Land Markets & Terrorism:

Uncovering Perceptions of Risk

by

Examining Land Price Changes Following 9/11

by

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Abstract

This paper addresses the market's perception of risk from terrorism by examining the prices of single-family homes before and after the terrorist attacks on September 11th, 2001. In the wake of the attacks, government officials responded by raising security at sites considered to be likely targets of future attacks. In the greater Los Angeles metropolitan area, these included the Ports of Long Beach and Los Angeles, Los Angeles International airport, and several local civic centers, among others. The skyscrapers of downtown Los Angeles were also thought to be potential targets. It is clear that some markets internalized these actions as representative of the real risk of repeat attacks (e.g. a pronounced increase in terrorism insurance premiums for commercial properties and "trophy" properties). It is not clear, however, that the consumers have similarly altered their behavior. Where surveys indicate that terrorism is seen as a genuine risk, the actions of home buyers in the L.A. Basin indicate otherwise: the effects of 9/11 on residential markets have been insignificant in the areas surrounding potential targets. Results suggest that the perceived risk of harm from terrorism is in fact unchanged in the wake of the attacks on September 11th, 2001.

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1. Introduction

On August 1st of this year, the Department of Homeland Security (DHS) issued a heightened security alert for financial institutions in the greater New York City area and Washington, D.C. It was the first time that specific targets had been identified in a DHS security advisory. Previously, the Department had issued broad warnings regarding the level of risk from attacks on domestic targets without guidance as to where, when, or what type of attack might be expected. Yet even when advisories are non-specific regarding location, it is implicitly clear that not all locales within the U.S. are equally exposed to the risk of attack. This paper exploits spatial variation in presumed risk to measure the public's assessment of actual risk from terrorism in the wake of the attacks of 9/11.

At issue are behavioral – rather than rhetorical – responses to terrorism. From the reorganization of the Federal government's counter-terror activities to the media's coverage of the "war on terror," consumers have had ample reason to reconsider their actions in light of the attacks and subsequent revelations about terrorist activities. Is consumer behavior consistent with consumer opinion about terror? One recent study (Lerner, Gonzalez, Small, and Fischhoff, 2003) reported that two months after the attacks on New York City and Washington, D.C. survey respondents placed the probability of their being hurt in a terrorist attack at 10%, while the probability that an "average American" would be hurt by a terrorist attack was deemed to be 50%. Presumably, this risk was not a general risk, but one concentrated on those living in areas that were likely targets of attack. If consumer behavior followed such sentiments, the cost of the attacks on 9/11 may be far greater than is generally calculated: the value of urban property may diminish substantially if consumers seek to avoid dense, "target-rich" environments.

In the extreme, aversion to density could alter the basic shape of cities.[2] We might expect flatter, more dispersed cities as a long-term outcome, since city shapes are well-established and the built environment is difficult and expensive to alter. However, it is precisely these inherent features of real estate that make it an ideal subject for the analysis of consumer sentiment regarding changes in expectations. Because the quantity of housing supply is fixed in the short-term, changes in demand will be seen in dwelling

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[2]Glaeser and Shapiro (2002) argue, however, that there is little evidence that armed conflict has ever undone the rationale for urbanization. Rossi-Hansberg (2004) and Harrigan and Martin (2002) suggest that terrorism will have only a mild effect on urban form.

prices and/or transaction volumes. The attacks on 9/11 created a setting for studying changes in the perceived risk of terrorism. If the attacks signaled a change in the probability of attack, proximity to potential targets would be seen as more dangerous. Not only could an attack result in physical harm in the vicinity of the target, it could damage a dwelling or the elements of a neighborhood that make a dwelling valuable. Because of its long life and immobility, real estate values are necessarily tied to expectations about the future – both that of the structure and its neighborhood. Changes in these expectations should be capitalized in real estate prices.

This paper looks to land-rent gradients around potential targets for evidence that consumers' perception of risk from terrorism changed after the attacks on New York City and Washington, D.C. on September 11th, 2001. Specifically, housing markets in the vicinity of Los Angeles International Airport (LAX), the Ports of Long Beach and Los Angeles, and the prominent skyscrapers in the downtown area are examined in the periods before and after 9/11. If individuals do, in fact, perceive a change in the threat from terror, they should pay a premium for land further from potential sites – or alternatively, demand a discount for land proximal to locations more likely to be impacted by a terrorist attack. Thus, the gradient surrounding potential terrorist targets should increase is the months that follow the 9/11 attacks.[3] If the probability of terrorism is perceived to be permanently higher, the change in the gradient should be also be permanent. If, on the other hand, the initial shock and caution regarding properties in the shadow of potential targets fades, the price gradient should first increase and then return to pre-attack levels. In fact, no significant change – temporary or permanent – is found.

