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The Effects of an Airport Relocation on Property Values: A Noxious Siting or Community Development?

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The Effects of an Airport Relocation on Property Values: A Noxious Siting or Community Development?

by

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Dedication

All I am, or can be, I owe to my family.

To Richard, Ruth, Rachel, Leah, and Mark.

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The Effects of an Airport Relocation on Property Values:
A Noxious Siting or Community Development?

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This dissertation estimates property value gains and losses resulting from an airport siting decision and the distributional effects among neighborhoods with different socio-economic characteristics. Airports are rich sitings for research because they are simultaneously amenities (employment centers, magnets for growth) and disamenities (sources of noise, congestion, danger). The hedonic analysis includes characteristics and prices of 21,000 houses sold in Austin between 1980 and 2001 combined with GIS maps and census data, to provide the capitalized costs and benefits of airports to homeowners.

Chapter One, "A Comparison of Methodologies to Measure Effects of Airport Siting Decisions," uses four model specifications to consider the removal of an airport. It proposes two modifications to the traditional hedonic model to account for the non-linearity in the effect of distance to an airport on house values

and to separately measure the amenity and disamenity aspects of proximity. Here, noise, distance, and access are separately identifiable, with noise and proximity being disamenities, but access to the facility is a boost to house prices. House values near the old airport changed little with early announcements but changed more with groundbreaking then with the final switch to the new airport.

Chapter Two, "Capitalized Gains and Losses from an Airport Relocation," compares the net value of removing an airport to homeowners near the old airport to the net value of adding an airport to homeowners near the new airport. Houses near both airports gain value in net, though the value is larger at the new airport because few houses are in close proximity where prices tumbled the most and many houses lie along the route where prices climbed the most.

Chapter Three, "House Price Gains and Losses: An illustration of environmental justice in a noxious facility relocation decision," estimates the distributional effects of the airport sitings. In this case, the same income and ethnic groups that bear the burden receive the benefits from changes in house prices near both airports, but the variance between the gains and losses are largest for the poorest and the tracts with the highest concentrations of Native American, black, and foreign-born populations.

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Introduction

Even though markets rarely exist for environmental goods, their effects on market prices can be measured in an urban setting by virtue of being 'bundled' to a residential location. When a household purchases a house, it implicitly buys an entire bundle of amenities – public schools, police protection, parks, transportation, even air and water quality. If, however, a model controls for all non-environmental factors, then any remaining difference in price can be attributed to differences in environmental quality. The hedonic pricing method, using regression techniques, can be used to identify what portion of property value differences can be attributed to the environmental differences and to infer an individual's willingness to pay.

This study applies the hedonic pricing method to analyze the removal of a major airport in an urban location. By the late 1980s, Mueller Airport in Austin, Texas was losing its ability to handle the dynamic growth of cargo and passengers flooding the airport as a result of the high-tech boom. If the City wanted to maintain this growth and job development, it would need to expand the airport. However, Mueller was an old facility, land-locked on only 711 acres in the heart of the city. Moreover, the recent growth in the number and size of planes coming into the airport had drastically elevated the noise level imposed on the more than 30,000 people living in noise impact areas. The City decided to solve both problems by relocating the airport to a new facility on the outskirts of town.

Clearly, the city required a larger airport, but what would happen to the neighborhoods that surrounded the old airport which both suffered from noise but also enjoyed the proximity to air travel? Do homeowners consider the airport a magnet for growth and development, or is it a noxious facility, spewing noise, pollution, congestion, even danger on its neighbors? Planners need the best available information before deciding where to put an airport, including not only the costs and benefits, but also estimates of who bears those costs and who gets the benefits.

This study answers these questions by combining the effects of airports on property values with several other sub-literatures within hedonics: the varying influences of noise and distance measures of airports on property values, house prices during noxious siting stages, and repeat-sale analysis. Several data sources are brought together, including Geographic Information Systems (GIS) maps and census data, on a variety of structural, neighborhood, and environmental variables over a twenty-year period. Due to the variety and length of the data set, the hedonic pricing technique can be applied in four different model specifications. Thus, not only is this study a determination of the impact of noise and proximity to an airport on residential property values in Austin, it is also a comparison of analytical methods.

The first chapter brings together important elements of each of these sub-literatures. First, the airport variables are disaggregated into noise and proximity in the manner of Espey and Lopez (2000) and Lipscomb (2003), plus a third variable that measures the effects of development along the major routes to the airport. This three-variable specification is unique to this study and hopes to answer the open question on the amenity versus disamenity nature of urban airports. In addition, the airport literature in hedonics tends to focus on building new airports or expanding current ones. This study looks at the question from the opposite direction; it focuses on houses in a neighborhood where an airport is being *removed*.

Second, this chapter links the siting stage models with traditional and repeat-sale models to find when, if at all, homeowners react to a noxious siting. The siting stage models divide the entire twenty-year period into five "stages" where households have different levels of certainty regarding the eventual relocation of the airport. The traditional and repeat-sale models, on the other hand, examine the reaction to specific events that lead to the relocation of the airport.

Finally, as mentioned above, the first chapter is a comparison of analytical methods. In the siting stage section of the paper, "phase models" are compared to "pooled models". The repeat sale section begins with a difference-in-difference calculation at the means. These results are then compared to a repeat-sale analysis and a traditional hedonic model. While neither siting stage nor specific event models are necessarily better, the conclusion compares results, as well as the ease of implementation and interpretation, across all four regression-model specifications.

The results of chapter one indicate the following. The result of the more flexible, non-linear specification of the environmental variables finds that noise, distance, and access to the airport are separately identifiable, with noise and proximity being disamenities, but access to the facility is a boost for house prices. The different model specifications find different event dates to which residents respond to the airport relocation. By and large, early announcements had little effect on house prices, though prices changed more with the groundbreaking than with the final switch to the new airport. This suggests homeowners have rational expectations and adjust to the relocation of the airport before the aircraft noise actually ceases. Comparing the different types of models, this paper finds that the phase specification is a better fit to the changing valuation of neighborhood characteristics across time than the pooled specification. The repeat sale and traditional hedonic models produce similar results that are consistent with expectations. Therefore, the appropriate choice of either a repeat sale or hedonic model would depend largely on the data available.

Chapter two builds on the first chapter by looking at not only the effects around an old airport being taken out of a community, but also looking at the effects around a new airport being located elsewhere. Coefficients for noise, distance, and location on the route to an airport are found using similar empirical methods from the earlier research but then applied to the exact houses and communities impacted.

In addition, this chapter discusses hysteresis for airport facilities. Here, the hysteresis question is taken from Barham, Chavas, and Coomes (1998). They define hysteresis quite generally as “situations of irreversibility where particular outcomes persist even after the conditions giving rise to their occurrence are removed" (429). This chapter analyzes the housing market in Austin near the old airport at three stages, equilibrium, clean-up (when the new airport is being built), and recovery (after the new airport opens) over six time periods. To answer hysteresis questions, the original equilibrium prices are compared with the post-airport closure recovery prices to see if the areas around the old airport rebound from the former airport siting. Bergstrom Air Force Base (BAFB) also goes through the same three stages during the model period, equilibrium, clean-up, and recovery. In contrast to the old municipal airport facility, which during the model period was not renovated for a new use, the recovery period for former Air Force base includes the rehabilitation of the facility into the new municipal airport. The hysteresis section briefly discusses the impact that rehabilitation has on an airport closure.

In the context of Austin's airports, hysteresis can also be defined as the question of whether adding an airport has the exact opposite effect of removing an airport. To answer this hysteretic question, the double-difference estimated coefficients are used to calculate the potential efficiency gain from the airport re-location by comparing the numbers of gainers and losers and the magnitude of the house price changes from the public policy decision. This section measures whether the decision to move the airport lessened the overall burden to homeowners near *both* airports in aggregate. Because airports contain some disamenity aspects, a Pareto improvement is not possible here. However, a *potentially efficient* improvement is still possible if the gains near the old airport outweigh the loss near the new airport, or if the amenity aspects of airports outweigh the disamenity aspects.

The decision to move the airport was quite likely made for reasons other than increasing or decreasing property values.[1] However, it turns out that only about half as many houses lie either within the first three miles, in a noise contour, or on the route to the new airport as lie within the same designations for the old airport. Also, the airport move was significantly driven by the homeowners near the old airport. Therefore, moving the location of the airport addressed the disamenity problem only if a net gain was realized by homeowners near the airports, without taking into account the costs and benefits to the city as a whole. If the burden to homeowners increases with the airport move, then building a new airport simply transferred the disamenity from one area to another without reducing it, leaving the City open to the same civil and legal turmoil as occurred before the move. Implicitly, then, this calculation compares the impact of being near an airport going in to the impact of being near an airport going out. The overall negative impact is expected to lessen due to the strategic location of the new facility.[2]

Unlike other airport location studies, this chapter uses three different estimates of each environmental variable: a single-difference (within-period)

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[1] It was widely believed that Austin had outgrown the old airport and a larger facility with international flights was necessary. The new location was chosen after years of deliberation and voting. In addition, outside of neighborhood concerns and development coalitions, the new site was chosen based on land costs and the pre-existance of runways. For the city as a whole, I assume that since the vote to move the airport passed, at least a majority of citizens believed the overall benefits of the new airport would compensate for the additional costs.

[2] When the old airport was first built in the 1930s it was also, presumably, in an area of low population density and the city grew in around the facility, creating more of a nuisance than was initially anticipated. The same may become true of the new airport over a similar long time frame.

estimate, a time-invariant estimate, and a double-difference estimate to measure the burden on homeowners near both airports in Austin. First, an empirical model similar to those used in the first chapter for the old airport is expanded to include distance and accessibility variables for the newly built airport. The new airport was built on the site of a closed Air Force base in an area of low population density. Due to the small number of houses and the use of the former Air Force runways, no houses in the data set are affected by aircraft noise above 65 decibels (the level FAA and HUD designate as incompatible with residential housing use). This is a limitation of the data, but also a reflection of how few houses are actually located near the new airport. Second, because the data set includes at least some houses near both airports over time, it is still possible to isolate the relative effects on the neighborhoods near the airports compared to the rest of Austin, as well as the effects of moving the airport over time. A difference-in-differences model is used to compare the estimated coefficients both within the model and across time periods.

However, rather than comparing these types of estimates to each other, this chapter uses the combination of results to draw a clearer picture of what actually happen to house prices as a result of the airport relocation. The single-difference estimates give the effect that different airport characteristics have on selling a house in any given time period. This estimate is useful for determining how the airport affects the selling price of a house holding everything else equal. The time-invariant estimate gives the effect of a policy over its lifetime, rather than focusing on any given period when the house sells. These time-invariant estimates are often zero and can be quite deceptive. A policy that has large positive impacts in one period but large negative impacts in the next can give a zero net impact without realizing the gains and losses to homeowners who buy or sell homes in between. Finally, the double-difference estimate takes account of both of the previous elements and highlights the true effect of airports on housing values across time.

The results of this investigation indicate the following. The single-difference models with independent regressions for each period finds that previous to breaking ground at the new airport, no significant difference in price of houses under the noise contours existed, compared to the rest of Austin. During the time it took to build the new airport while the old facility was still operating, house prices in the noise contours were lower than other prices in Austin. Once the new airport opened and noise ceased at the old facility, houses in previous noise contours at the old airport sold at a premium. When this model is extended to a difference-in-differences model, noise at the old airport caused temporary declines in house prices compared to the rest of Austin, in reaction to the announcements of the impending airport re-location. Even controlling for aircraft noise, a house located in an old airport neighborhood sold for less, all else equal. Except for the closest distance ring, however, these negative distance impacts lessen over time. Access to the old airport was clearly an amenity; houses along the route to the old airport suffered permanent value losses when the old airport closed.

Looking at the new airport, noise is not nearly the factor as it was for the old airport because of its location around a former Air Force Base. Fewer houses simply exist within the noise contours. This is also a factor for close proximity to the new airport, although enough houses sold to determine that the houses in the closest distance contour sold for lower prices than elsewhere in the city. The double-difference coefficients show that this disamenity effect lessens over time in anticipation of the airport opening, but it wanes again during initial flight operations. Again, access to the airport is an amenity. Despite negative single difference coefficients on route, the double-difference coefficients show a significant increase in the houses on the route to the new airport after construction begins compared to the pre-list period and compared to other locations.

The hystersis analysis finds that airports do have persistent effects on house prices in the surrounding communities, even after the facility is abandoned. As would be expected from the different impacts that noise, distance, and route have on communities surrounding functioning airports, the hysteretic effects are both positive and negative and depend on the number and value of houses located in the community. The history dependence of an airport on the community is influenced by redevelopment at the former facility. The results of converting the former Air Force Base into a new municipal airport suggest that while it is not advantageous to live very near any airport facility, building a new airport on the old grounds significantly reduced the negative impacts on the surrounding community that appeared when the Base closed.

The net gain calculation that incorporates all houses in Austin impacted by the airport move (115,927 total houses) finds that moving the airport from Austin's city center to a more remote location caused a potential gain of $1.5 billion to all homeowners over the fourteen years after the vote to move the airport passed. This gain is developed from the over $78 million that was realized through more than 10,000 houses in the data set that sold during this time period and weighted by the total number of houses. Houses near both airports gain value in net, though gains at the new airport are almost twice those at the old airport, driven mostly by gains to houses along the route to the new airport.

When the City of Austin relocated the municipal airport from its downtown location to a new facility on the outskirts of town environmental justice concerns were raised because both neighborhoods were home to large minority and lower income populations. At the outset of the move it was unclear whether the airport served as an amenity or a disamenity and whether the overall benefits from building a new facility would benefit a different group than those who would bear the burden. The third chapter, drawing on the models in earlier chapters, shows that overall the movement of the airport caused gains to homeowners in the surrounding communities. This is true for both the new and the old airport communities and generally true across income and ethnic groups. While lower-income and racial minority groups bore larger variance in house price fluctuations over model period, they also saw the largest positive percent changes in average house prices. In general, it can be said that the same groups that bear the burden also received the benefits and that the benefits outweighed the losses.

The U.S. EPA defines environmental justice as “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.”[3] In this paper, the focus is on the first half of the definition, measuring the extent of fair treatment in a local government policy decision, evaluating whether a small group of people, including a racial, ethnic, or a socioeconomic group, bears a disproportionate share of the negative environmental consequences resulting from the relocation of a municipal airport.

In this third chapter, Geographic Information System (GIS) maps are used to match house sale price information to the physical locations of the houses to determine whether or not one or both airports affect a house, and to match it to its 1990 census tract characteristics. Since it is possible to determine which houses received benefits and which houses suffered losses, the question here is whether houses that received benefits or suffered losses are significantly different from the population as a whole in Austin. If one or more ethnic or income groups suffered more losses than others, it could be an indicator of environmental inequity – where one group disproportionately bears the burden of a public good enjoyed by all.

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[3] U.S. Environmental Protections Agency website, http://www.epa.gov/compliance/environmentaljustice/.

The 1990 census data are used (as opposed to the 1980 or 2000 census reports that also cover relevant years included in the model) because, as will be described in detail later, 1990 was a critical year in the decision whether to relocate the airport, and if so, where it would be. This captures another aspect of the environmental justice literature, whether it is relevant to evaluate the demographic characteristics of the neighborhoods around a noxious siting using current population data or the data from the time of the siting. The 1990 population Census captures both of these concepts. At the old airport, 1990 captures the population who moved in around an established facility, likely because of lower house prices. At the new airport, 1990 captures the population at a proposed location before the decision was made to site a new facility. An interesting result of being able to look simultaneously at both an established site and a proposed site, is that the demographic characteristics of the airport neighborhoods are similar to each other, yet significantly different from the rest of Austin.

This study avoids the debate over the concepts of injustice in intent and injustice in outcome because the discussion cannot accurately capture the reasons behind the voluntary decision to purchase a home near a noxious facility. Instead, the focus is to find the effects of an exogenous shock on different socio-economic groups without labeling these effects as inherently “fair” or “unfair.”

Airport History Background

The movement of Mueller Airport was likely a transparent policy process. Talk of moving the municipal airport out of the Mueller location began as early as 1970, almost 30 years before the new Austin-Bergstrom International Airport (ABIA) opened. In March of 1970 Austin City Manager Lynn Andrew predicted, "Around 1974 or 1975 we're going to have to take a long, hard look at the airport and make a decision whether to buy a new site or work out, with the federal government, a joint use of Bergstrom Air Force Base."

In fact, in 1976 a joint use proposal with Bergstrom Air Force Base (BAFB) was submitted to the Air Force, but was denied by officials. On September 20, 1979 a study by R. Dixon Spears recommended a site east of the town of Manor (Manor location). However, within a few weeks the plan was replaced once again with a joint-use proposal with BAFB. Again, the Air Force rejected the proposal and in the ensuing years placed twenty-nine conditions for building a municipal airport west of the base. In 1982, then-Mayor Carole McClellan recommended that the city focus attention on expanding the current airport, instead of building at a new location. However, after the *Austin Chronicle* ran a newspaper article showing the proposed expansion area widespread public disapproval caused the City Council to unanimously vote the proposal down.

By this time the neighborhood organizations had grown active in their "Move-It" campaign to re-locate the airport and its noise. In the fall of 1984 a citizen task force, created to study the airport, recommended closing Mueller and building a new facility. Heavy advertising on both sides of the issue, including television spots and rented planes flying over Austin's downtown, attempted to draw a wider audience to the debate and to the polls. Despite these active groups, a referendum on January 19, 1985 on whether to move the airport to the Manor location failed by 748 votes.

By 1987 the number of commercial jets operating yearly out of Mueller airport reached its peak: 64,615. In February, the Austin City Council approved studies to find both the cost of alternative sites and the cost of enlarging the present facility. On November 3, 1987 voters rejected the idea of expanding Mueller, 88% to 12%. The referendum to build the new airport at Manor passed, but with a less impressive margin: 56% to 44%. After the vote, it took an entire year for the Council to choose a project manager, Sverdrup-Gilbane, for the new airport.

On April 18, 1989 the Austin mayor and other city officials told landowners in the Manor area that the city planned on buying their land as early as August of that year. Meanwhile, construction on a new terminal at Mueller airport began with a scheduled completion date of January 1990. The construction of the Manor airport was scheduled for completion in 1995. However, residents near the Mueller airport were growing concerned that the airport was not going to be re-located. In May 1989, the House State Affairs Committee responded to these concerns by unanimously approving a bill to mandate soundproofing at three elementary schools near Mueller, regardless of whether the City built the new airport at Manor. In addition, the bill required

Austin to have at least 10% of the land for the new airport under contract by March 31, 1990. If the city did not fulfill this obligation, they would be required to soundproof all of the public buildings in the flight path.

In January 1990 Bergstrom AFB was announced as one of bases for closure in a nationwide study. On the 27th, the Mayor Cooke and Council member Barnstone called for a moratorium on land purchases at Manor until the fate of BAFB was decided. Several other council members disagreed. Two days later, the U.S. Defense Secretary Dick Cheney officially recommended that BAFB be closed. This announcement caused a split in the support for a new airport. A group who supported keeping BAFB an active base wanted to focus on putting the new airport at the Manor location. Most of the residents near Mueller also continued to support the airport at Manor because they feared that starting new plans at Bergstrom would delay the move. However, many others immediately supported building the new airport at Bergstrom, should it close. Five local transportation experts called on in the days after the announcements also disagreed: three said Bergstrom was a cheaper alternative to Manor; two others said that Bergstrom had enough flaws to make it "unusable" as a city airport.

On the first of February, 1990 the City Council halted purchases of land at Manor and called for a study of BAFB as a commercial airport. This started a period of indecision in which the Council was waiting for the final decision on BAFB closure to resolve locating the new airport there, while continuing efforts at Manor to abide by a new state law that required Mueller Airport to be moved by December 31, 1996 or undertake millions of dollars in soundproofing all public buildings. In March of 1990, a master plan for the Manor airport was approved by the Council, followed by a $488,000 contract for appraisal services. However, they also limited spending to $45,000 until a decision was made at BAFB. The following month the City Council suspended all but a small fraction of the work at the Manor site.

On the same day, April 20, 1990, seventeen Mueller airport area homeowners, claiming that airport noise and pollution harmed their health and reduced the value of their property, filed a lawsuit against the City of Austin. Their lawyer said residents did not want the airport moved to Bergstrom because it would cause further delay to removing the Mueller airport and because it would cause southeast Austin residents the same problem the Mueller neighborhood residents were currently facing. The *Austin-American Statesman* ran a newspaper article on May 17th stating that "Black officials call Bergstrom airport racist".

Progress continued on all three fronts. On May 18th, the FAA signed off on the Environmental Impact Statement (EIS) for the Manor airport. However, federal officials also announced that should BAFB be closed, it would have to be ruled out as a viable alternative before the City could proceed with the airport at Manor. The Council also approved a $200,000 contract for soundproofing three schools near Mueller.

The summer of 1990 further complicated the issue. First, on July 21st a newspaper article reminded the city that the neighborhood closest to BAFB already contained several noxious sitings, including two sewage treatment plants, a jail, and a landfill. Residents of this neighborhood were split on the airport location decisions: some thought that an airport would be the answer to economic growth after the closure of the Air Force Base took away several thousand civilian jobs; others saw an airport as yet another noxious siting, bringing with it noise and pollution problems.

On August 12th, the "Move it to Manor" coalition organized a petition drive to demand that the City Council implement the 1987 voter mandate to replace Mueller by building a new airport in Manor. This group implied that the talk of moving the airport to Bergstrom was, in reality, a way to keep Mueller open longer. On August 13th, another newspaper article stated that Mueller airport was not overcrowded as commonly suggested. According to the article, in 1989 there were 186,149 takeoffs and landings, but the current runways could handle 300,000. Further, a FAA report stated that Mueller could handle up to 56 instrument landings per hour during periods of low visibility, while the peak hourly traffic at Mueller was only 30 arrivals per hour. Finally, since its peak in 1987, flight operations at Mueller had actually *decreased* more than nineteen percent.

Countering these observations another article ran in the *Austin- American Statesman* (*Statesman*) stating that, according to City statistics, more than 27,500 people lived in areas near the Mueller airport where noise levels exceeded 65 decibels (the level at which the government recommends against residential development). Another 3,100 people lived in areas where noise levels averaged a "deafening" 75 decibels. This article stated, "property values [had] fallen because of the airport uncertainty" and that "the biggest fear [was] that the airport [would] stay put and that the city leaders [would] look to swallow their neighborhoods in order to expand Mueller".

That same week of August 1990, another article ran stating that closed military bases could be economic assets to their communities. The article stated that of the one hundred bases closed by the Pentagon between 1961 and 1986, forty-two had become municipal airports. Ray Reece, the coordinator of the "Move it to Bergstrom" organization, was quoted as saying that in Austin moving the airport to Bergstrom would both save money and have a beneficial effect on the former Base's neighbors due to the reduction in noise from the military jets. He went on to say that communities near Bergstrom would "realize enormous economic development benefits" from "increased property values in the vicinity of a Bergstrom airport and from commercial and industrial development related to such a facility".

In October of 1990 the Austin City Council formed a citizen task force and gave them sixteen weeks to come up with recommendations for the best way to convert BAFB to civilian use. However, in early December the *Austin Partnership for a New Bergstrom Mission*, an adjunct of the Greater Austin Chamber of Commerce, held a news conference in support of finding a way to ensure that BAFB would not close. About this same time, the City Council voted down (3-2) a resolution to build a city airport near Manor. In reaction, five people who lived near Mueller filed a lawsuit against the city charging that Austin violated noise abatement laws that required them to hire land acquisition consultants by March 31, 1990. The city had met that requirement by approving a contract for the services, but then suspended the contracts a few weeks later. The mayor responded by saying he was waiting for the federal government decision on BAFB before he made any airport decisions.

By January of 1991 the airport issued had divided members of City Council and state lawmakers. State representative Delco filed a series of bills that would: (1) allow the state, instead of the city, to take over BAFB if it closed, (2) allow voters to create a Travis County Airport Authority with the power to take over Mueller airport and establish a new one, and (3) require the city to soundproof every public building around the existing airport at a cost of millions. The mayor strongly opposed all of these bills. The City Council postponed activities at Manor, but they were divided on whether BAFB could be converted to a municipal airport. Senator Barrientos wanted Mueller airport moved, but opposed moving it to Bergstrom, which he saw as just moving the problem to a new neighborhood.

Interestingly, according to a local Austin journalist covering the story (Mike Clark-Madison, *Austin Chronicle*, June 21, 2001), the base closure was not widely known in Austin. In June of 1991 when Bergstrom AFB actually appeared on the closure list the citizens of Austin were caught off-guard. However, the City Council was not surprised and in August passed a resolution indicating Bergstrom was the preferred site for the new city airport. The Bergstrom residential neighbors were divided at a Town Meeting: some approved of the airport in hopes it would bring economic growth, others already felt burdened by too many noxious sitings in the area.

By the end of December 1991, it was clear that the City Council members favored a move to Bergstrom, but were slowed by an earlier resolution that promised a public referendum. Some council members expressed concern that public sentiment appeared in favor of keeping the airport at Mueller. A telephone survey of 604 Austin-area residents conducted by IntelliQuest showed 44% favored keeping the airport at Mueller, 43% wanted it moved. The same survey also found that 61% were in favor of converting BAFB into an airport with 25% opposed. In contrast, only 21% favored an airport built at Manor with 61% opposed. The City Council voted to abandon the Manor project and vowed never to use the bond revenue approved in 1987 for a Manor airport.

For the next year, the newspapers were surprisingly empty of airport-related articles. Early in January 1992 an article ran indicating that more facts were needed before a decision on the airport could be made. Three days later, an article ran stating that if the Air Force Base closed, the land would automatically revert back to the City of Austin at no charge. This ceased any major articles on the airport for almost a year as Austin waited for the official decision on BAFB's expected closure.

In February of 1993 the City agreed to soundproof about 500 homes and three schools near Bergstrom that would be exposed to excess aircraft noise at a cost of $11 million. An Air Force analysis showed that 5,748 people would be affected by commercial aircraft noise. In March, the *Statesman* ran an article stating that most aircraft at Bergstrom would travel north and south, creating a primary flight path only over the eastern side of the interstate highway. It also noted that the aircraft would be at a much greater altitude than the planes that crossed the Mueller neighborhoods.

Though the move of the airport seemed imminent at this time, the major airlines that served Austin still had not taken a position on the proposed relocation to Bergstrom. Some airlines were considering the possibility of staying at Mueller, even if a new airport opened at Bergstrom. Further, in April 1993, Bergstrom-area school officials said they still had concerns about the effects on students if the airport was re-located to their neighborhood. On the 18th, the *Statesman* published a door-to-door survey on the effects of converting the Air Force Base to an airport that the newspaper had conducted. The survey found that noise was the greatest concern of local residents.

In May 1993, Austin voters approved a referendum to re-locate the airport to Bergstrom when the Base closed. By mid-June, the city airport team moved its offices to Bergstrom. Finally, in September 1993 the BAFB officially closed, and the next month the property reverted to the City of Austin. With the voter mandate in hand, the next year was spent submitting official noise reports to the FAA, designing the new airport, and addressing noise concerns of the Bergstrom neighbors.

On November 3, 1994 the City Council approved the name "Austin-Bergstrom International Airport" and on November 19th, the city celebrated the groundbreaking of the new airport. Actual construction began in March of 1995 and continued through May of 1999. On August14, 1995 the FAA announced their approval to fund $30 million to relocate four Del Valle schools in the Bergstrom flight path. Over two years later, on October 2, 1996, the City and Del Valle Independent School District reached an agreement over the relocation. The real estate transaction totaled almost $46 million. On June 30, 1997 air cargo operations began at ABIA. Finally, on May 23,1999 Austin-Bergstrom International Airport opened for passenger service. Operations were halted at Mueller airport the night before.

Access to the new airport was also a concern. The ABIA Planning Committee projected 36,000 auto trips per day to the new airport, about 7,000 more than were recorded when it was an Air Force Base. Austin-Bergstrom airport is located approximately 8 miles from downtown Austin, whereas the Mueller airport was only four miles. Mueller was directly accessible from the major interstate highway (I-35) from both the north and the south, via Manor Road. ABIA is accessible from two major highways, Texas 71 and US 183. On November 8, 1989, the *Austin-American Statesman* ran an article stating that these highways were both "ill-prepared" for additional traffic. From central areas of Austin, it was forecast that many commuters would instead choose to use city streets, mainly Riverside Drive, East 7th Street, and Airport Boulevard. The article went on to insist that, "it would be an understatement to say transportation planning for the new airport has been poor".

The neighborhoods surrounding Mueller airport were crucial in getting the airport moved. Long after the new airport was secure, the Mueller Neighborhood

Coalition formed (1996-1997) in reaction to the first consultant presentation for the redevelopment of Mueller. This coalition, consisting of 14 neighborhood associations and representing 17,500 households, believed the consultant presentation was unacceptable and focused too much on the business community. They consider their role to be making sure new development serves the community and will actually make a quality of life improvement for the residents. (Jim Walker, Mueller Neighborhood Coalition, guest speaker seminar 7/5/01). When ABIA opened for passenger service, the redevelopment of Mueller airport was still being hotly debated.

Chapter One: A Comparison of Methodologies to Measure Effects of Airport Siting Decisions

1.1 Introduction

Even though markets rarely exist for environmental goods, their effects on market prices can be measured in an urban setting by virtue of being 'bundled' to a residential location. When a household purchases a house, it implicitly buys an entire bundle of amenities – public schools, police protection, parks, transportation, even air and water quality. If, however, a model controls for all non-environmental factors, then any remaining difference in price can be attributed to differences in environmental quality. The hedonic pricing method, using regression techniques, can be used to identify what portion of property value differences can be attributed to the environmental differences and to infer an individual's willingness to pay.

This study applies the hedonic pricing method to analyze the removal of a major airport in an urban location. By the late 1980s, Mueller Airport in Austin, Texas was losing its ability to handle the dynamic growth of cargo and passengers flooding the airport as a result of the high-tech boom. If the City wanted to maintain this growth and job development, it would need to expand the airport. However, Mueller was an old facility, land-locked on only 711 acres in the heart of the city. Moreover, the recent growth in the number and size of planes coming into the airport had drastically elevated the noise level imposed on the more than

30,000 people living in noise impact areas. The City decided to solve both problems by relocating the airport to a new facility on the outskirts of town.

Clearly, the city required a larger airport, but what would happen to the neighborhoods that surrounded the old airport which both suffered from noise but also enjoyed the proximity to air travel? Do homeowners consider the airport a magnet for growth and development, or is it a noxious facility, spewing noise, pollution, congestion, even danger on its neighbors? Planners need the best available information before deciding where to put an airport, including not only the costs and benefits, but also estimates of who bears those costs and who gets the benefits.

This study answers these questions by combining the effects of airports on property values with several other sub-literatures within hedonics: the varying influences of noise and distance measures of airports on property values, house prices during noxious siting stages, and repeat-sale analysis. Several data sources are brought together, including Geographic Information Systems (GIS) maps and census data, on a variety of structural, neighborhood, and environmental variables over a twenty-year period. Due to the variety and length of the data set, the hedonic pricing technique can be applied in four different model specifications. Thus, not only is this study a determination of the impact of noise and proximity to an airport on residential property values in Austin, it is also a comparison of analytical methods.

The data on 21,386 home sales includes approximately 10,700 repeat sale observations (of over 5,350 houses). These data span the time of five separate “events” that might have been important to houses around the old airport. Thus, the data are used to compare the change in prices around the old airport before and after each such event, relative to the change in prices elsewhere. The four model specifications are: (a) a “phase model” that runs separate regressions for each of the five stages between events, (b) a “pooled model” that combines all stages into the same regression, (c) separate hedonic regressions on all houses for each event, and (d) a repeat-sale model for each event. The repeat-sale analysis applies a censored sample procedure to correct for sample selection bias, corrects for depreciation between the sale dates, and employs “effects coding” of the time dummy variables to control for other time variant effects on properties.

The effects of airport noise on property values are an entire literature within the hedonic literature.[4] In addition, several have attempted to separate out the costs and benefits of increased airport services to a residential community, including Lipscomb (2003) and Espey and Lopez (2000). Both of these studies realize that airports can be both amenities and disamenities, so they both define two separate environmental variables: noise and proximity. However, these two main studies come to opposite conclusions. Lipscomb concludes that closeness to the airport is a positive determinant of residential property prices and that airport noise is insignificant as a predictor of house sales price. Espey and Lopez find property values in noisier areas are 2.4% less than values in quieter areas and, even with controlling for noise, airport proximity is a disamenity, with about a

[4] Nelson (1980) is an early survey paper on the effects of airport noise on property values that includes thirteen empirical studies over eighteen different airports. A decade and many studies later, Pennington, Topham and Ward (1990) found that early studies of airport noise generally overstated the negative effects of airport noise on property values.

2.6% difference in value between equivalent houses one versus two miles from the airport.

While not directly addressing airport noise, several studies have expanded the hedonic literature to look at house prices during multiple stages of a noxious siting. Kolhase (1991) is an early study of toxic dumps in Houston in three discrete years. Kiel and McClain (1995) added to the literature on siting stages with a nineteen-year study of the placement of a waste-incinerator near Boston. The model is estimated two ways, a separate regression for each stage, similar to Kolhase, and over the entire sample with interaction terms of distance and time periods to measure the changing impact of the incinerator.

Of all the above hedonic models, only Kolhase (1991)[5] had a data set rich enough to apply a repeat-sale model as a second means of investigating the effects of noxious sitings on property values. Similar in nature to an airport, Gatzlaff and Smith (1993) use both a repeat-sale and a traditional hedonic model to evaluate the impact of announcing a Metrorail system on residential properties. They find that price indices between the two models are not significantly different. Finally, Palmquist and Smith (2002) combine a repeat-sale analysis with a regression discontinuity design to measure the impact of a new interstate highway on property values bisected by the road. They find that in all cases they specified, new information about the highway significantly reduced the sale prices of nearby houses.

[5] Kolhase appended her hedonic siting stage model with a repeat sales model for the years 1980 and 1985. Her findings reinforce the original results.

This paper brings together important elements of each of these sub-literatures. First, the airport variables are disaggregated into noise and proximity in the manner of Espey and Lopez (2000) and Lipscomb (2003), plus a third variable that measures the effects of development along the major routes to the airport. This three-variable specification is unique to this study and hopes to answer the open question on the amenity versus disamenity nature of urban airports. In addition, the airport literature in hedonics tends to focus on building new airports or expanding current ones. This study looks at the question from the opposite direction; it focuses on houses in a neighborhood where an airport is being *removed*.

Second, this paper links the siting stage models with traditional and repeat-sale models to find when, if at all, homeowners react to a noxious siting. The siting stage models divide the entire twenty-year period into five "stages" where households have different levels of certainty regarding the eventual relocation of the airport. The traditional and repeat-sale models, on the other hand, examine the reaction to specific events that lead to the relocation of the airport.

Finally, as mentioned above, this paper is a comparison of analytical methods. In the siting stage section of the paper, "phase models" are compared to "pooled models". The repeat sale section begins with a difference-in-difference calculation at the means. These results are then compared to a repeat-sale analysis and a traditional hedonic model. While neither siting stage nor specific event models are necessarily better, the conclusion compares results, as well as the ease of implementation and interpretation, across all four regression-model specifications.

A visual interpretation of the results is given by the maps in Figures 1 and 2 at the end of this chapter. These maps plot the percent change in houses prices evaluated at the two extreme counterfactuals: as if the airport never changed locations and as if the airport was never in the original location.[6] Figure 2 focuses on the neighborhoods closest to the old airport.

Each dot on the maps indicates a single house sale. The color of the dot indicates the estimated percent change in price resulting from the location of the old airport. Therefore, the darkest blue dots indicate that the price of the house would *more than double* if the city airport had never been at the old location (and, thus, had always been at the new location). The darkest red dots indicate that the price of the house would *fall* by twenty percent or more if the city airport had never been at the old location. The palest dots (both blue and red) indicate the price of the house changes very little with the location of the airport. Therefore, the distribution of the colored dots estimates which neighborhoods become more or less desirable as a result of the airport transition. The regression estimates of the price changes include variables to account for structural, neighborhood,

[6] The estimated prices of houses in the case of a permanent airport at the original site were calculated by first running a hedonic regression using only houses that sold *before* the vote to move the airport and then applying the estimated coefficients to all houses in the dataset. The estimated prices of houses in the case of no airport at the original site were calculated by first running a hedonic regression using only houses that sold *after* the new airport opened and then applying the estimated coefficients to all houses in the dataset. Since both hedonic estimates used a semi-logarithmic functional form, the percent change was calculated by subtracting the permanent original site price from the no airport price.

environmental, and time characteristics, in a similar manner to the hedonic regressions used in all sections of this paper.

Looking at Map 2, the neighborhoods with houses in the airport noise contours, but at a fair distance from the facility itself, show very large gains in value from removing the airport. Houses in the distance contours, but not in noise contours, show much smaller gains, and in some cases losses in value, from removing the airport. However, houses that show the largest losses are often those on the major routes to the old airport: Manor Road, Airport Boulevard, and to some extent, interstate highway 35 (IH-35), and those on the border of the one mile distance contour. These price changes imply that noise is a disamenity, distance from the airport can be an amenity or a disamenity, but being on the main routes to an airport is a clear amenity.

The different model specifications find different event dates to which residents respond to the airport relocation. By and large, early announcements had little effect on house prices, though prices changed more with the groundbreaking than with the final switch to the new airport. This suggests homeowners have rational expectations and adjust to the relocation of the airport before the aircraft noise actually ceases. Comparing the different types of models, this paper finds that the phase specification is a better fit to the changing valuation of neighborhood characteristics across time than the pooled specification. The repeat sale and traditional hedonic models produce similar results that are consistent with expectations. Therefore, the appropriate choice of either a repeat sale or hedonic model would depend largely on the data available.

The next section gives a review of Austin's airport history background. Then the data are described in Section 1.3 and Section 1.4 briefly reviews hedonic models. The estimation of the model is divided by the methodology used: house prices during siting stages in Section 1.5 and repeat sales in Section 1.6. Finally, Section 1.7 concludes and previews areas for future work.

1.2 BACKGROUND[7]

As with most policy decisions, the decision to re-locate Austin's municipal airport occurred over many years and information regimes. As early as 1970, talk began of either finding a new site to replace Robert Mueller Municipal Airport (Mueller), or working out a joint use facility with the federal government at Bergstrom Air Force Base (BAFB). However, by 1980 Air Force officials had twice denied requests for a joint use facility. For a few years the City focused its attention on expanding the current airport, but widespread public disapproval, driven by a multi-neighborhood organization "Move-It" campaign, caused the City Council to unanimously vote this proposal down. After failing once in 1985, a voter referendum in 1987 finally passed to build a new airport at a site east of the nearby town of Manor (Manor location).[8]

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[7]An extensive background was compiled to better understand the information regime of homeowners in Austin through the airport re-location process, see Background. The main source of information is searching newspaper articles in Austin's mainstream newspaper, the *Austin-American Statesman* as well as articles in the weekly city paper, the *Austin Chronicle*. The website for the new Austin-Bergstrom International Airport was also referenced. In addition, unique perspectives are provided by (1) planners at the City of Austin Transportation, Planning, and Sustainability Department, (2) a local Austin journalist, Mike Clark-Madison, and (3) the president of the Mueller Neighborhood Coalition, Jim Walker, in a Community and Regional Planning seminar at the University of Texas at Austin.

[8] On November 3, 1987 voters rejected the idea of expanding Mueller, 88% to 12%. The referendum to build the new airport at Manor passed with a less impressive margin, 56% to 44%.

Although the City began to purchase land at the Manor location in 1989, it was simultaneously involved in an expansion project at Mueller to add a new terminal. Then, to complicate matters further, early in 1990 the rumor spread that BAFB was slated for closure by the US government. In June 1991 BAFB actually appeared on a closure list. The City Council passed a resolution just two months later indicating Bergstrom was the preferred location for the new airport and voted to abandon the Manor project.

In May 1993, Austin voters approved a referendum to re-locate the airport to Bergstrom when the Base closed. In September, BAFB officially closed and the next month the property reverted to the City of Austin. Approximately one year later the City Council approved the name "Austin-Bergstrom International Airport" (ABIA) and on November 19, 1994 the groundbreaking was celebrated. Finally, on the night of May 22, 1999 all flight operations were halted at Mueller Airport, and the following day Austin-Bergstrom Airport opened for passenger service.

1.3 DATA

The data for this study were complied by First American Real Estate Solutions from individual sales of single-family residences in Travis County, Texas. The data include information about houses sold in thirty-three zip codes in the Austin Metropolitan Area. The total sample consists of 21,386 homes sold between January 1980 and June 2001. Each observation includes the property's address, the sale price, the sale date, certain house characteristics, and the census tract location.

The data set is built from 9,728 single sales and 5,829 repeat sales. The "full sample", therefore, refers to the dataset with 9,728 single sales, 5,829 first sales and 5,829 second sales. The "single sample" refers to the 9,728 houses that sold only once during the sample period. The "repeat sample" refers to 5,374 houses with two valid sale dates in two separate years during the sample period. This reflects a loss of 455 repeat sale observations that could not be used because the initial and second sales occurred in the same year. Summary statistics are shown in Tables A.1, A.2, and A.3 of Appendix A.

These data include all available houses from First American[9] that were sold in the thirty-three zip codes for the entire twenty-year period, so they avoid sample selection problems except those arising from the self-selection of houses to be sold. These are not panel data, since they do not show the prices of the same houses each year for twenty years, but they do have the significant advantage of covering all relevant neighborhoods for all relevant years. Thus, they can be used to show both time-series effects of relocating the airport and cross-section effects of one neighborhood compared to another. In addition, the repeat sample can be used for a difference-in-differences approach, looking at a cross-section of houses where the same houses sold more than once.

The structural variables in these data include the total living area in square feet, the total lot size in square feet, the age of house[10], the number of

[9] It should be stressed these are all available houses *from First American*, but not all houses that sold in Austin during the twenty-year period. Many attempts were made to acquire all house sales in the Multiple Listing Service (MLS) from the Austin Board of Realtors with no success. Therefore, a sample selection problem may arise with First American's selection of house sales available for purchase.

[10] Several specifications of age are tested, with slight variations in the results. Including only a single term for age produced the smallest coefficient (-0.00261) and the lowest R^2 (0.6501).

bathrooms, the existence of a pool or in-house spa, the existence of a fireplace, the existence of a garage or carport, and whether the house is constructed of wood, a wood and brick combination, masonry, or is a manufactured home. Summary statistics are shown in Table 1.1.

Table 1.1 Summary Statistics for Structural Variables

Variable	Mean	Std. Dev	Min	Max
Price*	$171,102.80	153,115.3	1,129	8,807,557
Gross Living Area (sq ft)	1,731.49	763.74	298	8,900
Total Land Area (sq ft)	11,570.83	16,048.06	660	679,971.6
Age	23.85	18.05	0	101
Bath1**	0.1861	0.3892	0	1
Bath2	0.5274	.49993	0	1
Bath3	0.2864	.4521	0	1
Fireplace	0.6832	0.4653	0	1
Pool	0.0603	0.2380	0	1
Spa	0.0187	0.1355	0	1
Garage	0.8207	0.3836	0	1
Carport	0.0884	0.2839	0	1
Manufactured Home	0.0001	0.0118	0	1
Masonry Construction	0.0042	0.0647	0	1
Wood Construction	0.6810	0.4661	0	1
Wood/Brick Construction	0.3147	0.4644	0	1

The total number of observations is 21,386

*All prices are CPI adjusted, 2001=1

**Bath1 indicates a house has one bathroom, Bath2 has either one and a half or two bathrooms. Bath3 has more than two bathrooms. Less than 5% of houses in the sample have more than three bathrooms.

To allow for a non-constant marginal value of a bathroom, the number of bathrooms variable is broken into a series of dummy variables. The number of bedrooms is not available in the data set. While bedrooms are an important

Adding a quadratic term increased the coefficient on age (-0.0128), produced a positive coefficient for the squared term (0.000161), and increased the R^2 (0.6549). Adding a cubed term reduced the size of the coefficient (-0.00011) and decreased the R^2 (0.6503). The best fit (R^2 of 0.6603) resulted when age entered the regression as a series of dummy variables: 0 to 5 years old, 5 to 10, 10 to 20, 20 to 30, 30 to 50, and over 50 years old. Leaving new houses as the baseline, houses 20 to 30 years old had the largest negative coefficient, followed by ages 30 to 50, then 5 to 10, 10 to 20, and the smallest (though still negative) coefficient on houses over 50 years old. All of these coefficients are significantly different from zero at a 99% confidence level in all models.

determinate of house price, Brookshire *et al*. (1982) finds collinearity between the number of bedrooms and the total living area, and thus uses living area as the only measure of house size.

The neighborhood characteristics for each house are matched from the 1990 U.S. Census of Population and Housing, and from GIS maps. These variables include: distance from the Austin central business district (CBD), distance to the University of Texas (UT, a major employment center as well as a common destination for over 50,000 students), the percentage of the population in the census tract who graduated from high school, a four-year college, and graduate school, the racial breakdown of the census tract, the percentage of vacant lots in the tract, and the percentage of homes that are owner-occupied. Summary statistics are shown in Table 1.2. It is a fairly common practice to include both the median household income in the census tract and the percent of the census tract that is unemployed as proxies for neighborhood quality. As pointed out by Butler (1982), however, "it is impossible to separate the function of, for example, income as a neighborhood quality proxy from its role as a characteristic of demanders in the neighborhood." Furthermore, "the income coefficient will reflect both the effect of income on households' bids and the rationing effect of prices in allocating households of different income to different types of housing" (Butler, 1982, 96-97).

The school district of a particular house is another common regressor that is left out of this model. School district information is available in GIS format, but after analysis, it was omitted for two reasons. First, almost 83% of the housing sample is in the same school district, Austin Independent School District (AISD). Second, the school district dummies are highly correlated with the series of zip code dummy variables added as neighborhood proxies.[11] The zip code variables are included rather than the school district variables because zip codes reveal greater neighborhood detail: thirty-three zip codes make up the sample, compared to only six school districts. Summary Statistics for zip code dummies are shown in Table A.4 of Appendix A and, in addition, they are plotted in Map B.1.[12] The zip code dummies are also highly collinear with dummies for the three cities encompassed by the sample: Austin, Manor, and Del Valle. All of the houses in Manor are in the zip code 78653 and all the houses in Del Valle are in the zip code 78617. Thus, dummy variables for individual cities are omitted from the analysis.

