quartile, and it should increase the efficiency of the parameter estimates on variables which do not have missing data (Pindyck and Rubinfeld, 1992). Finally, although quartiles on the real price are used to define submarkets, the number of observations used in each regression model is not identical. This is because the quartiles were determined prior to the implementation of the data screens. The regression results for each of the four submarkets are found in Table 3, with t-statistics reported below each coefficient. The overall fit of the models varies substantially across the four submarkets. The best fit is found for the first quartile (i.e., $R^2_{adjusted}$=0.31) and the poorest fit is in the second quartile (i.e., $R^2_{adjusted}$=0.13). Given the relatively poor fit in some of the models, we will investigate different functional forms in subsequent analyses on this data.

1. Structural Characteristics

For all of the regression models, the variables in the *Structure* category are typically of the expected sign and most are statistically significant. Although it is not necessary to discuss all of the coefficients, several of the findings require elaboration. The age of the house decreases the sale price for all but the highest quartile. This likely reflects the fact that older homes are more likely to be well maintained in that quartile than in other price ranges. Somewhat surprisingly, larger lot sizes reduce values in the first quartile, whereas they increase values for all other price ranges. This may be distinguishing between low income housing in rural versus urban areas. The number of stories has a positive and significant impact on home values on housing values in the second and third quartiles, and it has a negative influence on the first and fourth quartiles. The reason for these contrasting findings is unclear. Finally, the implicit value of structural characteristics as a percentage of housing value, is usually higher for the highest quartile than other submarkets.

2. Neighborhood Characteristics

The variables in the *Neighborhood* category are less frequently statistically significant, although when they are, they are frequently of the theoretically predicted sign. Again, we focus on a general description of findings and on results that are unexpected. High occupancy rates actually decrease the sale price for the third quartile. This could reflect the presence of new housing in the neighborhood, since we do not have a control for the average age of housing in the neighborhood. The racial mix of the neighborhood and the presence of high poverty levels, is statistically important for all submarkets, with high concentrations of minority or poor households, reducing the real sale price of homes in that market. Noxious activities such as railroads, interstate highways, airport noise, hazardous waste facilities, and Superfund sites typically reduce sale prices when they are statistically significant. The presence of correctional facilities and TRI sites actually increases housing prices for some submarkets. Proximity to these sites may be valuable to employees working at the facilities. Unfortunately, employment levels at the facilities are not known so proximity captures both noxious and employment effects[8]. Consistent with the predictions of urban land use models (Herrin and Kern, 1992), neighborhoods with high average commute times have lower home prices than those with faster commutes. However, although we find that high exposure to ozone, weighted by distance to the ozone monitor, decreases sale prices for most submarkets, the variable is never negative and significant. The only variable with a t-statistic exceeding 2 is the first quartile, and it is positive in that equation. The reason for this unexpected result is unclear.

3. Year and City Dummy Variables

Finally, dummy variables for the year that the home sold are generally negative, (when compared with sales occurring in 1990), although they are frequently not significant. The negative coefficients are not surprising given that the real estate market suffered substantial declines since the recession in the early 1990's, and it has yet to recover. Although city dummy variables are not separately reported in Table 3, there was significant variation in home prices

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[8] Terry (1994) also points out that the TRI does not actually measure exposure of the public to toxic chemicals, nor have chemicals on the list been subjected to toxicity measurements. Thus, it is perhaps not surprising that these facilities do not depress home prices.

across jurisdictions for all housing submarkets.

4. Nuclear Category

The first specification reveals that a distance premium of about 0.5-0.6% per mile exists for properties sold in the second and third submarkets. That is, properties that are 10 miles from the plant have sale prices that are 2.5-3% higher than those just 5 miles from the plant. The premium is even higher for the fourth quartile (1.4% per mile). However, there is little evidence to suggest that the announcement of dry storage increased the distance premium. On the contrary, when the interaction terms between distance and the year of the sale were statistically significant, they were negative. The only exception is DISTxYR91 in the third quartile submarket. However, given that the announcement took place in October of that year, one would suspect that properties sold in 1992 would also be impacted. The variable DISTxYR92 is insignificant in the and in fact, DISTxYR93 is actually negative and significant at the 10% level.