In fact, the price gradients surrounding the three potential targets examined vary over time in a manner that is roughly consistent with the hypothesis that consumers perceived no change in the threat from terrorism. No impact is found in either local indexes of house prices and sales volume or in the implicit price of proximity to potential targets of terrorism. The lack of findings in transaction data stands in marked contrast with the survey that found respondents anticipating a one-in-ten chance of personal injury and with evidence of sophisticated consumer pricing of small-probability risk in other housing markets. Several competing stories could explain the observed market

[3]"Increase" should not be confused with "steepen." Because the pre-9/11 gradients can be either positive or negative, changes in supply and/or demand that penalize sites closer to the target will result in increasing gradients: negative gradients becoming less negative – or even positive – and positive gradients becoming more positive.

outcomes, but one that cannot hold is that consumers have voted with their feet. They have not – in statistically significant numbers – perceived a large enough risk of personal and/or property loss to significantly change the price surface surrounding sites perceived to be at higher risk of terrorist attack.

The remainder of the paper is divided as follows. Section 2 develops a model of terrorism and land prices that follows from a broad literature on externalities and housing markets. Section 3 introduces and highlights the data used in the research. Results are reported and discussed in Section 4. The paper closes with a brief discussion of the conclusions and the planned extensions in Section 5.

2. Terrorism & Models of Externalities

Risk from property loss due to terrorist attacks can be modeled as a special case of a more general spatial externality. In the presence of a spatial externality, otherwise identical dwellings will have market values that vary as a function of their proximity to the source of the externality – in this case, the risk of collateral damage due to a terrorist attack. If consumers require a discount to live near a potential target, the closer of these two dwellings will be valued lower, reflecting the penalty associated with the risk of attack and the resulting damage. The literature on spatial externalities is large, including research on both positive and negative externalities. Among the positive externalities are access to work and consumption – the central variables on which much of the urban form literature is based; among the research on negative externalities is the study of the impact of exposure to noise (Wilhelmsson, 2000), smog Kahn, 2000), and environmental hazards such as Superfund sites (Greenberg and Hughes, 1992), among many others.

The standard approach to measuring the value of individual attributes of bundled goods is to estimate a hedonic price equation. In the standard application of hedonic pricing to housing, observed value is a function of quality flow – the services provided by the dwelling's physical characteristics and locational amenities and disamenities – and the unit price of quality. That is,

$$V_{it} = P_t Q_{it} \quad , \tag{1}$$

where V_{it} is property value, P_t is the unit price of quality, and Q_{it} is the quality flow; i and t index parcel and time, respectively. To arrive at the familiar hedonic pricing equation, take the natural log of both sides of the equation and reparameterize the log of quality, lnQ_{it}, as a linear function of attributes, $X_{it}\beta$:

(2) $$lnV_{it} = lnP_t + X_{it}\beta.$$

The vector X_{it} consists of all attributes which contribute to the market price of the parcel.

To make clear the role of spatial externalities consider the following variation of Equation 2. In it, environmental variables – in contrast to the physical characteristics of the dwelling itself – have been separated from the general matrix of dwelling attributes, X_{it}^{D}:

(3) $$lnV_{it} = lnP_t + X_{it}^{D}\beta + \beta^{N} Noise_{it} + \beta^{S} SchoolQuality + \beta^{C} Commute + ...$$

The list of environmental variables imparting spatially differing impacts on the value of dwellings is exceedingly long. In principle, estimating this regression would recover the contributions of both physical and spatial characteristics on dwelling values. In practice, the data required for its estimation are not generally available. As a proxy for the spatial variables, distances (or functions of distances) to point sources are occasionally used. (Although it is not uncommon to see aspatial hedonic pricing of housing.) If V_{it} is the value of periodic services for dwelling i in period t, an alternative definition of its sale price today, PV_{i0} – the dwelling's present value – is:

(4) $$PV_{i0} = V_i 0 + \frac{V_{i1}}{1+r_1} + \frac{V_{i2}}{(1+r_1)(1+r_2)} + \ldots + \frac{V_{iN}}{(1+r_1)(1+r_2)\cdots(1+r_N)} \quad ,$$

where V_t is the value of the net service flow to the owner during time period t and PV_0 is the present value of the series of cash flows.

The future values of the service flows from the dwelling are not known with certainty. They are expected values, embedding expectations about the integrity of the structure, the future quality of the local schools, crime in the neighborhood, employment in the metropolitan area, interest rates, and among many others, the risk of terrorism. In order to make explicit the role of terrorism risk on house prices, Equation 4 can be rewritten to include a basic parameterization that includes both the expected probability of an attack and the expected impact of an attack on the service flow from the dwelling. If p_t is the probability of attack in period t and d_t is the impact of the attack on the flow of services ($d = 0$ indicates no change, $d = 1$ indicates complete loss), Equation 4 becomes

(5) $$PV_{i0} = V_i 0 + \frac{(1-p_1)(1-d_1)V_{i1}}{1+r_1} + \frac{(1-p_2)(1-d_2)V_{i2}}{(1+r_1)(1+r_2)} + \ldots + \frac{(1-p_N)(1-d_N)V_{iN}}{(1+r_1)(1+r_2)\cdots(1+r_N)}$$