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[11] For example, of the 1,231 houses in the Eanes Independent School District (5.8% of the sample), all but nine of them are in the zip code 78746.

[12] Mueller Airport is contained in zip code 78723, but the noise contours extended into 78751 and 78756 on the northwest, 78722 on the southwest, 78724 on the northeast, and 78721 on the east. The mailing address for Austin-Bergstrom International Airport is 78719, though the eastern runway is largely located in 78617. The noise contours extend to the west into 78744 and to 78742 on the north.

Table 1.2 Summary Statistics for Neighborhood Variables

Variable	Mean	Std. Dev	Min	Max
CBD1*	0.0038	0.0614	0	1
CBD2	0.0476	0.2129	0	1
CBD3	0.0771	0.2668	0	1
UT1	0.0056	0.0747	0	1
UT2	0.0631	0.2431	0	1
UT3	0.0832	0.2762	0	1
% HS Graduates	0.1177	0.0445	0.01	0.23
% 4-year College Grads	0.1605	0.0696	0	0.39
% Graduate School Grads	0.0893	0.0632	0	0.25
% Foreign Born	0.0641	0.0374	0	0.33
% White	0.7882	0.1731	0.04	0.98
% Black	0.0859	0.1295	0	0.90
% Native American	0.0023	0.0045	0	0.02
% Asia – Pacific	0.0265	0.0243	0	0.25
% Other	0.0972	0.0929	0	0.72
% Vacant Lots	0.0904	0.0436	0.03	0.45

*CBD1 indicates a house is located less than one mile from the Austin central business district, CBD2 indicates between one and two miles, and CBD3 indicates between two and three miles. UT1 indicates a house is located less than one mile from the University of Texas, UT2, between one and two miles, UT3, between two and three miles.

The environmental characteristics are developed from the GIS and the Noise Exposure Maps furnished by the City of Austin Transportation, Planning, and Sustainability Department. Three variable groups are included: noise, distance, and route. The noise variables are a series of dummy variables that capture the noise contours: average noise level greater than 75 decibels (dB), 70-75dB, 65-70dB, and "undistinguishable from background noise". The FAA, as well as HUD, defines areas exposed to average sound levels of 65dB or over as incompatible with residential housing use. See noise contours in Map B.3 in Appendix B. These noise contours were developed by the City of Austin for both airports and are provided in "Part 150 Noise Study" reports. The evaluation of the noise contours was conducted using the Integrated Noise Model (INM) developed by the FAA, the most commonly used method to predict contours.[13] Summary statistics are reported in Table 1.3. Due to the small number of houses within noise contours greater than 70 decibels, the noise contours for average noise greater than 75 decibels has been combined with noise levels between 70 and 75 decibels (NGT70).

Table 1.3 Summary Statistics for Noise Variables

Dummy Variable	Mean	Std. Dev	Min	Max
N6570: Mueller Airport (MA) noise level 65-70 dBs	0.0176	0.1316	0	1
NGT70: MA noise level greater than 70 dBs	0.0067	0.0815	0	1

The distance from the airport is also represented by a series of dummy variables. They are measured in six half-mile concentric circles around the main terminal. Often, in the noxious siting and hedonic literature, distance is instead measured as a continuous variable and enters into the equation as a natural log. With the log specification, the negative effect of living near the noxious facility decreases at a decreasing rate, but more distance from the site is always advantageous. In the case of airports, however, proximity to the site may indeed be an amenity (controlling for noise). Dummy variables allow for a non-constant marginal value of distance from the airport that may change sign. See Map B.4 in Appendix B. Summary statistics are reported in Table 1.4.

[13] The INM determines aircraft noise level on an average-daily basis using a 'Day Night Average Sound Level' metric. This metric is a 24-hour average sound level weighted with a 10-decibel penalty for nighttime noise events.

Table 1.4 Summary Statistics for Distance from Mueller Airport Variables

Dummy Variable	Mean	Std. Dev	Min	Max
MAdist1: Less than ½ mile	0.0115	0.1066	0	1
MAdist2: Between ½ and 1 mile	0.0353	0.1846	0	1
MAdist3: Between 1 and 1 ½ mile	0.0250	0.1562	0	1
MAdist4: Between 1 ½ and 2 miles	0.0240	0.1532	0	1
MAdist5: Between 2 and 2 ½ miles	0.0311	0.1736	0	1
MAdist6: Between 2 ½ and 3 miles	0.0496	0.2170	0	1

The map given in Figure 1.3 at the end of this chapter combines the Mueller noise contours with a one-mile distance ring for reference. This map shows that noise contours are elongated at a diagonal across the interstate highway (IH-35) whereas the distance rings form concentric circles around the airport building outlines. Thus, as shown in Table 1.5, the correlation terms between the noise and distance variables are relatively low. At the highest, noise level in the 65-70 decibel contour and the 0.5 to 1.0 mile distance ring have a correlation of 0.2574. Therefore, these environmental variables are designed to determine the separate impacts of airport noise and proximity to the airport (Espey and Lopez, 2000 and Tomkins *et al,* 1998). The noise contour variables are expected to pick up the effects of actual noise on residents under the flight path, while the distance variables pick up other effects of proximity.

Table 1.5 Correlation Between Noise and Distance Variables

	N6570	NGT70
MAdist1	0.1422	0.2171
MAdist2	0.2574	0.1988
MAdist3	0.1856	0.1044
MAdist4	0.1599	-0.0129
MAdist5	0.0047	-0.0147
MAdist6	-0.0306	-0.0187

*See variable definitions in Tables 3 and 4

The construction of the "Route" variables is unique to this study. They are designed to pick up the effects of expectations about future land development related to the change in transportation through the regions as the airport changes location. It is expected that properties *bordering* the main routes to the airport are valuable for commercial use, thus raising their prices. In contrast, those properties near, but not bordering, the access routes may suffer from increased congestion, noise and pollution, thus reducing their prices. Mueller Airport was directly accessed from the city's major interstate highway (IH-35) from both the north and the south via Manor Road. Once the airport closed down, Manor Road was predicted to lose much of its vehicle traffic. Therefore, the Route dummies are: one-quarter mile buffer from Manor Road, one-half mile, and greater than a half mile.

The final set of variables is year dummies to control for the general market trend in Austin. The chart in Figure 1.4 at the end of this chapter reports the residential housing activity in Austin for all house sales.[14] From this chart, all

[14] This data is provided by the Real Estate Center at Texas A & M University, http://recenter.tamu.edu/data/hs/hs140a.htm, although they are unable to provide individual house sales.

else equal, it is expected that house prices in constant dollars will be lowest for the years 1990 and 1991. Therefore, in the hedonic regressions, the dummy variable for 1990 is left out to serve as the baseline. This convenient notation implies that the dummy for 1991 is expected to be relatively insignificant, but all other years will be significant and positive.

For the standard hedonic models, these year dummy variables take on the value of one if the house sold in that year, zero otherwise. For the repeat sales models, the variables to control for time effects are actually pairs of years involved in the sale, in the manner of Poulos and Smith (2002). These sets of time dummies are called "effects coding" and are similar to Black's boundary fixed effects, where the year is coded as negative one for the initial sale, positive one for the second sale, and zero otherwise.

1.4 HEDONIC MODELS

The theoretical framework most hedonic models use relies on the hedonic price method developed by Rosen (1974). The sale price of a house in a competitive market depends on its characteristics, all else equal. Because home buyers prefer a quiet location to being under the flight path of a jet, the market price of a house in a quiet location will be greater than the market price of a house in a noisy location. The general hedonic price of housing is estimated as:

1. 1 $\mathbf{P}_i = \boldsymbol{f}\,(\, S_{ij}, C_{ik}, Q_{im}, \mathbf{year}_i\,)$

where, for house i, P is the house price, $\mathbf{S_{ij}} = S_{ij}\ldots S_{ij}$ is a vector of j structural characteristics, $\mathbf{C_{ik}} = C_{i1}\ldots C_{ik}$ is a vector of k community characteristics, $\mathbf{Q_{im}} = Q_{i1}\ldots Q_{im}$ is a vector of m environmental quality characteristics, and *year* is the year of sale. This estimation provides the marginal implicit price of each of the quality characteristics. For example, if Q_{i1} is the noise level, and $\partial P_i / \partial Q_{i1} < 0$, then the price of a house decreases with an incremental increase in noise.

No theoretical justification defines the correct functional form for simple hedonic or repeat-sale models and as such, previous studies have estimated a variety of forms, including log-linear, semi-log, linear, and Box-Cox. In many cases, researchers have 'let the data determine the functional form' based on goodness of fit. However, this method has come under scrutiny of various forms.[15] As a result, this model adopted the most common form, semi-logarithmic, with the natural log of the housing price a linear function of its characteristics, without empirically testing for functional form.

Leaving aside the time component of the airport re-location on house prices for now,[16] this section analyzes various specifications for the distance and route variables in the hedonic model. Conventional wisdom and early hedonic studies on proximity to the airport suggests that, all else equal, people would prefer to live in a quiet location than a noisy one, thus making airports noxious

[15] Griliches (1971) pointed out that in the cases where form is determined empirically, most researchers settled on a semi-logarithmic relationship. Butler (1982) added that researchers who made these empirical comparisons, "by and large found little basis for choosing one form over another". Cassell and Mendelsohn (1985) had three additional criticisms of the method. First, the best-fitting criterion does not necessarily lead to more accurate estimates of characteristic prices. Second, the transformations required by Box-Cox result in complex estimates of slopes and elasticities that make policy analysis difficult (Palmquist, 1991 noted this as well). Third, the best-fit functional form may be inappropriate for the model's predictions.

[16] Price changes over time are discussed in detail in sections V and VI.

facilities when used as proxies for aircraft noise. As discussed in the introduction, more recent literature has suggested that commercial and infrastructure development may make airports more attractive neighbors than first perceived. In addition, the availability of GIS software and data has made it possible to differentiate the distance from an airport terminal separately from aircraft noise contours that follow take-off and landing patterns. Three recent studies on the effects of airport noise on property values have attempted to separate out the costs and benefits of increased airport services to a residential community by defining two separate environmental variables: aircraft noise and airport proximity. These studies, however, have not developed a consensus as to whether proximity is an amenity or a disamenity, or whether noise is even an important house price determinant.

The earliest of the three studies, Tomkins *et al.* (1998), suggests that effects of proximity to an airport, including traffic congestion, ease of access to airport, and pressures on land use, are more important than aircraft noise. They found that at any given distance to the Manchester airport, house values were inversely related to noise levels, but that overall, house prices declined with increasing distance to the airport. They suggest that this finding indicates that the positive benefits or airport proximity outweigh the negative effects of noise. Espey and Lopez (2000) studied house price sales near the Reno-Sparks airport. They find a statistically significant negative relationship between airport noise and house prices in addition to a significant negative relationship between property values and houses within one mile of the airport. The most recent study that separates the effects of noise and proximity, Lipscomb (2003), finds that airport noise is an insignificant predictor of house sales prices but that being one mile further from Hartsfield International airport lowers the selling price by $36,332 at the mean. Lipscomb suggests that, "the benefits from being near a large air transportation hub outweighs the liabilities."

This paper proposes two different methodological differences to account for these three different findings on the effects of airports on house values (noise is a disamenity but proximity is a greater amenity that overshadows the negative effects of noise, noise and proximity are both disamenitites, noise is not a significant predictor of house prices and proximity is an amenity). First, these three models, like most in airport hedonic literature, use the natural log of distance to reflect the non-linear relationship between distance from the airport and the house that sold. This paper proposes that the relationship between distance and house values is non-linear, but in a discontinuous way. Instead of specifying distance so that more distance is always preferable, this model uses dummy variables to allow each half-mile distance contour around the airport to have a different relationship to house values. Second, traditional airport hedonic studies have used proximity to the airport as a proxy for accessibility to the airport, which may or may not be the case. Since being near an airport is not necessarily equivalent to being in an area that is on the route to the airport and easily accessible or in an area of infrastructure development, this model specifies proximity separately from being on the route to the airport.

The first column of Table 1.6 lists the environmental variables for a regression as specified in equation 1.1 using the natural log of house price as the dependent variable.[17] Two types of distance variables are listed, "MAmiles" a continuous variable that measures the distance from Mueller airport to the house that sold in miles, and a series of dummy variables, "MAdist1" through "MAdist6" which are specified as one if the house falls within the half-mile contour from the airport and zero otherwise. The second column, "Traditional," lists the coefficients and t-statistics for a regression specified with MAmiles entering as the natural log. This model finds a result very similar to Lipscomb (2003): no effect of airport noise on house values, but a significant negative effect from increasing the distance between a house and the airport. The third column, "Dummy," lists the coefficients and t-statistics for a regression specified with the distance dummy variables (and without specifying any access or route variables). This model finds a similar non-impact result for airport noise and a more refined effect of distance. Instead of finding that any increase in distance from the airport has a negative impact, this model finds that houses within most half-mile contours to the airport have no significant pricing differences from houses elsewhere, positive or negative, but that two particular distance contours, being within a 0.5 and 1 mile, and being between 2.5 and 3 miles has a significant positive effect. While this result is similar, with noise having little effect and proximity being an amenity overall, the implications is that the effects of proximity are not equally distributed among all houses within three miles to the airport.

[17] The regression output for the structural and community variables are not shown here for brevity sake. Full regression output is available from the author by request.

Table 1.6 Distance and Route Specifications

Environmental Variables	*Traditional (No Route)*	*Dummy (No Route)*	*Traditional With Route*	*Dummy With Route*
N6570	0.0055 (0.20)	0.0177 (0.63)	-0.0531 (-2.14)	-0.0141 (-0.55)
NGT70	-0.0004 (-0.01)	0.0101 (0.24)	-0.0371 (-0.99)	-0.0094 (-0.24)
MAmiles	-0.0552 (-2.29)		-0.1589 (-7.15)	
MAdist1		-0.019 (-0.36)		-0.023 (-0.49)
MAdist2		0.0616 (1.51)		0.0744 (1.96)
MAdist3		0.0246 (0.61)		0.0419 (1.14)
MAdist4		-0.0016 (-0.05)		-0.0312 (-0.97)
MAdist5		0.0106 (0.37)		0.0116 (0.44)
MAdist6		0.0288 (1.58)		0.0654 (3.95)
ManorRd2			-0.1317 (-3.55)	-0.1251 (-3.30)
ManorRd3			-0.0812 (-3.14)	-0.0715 (-2.72)

Note. The first number is the regression coefficient. The t-statistics are in parentheses; **bold** indicates significance at a 90% confidence level or higher.

Another way to model the discontinuity in the effect of airport proximity on house values is to use a spline function. The spline function is the kind of estimate produced by a spline regression in which the slope varies for difference ranges of the regressors. Unlike dummy variables, the spline function is continuous, though it is usually not differentiable. The spline function works in a similar fashion to a series of dummy variables but smoothes the transitions from one dummy variable to the next. They are employed when a usually continuous variable, such as years of education, are thought to have natural cut-off points, such as diploma effects, where the effects of the continuous variable on the independent variable are different.[18] While using a spline function can provide a significant improvement in model fit, because it imposes more restrictions than a series of dummy variables, it often produces noisy estimates. In comparing a spline function with a series of dummy variables, Schady (2001) found the results to be "quite consistent." Given that the intention here is to allow greater flexibility in the model but not to determine at which points in the data the slope of the distance variable changes, dummy variables capture the intention without greatly increasing the complexity of the estimation technique.

The last two columns of Table 1.6 list the regression coefficients and t-statistics for regressions that include dummy variables to indicate whether the house is located directly on the route to the airport (within one-quarter mile), MAroute2, or near a route (within one-half mile), MAroute3. The third column, "Traditional with Route" is similar to the "Traditional" model in that distance from the airport enters as the natural log of continuous miles, but also adds the route variables. The final column, "Dummy with Route" is the most flexible model with both distance and route variables entering the model as discontinuous dummy variables.

Adding route to the airport dummy variables does not change the sign of the distance variables in either model, but two other results are worth noting. First, adding route dummy variables increases the significance of noise as a

[18] See Schady (2001), Lam and Schoeni (1993), and Hungerford and Solon (1987) for examples.

determinant of house price. In the model with dummy variables for distance, noise is still not significant at a 90% confidence level, but the sign on the coefficients is now negative instead of positive. In the traditional model, adding route to the airport dummy variables actually makes noise a significant predictor of house prices with a negative relationship between noise and house price. Because the continuous distance variable continues to have a significant and negative coefficient, this result is now more similar to Tompkins *et al.* (1998) than Lipscomb (2003). This indicates that the route to the airport variables may able to reconcile the results from these two studies.

The second effect of adding route to the airport dummy variables to note is that the route variables have the opposite sign of the distance variables. In the case of the traditional model, a negative sign on the MAmiles variable indicates that increases in distance from the airport decrease house sales prices. Since the route variables are dummy variables, the negative signs on MAroute2 and MAroute3 indicate that being along the route to the airport has a negative impact on house price. In the case of the last model, the positive signs on the distance dummy variables indicate that houses in those distance contours sell at higher prices than houses elsewhere. The negative signs on the route dummy variables indicate that houses in those route designations sell at lower prices than houses elsewhere. This difference in the signs on the coefficients indicate that route and distance variables are picking up differing effects related to proximity of the airport, some of which are amenities are others which are disamenities.

At this point in the model it is not possible to determine whether the results here generally support the findings of Espey and Lopez (2000) or of Tomkins *et al.* (1998) and Lipscomb (2003). This is because these models all look at the expansion of currently operating airports in a relatively short time frame. The data used in the above models cover a much longer time frame when the Austin airport was in a state of transition, at some points operating and at some points not. Therefore, the interpretation of the estimated coefficients is more complicated than positive or negative effects of airports on housing values -- depending on the time period, the interpretations change. For example, early in the model years when Mueller Airport is operating and most people expect it to continue, a negative coefficient on a route dummy would indicate a depressing effect of being on the route to the airport relative to houses elsewhere. In the later model years, when Mueller Airport is closed and the facility is empty, a negative coefficient on a distance dummy would indicate a depressing effect of no longer being on route to the airport relative to houses elsewhere. To sort out whether the negative coefficients refer to an airport or the lack of an airport, the model must be divided into time periods and compared across time as well as across space.

1.5 House Prices During Siting Stages

As Kolhase (1991) and Kiel and McClain (1995) point out, the impacts of environmental sitings are not constant over time. In these two studies, the authors investigate the relationship between the fall in house prices and the siting of a noxious facility by dividing the siting into distinct stages with different levels of risk perceived by potential neighbors. For Kiel and McClain, these stages are:

pre-rumor, rumor, construction (in which the probability that the siting will occur goes to one), opening, and on-going operations. Kolhase had information in three distinct years, and therefore ran a different regression for each study period to determine when homeowners reacted to the siting. Kiel and McClain had nineteen years of continuous data, and so had the option of either running separate regressions for each stage, or of using a pooled regression with interaction terms to specify the siting stage. This method assumes that the marginal contribution of each house attribute that is *not* interacted with the stage dummy remains constant over time. After estimating both types of models, Kiel and McClain use an F-test to test the hypothesis that the marginal contribution of house prices is constant over time. They reject the pooled form of the model in favor of individual regressions.

This section replicates the Kiel and McClain methodology, adjusting the siting stages for the removal of an airport (noxious siting) rather than the building of a new one. The stages remain the same, but the expected signs of the estimated coefficients are the opposite of those previously found. Based on the background section of this paper, the siting stages are defined as follows:

1. **Pre-rumor: 1980-1986** Before a voter referendum passed to relocate the airport away from the Mueller location.

2. **Rumor: 1987 – 1993** The referendum passes to move the airport to the Manor location in 1987, but then Bergstrom Air Force Base appears on the list for possible closure. The City simultaneously makes improvements at Mueller, buys land at Manor, and performs impact studies at Bergstrom.

3. **Construction: 1994-1998** The Base property reverts back to the City in late 1993 and a groundbreaking ceremony at Bergstrom is held in early

1994. Construction of the airport at Bergstrom continues through this entire period, and efforts at the Manor location cease.

4. **Opening: 1999** Austin-Bergstrom International Airport officially opens on May 23, 1999. Mueller Airport ceases operations the night before.[19]

5. **On-going Operations: 2000- June 2001** Housing prices adjust to the relocation of the airport.

Based on the general hedonic equation described in equation 1.1, the model in this section takes the following form:

$$2.1 \qquad \ln(P_i) = \beta_0 + \beta_1 S_{1i} + \beta_2 C_{2i} + \sum_{k=1}^{21} \beta_k dYear_{k_i} + \theta \cdot Noise_i + \varphi \cdot Dist_i + \sigma \cdot Route_i + \varepsilon_i,$$

where i indexes the house, $\boldsymbol{S_1}$ is a vector of structural characteristics, $\boldsymbol{C_2}$ is a vector of community characteristics, ***Noise*** is a vector of noise level dummies, ***Dist*** is a vector of distance ring dummies, ***Route*** is a vector of distance from the major routes to the airport dummies and $dYear_k$ is a dummy variable for the year of house sale to control for annual changes in overall house prices . All prices are adjusted to constant 2001 dollars using the Consumer Price Index.

A separate regression for each phase is run with two different specifications due to the lack of houses that live in the 70 and 75-decibel areas. Specification (A) combines all noise levels into one composite level (Noise2). Specification (B) allows each noise decibel level to enter separately. Table 1.7 provides a comparison of these two specifications. All phases of both

[19] Because the old airport closure and new airport opening happened mid-way through 1999, it is difficult to predict what happened to house prices in 1999.

specifications pass an F-test, implying that the results as a whole are significantly different from zero. The R^2 values range from a low of about 0.63 for the Rumor and On-going stages to a high of about 0.73 for the Pre-rumor and Construction stages. Full regression results are reported in Table D.1 of Appendix D.

Table 1.7 Noise Results for Models with a Separate Regression for Each Phase

Specification*	Variable	Pre-Rumor	Rumor	Construction	Opening	Ongoing
A	Noise2	-0.02	-0.078	-0.124	0.100	0.044
		(-0.17)	(-0.68)	(-3.09)	(1.46)	(1.26)
B	N6570	-0.10	-0.055	-0.095	0.085	0.030
		(-0.74)	(-0.46)	(-2.26)	(1.19)	(0.81)
	N7075	0.28	-0.169	-0.242	0.131	0.064
		(1.07)	(-0.92)	(-3.54)	(1.12)	(1.08)
	NGT75	-0.03	-0.164	-0.242	0.390	0.201
		(-0.10)	(-0.54)	(-1.24)	(1.03)	(2.07)

Note. The first number is the regression coefficient. The t-statistics are in parentheses.
*Specification (A) combines all noise levels into one composite level (Noise2). Specification (B) allows each noise level to enter separately.

The expected result here is that noise will start with a negative effect on house prices at the old airport, but that negative effect will disappear with later stages as homebuyers realize that the noise will disappear. Based on the first specification - combining all noise variables into one – being within a noise contour has a small and insignificant negative effect on house prices within a noise contour compared to those in a quiet location for the first two periods. Starting with the Construction phase, however, the coefficient on noise for houses in Mueller Airport noise contours is negative and significant. When the new airport opens in 1999, the coefficient on noise at the closed airport turns positive and remains significant at the 90% confidence level. This implies that any negative effect due to noise that developed during the years when then new airport was being built and aircraft operations continued at the old airport, disappeared with the noise.[20] In the final, on-going operations stage, the coefficient is still positive, but is not quite significant at the 90% level. It is difficult to know what to expect in this stage given that redevelopment of the former airport site had not yet begun.

The result of the second specification in Table 1.7, where each noise contour dummy enters separately, is similar in pattern, with a few idiosyncrasies. In the first, Pre-Rumor, stage the 70-to-75 decibels noise contour has a positive coefficient. Though it is not significant at the 90% confidence level, it is nevertheless a strange result, likely driven by the very few data points that fit into the criteria of both selling before 1987 and living in a loud contour. The intermediate stage coefficients tend to follow the above pattern with varying levels of significance. For the 70-to-75 decibels contour, the most significant coefficient is in the on-going stage, implying that the area where Mueller Airport used to be located is an attractive neighborhood now that is it no longer plagued by noise.

The coefficients for the distance variables are shown in Table 1.8. As would be expected, when changing the noise variables in specifications (A) and (B) results for distance are almost identical, so only specification (B) is reported.

[20] This may seem unintuitive; with no aircraft noise it seems like the coefficient on noise should be zero. However, the noise variable actually indicates a geographic location. In the absence of noise, that location may be more attractive than other locations. Referring back to Map 1, houses in noise contours on the west side of IH-35 are located in the affluent neighborhood that organized the “Move-It” campaign.

Table 1.8. Distance Results for Models with a Separate Regression for Each Phase

Variable	Pre-Rumor	Rumor	Construction	Opening	On-going
MAdist1	0.31	0.0425	0.0500	-0.0705	-0.1049
	(1.14)	(0.21)	(0.69)	(-0.47)	(-1.50)
MAdist2	0.25	-0.0307	0.0923	0.0931	0.0492
	(1.09)	(-0.19)	(1.58)	(0.77)	(0.90)
MAdist3	0.46	0.0085	0.0178	-0.0100	0.0533
	(1.87)	(0.05)	(0.32)	(-0.08)	(1.00)
MAdist4	-0.29	0.0684	-0.0758	-0.0800	-0.0447
	(-1.42)	(0.49)	(-1.51)	(-0.81)	(-0.97)
MAdist5	0.02	-0.0371	-0.0205	-0.0218	0.0295
	(0.11)	(-0.36)	(-0.51)	(-0.27)	(0.77)
MAdist6	0.17	0.0514	0.1211	0.0143	0.0427
	(1.67)	(0.93)	(5.18)	(0.26)	(1.67)

Note. The first number is the regression coefficient. The t-statistics are in parentheses.

The variables for distance from Mueller Airport (MA) tend not to be significant, and show no consistent pattern. At the Pre-Rumor stage, distances within a mile have a weak, but positive coefficient. A distance between one and 1.5 miles from the airport have a significant positive coefficient, compared to a house located more than three miles away (at 90% confidence level). However, moving just one additional half mile out, the coefficient turned negative and significant, only to turn back to positive and significant between 2.5 to 3.0 miles away. No coefficients are significantly different from zero at the Rumor stage. During the construction of the new airport, the distance variables looked similar to those during the Pre-Rumor stage, significant and positive at a half to one mile, negative from one to 1.5 miles, and positive again from 2.5 to three miles. After the opening of ABIA, no distance variables are significant at the 90% level. In the last stage, on-going operations, being within half a mile of Mueller had a negative effect compared to a house more than three miles away, but being within 2.5 to three had a significant positive effect.

While these distance coefficients may seem random and therefore meaningless, the point of the distance variables is to measure proximity to an airport separately from noise effects, and to control for distance when looking at noise. These results show that noise effects tend to be negative while Mueller was in operation (as expected), whereas distance variables indicate more often than not that houses within three miles of the airport are no different than houses farther away. In fact, with the exception of being 1.5 to two miles away, any significant effect of being near Mueller when it was open was positive. A particularly noticeable indication that the noise and distance variables pick up different effects occurs in the last period when being within a 75-decibel contour has a positive effect, but within a half-mile a negative effect.

The coefficients for the route variables are shown in Table 1.9. As would be expected, the results of noise specifications (A) and (B) are almost identical for route, so only specification (B) is reported. The first variable, ManorRd2 indicates a house is within a quarter mile of the main route to the Mueller Airport, Manor Road. The coefficient on this variable is negative and significant during all but the Rumor stage (where it is not significantly different from zero). This implies being on Manor Road is not a desirable location, regardless of whether it is on route to an airport or not. This may not imply anything about development, and may simply mean that people do not want to live along a busy street. The second variable represents a house between 0.25 and 0.5 miles from Manor Road.

In the Pre-Rumor and Construction stages the coefficients are relatively large and negative. During the Rumor and Opening phases, the coefficients are significant and positive, though somewhat smaller. After the airport re-location is finalized, the effect of being 0.25 to 0.5 miles away from Manor goes back to being negative. These results appear to be at odds with the map in Figure 1.1 that shows a strong decrease in the value of houses along Manor Road in the absence of Mueller Airport. The map in Figure 1.1 indication is that houses along Manor Road were worth considerably more when Mueller was open, *not* that Manor Road is, in general, an undesirable location.

Table 1.9 Route Results for Models with a Separate Regression for Each Phase

Variable	Pre-Rumor	Rumor	Construction	Opening	On-Going
ManorRd2	-0.31	0.1457	-0.2030	-0.1607	-0.1425
	(-1.61)	(0.92)	(-3.45)	(-1.34)	(-2.60)
ManorRd3	-0.43	0.2640	-0.1482	0.1109	-0.1139
	(-2.37)	(2.56)	(-3.54)	(1.34)	(-3.01)

Note. The first number is the regression coefficient. The t-statistics are in parentheses.

Depending on which structural or neighborhood characteristic is evaluated, the assumption that the coefficients are constant over time can be either accepted or rejected. The structural variables as a whole are fairly constant over the five stages, implying that a pooled model would not harm results. However, the coefficients on the zip code variables that proxy for neighborhood effects do tend to vary widely, implying that a pooled model is not empirically supported.

We now turn to the pooled model, which runs all years together and includes noise, distance, and route variables interacted with dummies that account for each phase of the model. When running the pooled model, the structural and neighborhood variables, as well as the year dummies, enter in a linear fashion as they are described in the data section of the model. The results of the regression for the environmental variables are reported in Table 1.10. Full regression results are in Table D.2 of Appendix D. Again, as with the phase models, the F-statistic indicates that the regression as a whole is significantly different from zero. The R-squared statistic is also comparable at 0.6650.

The pooled regression estimates are more difficult to interpret than the phase regression estimates because a dummy interaction term (in this case the Pre-Rumor stage) is necessarily omitted. In addition, terms to describe the relationship of the environmental variables in *all* stages of the model are included. The noise coefficients are all negative and significant for at least the Construction stage of the *phase* model. In comparison, the coefficients on 65-decibel noise contour for later stages are never significantly different than the Pre-Rumor stage in the *pooled* model, implying that the noise effect does not change over time. This result is somewhat tempered by the fact that the 70 and 75 decibel contours are significant and negative at the Rumor and Construction stages of the pooled model.

Table 1.10. Results for Environmental Variables in Pooled Regression

Variable	All Stages	Rumor	Construction	Opening	On-Going
N6570	0.0145	-0.0758	-0.0088	-0.0174	-0.0420
	(0.10)	(-0.45)	(-0.06)	(-0.11)	(-0.29)
N7075	0.2971	-0.5220	-0.3970	-0.3189	-0.2740
	(1.08)	(-1.68)	(-1.40)	(-1.07)	(-0.98)
NGT75	0.2291	-0.6560	-0.2885	0.0031	-0.0740
	(0.57)	(-1.40)	(-0.63)	(0.01)	(-0.18)
MAdist1	0.0598	-0.1662	-0.1143	-0.0367	-0.1206
	(0.37)	(-0.87)	(-0.69)	(-0.20)	(-0.74)
MAdist2	-0.1540	-0.0130	0.1441	0.3222	0.2587
	(-1.31)	(-0.10)	(1.20)	(2.50)	(2.19)
MAdist3	-0.0501	-0.0758	-0.0114	0.1354	0.1547
	(-0.33)	(-0.46)	(-0.07)	(0.83)	(1.01)
MAdist4	-0.2572	0.2141	0.1116	0.2810	0.2537
	(-2.26)	(1.61)	(0.96)	(2.28)	(2.22)
MAdist5	-0.2073	0.0900	0.1100	0.2628	0.2830
	(-2.07)	(0.83)	(1.09)	(2.44)	(2.82)
MAdist6	0.1743	-0.2732	-0.8364	-0.1153	-0.0964
	(1.91)	(-2.82)	(-0.90)	(-1.17)	(-1.05)
ManorRd2	0.2300	-0.3841	-0.3961	-0.7363	-0.4342
	(2.15)	(-2.16)	(-2.70)	(-4.50)	(-3.02)
ManorRd3	0.1608	-0.1377	-0.2150	-0.2823	-0.2815
	(1.53)	(-1.14)	(-1.99)	(-2.43)	(-2.65)

Note. The first number is the regression coefficient. The t-statistics are in parentheses.

The coefficients on the distance variables are never significantly different from zero at less than a quarter mile from Mueller airport, or between one and 1.5 miles. At other distances, the coefficients tend to be positive and significant at the later stages only. Once again, the coefficients on the distance variables change signs and significance at different distances and impact house prices separately from the noise variables.

The route variables are slightly less difficult to interpret and have greater similarity to the phase model regressions. The Manor Rd coefficients are all negative and significantly different from zero for the individual stages. However, the coefficient on "All Stages" is positive. Since the basis of comparison is the Pre-Rumor stage, this implies that the positive effect of being located Manor Rd coefficients decrease with time.

In comparison, the two types of models yield different results for noise. The phase model shows that homeowners react to the airport move only after the groundbreaking ceremony at the new airport. The pooled model shows that homeowner reaction was strongest at the Rumor stage and continued through construction of the new airport. The pooled model also implies that homeowners living in the 65-decibel contour never reacted to the airport relocation. Both models yield varying positive and negative coefficients for the distance and route variables. The model fit is also similar for the two types. The constant coefficient assumption for structural characteristics does not appear overly restrictive, although the coefficients on the neighborhood characteristics do vary, sometimes significantly, over time in the phase model, implying that the pooled model is not empirically supported.

1.6 REPEAT SALE MODEL

As mentioned earlier, the decision to relocate the airport occurred over many years and information regimes. In order to find the "true" event date(s) at which house buyers and sellers in Austin reacted to the re-location of the airport, five separate event dates are specified and described below in Table 1.11. Once again, the event dates are chosen based on the description of events in the background.

Table 1.11 Definition Repeat Sales Event Dates for Analysis

Variable	Year	Event
Vote	1987	Vote passes to move City airport to Manor location
List	1991	Bergstrom Air Force Base placed on the possible closure list; City Council resolves to locate airport at Bergstrom location
Close	1993	Vote passes to move City airport to Bergstrom; the Air Force Base officially closes; Base property reverts to City
Build	1994	Groundbreaking ceremony held at Bergstrom location
Open	1999	ABIA opens for passenger service; Mueller airport closes

Before running regression analysis to investigate the marginal effects of different aspects of airports on nearby properties, rough difference-in-difference estimates are calculated. Difference-in-difference calculations evaluated at the means give an estimate of the change in the average price of houses attributable to noise from Muller Airport, taking account of general market trends in Austin. Following Card (1990) and Hamermesh and Trejo (1997), the difference equation takes the form:

1.3 $$\Delta^2_{event} = \Delta\overline{P_N} - \Delta\overline{P_Q}$$

$$= \left\{ \left[\overline{P_{N,post}} - \overline{P_{N,pre}}\right] - \left[\overline{P_{Q,post}} - \overline{P_{Q,pre}}\right] \right\}$$

where $\overline{P}$ is the average price of a house, N (noise) indicates the house is located in an area where average aircraft noise from Mueller Airport equals or exceeds 65 decibels, Q (quiet) indicates the house is located in an area where average aircraft noise from Mueller Airport is indistinguishable from background noise, *post* indicates the house sold after the event, and *pre* indicates the house sold before the event (also includes the year the event occurred). Because the event dates cut across twenty years of data, all prices are adjusted to constant 2001 dollars using the Consumer Price Index before the differences are taken.

The first difference, $\Delta\overline{P_N}$, is the average price difference before and after an event leading to the closure of Mueller Airport for all houses in "noisy" areas, that is houses located in 65 of higher decibel areas. The second difference, $\Delta\overline{P_Q}$, is the average price difference before and after the same event date for all houses in "quiet" areas. Taking the differences between these two differences gives Δ^2, the change in house prices before and after each event that is attributable to Mueller Airport noise. Table 1.12 reports the results of the difference-in-difference calculations.

These difference-in-difference calculations can be used to predict the sign and magnitude of the coefficients on noise in the repeat sale model. They predict a small, positive coefficient on noise for the List event, with subsequently larger coefficients on noise for each later event. Difference-in-difference calculations are a rough estimate of the changes in average house price due to changes in noise level, relative to average house prices city-wide, but a hedonic regression is required to separate out effects of noise, distance, and development along the routes.

Table 1.12 Difference in Difference Calculations

	Vote	List	Close	Build	Open
$\overline{P_{N,post}}$ (# of obs)	\$114,909 (211)	\$119,842 (192)	\$125,478 (176)	\$129,583 (163)	\$153,058 (90)
$\overline{P_{N,pre}}$ (# of obs)	95,764 (15)	78,606 (34)	71,964 (50)	72,386 (63)	86,574 (134)
ΔP_N	19,145	41,236	53,513	57,197	66,484
$\Delta\overline{P_{Q,post}}$ (# of obs)	170,191 (9800)	175,994 (8705)	182,484 (7567)	185,692 (6981)	206,946 (3100)
$\Delta\overline{P_{Q,pre}}$ (#of obs)	158,629 (722)	137,795 (1817)	135,885 (2955)	137,272 (3541)	153,714 (7422)
ΔP_Q	11,561	38,198	46,599	48,420	53,232
Δ^2	\$7,584	\$3,038	\$6,914	\$8,777	\$13,252
$\%\Delta$	7.92%	3.86%	9.61%	12.13%	15.31%

Total number of observations is 10,748; all repeat sale transactions, one observation per sale.
All prices are CPI adjusted, 2001=1.

Traditional hedonic models attempt to control for all structural, neighborhood, and environmental characteristics of a particular home in order to isolate the effect of a natural experiment. However, it is impossible to control for all characteristics of any particular house and neighborhood. In the case of this analysis, one neighborhood is particularly attractive to home buyers, even though it is a neighborhood that is within the noise contours of Mueller Airport. Several new variables were designed to attempt to control for this, including investigating neighborhood associations and adding zip code variables, but a variable was never found that could capture the historic neighborhood with old shade trees and wide streets.

A better model would be able to look at the *same* house before and after the airport moved. In that case, all the qualities of a house or neighborhood that make it particularly attractive (or unattractive) to home buyers are controlled for inherently. The repeat sale model developed by Palmquist (1982) is a variant of the hedonic price model that does just that. It uses houses that have sold more than once during the period in which the environment undergoes a change. If the environmental change affects some houses and not others, then it is possible to use these repeat sales to estimate the effect of the change on property values, without controlling for static house characteristics.

So, for any particular year, a hedonic price function can be estimated as described in equation 1.1. If at least one environmental variable that varies across space also varies with time at some locations, then it is possible to subtract the earlier price equation from the later to isolate the effect of the environmental change from the effects of other characteristics of the house that are constant over time. Given any two years 1 and 2, and variable q_j that varies across space and time, the model becomes:

$$1.4 \qquad P^2_i - P^1_i = f(S_{i1},\ldots,S_{ij}, C_{i1},\ldots,C_{ik}, Q_{i1},\ldots,Q_{im}, q^2_j) - f(S_{i1},\ldots,S_{ij}, C_{i1},\ldots,C_{ik}, Q_{i1},\ldots,Q_{im}, q^1_j)$$

If $f(\,)$ is additively separable in q_j, as would be the case of linear or linear in logs specifications, all terms involving characteristics other than the effect of q_j cancel out.

1.5 If $f(\mathbf{S}, \mathbf{C}, \mathbf{Q}, q_j) = g(\mathbf{S}, \mathbf{C}, \mathbf{Q}) + h(q_j)$

then, $$P^2_i - P^1_i = f(\mathbf{S}, \mathbf{C}, \mathbf{Q}, q_j^2) - f(\mathbf{S}, \mathbf{C}, \mathbf{Q}, q_j^1)$$

$$= h(q_j^2) - h(q_j^1).$$

The advantages of repeat sale models come at certain costs. The first cost is loss of observations in the model that either do not have a second sale or that do not have sale dates that straddle the event date (signifying a change in environmental variable of interest). The second cost is the imposition of constant marginal contributions of all house characteristics that are “differenced-out” of the model.[21] The following section of the paper attempts to evaluate the advantages and disadvantages by estimating a repeat-sale model and comparing the results with a standard hedonic model including interaction terms for the environmental variables. The repeat sale analysis follows Poulos and Smith (2002).

The five events designed to test for the “true” event date(s) are as described above in Table 1.11. This model specification is similar to the phase model employed by Kolhase (1991) and Kiel and McClain (1995) but only repeat sales are used and the event date is always a single year. These event dates are created as dummy variables and equal one if, for a given house, the first sale occurred before the event date and the second sale occurred after the event date; zero otherwise.

[21] The characteristics do not change, but the model must assume that their coefficients do not change either.

The random error specified back in Equation 1.2 can be expressed as the sum of three separate errors:

1.6 $$\varepsilon_{it} = \mu_i + \nu_t + e_{it}$$

where μ_i represents the error due to time-invariant, property-specific unobservables, v_t represents error due to the time-variant unobservables, and e_{it} represents random variation across both properties and time. When equation 1.2 in one period is differenced for the same property in a second period, the μ_i error is eliminated along with the structural and neighborhood characteristics X_{1i} and X_{2i} .

The new estimation equation is defined as:

1.7 $$\begin{aligned}\ln(P_{i\,t+s}) - \ln(P_{it}) = \beta_0 + \sum_{k=1}^{21} \beta_k dYear_{ik} + \tau \cdot dEvent_i + \theta \cdot dNoise_i \cdot dEvent \\ + \varphi \cdot dDist_i \cdot dEvent + \sigma \cdot dRoute_i \cdot dEvent + u_i\end{aligned}$$

where all the structural and neighborhood variables of each house have been differenced out and what is left is the sum over the year dummies, an information effect ($\tau \cdot dEvent_i$) that is equal to one if the two sales of the same house straddle the environmental change and zero otherwise, and the information effect interacted with the dummy for each of the environmental variables. The coefficient θ measures the double difference on noise described above. If, in the difference-in-difference calculation the first set of houses are those within a specified distance of the airport rather than a noise contour, the coefficient φ

would measure the double difference. And it then follows that if the first set of houses are those within a specified distance to the main routes to the airport the coefficient σ would measure the double difference. All prices are adjusted to constant 2001 dollars using the Consumer Price Index.

As described in the data section, the year dummies are "effects coded". They take on the value of –1 if a house sold for a first time in that year, +1 if it sold for a second time in that year, and zero otherwise. Though the coding may initially seem cumbersome, it is actually a compact way to implement the subtraction of year dummies in the regression equation. Suppose for simplicity that the hedonic equation in year $t+s$ could be simplified to:

1.8 $$\ln(P_{t+s}) = \beta \cdot dYear_{t+s} + \varepsilon_{t+s}$$

and the hedonic equation in year t could be simplified to:

1.9 $$\ln(P_t) = \beta \cdot dYear_t + \varepsilon_t .$$

Then the repeat sale model would subtract one from the other to provide:

1.10 $$\ln(P_{t+s}) - \ln(P_t) = \beta(dYear_{t+s} - dYear_t) + (\varepsilon_{t+s} - \varepsilon_t).$$

So if house i sold for the first time in t the difference in the year dummies above would be (0 – 1) = -1. If house i sold for the second time in year $t+s$ the difference in the year dummies would be (1 – 0) = +1. And if i did not sell in either t or $t+s$ the difference would be (0 – 0) = 0.

The implementation of the model accounts for two other influences on the observations in the repeat sale analysis: selection effects and depreciation effects. Gatzlaff and Haurin (1994) indicate that the estimation of hedonic models may be substantially biased if the sample of houses in the model consist only of properties that sold. For any house to sell in a general real estate market, the bid offered by a buyer must exceed the reservation price of the builder or current owner. Even if one may argue that property owners in any given market randomly choose to sell their homes for reasons unrelated to the economy as a whole, Gatzlaff and Haurin point out that variations in economic conditions may still affect offer and reservation prices, so that a sample of only sold homes may change in a non-random manner. The correction for this self-sampling requires a joint estimation of the probability that a house will sell and the sale price.

Gatzlaff and Haurin (1997) extend this reasoning to repeat sale analysis; for a house to sell twice within the time frame of the model, the bid price must exceed the reservation price twice in a relatively short number of years. If the first set of sold houses is not randomly selected, then it is certainly possible that the second sale would suffer from a similar bias. They argue that if this double, sequential selection effect is ignored, it leaves the repeat sale estimation substantially biased. Again, the correction for this self-sampling requires a joint estimation with two selection rules defined by the fact that both rules are observed only when the offer price from the first sale exceeds the reservation price of the first sale and the offer price of the second sale exceeds the reservation price of the second sale. The authors use Tunali's (1986) generalization to the Heckman (1979) two-step correction for sample selection effects.

Unfortunately, since the data in this model consist only of houses that sold at least once, it is not possible to use Heckman's procedure to correct for houses that first self-selected to sell. However, since the data include both houses that sold only once and others that sold twice, it is possible to correct for self-selected repeat sale houses using the houses that sold only once as part of the Heckman two-step correction. The first step is to run a *probit* model with a dummy for whether the house is a repeat or single sale as the dependent variable and the age difference between sales, the environmental variables, and the year dummies as explanatory variables. From the regression results, it is possible to compute the associated inverse Mills ratios. The second step is to add the inverse Mills ratios to the regression equation:

1.11
$$\ln(P_{it+s}) - \ln(P_{it}) = \beta_0 + \sum_{k=1}^{21} \beta_k dYear_{ik} + \gamma \cdot Mills_i + \tau \cdot dEvent_i$$
$$+ \theta \cdot dNoise_i \cdot dEvent_i + \varphi \cdot dDist_i \cdot dEvent_i + \sigma \cdot dRoute_i \cdot dEvent_i + u_i$$

The error term u_i now implicitly incorporates the fact that selection effect terms used to estimate the model are separately estimated inverse Mills ratios.

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1.12
$$\ln\left(P_{i_{t+s}}\right) - \ln\left(P_{it}\right) = \beta_0 + \sum_{k=1}^{21} \beta_k dYear_{ik} + \gamma \cdot Mills_i + \tau \cdot dEvent_i$$
$$+ \theta \cdot dNoise_i \cdot dEvent + \varphi \cdot dDist_i \cdot dEvent + \sigma \cdot dRoute_i \cdot dEvent + u_i$$

The error term u_i now implicitly incorporates the fact that selection effect terms used to estimate the model are separately estimated inverse Mills ratios.