The second model measures the influence of newspaper articles about Rancho Seco which appeared in the local newspaper within the period of 120 to 45 days prior to the sale of the property. There is some evidence that the equilibrium price surface is significantly influenced by media coverage. First, the number of articles actually increased prices in the second and third submarkets (i.e., 0.4% and 0.3% respectively for each article) for properties which sold in 1990. Given that Rancho Seco was decommissioned in 1989, this may be reflecting that phenomenon. In the post-announcement period, several models have significant coefficients on the interaction terms. For example, all but the third quartile submarket had lower equilibrium prices in 1992 than the base year, 1990. The reductions range from 0.5% to 1.9%. However, the reductions were temporary. In 1993, prices were not significantly different than they were in 1990, and in 1994, there was only one submarket (the second) which had significantly lower prices than in

1990.

In the third specification, the appearance of articles is weighted by distance from the Rancho Seco plant. Note that the interpretation of the coefficient differs from the second specification (i.e., the percentage change in sale price for each article written at one mile from the plant). Thus, the impact of the coefficient erodes inversely with the of the property distance from the plant, so that the impact of an article at 10 miles from the plant is only 1/10 of the impact at 1 mile. The results for 1990 are similar to that for the second specification. The sale price impact of an article is an increase of 6.9% (second quartile) and 5.8% (third quartile) for homes located 1 mile from the site. Properties at the edge of the region investigated in this study (i.e., 25 miles from the plant) increase only 0.3% and 0.2% respectively. In addition, the only submarkets which experienced significantly different impacts than 1990 were the second and third quartiles. For the second quartile, property values per additional article (at one mile from the plant) fell 10% below 1990 levels in 1992, and fell 0.2% below those levels in 1994. Third quartile measures showed a coefficient for the 1994 interaction term of -0.0489 (i.e., 4.9% lower values per article at one mile, as compared to 1990). In addition, even that other coefficients are not significant, a consistent pattern does emerge. The interaction term for 1992 (i.e., the first year after the announcement of the plan to build a dry storage facility in mid-October, 1991) was always the largest negative interaction term, and the coefficient values typically became less negative over time. Thus, any property value impacts from the announcement appear to be temporary rather than sustained.

V. Conclusion and Discussion

Collectively, these findings suggest that nuclear power plants do exert an influence on local property markets. Properties further away from the plant are found to sell at higher prices other things equal. In addition, the publication of newspaper articles does appear to reduce sale prices, especially within a year of the announcement. However, the impact appears to decline over time. Furthermore, when proximity to the plant is taken into consideration, the impact to the community is shown to be even smaller, since the Rancho Seco plant is in a relatively sparsely populated area.

In some regards, the Rancho Seco plant provides ideal circumstances to investigate the influence of waste storage on property markets. The plant is no longer operating, so employment effects are insignificant. The plant has been located in the community for a considerable time, and hence the long-run adjustments in the residential mix, identified by Galster (1986), are likely to have already occurred. Third, with the low activity at the plant, there have also been no protests in recent years by activists which may accentuate property value impacts.

There are a number of extensions of this research that are currently under way. We are in the process of classifying the newspaper articles according to their content (i.e., regarding waste, waste transportation, and nuclear power in general) to determine whether the type of newspaper article which appeared in the press has an impact on sale prices. This will hopefully shed further light on the role that media coverage of risky activities has on residential housing prices. Second, as noted in the discussion of the scope of the project, we are also investigating other nuclear sites in California, and in other regions of the country. It is important to continue this effort. A number of nuclear plants are approaching the capacity of their wet storage pools. Given that DOE will not begin accepting high-level nuclear waste until at least 2010, on-site dry storage is the likely alternative. These hedonic estimates can be used to determine the likely impact of waste storage on the local property market. Moreover, there may be regional differences in attitudes regarding nuclear waste which may be revealed in different hedonic impacts. Finally, if DOE does eventually site a permanent nuclear waste repository, this technique may be used, in conjunction with willingness to pay surveys, to assess the likely impact of such a facility on home prices.