Any non-zero probability of attack leads to lower home prices than would have resulted in the absence of terrorism risk. More generally, any change in the expectation of the probability of attack or its severity will cause a change in the value of homes. Specifically,

$$\partial PV / \partial p_k < 0 \quad , \quad \partial PV / \partial d_k < 0 \quad . \tag{6}$$

Of course, it is likely that changes in probability and loss are correlated as are changes in probabilities and losses in adjacent periods – destruction of a property in period t will lead to losses in service flow from the property for many subsequent periods.[4]

The two relevant questions for this approach are first, do consumers respond to changes in the perceived risk of terrorism or other small probability events? And second, is this approach capable of capturing risk pricing along a single dimension of an asset whose observed price is the capitalization of so many location-specific factors? On the matter of consumer responsiveness to terrorism, there is evidence that tourists are sensitive to attacks (Enders, Sandler, and Parise, 1992; Pizam and Smith, 2000; Sloboda, 2003). However, tourism destinations are relatively fungible and easily adjusted, and these studies may not be applicable to durable goods markets like housing.

There is some support, however, for the hypothesis that consumers are sophisticated regarding their assessment of risk in the context of a larger and more permanent investment in a dwelling. In an examination of housing market behavior before and after an explosion of a local chemical plant and after the subsequent announcement that the plant would be relocated, Carroll, Clauretie, Jensen, and Waddoups (1996) find that after the relocation announcement, "property values rebounded to reflect the reduction in the number of [local] hazardous plants." Also, in a study of pricing of houses in the San Francisco Bay Area after the Loma Prieta earthquake in 1991, Murdoch, Singh, and Thayer (1993) find significant price differences by *soil type*. This reflects a remarkable sophistication on the part of consumers to assess and price risk. In this case, home buyers recognized that different soil types imply distinct distributions of damage in the event of an earthquake and warrant differential pricing.

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[4]The underlying utility function of a representative consumer is simplified here. A risk-seeking individual may be willing to pay more for the opportunity to experience a wider range of outcomes and the signs on the partial derivatives in Equation 6 would be reversed. It is also possible that an individual whose income is positively correlated with terrorism risk could find dwellings near target maximizing in a portfolio sense. While both are possible, the kind of aggregate effects we are examining are not likely to be influenced by these exceptions.

2.1 Empirical Strategy

The central empirical challenge in measuring the impact of spatial externalities is controlling for other influences on real estate prices that vary by location. It may be, for instance, that ports are likely targets of terror. However, it is also likely that land prices near ports are impacted by noise, truck traffic, and pollution. A simple hedonic regression that includes dwelling characteristics and the distance to the port as explanatory variables may find that proximity to the port is in fact a significant and negative impact of housing values. Attributing this to terrorism risk would be inappropriate as the coefficient simply measures the influence of distance, commingling the influence of port noise, traffic, and pollution as well as the exposure to fallout from an attack on the port.

The attacks on September 11th, 2001 offer an opportunity to identify the idiosyncratic influence of perceived risk from terrorism. The attacks offer the opportunity to perform a natural experiment to assess home prices before and after the events in order to isolate price changes due to changes in expectations about future attacks and their impacts on housing values. In general, the spatial variables mentioned above are slow changing variables – noise, traffic, and pollution are all relatively fixed in the short term. In the wake of the attacks on New York and Washington, D.C., none of the other environmental variables should change significantly. As a result, changes in house prices around potential terrorist targets can be attributed to consumer responses to the attacks themselves. The hypothesis that consumers have altered their valuation of risk should be testable by examining the price gradient around these targets – prices closer to sites of greater perceived risk should become relatively less valuable.

There are several margins of variation across the data that will allow for identification of the penalty of terrorist risk. The first is spatial: the potential targets are spread throughout the metropolitan area. It will be possible to pool housing sales around several targets to look for systematic changes in the cost of proximity. The second is temporal. Ostensibly the risk of terrorism has been non-zero since well before the 9/11 attacks. But the attacks made the reality of that risk far more palpable and presumably made actors previously ignorant of terrorism more aware. Finally, there is variation in targets themselves, which are perceived to be differentially at risk.

These margins motivate two basic empirical approaches. The first is to consider proximity as discrete; dwellings are "adjacent," "near," or "far" from the potential targets and face differential risk from attach in each category. Based on this conception of terrorism risk, the appropriate test of differential pricing of proximity – evidence of changes in perceived risk "near" targets – would be based on differences in aggregate prices over the pre- and post-September 11th attacks. The second approach is to conceive of risk from terrorism as a continuous variable, declining in relevance with distance from potential targets. Here, distance from the target in question is included in the pricing regression. Again, the inference of changes in consumer perception of risk would be apparent in changes in the the coefficient on distance – that is, changes in the price gradient.