Table E.1 of Appendix E lists the number of residential sales and the mean sale price by year for all houses in the sample, and broken down into repeat and single sales. Simply looking at the table it is difficult to determine how the repeat sales differ from the single sales, or if they do so systematically. Therefore, Chart E.2 of Appendix E plots Mean Sale Price by selected years within the dataset for the three sub-samples of the model: all sales, single sales, and repeat sales. Sale prices before 1992 were left off of the chart due to the low number of observations, particularly in single sales, for those years. The trendline for repeat sales is roughly at or above that that of single sales up until 1999 when the mean repeat sale price falls below the single sale price, and remains below for the duration of the model. However, it should be noted that the rather extreme drop in mean sale price in 1998 is likely due to the very small number of observations.

Chart E.3 of Appendix E plots Mean Noise Level in decibels for the same years.[22] Except for the years 1993 and 1994, the mean noise level is higher for single sales than repeat sales. Again, the jump in levels in 1998 is more likely due to the lack of observations than a change in the real estate market. Judging from these plots, it appears that twice sold houses are slightly less expensive on average and less likely to be in a Mueller Airport noise contour. However, the mean noise level for repeat and single sales seems to be converging at the tail end of the data set, while the mean prices are diverging.[23] One possible hypothesis for this behavior is that homeowners who bought a home near the airport before noise was an important determinate of sale price were reluctant to sell their homes until Mueller Airport closed.[24] This reluctance to sell could be the real or perceived effects of noise or stigma that would cause a local housing market depression until the airport closed.

Depreciation effects are the second influence on the observations in the repeat sale analysis that the model adjusts for before implementation. Poulos and Smith (2002) follow Palmquist (1980) and adjust the dependent variable price

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[22] Chart F.3 looks like actual "noise level" is rising and falling. In reality, the number of houses located in Mueller Airport noise contours rises and falls, affecting the mean noise level.

[23] Again, this result may be driven by a small sample. In this case, few houses that sold for a second time had a first sale in 2001.

[24] While Mueller Airport first opened in 1930, aircraft noise did not become a large problem until the 1970s and 1980s when the Austin area saw rapid growth. The annual number of passengers using Mueller increased by 215% from 1979 to 1989. The number of commercial jets operating at Mueller (and presumably noise levels) peaked in 1987.

differential for depreciation based on a separate estimate of this effect, and then take the natural log.[25] Because the dataset used in this study provided both the years of sale as well as the year each house is built, two different depreciation measures are used. First, in the manner of Palmquist (1980), a standard hedonic property price regression is used to determine the coefficient on age (-0.00261). This depreciation rate is multiplied by the number of years between the two sales of the house. The resulting factor is then used to adjust the second sale price in a linear fashion before the natural log of the price ratio is taken. A second measure of depreciation, which takes full advantage of the dataset, is to compute the age of the house at the times of both sales and then use the difference as an independent variable in the repeat sale regression. The two sets of regression results are reported in Table F.1 of Appendix F.

In the second specification, the coefficient on the age difference is always significant at the 99% confidence level, and varies across the events from –0.183 to –0.212. This implies that a marginal increase in the age difference between sales causes a decrease in the price differential. This is what is expected; as the time between the two sales increases, the age of the house at the second sale increases, which, all else equal, should decrease the selling price of the house. For the environmental variables, the sign and magnitude of the coefficients, as well as the t-statistics, are very close and, in some cases, identical. The event dummy variables are of similar sign and significance, though the magnitude is

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[25] Poulos and Smith (2002) estimate the depreciation effect using a hedonic property value model for all residential sales in the model county as a semi-log with fixed effects for year, age, square feet of living space, and lot size as independent variables. They found the estimated annual depreciation rate to be -0.2. Palmquist (1980) also used a coefficient on age from a standard hedonic property model to adjust the price ratio. His estimated rate of depreciation is 0.0081.

larger in the depreciation-adjusted models. Since the estimates for the environmental variables are similar, the rest of the repeat-sale analysis follows Palmquist (1980) and Poulos and Smith (2002) and uses depreciation- adjusted log house differentials.

The full statistical output from the five separate regressions[26] is reported in Table F.2 of Appendix F. The coefficients for the environmental variables are reported in Table 1.13. As stated above, the dependent variable is the depreciation-adjusted percent change in house price. The coefficient on the "Event Dummy" reports the change in *all* house prices in the regression that sold once before and once after the event date. It is significant for all events except Close. The Vote, List, and Build periods are positive and significant at the 90% confidence level. This implies that houses that sold after these event dates sold at a higher price than before the events.[27] The coefficient for the final event, Open, is negative and significant, implying that houses that sold after the airport closed down sold at a lower price than before.

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[26] For a closer comparison to the difference-in-difference calculation, the repeat-sale regression was also run with a single noise term variable combining houses in all three noise contours. The results do not change in sign or relative significance; see Table G.3 of the Appendix.

[27] These results are somewhat difficult to interpret because the regression inherently controls for house depreciation over time, the year of sale, and general inflation effects. This coefficient captures the difference in house prices before and after each event, not related to the airport closure, the year of sale, inflation, or depreciation.

Table 1.13. Repeat Sale Model: Event Dates

Variable	Vote	List	Close	Build	Open
Event Dummy*	0.139	0.186	-0.096	0.126	-0.186
	(1.54)	(2.10)	(-0.19)	(1.41)	(-4.46)
N6570**	-0.014	0.025	0.064	0.078	0.075
	(-0.07)	(0.19)	(0.56)	(0.78)	(0.79)
NGT70	-0.147	0.013	0.296	0.272	0.114
	(-0.46)	(0.06)	(1.89)	(1.82)	(0.66)
MAdist1	0.107	0.134	0.268	0.233	0.293
	(0.56)	(0.92)	(2.23)	(2.17)	(2.60)
MAdist2	0.226	0.244	0.288	0.256	0.229
	(1.59)	(2.43)	(3.60)	(3.49)	(3.21)
MAdist3	0.120	0.240	0.296	0.321	0.308
	(0.58)	(2.14)	(3.50)	(4.21)	(4.16)
MAdist4	0.409	0.282	0.227	0.187	0.077
	(2.74)	(2.63)	(2.44)	(2.38)	(1.00)
MAdist5	0.216	0.271	0.252	0.212	0.255
	(1.63)	(2.78)	(3.69)	(3.57)	(4.20)
MAdist6	-0.025	0.080	0.181	0.174	0.273
	(-0.20)	(1.07)	(3.42)	(3.71)	(5.80)
ManorRd2	-0.468	-0.246	-0.257	-0.152	0.014
	(-2.36)	(-1.68)	(-1.93)	(-1.30)	(0.11)
ManorRd3	-0.264	-0.178	-0.168	-0.147	0.166
	(-1.46)	(-1.23)	(-1.45)	(-1.38)	(1.57)

Note. The first number is the regression coefficient. The t-statistics are in parentheses.
*The "Event Dummy" is the coefficient for the event dummy listed at the head of the respective columns.
**The environmental dummies listed represent that environmental dummy interacted with the event dummy listed at the head of the column.

All of the environmental dummy variables in the table represent the interaction of the dummy variable listed with the event date. That is, N6570 in the Vote specification represents the percent change in prices only for houses within the Mueller Airport 65-to-70 decibels noise contour that sold once before and once after the 1987 vote, relative to the price change in all houses during this time period given by the coefficient on "Event Dummy" in the Vote regression. Since aircraft noise had been a problem for residents near Mueller Airport since the late 1970s, the interaction terms for noise and event date should be positive and significant for any event that convinced homeowners that Mueller Airport was going to close. This would imply that beyond the trend of all house prices in Austin before and after that event (given by the Event Dummy variables), house prices in noise contours increase an additional amount.

For the 65-to-70 decibels noise contour, the coefficients on the interaction of the noise dummy with the event dummies are not significantly different from zero at the 90% confidence level. The last two specifications, representing the construction and opening of ABIA and the end of noise in the Mueller airport neighborhood, has a positive coefficient on noise that is significant at the 75% confidence level. This implies that houses in the 65-decibel noise contour sold for 7% more after construction began and after ABIA opened, in addition to the overall changes in house prices in Austin. Judging from this criterion only, the housing market adjusts twice; the correct event dates are both the construction and opening of the new airport.

The coefficient on the louder noise contours interacted with the Close and Build event dummy variables are positive and significant at the 95% confidence level. This implies that houses in the loudest noise contour sold for almost a third more after the Air Force Base closed and construction began on the new airport, relative to the price changes for all houses in Austin.[28] Altogether, it appears that home prices in the Mueller Airport noise contours, which had already adjusted to the general noise level by 1980 when the data begins, did not react to early

[28] Halverson and Palmquist (1981) show that the correct interpretation of dummy variables in semilogarithmic equations is the percent change resulting from taking the inverse log of the estimated coefficient and subtracting one.

announcements of the airport closure. In the areas most affected by noise, home buyers and sellers waited until the outcome was more certain -- when BAFB closed and building at the new site began. Houses in the loudest contours had almost fully adjusted to this change by 1999 when ABIA opened. House prices in the quieter contours had a much more modest adjustment after each event leading to the airport closure, implying that noise had a smaller negative effect from which to recover.

At this point, it is possible to compare the repeat-sale model with the difference-in-difference calculation at the means. The difference-in-difference predicted that the change in sale prices for houses in any noise contour would be higher than changes elsewhere for all event dates. In addition, the double-difference predicted that this effect would be smallest after the List event and largest after the Open event. The results of the repeat-sale analysis, which is able to more effectively control for other aspects of the airport move than simply noise, finds no additional change for houses in Mueller contours after Vote or List, but additional increases relative to other locations for all later events: Close, Build, and Open. For the quieter contours, the largest effects come after Build and Open, but these are considerably smaller than the effects after Close and Build in the noisiest contours.

The coefficients on the Mueller airport distance variables interacted with event dummies are positive and significant for all distance rings in the later periods. These coefficients imply that houses near Mueller Airport sold at subsequently higher prices after each of the event dates relative to other house prices as Mueller prepared for closure and finally closed. The vote to move the airport did not have an effect significantly different from zero in three out of the six distance rings of the Mueller airport, relative to other houses. For these houses that were not affected by aircraft noise but were affected by stigma related to proximity to the airport, the initial vote to move the airport was not a convincing policy change, but all later events that led to the airport closure positively and significantly impacted the housing market.

The coefficients on the interaction between the first four event dates and the distance to Manor Road variables are all negative and significantly different from zero. These coefficients imply that for houses on Manor Rd, each event date moving toward the airport closure reduced the price of the house, relative to all other house sales in Austin. The same is true for houses within a half-mile of Manor Road. This result is consistent both with the findings in Map 2 and with planners' expectations that traffic along Manor Road would sharply decrease with the movement of the airport, causing the land to be less attractive for commercial development. The last period reverses this trend; the coefficients for houses on Manor Rd are not significantly different from zero and the coefficients on houses within a half-mile are significant and positive. Thus, by the time the old airport closed and the new airport opened, the market for housing on the route to the old airport had fully adjusted.

This repeat-sale analysis reveals that no one event leading to the airport relocation caused the housing market in Austin to adjust to the policy change. The houses along the route to the airport were impacted first, losing value after the vote to move the airport first passed, with losses continuing through the Build period. The houses in the distance contours were impacted at almost every period of the model, though only about half of the distance contours reacted to the first vote. The houses within the noise contours were the slowest to react to the airport relocation. For these houses, the early periods of the model showed no significant changes, though once the Air Force Base closed, the gains for these houses were among the largest in the model. With the exception of houses located within just one-quarter mile of the route to the airport, the housing market was still adjusting to the airport re-location in the final period of the model.

In addition to the environmental variables, the coefficients on the Mills ratios are always significant at the 99% confidence level. This warrants the adjustment made for sample selection bias. The fixed effects for the years bracketing the event dates are also highly significant. These dummy variables take account of time varying influences in the Austin area aside from the changes in the location of the airport.

The repeat-sale model has the significant advantages of eliminating random error due to property-specific heterogeneity over time and of greatly reducing the structural and neighborhood data requirements for model estimation. However, as mentioned above, the advantages come at some cost. The first of these costs is the loss of observations, both for those houses that did not sell a second time within the sample period and those that sold twice within the same year.

In order to see how the loss of these observations affects the results, the full data set is again used to regress the log price of a house on its structural, neighborhood, and environmental characteristics. To simulate the repeat sales model, the five event date dummies are interacted with the environmental variables in the models, but all other explanatory structural and neighborhood variables enter in a linear fashion. Full results are reported in Table F.4 of Appendix F. The environmental results are below.

In contrast to the repeat sale model where a positive coefficient on the event dummies and interaction terms implies an increase in house price from the first to the second sale, here a negative coefficient on the event dummy variables and interaction terms implies a positive impact on house price. This is because the left-hand variable is no longer a percent change in price over two sales, but simply the log price of one sale. The interaction dummy "turns on" for houses that sold before the event, so the coefficient is now the impact on log price of selling before an event relative to selling after. Therefore, a negative coefficient says house prices increased after the event occurred.

The coefficients on the "Event Dummy" variables report the effect on *all* house prices of being sold *before* the event occurred. So, for the first event, Vote, the coefficient is positive and significant, implying that houses that sold before 1987 (in constant 2001 dollars) sold at a premium to later houses. This is consistent with the chart in Figure 1.4 that shows the average house price in Austin initially peaked in 1987, then fell the following year and remained below the average 1987 price for over five years. For all other event dates, the coefficients are negative and significant, implying that in constant dollar terms, house prices continuously rose over time. The large negative coefficient on Open implies that houses that sold *after* 1999 sold at a considerable premium, which is also consistent with chart in Figure1 that shows a sharp increase in average house prices after 1999.

Table 1.14 All Sales: Event Date Regressions

Variable	Vote	List	Close	Build	Open
Event Dummy	0.2871	-0.1209	-0.1931	-0.1204	-0.6584
	(5.28)	(-2.68)	(-7.50)	(-2.68)	(-28.29)
N6570	-0.0321	0.0306	-0.0450	-0.0952	-0.0167
	(-0.24)	(0.35)	(-0.62)	(-1.46)	(-0.49)
NGT70	0.1649	-0.0323	-0.1649	-0.1305	-0.1032
	(0.80)	(-0.24)	(-1.48)	(-1.33)	(-1.96)
MAdist1	0.0913	-0.0210	-0.0193	-0.0230	-0.0759
	(0.64)	(-0.21)	(-0.23)	(-0.28)	(-1.69)
MAdist2	-0.1501	-0.1969	-0.1541	-0.1152	-0.0460
	(-1.42)	(-2.68)	(-2.53)	(-2.06)	(-1.47)
MAdist3	-0.1031	-0.1967	-0.1242	-0.1242	-0.1038
	(-0.74)	(-2.53)	(-2.00)	(-2.30)	(-3.33)
MAdist4	-0.2446	-0.1602	-0.1168	-0.1117	-0.1341
	(-2.26)	(-2.13)	(-1.90)	(-1.98)	(-4.45)
MAdist5	-0.2232	-0.1630	-0.1038	-0.1126	-0.0994
	(-2.40)	(-2.72)	(-2.31)	(-2.74)	(-4.11)
MAdist6	0.0569	-0.0384	-0.0564	-0.0510	0.0342
	(0.74)	(-0.85)	(-1.66)	(-1.67)	(1.92)
ManorRd2	0.3502	0.2730	0.1512	0.1107	-0.0493
	(2.65)	(2.75)	(1.75)	(1.38)	(-1.16)
ManorRd3	0.2359	0.1887	0.1196	0.0932	0.0252
	(2.41)	(2.83)	(2.19)	(1.88)	(0.90)

Note. The first number is the regression coefficient. The t-statistics are in parentheses.
*The "Event Dummy" is the coefficient for the event dummy listed at the head of the respective columns.
**The environmental dummies listed represent that environmental dummy interacted with the event dummy listed at the head of the column.

The coefficients for the noise variables interacted with the event dummies report the effect of being sold before the various events occurred on houses within the Mueller Airport noise contours, relative to the price changes for the city as a whole. For the quieter contour, house prices did not react to early events (Vote, List, or Close). However, after 1994, when the City of Austin broke ground on a new airport, house prices saw a significant increase in this contour relative to all other areas. By the time ABIA opened in 1999, the coefficient on houses in the Mueller 65-decibel contour returned to zero, implying that the housing market fully adjusted before the noise actually ended. For houses in louder contours the largest increase in house prices relative to Austin as a whole, occur after the closure of Bergstrom Air Force Base. House prices increased again after groundbreaking at Bergstrom, relative to the city-wide effects, and once again after the new airport opened. While it is not unreasonable for house prices in the very loudest contours to not fully adjust until the noise ceased, the magnitude of the change decreases with each event after the Base closed.

These results are very similar to the repeat-sale model; house prices in the noise contours did not react to early announcements relative to other houses in Austin, and the changes are both larger in magnitude and more significant for the house in the loudest contours. Once again, the most important event for houses in the quieter contour is the BAFB closure, and the most important for the loudest contours is the groundbreaking of the new airport.

Several of the coefficients for houses in the closest distance contour lost significance in the intermediate periods, compared to the repeat sale model. The all house sales model finds that houses closest to the airport did not react to the announcements and events leading to the airport closure, but that prices began to rebound in the last period after the airport closed. For the houses that are still within three miles of the old airport, but not bordering it, the increases in house values started after the first vote to move the airport passed. Similarly to the noise variables, the more directly the airport is related to the house, the more time it took for the house values to increase.

The coefficients on the distance from Manor Road variables interacted with event dummy variables are positive and significant at early events, but decrease in size and significance with time, until at the Open event when they are no longer significant at the 90% confidence level. This implies that when Mueller was open and residents were more likely to believe it would stay open, living on the main route to the airport was an amenity relative to other locations. For all events that led to the closure, the before prices were higher than the after prices, but the difference becomes smaller as time passes until the in the last period the difference between the before and after is no longer significant. This agrees with the repeat-sale model where each significant event toward the airport closure reduced the price of the house relative to all houses in Austin.

Allowing all the house price sales, rather than only the repeat sales, into the model adds more detail to the last period of the model because many of the houses that sold only once were those that sold in the later years of the data set. Not surprisingly then, most of the differences in the estimated coefficients between the repeat sales and the all sales models occur in the last period. In two cases, the fourth distance contour and the closest proximity to Manor Road, the coefficients are significant for the all sales model when they are not in the repeat sales model. In three cases, the Open event dummy, the farthest distance contour, and the farthest route contour, the coefficients in the last period actually change sign between the two models. These changes do not change the outcome of the model; the noise and first four distance contours are not affected, and the changes in the Manor Rd variables are more consistent with the results for earlier stages of the repeat sales model.

The second cost of the repeat sale model is constraining the coefficients on the structural and community characteristics to be constant over time.[29] Therefore, a final regression is used to test the validity of this assumption by comparing the results of the above hedonic regression, where only the environmental variables are interacted with the event dummies, to another full sample specification in which the event dummies are interacted with all variables in the model (not including the year fixed-effect dummies). The full regression results for the second specification are reported in Table F.5 of Appendix F. The goodness of fit and significance statistics for both models are reported below in Table 1.15.

For all the model specifications the F-statistic is large enough to reject the null hypothesis that the regression is not significantly different from zero. The goodness of fit criterion (the R^2 statistic) is significantly better for the models without interaction terms for the structural and neighborhood variables. Looking at the actual regression coefficients, the coefficients across the two specifications are remarkably similar for the structural characteristics. The neighborhood

[29] This constraint is implied by not explicitly including the structural and community characteristics in the regression.

characteristics do not fare as well. Many of the coefficients on the demographic characteristics fail to be significantly different from zero in the unconstrained model. The coefficients on the zip code variables differ significantly across the two specifications and across the event dates within the specifications. This implies that a possible improvement to the repeat sale model would be to include interaction terms with the neighborhood as well as the environmental characteristics, thus allowing the value of various neighborhoods to change over time.

Table 1.15 All Sales: Event Date Regression Comparison

Specification	Event Dummy	F-stat	Prob F > 0	R^2
All Variables Interact with Event Dummy	Vote	18.4	0.00	0.07
	List	28.54	0.00	0.11
	Close	40.15	0.00	0.15
	Build	44.89	0.00	0.17
	Open	165.79	0.00	0.42
Only Environmental Variables Interact with Event Dummy	Vote	427.52	0.00	0.66
	List	428.71	0.00	0.66
	Close	429.23	0.00	0.66
	Build	429.47	0.00	0.66
	Open	429.82	0.00	0.66

1.7 CONCLUSIONS

The contributions of this model are at least three-fold. First, this model adds to the hedonic pricing literature on airport sitings by comparing the differences in noise and distance variables and adds a new element to the model: development along routes to the airports. Espey and Lopez (2000) find that not only is noise a disamenity associated with airports, but that airport proximity also decreases the value of a house. Tomkins, et al (1998) find the opposite to be true: not only is proximity an amenity, but that the benefits of travel access and increased infrastructure outweigh the costs of noise. Lipscomb (2003) finds that noise at the margin is not a determinate of house prices and proximity is an amenity. This study finds that these findings can potentially be reconciled by adding more flexibility to the distance measurements and providing a separable measure for access to the airport. When looking at across time, this study finds that noise is a disamenity that is separately measurable from distance to the airport. In the repeat sales and all sales event date models, distance is an amenity with houses in the closest distance contours seeing substantial gains in value when the old airport prepared to and finally closed.

Adding route-to-the-airport variables to the siting stage models is not very informative. In general, these models find that the effects of living on these major roadways did not vary with changing events. However, in the repeat sale and the comparable hedonic model, the route variables behave exactly as predicted. These models find that in the early stages when Mueller was expected to remain the City's airport, living on a route to Mueller was an amenity. In later stages when it was apparent the airport was moving to Bergstrom, living on a route to Mueller was a disamenity.

The second contribution to the literature involves the timing of noxious sitings. This paper actually uses five different estimations of when home buyers and sellers in Austin reacted to the movement of the airport. The phase model finds that the housing market reacted when construction began at the new airport, indicating that homeowners waited until the probably of not moving the airport to Bergstrom was zero, but before the noise actually ceased. The pooled model finds that homeowners reacted sooner, showing signs of increased house values at both the rumor and construction phases. The simple difference-in-difference calculation indicates that average house prices in Mueller Airport noise contours increased, relative to other house prices, by the highest percentage after the new airport opened. The repeat sales analysis finds that property values near the old airport did not react to early events in the movement of the airport, and somewhat surprisingly, reacted more strongly when the Air Force Base closed than when either construction began, or the new airport opened. However, jumps in house prices near Mueller relative to elsewhere, occurred at these events as well. The standard hedonic estimate finds the same basic result.

Finally, the third contribution is to the hedonic literature by comparing several different methodologies. The siting stage hedonic models are both cumbersome to implement and, particularly in the case of pooled models, difficult to interpret. In some cases, they also produce some unintuitive results. Two particularly strange results are first, that, controlling for other factors, house prices in the 65-decibel contour never changed with the events leading up to, or the actual closure of, Mueller Airport, and second, the strongest reaction for houses in the 75-decibel contour occurred at the rumor stage. This first result is at odds with the original mapping of results on pages five and six. Further, even though the models are largely the same and use the same dataset, the phase model and the pooled model do not always produce the same, or even similar, results.

Siting stage models require the imposition of "stages" within the data that correspond to the author's insight into homeowners' beliefs about the certainty of the noxious siting's occurrence. A more straightforward way of judging when the housing market reacts to a noxious siting is to divide the data around publicly known events. Here, both a repeat-sale and standard hedonic model divide the data around five major events in five separate regressions. These two models produce similar results that are more consistent with expectations than the siting stage models. The repeat-sale model has the definite advantage of requiring less data on each house in the sample and yet eliminates all error due to property-specific heterogeneity. On the other hand, repeat-sale analysis requires more corrections and modifications before the model is run. The standard hedonic model requires far more data to attempt to control for all characteristics of a property and thus is subject to both collinearity problems and left-out variable error. However, the implementation of the model and the interpretation of the results are both simpler. Based on these results, the choice of the "correct" specification depends more on the data available than the inherent abilities of the models.

Several refinements to the repeat sales analysis would improve the reliability of the results. First, a record of all building permits in the City of Austin have already been acquired, the next step is to eliminate addresses with significant improvements to them. Second, it would be useful to obtain records of the characteristics of all houses in the Austin area, not just the ones that sold, so that a correction for sample selection among the first sales could be added. Third, additional neighborhood variables, such as distance to the major city interstates, number of parks, and crime statistics may provide a sharper estimation of the variables of interest. These variables could also be collected with the aid of Geographic Information Systems maps.

A second direction for future work is use this data set to expand research on airport siting decisions in Austin. A second paper, already in progress, repeats much of the analysis for the new airport and tests whether the effects of building a new airport in a new neighborhood are similar in sign and magnitude to the effects of removing an old airport. A third paper is planned to look at the environmental justice issues involved in making the actual siting decision. Finally, the Mueller airport property has not yet been developed. Once these planning developments have been finalized, a similar event date analysis could be performed to test the timing and significance of the redevelopment plans.

Figure 1.1 Map of the Effects of Mueller Airport on Property Values

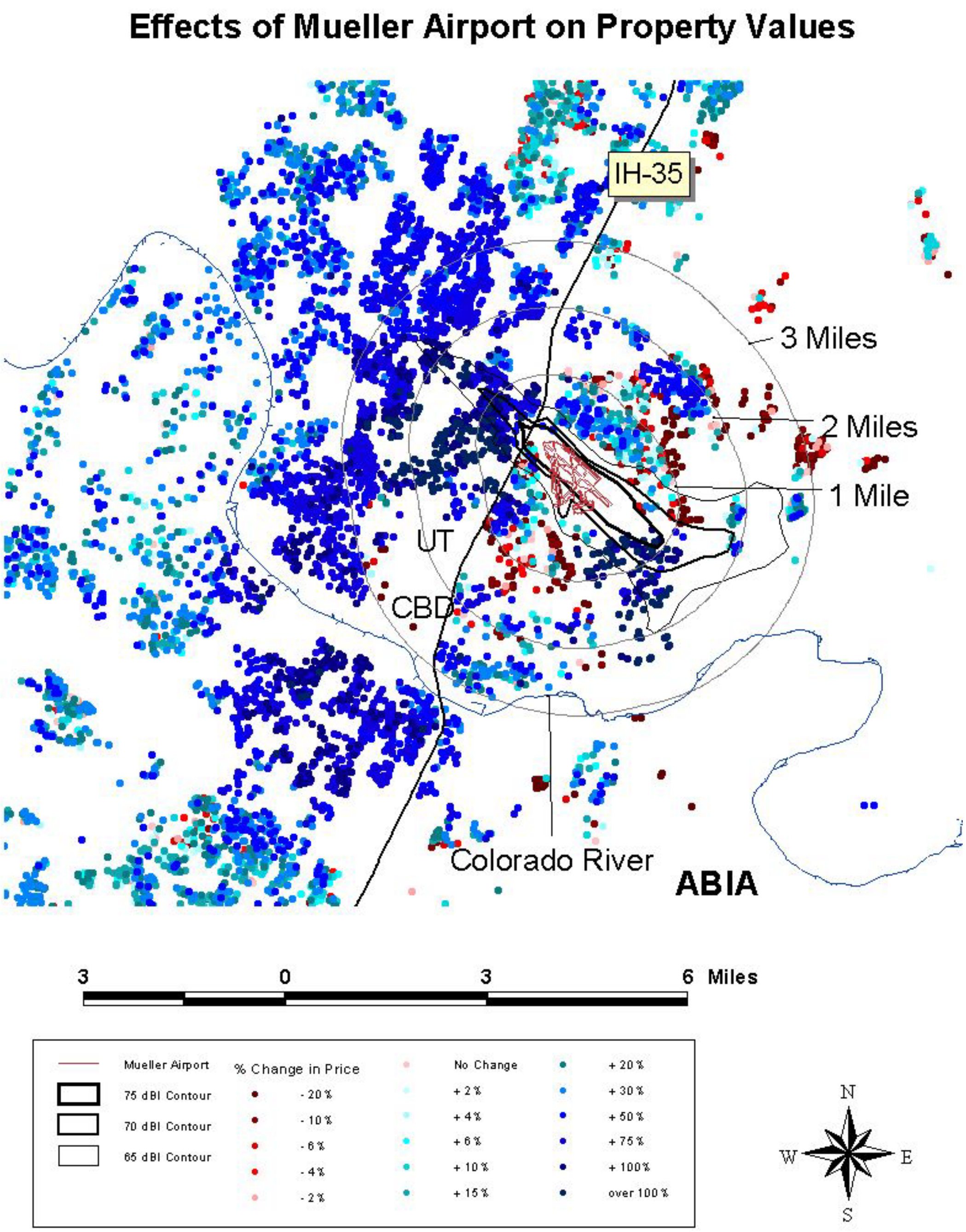


Figure 1.2 Neighborhood Focus of Effects of Mueller Airport on Property Values

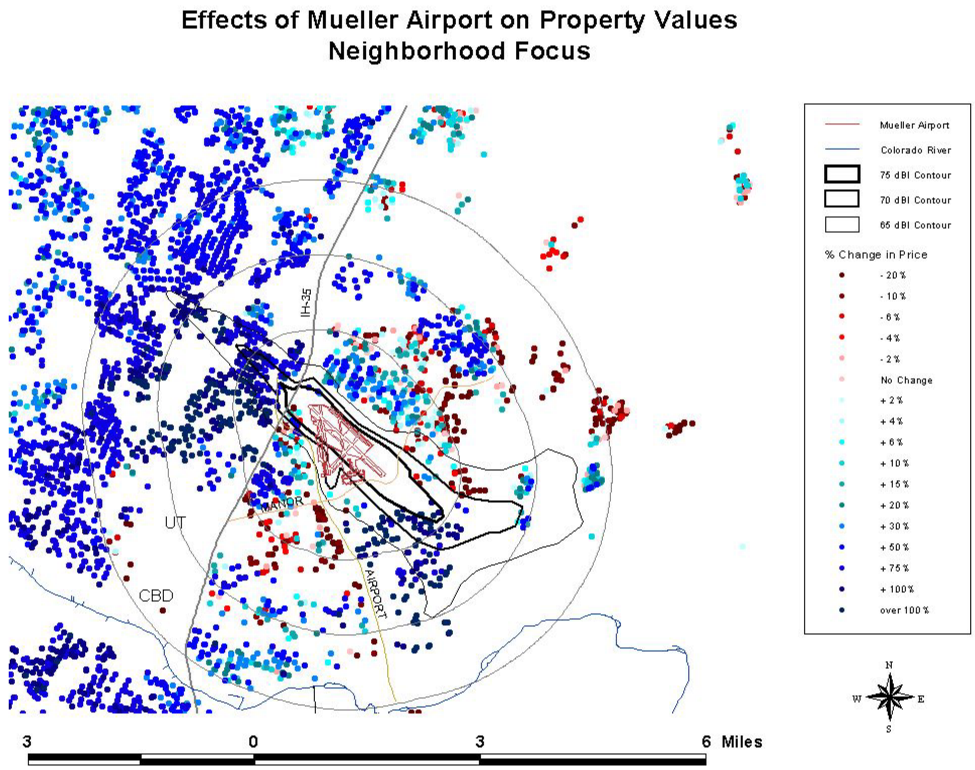


Figure 1.3 Map of Mueller Airport's Noise Contours

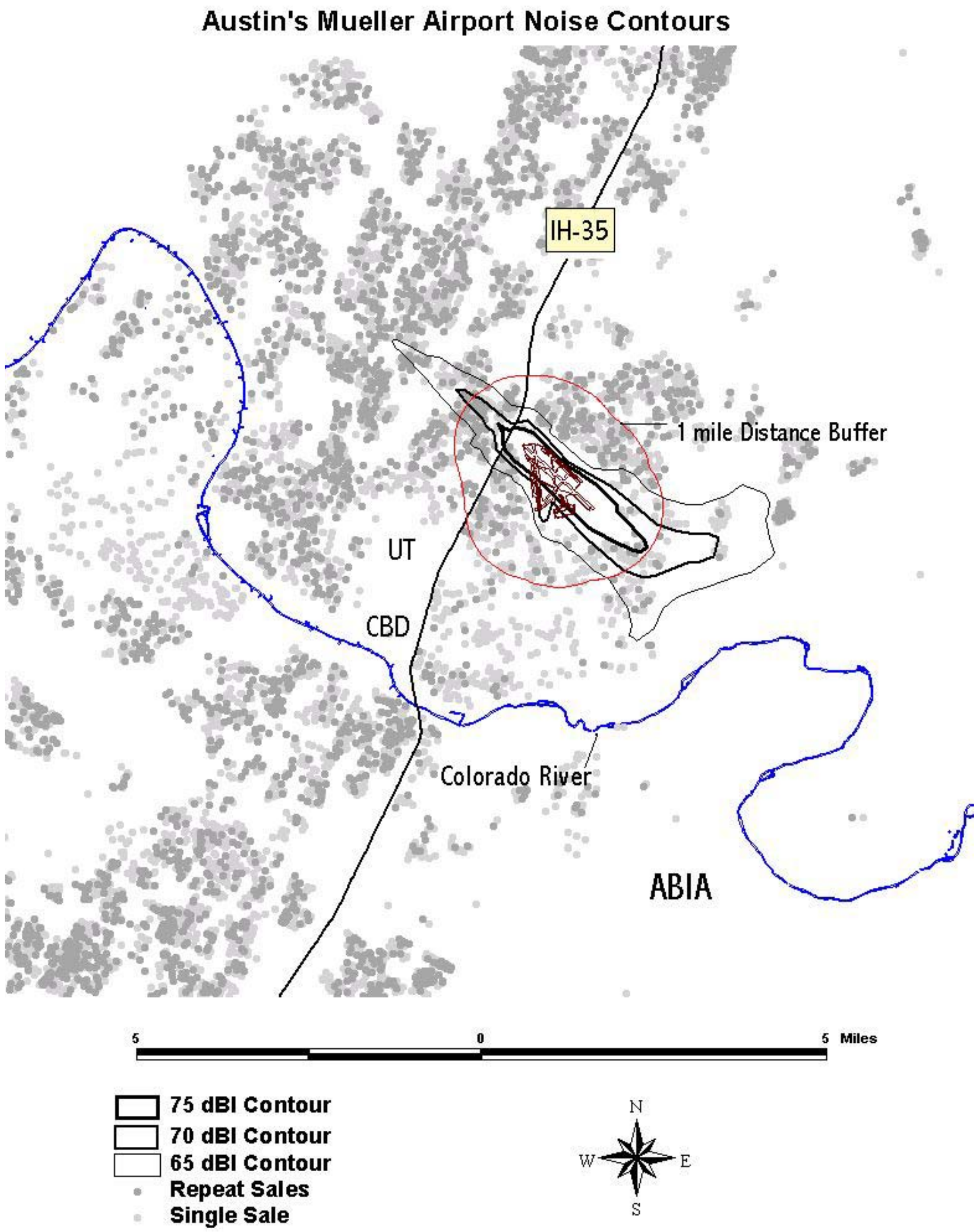
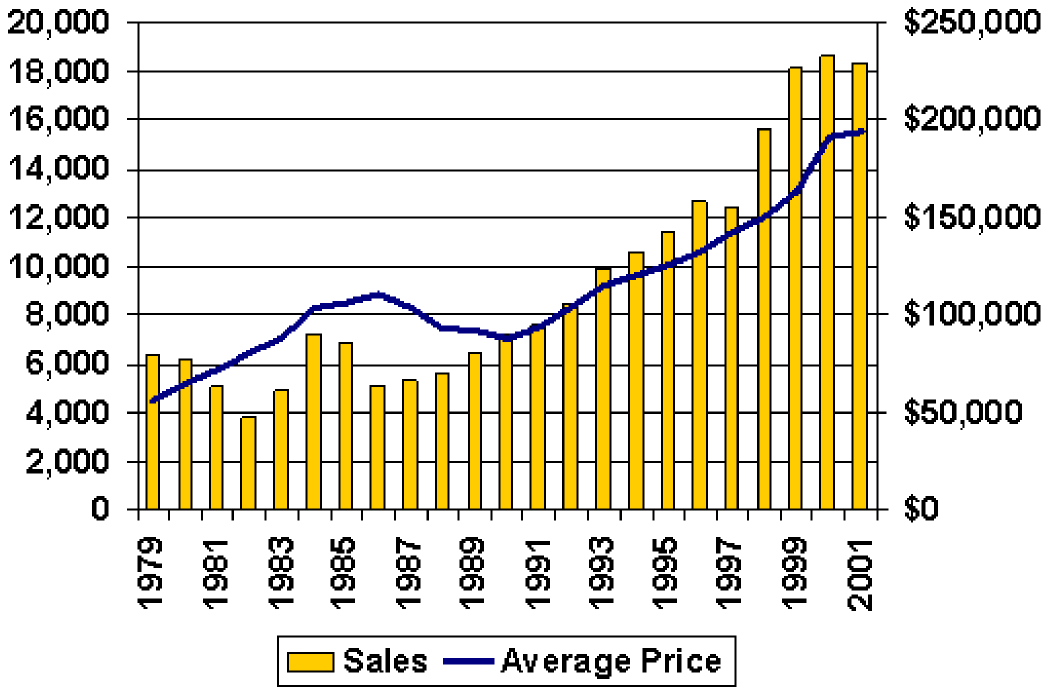


Figure 1.4 Austin MLS Residential Housing Sales



*Average house prices are *not* CPI-adjusted.

This data is provided by the Real Estate Center at Texas A & M University, http://recenter.tamu.edu/data/hs/hs140a.htm

Chapter Two: Capitalized Gains and Losses from an Airport Relocation

2.1 Introduction

To support urban lifestyles, modern cities need amenities such as parks and schools, but also ‘noxious facilities’ like waste incinerators, prisons, and airports. While most people would like to live near employment, or a park, few want to live under the flight paths of commercial jets. Furthermore, while everyone in the city benefits from access to air travel, the costs of noise, pollution, congestion, and safety concerns concentrate on the few who live beneath a flight path or within a few miles of the facility. Planners need the best available information before deciding where to put an airport, including not only costs and benefits, but also estimates of who bears those costs and who gets the benefits.

The City of Austin provides a distinctive opportunity to study the costs and benefits of noxious facility location because it recently closed a major airport and opened a new one. This study combines several data sources, including Geographic Information System (GIS) maps and census data, on a variety of structural, neighborhood, and environmental variables over a twenty-year period. The data on 21,386 home sales span the time of five separate “events” that may have been important to prices of houses around both the old and new airports. The data are divided into six periods corresponding to the timing of the events, and hedonic regressions are run to determine the impacts on house price from noise, distance, and access to airports. Due to the variety and length of the data set, hedonic pricing models can determine not only how an airport impacts house prices, but which houses and when.

Airports make an interesting study for noxious facilities because they contain both amenity and disamenity aspects. Earlier research on this topic found aircraft noise to be a disamenity, but proximity to the airport causes both house price increases and decreases, depending on the time period and the relative distance to the airport.[30] While distance has been used as a proxy for access to the airport, in many cases it seems to pick up visual, safety, or traffic impacts as opposed to convenience. This chapter, in combination with the previous chapter, develops a new measure of access to an airport based on locations near the main route to an airport. This new measure is designed to pick up the effects of infrastructure development, shorter commute times for airport and airline employees, as well as business development to support the airport or resulting from the increase in vehicle traffic along the route. This new variable seeks to explain why recent research has disagreed on the effects of distance to an airport on house prices (Lipscomb, 2003; Espey & Lopez, 2000; and Tomkins *et al*., 1998).

Chapter one uses the same basic data set used here to measure whether an airport is an amenity or a disamenity to the neighborhoods surrounding it. It is a case study of the neighborhoods near a single airport, over time, using information on houses in the rest of Austin as a control group. The earlier chapter focuses on several different empirical methods for determining the amenity and

[30] See Nelson (1980) for a review of airport literature, Penningtom, Topham, and Ward (1990), Levesque (1994), Tomkins et al (1998), Espey & Lopez (2000), and Lipscomb (2003) for more recent work.

disamenity values based on aircraft noise, distance from the airport, and accessibility to the airport for the *old* airport only. It finds that noise, distance, and access attributes are separately identifiable, with noise and often distance being disamenities, but access the facility a boost for house prices. The current work builds on the first chapter by looking at not only the effects around an old airport being taken out of a community, but also looking at the effects around a new airport being located elsewhere. Coefficients for noise, distance, and location on the route to an airport are found using similar empirical methods from the earlier research but then applied to the exact houses and communities impacted.

In addition this chapter discusses hysteresis for airport facilities. The concept of hysteresis is taken from the study of physics, the *history* dependence of physical systems. In the words of a scientist at the Laboratory of Atomic and Solid State Physics at Cornell University, "If you push on something, it will yield: when you release, does it spring back completely? If it doesn't, it is exhibiting hysteresis, in some broad sense."[31] Economists have borrowed the term to explain several kinds of phenomena: persistent and high levels of unemployment (Blanchard and Summers, 1986), the value of international operations in multinational corporations (Christophe, 1997), and projecting history into the present using dynamic economic modeling (Katzner 1999).

Here, the hysteresis question is taken from Barham, Chavas, and Coomes (1998). They define hysteresis quite generally as "situations of irreversibility where particular outcomes persist even after the conditions giving rise to their

[31] http://www.lassp.cornell.edu/sethna/hysteresis/WhatIsHysteresis.html

occurrence are removed" (429). Hysteresis in this sense is similar to the literature in environmental economics that looks at stigma effects and price rebounds after noxious sitings. Kiel (1995) uses a six-period model to find the impact of the discovery and cleaning of Superfund sites near Boston. She does not find house price recovery even after the Superfund sites were fully cleaned. Kiel and McClain (1996) use a five-period model to evaluate a failed noxious siting. They find that while proposing an undesirable facility does decrease house prices in the area, the failure of such a siting does not permanently stigmatize the location. Finally, Dale et al (1999) use a five-period model to find whether property values in Dallas recover from the stigma of a lead smelter after the plant is closed and the land restored. They find that house prices near the smelter rebounded both when the facility closed and when the clean-up was completed.

This chapter analyzes the housing market in Austin near the old airport at three stages, equilibrium, clean-up (when the new airport is being built), and recovery (after the new airport opens) over six time periods. To answer hysteresis questions, the original equilibrium prices are compared with the post-airport closure recovery prices to see if the areas around the old airport rebound from the former airport siting. Bergstrom Air Force Base (BAFB) also goes through the same three stages during the model period, equilibrium, clean-up, and recovery. In contrast to the old municipal airport facility, which during the model period was not renovated for a new use, the recovery period for former Air Force base includes the rehabilitation of the facility into the new municipal airport. The hysteresis section briefly discusses the impact that rehabilitation has on an airport closure.

In the context of Austin's airports, hysteresis can also be defined as the question of whether adding an airport has the exact opposite effect of removing an airport. To answer this hysteretic question, the double-difference estimated coefficients are used to calculate the potential efficiency gain from the airport re-location by comparing the numbers of gainers and losers and the magnitude of the house price changes from the public policy decision. This section measures whether the decision to move the airport lessened the overall burden to homeowners near *both* airports in aggregate. Because airports contain some disamenity aspects, a Pareto improvement is not possible here. However, a *potentially efficient* improvement is still possible if the gains near the old airport outweigh the loss near the new airport, or if the amenity aspects of airports outweigh the disamenity aspects.

The decision to move the airport was quite likely made for reasons other than increasing or decreasing property values.[32] However, it turns out that only about half as many houses lie either within the first three miles, in a noise contour, or on the route to the new airport as lie within the same designations for the old airport. Also, the airport move was significantly driven by the homeowners near the old airport. Therefore, moving the location of the airport

[32] It was widely believed that Austin had outgrown the old airport and a larger facility with international flights was necessary. The new location was chosen after years of deliberation and voting. In addition, outside of neighborhood concerns and development coalitions, the new site was chosen based on land costs and the pre-existence of runways. For the city as a whole, I assume that since the vote to move the airport passed, at least a majority of citizens believed the overall benefits of the new airport would compensate for the additional costs.

addressed the disamenity problem only if a net gain was realized by homeowners near the airports, without taking into account the costs and benefits to the city as a whole. If the burden to homeowners increases with the airport move, then building a new airport simply transferred the disamenity from one area to another without reducing it, leaving the City open to the same civil and legal turmoil as occurred before the move. Implicitly, then, this calculation compares the impact of being near an airport going in to the impact of being near an airport going out. The overall negative impact is expected to lessen due to the strategic location of the new facility.[33]

Unlike other airport location studies, this paper uses three different estimates of each environmental variable: a single-difference (within-period) estimate, a time-invariant estimate, and a double-difference estimate to measure the burden on homeowners near both airports in Austin. First, an empirical model similar to those used in the first chapter for the old airport is expanded to include distance and accessibility variables for the newly built airport. The new airport was built on the site of a closed Air Force base in an area of low population density. Due to the small number of houses and the use of the former Air Force runways, no houses in the data set are affected by aircraft noise above 65 decibels (the level FAA and HUD designate as incompatible with residential housing use). This is a limitation of the data, but also a reflection of how few houses are actually located near the new airport. Second, because the data set includes at least some houses near both airports over time, it is still possible to isolate the

[33] When the old airport was first built in the 1930s it was also, presumably, in an area of low population density and the city grew in around the facility, creating more of a nuisance than was initially anticipated. The same may become true of the new airport over a similar long time frame.

relative effects on the neighborhoods near the airports compared to the rest of Austin, as well as the effects of moving the airport over time. A difference-in-differences model is used to compare the estimated coefficients both within the model and across time periods.

However, rather than comparing these types of estimates to each other, this paper uses the combination of results to draw a clearer picture of what actually happen to house prices as a result of the airport relocation. The single-difference estimates give the effect that different airport characteristics have on selling a house in any given time period. This estimate is useful for determining how the airport affects the selling price of a house holding everything else equal. The time-invariant estimate gives the effect of a policy over its lifetime, rather than focusing on any given period when the house sells. These time-invariant estimates are often zero and can be quite deceptive. A policy that has large positive impacts in one period but large negative impacts in the next can give a zero net impact without realizing the gains and losses to homeowners who buy or sell homes in between. Finally, the double-difference estimate takes account of both of the previous elements and highlights the true effect of airports on housing values across time.

The results of this investigation indicate the following. The single-difference models with independent regressions for each period finds that previous to breaking ground at the new airport, no significant difference in price of houses under the noise contours existed, compared to the rest of Austin. During the time it took to build the new airport while the old facility was still operating, house prices in the noise contours were lower than other prices in Austin. Once the new airport opened and noise ceased at the old facility, houses in previous noise contours at the old airport sold at a premium. When this model is extended to a difference-in-differences model, noise at the old airport caused temporary declines in house prices compared to the rest of Austin, in reaction to the announcements of the impending airport re-location. Even controlling for aircraft noise, a house located in an old airport neighborhood sold for less, all else equal. Except for the closest distance ring, however, these negative distance impacts lessen over time. Access to the old airport was clearly an amenity; houses along the route to the old airport suffered permanent value losses when the old airport closed.