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Table 1
Variable name and definition , data source, predicted sign

Variable Name	Definition	Source	Predicted Sign
Dependent Variable and Variables in the *Structure* Category			
LRPRICE	Natural log of the real sale price of the property (1990 dollars)	TRW nominal price divided by the national CPI for housing.	dependent variable.
AGEHOUSE	Age of house in years	TRW	-
BEDROOM	Number of bedrooms in house	TRW	+
CNTRLAIR	1=presence of central air conditioning, 0 otherwise	TRW	+
FIREPLCE	Number of fireplaces in the residence	TRW	+
FULLBATH	Number of full bathrooms in the home	TRW	+
HALFBATH	Number of half bathrooms in the home	TRW	+
NUMSTORY	Number of stories in the house.	TRW	?
LOTAREA	Size of the lot on which the residence resides	TRW	+
Variables in *Nuclear* category			
Model #1: DISTANCE DISTxYR91-94	Distance of the plant from the property. Also interacted with year dummy variables.	Computed using MapInfo.	?
Model #2: ARTICLES ARTxYR91-94	Number of articles written about Rancho Seco in the period between 120 days and 45 prior to sale. Also interacted with year dummy variables.	Sacramento Bee	?
Model #3: DSTWTART DWAxYR91-94	(Number of articles written about the facility in the period 120 days and 45 days prior to the sale interacted with the year in which the property sold), divided by distance of the property from the plant. Also interacted with year dummy variables.	Sacramento Bee, Mapinfo computed	?

Variable Name	Definition	Source	Predicted Sign
Variables in the *Neighborhood* Category			
OZONE	Distance weighted value of the nearest ozone monitor, computed as the ozone concentration divided by the distance of the monitor to the property.	EPA-AIRS AQS database.	-
AIRPTNOISE	Number of operations at the airport * proximity dummy (proximity=1 if property is within 2 miles of airport, 0 otherwise).	FAA	-
INTRSTATE	1=interstate highway within 0.25 miles of property. 0=otherwise.	MapInfo computed	-
RAILROAD	1=railroad tracks within 0.25 miles of property. 0=otherwise.	MapInfo computed.	-
EQUKRISK	Earthquake risk classification of the zip code in which the property resides (left out dummy is always lowest risk classification). EQUKRISK=1 if moderate risk, 0 if low risk.	Risk Management Associates study prepared for Freddie Mac.	-
PCTHISPAN	Percent of the census tract population that is of hispanic origin.	Census STF-3A	?
PCTBLACK	Percent of the census tract population that is black.	Census STF-3A	?
PCTASIAN	Percent of the census tract population that is asian or pacific islander.	Census STF-3A	?
PCTOWNOC	Percent of the census tract occupied housing units that are owner occupied.	Census STF-3A	+
PCTOCCUN	Percent of the census tract housing units that are occupied	Census STF-3A	+
PCTPASST	Percent of the census tract population that is on public assistance	Census STF-3A	-
TAXRATE	1994 tax payment divided by 1994 assessed valuation	TRW	?
COMMUTE	Average travel time of households living in that census tract.	Census STF-3A	-