The aggregate index approach requires the estimation of price indexes for each of the subsamples – "adjacent," "near," and "far." This is undertaken by estimating a variant of Equation 2:

$$lnV_{it} = lnP_t + X_{it}^{D}\beta + \sum \delta_k D_{ik} \qquad (7)$$

where k indexes quarters. D_k is an dummy variable, indicating whether or not dwelling i was sold in quarter k. exp(δ) is then the price level in quarter k. The hypothesis that proximity to potential targets became more penalized after September 11th, 2001 would be examined by testing whether or not the indexes were significantly different before and after the attacks. This test may have little power against alternative hypotheses that some other factor coincident with the attacks led to changes. This is discussed further in the results section.

It is also possible that the aggregate indexes may not indicate any change in behavior despite a genuine increase in the discount required to live near a potential target. Consider a basic model of buyer and seller interaction. In the immediate post-attack housing market near a potential target, buyers have not yet lowered their reservation prices, but sellers have reduced their offer prices. Given the idiosyncracies of buyers and sellers and the distributions of their valuations of dwellings, transactions will still occur at similar prices, but fewer will occur in aggregate. In this setting, the impact of changes in perceived risk may first be apparent in sales volume, but not in prices. Both aggregate prices and sales volumes are reported below.

The second approach to assessing price changes is to conceive of risk as a continuous variable that varies with distance from the target. In this case, the basic hedonic equation is specified as follows:

$$lnV_{it} = lnP_t + X_{it}^{D}\beta + \beta^{T} Terrorism\ Risk_{it} + \sum \beta^{O} Other\ Locational\ Amenities_{it} \qquad (8)$$

If it assumed that the other locational amenities and disamenities are not responsive to the attack on September 11th, they are fixed over our sample period and Equation 8 becomes:

$$lnV_{it} = lnP_t + X_{it}^{D}\beta + \beta^{T} f(dist_i) \quad (9)$$

Here, $f(dist_i)$, is one of several different functional form used to examine changes in the price of proximity before and after 9/11.

The simplest functional form is an interaction with a dummy variable indicating whether the sale occurred before or after the attacks. If the change in perceptions – and pricing – is permanent, then this is the correct specification. If, on the other had, consumer response varies over time after the attacks, it would be more appropriate to use a series of interaction dummies to pick up the evolution of pricing in the wake of the attacks.

3. Data

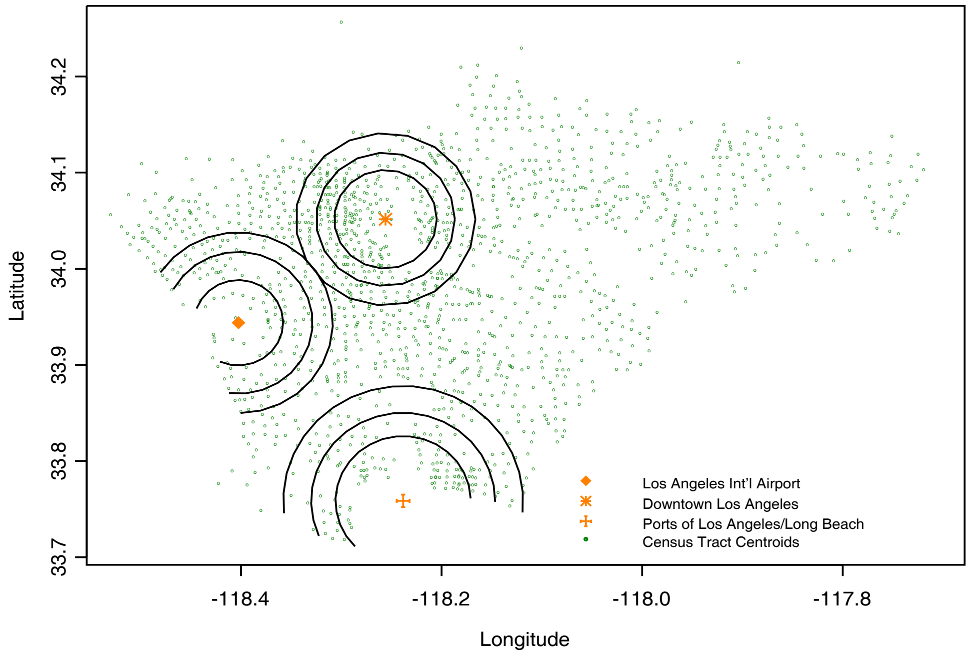
Three types of variables from housing markets are required to make possible a measurement of changes in perceived terrorism risk. As discussed in the previous section, evidence of consumer responses will be looked for in housing market outcomes. It is then necessary to have transactional data, both sale price and sale date. This data is fairly easily obtained, but is by itself inadequate to make a credible assessment of risk pricing. Housing varies substantially from dwelling to dwelling. In order to recover the parameters on interacted distance variables it will be necessary to control for physical heterogeneity. This implies that data on dwelling physical characteristics are also needed. Finally, locational information is essential.

All three types of data are gathered on an ongoing basis by DataQuick, a real estate market information firm. For this study, DataQuick data on dwelling transactions and characteristics for single family residences in the central and southern parts of Los Angeles county are employed. The data include sales price and date, a number of physical characteristics, and are identified by their census tract.