Looking at the new airport, noise is not nearly the factor as it was for the old airport because of its location around a former Air Force Base. Fewer houses simply exist within the noise contours. This is also a factor for close proximity to the new airport, although enough houses sold to determine that the houses in the closest distance contour sold for lower prices than elsewhere in the city. The double-difference coefficients show that this disamenity effect lessens over time in anticipation of the airport opening, but it wanes again during initial flight operations. Again, access to the airport is an amenity. Despite negative single difference coefficients on route, the double-difference coefficients show a significant increase in the houses on the route to the new airport after construction begins compared to the pre-list period and compared to other locations.

The hystersis analysis finds that airports do have persistent effects on house prices in the surrounding communities, even after the facility is abandoned. As would be expected from the different impacts that noise, distance, and route have on communities surrounding functioning airports, the hysteretic effects are both positive and negative and depend on the number and value of houses located in the community. The history dependence of an airport on the community is influenced by redevelopment at the former facility. The results of converting the former Air Force Base into a new municipal airport suggest that while it is not advantageous to live very near any airport facility, building a new airport on the old grounds significantly reduced the negative impacts on the surrounding community that appeared when the Base closed.

The net gain calculation that incorporates all houses in Austin impacted by the airport move (115,927 total houses) finds that moving the airport from Austin's city center to a more remote location caused a potential gain of $1.5 billion to all homeowners over the fourteen years after the vote to move the airport passed. This gain is developed from the over $78 million that was realized through more than 10,000 houses in the data set that sold during this time period and weighted by the total number of houses. Houses near both airports gain value in net, though gains at the new airport are almost twice those at the old airport, driven mostly by gains to houses along the route to the new airport.

The next section summarizes the background of Austin's airport history. Then the data are described in Section 2.3, and Section 2.4 briefly reviews hedonic models and Section 2.5 introduces the single-difference model estimation. Section 2.6 expands the model into a difference-in-differences analysis. Section 2.7 develops a measurement of net gain from moving Austin's airport. Finally, Section 2.8 concludes, and it previews areas for future work.

2.2 BACKGROUND[34]

As with most policies, the decision to re-locate Austin's municipal airport developed over many years and information regimes. As early as 1970, talk began of either finding a new site to replace Robert Mueller Municipal Airport (Mueller), or working out a joint-use facility with the federal government at Bergstrom Air Force Base (BAFB). By 1980, however, Air Force officials had twice denied requests for a joint-use facility. For a few years, the City focused its attention on expanding the current airport, but widespread public disapproval, driven by a multi-neighborhood organization "Move-It" campaign, caused the City Council to vote down this proposal unanimously. After failing once in 1985, a voter referendum in 1987 finally passed to build a new airport at a site east of the nearby town of Manor.[35] Aircraft noise levels and the number of commercial jets operating yearly out of Mueller airport reached their peaks that same year.

[34]I compiled an extensive background to understand the information regime for homeowners in Austin through the airport re-location process, see Background. The main source of information is articles in Austin's main daily newspaper, the *Austin-American Statesman,* as well as in the weekly paper, the *Austin Chronicle*. I also used the website for the new Austin-Bergstrom International Airport. In addition, unique perspectives are provided by (1) planners at the City of Austin Transportation, Planning, and Sustainability Department, (2) a local Austin journalist, Mike Clark-Madison, and (3) the president of the Mueller Neighborhood Coalition, Jim Walker, in a Community and Regional Planning seminar at the University of Texas at Austin.

[35] On November 3, 1987, voters rejected the idea of expanding Mueller, 88% to 12%. The referendum to build the new airport at Manor passed with a less impressive margin, 56% to 44%.

Although the City began to purchase land at the Manor location in 1989, it was simultaneously involved in an expansion project at Mueller to add a new terminal. Then, early in 1990, to complicate matters further, the rumor spread that BAFB was slated for closure by the U.S. government. In June 1991, BAFB actually appeared on a closure list. The City Council passed a resolution just two months later indicating Bergstrom was the preferred location for the new airport and voted to abandon the Manor project.

In May 1993, Austin voters approved a referendum to re-locate the airport to Bergstrom when the Base closed. In September, BAFB officially closed, and the next month the property reverted to the City of Austin. Approximately one year later, the City Council approved the name "Austin-Bergstrom International Airport" (ABIA), and on November 19, 1994, the City celebrated the groundbreaking. Finally, on the night of May 22, 1999, all flight operations were halted at Mueller Airport, and the following day Austin-Bergstrom Airport opened for passenger service.

2.3 DATA

The data for this study were compiled by First American Real Estate Solutions from individual sales of single-family residences in Travis County, Texas. The data include information about houses sold in thirty-three zip codes in the Austin Metropolitan Area. The total sample consists of 21,386 homes sold between January 1980 and June 2001. Each observation includes the property's address, the sale price, the sale date, certain house characteristics, and the census tract location.

The data set is built from 9,728 single sales and 5,829 repeat sales. Therefore, the full sample contains 21,386 observations. Summary statistics are shown in Tables A.1 through A.3 of Appendix A. These data include all available houses from First American that were sold in the thirty-three zip codes for the entire twenty-year period, so they avoid sample selection problems except those arising from the self-selection of houses to be sold.[36] These are not panel data, since they do not show the prices of the same houses each year for twenty years, but they do have the significant advantage of covering all relevant neighborhoods for all relevant years.[37] Thus, they can be used to show both time-series effects of relocating the airport and cross-section effects of one neighborhood compared to another.

The structural variables in these data include the total living area in square feet, the total lot size in square feet, the age of house,[38] the number of bathrooms,[39] the existence of a pool or in-house spa, the existence of a fireplace, the existence of a garage or carport, and whether the house is constructed of wood, a wood and brick combination, masonry, or is a manufactured home. To

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[36] It should be stressed that these are all houses available from *First American*, but not all houses that sold in Austin during the twenty-year period. Many attempts were made to acquire all house sales in the Multiple Listing Service (MLS) from the Austin Board of Realtors, with no success. Therefore, a sample selection problem may arise with the house sales information First American had available for purchase.

[37] See Maps B.2 – B.7 in the Appendix to see the distribution of observations across the city.

[38] Several specifications of age are tested, with slight variations in the results. Including only a single term for age produces the smallest coefficient (-0.00261) and the lowest adjusted R^2 (0.6501). Adding a quadratic term increases the coefficient on age (-0.0128), produces a positive coefficient for the squared term (0.000161), and increases the adjusted R^2 (0.6549). Adding a cubed term reduces the size of the coefficient (-0.00011) and decreases the adjusted R^2 (0.6503). All of these coefficients are significantly different from zero at a 99% confidence level in all models.

[39] The number of bathrooms is listed as an integer in the original data set. I assume that half bathrooms are rounded up and listed as the next full integer.

allow for a non-constant marginal value of a bathroom, the number of bathrooms variable is broken into a series of dummy variables. Summary statistics are shown in Table 2.1. The number of bedrooms is not available in the data set, but the total living area is included. While bedrooms are an important determinate of house price, Brookshire *et al*. (1982) finds collinearity between the number of bedrooms and the total living area and thus use living area as the only measure of house size.

Table 2.1. Summary Statistics for Structural Variables

Variable	Mean	Std. Dev	Min	Max
Price*	$171,102.80	153,115.3	1,129	8,807,557
Gross Living Area (sq ft)	1,731.49	763.74	298	8,900
Total Land Area (sq ft)	11,570.83	16,048.06	660	679,971.6
Age	23.85	18.05	0	101
Bath1**	0.1861	0.3892	0	1
Bath2	0.5274	.49993	0	1
Bath3	0.2864	.4521	0	1
Fireplace	0.6832	0.4653	0	1
Pool	0.0603	0.2380	0	1
Spa	0.0187	0.1355	0	1
Garage	0.8207	0.3836	0	1
Carport	0.0884	0.2839	0	1
Manufactured Home	0.0001	0.0118	0	1
Masonry Construction	0.0042	0.0647	0	1
Wood Construction	0.6810	0.4661	0	1
Wood/Brick Construction	0.3147	0.4644	0	1

The total number of observations is 21,386
*All prices are CPI adjusted, 2001=1
**Bath1 indicates a house has one bathroom, Bath2 has either one and a half or two bathrooms. Bath3 has more than two bathrooms. Less than 5% of houses in the sample have more than three bathrooms.

The neighborhood, or community, characteristics for each house are matched from the 1990 U.S. Census of Population and Housing, and from GIS maps. These variables include distance from the Austin central business district (CBD), distance to the University of Texas (UT, a major employment center as well as a common destination for over 50,000 students), the percentage of the population in the census tract who graduated from high school, a four-year college, and graduate school, the racial breakdown of the census tract, the percentage of vacant lots in the tract, and the percentage of homes that are owner-occupied. Summary statistics are shown in Table 2.2. [40]

Table 2.2 Summary Statistics for Community Variables

Variable	Mean	Std. Dev	Min	Max
CBD1*	0.0038	0.0614	0	1
CBD2	0.0476	0.2129	0	1
CBD3	0.0771	0.2668	0	1
UT1	0.0056	0.0747	0	1
UT2	0.0631	0.2431	0	1
UT3	0.0832	0.2762	0	1
% HS Graduates	0.1177	0.0445	0.01	0.23
% 4-year College Grads	0.1605	0.0696	0	0.39
% Graduate School Grads	0.0893	0.0632	0	0.25
% Foreign Born	0.0641	0.0374	0	0.33
% White	0.7882	0.1731	0.04	0.98
% Black	0.0859	0.1295	0	0.90
% Native American	0.0023	0.0045	0	0.02
% Asia – Pacific	0.0265	0.0243	0	0.25
% Other	0.0972	0.0929	0	0.72
% Vacant Lots	0.0904	0.0436	0.03	0.45
% Owner Occupied	0.4727	0.1896	0	0.80

*CBD1 indicates a house is located less than one mile from the Austin central business district, CBD2 indicates between one and two miles, and CBD3 indicates between two and three miles. UT1 indicates a house is located less than one mile from the University of Texas, UT2, between one and two miles, UT3, between two and three miles.

[40] Map B.2 shows the distribution of houses around the CBD and UT and their locations relative to the airports.

It is a fairly common practice to include both the median household income in the census tract and the percent of the census tract that is unemployed as proxies for community quality. As pointed out by Butler (1982), however, "it is impossible to separate the function of, for example, income as a neighborhood quality proxy from its role as a characteristic of demanders in the neighborhood." Furthermore, "the income coefficient will reflect both the effect of income on households' bids and the rationing effect of prices in allocating households of different income to different types of housing" (Butler, 1982, 96-97).

The school district of a particular house is another common regressor that is left out of this model. School district information is available in GIS format, but after analysis, it was omitted for two reasons. First, almost 83% of the housing sample is in the same school district, Austin Independent School District (AISD). Second, the school district dummies are highly correlated with the series of zip code dummy variables added as community proxies.[41] The zip code variables are included rather than the school district variables because zip codes reveal greater community detail: thirty-three zip codes make up the sample, compared to only six school districts. Summary Statistics for zip code dummies are shown in Table A.4 and plotted in Map B.1 of the Appendix.[42] The zip code dummies are also highly collinear with dummies for the three cities encompassed by the sample: Austin, Manor, and Del Valle. All of the houses in Manor are in

[41] For example, of the 1,231 houses in the Eanes Independent School District (5.8% of the sample), all but nine of them are in the zip code 78746.

[42] Mueller Airport is contained in zip code 78723, but the noise contours extend into 78751 and 78756 on the northwest, 78722 on the southwest, 78724 on the northeast, 78721 on the southeast. The mailing address for Austin-Bergstrom International Airport is 78719, though the eastern runway is largely located in 78617. The noise contours extend to the west into 78744 and to 78742 on the north.

the zip code 78653, and all the houses in Del Valle are in the zip code 78617. Thus, dummy variables for individual cities are omitted from the analysis.

The environmental characteristics are developed from the GIS and the Noise Exposure Maps furnished by the City of Austin Transportation, Planning, and Sustainability Department. Three variable groups are included: Noise, Distance, and Route. The Noise variables are a series of dummy variables that capture the noise contours: average noise level greater than 75 decibels (dB), 70-75dB, 65-70dB, and “undistinguishable from background noise”. The FAA, as well as HUD, defines areas exposed to average sound levels of 65dB or over as incompatible with residential housing use. See noise contours in Map C.3 and C.4. These noise contours were developed by the City of Austin for both airports and are provided in “Part 150 Noise Study” reports. The evaluation of the noise contours was conducted using the Integrated Noise Model (INM) developed by the FAA, the method most commonly used to predict contours.[43] Summary statistics are reported in Table 2.3. Due to the small number of houses within noise contours greater than 70 decibels, the noise contours for average noise greater than 75 decibels are combined with noise levels between 70 and 75 decibels (NGT70).

[43] The INM determines aircraft noise level on an average-daily basis using a ‘Day Night Average Sound Level’ metric. This metric is a 24-hour average sound level weighted with a 10-decibel penalty for nighttime noise events.

Table 2.3 Summary Statistics for Mueller Airport Noise Variables

Dummy Variable	Mean	Std. Dev	Min	Max
N6570: Noise level 65-70 dBs	0.0176	0.1316	0	1
NGT70: Noise level greater than 70 dBs	0.0067	0.0815	0	1

Aircraft noise levels at the new airport exceed 65 decibels for only a single house in the entire dataset. Not having houses in the data set that are within the new airport noise contours prevents a full-scale comparison of the old airport with the new, assuming that houses at the new airport do suffer from noise, but that the data sample is not representative. However, it was by design that the new airport would cause less noise pollution. The longer runways allow planes to achieve a higher elevation before flying over residential areas, causing less overall noise. Less noise combined with low housing density makes it likely that few houses are impacted by noise. Thus, the lack of noise at the new airport is both a data limitation and a valid component of the model to be figured into the cost and benefits of the airport location decision.

The Distances from each airport are also represented by series of dummy variables. The summary statistics are provided in Tables 2.4 and 2.5. For the old airport, Distance is measured in six, one-half mile concentric circles around the main terminal. The neighborhoods around the old airport are in a relatively dense urban area (Map B.4). For the new airport, variables for the distance from the airport are measured in five one-mile concentric circles around the main terminal

(Map B.7).[44] The neighborhoods around the new airport are still relatively sparsely populated, with fewer roadways and traffic intersections than are around the old airport. In addition, the neighborhoods around the old airport change character after only a mile or two (near downtown, the University, the Colorado River). On the other hand, the neighborhoods around the new airport remain relatively unchanged for several miles.

Table 2.4 Summary Statistics for Distance from *Old Airport* Variables

Dummy Variable	Mean	Std. Dev	Min	Max
MAdist1: Less than ½ mile	0.0115	0.1066	0	1
MAdist2: Between ½ and 1 mile	0.0353	0.1846	0	1
MAdist3: Between 1 and 1 ½ mile	0.0250	0.1562	0	1
MAdist4: Between 1 ½ and 2 miles	0.0240	0.1532	0	1
MAdist5: Between 2 and 2 ½ miles	0.0311	0.1736	0	1
MAdist6: Between 2 ½ and 3 miles	0.0496	0.2170	0	1

Table 2.5 Summary Statistics for Distance from *New Airport* Variables

Dummy Variable	Mean	Std. Dev	Min	Max
ABIAdist1: Less than 1 mile	0.0004	0.0193	0	1
ABIAdist2: Between 1 and 2 miles	0.0029	0.0538	0	1
ABIAdist3: Between 2 and 3 miles	0.0064	0.0795	0	1
ABIAdist4: Between 3 and 4 miles	0.0398	0.1956	0	1
ABIAdist5: Between 4 and 5 miles	0.0602	0.2378	0	1

Often, in the noxious siting and hedonic literature, Distance is instead measured as a continuous variable and enters into the equation as a natural log. With the log specification, the negative effect of living near the noxious facility

[44] I conjecture that traveling a half-mile from the old airport would take approximately the same time as traveling a full mile from the new airport.

decreases at a decreasing rate, but more distance from the site is always advantageous. In the case of airports, however, proximity to the site may indeed be an amenity (controlling for noise). Dummy variables allow for a non-constant marginal value of distance from the airport that may change sign.

The map in Figure 2.1 at the end of this chapter combines the airport noise contours with a one-mile distance ring for reference. This map shows that at Mueller Airport, the noise contours are elongated at a diagonal across the interstate highway (IH-35), whereas the distance rings form concentric circles around the old airport building perimeter. Thus, as shown in Table 2.6, for Mueller Airport the correlation terms between the noise and distance variables are relatively low. At the highest, noise level in the 65-70 decibel contour and the 0.5 to 1.0 mile distance ring have a correlation of 0.2574, below the threshold that determines multicollinearity. Therefore, these environmental variables can help determine the separate impacts of airport noise and proximity to the airport. The Noise variables are expected to pick up the effects of actual noise on residents under the flight path, while the Distance variables pick up other effects of proximity. Since Noise at ABIA is not a factor for any houses in the data set, a similar correlation matrix is not necessary for the new airport.

Table 2.6. Correlation Between Noise and Distance Variables for Mueller Airport

	MAdist1	**MAdist2**	**MAdist3**	**MAdist4**	**MAdist5**	**MAdist6**
N6570	0.1422	0.2574	0.1856	0.1599	0.0047	-0.0306
NGT70	0.2171	0.1988	0.1044	-0.0129	-0.0147	-0.0187

*See variable definitions in Tables 2.3 and 2.4

The construction of the "Route" variables is unique to this study. They are designed to pick up the effects of expectations about future land development related to the change in transportation through the region as the airport changes location. It is expected that properties *bordering* the main routes to the new airport will become valuable for commercial use, thus raising their prices. In contrast, those properties near, but not bordering, the access routes may suffer from increased congestion, noise and pollution, thus reducing their prices.

Map B.5 in Appendix B plots the various routes to each airport. These routes are developed from the City of Austin, "Map to the Airport" directions.[45] The ABIA Planning Committee projected 36,000 auto trips per day to the new airport, about 7,000 more than were recorded when it was an Air Force Base. Mueller Airport was directly accessed from the city's major interstate highway (IH-35) from both the north and the south via Manor Road. ABIA is accessible from two major highways, Texas 71 (Hwy 71) and US 183 (Hwy 183).[46] From central areas of Austin, however, it was forecast that many commuters would instead choose city streets, mainly Riverside Drive, East 7th Street, and Airport Boulevard. Planners projected that the already heavily used IH-35 would not be impacted by the change in airport location, but that Riverside, East 7th St, Airport Blvd, Hwy 183, and Hwy 71 would all see an increase in traffic flows. Manor Rd was predicted to lose much of its vehicle traffic.

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45 http://www.ci.austin.tx.us/austinairport/.

46 On November 8, 1989 the *Austin-American Statesman* ran an article stating that these highways were both "ill-prepared" for the projected increase in traffic.

The Route variables, therefore, are divided into two sets: Manor Rd dummies for the old airport and ABIA route dummies for the new airport. The Manor dummies are: one-quarter mile buffer from Manor Road, one-half mile, and greater than a half mile. The ABIA route variables are: one-quarter mile buffers of Hwy 71, Hwy 183, Airport Blvd, East 7th St, and Riverside Dr, one-half mile buffers, and greater than a half mile. Because the purpose of the Route variables is to pick up development effects and not to determine which routes are used most, the buffers for all roads in the ABIA route dummies are combined into one measure.

The final set of variables is year dummies to control for the general market trend in Austin. Each year dummy takes on the value of one if the house sold in that year, zero otherwise. The chart in Figure 2.2 at the end of this chapter shows the residential housing activity in Austin for all house sales.[47] From this chart, all else equal, it is expected that house prices in constant dollars will be lowest for the years 1990 and 1991. Therefore, when possible in the hedonic regressions, the dummy variable for 1990 is left out to serve as the baseline. This convenient notation implies that the dummy for 1991 is expected to be relatively insignificant, but all other years will be significant and positive.

2.4 HEDONIC MODEL

The theoretical framework for most hedonic models relies on the hedonic price method developed by Rosen (1974). The sale price of a house in a

[47] This data is provided by the Real Estate Center at Texas A & M University, http://recenter.tamu.edu/data/hs/hs140a.htm, although they are unable to provide individual house sales.

competitive market depends on its characteristics, all else equal. Because home buyers prefer a quiet location to being under the flight path of a jet, the market price of a house in a quiet location will be greater than the market price of a house in a noisy location. The general hedonic price of housing is estimated as:

2.1 $P_i = f(S_i, C_i, Q_i, dyear_i)$

where, for house *i*, P is the house price, **S** = $S_{i1} \ldots S_{ij}$ is a vector of *j* structural characteristics, **C** = $C_{i1} \ldots C_{ik}$ is a vector of *k* local community characteristics, **Q** = $Q_{i1} \ldots Q_{im}$ is a vector of *m* environmental quality characteristics, and *dyear* is the dummy variable for year of sale. This estimation provides the marginal implicit price of each of the characteristics. For example, if Q_{i1} is the noise level, and $\partial P_i / \partial Q_{i1} < 0$, then an incremental increase in noise reduces the price of a house.

No theoretical justification defines the correct functional form for hedonic models, and previous studies have estimated a variety of forms including log-linear, semi-log, linear, and Box-Cox. In many cases, researchers have 'let the data determine the functional form' based on goodness of fit. However, this method has come under scrutiny of various forms.[48] As a result, this model adopts the most common form, semi-logarithmic, where the natural log of the housing price is a linear function of its characteristics, without empirically testing for functional form.

[48] Griliches (1971) points out that in cases where form is determined empirically, most researchers settle on a semi-logarithmic relationship. Butler (1982) adds that researchers who made these empirical comparisons, "by and large found little basis for choosing one form over another". Cassell and Mendelsohn (1985) have three additional criticisms of the method. First, the best-fitting criterion does not necessarily lead to more accurate estimates of characteristic prices. Second, the transformations required by Box-Cox result in complex estimates of slopes and elasticities that make policy analysis difficult (Palmquist, 1991 noted this as well). Third, the best-fit functional form may be inappropriate for the model's predictions.

Based on the general hedonic equation described in equation (1), the empirical models in this paper take the following form:

2.2 $$\ln(P_i) = \alpha_i + \beta_{it} S_{it} + \gamma_{it} C_{it} + \theta_{it} N_{it} + \varphi_{it} D_{it} + \sigma_{it} R_{it} + \sum_{k=1}^{21} \delta_k dYear_{k\,i} + \varepsilon_{it},$$

where i indexes the house, $\boldsymbol{S_{it}}$ is a vector of structural characteristics, $\boldsymbol{C_{it}}$ is a vector of local community characteristics, and $\boldsymbol{Q_{it}}$, the environmental quality variable, is subdivided into three variables relevant to this study ($\boldsymbol{N_{it}}$, $\boldsymbol{D_{it}}$, and $\boldsymbol{R_{it}}$), where $\boldsymbol{N_{it}}$ is a vector of noise level dummies, $\boldsymbol{D_{it}}$ is a vector of distance ring dummies, $\boldsymbol{R_{it}}$ is a vector of dummies for distance from the major routes to the airport. The dummy variable for the year of house sale, $dYear_{k,}$ controls for annual variations in overall real house prices. All prices, P_i, are adjusted to constant 2001 dollars using the Consumer Price Index. The time subscript, t refers not to the year that the house sold, but to the six time periods in the model, defined below.

In line with the change in focus from the *measurement* of the impact of an airport on the surrounding community to a *comparison* of two airport communities, one with an airport being located and another with an airport closing down, several important differences exist from the first chapter. First, as mentioned earlier, chapter one included variables for Noise, Distance, and Route for a single airport, the old airport. This model extends that by adding Distance and Route to the new airport variables. As mentioned earlier, adding Noise variables for the new airport is not necessary, as aircraft noise levels exceed 65 decibels for only a single house in the entire dataset. Second, the "Event" dummy variables now divide the data into six time periods based on the postulated significant events toward airport relocation that may influence Austin homebuyers and sellers. Also, as a refinement to the earlier model, the time periods are broken up by month, when appropriate, the better to capture the events. A summary of the Event dummy variables is given in Table 2.7.

Table 2.7 Explanation of Event Dummy Variables

Variable	*Dates*	*Definition*	*Number of Obs*
preVote	Jan 1980 – Nov 1987	House sold before vote passed to move airport to Manor location	787
preList	Dec 1987 – Jun 1991	House sold after Vote, but before BAFB was placed on the possible closure list; during this time City Council resolved to locate airport at Bergstrom location	977
preClose	Jul 1991 – Sept 1993	House sold after List, but before BAFB officially closed; during this time Base property reverted to City	1,361
preBuild	Oct 1993 – Nov 1994	House sold after Close, but before the groundbreaking ceremony held at Bergstrom location	805
preOpen	Dec 1994 – May 1999	House sold after Build, but before ABIA opened for passenger service and Mueller airport closed	7,107
Final	Jun 1999 – Jun 2001	House sold after airport re-location was complete	10,349

The first time period dummy, *preVote*, indicates that the house was sold *before* the November 1987 vote to re-locate the airport to the Manor location passed. During this time noise pollution from the old airport had existed for several decades; however, despite the efforts of neighborhood groups, a vote had not been passed to move the airport out of the city center. Because noise level and the number of aircraft using Mueller airport peaked in 1987, it was likely a turning point for the surrounding community. The passage of the vote may signify the noise level difference between a unique community characteristic and a true nuisance.[49] This time period serves as the pre-location decision equilibrium to which the other events can be compared, and, ultimately, is the basis for determining hysteresis.

The second time period dummy, *preList*, indicates that the house was sold after the vote to move the airport passed, but before Bergstrom Air Force Base was placed on the possible closure list. At this time, I assume that most residents believed the new airport was going to be built to the northeast of the city and not at its ultimate location on the former Base.[50] The third time period, *preClose*, indicates that the house sold after BAFB was placed on the possible closure list, but before it officially closed. During this time period, as mentioned in the Background section, a great deal of confusion and uncertainty existed as to the final location of the airport. The old airport continued to expand locally and land was being purchased at the Manor location, but most believed that if the Base closed, the airport would be re-located there.

The fourth time period, *preBuild*, indicates that a house sold after BAFB was placed on the official closure list, but before actual construction of the new airport began. During this time period most of the uncertainties resolved

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49 The neighborhood most affected by noise, but separated visually by the interstate highway, enjoyed a certain notoriety from the aircraft flying overhead. The 'Flight Path Café' is an example of a coffee house that capitalized on the neighborhood's unique characteristic.

50 However, the rumor that the Air Force Base would be placed on the possible closure list had been circulating for some time. Even if those concerned with the Base could already foresee its closure, it was largely unpublicized.

themselves. A vote passed to abandon the Manor location once and for all. In addition, a vote had previously passed to move the airport to the Bergstrom location if and when it did close.

The event *preOpen* indicates that a house sold after the groundbreaking ceremony at the former Air Force Base, but before the new airport opened. This is an interesting period, because while the question of the new airport location was resolved, aircraft noise still existed near the old airport. Therefore, if people have rational expectations, then anticipated noise around Bergstrom should reduce house prices there and the anticipated removal of noise around Mueller should raise house prices under the old noise contours, especially the noisiest areas.[51] In actuality, the housing market may not react quite so determinedly. Rational expectations about noise may well drive down house prices at the new airport location once the groundbreaking occurs, but the situation at the old airport is not as clear. In this period, not only are the residents still suffering from noise, but the fate of the old airport facility had not yet been determined. This uncertainty about what would replace the airport, including the uncertainty whether the noise would actually cease may cause mix reactions, or no reaction at all, in the housing market.[52] In practice, the rational expectation effects may be dampened if home buyers and sellers do not trust the City's airport relocation program to take effect as intended, or if they believe that the new use of the old airport facility will be worse than the noise nuisance was.

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[51] Both airports see development and infrastructure effects, though they should work in opposite directions: positive impacts at the new airport and negative impacts at the old airport.

[52] One option considered for the old facility was to keep it open as a second airport, similar to Love Field in Dallas.

The sixth and final time period, *Final*, indicates that the house sold after the new airport opened and the old airport closed. This period is the rebound period for the old airport, not in the rational expectations sense, but in the hysteretic sense. If the housing market fully and correctly anticipates all the changes near the old airport, then prices should rebound in the periods before its final closure. In the hysteretic sense, however, this Final period is the comparison state to the change in policy imposed on the old airport neighborhood. In the initial period the community house prices had adjusted to an equilibrium given the airport noise. In the following periods, the local government 'pushed' the system by imposing a series of policies to close the airport and open one in a new location. In this Final period, the effects of these policies 'release' and it is time to see if the house price system 'springs back completely' to the preVote equilibrium, or if the government policies have caused a permanent change. Negative impacts at the old airport this period of the model imply the presence of stigma - persistent negative effects from perceived negative environmental consequences, regardless of whether they actually exist.

2.5 SINGLE-DIFFERENCE MODEL

In this section, two forms of the single-difference model are run, a pooled model where only the environmental variables are interacted with the event dummies, and a six-equation model that allows the valuation of all house price determinants to vary over time. When using the semi-log form, the coefficient on a continuous variable is interpreted as the percentage impact on house price for an incremental change in the independent variable. However, the interpretation for the coefficient on a dummy variable is not as straightforward. As pointed-out by Halvorsen and Palmquist (1980) and Kennedy (1981), the percentage impact of a dummy variable on the dependent variable is measured by taking the inverse natural logarithm of the dummy coefficient and subtracting one.

The first issue to address is whether the house characteristics that are unrelated to the airport relocation remain constant over the six time periods in the model. The marginal value of a second bathroom or square foot of living space, adjusted for inflation, is not expected to vary greatly over a period of twenty years. However, the marginal value of living in a specific community may. Entirely unrelated to the location of the airport, certain communities grow in popularity while others fall into disrepair. The pooled data are used to test the hypothesis that the values of the structural and community variables do not change over time. If a pooled model is not subject to aggregation bias, then it can be used for estimation over all time periods with interaction terms for the environmental variables and the event dummies.

An F-test is defined to test whether all coefficients in equation (2.2) are equal across time (except the intercept, the environmental variables and the year dummies). The null hypothesis for the coefficients on the structural variables in equation (2.2) is:

$$\boldsymbol{H}_0: \quad \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 .$$

In accordance with equation (2.2), the *beta* indicates the coefficients for the vector of all structural variables and the subscript indicates the time period.

This hypothesis is tested jointly with the null hypothesis on the community variables:

$$\boldsymbol{H}_0 : \qquad \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6$$

where the *gamma* indicates the coefficients for the vector of all community variables and the subscript indicates the time period.

The F-test compares the residual sum of squares from the pooled model to the residual sum of squares from the six individual period equations estimated separately. The F-statistic value of 5.75 (81 restrictions, 21,206 degrees of freedom) indicates rejection of the null hypothesis that all structural and community coefficients were constant over the six time periods. Therefore, it is appropriate to use either six individual equations, one for each time period, or, since ample degrees of freedom exist, a full-interaction model that allows all coefficients to vary over time. The regression output for the pooled model is available upon request.

The regression diagnostics for the model are listed in Table 2.8. The R^2 statistics show goodness of fit and imply that between 60-75 percent of the variation in home sale price is explained by variations in the independent variable set. The F-statistics show that every regression as a whole is significantly different from zero at a very high confidence percentile.

Table 2.8 Diagnostic Statistics for Single Difference Models

	preVote	**preList**	**preClose**	**preBuild**	**preOpen**	**Final**
Adj R^2	0.6914	0.7500	0.6025	0.6284	0.7153	0.6364
F-stat	23.29	39.52	28.12	19.63	216.86	227.44
Prob F>0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

The full regression output for the six individual equations is available in Table G.1 in Appendix G. Taking the inverse natural log of the intercept for each time period gives the average price of a one-bathroom house with wood construction and located in zip code 78759, well outside of either airport location. The omitted year dummy depends on the time period; 1983 in the first, 1990 in the second, 1991 in the third, 1993 in the fourth, 1999 in the fifth, and 2000 in the last. The majority of the structural variables are significantly different from zero at the 10% level or better and show the expected sign. The value of a house rises with increases in the gross building area, additions of a second or third bathroom, fireplace, garage, pool, or in-house spa. The coefficients are negative on age, manufactured home, and percent of the census track listing "black" as ethnicity.

The regression results for the Noise variables are shown here in Table 2.9. Recall that the first noise dummy, *N6570*, indicates a house is located in the 65-70 dB noise contour of the old (Mueller) airport and the second noise dummy, *NGT70*, indicates that a house is located in a noise contour exceeding 70 dBs. Previous to breaking ground at the new airport, no significant differences exist between the price of houses at distant locations compared to those in a noise contour of the old airport. For the period of time it took to build the new airport, while the old was still functioning, house prices for properties in noise contours of the old airport are lower than other prices in Austin. However, once the new airport opened and noise ceased at the old airport, houses in a previous noise contour sold at a premium to other homes in Austin.

Table 2.9 Noise Results for Single Difference Model

	preVote	preList	preClose	preBuild	preOpen	Final
N6570	-0.0612	0.1174	0.0283	-0.2646	-0.0561	0.0456
	(-0.50)	(0.74)	(0.12)	(-1.64)	(-1.28)	(1.37)
NGT70	0.1576	0.0231	-0.0535	-0.1549	-0.2059	0.1113
	(0.86)	(0.09)	(-0.19)	(-0.59)	(-3.03)	(2.22)

Note. The first number is the regression coefficient. The t-statistics are in parentheses; an absolute value of at least 1.28 indicates significance at the 10% level.

The regression results for the Distance variables are shown in Table 2.10. The previous chapter found Distance to be neither strictly an amenity nor a disamenity, but its coefficient varied with different events and for different areas. Here again, distance from the old airport is important in that it is separately measurable from noise and may work either to increase or to decrease the negative impact that noise has on housing values in the area.

However, a clearer pattern appears when looking at the results for the new (ABIA) airport. These results show either no impact or a weakly negative impact of distance to the new airport on house values before the Air Force Base officially closed. Then, for the brief period when the Base was closed but building on the airport had not yet begun, the Distance coefficients were positive and significant. This rebound from the Base closure disappeared by the time the groundbreaking ceremony was held for the new airport, and the negative impact returned for the rest of the model period. This result implies that proximity to the new airport is a disamenity – one that was foreseen when building began and that persisted after the new airport was in full operation. This unexpected result sides with Espey and Lopez (2000) in the airport and hedonics literature and against Lipscomb (2330) and Tomkins, *et al*. (1988). [53]

Table 2.10 Distance Results for Single Difference Model

	preVote	**preList**	**preClose**	**preBuild**	**preOpen**	**Final**
MAdist1	0.2245	-0.2650	0.0495	0.3697	-0.0005	-0.1012
	(0.91)	(-0.81)	(0.14)	(1.13)	(-0.01)	(-1.57)
MAdist2	0.2005	-0.4396	-0.2151	0.1399	0.0672	0.0655
	(0.97)	(-1.57)	(-0.86)	(0.55)	(1.09)	(1.31)
MAdist3	0.3642	-0.3766	-0.0839	-0.0820	-0.0058	0.0480
	(1.65)	(-1.45)	(-0.35)	(-0.34)	(-0.10)	(0.99)
MAdist4	-0.3045	-0.3241	-0.0053	-0.0539	-0.1009	-0.0374
	(-1.68)	(-1.34)	(-0.02)	(-0.24)	(-1.90)	(-0.90)
MAdist5	-0.0511	-0.1512	-0.0206	-0.0468	-0.0339	0.0298
	(-0.32)	(-0.87)	(-0.14)	(-0.27)	(-0.79)	(0.86)
MAdist6	0.0850	0.1018	0.0141	0.0489	0.1196	0.0290
	(0.96)	(1.25)	(0.17)	(0.59)	(4.84)	(1.25)
ABIAdist1	-	-	-0.7911	-	-0.0029	-0.3224
			(-1.54)		(-0.01)	(-1.67)
ABIAdist2	-	-0.1927	-0.5403	-	-0.2407	-0.4097
		(-0.45)	(-1.29)		(-2.39)	(-4.56)
ABIAdist3	0.0512	-0.0918	0.1323	0.4368	-0.0677	-0.0994
	(0.16)	(-0.49)	(0.63)	(1.09)	(-1.06)	(-1.63)
ABIAdist4	-0.2057	-0.0793	0.0050	0.5285	-0.1361	-0.1001
	(-1.43)	(-0.61)	(0.03)	(3.11)	(-3.24)	(-2.69)
ABIAdist5	-0.1210	-0.0442	-0.0429	0.2152	-0.0489	-0.0964
	(-0.99)	(-0.42)	(-0.34)	(1.52)	(-1.51)	(-3.40)

Note. The first number is the regression coefficient. The t-statistics are in parentheses; an absolute value of at least 1.28 indicates significance at the 10% level.

The regression results for the Route variables are shown in Table 2.11. The first thing that stands out is that the coefficients for the old airport (ManorRd)

[53] Espey and Lopez (2000) find that noise is a disamenity, but even controlling for it, proximity to the airport also decreases the value of a house. Tomkins et al (1998) find the opposite; not only is proximity an amenity, but that the benefits of travel access and increased infrastructure outweigh the costs of noise.

and the new airport (ABIAroute) are opposite in sign. Second, the valuation of being on the route to an airport changes from a disamenity to an amenity. For Mueller Airport, the coefficients on Route are initially negative but after the vote passed to close the facility, these house values are higher in comparison to others in Austin. This indicates a negative impact on real estate bordering the route to the old airport in the early periods.[54] In the intervening years when much confusion existed, no significant difference is detected from being on the route to the old airport. Once it became certain that Mueller Airport would close, however, the Route coefficients for this airport are significant and negative, indicating home owners see no advantage, and in fact are being hurt, from being on the route to a vacated facility.

For Bergstrom, initially when the Air Force Base was operating, being on the route to this facility is an amenity. This advantage disappears even before BAFB was placed on the possible closure list. Similar to the old airport communities, home owners on the route to Bergstom see no impact on house values in the intervening years, but once construction began, the coefficients are significant and positive.

[54] The negative and significant coefficients on Route to the old airport in the pre-period are inconsistent with the other Route results in this model, but are robust to various specifications and time delineations in the model form. A correlation coefficient matrix among the environmental variables in the preVote period found no statistically significant multicollinearity, though the correlation coefficients between the second distance ring and both ManorRd variables are relatively high (0.4713 and 0.3939). Because the preVote period occurs at least 15 years before this model was run, it is quite likely that some quality particular to the houses along Manor Road in this time period is simply not included in the model (for example construction or crime).

Table 2.11 Route Results for Single-Difference Model

	preVote	preList	preClose	preBuild	preOpen	Final
ManorRd2	-0.2077	0.2885	0.0201	-0.0485	-0.2126	-0.1434
	(-1.26)	(1.55)	(0.07)	(-0.14)	(-3.54)	(-2.85)
ManorRd3	-0.2924	0.2049	0.4122	-0.0369	-0.1375	-0.0786
	(-1.85)	(1.44)	(2.32)	(-0.19)	(-3.19)	(-2.25)
ABIAroute2	0.3758	0.0344	-0.1483	0.0799	0.0528	0.0177
	(2.41)	(0.22)	(-0.84)	(-0.84)	(1.24)	(0.49)
ABIAroute3	0.1585	-0.0258	-0.0940	-0.0773	0.0378	0.0563
	(1.44)	(-0.29)	(-0.85)	(-0.67)	(1.35)	(2.28)

Note. The first number is the regression coefficient. The t-statistics are in parentheses; an absolute value of at least 1.28 indicates significance at the 10% level.

2.6 DIFFERENCE-IN-DIFFERENCES MODEL

The benefit to running the hedonic model as six independent equations is that without having to include any dummy interaction terms, all variables to describe house prices are able to vary across time. This specification is parsimonious in terms of model size and, hence, computational time and ease. However, the difficulty that arises with independent regressions is in comparing the coefficients across time, because the coefficients for each period are independent from the other periods. It is impossible to look just at the coefficients and know if they are significantly different from each other, since they were produced from different regressions using different data. When the model is run with a separate equation for each of the six time periods, in each period a house in a noise contour is compared only to a house that is *not* in a noisy area, and not to the same house in every period (single-difference).

The implication from the first three independent regressions is that houses under noise contours sell for the same prices as houses in quiet locations, all else equal, but this does not necessarily mean that noise has no impact because it fails to capture any differences across time. In fact, the sharp increase in house prices under the old airport's noise contours in the Final period imply that houses affected by low-level noise have another characteristic that makes them worth more than other houses in that time period. Therefore, the difference-in-differences model isolates the effects of Noise by comparing the difference for houses in noise contours from the first period to the last period to the difference for all houses in Austin from the first to the last periods. In this way it is possible to see if the houses in the former noise contours increase more than similar houses elsewhere.

2.6.1 Empirical Model

The underlying model of the difference-in-differences approach used here is based on Meyer (1995). The variables are separated into three groups: treatment, control, and event groups. Variables in the treatment groups indicate that a house is affected by noise, distance, or route during the airport relocation. Variables in the control group indicate the set of houses that are away from both airports. Variables in the event groups indicate the six time periods. Therefore, the estimated coefficients on the treatment variables captures the time-invariant difference in the overall means between the houses affected by the airport relocation and the rest of Austin, and the coefficients on the event groups captures the way the treatment variables are influenced by time. The control group is implicitly represented by the intercept. When the treatment and event groups are interacted, the estimated coefficient gives the true causal price effect of selling during a given time period for a house in a noise contour, distance contour, or along the route to an airport. Equation (2.3) extends Equation (2.2) to include the six Event dummy variables and the interaction terms between the Event and treatment (Noise, Distance, Route) variables.

2.3
$$\ln(P_i) = \alpha_i + \beta_i S_i + \gamma_i C_i + \theta_i N_i + \varphi_i D_i + \sigma_i R_i + \sum_{k=1}^{21} \delta_k dYear_{ki} + \sum_{l=1}^{6} \phi_l dEvent_{li} + \sum_{l=1}^{6} \rho_{li} N_i * dEvent_{li} + \sum_{l=1}^{6} \upsilon_{li} D_i * dEvent_{li} + \sum_{l=1}^{6} \omega_{li} R_i * dEvent_{li} + \varepsilon_i$$

In the estimation results, the coefficients θ, φ, and σ are the time-invariant single difference effects of Noise, Distance, Route, and ρ, υ, and ω are the double-difference effects of each environmental variable for the time period specified. Because these double-difference variables are dummies, one of the group must be left-out to avoid over-specification and to act as the comparison time period for the double-difference effect. In the case of the old airport, the left-out dummy variables are the interaction terms with the preVote period. This means that all the double-difference comparisons are of houses in the specified later time period with the initial period (when no official plans to re-locate the airport existed).

The vote to move the airport away from the Mueller location is not particularly meaningful for the new airport, because at that time Bergstrom Air Force Base (BAFB) was still an active military base and the anticipated location of the new airport was the Manor location. The preList period is more meaningful for the new airport because this is the time period right before BAFB was placed on the closure list, which signaled the change in policy. Therefore, for the new airport, the left-out dummy variables are the interaction terms with the preList period.

2.6.2 Results

The regression results for the treatment and event variables in difference-in-differences model are given in Tables 2.12 and 2.13. The other structural, community, and year of sale variables turned out as would be predicted based on other hedonic studies; the estimated coefficients are listed in Table G.2. Gross building area, total land area, second and third bathrooms, pools, spas, garages all have a significant and positive effect on house prices. Manufactured homes have significant and large in magnitude negative impact on house price, whereas brick and masonry have significant positive effects compared to the left-out wood and brick home. The education and racial community characteristics are significant, with houses in neighborhoods that are predominantly white and neighborhoods with highly educated residents selling at higher prices. Almost all of the community classifications by zip code are significant and both positive and negative, showing variation across Austin neighborhoods. The year dummy variables also turn out as expected as well. Compared to the left-out year, 1990, which is the slowest year for house prices and house sales according to MLS data, most other years have significant positive coefficients, with the exception of some non-significant differences in the early 1990s. As would be predicted by the high-tech housing boom, the years 1999 through 2001 have large, positive, and significant coefficients. The R^2 statistic implies that two-thirds of the variation in home sale price is explained by variations in the independent variable set. The F-statistics show that the regression as a whole is significantly different from zero at very high confidence percentiles.

Table 2.12 Double-Difference Estimates for *Old Airport* Variables

Variable	Single	preList	preClose	preBuild	preOpen	Final
N65-70	-0.0244	0.1390	-0.1601	-0.2635	0.0554	0.0105
	(-0.19)	(0.70)	(-0.81)	(-1.48)	(0.40)	(0.08)
NGT70	0.1399	-0.2670	-0.5154	-0.0867	-0.2237	-0.0914
	(0.68)	(-0.91)	(-1.86)	(-0.30)	(-1.03)	(-0.43)
MAdist1	0.1132	-0.3329	-0.1960	-0.2817	-0.1877	-0.1395
	(0.77)	(-1.35)	(-0.92)	(-1.15)	(-1.24)	(-0.94)
MAdist2	-0.1403	-0.1258	0.0803	0.1317	0.1489	0.2547
	(-1.27)	(-0.82)	(0.52)	(0.78)	(1.33)	(2.33)
MAdist3	-0.0518	-0.1925	0.0344	-0.1206	0.0083	0.1393
	(-0.36)	(-1.09)	(0.20)	(-0.70)	(0.06)	(0.98)
MAdist4	-0.2509	0.1117	0.3119	0.1656	0.1052	0.2469
	(-2.25)	(0.70)	(2.05)	(1.00)	(0.92)	(2.22)
MAdist5	-0.2313	0.0897	0.1801	0.1625	0.1391	0.3116
	(-2.43)	(0.69)	(1.63)	(1.29)	(1.45)	(3.29)
MAdist6	0.0851	-0.1583	-0.1533	-0.1196	0.0203	-0.0210
	(1.09)	(-1.56)	(-1.70)	(-1.22)	(0.25)	(-0.27)
ManorRd2	0.2846	-0.1490	-0.6760	-0.4772	-0.3973	-0.4517
	(2.09)	(-0.73)	(-2.95)	(-1.78)	(-2.76)	(-3.22)
ManorRd3	0.1932	-0.0143	-0.3027	-0.2933	-0.2395	-0.3062
	(1.94)	(-0.10)	(-2.27)	(-2.05)	(-2.33)	(-3.05)

Note. The first number is the regression coefficient. The t-statistics are in parentheses; an absolute value of at least 1.28 indicates significance at the 10% level.