Variable Name	Definition	Source	Predicted Sign
Neighborhood Characteristics (continued)			
CORRECTN	1=Corrections facility within 5 miles, 0=otherwise.	CA Department of Corrections	+
HAZWASTE	Number of hazardous waste treatment facilities within 5 miles of property.	Landview II	-
TRI	Number of manufacturing facilities which are on the Toxic Release Inventory within 5 miles of property.	Landview II	-
SUPERFUND	Number of sites which are on the National Priorities List (i.e., Superfund site), within 5 miles of the property	Landview II	-
City dummy variables	Separate dummy variables for the following cities: Carmichel, Citris Heights, Courtland, Elk Grove, Fair Oaks, Folsom, Galt, Herald, Northern Highlands, Orangevale, Rancho Cordova, Sloughhouse, Walnut Grove, and Wilton. Sacramento is the left out dummy category.	TRW REDI-Property	?
Year dummy variables	Separate dummy variables for 1991-1994. 1990 is the left-out dummy category.	TRW REDI-Property	?

Table 3: Hedonic Regression Models
Dependent Variable: Log of Real Sale Price

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
INTERCEPT	11.680603	11.503719	12.009345	12.21239
	(68.985	(212.034)	(152.495)	(47.608)
Variables in the *Structure* Category				
BEDROOM	0.052773	0.011683	0.019129	0.04108
	(9.908)	(6.494)	(8.046)	(6.09)
FULLBATH	0.026535	0.015543	0.024146	0.169269
	(3.08)	(5.045)	(5.958)	(19.347)
HALFBATH	0.013537	0.00274	0.01705	0.112967
	(1.053)	(0.693)	(4.029)	(11.707)
FIREPLCE	0.074617	0.015845	0.020325	0.075115
	(11.259)	(6.547)	(4.717)	(7.35)
AGEHOUSE	-0.001036	-5.0683E-05	-0.000353	0.000763
	(-4.052)	(-0.533)	(-2.591)	(1.704)
CNTRLAIR	0.0217	0.00094	0.00326	-0.022361
	(2.823)	(0.368)	(0.833)	(-1.589)
LOTAREA	-7.58E-07	3.87E-07	4.78E-07	8.09E-07
	(-1.697)	(3.197)	(5.215)	(7.151)
NUMSTORY	-0.099969	0.0172	0.012948	-0.02303
	(-6.493)	(4.243)	(3.131)	(-2.488)
Variables in the *Neighborhood* Category and Year Dummy Variables				
PCTOCCUN	-0.000754	-0.000415	-0.00251	-0.002553
	(-0.632)	(-1.09)	(-4.565)	(-1.32)
PCTOWNOC	-0.000244	0.000156	0.00015	-2.5556E-05
	(-0.873)	(1.918)	(1.298)	(-0.063)
PCTBLACK	-0.002026	-0.000641	-0.001047	-0.001076
	(-4.328)	(-3.11)	(-2.274)	(-0.482)
PCTASIAN	-0.00051	-0.000264	-0.000406	-0.004175
	(-0.888)	(-1.324)	(-1.271)	(-3.143)
PCTHISPAN	-0.00341	-0.001519	-0.002045	-0.009193
	(-5.179)	(-5.099)	(-3.749)	(-4.297)
PCTPASST	-0.005856	-0.000843	-0.001785	-0.004278
	(-8.297)	(-3.423)	(-4.165)	(-2.154)
TAXRATE	-6.952981	0.254876	-0.568326	0.728055
	(-4.022)	(0.363)	(-0.478)	(0.167)
COMMUTE	-0.004945	0.000355	-0.00488	-0.014578
	(-2.214)	(0.503)	(-4.639)	(-4.247)
OZONE	0.002633	-0.000314	-0.000425	-0.00187
	(2.38)	(-1.236)	(-1.486)	(-1.481)

Table 3: Hedonic Regression Models (continued)