The geographic scope of the data was defined to include three prominent potential targets of terrorism and their surrounding housing markets; these include Los Angeles International Airport (LAX), the ports of Long Beach and Los Angeles, and the central business district (CBD) of downtown Los Angeles. Certainly, there are other candidates for attack. Discussions in the media have identified water and power facilities as potential targets, as well as cultural institutions associated with the projection of America abroad (Hollywood), but none are as prominent as the three employed in this research.

Figure 1 shows the U.S. Census centroids for the southern portion of Los

Figure 1. Potential Targets & Their Environs



Angeles County as well as the three locales being examined. For each of the three - the central business district (CBD), the Ports of Los Angeles and Long Beach (the Ports), and Los Angeles International Airport (LAX) - the figure also shows three concentric rings indicating the boundaries of the discrete regions introduced in the previous section. These regions - "adjacent," "near," and "far" are chosen to include roughly the same number of observations on housing sales. Note that the rings around the Ports are bigger. The ports are comprised of large areas in which there are no dwellings and hence no sales. Therefore, the rings have been extended.

Table 1 reports average characteristics for the dwelling

Table 1. Sample Means by Proximity & Locale

(Standard Deviation in Parentheses)

	Sales by Proximity			Sales by Locale		
	'Adjacent' Sales	'Near' Sales	'Far' Sales	LAX Sales	CBD Sales	Ports Sales
Observations	6,342	11,728	17,696	12,902	11,464	11,956

Sale Price	261	336	326	369	282	291
(000s of dollars)	(175)	(280)	(240)	(274)	(238)	(206)
Interior Area	1,297	1,514	1,486	1,504	1,432	1,432
(sqft)	(607)	(762)	(707)	(697)	(755)	(677)
Baths	1.74	1.95	1.93	2.02	1.69	1.95
(number)	(0.76)	(0.94)	(0.92)	(0.95)	(0.87)	(0.84)
Bedrooms	2.43	2.70	2.68	2.70	2.55	2.67
(number)	(1.00)	(0.96)	(0.92)	(0.89)	(1.01)	(0.94)
Fireplace	0.24	0.34	0.36	0.32	0.42	0.28
(percent)	(0.43)	(0.47)	(0.48)	(0.47)	(0.49)	(0.45)
Garage	0.42	0.53	0.57	0.55	0.50	0.54
(percent)	(0.49)	(0.50)	(0.49)	(0.50)	(0.50)	(0.50)
Dwelling Age	45.2	47.7	46.6	41.8	62.1	38.5
(years)	(29.4)	(27.6)	(25.3)	(23.7)	(27.6)	(23.2)
Renter Occupied	0.12	0.10	0.10	0.10	0.11	0.10
(percent)	(0.32)	(0.30)	(0.30)	(0.30)	(0.31)	(0.30)
Pool	0.02	0.04	0.05	0.04	0.04	0.06
(percent)	(0.15)	(0.20)	(0.22)	(0.19)	(0.19)	(0.23)
View	0.02	0.06	0.05	0.03	0.09	0.03
(percent)	(0.16)	(0.25)	(0.22)	(0.17)	(0.29)	(0.17)

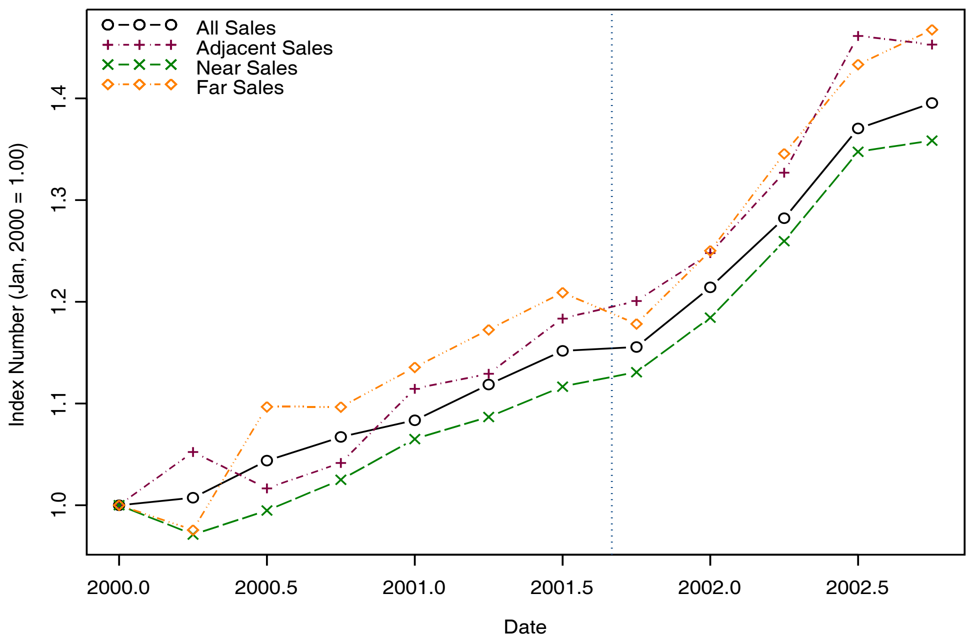
sales used in this analysis. It makes clear the need to control for physical heterogeneity and suggests that while there are systematic differences across the types of dwelling within each of the discrete categories of proximity, the differences are far greater across the submarkets defined by the neighborhoods around each potential target. For example, dwellings sold in the region adjacent to the potential targets are systematically smaller and lower quality, and sell for less. However, there is essentially no difference in the average age by proximity, whereas the vintage of the housing stock appears to be drastically different across the three locational submarkets.