Greater precision in describing the impact of re-locating Austin's airport is derived from combining these double-difference results with those from the six independent regressions. The six independent regressions are single-difference estimates because they look at the differences between the treatment and control variables within a single time period. The "*Single*" coefficients from the difference-in-differences estimations in this section are time-invariant single-difference estimates because they look at the difference between the treatment and control groups as if the entire model consisted of only one time period. The double-difference estimates, on the other hand, look at the difference between the treatment and control groups while controlling for house prices changes in each time period for Austin as a whole.

Table 2.13. Double-Difference Estimates for *New Airport* Variables

Variable	Single	preVote	preClose	preBuild	preOpen	Final
ABIAdist1	0.1143	-	-0.7683	-	-	-0.4349
	(0.41)		(-1.62)			(-1.39)
ABIAdist2	0.1064	-	-0.8244	-1.3736	-0.435	-0.4982
	(0.28)		(-1.77)	(-2.53)	(-1.07)	(-1.29)
ABIAdist3	0.03483	0.1064	-0.0362	-0.1928	-0.0871	-0.1501
	(0.22)	(0.36)	(-0.18)	(-0.48)	(-0.53)	(-0.93)
ABIAdist4	-0.0729	0.0761	0.0124	-0.0313	-0.0421	-0.0026
	(-1.00)	(0.79)	(0.13)	(-0.29)	(-0.58)	(-0.04)
ABIAdist5	-0.1479	0.1718	0.0242	-0.1165	0.0603	0.1045
	(-2.30)	(2.00)	(0.30)	(-1.21)	(0.93)	(1.65)
ABIAroute2	-0.0398	0.0269	0.0075	0.2428	0.0401	0.0815
	(-0.29)	(0.15)	(0.04)	(1.38)	(0.28)	(0.59)
ABIAroute3	-0.1492	-0.0310	0.0648	0.1175	0.1501	0.2255
	(-2.09)	(-0.31)	(0.71)	(1.14)	(2.04)	(3.13)

Note. The first number is the regression coefficient. The t-statistics are in parentheses; an absolute value of at least 1.28 indicates significance at the 10% level.

2.6.3 Hysteresis

As stated in the introduction, hysteresis is first used as a measure of whether the impacts of an airport on house prices disappear after the airport is removed, or if the house values continue to reflect the old regime. The empirical tests for hystersis are implicitly calculated in the difference-in-differences estimates. A statistically insignificant coefficient on the Final double-difference implies that no hysteresis exists. Either a positive or a negative statistically significant coefficient implies that some permanent change is imposed by the policy.

Looking at hysteresis this way, the question can be explored at both airport locations. For Mueller, house values before the vote to relocate the airport ever passed are compared to house values after the facility closed. But an airport also closed at Bergstrom. In the first two periods the Air Force Base was operating military jet flights, but in the third period residents knew that the Base was going to be closed. [55] In the following period, the military facility was actually closed down. Unlike the Mueller airport, which had yet to be converted to a new use in the model period, Bergstrom was converted to a private facility in the last periods. This section explores the effects of airport closure under two different regimes, when one is left vacant and another is rehabilitated into a new facility.

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[55] In August 1990 (still in the preList period), an article in the local paper ran that argued that closed military bases could be economic assets to their communities. The article stated that of the one hundred bases closed by the Pentagon between 1961 and 1986, forty-two had become municipal airports. Ray Reece, the coordinator of the "Move it to Bergstrom" organization, was quoted as saying that, in Austin moving the airport to Bergstrom would both save money and have a beneficial effect on the former Base's neighbors due to the reduction in noise from the military jets. He went on to say that communities near Bergstrom would "realize enormous economic development benefits" from "increased property values in the vicinity of a Bergstrom airport and from commercial and industrial development related to such a facility".

Mueller Airport

The double-difference coefficients for the old airport Noise variables finds that the vote to move the airport had no significant impact on houses prices, relative to other houses, but that the market reacted to the intermediate announcements of the closure with significant price drops. In the end, the Final period estimate reveals that once the old airport closed, the prices for houses under the noise contours returned to their initial preVote levels, controlling for house price changes in Austin as whole. Not surprisingly then, the time-invariant single-difference coefficients for Noise are not significantly different from zero. Altogether these estimates show that the price jump in the Final period of the within-period single-difference model is due to the recovery of the houses in noise contours from the intermediate drops, and not from the initial condition.

Therefore, even though house prices within the old airport noise contours did not increase relative to all other houses when the old airport closed, at least no permanent stigma effect remained either. All the negative effects on house price resulting from the policy change disappear in the Final period. This is not to say that re-locating the urban airport did not have costs to those people who lived beneath the noise contours. Indeed, those who owned homes in noise contours of the old airport who sold at depressed values starting in 1991, potentially lost up to 40% of the house value that could have been recovered by selling eight to ten years later.

Several of the double-difference coefficients for the old airport Distance contours are positive and significantly different from zero in the Final period.

This implies that after the airport relocated, these houses very close to the airport not only rebounded from the policy developments that may have depressed their values, but also potentially rebounded from the original negative impacts of the airport on the surrounding community. The Distance variables often have significant, but negative single-difference coefficients. This implies that the time-invariant effects of Distance are negative in this model. Looking, however, at the independent regression model, the Distance variables in the Final period are only significantly different from zero in the first two rings. For the closest one-half mile, the rebound effects in the Final period went back to their preVote levels, but houses in that ring still sell at lower prices than the rest of Austin. The next closest one-half mile fares much better. The single-difference coefficient implies that this Distance ring experiences a negative time-invariant impact, but the independent regression finds house prices almost 7% above those in the rest of Austin. Therefore, the 28% increase in house price implied by the double-difference coefficient in the Final period reflects both the rebound from the intermediate decreases and the preVote depressed prices. Distances further out show a similar pattern from preVote to Final, but do not have price premiums compared to similar houses elsewhere.

While the impacts of Noise appear to have no permanent effects on house price after the old airport closed and the impacts of Distance rebound in the Final period, in the end, the impacts of Route to a now-vacated facility reflect a loss to nearby homeowners. The single difference, time-invariant, effects of being on the Route to the old airport are positive and significant, but the independent single period models reveal that the driving force behind this positive impact are the large positive coefficients in the preList and preClose periods. By the last two periods, the single-period estimates are negative and significant. The double-difference coefficients reveal this negative impact is not only significant within the period, but also significantly lower than the prices in the pre-period before the re-location policy began to take effect.

Therefore, in the case of an airport closing without a new use for the facility established, hysteresis exists, though whether this final effect is positive or negative will depend on the number and value of houses in the Distance contours as opposed to the Route contours. This is explored further in Section 2.7.

Bergstrom

The hysteresis effects at Bergstrom Air Force Base are subtler because the effects of interest are in the intervening years between the municipal airport re-location. When Bergstrom was operating as a military airport, all the houses affected by Noise were owned by the Base and therefore not captured in the housing sales data. Many of the houses in the closest Distance contour were also government property, though these homes were auctioned off when the land reverted back to the City of Austin, and may subsequently be part of the data set in post-Close periods. Similar to Noise, the Route variables are not as relevant to the Air Force Base as the Distance variables. This is because before 1999, the vehicle traffic was much lighter due to the significantly smaller population who used the Base, compared to its use as the municipal airport. Therefore, the initial equilibrium period for BAFB is preList, the period before the Base was put on the government list of military base closures. The clean-up period includes preClose and preBuild, the periods after it was clear that the Base would be closed, but before any new construction had begun. Finally, the rebound period is preOpen, when the plans for the new airport were final and the conversion to a civilian facility were begun.

The double-difference coefficients for the Distance contours comparing the initial period with the clean-up period are either unable to be estimated because of the absence of houses sold, or significant and negative. In fact, the negative double-difference coefficients are the largest, in absolute value, of any coefficients in the model, implying that the closure of the Air Force Base is a significant disamenity for the houses closest to the facility, compared to the period when the Base was still operating. However, after construction began on renovating the facility for a new use, the coefficients on the closest contours are no longer significant. Thus, building the new airport may partially compensate for the removal of the Air Force Base. In the Final period, the double-difference coefficients for Distance are significant and negative, reflecting the new airport disamenity effects. However, these disamenity effects are much smaller than the disamenity effects associated with uncertain period after the Base closed and before the new airport was built.

The time-invariant comparisons of houses on the Route to the new airport to all others in Austin are significant and negative or not significantly different from zero. The double-difference coefficients show that in the early periods, before BAFB was officially closed, no significant difference exists for houses along the route to the hypothetical new airport from the initial period. Once the Base closed and it appeared that it would be the site of the new airport in Austin, being on the route to this airport has a positive, significant effect on house prices, in every subsequent period, above what it was in the preList period.

Not surprisingly, the double-difference coefficients for the preVote period are not significantly different from zero for all but one Route variable at the new airport. For the new airport the preVote and preList periods together make up the initial period: before a government policy, the listing of BAFB for closure, was announced. Therefore, in the absence of any policy change between these two periods and controlling for other yearly fluctuations in house prices, no price changes for houses on the route to the new airport or in a distance ring would be expected.

These results show that the values of single-family homes are dependent on the current use and characteristics of the surrounding areas, and also depend upon the former uses of the land. The housing market in Austin reveals that the absence of a former amenity (in this case, easy access to airline travel) causes a depression in house values that could potentially be lessened if another perceived amenity takes its place.

2.7 Measurements of Home Values Net Gain

In most noxious facility siting decisions, some neighborhoods bear the burden of the facility enjoyed by all. In the case of Austin's airport re-location, the previous sections found that removing the old facility causes a rebound in house prices at the closest distances, but also causes large decreases for houses that used to have easy access to the airport but are now on the route to a vacant site. Building the new airport also had both amenity and disamenity effects – houses very near the new facility lost value compared to the pre-period, but those on the route to the airport gained quite significantly. Given these diverse reactions, the hysteresis question here is whether the closing of the old airport had the equal and opposite effect of building the new airport to homeowners near the facilities. To answer this question, a measure of net gain was developed to sum the gains and losses in house values near both airports, including all time periods after the policy was proposed. Including all time periods measures both the winners and the losers in the airport relocation, as well as those who may have ended up exactly even by holding onto their property for the entire time period.

The measure of house value net gain employs the estimated treatment variable coefficients that are significant at a 10% level or better from the double-difference model. These coefficients are manipulated to provide the percent change on a house price, and then multiplied by the value of each house that was impacted. These changes in house prices are summed over each environmental variable, and then the old airport sum is compared to the new airport sum. Once the measure of net gain is developed for the houses in the data set, the sample is weighted to account for the fact that 115,927 total houses are impacted by the airport move, but the data sample only contains the 10,107 that sold. Equation (2.4) describes this model for each airport:

$$\text{Gain} = \text{sum}(\%\Delta N) \times (\text{value of house}_N) + \text{sum}(\%\Delta D) \times (\text{value of house}_D) + \text{sum}(\%\Delta R) \times (\text{value of house}_R) \tag{2.4}$$

where N indicates a house is under an aircraft noise contour, D indicates a house is within one of the distance rings of an airport, and R indicates a house located on the route to an airport. The results of the internal summations are reported in Table 2.14 for the old airport and in Table 2.15 for the new.

Table 2.14 Dollar Value of Environmental Impacts at Old Airport

	preList	**preClose**	**preBuild**	**preOpen**	**Final**
N6570	0	0	-246,620	0	0
NGT70	0	-134,016	0	-550,211	0
Madist1	-93,269	0	-78,743	-1,181,686	0
Madist2	0	0	0	3,387,677	18,026,075
Madist3	-168,538	0	0	0	0
Madist4	0	515,091	166,118	0	11,658,072
Madist5	0	804,826	502,207	3,972,012	23,512,431
MAdist6	-618,670	-1,278,327	-639,113	0	0
ManorRd2	0	-102,616	-62,265	-1,857,143	-5,985,595
ManorRd3	0	-649,613	-388,605	-5,101,586	-15,491,769
Total	-\$880,477	-\$844,653	-\$747,020	-\$1,330,936	\$31,719,214

Table 2.15 Dollar Value of Environmental Impacts at New Airport

	preVote	**preClose**	**PreBuild**	**preOpen**	**Final**
ABIAdist1	-	-13,472	-	-	-153,270
ABIAdist2	-	-22,475	-	-385,232	-883,636
ABIAdist3	0	0	-16,064	0	0
ABIAroute2	0	0	722,436	0	0
ABIAroute3	0	0	625,302	9,273,713	40,844,002
Total	\$0	-\$35,947	\$1,331,674	\$9,025,025	\$39,807,096

Again, these tables include values only for houses that sold after the vote to move the airport passed, signaling the imposition of the new policy to move the airport. The measure of net gain for the houses in the sample impacted by the old airport is $27,916,129; therefore, the rebound effects for the Distance variables in the last period outweighed the negative impacts from the Noise and Route variables in the periods after the airport closure was passed. The measure of net gain for houses in the sample impacted by the new airport is $50,127,849; therefore, the amenity effects for houses that now have easy access to the new airport outweighed the depression of house prices located very near the new facility. Together, the realized net effect of relocating the airport to homeowners near the two airports is $78,043,978. Adding the normal distributions of the error terms for each of the environmental variables gives a 95% confidence interval between $25,150,569 and $141,561,449.

What this measure does not take into account is that the gain or loss of moving the airport affects more than just the houses that sold during the period, it affects all houses existing in the airport neighborhoods. The capital gain or loss does not need to be realized to be a gain or a loss. Not all houses in Austin are included in the study. In fact, in the least well-represented neighborhood, only 0.5% of the houses that exist actual sold during the time period and ended up in the data set. Therefore, the approximate the net gain for *all* houses is found by multiplying the estimated coefficient for each environmental variable times the average value of the houses sold in each environmental category, times the total number of houses that actually exist in each category. The house address for all single-family residences in Austin was downloaded from the City of Austin and geo-mapped onto the same reference map as the environmental variables. From this map, it is possible to calculate how many houses are within each noise contour at Mueller Airport, how many within each of the distance rings of both airports, and how many are within the quarter and half mile delineations of the routes to both airports. Table 2.16 gives the number of houses that sold and that exist in each category.

To get the average price of houses to multiply by the number of houses, the data were subdivided into categories first by time period and then by environmental variable. Within these categories, the average house price was found and applied to the net gain calculation. The new net gain calculations adjusted to capture more accurately the capital gains and losses to all houses in Austin are shown in Tables 2.17 and 2.18.

Table 2.16 Number of Houses Sold vs Number of Houses Existing in Austin

Environmental Variable	Number of houses sold	Number of houses existing	Percent of houses in data set
NLT65	377	4,178	9.0%
NGT70	143	1,841	7.8%
MAdist1	247	2,450	10.1%
MAdist2	755	7,150	10.6%
MAdist3	535	7,250	7.4%
MAdist4	514	7,720	6.7%
MAdist5	665	9,568	7.0%
MAdist6	1,060	10,727	9.9%
ManorRd2	238	2,950	8.1%
ManorRd3	863	3,024	28.5%
ABIAroute2	503	9,412	5.3%
ABIAroute3	1,862	10,283	18.1%
ABIAdist1	8	1,678	0.5%
ABIAdist2	62	3,455	1.8%
ABIAdist3	136	3,323	4.1%
ABIAdist4	852	12,306	6.9%
ABIAdist5	1,287	18,612	6.9%

Table 2.17 Dollar Value of Environmental Impacts at Old Airport – Weighted for Sample Size

	preList	**preClose**	**preBuild**	**preOpen**	**Final**
N6570	0	0	-55,705,707	0	0
NGT70	0	-41,120,335	0	-32,026,448	0
MAdist1	-45,702,033	0	-38,584,020	-39,123,469	0
MAdist2	0	0	0	111,109,737	294,261,723
MAdist3	-83,982,305	0	0	0	0
MAdist4	0	220,915,720	116,584,708	0	9,389,450
MAdist5	0	192,514,734	228,814,605	170,422,124	650,192,397
MAdist6	-218,885,401	-201,656,270	-167,212,752	0	0
ManorRd2	0	-60,543,740	-79,456,671	-88,815,951	-151,603,652
ManorRd3	0	-56,126,786	-58,171,038	-50,510,727	-109,648,545
Total	-$348,569,739	$53,983,322	-$53,730,874	$71,055,266	$972,591,374

Table 2.18 Dollar Value of Environmental Impacts at New Airport – Weighted for Sample Size

	preVote	**preClose**	**preBuild**	**preOpen**	**Final**
ABIAdist1	-	-22,606,022	-	-	-51,437,628
ABIAdist2	-	-38,828,139	-55,500,432	-57,868,443	-87,227,306
ABIAdist3	0	0	0	0	0
ABIAroute2	0	0	399,975,705	0	0
ABIAroute3	0	0	121,320,108	173,070,074	393,256,517
Total	$0	-$61,434,061	$521,295,813	$115,201,631	$254,591,583

The adjusted measure of net gain for the houses impacted by the old airport is $695,329,350. The adjusted measure of net gain for houses impacted by the new airport is $829,654,966. Therefore, the net effect of relocating the airport to homeowners near the two airports is just over $1.5 billion. Adding the normal distributions of the error terms, the 95% confidence interval is between negative $539,367,290 and positive $3,454,220,189. These new values account for the fact that 115,927 total houses are impacted by the airport move, but the data sample only contains the 10,107 that sold. They reflect the fact only about half as many houses lie either within the first three miles or on the route to the new airport than live within the first three miles, or on a noise contour, or on the route to the old airport (56,858 for MA and 27,943 for ABIA). However, the impact is larger at the new airport because very few houses lie within the first two miles of the new airport where house prices tumbled the most and many houses lie in the route to the new airport where house prices climbed the most. The confidence interval in this estimation is quite wide and even encompasses zero, whereas the calculation of net gain for the houses that actually sold remained positive. This is because the scarcity of houses near the new airport produced very noisy estimates of the effects of proximity to the new airport on house values; hence the largest variances in the estimated coefficients are also the largest negative coefficients. These noisy estimates widen the confidence intervals substantially, but in reality are unlikely to be the driving influence in the airport costs and benefits because of the very small number of houses affected.

This calculation of net gain does not reflect a full cost-benefit analysis of changing the airport's location; it is an illustrative example of the costs and benefits of the airport that are capitalized into house values. Specifically, it does not include a measure for benefits from having services of a new, larger airport, or the change in costs from the changes in travel time to the new airport, or the construction and relocation costs to the city, or even a calculation of the number of jobs lost or gained in the city. In addition, this calculation is specific to privately owned residential property and does not include the gains and losses to owners of vacant and commercial land.[56] Instead, this calculation looks at the imposition on private homes that bear the burden or enjoy the benefit of a public good enjoyed by the entire city. Because the City as a whole passed a vote to build a larger airport in a new location, it is assumed that the majority of Austinites believed the construction and development costs of building the new airport would be outweighed by having access to the new facility.[57] This

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[56] Because the dummy variables for properties that border the routes to the airports and those that are within a half-mile to the routes move together, it is likely that these coefficients would be similar to estimates for vacant and commercial property. The extension of the noise and distance coefficients to vacant and commercial property is not as clear.

[57] The ABIA website does not state outright the costs for the airport relocation and new facility construction. It does list the construction budget, approximately $585 million, and states the about

calculation does reflect that the estimated benefits of moving the airport outweighed the estimated costs to homeowners near both airports, and in net, lessened the overall burden homeowners bear for air travel in Austin.

2.8 CONCLUSIONS

In the case of Austin, the placement of an airport downtown gave rise to both positive and negative aspects. Aircraft noise is a disamenity that caused house price fluctuations around the policy announcements but did not permanently stigmatize neighborhoods. Proximity to the airport also causes house price decreases, possibly due to visual, safety, or traffic impacts, though these decreases disappeared when the airport relocated. On the other hand, access to an airport, as measured by location of a house within one-half mile of a major route to an airport, is an amenity. However, this amenity does not remain after the airport closed, implying that the development effects relied on the airport and are not sustainable in the face of uncertain future uses of the facility.

Previous literature finds similar effects from noise on residential property values, particularly Tomkins *et al*. (1998) who find that noise has a negative impact on house price, but the impact does not outweigh the other benefits of airports (and is sensitive to the way in which noise values are measured). However, Tomkins *et a*l. also find that proximity to the airport was an amenity, which this study does not. In this regard, the results are more similar to Espey and Lopez (2000) who find that proximity is a disamenity, even after controlling

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one-quarter of this was funded by the FAA. www.ci.austin.tx.us/austinairport/projsumnr.htm This additional construction cost information reduces the net gain to under $1 billion.

for noise. Neither of these papers have a separate control variable for access to the airport, which may explain the difference in their findings. This analysis found that access to the airport is a significant determinate of house prices around airports. Proximity to the airport can be a proxy for access, but if physical distance does not approximate travel time, proximity can also be a proxy for how closely associated a neighborhood is with the noxious facility nature of airports. This study makes the distinction between being close to the airport (Distance) and short travel times (Route), which may explain the results that adopt some characteristics from each of these previous studies.

This study also found that house prices depend on the history of community, instead of relying only on the current characteristics of the neighborhood. This implies that local government policy has implications beyond the current agenda. The benefits from projects designed to attract business and development may only last as long as the project lasts, and will transfer to the next 'hot spot' when policies change. On the other hand, this model shows that noxious facility sitings do not always permanently stigmatize a neighborhood. The housing market failed to have perfectly rational expectations throughout the airport move, giving rise to both windfall gains and losses to buyers and sellers over the twenty-year model period. Homeowners who sold property near the old airport or in a noise contour in the intermediate periods lost the most even though these prices rebounded by the final period. This has implications for local governments and planners as well. As noted by Kiel and McClain (1996), "keeping the period of uncertainty short is clearly advantageous, since the shorter the time period, the smaller the social costs become relative to the development costs" (1357).

The geo-mapping capabilities used in this research provide for more accurate classifications of houses into environmental categories, which in turn provides more accurate estimates of the differing impacts a government policy can have. The next step in this research is to use the geo-mapping capabilities that match Census data to the house that sold in order to determine if the gains and losses associated with the airport re-location are evenly distributed among demographic groups.

Figure 2.1 Map of Austin's Airports and Noise Contours

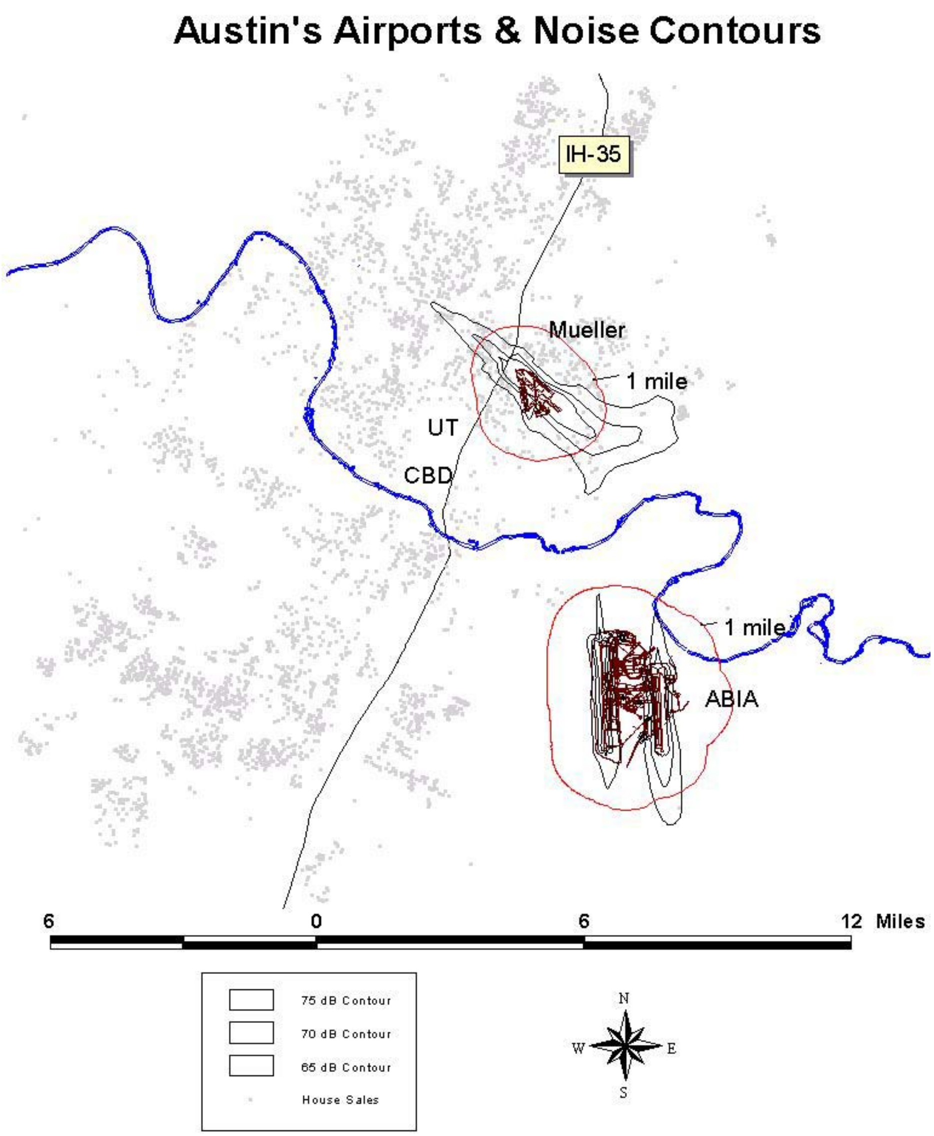
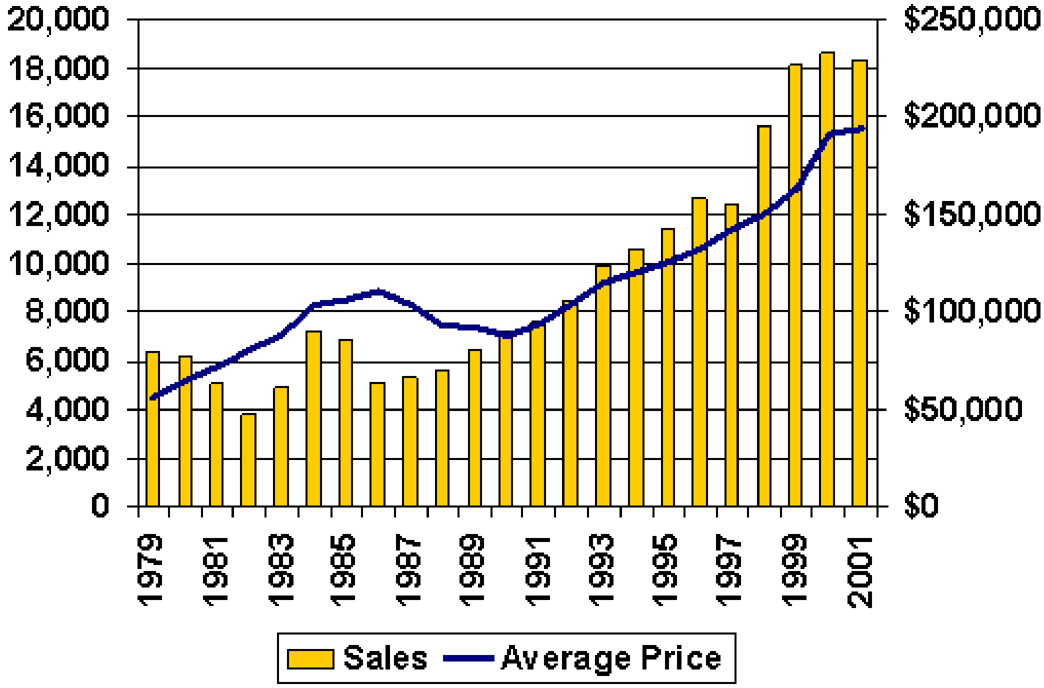


Figure 2.2 Austin MLS Residential Housing Sales



*Average house prices are *not* CPI-adjusted.

This data is provided by the Real Estate Center at Texas A & M University, http://recenter.tamu.edu/data/hs/hs140a.htm

Chapter Three: House Price Gains and Losses: An illustration of environmental justice in a noxious facility relocation decision

3.1 INTRODUCTION

When the City of Austin relocated the municipal airport from its downtown location to a new facility on the outskirts of town environmental justice concerns were raised because both neighborhoods were home to large minority and lower income populations. At the outset of the move it was unclear whether the airport served as an amenity or a disamenity and whether the overall benefits from building a new facility would benefit a different group than those who would bear the burden. This study, in combination with earlier hedonic analysis on the Austin airport move, shows that overall the movement of the airport caused gains to homeowners in the surrounding communities. This is true for both the new and the old airport communities and generally true across income and ethnic groups. While lower-income and racial minority groups bore larger variance in house price fluctuations over model period, they also saw the largest positive percent changes in average house prices. In general, it can be said that the same groups that bear the burden also received the benefits and that the benefits outweighed the losses.

The U.S. EPA defines environmental justice as “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."[58] In this paper, the focus is on the first half of the definition, measuring the extent of fair treatment in a local government policy decision, evaluating whether a small group of people, including a racial, ethnic, or a socioeconomic group, bears a disproportionate share of the negative environmental consequences resulting from the relocation of a municipal airport.

For years, the City of Austin had been outgrowing Mueller Airport, its municipal airport located near downtown since the 1930s. By 1987 the decision was made to move it to a new location where flight operations could be expanded without causing undue hardship on the surrounding communities, while still providing convenient access to air travel. The most favorable option was to create a joint-use facility with then-active Bergstrom Air Force Base (BAFB), an option rejected by the Air Force on at least two occasions. Therefore, in the years that followed, finding such a location proved difficult and the project fell victim to several delays.

On April 20, 1990, seventeen Mueller Airport area homeowners, claiming that airport noise and pollution harmed their health and reduced the value of their property, filed a lawsuit against the City of Austin. Their lawyer said residents did not want the airport moved to the soon-to-be-former Air Force base because it would cause further delay to removing Mueller airport and because it would cause southeast Austin residents the same problem the Mueller neighborhood residents were currently facing. To complicate the issue, the neighborhoods surrounding

[58] U.S. Environmental Protections Agency website, http://www.epa.gov/compliance/environmentaljustice/.

the former Air Force base were predominantly lower income than the rest of Austin and contained higher proportions of minority populations. In May, the *Austin-American Statesman* ran a newspaper article stating that "Black officials call Bergstrom airport racist." In addition, many believed the Bergstrom airport neighborhood already bore more than its fair share of municipal noxious facilities. A newspaper article in the summer of 1990 reminded the city that the neighborhood closest to BAFB already contained several noxious sitings, including two sewage treatment plants, a jail, and a landfill. Residents of this neighborhood were split on the airport location decisions: some thought that an airport would be the answer to economic growth after the closure of the Air Force Base took away several thousand civilian jobs; others saw an airport as yet another noxious siting, bringing with it noise and pollution problems.

Chapter one uses several different types of empirical models to determine if the original airport was an amenity or disamenity to the local community in which it was situated. It finds that there is no simple answer to that question; the airport exhibited both positive and negative effects on house values in different nearby locations. Positive impacts are associated with easy access to the facility and infrastructure improvements that occur along the route to an airport. Negative impacts are associated with living close to an airport, measured in concentric circles from the terminal building and, under certain conditions, with living under a noise contour.

Chapter two then builds upon the data and the hedonic models developed in the first paper and adds information on the new airport in order to explore questions of potential efficiency gains from re-locating the airport to a new community. It uses a difference-in-difference model to isolate the relative effects on the neighborhoods near the airports compared to the rest of Austin as well as the effects of moving the airport over time. Many of these results confirm the findings from the first paper, that airports contain both amenities from infrastructure development, but also disamenities from noise, pollution, and safety factors, even if these effects are more perception than reality.[59] In net, over time and over the two facilities, the second chapter finds that moving the airport from Austin's city center to a more remote location caused a potential gain to the homeowners in the fourteen years after the vote to move the airport first passed.

In this third chapter, Geographic Information System (GIS) maps are used to match house sale price information to the physical locations of the houses to determine whether or not a house is impacted by one or both airports, and to match it to its 1990 census tract characteristics. Since it is possible to determine which houses received benefits and which houses suffered losses, the question here is whether houses that received benefits or suffered losses are significantly different from the population as a whole in Austin. If one or more ethnic or income groups suffered more losses than others, it could be an indicator of environmental inequity – where one group disproportionately bears the burden of a public good enjoyed by all.

[59] Review of crash data suggests the majority of aviation crashes occur in vicinity an airport, which implies that people who live near an airport are at greater risk, with risk declining rapidly outside the first two miles around an airport. While the risk of a groudling fatality is greater near an airport, it is still an unlikely event, with an annual risk of 1 in 130 million. Thompson, Rabouw, and Cooke (2001).

The 1990 census data are used (as opposed to the 1980 or 2000 census reports that also cover relevant years included in the model) because, as highlighted above, 1990 was a critical year in the decision whether to relocate the airport, and if so, where it would be. This captures another aspect of the environmental justice literature, whether it is relevant to evaluate the demographic characteristics of the neighborhoods around a noxious siting using current population data or the data from the time of the siting. As part of a historical overview of waste siting in Chicago, Baden and Coursey (2002) define and explore two types of potential environmental injustice: injustice in intent and injustice in outcome. Injustice in intent is an *ex ante* siting decision that targets subpopulations. It is not well studied because of the lack of data on socio-economic characteristics around sites as they are being chosen, though it is becoming more of a focus. Been and Gupta (1997) use census tract information for 1970 through 1990 to estimate factors that influence the siting of RCRA facilities. On the other hand, injustice in outcome is an *ex post* siting decision that finds an over-representation of subpopulations near existing facilities. This has been the focus of many environmental justice studies, including the landmarks GAO (1983) and UCC (1987). Lambert and Boerner (1995) discuss "white flight" in reference to noxious facility location. While injustice in outcome does not seem necessarily discriminatory in nature, Title VI of the Civil Rights Act only requires proof of differential racial impact, not discriminatory intent (Schwartz, 1997).[60]

[60] Title VI of the Civil Rights Act prohibits racial and ethnic discrimination in federally funded programs.

The 1990 population Census captures both of these concepts. At the old airport, 1990 captures the population who moved in around an established facility, likely because of lower house prices. At the new airport, 1990 captures the population at a proposed location before the decision was made to site a new facility. An interesting result of being able to look simultaneously at both an established site and a proposed site, is that the demographic characteristics of the airport neighborhoods are similar to each other, yet significantly different from the rest of Austin. This paper avoids the debate over the concepts of injustice in intent and injustice in outcome because the discussion cannot accurately capture the reasons behind the voluntary decision to purchase a home near a noxious facility. Instead, the focus is to find the effects of an exogenous shock on different socio-economic groups without labeling these effects as inherently "fair" or "unfair."

Two landmark studies in the 1980s found that minority populations shoulder the majority of the environmental burden in hazardous waste landfills, sparking national attention and changes in EPA's policy for siting noxious facilities. The first study by the GAO in 1983 found that three out of the four hazardous waste landfills they studied were located in predominantly black communities. The second study, conducted by the United Church of Christ's Commission for Racial Justice in 1987, found that race was the most significant of all the variables they tested for predicting the location of commercial hazardous waste facilities on a national level UCC, 1987).

Since those early studies, the evidence for environmental justice has been mixed. Mohai and Brandt (1992) studied the racial and socioeconomic distribution of communities that host commercial hazardous waste facilities in Detroit, and found that higher percentages of minority populations live within one mile of a waste facility than white populations. However, Anderton *et al.* (1994) looking at the national distribution of RCRA facilities at the census tract level; Bowen *et al.*(1995) looking at facilities on EPA's Toxic Release Index; and Jerrett *et al.* (1997) looking at the income distribution of pollution in Ontario, Canada, all found no association, or negative associations, between racial minorities and low-income households and environmental hazards. More studies have found mixed results, including Zimmerman (1993), Goldman and Fitton (1994), Been and Gupta (1997), and Boer *et al*. (1997). Baden and Coursey (2002) find that using data from the 1960s, more minority and low-income communities host CERCLIS facilities than other communities in Chicago, but the same framework using data from the 1990s finds no income or minority variables to be significant predictors of RCRA sites.

The early studies into environmental justice tend to compare the means of the demographic characteristics of the communities surrounding noxious facilities to the means of the demographic characteristics in other communities. This "with-without" comparison of the means gives a reasonable description of the distribution of people and noxious facilities, but it does not control for multivariate effects. Historically, a strong correlation exists between minority groups and low-income households. Environmental justice is concerned with specific groups that may bear a disproportionate share of the burdens of public goods; therefore, income levels and minority status should have separate controls to evaluate the independent effects within each group. Logit models are used to separate out these multivariate effects, without assuming to know the causal structure of the location theory.[61] Anderton *et al.* (1994) and Davidson and Anderton (2000) use logit models to separate the effects and find that employment in the manufacturing sector, more than socioeconomic characteristics of the community, determine the location of hazardous waste sites. Baden and Coursey (2002) take this a step farther, combing logistic, linear probability, and Tobit regression results with historical record to separate out relationships within demographic groups and changes over time.

While environmental justice continues to be a heated and important issue on a national scale, Baden and Coursey (2002) point out that the specific conditions, such as proximity to transportation and industrial infrastructure, within cities make some communities more appropriate for noxious facilities. Therefore, looking only at a national scope and blurring these compounding factors may, "risk creating more confusion than clarity" by overlooking important jurisdictional and physical relationships within the siting location choices. Further, Bowen and Haynes (2000) argue that concentration on a well specified urban area is less likely to produce improper judgments of statistical significance and bias due to spatial auto-correlation that arise when the studies are conducted at the state or national level.

[61] Theory-based environmental justice literature does exist, including incorporating discrimination, compensation, and collective action motivations of minority and low-income groups into traditional firm location theory; see Hamilton (1995) and Kriesel *et al*. (1996).

The airport re-location in Austin brought up serious charges of environmental injustice by moving the facility to a neighborhood with a high minority and low-income population, which already contained several other noxious facilities. Aside from the demographics of the surrounding community, however, the site of the former Air Force Base seems a logical choice for the airport given the pre-existence of aircraft runways and the relatively sparse population density. To complicate matters, since airports have positive, as well as negative, impacts on the surrounding community, removing the airport from its original location could have adverse impacts on the minority and low-income community that surrounded the old airport. A review of the environmental justice literature does not find any studies that look specifically at airports or that decipher any positive aspects out of perceived negative sitings. Thus, this study is important not only for local decision-making in Austin, but also as an example of a noxious siting that could potentially improve the house values of minority communities that surround it.

This study finds that lower income and ethnic minority groups were disproportionately affected, both positively and negatively, by the airport locations in Austin, though the net effect of re-locating the airport results in increases in the average house values for many of these groups. Income was consistently one of the largest predictors of airport impact on house values, and always had a negative correlation to a facility location. Percent foreign-born and percent of the census tract that is black also are significant predictors of airport impact, but in the opposite direction; if these percentages increased, the likelihood of an airport impacting house values increased. Surprisingly, percent Hispanic is negatively correlated to an airport location, and once income and other racial groups are controlled for, have relatively small impacts.

The next section describes the various data sources for this analysis. Section 3.3 evaluates the summary statistics using a with-without comparison of the means and Section 3.4 implements an incidence analysis to control for the multivariate effects in order to draw general results within each income and racial group. Section 3.5 concludes.

3.2 DATA

The data for this study come from three sources, individual sales of single-family residences in Travis County, Texas, GIS maps, and the 1990 U.S. Census of Population and Housing. These three data sources are used in the same equation as Chapter 2 to estimate difference-in-difference coefficients from a six-period hedonic model, and then the estimated coefficients for the environmental variables (distance to both airports, noise contours around Mueller airport, and proximity to route to both airports) are used to estimate the price change of each house in the data set resulting from the local government policy change. A full description of the data and the hedonic model can be found in the previous chapter. A brief description of the hedonic model follows.

The environmental characteristics are developed from the GIS and the Noise Exposure Maps furnished by the City of Austin Transportation, Planning, and Sustainability Department. Three variable groups are included: Noise, Distance, and Route. The Noise variables are a series of dummy variables that capture the noise contours: average noise level greater than 70 decibels (dB), 65-70dB, and "undistinguishable from background noise". The distances from each airport are also represented by series of dummy variables. For the old airport, Distance is measured in six, one-half mile concentric circles around the main terminal (variables: MAdist1 through MAdist6). For the new airport, variables for the distance from the airport are measured in five one-mile concentric circles around the main terminal (variables ABIAdist1 through ABIAdist5).[62] The Route variables are divided into two sets: Manor Rd dummies for the old airport and ABIA route dummies for the new airport. The Manor dummies are: one-quarter mile buffer from Manor Road (ManorRd2), one-half mile (ManorRd3), and greater than a half mile (left-out variable). The ABIA Route variables are: one-quarter mile buffers of Hwy 71, Hwy 183, Airport Blvd, East 7th St, and Riverside Dr (ABIAroute2), one-half mile buffers (ABIAroute3), and greater than a half mile (left out variable). Because the purpose of the route variables is to pick up development effects and not to determine which routes are used most, the buffers for all roads in the ABIA route dummies are combined into one measure.

The underlying model of the difference-in-differences approach used in Chapter 2 is based on Meyer (1995). The variables are separated into three groups: treatment, control, and event groups. Variables in the treatment groups indicate that a house is affected by Noise, Distance, or Route during the airport relocation. Variables in the control group indicate the set of houses that are away from both airports. Variables in the event groups indicate the six time periods.

[62] I conjecture that traveling a half-mile from the old airport would take approximately the same time as traveling a full mile from the new airport.

Therefore, the estimated coefficients on the treatment variables captures the time-invariant difference in the overall means between the houses affected by the airport relocation and the rest of Austin, and the coefficients on the event groups captures the way the treatment variables are influenced by time. The control group is implicitly represented by the intercept. When the treatment and event groups are interacted, the estimated coefficient gives the true causal price effect of selling during a given time period for a house in a noise contour, distance contour, or along the route to an airport. Other structural and community characteristics are included in the model to capture housing heterogeneity, including: gross building area, total land area, second and third bathrooms, pools, spas, garages, building material, education and racial community dummy variables, and community classifications by zip code. In addition, year dummy variables control for the general market trend in Austin. Equation (3.1) describes this model.

3.1
$$\ln(P_i) = \alpha_i + \beta_i S_i + \gamma_i C_i + \theta_i N_i + \varphi_i D_i + \sigma_i R_i + \sum_{k=1}^{21} \delta_k dYear_{ki} + \sum_{l=1}^{6} \phi_l dEvent_{li} + \sum_{l=1}^{6} \rho_{li} N_i * dEvent_{li} + \sum_{l=1}^{6} \upsilon_{li} D_i * dEvent_{li} + \sum_{l=1}^{6} \omega_{li} R_i * dEvent_{li} + \varepsilon_i$$

In the estimation results, the coefficients θ, φ, and σ are the time-invariant single difference effects of Noise, Distance, Route, and ρ, υ, and ω are the double-difference effects of each environmental variable for the time period specified. Because these double-difference variables are interactions of dummy variables, one of the group must be left-out to avoid over-specification and to act as the comparison time period for the double-difference effect. In the case of the old airport, the omitted dummy variables are the interaction terms with the preVote period. This means that all the double-difference comparisons are of houses in the time period specified with the initial period when no official plans to re-locate the airport existed.

The vote to move the airport away from the Mueller location is not particularly meaningful for the new airport because at that time Bergstrom Air Force Base (BAFB) was still an active military base and the anticipated location of the new airport was the Manor location.[63] The preList period is more meaningful for the new airport because this is the time period right before BAFB was placed on the closure list, which signaled the change in policy. Therefore, for the new airport, the omitted dummy variables are the interaction terms with the preList period.

For the discussion here, the relevant coefficients are the difference-in-difference coefficients that give the change in house price from the initial period to the final period for houses affected by the airports' amenity and disamenity factors, and controlling for house prices changes in all of Austin. The regression results for variables in difference-in-difference model in chapter 2 are repeated here in Table 1 for convenience. These estimates are used in Section 3.5 to perform the incidence analysis by income and minority group.

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[63] See the Background for more information.

Table 3.1 Double-Difference Estimates for Airport Variables

Old Airport		New Airport	
Noise 65-70dB	0.0105 (0.08)		
Noise >70dB	-0.0914 (-0.43)		
MAdist1	-0.1395 (-0.94)	ABIAdist1	-0.4349 (-1.39)
MAdist2	0.2547 (2.33)	ABIAdist2	-0.4982 (-1.29)
MAdist3	0.1393 (0.98)	ABIAdist3	-0.1501 (-0.93)
MAdist4	0.2547 (2.33)	ABIAdist4	-0.0026 (-0.04)
MAdist5	0.3116 (3.29)	ABIAdist5	0.1045 (1.65)
MAdist6	-0.0210 (-0.27)		
ManorRd2	-0.4517 (-3.22)	ABIAroute2	0.0815 (0.59)
ManorRd3	-0.3062 (-3.05)	ABIAroute3	0.2255 (3.13)

Note. The first number is the regression coefficient. The t-statistics are in parentheses; an absolute value of at least 1.28 indicates significance at the 10% level.

Using only the coefficients in the last two columns of the Chapter 2 tables implies that the environmental justice questions examines the difference in housing prices after the siting decision is complete, and does not account for temporary adjustments during the siting years. Using only the before and after the entire policy change double-difference coefficients, the houses that are in former Mueller Airport noise contours return to their pre-policy levels, houses in distance contours from the old airport rise in value, while those that are along the route to the former airport decrease in value. The overall policy change has the opposite effect at the new (ABIA) airport: houses in the distance contours decrease in value and houses on the route to the new facility increase in value.

In addition to spatially defining the environmental variables, Noise, Distance, and Route, GIS maps are used to match all houses in the dataset to their 1990 Census tract information. It is then possible to group them into houses that have been impacted by each of the environmental variables (a "with" group) and those that have not (a "without" group) and compare how the demographics of the with and without groups differ. While it would be ideal to have specific demographic information of every household in the model, these data are unavailable, and census tracts are considered good estimates for neighborhood qualities. Anderton *et al.* (1994) argue for using tracts rather than zip code designations because, "tract boundaries are setup by local census tract committees with instructions to 'reflect the structure of the metropolis as viewed by those most familiar with it' and hence, are more likely to be drawn to reflect local ideas of homogeneous neighborhoods." Census tracts contain an average of 4,000 people per track and a median land area of 0.74 miles.