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
	Variables in the *Neighborhood* Category (continued)			
EQUKRISK	0.055585	-0.004913	0.007977	-0.014955
	(1.40)	(-0.57)	(0.653)	(-0.36)
CORRECTN	-0.017353	-0.003308	0.022826	0.034543
	(-1.14)	(-0.712)	(3.731)	(1.975)
RAILROAD	-0.00292	0.001458	0.000646	-0.025259
	(-0.349)	(0.523)	(0.16)	(-1.824)
INTRSTATE	-0.003808	-8.4751E-05	0.004062	-0.063075
	(-0.35)	(-0.024)	(0.793)	(-3.663)
AIRPTNOISE	-1.73E-07	5.5552706E-08	2.6332379E-08	-7.25E-07
	(-1.884)	(1.266)	(0.395)	(-3.473)
HAZWASTE	-0.000547	-0.003048	0.001383	0.011745
	(-0.138)	(-2.097)	(0.592)	(1.514)
SUPERFUND	-0.014358	0.005799	-0.00848	-0.025715
	(-1.96)	(2.572)	(-2.645)	(-2.382)
TRI	0.008006	0.002775	0.001442	-0.004208
	(3.246)	(3.76)	(1.373)	(-1.118)
YEAR91	0.035102	-0.007645	-0.051082	0.013493
	(0.381)	(-0.36)	(-2.242)	(0.205)
YEAR92	0.133235	-0.044213	-0.022668	0.040623
	(1.563)	(-2.32)	(-1.051)	(0.633)
YEAR93	0.034548	-0.071128	-0.004691	0.012635
	(0.451)	(-3.756)	(-0.227)	(0.193)
YEAR94	0.065272	-0.070077	-0.036611	0.012535
	(0.89)	(-3.659)	(-1.764)	(0.193)
	Public Information Variables			
Model #1: Distance to Rancho Seco				
DISTANCE	-0.001696	0.005432	0.005836	0.014441
	(-0.464)	(5.955)	(5.681)	(4.236)
DISTxYR91	0.00019	0.000199	0.002296	-0.000944
	(0.043)	(0.189)	(2.08)	(-0.31)
DISTxYR92	-0.006264	0.000897	0.0002	-0.004344
	(-1.521)	(0.952)	(0.192)	(-1.449)
DISTxYR93	-0.003902	0.001357	-0.001804	-0.004321
	(-1.05)	(1.451)	(-1.806)	(-1.404)
DISTxYR94	-0.00768	0.001058	-0.000235	-0.004538
	(-2.166)	(1.128)	(-0.236)	(-1.494)
# observations	4220	4179	3964	3997
$R^2_{adjusted}$	0.3104	0.1282	0.1562	0.2298
# unreported city dummy variables	12	12	11	13

Table 3: Hedonic Regression Models (continued)

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
	Public Information Variables (continued)			
Model #2: Number of Articles				
NUMBNEWS	0.006022	0.003568	0.003046	0.004890
	(1.460)	(2.781)	(1.923)	(1.086)
NEWS91	-0.005377	-0.002405	0.001374	0.008503
	(-0.581)	(-0.934)	(0.358)	(0.826)
NEWS92	-0.011966	-0.004709	-0.003744	-0.019263
	(-1.802)	(-2.346)	(-1.274)	(-2.216)
NEWS93	0.012562	-0.0000554	-0.001952	-0.000263
	(1.461)	(-0.019)	(-0.468)	(-0.020)
NEWS94	-0.002275	-0.002579	-0.002340	-0.003839
	(-0.525)	(-1.831)	(-1.330)	(-0.735)
Model #3: Distance Weighted Measure of Articles				
DSTWTART	0.098049	0.069289	0.058000	0.057805
	(1.164)	(2.793)	(2.32)	(0.676)
DSTWT91	-0.163863	-0.048118	-0.063026	0.090100
	(-0.883)	(-0.989)	(-0.914)	(0.509)
DSTWT92	-0.200447	-0.10160	-0.069617	-0.243443
	(-1.476)	(-2.645)	(-1.311)	(-1.607)
DSTWT93	0.216651	-0.021309	-0.042277	-0.172769
	(1.292)	(-0.387)	(-0.576)	(-0.730)
DSTWT94	-0.021806	-0.002275	-0.048948	-0.021663
	(-0.248)	(-1.936)	(-1.666)	(-0.225)