4. Results

The models introduced above suggest that any measurable impact of changes in the perceived risk of terrorism should appear in either dwelling prices or in aggregate sales volume. Aggregate price and sales volume are presented first. These models use discrete regions of proximity to potential targets to partition sales according to presumed exposure to risk. The results for the continuous models of risk - those that include linear distance to potential targets - are presented second.

The results of the aggregate price indexes are inconclusive. The indexes are shown in Figure 2. If consumer valuations of

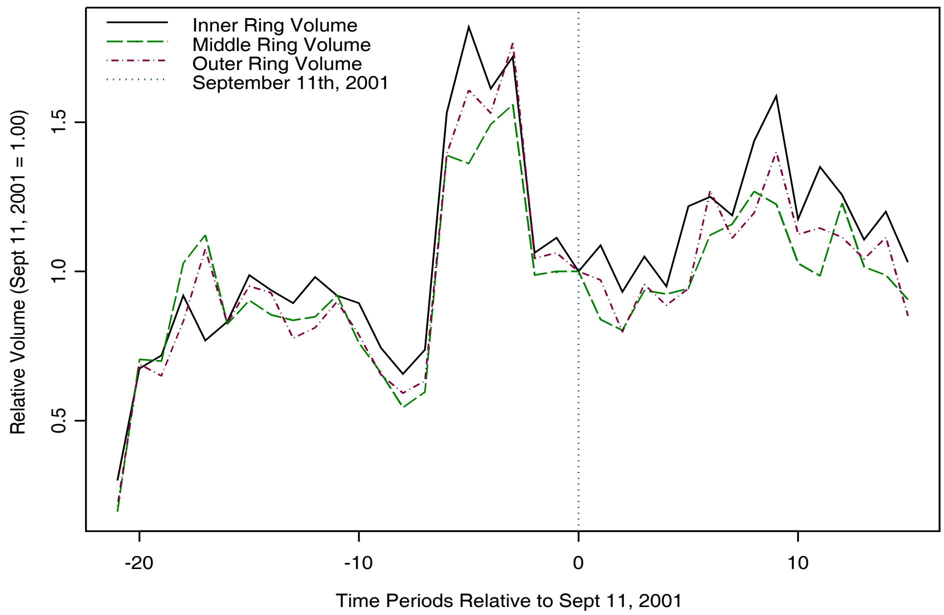
Figure 2. Aggregate House Price Indexes by Proximity to Potential Targets



dwellings proximal to potential targets had indeed declined in response to their higher perceived risk, the aggregate index measuring prices in the adjacent regions should have shown a decline relative to the other two regions in the neighborhood of the potential targets. In fact, it is the region furthest – ostensibly the region at least risk – that is the only one to show an absolute decline in the point estimates of price levels. Further conclusions cannot be drawn between the differences in the indexes because the 95-percent confidence interval for each includes the other indexes.

The same lack of any evidence of changes in housing markets resulting from the September 11th attacks appears in Figure 3. It shows sales volume for the same three discrete regions within the neighborhood of the potential targets: "adjacent," "near," and "far." According to the results presented in the figure, there is no adverse market reaction to proximity. Quite the opposite, transaction volume is higher in the two-month period after the attack than in the two-month period preceding it. Transaction data are. noisy and frequently reported with some lag – sale dates are the date of closing rather

Figure 3. Aggregate House Sales by Proximity to Potential Targets



than the date of the agreement to sell. That said, there is no pronounced relative decline in the adjacent regions at any point in the sample period.

Both of the sets of results presented in Figures 2 and 3 are dependent on the delineation of what constitutes "near." Numerous radii were used, but none yielded evidence of systematic impact on housing markets as a result of the attack. Despite this robustness, it may be possible that using discrete regions and pooling sales across potential targets is masking marginal effects that vary across the sites.