The environmental justice variables from the Census information include income and race categories that have been the focus of discrimination, and hence the previous literature. As described in Figure 3.1 at the end of this chapter the explanatory variables are: median household income, percent poverty, percent Hispanic, percent foreign-born, percent white, percent black, percent American Indian or Alaskan Native, percent Asian or Pacific Islander, and percent in another category. Hispanic and foreign-born categories are collected separately from the other race characteristics in the 1990 Census. So, while the percentages for white, black, American Indian or Alaskan Native, and Asian or Pacific Islander sum to one, Hispanic and/or foreign-born can be selected in addition by the household. The summary statistics for these variables are described in Table 3.2.

Income is measured separately from poverty to allow a non-constant marginal value of income on the siting decision for the very lowest income groups. Hispanic and Foreign-Born are also added to the standard Census race categories because Hispanic is the largest minority group in Austin. These categories probably overlap, but while Hispanics in Austin may also be foreign-born, the second category captures the segment of the population least likely to be assimilated into mainstream culture, and potentially those with the least legal clout.

Table 3.2 Summary Statistics for Environmental Justice Variables

Variable	Mean	Std. Dev	Min	Max
Income	$37,458	$15,881	$5,155	$87,175
% Poverty	0.1067	0.0965	0.01	0.70
% Hispanic	0.1768	0.1281	0.02	0.91
% Foreign-Born	0.0641	0.0374	0.00	0.33
% White	0.7882	0.1731	0.04	0.98
% Black	0.0859	0.1295	0.00	0.90
% Native American	0.0023	0.0045	0.00	0.02
% Asian Pacific	0.0265	0.0243	0.00	0.25
% Other	0.0972	0.0929	0.00	0.72

Other recent environmental justice studies include the percent of the census tract that is employed in manufacturing and industry (Anderton *et al.,* 1994) or proximity to infrastructure (Baden and Coursey, 2002) and find these variables as important, or more important, than income and ethnic groups in predicting the location of the waste facilities. The question here is not to determine the features that cause a facility to be located in one area over another, but whether the area where a facility is placed has significantly different demographic distribution than other areas in the city.

The summary statistics imply that in 1990, Austin households were predominantly white, and on average, earned an income well above the poverty line. Therefore, if all census tracts in Austin were equally likely to be impacted by the old and new airports, then white, relatively affluent, neighborhoods would both bear the burden and receive the benefits of the airports. A discrimination motive is not expected to change this likelihood; access to a large land area and a location convenient for travelers are more important criteria. Airports are not traditional noxious sitings where one could envision planners trying to hide the public nuisance in a location that would not be exposed to tourists or politically powerful people within the local community. Or in a more negative interpretation, trying to place a dangerous or ugly facility as far as feasible from yourself and close to your enemy.[64] Airports are used by the entire city, and it is

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[64] Several studies look at political power and the siting of waste (Hamilton, 1993; Hamilton, 1995; Kim, 1997; and Been and Gupta, 1997). This type of model could be appropriate here, especially since "Move It" campaign was so influential. Initial searches for voter registration and turnout data at the census tract level found only information for the year 2000. Further research could use 2000 data, or perhaps build a new 1990 data set.

likely that higher income groups will use them more often than lower income groups.

Unlike waste disposal sites, airports have both good and bad aspects on the nearby property values. Once a location is chosen, which houses receive the good aspects and which houses receive the bad aspects is largely out of the local government's control. Although the positioning of runways is key to controlling noise dispersion, distance from the facility cannot exclude some neighborhoods just because they are wealthier or more politically active, and the roads leading to airport existed prior to the siting.

3.3 WITH-WITHOUT COMPARISON OF THE MEANS

The first step in the environmental justice analysis is to determine how census tracks that are affected by the various aspects of an airport differ from other census tracks in Austin. Before running regression analysis, a raw look at the data using a with-without comparison of the means provides an overview of the demographics in Austin around both airports. Comparison of the means cannot control for multivariate effects in the model, but it does allows for basic comparisons to be made without placing any restrictions on the model form. It is, therefore, a first glance at the socio-economic conditions around the airports, and also serves as a consistency check for the regression models. Tables 3.3 – 3.5 provide the variable means and the number of contributing cases for each of the nine demographic characteristics in the justice model for houses in airport distance contours, noise contours, and on the route to an airport, respectively, compared to the means and cases of other tracts in Austin that are not impacted by an airport. The tables also present the two-sample t-tests for a significant difference between the two means.

3.3.1 Distance

The means for the environmental justice variables are significantly different at the 99% confidence level, or higher, for houses within three miles of the new airport than those further away. A significantly higher number of people live below the poverty line near the new airport than in the rest of the city, with the average income near the new airport under $25,000 compared to almost $40,000 for the rest of the city. A significantly higher percentage of black, Hispanic, American Indian-Alaskan Native, and foreign-born people live near the new airport than the rest of the city. The difference-in-difference coefficients from Chapter 2 are negative and significant for all distance contours around ABIA, implying that house values near the new airport are significantly lower than they were before the Air Force Base closed and the new airport was located there. The means reflecting the difference from being located within these contours indicate that minority and economically disadvantaged households are more likely to have suffered these losses than predominantly white and higher income neighborhoods.

Comparing the with-means for Distance from the old airport, the surrounding communities again tend to be lower income on average and have more than twice the percentage of people earning an income below the poverty line. The communities within three miles of the old airport also have higher percentages of minority groups, including foreign-born, Hispanic, black, and

American Indian-Alaskan Native, than communities outside of these distance contours. The difference between the two means of the with-and without groups are highly significant.

Table 3.3 With-Without Comparison of Means for Houses in Airport Distance Contours

	ABIA			**Mueller Airport**		
Distance	Without (N=19,041)	With (N=2,345)	t-test	Without (N=17,611)	With (N=3,775)	t-test
Income	$39,201 (15,749)	$23,299 (7,813)	80.47 ***	$40,399 (15,397)	$23,736 (9,703)	85.03 ***
Poverty	9.20 (8.47)	22.55 (10.39)	-59.81 ***	8.19 (6.97)	22.21 (11.80)	-70.47 ***
Hispanic	15.13 (9.20)	38.33 (18.16)	-60.90 ***	17.30 (11.73)	19.46 (16.84)	-7.51 ***
Foreign-Born	6.17 (3.69)	8.35 (3.68)	-27.07 ***	6.09 (3.08)	7.91 (5.73)	-18.95 ***
White	82.08 (13.51)	52.73 (22.06)	63.00 ***	81.80 (12.93)	65.14 (26.29)	37.97 ***
Black	7.20 (10.57)	19.41 (22.27)	-26.20 ***	6.13 (6.93)	19.74 (24.02)	-34.51 ***
Native American	0.31 (0.33)	0.43 (0.36)	-15.52 ***	0.31 (0.33)	0.36 (0.36)	-7.56 ***
Asian Pacific	2.70 (2.41)	1.57 (1.28)	35.50 ***	2.63 (2.08)	2.32 (3.29)	5.51 ***
Other	7.71 (6.05)	25.85 (14.16)	-61.35 ***	9.12 (8.33)	12.43 (12.60)	-15.45 ***

"With" indicates a house was within three miles of the airport indicated.
Number is the mean value; standard deviation is in parentheses
* indicates significance at the 90% confidence level; *** indicates significance at the 99% confidence level

The difference between the two airports, however, is that at the old airport, the double-difference coefficients for distance from the facility showed either no, or a positive, change in house prices from the pre-period to the final period. Moving the airport away from that community helped the minority and economically disadvantaged groups. Thus, the lower income and minority groups that are over-represented in the communities that took house value losses at distance close to the new airport are also the same groups that are over-represented in the communities that had house value gains at distances close to the old airport after it ceased flight operations. In some locations the airport move helped minority and low-income groups and in other locations it hurt them, through the value of what is probably their largest financial investment, their homes. The net cost or benefit to these minority groups depends on the relative number of households living near the two airports and the amounts by which the house prices rose or fell.

3.3.2 Noise

Table 3.4 looks at the specific communities around Mueller airport where houses were affected by aircraft noise. The double-difference coefficients reveal that these houses did not lose value as a result of the government policy change from the pre-period to the final period.[65] Similar to the findings for communities in the airport distance contours, houses affected by aircraft noise are located in

[65] However, at several stages in between the announcement of the policy change and the actual closure of the old airport, when aircraft noise was still a factor, these house values dropped, they rebounded after the airport closed.

communities with significantly higher percentages of ethnic and racial minorities and lower income groups.

Table 3.4 With-Without Comparison of Means for Houses in Mueller Airport Noise Contours

	Mueller		
Noise	Without (N=20,864)	With (N=522)	t-test
Income	$37,933 (15,771)	$18,452 (4,617)	84.82 ***
Poverty	10.21 (9.26)	28.75 (7.43)	-55.94 ***
Hispanic	17.56 (12.86)	22.52 (9.63)	-11.53 ***
Foreign-Born	6.31 (3.64)	10.23 (5.63)	-15.82 ***
White	79.47 (16.54)	54.45 (27.46)	20.78 ***
Black	8.06 (11.79)	27.42 (31.27)	-14.12 ***
Native American	0.32 (0.34)	0.45 (0.37)	-7.82 ***
Asian Pacific	2.57 (2.34)	2.96 (2.60)	-3.44 ***
Other	9.58 (9.35)	14.73 (5.81)	-19.66 ***

"With" indicates a house was within 65 dB or louder noise contour of the old airport
Number is the mean value; standard deviation is in parentheses
* indicates significance at the 90% confidence level; *** indicates significance at the 99% confidence level

The mean income is lower and the percent of households with incomes below the poverty line is higher for houses in Mueller airport noise contours than for any other group in the model. In fact, the mean income for communities with houses in the noise contours is less than half of the mean income for the rest of Austin. The percentage of the population identifying their race as black is more than three times larger for communities with houses in the noise contours than in the rest of Austin. Moving the airport to Bergstrom neither helped nor hurt house values in the long-run for these particular groups.

3.3.3 Route

Finally, Table 3.5 compares the with-without difference in means for houses on the Route to an airport. The difference-in-difference model found that being on the route to an operational airport was an amenity, but that the amenity characteristics disappeared when the airport ceased flight operations. Therefore, houses on the route to the old airport lost value in the final period of the model compared to the initial period and houses on the route to the new airport either did not change in value, or increased in value compared to the initial period. Again, the census variables for houses on the routes to both airports show income and ethnic differences from the rest of the Austin community.

The demographic characteristics for houses on the route to the new airport are similar to the demographics for the other environmental variables: significantly lower incomes, but higher percentages of people below the poverty line and higher percentages of minorities. While all of the race and ethnic groups have significantly different means in the with and without groups, except Asian-Pacific, the largest difference is the percent of people identifying themselves as black, with almost three and one-half times the percentage of black people living on the route to the new airport than in the rest of Austin.

While still significantly lower than the average income for the rest of Austin, the average incomes in the with - without groups for route to old airport have the smallest discrepancy of any in the model. Also different from the other environmental variables, the percentages of Hispanic, foreign-born, Asian-Pacific, American Indian-Alaskan Native, and "other" ethnic groups are all lower on the route to the old airport than in the rest of Austin. In contrast, the percentage of the census tract households identifying themselves as black is over six times higher for houses on the route to the old airport than elsewhere in Austin.

Similar to the Distance variables, the double-difference effect of living on the route to the new airport is almost exactly the opposite as living on the route to the old airport. In both cases, the neighborhoods impacted by these house price changes have lower average incomes and significantly higher percentages of black people, though unlike the other environmental variables, significantly lower percentages of Hispanic people are negatively affected by the closure of the old airport.

Table 3.5 With-Without Comparison of Means for Houses on Route to an Airport

Route	ABIA Without (N=19,021)	ABIA With (N=2,365)	ABIA t-test	Mueller Airport Without (N=20,281)	Mueller Airport With (N=1,101)	Mueller Airport t-test
Income	$39,565	$20,509	98.81	$38,114	$25,360	42.01
	(15,366)	(7,656)	***	(15,898)	(9,369)	***
Poverty	8.68	26.65	-81.45	10.02	22.61	-38.96
	(7.45)	(10.41)	***	(9.17)	(10.51)	***
Hispanic	16.42	27.83	-26.89	17.81	15.15	12.26
	(10.91)	(20.28)	***	(13.05)	(6.53)	***
Foreign-Born	6.02	9.53	-32.50	6.46	5.41	8.39
	(3.35)	(5.12)	***	(3.72)	(4.06)	***
White	81.80	55.24	50.99	80.64	46.04	48.48
	13.51)	(24.88)	***	(15.00)	(23.42)	***
Black	6.69	23.40	-31.38	6.68	42.71	-50.56
	(8.73)	(25.72)	***	(8.97)	(23.55)	***
Native American	0.31	0.43	-16.61	0.32	0.31	1.49
	(0.33)	(0.33)	***	(0.34)	(0.36)	*
Asian Pacific	2.57	2.64	-1.09	2.61	2.01	5.77
	(2.17)	(3.41)		(2.27)	(3.38)	***
Other	8.64	18.28	-29.80	9.74	8.92	5.32
	(7.57)	(15.52)	***	(9.50)	(4.63)	***

"With" indicates a house was within one-half mile of the airport indicated
Number is the mean value; standard deviation is in parentheses
* indicates significance at the 90% confidence level; *** indicates significance at the 99% confidence level

3.4 INCIDENCE ANALYSIS

The with-without comparison of means tables show how individual demographic characteristics for houses impacted by the airports differ from other houses in Austin, but these are summary statistics that do not take into account the relationships among the variables. For example, because of the way the Census questions were structured in 1990, a person who classified their race as Hispanic also had to choose among the list of white, black, Asian-Pacific Islander, American Indian – Alaskan Native, or other. Therefore, a multivariate analysis is required to control for these relationships. It is possible that once the percent of the population who classify themselves as Hispanic or Foreign-Born are controlled for, the significance of the other race variables may change. It is also possible that interactions among the income and ethnic groups may lead to changes in the significance of any of these potentially overlapping categories.

It is clear the old airport was sited in a low income community with significant minority populations, but it is not clear whether, in net, these populations were made better or worse off by the airport move since they were both positively and negatively affected. The same is true for the new airport. Given that these neighborhoods both have significantly different compositions than the rest of Austin, whether the net effect of the airport move is positive or negative for these groups determines whether these groups shoulder a disproportionate burden.

Logit regressions are traditionally used in the environmental justice literature to examine the relative strengths of the relationships between the demographic characteristics and the location of noxious facilities as well as to predict their location. However, this paper does not attempt to model the decision-making involved in the location of the airport (or predict the location), it seeks to find the exogenous shock of the government policy on different socio-economic groups. And while logit regression can be used to determine the logistical odds for presence of an airport amenity or disamenity for a particular group, it cannot be used to calculate a net effect of the positive and negative aspects of the siting. Therefore, logit models using dichotomous independent variables to indicate the Noise impact at the old airport and the Distance and

Route impacts at both airports are run to be consistent with the literature, but are not discussed here. They can be found in Appendix H.

Because the same patterns of ethnic minorities and economic groups exist around both the amenity and disamenity aspects of the airport siting a method is needed that is able to calculate both the positive and negative impacts on housing prices for all aspects of the siting by demographic group. The method used here is an incidence analysis, similar to the tax incidence literature, which uses the siting coefficients from regression estimates to predict the change in house values for each of the demographic groups in the model. The groups are then arranged from either lowest income to highest income, or highest percent minority to lowest percent minority, and the change in average house price is plotted. This will provide a visual description of who gained, who lost, who was not impacted, and who had the greatest variance in gains and losses from the airport re-location.

This chapter does not introduce a theoretically-specified model, nor one that represents the causal structure that accounts for the airport re-location decision. The estimated coefficients are taken from the last period in the double-difference model described in the Data section of the paper. These coefficients represent the gain (or loss) above and beyond the gain (or loss) that would have been expected looking at other changes to similar neighborhoods away from the airports. If the coefficient is significant at the 90% confidence level, then the coefficient is manipulated to give a percent change and multiplied by the dummy variable indicating whether each house is impacted by the environmental variable and by the sale price of the house. These predicted changes in house prices resulting from the policy change are averaged over each decile (for income groups) or quintile (for percent in poverty and racial groups) and plotted in charts in Figures 3.2 through 3.7 at the end of the chapter. These charts show the net effect of the airport re-location from the initial period to the final period, using estimates from both the new and the old airport.

Initially the price changes were plotted on the vertical axis with the demographic variables on the horizontal, one dot for each data point. The resulting charts found that expensive home fluctuate in prices more, even though both the comparison of the means would have predicted the opposite. This greater fluctuation is probably the result of the fact that the model is less able to capture house quality at the luxurious end of the spectrum (high ceilings, crown moldings, landscaped yards), and that when looking at expensive houses the numbers are larger to start with. Looking back at Table 3.2, the first significant double-difference coefficient for the Final period is a 25% increase in house prices between one-half and one mile from the old airport. This is a significant change for any house, but looking purely at the price change, 25% of a $300,000 house appears to be a much greater amount than 25% of a $50,000 house. The data are not available to fix the first problem, but the second can be corrected by using the percent change in house prices. Therefore, the charts that follow reflect percent change in house price.

Since median household income differs so dramatically between airport and non-airport neighborhoods in the with-without comparison of the means, it is the first incidence analysis plotted here. This estimation finds an average change in house price between –1% and 22%. The largest gains went to the lowest income census tracts. By the fourth decile, however, the average change in house price actually became very slightly negative. Higher income deciles, those starting at around $35,000 through the highest income, had an average change in house prices of zero. This is expected since the with-without comparison of the means found that higher income households were less likely to live near either airport. This chart also reveals that the losses in house values also fell on the poor, even though average changes were positive. The minimum numbers show that no households in a census tract with a median income above $35,000 lost value, while a few in less affluent tracts potentially lost over 50% of the value of their homes. While these huge losses are outliers, even in the lowest income groups, such losses do no exist in higher income neighborhoods. The most dramatic windfall gains in house prices as a result of the airport relocation also accrue to the very lowest income deciles. Therefore, it is the lowest income groups that won the most and lost the most from the airport re-location, though in net, the change was more positive than negative, a relief of some of the airport burden.

Figure 3.3 looks at the lowest income groups from Figure 3.2 by focusing on households whose reported income was below the poverty line. Separating the data into five groups with approximately 4,000 households in each, I find that 60% of the census tracts in Austin have a poverty level below 10%. These census tracts had average house prices gains of one percent or less, but none of them had an average or minimum that was a loss. The largest gains went to the census tracts with the highest percentage in poverty; on average these tracts gained about 15% of their house value. Windfall gains impacted a few houses in this category. The largest losses also fell on census tracts with at least 8.8% of the population earning levels below the poverty line. Once again, it is the poorest census tracts that saw the greatest variation from the policy change, and in net, the gains outweigh the losses.

The chart in Figure 3.4 divides the data set into five more-or-less equal groups based on the percent of the census tract that is white. This attempts to capture the effect of all minority groups together, by difference from the percent white, though it does not separate out those households who chose "white" as race, but also "Hispanic" or "Foreign-Born" as part of their ethnicity. All of these quintiles have a positive average gain, though in the highest categories the average gain is between one and three percent. Once again the losses fall only in census tracts with at least 8% minorities, and the largest losses only in census tracts with at least 20% minorities. The effects from looking at all non-white race groups together, reveals some evidence of differential burden between white and nonwhite communities, though the average changes are close across all quintiles.

The next three charts break out the racial and ethnic groups that have been the focus of the majority of the environmental justice literature: percent black, percent Hispanic, and percent foreign-born. In these charts, the grouping of quintiles is less equal. Instead of focusing on allocating the same number of house sale data points into each category, the groups attempt to better represent the concentration of the minority population. Tables 3.6 through 3.8 show how the data is divided.

Table 3.6. Percent Black Quintiles

Quintile	N	% Black	Average House Price
1	4,418	Less than 1%	$295,740
2	4,983	2 – 4%	$183,836
3	4,774	5 – 7%	$137,918
4	5,195	8 – 20%	$112,686
5	2,015	20 – 90%	$91,285

Table 3.6 and Figure 3.5 describe the percent change in house prices by percent black quintiles. Visually, the chart looks almost the exact opposite of the percent white chart, with the most dramatic losses in the last two quintiles, where more than 8% of the community is black. The average percent changes in house prices are largest for the last quintile, greater than 20% black. The results from percent black show some evidence that the black population in Austin bears more of the burden of the airport re-location than other groups; however, the relationship between race and house value losses is less striking than the income groups.

Table 3.7 and Figure 3.6 describe the percent change in house prices by percent Hispanic quintiles. All quintiles saw a positive percent change in average house prices, though census tracts where more than half the population is Hispanic saw the largest increases. Unlike the other income and race groups, all five quintiles had maximum changes above zero and minimum changes below zero, with some of the largest losses for the middle quintile, about 20% Hispanic.

Maximum gains were fairly evenly distributed, though the quintile with the largest losses also had the smallest gains (tracts with 17 – 21% Hispanic).

The relatively even dispersion of maximum, average, and minimum changes in house prices found in the Hispanic incidence analysis is somewhat surprising. The with-without comparison of the means found a significantly higher percentage of Hispanics in census tracts impacted by all the airport variables except the route to the old airport, which actually found significantly fewer. This difference between the with-without variables and the incidence model potentially can be explained by controlling for multiple race categories in the incidence model, and implicitly controlling for income by using price as the independent variable.

Table 3.7 Percent Hispanic Quintiles

Quintile	N	% Hispanic	Average House Price
1	5,215	Less than 8%	$286,804
2	4,935	9 – 16%	$152,124
3	5,407	17 – 21%	$138,834
4	4,948	22 – 49%	$103,551
5	466	Greater than 50%	$91,319

However, the incidence analysis does not necessarily contradict the earlier findings. The incidence analysis finds the largest average increase in house prices for the quintile with the highest percentage of Hispanics, but it finds large minimum and maximum gains for every quintile; the airport does affect Hispanic communities, but not more so than non-Hispanic communities.

The final race category, percent of the census tract that is foreign-born, potentially overlaps any of the race categories, but in Austin, it is most likely to overlap with the Hispanic groups due to Texas' relative proximity to Mexico and Central American countries.[66] However, in all but one of the logit models, the percent foreign-born acted in the opposite direction of percent Hispanic. While increases in the percent Hispanic decreased the likelihood of being in an airport community, increases in the percent foreign-born increases the likelihood of being within three miles of the old airport, under a noise contour, or on the route to either of the airports. So, rather than being simply a measure of non-white communities, foreign-born captures the segment of the minority community least assimilated into Austin culture and politics. The net impacts on this particular community are important, because along with income, the percent foreign-born is one of the most influential demographics for the location variables distance to the new airport, old airport noise, and route to the old airport.[67]

Table 3.8 and Figure 3.7 describe the percent change in house prices by percent foreign-born quintiles. By far, the largest increases in average house prices accrued to the highest quintile, the group where at least 15% of the population was foreign-born. Similar to the Hispanic incidence analysis, all five quintiles have a positive maximum price change and a negative minimum, implying that the burden is better shared among foreign-born communities and

[66] The logit regressions control for all racial and ethnic groups modeled here; they give the independent effect of Hispanic controlling for foreign-born and vice versa.
[67] American Indian – Native Alaskan is often one of the most influential determinates as well, but Austin has only a very small population of this group, 0.23%.

non-foreign-born communities, than for percent black and low income communities.

Table 3.8 Percent Foreign-Born Quintiles

Quintile	N	% Foreign-Born	Average House Price
1	6,249	Less than 4%	$204,184
2	5,228	5 %	$157,622
3	4,817	6 – 7%	$182,075
4	4,011	8 – 14%	$126,574
5	1,081	15 - 33%	$153,436

As would be predicted from the summary data, income and poverty levels have the most inequitable distribution of gains and losses from the re-location of the airport. In addition, given the relatively low levels of black populations in Austin, there is some evidence that this group bears more than a proportionate share of the airport gains and losses. In general, more affluent tracts with higher concentrations of white people see far less fluctuation in house prices due to this policy change, with no losses and some large gains.

This model only captures the gains and losses of the airport move as capitalized into house prices. If, for example, a large percentage of the houses in the areas that saw house value gains are not owner-occupied then the benefits to the income or ethnic group in that community could potentially be overstated depending on the ethnicity and income status of the owner. The American Housing Survey, collected every six years by the Bureau of the Census for the Department of Housing and Urban Development, provides estimates of homeownership by ethnic groups. Unfortunately, Austin is not one of the 47 selected Metropolitan Areas for which this data is collected and no data is collected on a state-level. Therefore, the closest estimates for owner occupancy by ethnic groups are at the national level. The national average of owner-occupied housing in the United States is 68 percent. The percent owner-occupied is highest for white populations, at about 73 percent, and lowest for groups identified as "other" at about 37 percent. Owner occupancy is about 55 percent for Hispanic populations, 54 percent for Asian and Pacific Islander populations, 49 percent for Native Americans, and 48 percent for black populations. In the dataset used in this analysis, none of the census tracts show owner occupancy rates above 80 percent. About half of the census tracts are between zero and 47 percent owner-occupied and the other half are between 48 and 80 percent owner-occupied. Therefore, it is possible that around half of the house value gains in communities with ethnic minorities are actually accruing to people who do not live in those communities. (National 2001 American Housing Survey)

3.5 CONCLUSIONS

At the time of the policy change, minority groups and residents near the old airport feared that low income and minority groups were going to bear the burden of the re-location of the airport. As it turned out, this was a valid concern. Significantly higher percentages of lower income groups and ethnic minorities live in areas surrounding both airports. However, other groups saw that the airport move was a chance to build-up the area around the closed Air Force base and potentially bring in jobs and improve the basic facilities, services, and installations needed for the functioning of the community. These groups were also partially correct. Using house values as a proxy for general land development, houses on the route to the new airport saw significant increases in their value, even if homes very near the airport itself lost value.

This analysis finds that indeed, the same income and ethnic groups that bear the burden receive the benefits from changes in house prices near both the old and the new airport. In all cases, summing the gains and losses within each group found either a zero or positive net effect. The variance between the maximum gains and the minimum losses are largest for the poorest and those with the highest concentrations of Native American, black, and foreign-born populations. The highest income communities and those with the highest concentration of white residents received no house price gains on average, though some received substantial benefits.

The zero or positive net effect from the airport re-location is consistent with the results found in Chapter 2. The earlier chapter finds a net gain to homeowners near both airports as a result of the policy, but it does not take into account the demographic characteristics of these gains, or the smaller losses. This analysis identifies which socio-economic groups live in the neighborhoods that saw the gains and losses in order to identify who in Austin bore the exogenous shock of the airport relocation.

This analysis does not capture all costs and benefits of the model because only looks at how things ended up, and does not account for the changes that happened in the market while adjusting to the new airport location. This may underestimate the impact on the very poorest communities in the model, those that live under the former noise contours of Mueller airport. Because the post-period house prices are not significantly different from the pre-period prices, no loss to these homeowners is recorded here. However, chapter 2 found the significant decreases in house prices in the intervening years, so real losses to these homeowners are directly tied to the local government policy.

Much debate exists as to the correct size of the unit of demographic analysis. Since this study is local in scope, the question of whether to aggregate to the city or county level is unnecessary. However, in addition to census tracts, zip code information is available for each house in the data set. Aggregation to zip code level has been used in several environmental justice analyses, including the original United Church of Christ study (UCC, 1987) and may explain some of the different findings of environmental injustice. Future work could compare the environmental justice results from zip code and census tract demographic aggregation. If significant differences appear in the results, more local neighborhood history would be necessary to determine which more accurately captures the effects of the local siting decision.

Given the suggestion that low income and minority groups are disproportionately affected by the airport change, future work should investigate the multiple other noxious sitings located around the new airport. A concentration analysis could test whether the airport is latest in series of sitings that all fall on the same community, or whether they are evenly distributed throughout Austin. This analysis could better capture whether some income and ethnic groups bear more of all environmental burdens that keep the city functioning.

Figure 3.1 Environmental Justice Variable Definitions

Income: the median income reported for each census tract
Poverty: the percentage of all households in the census tract whose reported income was below the poverty line
Hispanic: the percentage of all households in the census tract identifying their race as Hispanic
Foreign-Born: the percentage of all households in the census tract who reported they were born in a foreign country
White: the percentage of households in the census tract identifying their race as white
Black: the percentage of households in the census track identifying their race as black
Native American: the percentage of all households in the census tract identifying their race as American Indian or Alaskan Native
Asian Pacific: the percentage of all households in the census tract identifying their race as Asian or Pacific Islanders
Other: the percentage of all households in the census tract identifying their race as other than white, black, American Indian or Alaskan Native, or Asian or Pacific Islander

Figure 3.2 Chart of Change in House Prices by Income Deciles

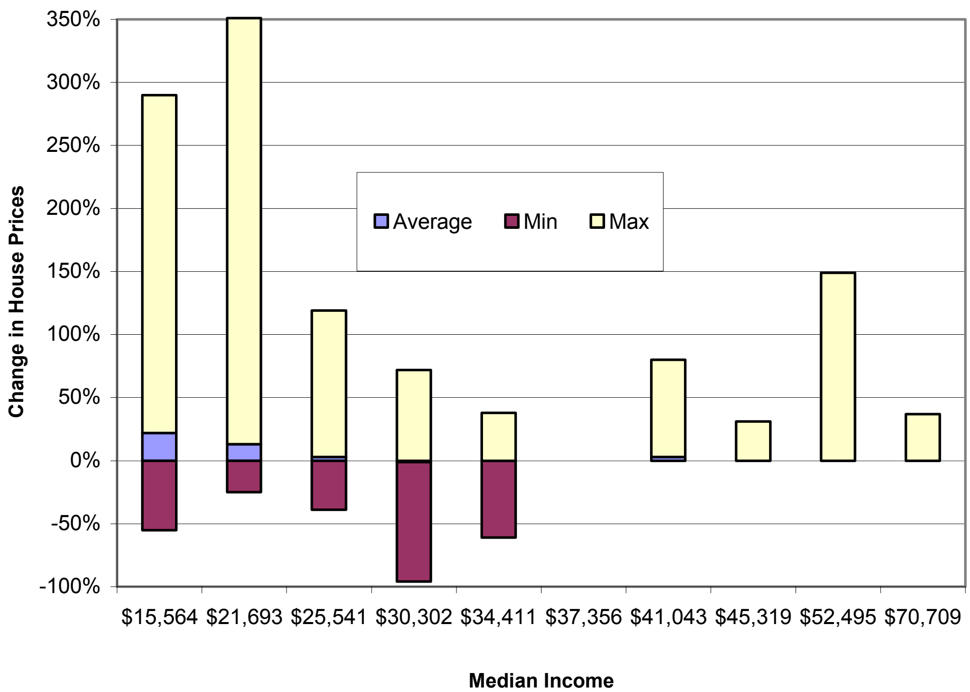


Figure 3.3 Chart of Change in House Prices by Poverty Quintiles

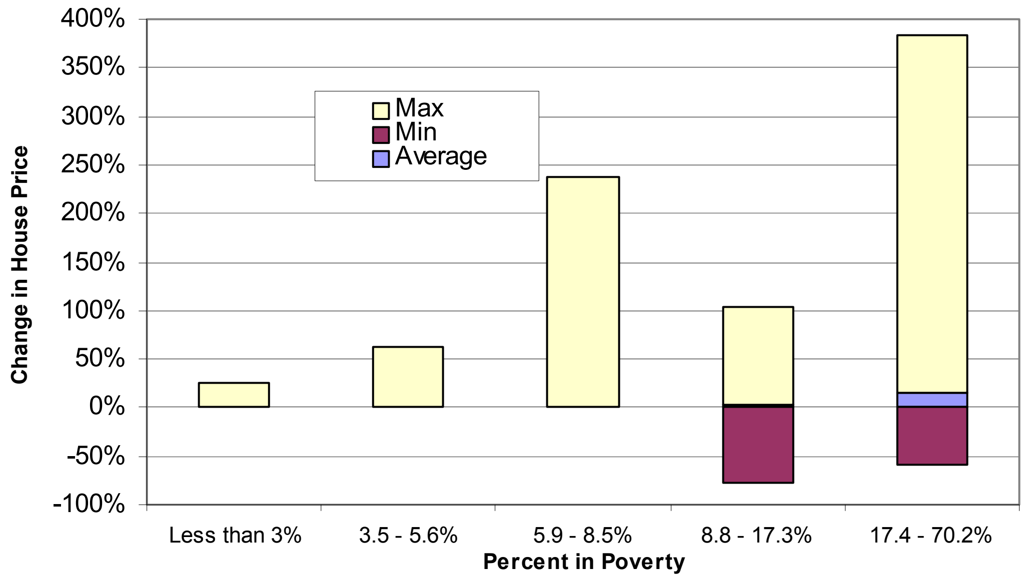


Figure 3.4 Chart of Change in House Prices by Percent White Qunitiles

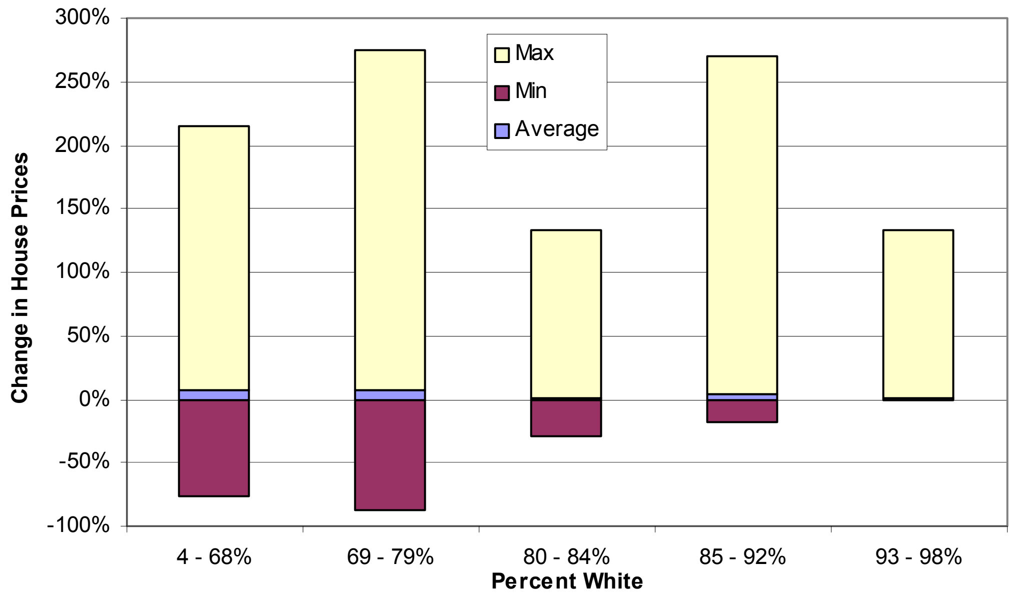


Figure 3.5 Chart of Change in House Prices by Percent Black Quintiles

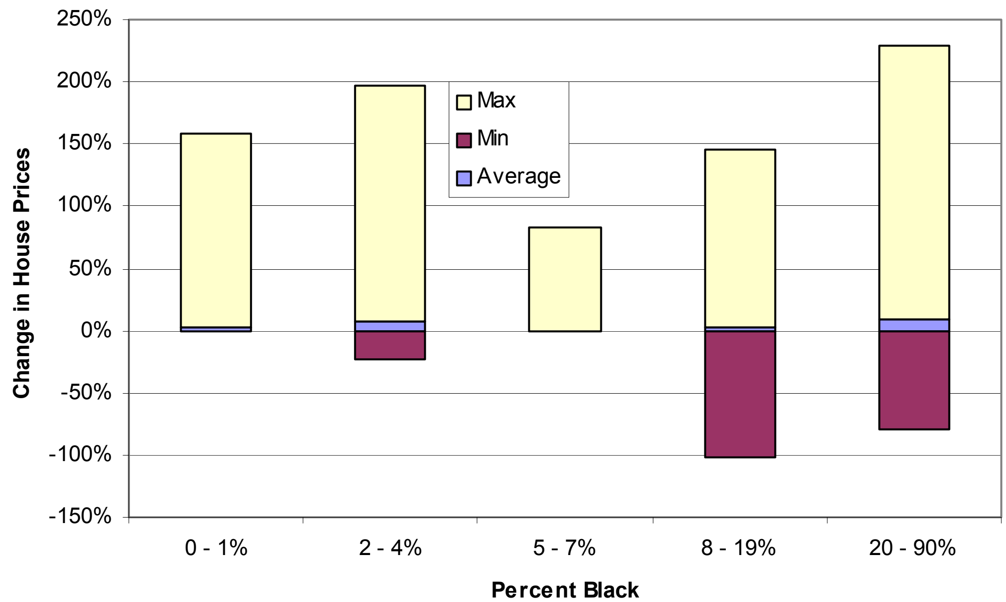


Figure 3.6 Chart of Change in House Prices by Percent Hispanic Quintiles

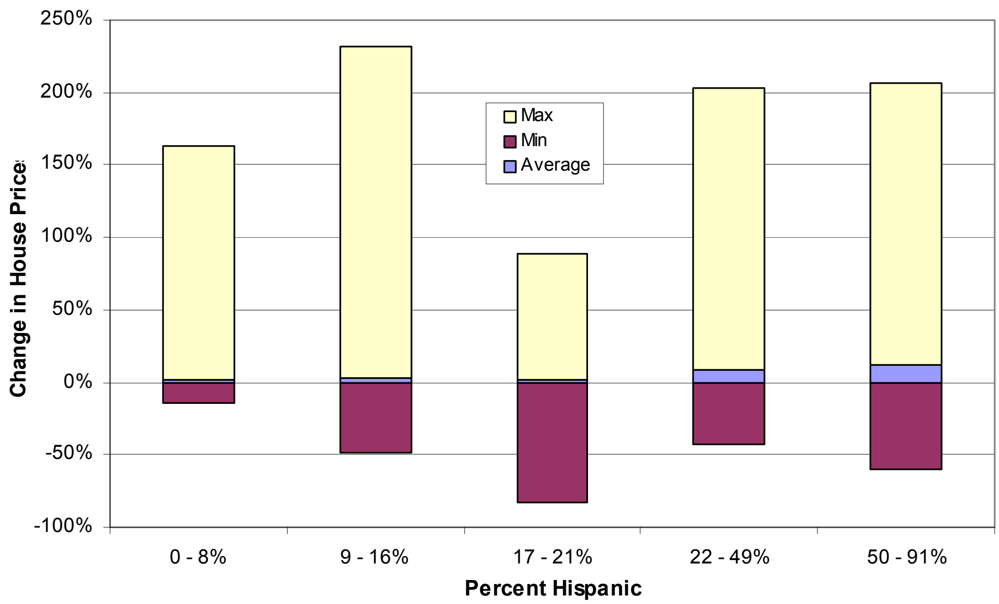
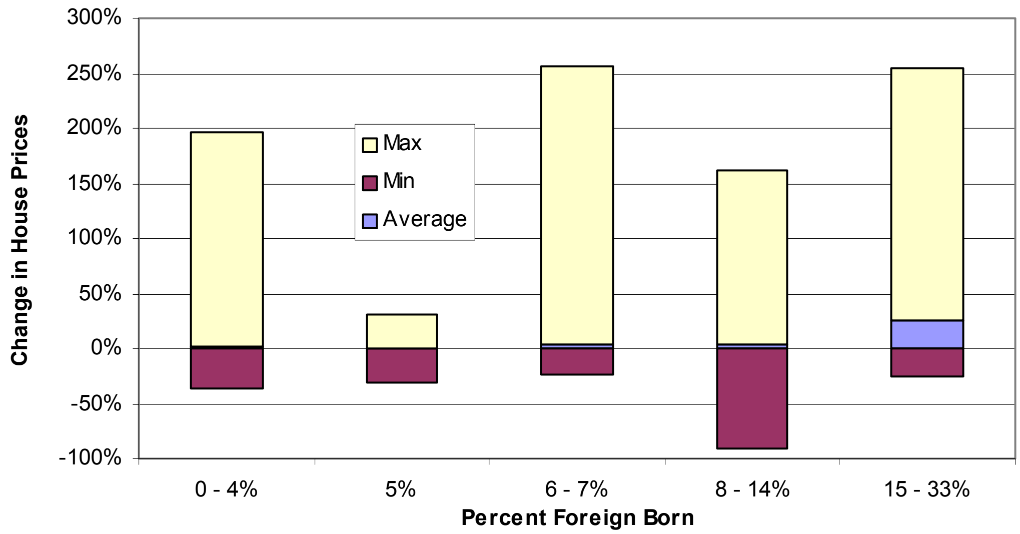


Figure 3.7 Chart of Change in House Prices by Percent Foreign-Born Quintiles



Conclusions

Airports have traditionally been seen as noxious sitings: a community necessity, but an unwelcome next-door neighbor. More recent literature, however, has found mixed results with some that find proximity to an airport could actually increase the selling price of a house. This dissertation looks at the removal and simultaneous imposition of an airport to determine the costs and benefits as they are capitalized into the house prices in the surrounding community. Given that airports are neither intrinsically a neighborhood 'good' or 'bad,' this analysis measures all aspects, then determines the overall effect, and finally determines if the balance of good and bad aspects are evenly divided among the population that all gains access to air travel.

The contributions of the first chapter are at least three-fold. First, the model adds to the hedonic pricing literature on airport sitings by comparing the differences in noise and distance variables and adds a new element to the model: development along routes to the airports. This study finds that previous contradictory studies can potentially be reconciled by adding more flexibility to the distance measurements and providing a separable measure for access to the airport. When looking at across time, this study finds that noise is a disamenity that is separately measurable from distance to the airport. In the repeat sales and all sales event date models, distance is an amenity with houses in the closest distance contours seeing substantial gains in value when the old airport prepared to and finally closed.

The second contribution to the literature involves the timing of noxious sitings. This paper uses five different estimations of when home buyers and sellers in Austin reacted to the movement of the airport. Though the timing of house prices changes varied somewhat under different specifications, in all models there were house price gains in losses in the year the City of Austin broke ground on the new airport. This is a significant finding because it indicates that homeowners are not necessarily perfectly rational; they waited through more than ten years of the City talking of moving the airport before house price changes actually occurred. As to be expected however, most of the market fluctuations were complete by the time the new airport opened and the old airport closed. Finally, the third contribution is to the hedonic literature by comparing several different methodologies. Siting stage models require assumptions about certainty across years that is not empirically supported. Repeat sale models requires less data, but additional corrections to the model itself. Traditional hedonic models do not require constant coefficient assumption, are reasonable simple to estimate, but require large sets of explanatory house characteristics. Based on these results, the choice of the "correct" specification depends more on the data available than the inherent abilities of the models.

The second chapter found that, in the case of Austin, the placement of an airport downtown gave rise to more positive than negative aspects. Aircraft noise is a disamenity that caused house price fluctuations around the policy announcements but did not permanently stigmatize neighborhoods. Proximity to the airport also causes house price decreases, possibly due to visual, safety, or traffic impacts, though these decreases disappeared when the airport relocated. On the other hand, access to an airport, as measured by location of a house within one-half mile of a major route to an airport, is an amenity. However, this amenity does not remain after the airport closed, implying that the development effects relied on the airport and are not sustainable in the face of uncertain future uses of the facility.

This study also found that house prices depend on the history of community, instead of relying only on the current characteristics of the neighborhood. This implies that local government policy has implications beyond the current agenda. The benefits from projects designed to attract business and development may only last as long as the project lasts, and will transfer to the next 'hot spot' when policies change. On the other hand, this model shows that noxious facility sitings do not always permanently stigmatize a neighborhood. The housing market failed to have perfectly rational expectations throughout the airport move, giving rise to both windfall gains and losses to buyers and sellers over the twenty-year model period. Homeowners who sold property near the old airport or in a noise contour in the intermediate periods lost the most even though these prices rebounded by the final period. This has implications for local governments and planners as well. As noted by Kiel and McClain (1996), "keeping the period of uncertainty short is clearly advantageous, since the shorter the time period, the smaller the social costs become relative to the development costs" (1357).

The geo-mapping capabilities used in this research provide for more accurate classifications of houses into environmental categories, which in turn provides more accurate estimates of the differing impacts a government policy can have. In net, lessened the overall burden homeowners bear for air travel in Austin.The realized net impact over all time periods for house near the old airport was $31.7 million, Driven by large gains for houses closest to old airport in Final period. The realized net impact over all time periods for house near the new airport was $39.8 million, driven by large gains for houses on route to new airport. Therefore, in net, moving the airport lessened the overall burden to homeowners near both airports and likely created an efficiency gain for the City of Austin.

Landmark studies (1980s) found that minority populations shoulder the majority of the environmental burden. Since then, evidence has been mixed. The third chapter looked at Austin as a recent case study to determine whether even if homeowners in the City as whole enjoyed more benefits than costs from the airport relocation , some communities shouldered a disproportionate burden. At the time of the policy change, minority groups and residents near the old airport feared that low income and minority groups were going to bear the burden of the re-location of the airport. As it turned out, this was a valid concern. Significantly higher percentages of lower income groups and ethnic minorities live in areas surrounding both airports. However, other groups saw that the airport move was a chance to build-up the area around the closed Air Force base and potentially bring in jobs and improve the basic facilities, services, and installations needed for the functioning of the community. These groups were also partially correct. Using house values as a proxy for general land development, houses on the route to the new airport saw significant increases in their value, even if homes very near the airport itself lost value.

This analysis finds that indeed, the same income and ethnic groups that bear the burden receive the benefits from changes in house prices near both the old and the new airport. In all cases, summing the gains and losses within each group found either a zero or positive net effect. The variance between the maximum gains and the minimum losses are largest for the poorest and those with the highest concentrations of Native American, black, and foreign-born populations. The highest income communities and those with the highest concentration of white residents received no house price gains on average, though some received substantial benefits.

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All the issues regarding the amenity and disamenity aspects of airport sitings are far from settled. This dissertation finds, however, that careful measurement and planning for the imposition of the disamenity aspects can result in a placement of an airport that causes the least degradation to house prices while still providing access to air travel and community development.

Appendices

APPENDIX A: SUMMARY STATISTICS

Table A.1 Summary Statistics of All Observations
(by year of sale)

Year of Sale	Obs	Mean Price	Mean Living Area	Mean Lot Size	Mean Age	Mean Bath
1980	57	128353.4	1517.3	12877.1	9.9	2.1
1981	62	114071.7	1445.4	10526.9	9.8	2.1
1982	87	144156.8	1647.3	10592.7	11.6	2.1
1983	56	173198.3	1701.7	10308.4	10.7	2.3
1984	126	198944.4	1625.9	10485.1	11.3	2.2
1985	188	162672.4	1551.4	9153.3	11.4	2.2
1986	107	158473.0	1587.3	10108.6	18.2	2.0
1987	108	158473.0	1587.3	10108.6	18.2	2.0
1988	176	146848.8	1769.9	14532.3	14.4	2.3
1989	266	141344.3	1843.1	12012.6	16.1	2.4
1990	316	124618.4	1786.6	11862.9	15.2	2.3
1991	473	119830.6	1768.2	11325.0	18.1	2.3
1992	595	128601.7	1781.3	11123.0	18.3	2.2
1993	689	139365.1	1809.3	12654.8	19.0	2.2
1994	667	148758.9	1839.4	11871.3	18.9	2.3
1995	2389	152758.6	1839.5	12306.8	20.9	2.2
1996	3627	154041.2	1808.0	11594.6	20.6	2.2
1997	701	103683.2	1561.1	8851.9	24.0	2.0
1998	90	103683.2	1561.1	8851.9	24.0	2.0
1999	1947	175735.7	1667.1	12008.3	27.4	2.1
2000	6907	196884.0	1667.7	11174.4	28.3	2.1
2001	1752	197580.1	1647.8	11355.9	28.9	2.1
Total	21386					

Table A.2 Summary Statistics of Single Sale Observations
(by year of sale)

Year of Sale	Obs	Mean Price	Mean Living Area	Mean Lot Size	Mean Age	Mean Bath
1980	1	232121.0	2402.0	12838.0	2.0	4.0
1981	4	102991.8	1275.8	7771.3	10.8	2.0
1982	2	91374.5	1612.5	8416.0	23.5	1.5
1983	3	78415.0	2532.3	9691.7	20.3	2.7
1984	2	191673.5	2012.5	12580.0	25.0	2.0
1985	1	195649.0	2431.0	13770.0	0.0	3.0
1986	5	121352.4	1233.4	10374.4	14.6	1.8
1987	1	210462.0	2150.0	10500.0	41.0	2.0
1988	2	139823.5	1857.5	9921.0	15.5	2.5
1989	8	145068.3	2127.6	16797.8	19.5	2.6
1990	7	131203.7	1627.1	8958.4	18.0	2.3
1991	4	121545.0	1795.8	8460.0	11.5	2.3
1992	12	105419.6	1494.9	21501.7	28.3	1.9
1993	11	133930.7	1648.6	8568.5	12.9	2.2
1994	14	121169.8	1620.0	8401.4	21.5	1.9
1995	1116	149181.4	1847.9	12879.3	20.4	2.2
1996	1816	149692.2	1789.4	11760.3	21.8	2.2
1997	361	164185.9	1817.7	12139.9	25.5	2.2
1998	38	101463.6	1575.2	9213.2	25.0	1.9
1999	1102	175523.3	1629.9	12133.4	29.5	2.0
2000	4156	193405.1	1638.9	11267.2	29.0	2.1
2001	1062	200316.6	1624.1	11812.8	30.4	2.0
Total	9728					

Table A.3 Summary Statistics of Repeat Sale Observations
(by year of initial sale)

Year of Sale	Obs	Mean Price	Mean Living Area	Mean Lot Size	Mean Age	Mean Bath
1980	50	108876.1	1463.5	9346.7	10.8	1.9
1981	56	111055.1	1424.4	9157.7	10.4	2.0
1982	83	133581.7	1652.1	10524.7	11.2	2.1
1983	48	163883.3	1678.4	9960.2	11.3	2.3
1984	120	195656.5	1609.1	10057.1	11.4	2.2
1985	179	159900.2	1600.5	9026.0	10.8	2.2
1986	101	171429.6	1537.9	9701.5	13.1	2.2
1987	100	159350.2	1649.9	10100.6	18.0	2.1
1988	156	139913.1	1744.7	14553.2	14.8	2.3
1989	241	132567.9	1791.7	11064.1	17.1	2.3
1990	287	116498.0	1795.4	11296.8	15.4	2.3
1991	430	115976.1	1787.2	11099.0	17.9	2.3
1992	540	123841.5	1774.1	10142.6	18.5	2.2
1993	613	138818.5	1823.4	12111.9	18.4	2.3
1994	599	142742.2	1830.7	11634.1	19.1	2.3
1995	623	144909.1	1829.8	11299.9	20.9	2.2
1996	597	152827.3	1783.9	9613.5	18.7	2.2
1997	79	158595.8	1839.3	12367.4	20.0	2.2
1998	22	127217.2	1895.5	8990.6	21.9	2.1
1999	177	148511.9	1558.2	10429.4	25.7	2.1
2000	257	173869.3	1611.1	11035.0	31.7	1.9
2001	16	87600.8	1255.3	12262.1	29.5	1.6
Total	5374					

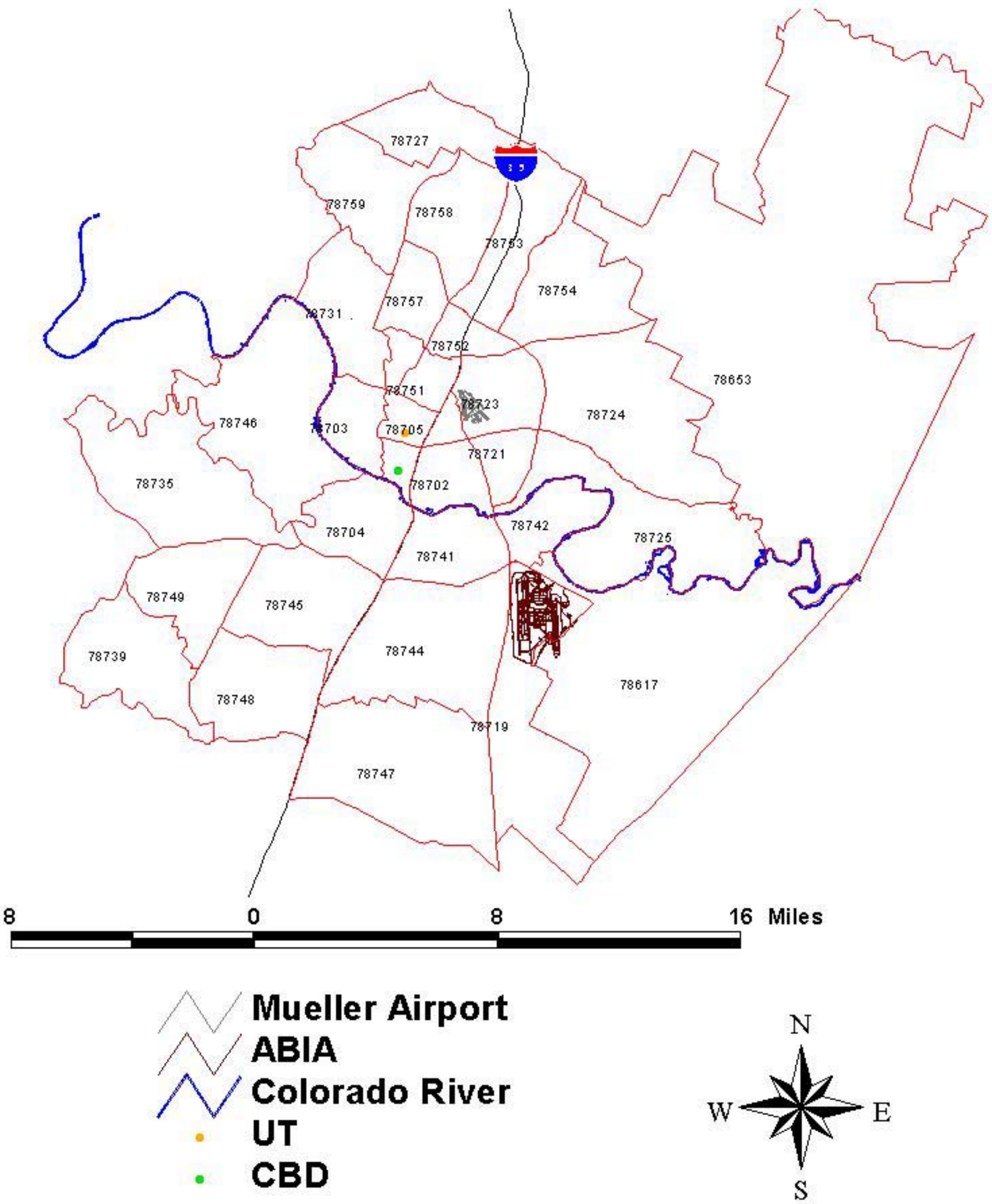
Table A.4 Zip Code Dummy Variables

Variable	Mean*	Standard Deviation
d78617	0.000655	0.025578
d78653	0.001122	0.033482
d78701	0.000281	0.016748
d78702	0.013373	0.11487
d78703	0.039652	0.195145
d78704	0.049659	0.217244
d78705	0.005424	0.07345
d78719	4.68E-05	0.006838
d78721	0.007248	0.084827
d78722	0.011643	0.107276
d78723	0.037501	0.189991
d78724	0.011737	0.107701
d78725	0.000701	0.026475
d78727	0.054615	0.227233
d78731	0.055737	0.229419
d78735	0.017722	0.131942
d78739	0.02193	0.146459
d78741	0.009025	0.094571
d78742	0.000374	0.019338
d78744	0.052885	0.223809
d78745	0.104882	0.306408
d78746	0.058403	0.234509
d78747	0.007248	0.084827
d78748	0.072057	0.258588
d78749	0.086225	0.280702
d78751	0.022725	0.149029
d78752	0.01183	0.108124
d78753	0.049518	0.216953
d78754	0.005751	0.075622
d78756	0.019078	0.136802
d78757	0.047788	0.213323
d78758	0.051249	0.220509
d78759	0.071916	0.258355

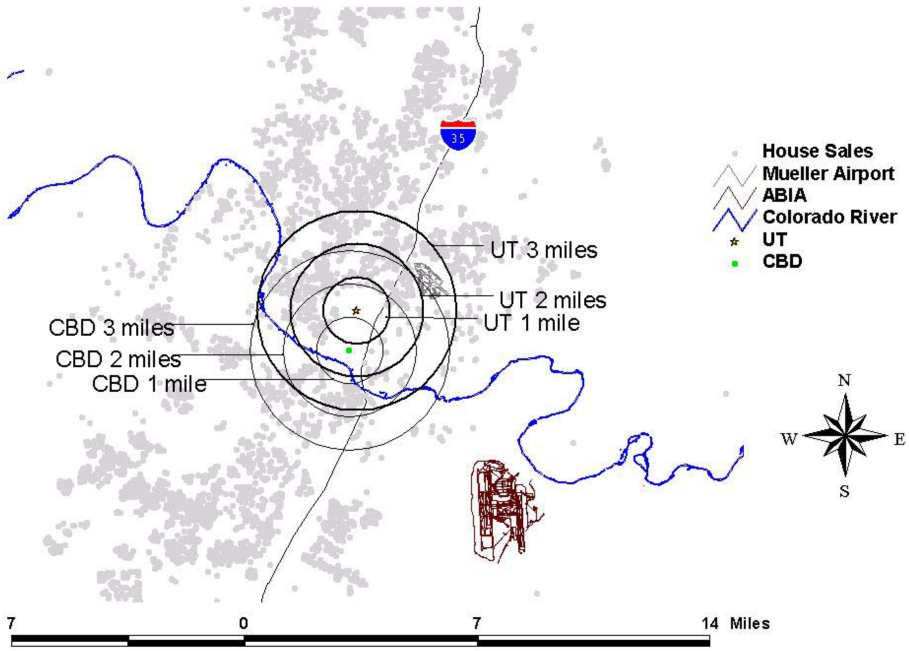
*Mean for zip code dummy variables gives the fraction of the full sample that are located in the zip code.

APPENDIX B: MAPS

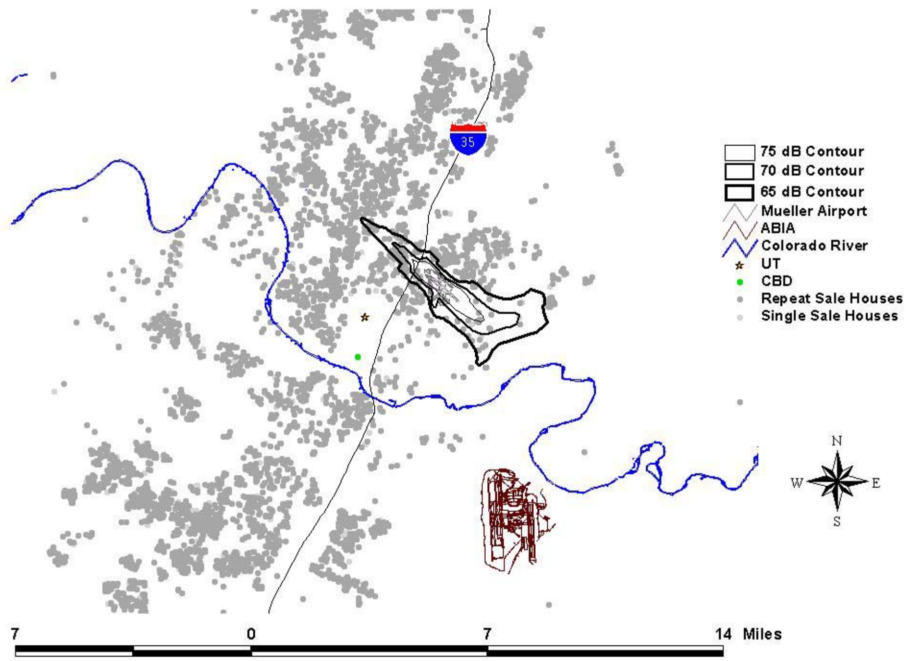
Map B.1 Zip Codes in Austin



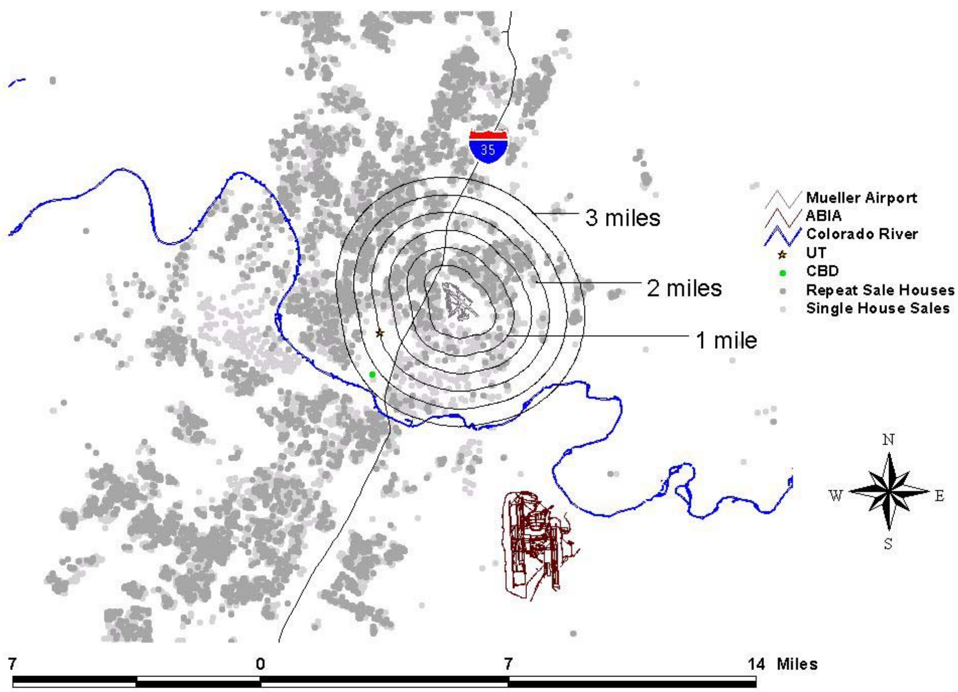
Map B.2 Central Business District (CBD) & The University of Texas (UT)



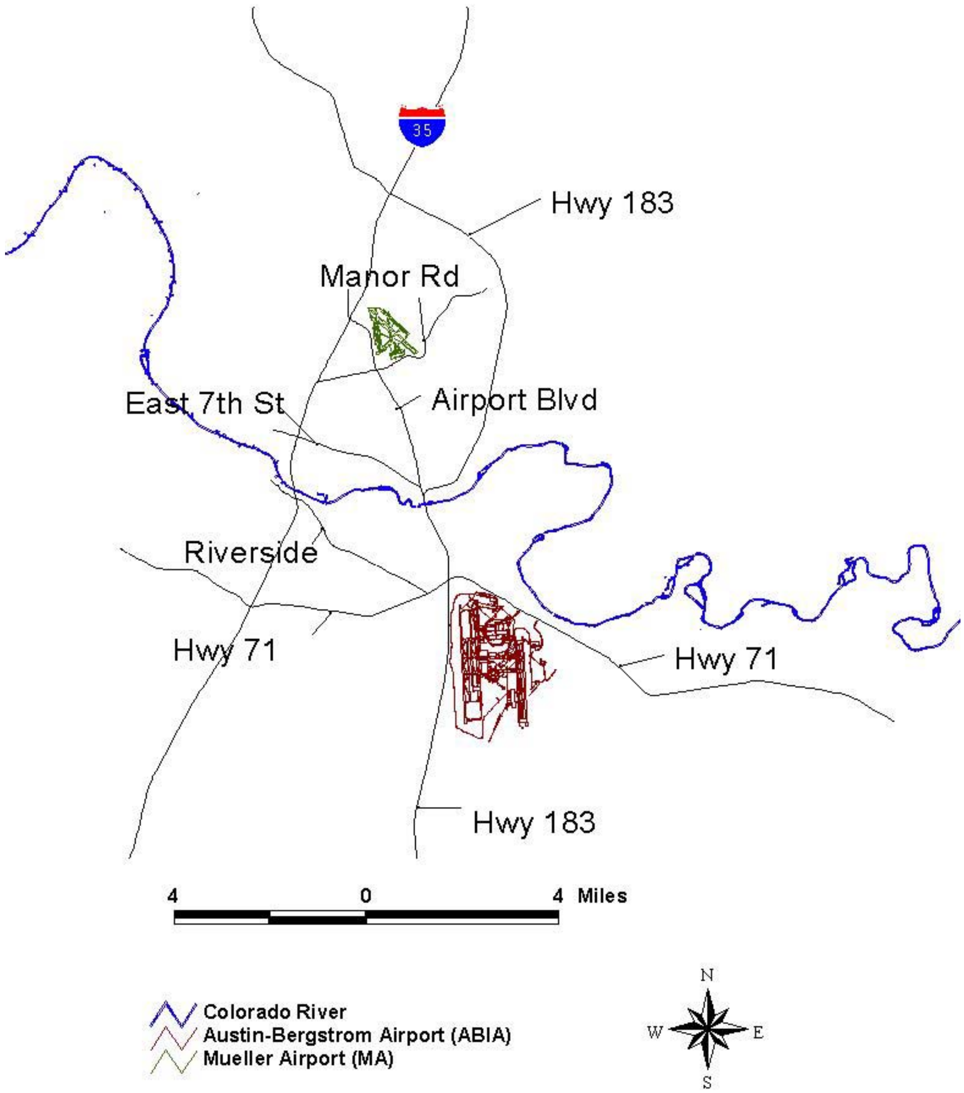
Map B.3 Mueller Airport Noise Contours



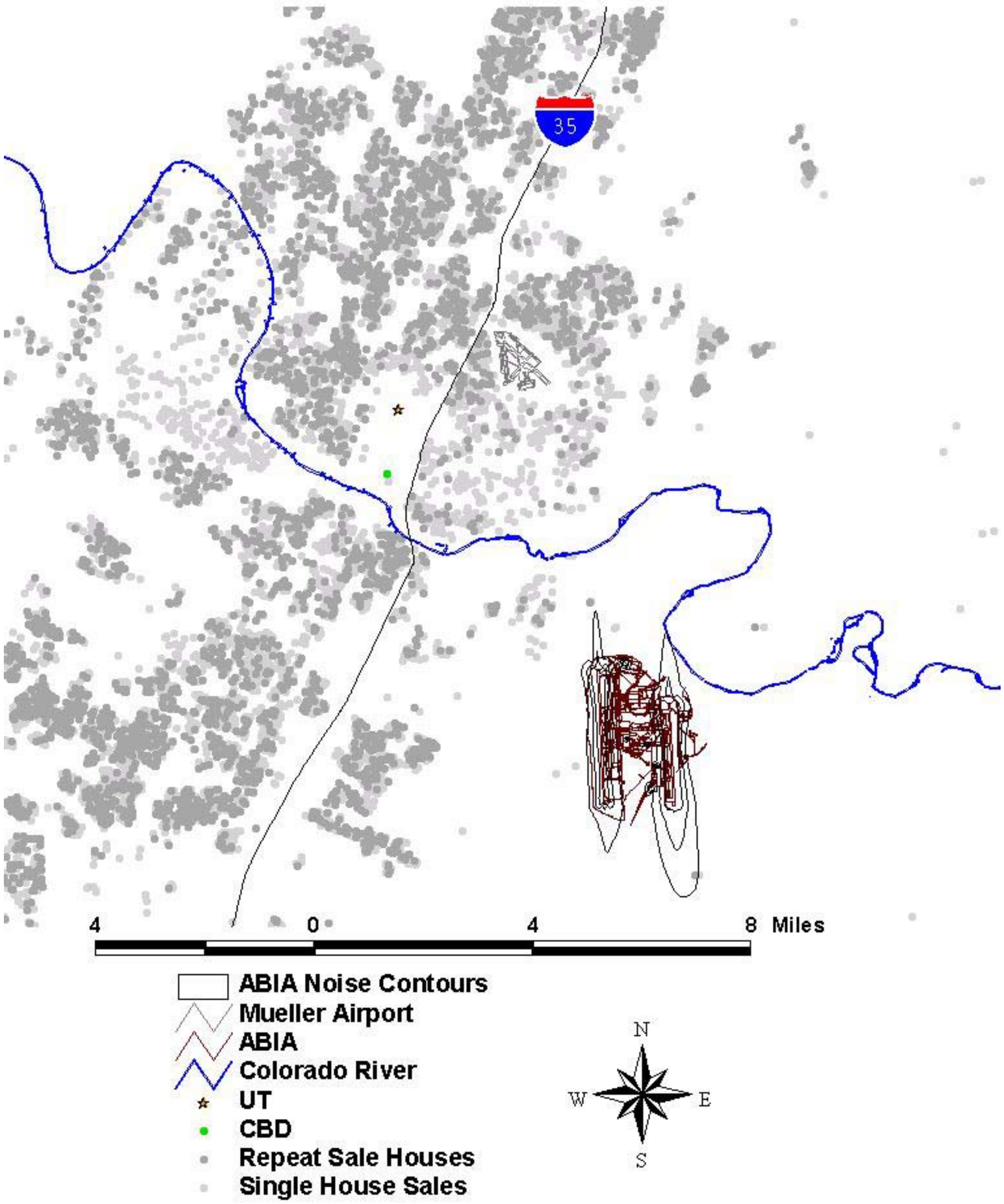
Map B.4 Mueller Airport Distance Contours



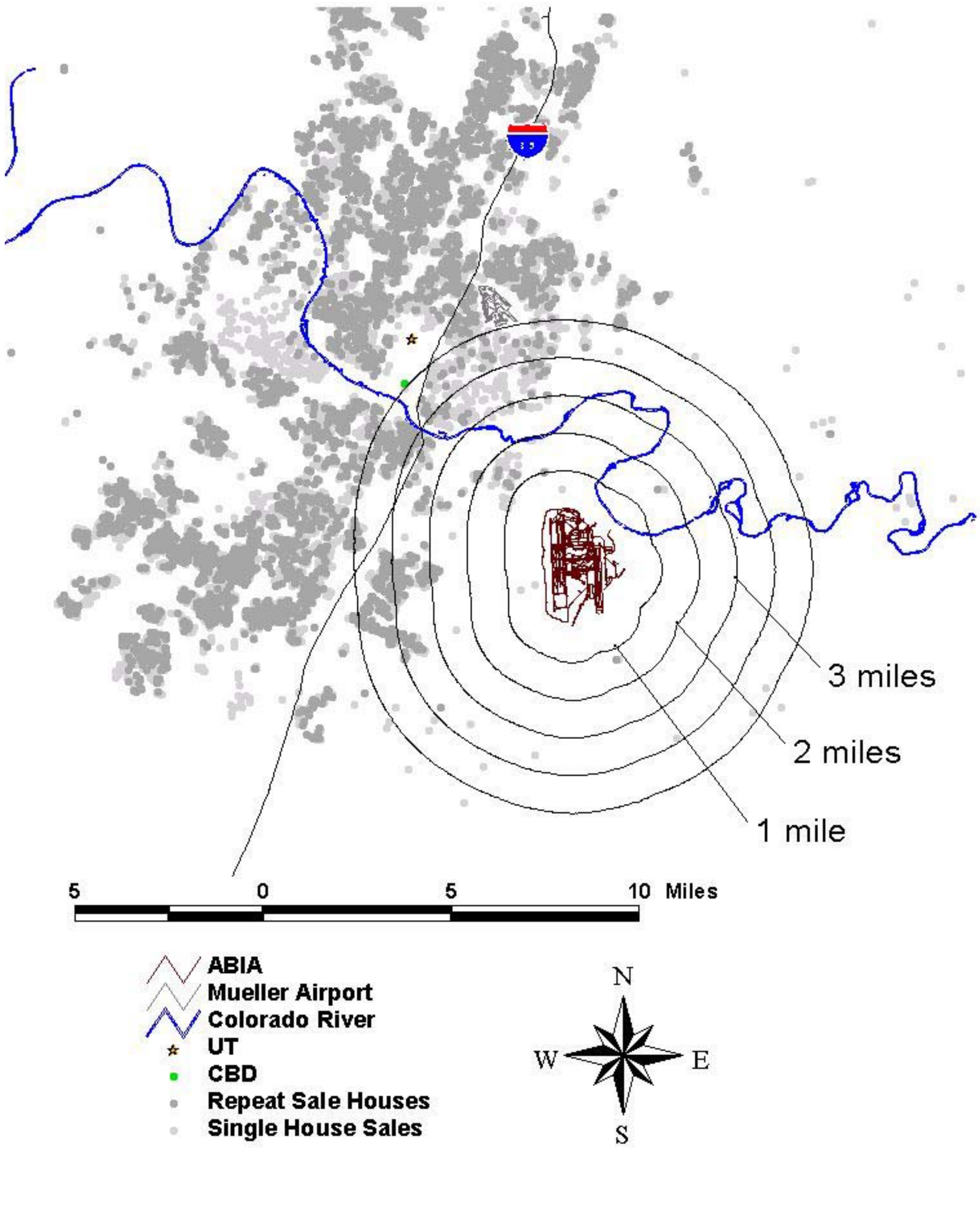
Map B.5 Route to the Airports



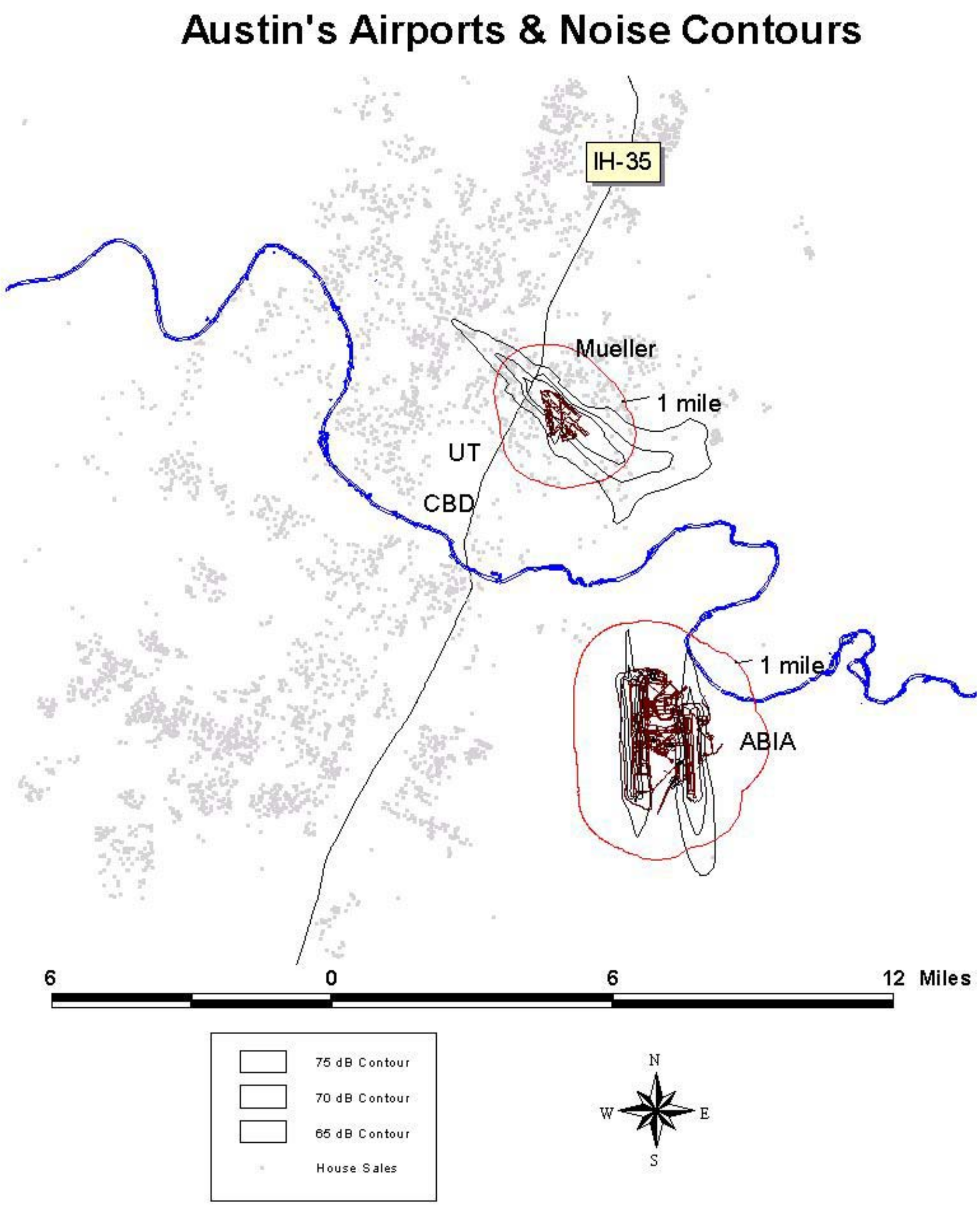
Map B.6 ABIA Noise Contours



Map B.7 ABIA Distance Contours



Map B.8 Austin's Airports Noise and Distance Contours



APPENDIX C: VARIABLE DEFINITIONS

(for Appendices Tables)

Variable Name	Definition
(in order of appearance in following Tables)	
New for Table D.1	
lnprice	natural log of house price; dependent variable
gba	gross building area, in square feet
tla	total lot area, in square feet
age2	between 5 and 10 years old, dummy variable
age3	between 10 and 20 years old, dummy variable
age4	between 20 and 30 years old, dummy variable
age5	between 30 and 50 years old
age6	over 50 years old
dbath2	between 1.5 and 2 bathrooms, dummy variable
dbath3	more than 2 bathrooms, dummy variable
dfire	fireplace, dummy variable
dpool3	swimming pool, dummy variable
dspa	spa, sauna, or hot tub, dummy variable
dgarage	garage, dummy variable
dcarport	carport, dummy variable
dmanuf	manufactured home, dummy variable
dmasonry	masonry construction, dummy variable
dbrick	brick construction, dummy variable
pcthsgrad	percent of census tract that has only a high school degree
pctbchdeg	percent of census tract that has a 4-year college degree
pctgrddeg	percent of census tract that has a graduate degree
pctforbrn	percent of census tract that is foreign born
pctpopbl	percent of census tract that is Black
pctpopna	percent of census tract that is native American
pctpopap	percent of census tract that is Asian Pacific
pctpopoth	percent of census tract categorized as “Other”
pctvachs	percent of lots in census tract that are vacant

Variable Name	Definition
(in order of appearance in following Tables)	
pctownocc	percent of houses in census tract that are owner-occupied
d1980	house sold in 1980, dummy variable
d1981	house sold in 1981, dummy variable
d1982	house sold in 1982, dummy variable
d1983	house sold in 1983, dummy variable
d1984	house sold in 1984, dummy variable
d1985	house sold in 1985, dummy variable
d1986	house sold in 1986, dummy variable
d1987	house sold in 1987, dummy variable
d1988	house sold in 1988, dummy variable
d1989	house sold in 1989, dummy variable
d1990	house sold in 1990, dummy variable
d1991	house sold in 1991, dummy variable
d1992	house sold in 1992, dummy variable
d1993	house sold in 1993, dummy variable
d1994	house sold in 1994, dummy variable
d1995	house sold in 1995, dummy variable
d1996	house sold in 1996, dummy variable
d1997	house sold in 1997, dummy variable
d1998	house sold in 1998, dummy variable
d1999	house sold in 1999, dummy variable
d2000	house sold in 2000, dummy variable
d2001	house sold in 2001, dummy variable
d78617	house located in zip code 78617, dummy variable
d78653	house located in zip code 78653, dummy variable
d78701	house located in zip code 78701, dummy variable
d78702	house located in zip code 78702, dummy variable
d78703	house located in zip code 78703, dummy variable
d78704	house located in zip code 78704, dummy variable
d78705	house located in zip code 78705, dummy variable
d78719	house located in zip code 78719, dummy variable
d78721	house located in zip code 78721, dummy variable
d78722	house located in zip code 78722, dummy variable
d78723	house located in zip code 78723, dummy variable

Variable Name	Definition
(in order of appearance in following Tables)	
d78724	house located in zip code 78724, dummy variable
d78725	house located in zip code 78725, dummy variable
d78727	house located in zip code 78727, dummy variable
d78731	house located in zip code 78731, dummy variable
d78735	house located in zip code 78735, dummy variable
d78739	house located in zip code 78739, dummy variable
d78741	house located in zip code 78741, dummy variable
d78742	house located in zip code 78742, dummy variable
d78744	house located in zip code 78744, dummy variable
d78745	house located in zip code 78745, dummy variable
d78746	house located in zip code 78746, dummy variable
d78747	house located in zip code 78747, dummy variable
d78748	house located in zip code 78748, dummy variable
d78749	house located in zip code 78749, dummy variable
d78751	house located in zip code 78751, dummy variable
d78752	house located in zip code 78752, dummy variable
d78753	house located in zip code 78753, dummy variable
d78754	house located in zip code 78754, dummy variable
d78756	house located in zip code 78756, dummy variable
d78757	house located in zip code 78757, dummy variable
d78758	house located in zip code 78758, dummy variable
d78759	house located in zip code 78759, dummy variable
manoise2	house located in any Mueller Airport noise contour, dummy variable
manoise65	house located in 65-70 dB noise contour, dummy variable
manoise70	house located in 70-75 dB noise contour, dummy variable
manoise75	house located in greater than 75 dB noise contour, dummy variable
madist1	house located within 1/2 mile of Mueller Airport, dummy variable
madist2	house located between 1/2 and 1 mile of Mueller Airport, dummy variable
madist3	house located between 1 and 1.5 miles of Mueller Airport, dummy variable
madist4	house located between 1.5 and 2 miles of Mueller Airport, dummy variable
madist5	house located between 2 and 2.5 miles of Mueller Airport, dummy variable
madist6	houses located between 2.5 and 3 miles of Mueller Airport, dummy variable
manorrd2	house located within 1/4 mile of Manor Rd, dummy variable
manorrd3	house located between 1/4 and 1/2 mile of Manor Rd, dummy variable

Variable Name	Definition
(in order of appearance in following Tables)	
abiaroute2	house located within 1/4 mile of route to ABIA, dummy variable
abiaroute3	house located between 1/4 and 1/2 mile of route to ABIA, dummy variable
dcbd1	house located within 1 mile of central business district, dummy variable
dcbd2	house located between 1 and 2 miles of central business district, dummy variable
dcbd3	house located between 2 and 3 miles of central business district, dummy variable
dut1	house located within 1 mile of the University of Texas, dummy variable
dut2	house located between 1 and 2 miles of the University of Texas, dummy variable
dut3	house located between 2 and 3 miles of the University of Texas, dummy variable
_cons	constant

New for Table D.2

ma658793	interaction between manoise65 and dummy for stage2: sold between 1987 and 1993
ma708793	interaction between manoise70 and dummy for stage2: sold between 1987 and 1993
ma758793	interaction between manoise75 and dummy for stage2: sold between 1987 and 1993
ma659498	interaction between manoise65 and dummy for stage3: sold between 1994 and 1998
ma709498	interaction between manoise70 and dummy for stage3: sold between 1994 and 1998
ma759498	interaction between manoise75 and dummy for stage3: sold between 1994 and 1998
ma6599	interaction between manoise65 and dummy for stage4: sold in 1999
ma7099	interaction between manoise70 and dummy for stage4: sold in 1999
ma7599	interaction between manoise75 and dummy for stage4: sold in 1999
ma650001	interaction between manoise65 and dummy for stage5: sold between 2000 and 2001
ma700001	interaction between manoise70 and dummy for stage5: sold between 2000 and 2001
ma750001	interaction between manoise75 and dummy for stage6: sold between 2000 and 2001
mad18793	interaction between madist1 and dummy for stage2: sold between 1987 and 1993
mad28793	interaction between madist2 and dummy for stage2: sold between 1987 and 1993
mad38793	interaction between madist3 and dummy for stage2: sold between 1987 and 1993
mad48793	interaction between madist4 and dummy for stage2: sold between 1987 and 1993
mad58793	interaction between madist5 and dummy for stage2: sold between 1987 and 1993
mad68793	interaction between madist6 and dummy for stage2: sold between 1987 and 1993
mad19498	interaction between madist1 and dummy for stage3: sold between 1994 and 1998
mad29498	interaction between madist2 and dummy for stage3: sold between 1994 and 1998
mad39498	interaction between madist3 and dummy for stage3: sold between 1994 and 1998
mad49498	interaction between madist4 and dummy for stage3: sold between 1994 and 1998

Variable Name	Definition
(in order of appearance in following Tables)	
mad59498	interaction between madist5 and dummy for stage3: sold between 1994 and 1998
mad69498	interaction between madist6 and dummy for stage3: sold between 1994 and 1998
mad199	interaction between madist1 and dummy for stage4: sold in 1999
mad299	interaction between madist2 and dummy for stage4: sold in 1999
mad399	interaction between madist3 and dummy for stage4: sold in 1999
mad499	interaction between madist4 and dummy for stage4: sold in 1999
mad599	interaction between madist5 and dummy for stage4: sold in 1999
mad699	interaction between madist6 and dummy for stage4: sold in 1999
mad10001	interaction between madist1 and dummy for stage5: sold between 2000 and 2001
mad20001	interaction between madist2 and dummy for stage5: sold between 2000 and 2001
mad30001	interaction between madist3 and dummy for stage5: sold between 2000 and 2001
mad40001	interaction between madist4 and dummy for stage5: sold between 2000 and 2001
mad50001	interaction between madist5 and dummy for stage5: sold between 2000 and 2001
mad60001	interaction between madist6 and dummy for stage5: sold between 2000 and 2001
manor28793	interaction between manorrd2 and dummy for stage2: sold between 1987 and 1993
manor38793	interaction between manorrd3 and dummy for stage2: sold between 1987 and 1993
route28793	interaction between abiaroute2 and dummy for stage2: sold between 1987 and 1993
route38793	interaction between abiaroute3 and dummy for stage2: sold between 1987 and 1993
manor29498	interaction between manorrd2 and dummy for stage3: sold between 1994 and 1998
manor39498	interaction between manorrd3 and dummy for stage3: sold between 1994 and 1998
route29498	interaction between abiaroute2 and dummy for stage3: sold between 1994 and 1998
route39498	interaction between abiaroute3 and dummy for stage3: sold between 1994 and 1998
manor299	interaction between manorrd2 and dummy for stage4: sold in 1999
manor399	interaction between manorrd3 and dummy for stage4: sold in 1999
route299	interaction between abiaroute2 and dummy for stage4: sold in 1999
route399	interaction between abiaroute3 and dummy for stage4: sold in 1999
manor20001	interaction between manorrd2 and dummy for stage5: sold between 2000 and 2001
manor30001	interaction between manorrd3 and dummy for stage5: sold between 2000 and 2001
route20001	interaction between abiaroute2 and dummy for stage5: sold between 2000 and 2001
route30001	interaction between abiaroute3 and dummy for stage5: sold between 2000 and 2001
New for Table F.1	
lndep_ratio	natural log of house price ratio, depreciation adjusted; dependent variable

Variable Name (in order of appearance in following Tables)	Definition
lnp_ratio	natural log of house price ratio, NOT depreciation adjusted; dependent variable
Age Difference	difference in age of house between first and second sale
Event Dummy	dummy variable for one of five events: vote, list, close, build, or open
manoise3	house located in greater than 70 dB noise contour, dummy variable
mills	Mills ratio, calculated from Probit model
New for Table F.2	
age	age of house, in years
agesq	squared value of age of house in years

APPENDIX D: REGRESSION RESULTS FOR SITING STAGE MODELS

Table D.1 Phase Model - Mueller Airport Analysis

lnprice	**1980-87**	**1987-93**	**1994-998**	**1999**	**2000-2001**
gba	2.62E-04	2.34E-04	0.0002542	0.0002881	0.0003329
	(6.65)	(11.64)	(30.69)	(13.4)	(31.56)
tla	2.70E-06	3.15E-07	1.44E-06	2.10E-06	3.57E-06
	(1.03)	(0.5)	(5.21)	(5.22)	(10.74)
age2	-0.10	-0.3427264	-0.4305665	-0.0608355	-0.0116655
	(-2.82)	(-13.2)	(-27.06)	(-1.39)	(-0.57)
age3	0.02	-0.2072449	-0.2051135	-0.203022	-0.1028777
	(0.44)	(-7.15)	(-15.8)	(-6.04)	(-5.51)
age4	-0.03	-0.1669155	-0.2011147	-0.2253302	-0.1179404
	(-0.4)	(-4.1)	(-12.48)	(-6.06)	(-6.01)
age5	-0.02	-0.2153791	-0.2266616	-0.2309923	-0.1129549
	(0.2)	(-4.31)	(-11.21)	(-5.35)	(-4.99)
age6	-0.04	-0.1149449	-0.2218095	-0.1717579	-0.1006376
	(-0.25)	(-1.7)	(-8.15)	(-3.13)	(-3.57)
dbath2	0.13	0.1366808	0.0982528	0.0475013	0.0126938
	(2.4)	(4.14)	(7.00)	(1.55)	(0.86)
dbath3	0.16	0.2523329	0.146175	0.0640401	0.0100552
	(2.39)	(6.1)	(8.12)	(1.57)	(0.50)
dfire	0.16	0.0919557	0.054505	0.0047007	0.0174147
	(4.31)	(3.43)	(4.50)	(0.18)	(1.36)
dpool3	0.07	0.1888004	0.1373202	0.1232929	0.0416263
	(1.19)	(5.61)	(8.54)	(3.20)	(2.09)
dspa	0.17	0.1452485	0.1180054	0.0934733	0.1083745
	(1.77)	(3.03)	(4.46)	(1.51)	(3.01)
dgarage	0.07	0.1156343	0.1258677	0.0717965	0.0887036
	(1.35)	(3.34)	(8.35)	(2.43)	(5.68)
dcarport	-0.06	0.0939263	0.1368809	0.0528578	0.0911175
	(-0.91)	(2.08)	(7.09)	(1.41)	(4.78)
dmanuf	-0.78		-0.6812037	-0.1565473	
	(-2.09)		(-2.14)	(-0.42)	
dmasonry	-0.45	-0.0611365	0.0709328	-0.2418429	0.0955626
	(-1.56)	(-0.33)	(1.07)	(-1.61)	(1.67)

Table D.1 Phase Model - Mueller Airport Analysis

lnprice	1980-87	1987-93	1994-998	1999	2000-2001
dbrick	0.02	-0.0877029	0.026542	0.050249	0.0467728
	(0.6)	(-4.2)	(2.72)	(2.30)	(4.20)
pcthsgrad	0.29	-2.703401	-0.8442783	-0.382898	0.3297975
	(0.33)	(-4.62)	(-3.29)	(-0.72)	(1.22)
pctbchdeg	-0.63	-0.88692	0.244326	-0.5494313	0.1253069
	(-0.77)	(-1.84)	(1.09)	(-1.18)	(0.52)
pctgrddeg	2.55	0.5272484	2.024945	2.711018	1.426991
	(2.45)	(0.88)	(7.39)	(4.50)	(4.68)
pctforbrn	-0.58	3.214311	-1.324227	0.2875694	-0.1854989
	(-0.48)	(4.52)	(-4.18)	(0.45)	(-0.56)
pctpopbl	0.05	-0.965626	-0.4430848	-0.9568945	-0.4277038
	(0.14)	(-3.94)	(-5.10)	(-5.61)	(-5.15)
pctpopna	-1.26	4.021718	1.859597	0.2627046	-0.2831276
	(-0.36)	(1.6)	(1.66)	(0.11)	(-0.24)
pctpopap	-0.87	-5.532417	1.047858	0.3298501	-0.1826978
	(-0.56)	(-6.52)	(2.77)	(0.42)	(-0.46)
pctpopoth	-0.22	-1.654241	0.0456053	-0.032342	-0.2522085
	(-0.47)	(-5.64)	(0.36)	(-0.13)	(-1.95)
pctvachs	0.57	-0.5995145	0.3335536	0.5808418	0.0142593
	(0.88)	(-1.27)	(1.72)	(1.54)	(0.07)
pctownocc	0.00	0.24927	0.0096059	0.0933672	-0.0385073
	(0.01)	(2.77)	(0.23)	(1.05)	(-0.84)
d1981	-0.05				
	(-0.8)				
d1982	0.00				
	(-0.07)				
d1983	0.02				
	(0.35)				
d1984	0.24				
	(4.72)				
d1985	0.27				
	(5.53)				
d1986	0.25				
	(4.58)				
d1988		0.0451684			
		(1.22)			
d1989		-0.0246554			