To address this concern, the basic hedonic regression, Equation 2, was modified to include a continuous measure of proximity. Also, housing sales around the three potential targets examined were not pooled. Testing for changes in the pricing of proximity is conducted by interacting the distance variable with several different specifications of time dummies. The base-case is the simplest model: house price is a function of a dwelling's physical characteristics, its distance from the potential target, and the price level during the quarter of sale.[5] The physical characteristics included in the regression include dwelling size (interior), number of baths, number of bedrooms, the

[5]It should be noted in the results presented here, distance is not to the dwelling itself but rather to the centroid of the census block group in which the dwelling is located. This loses some of the individual variation in distance, but there remains substantial locational variation across block groups. Moreover, in trial tests using dwelling specific distances, there was no disagreement with

age of the dwelling at time of sale (and its square), and a series of dummy variables indicating the presence of a fireplace, garage, central heat, central air, a pool, and whether or not it has a view and is occupied by the owner.[6]

Tables 2, 3, and 4 report the distance coefficients for regressions using dwelling

Table 2. Differential Pricing of Proximity Before and After 9/11 - L AX

(t-Statistics in Parentheses)

	Model I	Model II	Model III	Model IV	Model V	Model VI
Observations	1,980	1,979	1,978	1,977	1,976	1,975
R-squared	0.626	0.626	0.625	0.626	0.626	0.626
ln(Distance)	-0.20	-	-	-	-	-
	(8.31)					
ln(Dist)*QTR7-	-	-0.18	-0.18	-0.18	-0.18	-0.18
		(5.37)	(5.33)	(5.34)	(5.34)	(5.34)
ln(Dist)*QTR8/8+	-	-0.22	-0.13	-0.13	-0.14	-0.14
		(6.52)	(1.72)	(1.73)	(1.73)	(1.74)
ln(Dist)*QTR9/9+	-	-	-0.26	-0.18	-0.18	-0.18
			(6.02)	(2.52)	(2.52)	(2.52)
ln(Dist)*QTR10/10+	-	-	-	-0.30	-0.38	-0.38
				(5.62)	(3.82)	(3.82)
ln(Dist)*QTR11/11+	-	-	-	-	-0.26	-0.21
					(4.27)	(2.48)
ln(Dist)*QTR12	-	-	-	-	-	-0.32
						(3.60)

sales from the neighborhoods of the Los Angeles International Airport, the central business district, and the Ports of Los Angeles and Long Beach, respectively. For each neighborhood, the subsample of dwellings was selected from the cumulative discrete regions used in aggregate analysis above – using r-squared as the criteria for selection. That is, three regressions were executed for each of the potential targets. The first

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the results presented in this paper.

[6]The coefficients on these variables are not included due to space constraints. They are available from the author. They behave as expected with view and pool as the most valuable of the indicator variables; interior size is highly valued; and age diminishes house price, but at a declining rate. All but the heating/cooling variables are consistently significant.

included only those dwellings from the "adjacent" region, the second from the pooled "adjacent" and "near" regions, and the third included all sales from the three regions.

Each of the tables reports the base model (Model I) as well as five additional models. Each of the additional models allows more flexibility regarding the temporal variation in the price gradient around the targets. A significant response on the part of home buyers to demand a discount in order to live near the potential targets would be reflected in the the gradient becoming more positive. Note that the gradient can be either negative – if land closer to the site is in higher demand – or positive – if the opposite is true. In either case, a change in the perception of risk from terrorism and the resulting drop in relative demand near the site would have the effect of making either positive or negative gradients more positive.

Table 2 is typical of the three tables reporting the time and distance interactions.

Table 3. Differential Pricing of Proximity Before and After 9/11 - CBD

(t-Statistics in Parentheses)

	Model I	Model II	Model III	Model IV	Model V	Model VI
Observations	11,439	11,438	11,437	11,436	11,435	11,434
R-squared	0.589	0.589	0.589	0.589	0.589	0.589
ln(Distance)	-0.10	-	-	-	-	-
	(7.52)					
ln(Dist)*QTR7-	-	-0.12	-0.12	-0.12	-0.12	-0.12
		(6.24)	(6.22)	(6.22)	(6.21)	(6.21)
ln(Dist)*QTR8/8+	-	-0.08	-0.15	-0.15	-0.15	-0.15
		(4.70)	(3.08)	(3.08)	(3.08)	(3.08)
ln(Dist)*QTR9/9+	-	-	-0.07	-0.08	-0.08	-0.08
			(3.75)	(1.94)	(1.94)	(1.94)
ln(Dist)*QTR10/10+	-	-	-	-0.07	0.00	0.00
				(3.24)	(0.01)	(0.01)
ln(Dist)*QTR11/11+	-	-	-	-	-0.11	-0.10
					(3.99)	(2.65)
ln(Dist)*QTR12	-	-	-	-	-	-0.12
						(3.03)

.The table shows that very little additional explanatory power is gained by adding the interaction terms. Moreover, there is no perceptible trend towards a more positive gradient. In the models with three or more interaction terms, the point estimate of the price gradient in the quarter following the attacks is greater. However, the hypothesis that it is more negative cannot be rejected. Furthermore, the greater the number of interaction terms, the more the trend appears to be towards a more negative gradient. This would imply the curious result that, in the wake of the attacks on September 11th, 2001, consumers responded by bidding up dwellings closer to potential targets.

Table 3 repeats the same basic story as revealed in the previous table. The sample size is much larger for the CBD regressions, as the fit of the model was best using all three of the discrete surrounding regions. The explanatory power of the model is roughly equivalent as that using the LAX data. So, too, are the trends in the coefficients on the time-distance interactions. Once more, the immediate response in the quarter following the attacks appears to be that proximity is more valued, not less. Like the "trends" in the LAX neighborhood, the absence of pattern is the most notable feature of this table.

Finally, Table 4 reports the interaction coefficients for the regressions using data

Table 4. Differential Pricing of Proximity Before and After 9/11 – Ports

(t-Statistics in Parentheses)

	Model I	Model II	Model III	Model IV	Model V	Model VI
Observations	11,931	11,930	11,929	11,928	11,927	11,926
R-squared	0.621	0.621	0.619	0.619	0.619	0.619
ln(Distance)	0.24	-	-	-	-	-
	(20.8)					
ln(Dist)*QTR7-	-	0.24	0.24	0.24	0.24	0.24
		(14.4)	(14.2)	(14.2)	(14.2)	(14.2)
ln(Dist)*QTR8/8+	-	0.25	0.18	0.18	0.18	0.18
		(15.9)	(4.67)	(4.67)	(4.67)	(4.67)
ln(Dist)*QTR9/9+	-	-	0.25	0.25	0.25	0.25
			(13.6)	(6.59)	(6.59)	(6.59)
ln(Dist)*QTR10/10+	-	-	-	0.25	0.22	0.22
				(12.0)	(6.11)	(6.11)
ln(Dist)*QTR11/11+	-	-	-	-	0.27	0.25

					(10.6)	(6.48)
ln(Dist)*QTR12	-	-	-	-	-	0.30
						(8.46)

from the environs of the Ports of Los Angeles and Long Beach. As in the case of the CBD, the best statistical fit of the continuous model employed the full subsample comprised of all sales from the three discrete regions around the Ports.

The notable difference in the Ports regressions is that the price gradient is positive - implying that buyers already demanded a discount to be nearer the Ports. However, like the other potential targets, the immediate response of markets was to demand less of a discount – directly opposite of a collective move to avoid any perceived risk from living in the shadow of the Ports.

Overall, the regressions using distance as a continuous variable leave little impression that housing markets in the areas surrounding highly visible targets responded at all, let alone in a manner consistent with risk averse individuals requiring compensation for bearing additional risk.

Of course, there are a number of possible explanations for these collective results that are more in concert with the survey results reported in the introduction – that respondents felt they faced 10% probability of personally being injured by a terrorist attack. They are all methodological. The most obvious is that the level of aggregation is too course. Indeed, the distance variable that is so crucial to this analysis is measured not at the dwelling level, but at the Census block group level. This is possible, but with an average of approximately 158 different centroids for each of the three potential targets, there is ample variation to identify systematic trends in prices. In fact, if prices were to respond on the same scale is was enunciated in the survey, price trends in housing should be visible at a broader level of aggregation than the Census tract.

Alternatively, the wrong targets have been chosen to study. There are, in fact, over a hundred sites in California considered at elevated risk of attack. Further research could address others on the list, but the three included in this list are consistently the most prominently discussed. (LAX was the intended target of a terrorist intercepted at the Canadian-American border.) Other potential target might include Disneyland, or the other regional airports. That said, it is unlikely that the perceived risk is systematically higher at any other site. It is therefore difficult to believe that a stronger behavioral response can be found when none was found in the neighborhoods around LAX, the

Ports, and the CBD

An alternative hypothesis that could explain these findings is that individuals respond to surveys in a manner that is inconsistent with their actual behavior. While this is not directly tested, it is consistent with the results.

5. Conclusions & Extensions

Since the attacks of September 11th, 2001, the threat of terrorism has been viewed by the American public as sufficiently great to provide broad support for the invasion of two countries, to add an additional cabinet post and create the Department of Homeland Security, and even cause the reorganization of the intelligence communities at the highest levels of government. In the private sector, commercial real estate markets have been hit with doubling of terrorism insurance premiums - where it remains available at all. Voters felt terrorism was a major issue in the presidential elections. The question addressed in this research is do individuals act the same way they do when they buy houses as they do when they answer surveys?

The results presented in this paper suggest that they do not. If fact, the results are consistent with the hypothesis that homebuyers' perception of risk is unchanged in the wake of the attacks of 9/11. No significant change was measured in prices or sales volume in neighborhoods of prominent potential targets of terrorist attack.

There is striking evidence of the ability of markets to price small probability risks – the type of soil, and its underlying performance during earthquakes, is shown to be priced in one study. This example of markets "discovering" pricing indicates that the lack of any significant response is not likely the result of market participants being ignorant of the effect of even small changes in the likelihood of damage from terrorism. It is more likely that consumers simply do not believe that a second attack of the scale of the attacks on New York and Washington, D.C. will occur.

The apparent conflict between the survey discussed above, the inordinate media coverage of terrorism, and the absence of any manifest pricing of additional risk is best viewed as reason to use market-based transaction data. This capitalization of expectations represents an advantage over polls or surveys in ascertaining consumer beliefs because transactions are costly whereas survey responses are not.

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