Table D.1 Phase Model - Mueller Airport Analysis

lnprice	**1980-87**	**1987-93**	**1994-998**	**1999**	**2000-2001**
		(-0.76)			
d1991		-0.1028731			
		(-3.71)			
d1992		-0.0385278			
		(-1.44)			
d1993		-0.01696			
		(-0.65)			
d1995			0.0322088		
			(2.31)		
d1996			0.0574888		
			(4.26)		
d1997			0.0601022		
			(3.48)		
d1998			-0.1206804		
			(-3.35)		
d2001					0.0633666
					(6.17)
d78617	-0.03		-0.7855064	-0.3796617	-0.5745608
	(-0.1)		(-2.47)	(-1.73)	(-4.05)
d78653		0.7873801	0.1810903	-0.006258	-0.6041786
		(3.38)	(1.30)	(-0.03)	(-4.33)
d78701			0.8064896	-0.3977268	-0.2375128
			(2.46)	(-1.01)	(-1.02)
d78702	-0.10	-1.053571	-0.6211405	-0.5934237	-0.4535744
	(-0.33)	(-5.24)	(-8.19)	(-4.03)	(-6.26)
d78703	0.52	0.0228168	0.1510739	-0.0128569	0.2373821
	(2.72)	(0.22)	(3.18)	(-0.13)	(4.69)
d78704	0.05	-0.0214877	0.1217466	0.0011421	0.1641535
	(0.39)	(-0.26)	(3.04)	(0.01)	(3.79)
d78705	-2.20	-0.2020635	0.0814569	0.0435535	0.2566598
	(0.44)	(-1.09)	(0.93)	(0.27)	(2.72)
d78719					-0.4751076
					(-1.24)
d78721	-1.58	-0.8709959	-0.1886498	-0.4034457	-0.3234436
	(-5.25)	(-2.91)	(-2.08)	(-2.67)	(-4.12)
d78722	0.48	-0.2652457	0.0709865	-0.2860847	0.0124606
	(1.21)	(-1.15)	(0.87)	(-1.81)	(0.16)

Table D.1 Phase Model - Mueller Airport Analysis

lnprice	1980-87	1987-93	1994-998	1999	2000-2001
d78723	-0.15	-0.2267731	-0.0570748	-0.1671292	-0.1099233
	(-0.57)	(-1.39)	(-0.94)	(-1.36)	(-1.91)
d78724	-0.22	0.0077492	0.2513388	-0.049523	-0.2540038
	(0.31)	(0.04)	(4.13)	(-0.39)	(-3.74)
d78725	-0.43	0.4289549	-0.3350374	-0.1244185	-0.2996376
	(-1.00)	(0.99)	(-2.44)	(-0.33)	(-1.83)
d78727	-0.14	-0.0328676	-0.0438047	-0.101194	-0.0904167
	(-1.41)	(-0.6)	(-1.67)	(-1.73)	(-3.05)
d78731	-0.07	0.0221564	-0.0166742	-0.0427733	0.1003241
	(-0.64)	(0.33)	(-0.53)	(-0.60)	(2.75)
d78735	-0.01	0.0222401	-0.2148127	-0.1460354	-0.0401561
	(-0.06)	(0.27)	(-6.96)	(-1.55)	(-0.98)
d78739	0.08	0.0141695	0.0684202	-0.1825838	-0.1088306
	(0.52)	(0.19)	(2.16)	(-2.56)	(-2.92)
d78741	-0.45	-0.0505509	-0.1811752	-0.486662	-0.2722828
	(-1.76)	(-0.37)	(-3.40)	(-4.31)	(-4.69)
d78742		-0.9596659	-0.33364	-0.5609631	-0.7016161
		(-2.24)	(-1.04)	(-2.45)	(-3.11)
d78744	-0.24	-0.1234831	-0.2703164	-0.3961035	-0.3298018
	(-2.16)	(-1.66)	(-7.91)	(-5.43)	(-8.89)
d78745	-0.18	-0.1183966	-0.0768935	-0.2230949	-0.1900046
	(-2.06)	(-2.04)	(-2.83)	(-3.72)	(-6.39)
d78746	0.19	-0.048995	0.1106046	0.0774865	0.2270771
	(1.76)	(-0.8)	(3.76)	(1.13)	(6.60)
d78747	-0.39	0.1932657	0.2423391	-0.1680338	-0.0663494
	(0.12)	(1.92)	(4.51)	(-1.60)	(-1.21)
d78748	-0.15	-0.3176521	-0.0138854	-0.1573359	-0.1634756
	(-1.61)	(-5.55)	(-0.52)	(-2.59)	(-5.44)
d78749	-0.22	-0.0164169	-0.0405877	-0.1612989	-0.151772
	(-2.72)	(-0.33)	(-1.75)	(-2.99)	(-5.80)
d78751	-0.20	-0.0332009	0.1752547	-0.0780202	0.1361293
	(-0.70)	(-0.19)	(2.67)	(-0.57)	(2.11)
d78752	-0.05	-0.2122048	0.080056	-0.0216387	-0.0057084
	(-0.24)	(-1.37)	(1.31)	(-0.17)	(-0.09)
d78753	-0.29	0.0051353	-0.0499893	-0.2006323	-0.2104078
	(-2.97)	(0.08)	(-1.68)	(-3.19)	(-6.50)
d78754	0.01	0.2443674	-0.0178611	-0.1418497	-0.2448554

Table D.1 Phase Model - Mueller Airport Analysis

lnprice	**1980-87**	**1987-93**	**1994-998**	**1999**	**2000-2001**
	(0.05)	(1.26)	(-0.33)	(-1.24)	(-4.02)
d78756	0.12	0.1234738	0.2001831	0.0402142	0.2238053
	(0.47)	(1.12)	(4.12)	(0.37)	(4.21)
d78757	-0.10	0.0376949	0.0926142	0.1334379	0.0874113
	(-1.10)	(0.59)	(3.19)	(2.07)	(2.72)
d78758	-0.11	0.0278587	-0.0583649	-0.203974	-0.1636918
	(-1.36)	(0.48)	(-2.17)	(-3.31)	(-5.52)
manoise2					
manoise65	-0.10	-0.0550523	-0.0950655	0.0853733	0.0297555
	(-0.74)	(-0.46)	(-2.26)	(1.19)	(0.81)
manoise70	0.28	-0.1688074	-0.2421375	0.1307599	0.0643627
	(1.07)	(-0.92)	(-3.54)	(1.12)	(1.08)
manoise75	-0.03	-0.1641373	-0.2417874	0.3898175	0.2008142
	(-0.10)	(-0.54)	(-1.24)	(1.03)	(2.07)
madist1	0.30	0.0491092	0.0537751	-0.0788071	-0.119564
	(1.14)	(0.25)	(0.74)	(-0.53)	(-1.69)
madist2	0.21	-0.0313781	0.0927932	0.0913303	0.0460233
	(0.91)	(-0.2)	(1.59)	(0.76)	(0.84)
madist3	0.43	0.0078387	0.011259	-0.0131273	0.0529542
	(1.74)	(0.05)	(0.20)	(-0.11)	(1.00)
madist4	-0.29	0.0688804	-0.0858941	-0.0788822	-0.0438315
	(-1.41)	(0.49)	(-1.70)	(-0.80)	(-0.95)
madist5	0.02	-0.0355882	-0.0239556	-0.0219084	0.029462
	(0.13)	(-0.34)	(-0.59)	(-0.27)	(0.77)
madist6	0.17	0.0530179	0.1224844	0.0130781	0.0408051
	(1.64)	(0.96)	(5.24)	(0.24)	(1.59)
manorrd2	-0.30	0.1344145	-0.2057887	-0.1463644	-0.1334768
	(-1.60)	(0.83)	(-3.48)	(-1.20)	(-2.43)
manorrd3	-0.44	0.2546136	-0.1459204	0.1199764	-0.1090736
	(-2.41)	(2.39)	(-3.44)	(1.43)	(-2.88)
abiaroute2	0.45	-0.0328077	0.0854765	-0.1056788	0.0067802
	(2.78)	(-0.34)	(2.24)	(-1.31)	(0.18)
abiaroute3	0.10	-0.0771814	0.0304806	0.057718	0.0282066
	(0.88)	(-1.24)	(1.20)	(1.12)	(1.07)
dcbd1		0.287799	-0.0111683	0.3491263	0.1953725
		(1.48)	(-0.12)	(2.65)	(2.27)

Table D.1 Phase Model - Mueller Airport Analysis

lnprice	**1980-87**	**1987-93**	**1994-998**	**1999**	**2000-2001**
dcbd2	-0.03	0.1410299	0.0265697	0.0469865	0.1600715
	(-0.17)	(1.59)	(0.62)	(0.56)	(3.70)
dcbd3	-0.18	0.1077454	-0.008904	0.1073622	0.1061732
	(-1.69)	(1.69)	(-0.29)	(1.84)	(3.45)
dut1	2.52	0.1418896	0.2657121	0.4502477	0.1921643
	(6.42)	(0.7)	(3.03)	(2.61)	(2.11)
dut2	-0.25	0.0150214	0.0684207	0.2274176	0.1763875
	(-1.34)	(0.15)	(1.58)	(2.56)	(3.87)
dut3	-0.22	0.0932271	0.0634628	0.1784963	0.0606943
	(-2.01)	(1.65)	(2.47)	(3.19)	(2.15)
_cons	10.97	11.57655	11.06583	11.35358	11.29665
	(40.59)	(68.08)	(147.24)	(69.75)	(138.13)
Number of obs	684	2623	7474	1947	8659
F-Stat	21.15	57.96	248.34	56.78	187.21

Table E.2 Full Regression Results for Pooled Model

Base case for comparison is a new house with a single bath, constructed of wood in zip code 78759, more than three miles away from either the central business district or UT.

Number of obs	=	21387
F(151, 21235)	=	279.14
Prob > F	=	0.0000
R-squared	=	0.6650
Adj R-squared	=	0.6626
Root MSE	=	.36969

lnprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
cons	10.96	.0546877	200.47	0.000	10.85599	11.0703
gba	.00028	6.13e-06	46.67	0.000	.000274	.000298
tla	2.1e-06	1.86e-07	11.29	0.000	1.73e-06	2.46e-06
age2	-.2422	.0105384	-22.99	0.000	-.2628969	-.2215847
age3	-.1813	.0095247	-19.04	0.000	-.2000247	-.1626865
age4	-.2121	.0111665	-18.99	0.000	-.2339954	-.1902209
age5	-.2106	.0136321	-15.45	0.000	-.2373325	-.1838925
age6	-.1568	.0178366	-8.79	0.000	-.191783	-.1218609
dbath2	.05923	.0094779	6.25	0.000	.0406553	.07781
dbath3	.09143	.0124693	7.33	0.000	.0669945	.115876
dfire	.03462	.008055	4.30	0.000	.0188364	.050413
dpool3	.10524	.0115814	9.09	0.000	.0825398	.1279405
dspa	.10976	.0191012	5.75	0.000	.0723245	.1472042
dgarage	.1058	.0099736	10.61	0.000	.086266	.1253641
dcarport	.1160	.0125108	9.28	0.000	.0915196	.140564
dmanuf	-.4865	.2176257	-2.24	0.025	-.913153	-.0600272
dmasonry	.0614	.0412889	1.49	0.137	-.019489	.1423698
dbrick	.0354	.0066501	5.33	0.000	.0224435	.048513
pcthsgrad	-.4346	.171441	-2.54	0.011	-.7706981	-.0986237
pctbchdeg	-.1696	.150299	-1.13	0.259	-.464245	.1249497
pctgrddeg	1.783	.1877522	9.50	0.000	1.415021	2.151038
pctforbrn	-.2411	.2100846	-1.15	0.251	-.6528867	.1706766
pctpopbl	-.4615	.0555589	-8.31	0.000	-.5704578	-.3526584
pctpopna	.8944	.7549879	1.18	0.236	-.5853909	2.374276
pctpopap	-.3161	.2518957	-1.25	0.210	-.8098441	.1776252
pctpopoth	-.2416	.0829213	-2.91	0.004	-.4041376	-.0790735
pctvachs	.0747	.1270543	0.59	0.556	-.1742965	.3237754
pctownocc	.0294	.0283523	1.04	0.298	-.0260883	.0850569

lnprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
d1980	.2432	.0539016	4.51	0.000	.1376171	.3489195
d1981	.1972	.0522948	3.77	0.000	.0947605	.2997641
d1982	.2426	.0462623	5.25	0.000	.152014	.3333691
d1983	.2148	.0541171	3.97	0.000	.1087776	.3209247
d1984	.5166	.0397337	13.00	0.000	.4387189	.5944811
d1985	.5257	.035333	14.88	0.000	.4565134	.5950242
d1986	.4892	.0422058	11.59	0.000	.4065102	.5719633
d1987	.4001	.0413953	9.67	0.000	.3190538	.4813298
d1988	.1555	.0349041	4.46	0.000	.0871575	.223987
d1989	.0866	.0308482	2.81	0.005	.0262096	.1471393
d1991	-.0048	.0269641	-0.18	0.858	-.0576876	.0480157
d1992	.07087	.0258785	2.74	0.006	.0201502	.1215979
d1993	.0697	.0252253	2.76	0.006	.0202667	.1191535
d1994	.1750	.0256185	6.83	0.000	.124817	.2252454
d1995	.2172	.0226123	9.61	0.000	.1729078	.2615514
d1996	.2561	.022219	11.53	0.000	.2125803	.2996819
d1997	.2485	.0255573	9.72	0.000	.1984292	.2986176
d1998	.0952	.044835	2.12	0.034	.0073787	.1831387
d1999	.4244	.0233772	18.16	0.000	.378665	.4703071
d2000	.5305	.0219188	24.20	0.000	.4875547	.5734797
d2001	.5976	.0232389	25.72	0.000	.5521136	.6432135
d78617	-.4006	.1025554	-3.91	0.000	-.6016376	-.199605
d78653	-.1229	.0835004	-1.47	0.141	-.2865749	.0407593
d78701	.2578	.1587879	1.62	0.104	-.0533884	.5690844
d78702	-.5796	.0481464	-12.04	0.000	-.6740464	-.4853054
d78703	.1325	.0317691	4.17	0.000	.0703066	.1948464
d78704	.0779	.0267979	2.91	0.004	.0253741	.1304261
d78705	.1100	.0577031	1.91	0.056	-.0030174	.2231875
d78719	-.4569	.370532	-1.23	0.217	-1.183262	.2692796
d78721	-.4015	.0536323	-7.49	0.000	-.5066956	-.2964488
d78722	-.0186	.0520417	-0.36	0.720	-.1206291	.0833824
d78723	-.1253	.0388004	-3.23	0.001	-.2014322	-.0493289
d78724	-.0478	.0421564	-1.13	0.257	-.1304596	.0347998
d78725	-.3207	.1013757	-3.16	0.002	-.519456	-.1220479
d78727	-.0907	.0180106	-5.04	0.000	-.1260338	-.0554296
d78731	.01237	.021858	0.57	0.571	-.0304643	.0552224
d78735	-.1804	.0237056	-7.61	0.000	-.2269184	-.1339889
d78739	-.0579	.0226265	-2.56	0.010	-.1023447	-.0136455
d78741	-.2634	.0368437	-7.15	0.000	-.3356674	-.1912344
d78742	-.6483	.1355777	-4.78	0.000	-.914084	-.3825991
d78744	-.3285	.0229192	-14.34	0.000	-.3735101	-.2836635
d78745	-.1687	.0183387	-9.20	0.000	-.2046556	-.1327649
d78746	10532	.0204888	5.14	0.000	.0651692	.1454884
d78747	.0071	.0335604	0.21	0.830	-.0585844	.0729774
d78748	-.1703	.0182707	-9.32	0.000	-.2061842	-.1345605
d78749	-.1207	.0159566	-7.57	0.000	-.1520219	-.0894695
d78751	.1038	.0429594	2.42	0.016	.0196686	.1880758
d78752	.0138	.0399689	-0.35	0.728	-.0922169	.0644674

lnprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval
d78753	-.1671	.0199861	-8.36	0.000	-.206312	-.1279635
d78754	-.1198	.03877	-3.09	0.002	-.1958736	-.0438893
d78756	.1586	.033269	4.77	0.000	.0934226	.2238421
d78757	.0718	.0197445	3.64	0.000	.0331267	.110528
d78758	-.1234	.0181821	-6.79	0.000	-.159069	-.0877923
ma658793	-.0757	.1682678	-0.45	0.653	-.4055728	.2540623
ma708793	-.5219	.3098329	-1.68	0.092	-1.129268	.0853237
ma758793	-.6560	.4688006	-1.40	0.162	-1.574917	.2628522
ma659498	-.0087	.1487795	-0.06	0.953	-.3003704	.2828676
ma709498	-.3970	.2842953	-1.40	0.163	-.9542613	.1602193
ma759498	-.2884	.4584155	-0.63	0.529	-1.186981	.6100775
ma6599	-.0173	.1570425	-0.11	0.912	-.3251848	.2904455
ma7099	-.3188	.2966357	-1.07	0.282	-.9002885	.2625683
ma7599	.0031	.5540545	0.01	0.996	-1.082889	1.089089
ma650001	-.0419	.1461221	-0.29	0.774	-.3283677	.2444531
ma700001	-.2739	.2806687	-0.98	0.329	-.8241152	.2761486
ma750001	-.0739	.4108766	-0.18	0.857	-.8793274	.7313712
mad18793	-.1662	.1904476	-0.87	0.383	-.5395216	.2070619
mad28793	-.0129	.1342836	-0.10	0.923	-.2761948	.250217
mad38793	-.0757	.1650186	-0.46	0.646	-.3992118	.2476862
mad48793	.2141	.1328017	1.61	0.107	-.04618	.4744229
mad58793	.0900	.1085456	0.83	0.407	-.1227315	.3027838
mad68793	-.2732	.0970237	-2.82	0.005	-.4634214	-.0830738
mad19498	-.1143	.1660229	-0.69	0.491	-.4397331	.2111017
mad29498	.1440	.1198061	1.20	0.229	-.0907743	.3788836
mad39498	-.0114	.155141	-0.07	0.941	-.3155314	.2926446
mad49498	.1115	.1167782	0.96	0.339	-.1173311	.3404571
mad59498	.1100	.1005607	1.09	0.274	-.0871047	.3071084
mad69498	-.0836	.0925301	-0.90	0.366	-.2650108	.097721
mad199	-.0367	.1833367	-0.20	0.841	-.396091	.3226165
mad299	.3221	.1289828	2.50	0.013	.0693349	.5749671
mad399	.1353	.1628994	0.83	0.406	-.183907	.4546831
mad499	.2810	.1230007	2.28	0.022	.0399105	.522092
mad599	.2628	.1078954	2.44	0.015	.0513207	.4742871
mad699	-.1152	.0981049	-1.17	0.240	-.307549	.0770371
mad10001	-.1206	.1631862	-0.74	0.460	-.4404802	.1992345
mad20001	.2587	.1180244	2.19	0.028	.0273983	.4900717
mad30001	.1546	.1538959	1.01	0.315	-.1469677	.4563277
mad40001	.2536	.1143692	2.22	0.027	.0294824	.4778271
mad50001	.2830	.1002353	2.82	0.005	.0865491	.4794867
mad60001	-.0964	.0922773	-1.05	0.296	-.2773061	.0844349
manor28793	-.3840	.1774456	-2.16	0.030	-.7318882	-.0362745
manor38793	-.1377	.1210112	-1.14	0.255	-.3749293	.0994529
route28793	-.1955	.134697	-1.45	0.147	-.459596	.0684365
route38793	-.0203	.0837187	-0.24	0.808	-.1844748	.1437152
manor29498	-.3960	.1468082	-2.70	0.007	-.6838143	-.1083039
manor39498	-.2149	.1080278	-1.99	0.047	-.4267329	-.0032474
route29498	-.1034	.1213395	-0.85	0.394	-.3412785	.1343907
route39498	.1223	.0772301	1.58	0.113	-.0289993	.2737542

lnprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval
manor299	-.7362	.1637858	-4.50	0.000	-1.057316	-.4152504
manor399	-.2822	.1159802	-2.43	0.015	-.5095818	-.0549217
route299	-.1715	.1323191	-1.30	0.195	-.4308742	.0878368
route399	.2560	.0819962	3.12	0.002	.0953204	.4167578
manor20001	-.4342	.1438576	-3.02	0.003	-.7162208	-.1522772
manor30001	-.2814	.1064067	-2.65	0.008	-.4900611	-.0729309
route20001	-.0637	.119502	-0.53	0.594	-.2979651	.1705006
route30001	.2166	.0764022	2.84	0.005	.0669279	.3664361
manoise65	.0145	.142548	0.10	0.919	-.2649019	.2939078
manoise70	.2971	.2758416	1.08	0.281	-.2435682	.8377724
manoise75	.2290	.4005552	0.57	0.567	-.5560271	1.01421
madist1	.0598	.1611439	0.37	0.710	-.2560089	.3756997
madist2	-.1539	.1178355	-1.31	0.191	-.3849233	.0770097
madist3	-.0506	.15377	-0.33	0.745	-.3514618	.2513398
madist4	-.2571	.1139011	-2.26	0.024	-.4804491	-.0339394
madist5	-.2073	.1000845	-2.07	0.038	-.4035174	-.0111711
madist6	.1742	.0910955	1.91	0.056	-.0042678	.3528405
manorrd2	.2996	.1391604	2.15	0.031	.026916	.572446
manorrd3	.1608	.1050544	1.53	0.126	-.0450748	.3667542
abiaroute2	.1074	.1173422	0.92	0.360	-.1225408	.3374584
abiaroute3	-.1544	.0753724	-2.05	0.040	-.3021587	-.0066876
dcbd1	.1771	.0540046	3.28	0.001	.0713303	.2830364
dcbd2	.1101	.0277477	3.97	0.000	.0557918	.1645671
dcbd3	.0701	.0197166	3.56	0.000	.0315536	.1088458
dut1	.2347	.0578808	4.06	0.000	.1212977	.3481993
dut2	.1213	.0290232	4.18	0.000	.0644558	.1782311
dut3	.0740	.0175907	4.21	0.000	.0395671	.1085254

APPENDIX E: SAMPLE SELECTION STATISTICS

Table E.1 Number of Residential Sales and Mean Sale Prices in Study Area, by Year

	Residential Properties that Sold Twice During the Study Period**		Residential Properties that Sold Once During the Study Period		All Residential Properties that Sold During the Study Period	
Year	**Mean Sales Price***	**Number of Sales**	**Mean Sales Price***	**Number of Sales**	**Mean Sales Price***	**Number of Sales**
1980	108,876	50	232,121	1	128,353	57
1981	111,055	56	102,992	4	114,072	62
1982	133,582	83	91,375	2	144,157	87
1983	163,883	48	78,415	3	173,198	56
1984	195,657	120	191,674	2	198,944	126
1985	159,900	179	195,649	1	162,323	189
1986	171,430	101	121,352	5	172,425	107
1987	159,350	100	210,462	1	158,473	108
1988	139,913	156	139,824	2	146,849	176
1989	132,568	241	145,068	8	141,344	266
1990	116,498	287	131,204	7	124,618	316
1991	115,976	430	121,545	4	119,831	473
1992	123,842	540	105,420	12	128,602	595
1993	138,819	613	133,931	11	139,365	689
1994	142,742	599	121,170	14	148,759	667
1995	144,909	623	149,181	1,116	152,759	2,389
1996	152,827	597	149,692	1,816	154,041	3,627
1997	158,596	79	164,186	361	169,644	701

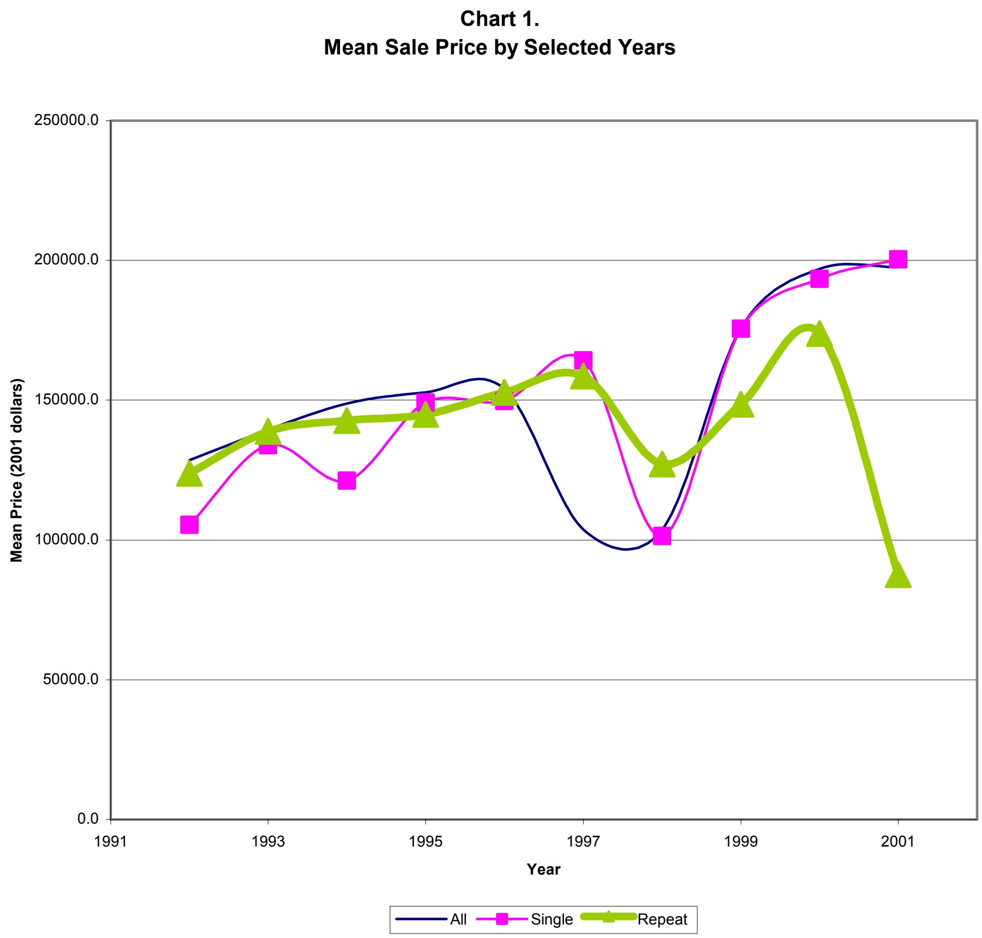
Table E.1 Number of Residential Sales and Mean Sale Prices in Study Area, by Year

	Residential Properties that Sold Twice During the Study Period**		Residential Properties that Sold Once During the Study Period		All Residential Properties that Sold During the Study Period	
Year	**Mean Sales Price***	**Number of Sales**	**Mean Sales Price***	**Number of Sales**	**Mean Sales Price***	**Number of Sales**
1998	127,217	22	101,464	38	103,683	90
1999	148,512	177	175,523	1,102	175,736	1,947
2000	173,869	257	193,405	4,156	196,884	6,907
2001	87,601	16	200,317	1,062	197,580	1,751
Full Study Period	$141,373	5,374	$176,927	9,728	$171 099	21,386

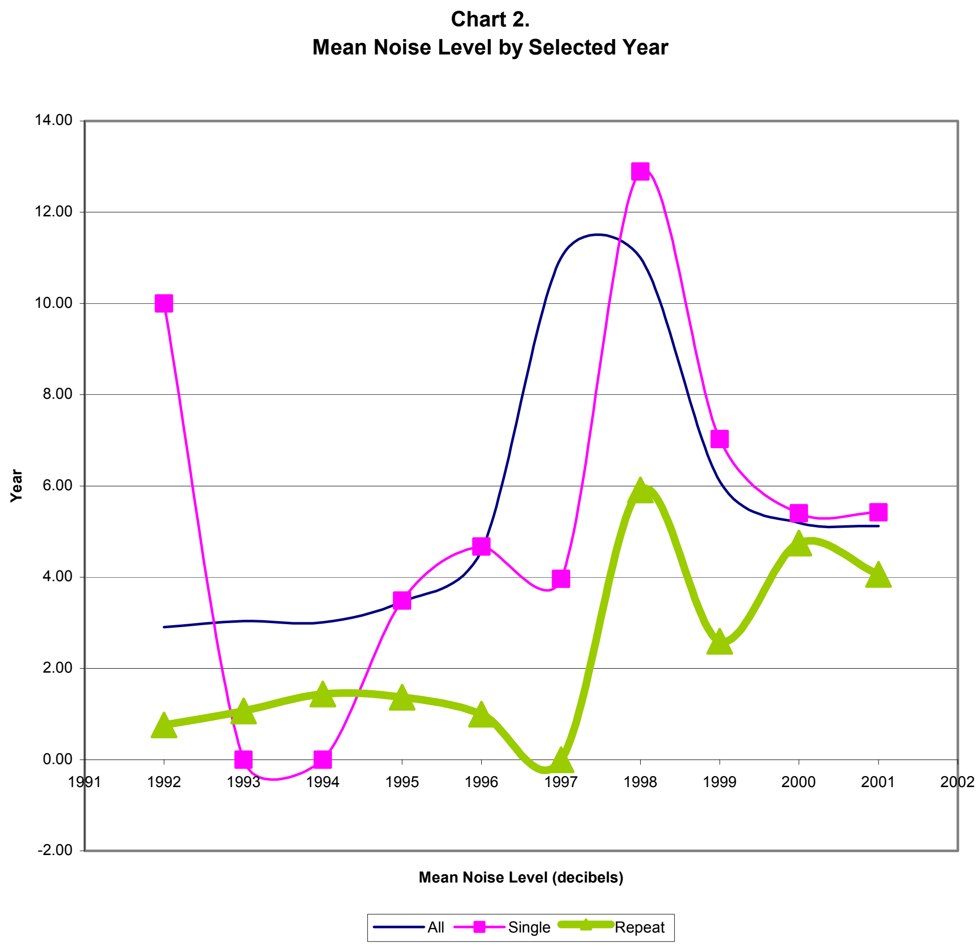
*Mean Sale Price is deflated using the Consumer Price Index (base=2001)

**Listed by year of first sale

E.2 Chart: Mean Sale Price by Year



E.3 Chart: Mean Noise Level by Year



APPENDIX F: REGRESSION RESULTS FOR REPEAT SALES

Table F.1 Repeat Sales: Depreciation Adjusted vs Age Differenced Models

First Three Time Periods

	dvote		dlist		dclose	
	lndep_ratio	lnp_ratio	lndep_ratio	lnp_ratio	lndep_ratio	lnp_ratio
Age Difference		-0.18297		-0.1830073		-0.183397
		(-10.58)		(-10.59)		(-10.66)
Event Dummy	8.230	3.601	8.448	3.592	-0.710	-0.073
	(87.82)	(10.79)	(93.79)	(10.78)	(-1.36)	(-0.14)
manoise65	-0.018	-0.013	0.055	0.004	0.051	0.026
	(-0.08)	(-0.06)	(0.4)	(0.03)	(0.44)	(0.23)
manoise3	-0.271	-0.133	-0.026	0.004	0.240	0.242
	(-0.81)	(-0.42)	(-0.11)	(0.02)	(1.48)	(1.53)
madist1	0.181	0.095	0.156	0.120	0.231	0.211
	(0.89)	(0.49)	(1.05)	(0.82)	(1.83)	(1.71)
madist2	0.099	0.228	0.146	0.243	0.221	0.278
	(0.67)	(1.61)	(1.42)	(2.43)	(2.71)	(3.49)
madist3	0.159	0.118	0.199	0.247	0.264	0.311
	(0.74)	(0.58)	(1.75)	(2.22)	(3.07)	(3.71)
madist4	0.215	0.420	0.137	0.288	0.104	0.228
	(1.38)	(2.83)	(1.26)	(2.71)	(1.11)	(2.48)
madist5	0.186	0.211	0.267	0.266	0.241	0.248
	(1.35)	(1.6)	(2.7)	(2.75)	(3.47)	(3.66)
madist6	-0.053	-0.026	0.056	0.079	0.174	0.181
	(-0.41)	(-0.21)	(0.73)	(1.06)	(3.25)	(3.47)
manorrd2	-0.343	-0.475	-0.165	-0.246	-0.185	-0.242
	(-1.66)	(-2.41)	(-1.1)	(-1.69)	(-1.37)	(-1.83)
manorrd3	-0.167	-0.273	-0.137	-0.187	-0.164	-0.179
	(-0.89)	(-1.53)	(-0.93)	(-1.30)	(-1.40)	(-1.56)
abiaroute2	-0.138	0.055	0.014	0.084	0.121	0.175
	(-0.69)	(0.29)	(0.11)	(0.66)	(1.23)	(1.83)

Table F.1 Repeat Sales: Depreciation Adjusted vs Age Differenced Models

First Three Time Periods

	dvote		dlist		dclose	
	lndep_ratio	lnp_ratio	lndep_ratio	lnp_ratio	lndep_ratio	lnp_ratio
mills	-0.067	-0.106	-0.064	-0.101	-0.059	-0.096
	(-2.68)	(-4.42)	(-2.64)	(-4.25)	(-2.44)	(-4.04)
d1980	-0.269	(dropped)	(dropped)	(dropped)	-9.152	-3.666
	(-2.47)				(-17.21)	(-6.02)
d1981	-0.103	0.245	0.166	0.246	-8.985	-3.419
	(-0.97)	(2.41)	(1.63)	(2.43)	(-16.92)	(-5.70)
d1982	-0.090	0.459	0.179	0.457	-8.971	-3.206
	(-0.92)	(4.65)	(1.91)	(4.65)	(-16.93)	(-5.44)
d1983	(dropped)	0.603	0.265	0.601	-8.887	-3.062
		(5.2)	(2.51)	(5.20)	(-16.71)	(-5.25)
d1984	0.344	1.085	0.615	1.086	-8.536	-2.577
	(3.73)	(9.82)	(6.98)	(9.85)	(-16.15)	(-4.50)
d1985	0.400	1.254	0.678	1.263	-8.459	-2.390
	(4.54)	(10.51)	(8.07)	(10.61)	(-16.11)	(-4.25)
d1986	0.394	1.348	0.666	1.347	-8.476	-2.307
	(4.15)	(9.86)	(7.33)	(9.88)	(-16.02)	(-4.12)
d1987	-7.925	-2.239	0.589	1.386	-8.551	-2.267
	(-105.55)	(-10.5)	(6.48)	(9.25)	(-16.16)	(-4.10)
d1988	-8.003	-2.238	0.499	1.370	-8.647	-2.286
	(-177.9)	(-11.5)	(5.85)	(8.50)	(-16.37)	(-4.18)
d1989	-7.945	-2.142	0.562	1.475	-8.585	-2.183
	(-127.27)	(-12.11)	(6.9)	(8.46)	(-16.27)	(-4.04)
d1990	-7.930	-2.070	0.578	1.547	-8.567	-2.109
	(-130.15)	(-12.93)	(7.2)	(8.16)	(-16.24)	(-3.94)
d1991	-7.771	-1.869	-7.728	-1.868	-8.402	-1.902
	(-133.81)	(-13.07)	(-136.71)	(-13.08)	(-15.94)	(-3.58)
d1992	-7.513	-1.612	-7.473	-1.611	-8.152	-1.650
	(-132.02)	(-12.71)	(-134.91)	(-12.72)	(-15.47)	(-3.13)
d1993	-7.299	-1.427	-7.256	-1.426	-7.255	-1.424
	(-130.98)	(-12.85)	(-133.77)	(-12.86)	(-134.17)	(-12.9)

Table F.1 Repeat Sales: Depreciation Adjusted vs Age Differenced Models

First Three Time Periods

	dvote		dlist		dclose	
	lndep_ratio	lnp_ratio	lndep_ratio	lnp_ratio	lndep_ratio	lnp_ratio
d1994	-6.962	-1.160	-6.919	-1.159	-6.917	-1.158
	(-125.39)	(-12.06)	(-128.04)	-12.07	(-128.46)	(-12.1)
d1995	-6.765	-1.057	-6.732	-1.056	-6.729	-1.055
	(-144.48)	(-13.67)	(-147.69)	(-13.67)	(-148.2)	(-13.72)
d1996	-6.546	-0.842	-6.533	-0.841	-6.530	-0.838
	(-150.78)	(-13.58)	(-154.59)	(-13.58)	(-155.08)	(-13.6)
d1997	-6.325	-0.638	-6.300	-0.636	-6.297	-0.633
	(-125.02)	(-11.2)	(-127.94)	(-11.18)	(-128.34)	(-11.17)
d1998	-6.059	-0.548	-6.041	-0.561	-6.049	-0.567
	(-69.67)	(-6.54)	(-71.24)	(-6.69)	(-71.73)	(-6.81)
d1999	-5.701	-0.203	-5.676	-0.202	-5.675	-0.200
	(-132.86)	(-4.95)	(-135.88)	(-4.93)	(-136.37)	(-4.91)
d2000	-5.541	0.035	-5.522	0.035	-5.522	0.036
	(-149.01)	(0.86)	(-152.58)	(0.86)	(-153.16)	(0.88)
d2001	-5.452	0.232	-5.420	0.232	-5.420	0.233
	(-132.98)	(4.33)	(-135.85)	(4.34)	(-136.36)	(4.39)
_cons	-5.296	0.335	-5.278	0.333	-5.280	0.330
	(-198.3)	(13.06)	(-203.06)	(12.97)	(-203.98)	(12.94)
F-stat	751.89	22.89	789.36	23.3	773.96	24.23
Prob > F	0	0	0	0	0	0
R-squared	0.8272	0.1305	0.8341	0.1325	0.8354	0.1405
Root MSE	0.533706	0.51116	0.52268	0.51057	0.52066	0.50828

Table F.2 Repeat Sales: Depreciation Adjusted vs Age Differenced Models

Last Two Time Periods

	dbuild		dopen	
	lndep_ratio	**lnp_ratio**	**lndep_ratio**	**lnp_ratio**
Age Difference		-0.18321		-0.2125019
		(-10.66)		(-10.36)
Event Dummy	8.442	3.593	0.381	0.093
	(94.32)	(10.84)	(9.10)	(1.88)
manoise65	0.059	0.038	0.091	0.058
	(0.57)	(0.38)	(0.95)	(0.61)
manoise3	0.217	0.223	0.058	0.089
	(1.42)	(1.49)	(0.33)	(0.52)
madist1	0.203	0.187	0.203	0.243
	(1.81)	(1.72)	(1.72)	(2.09)
madist2	0.199	0.246	0.207	0.215
	(2.67)	(3.39)	(2.88)	(3.04)
madist3	0.301	0.338	0.299	0.311
	(3.88)	(4.46)	(4.02)	(4.23)
madist4	0.087	0.187	0.054	0.071
	(1.09)	(2.40)	(0.70)	(0.93)
madist5	0.203	0.204	0.274	0.242
	(3.37)	(3.48)	(4.49)	(4.01)
madist6	0.171	0.175	0.301	0.270
	(3.61)	(3.78)	(6.39)	(5.79)
manorrd2	-0.125	-0.145	-0.018	0.022
	(-1.05)	(-1.24)	(-0.14)	(0.16)
manorrd3	-0.139	-0.154	0.150	0.156
	(-1.29)	(-1.46)	(1.41)	(1.49)
abiaroute2	0.118	0.159	0.136	0.110
	(1.40)	(1.94)	(1.63)	(1.34)
mills	-0.058	-0.094	-0.048	-0.089
	(-2.37)	(-3.97)	(-2.00)	(-3.76)

Table F.2 Repeat Sales: Depreciation Adjusted vs Age Differenced Models

Last Two Time Periods

	dbuild		dopen	
	lndep_ratio	**lnp_ratio**	**lndep_ratio**	**lnp_ratio**
d1980	(dropped)	(dropped)	-8.113	-4.067
			(-84.95)	(-10.98)
d1981	0.169	0.249	-7.936	-3.789
	(1.67)	(2.48)	(-85.92)	(-10.83)
d1982	0.183	0.459	-7.931	-3.554
	(1.96)	(4.70)	(-94.52)	(-10.84)
d1983	0.267	0.604	-7.844	-3.366
	(2.53)	(5.26)	(-81.35)	(-10.79)
d1984	0.617	1.088	-7.492	-2.861
	(7.03)	(9.93)	(-96.33)	(-9.99)
d1985	0.692	1.277	-7.414	-2.640
	(8.28)	(10.79)	(-101.45)	(-9.94)
d1986	0.678	1.358	-7.437	-2.540
	(7.52)	(10.03)	(-92.45)	(-10.24)
d1987	0.603	1.398	-7.509	-2.469
	(6.68)	(9.38)	(-92.86)	(-10.80)
d1988	0.508	1.381	-7.595	-2.446
	(6.00)	(8.61)	(-101.57)	(-11.80)
d1989	0.569	1.482	-7.544	-2.325
	(7.03)	(8.55)	(-107.41)	(-12.44)
d1990	0.587	1.556	-7.528	-2.221
	(7.35)	(8.26)	(-109.37)	(-13.25)
d1991	0.751	1.762	-7.355	-1.980
	(9.65)	(8.66)	(-110.18)	(-13.39)
d1992	1.001	2.014	-7.108	-1.701
	(12.99)	(9.19)	(-108.11)	(-13.13)
d1993	1.218	2.201	-6.895	-1.489
	(15.88)	(9.36)	(-106.38)	(-13.31)
d1994	-6.915	-1.157	-6.562	-1.196
	(-128.56)	(-12.11)	(-101.77)	(-12.48)

Table F.2 Repeat Sales: Depreciation Adjusted vs Age Differenced Models

Last Two Time Periods

	dbuild		dopen	
	lndep_ratio	**lnp_ratio**	**lndep_ratio**	**lnp_ratio**
d1995	-6.728	-1.055	-6.393	-1.065
	(-148.31)	(-13.73)	(-113.76)	(-13.88)
d1996	-6.529	-0.838	-6.205	-0.822
	(-155.22)	(-13.61)	(-117.27)	(-13.25)
d1997	-6.297	-0.634	-5.973	-0.591
	(-128.45)	(-11.20)	(-102.35)	(-9.93)
d1998	-6.047	-0.567	-5.688	-0.458
	(-71.79)	(-6.81)	(-63.63)	(-5.18)
d1999	-5.674	-0.201	-5.446	-0.129
	(-136.48)	(-4.93)	(-115.4)	(-2.54)
d2000	-5.521	0.035	-5.609	0.036
	(-153.26)	(0.88)	(-154.06)	(0.89)
d2001	-5.421	0.231	-5.514	0.260
	(-136.5)	(4.35)	(-137.43)	(4.75)
_cons	-5.281	0.329	-5.250	0.336
	(-204.2)	(12.89)	(-202.05)	(12.60)
F-stat	798.08	25.16	800.6	25.26
Prob > F	0	0	0	0
R-squared	0.8356	0.1416	0.84	0.1456
Root MSE	0.52029	0.50789	0.51334	0.50676

Table F.3 Repeat Sales: Event Dates, Depreciation Adjusted

	dvote	dlist	dclose	dbuild	dopen
	lndep_ratio	lndep_ratio	lndep_ratio	lndep_ratio	lndep_ratio
Event Dummy	8.230	8.448	-0.710	8.442	0.381
	(87.82)	(93.79)	(-1.36)	(94.32)	(9.10)
manoise65	-0.018	0.055	0.051	0.059	0.091
	(-0.08)	(0.4)	(0.44)	(0.57)	(0.95)
manoise3	-0.271	-0.026	0.240	0.217	0.058
	(-0.81)	(-0.11)	(1.48)	(1.42)	(0.33)
madist1	0.181	0.156	0.231	0.203	0.203
	(0.89)	(1.05)	(1.83)	(1.81)	(1.72)
madist2	0.099	0.146	0.221	0.199	0.207
	(0.67)	(1.42)	(2.71)	(2.67)	(2.88)
madist3	0.159	0.199	0.264	0.301	0.299
	(0.74)	(1.75)	(3.07)	(3.88)	(4.02)
madist4	0.215	0.137	0.104	0.087	0.054
	(1.38)	(1.26)	(1.11)	(1.09)	(0.70)
madist5	0.186	0.267	0.241	0.203	0.274
	(1.35)	(2.7)	(3.47)	(3.37)	(4.49)
madist6	-0.053	0.056	0.174	0.171	0.301
	(-0.41)	(0.73)	(3.25)	(3.61)	(6.39)
manorrd2	-0.343	-0.165	-0.185	-0.125	-0.018
	(-1.66)	(-1.1)	(-1.37)	(-1.05)	(-0.14)
manorrd3	-0.167	-0.137	-0.164	-0.139	0.150
	(-0.89)	(-0.93)	(-1.40)	(-1.29)	(1.41)
abiaroute2	-0.138	0.014	0.121	0.118	0.136
	(-0.69)	(0.11)	(1.23)	(1.40)	(1.63)
mills	-0.067	-0.064	-0.059	-0.058	-0.048
	(-2.68)	(-2.64)	(-2.44)	(-2.37)	(-2.00)
d1980	-0.269	(dropped)	-9.152	(dropped)	-8.113
	(-2.47)		(-17.21)		(-84.95)
d1981	-0.103	0.166	-8.985	0.169	-7.936
	(-0.97)	(1.63)	(-16.92)	(1.67)	(-85.92)
d1982	-0.090	0.179	-8.971	0.183	-7.931
	(-0.92)	(1.91)	(-16.93)	(1.96)	(-94.52)
d1983	(dropped)	0.265	-8.887	0.267	-7.844

Table F.3 Repeat Sales: Event Dates, Depreciation Adjusted

	dvote	dlist	dclose	dbuild	dopen
	lndep_ratio	lndep_ratio	lndep_ratio	lndep_ratio	lndep_ratio
		(2.51)	(-16.71)	(2.53)	(-81.35)
d1984	0.344	0.615	-8.536	0.617	-7.492
	(3.73)	(6.98)	(-16.15)	(7.03)	(-96.33)
d1985	0.400	0.678	-8.459	0.692	-7.414
	(4.54)	(8.07)	(-16.11)	(8.28)	(-101.45)
d1986	0.394	0.666	-8.476	0.678	-7.437
	(4.15)	(7.33)	(-16.02)	(7.52)	(-92.45)
d1987	-7.925	0.589	-8.551	0.603	-7.509
	(-105.55)	(6.48)	(-16.16)	(6.68)	(-92.86)
d1988	-8.003	0.499	-8.647	0.508	-7.595
	(-177.9)	(5.85)	(-16.37)	(6.00)	(-101.57)
d1989	-7.945	0.562	-8.585	0.569	-7.544
	(-127.27)	(6.9)	(-16.27)	(7.03)	(-107.41)
d1990	-7.930	0.578	-8.567	0.587	-7.528
	(-130.15)	(7.2)	(-16.24)	(7.35)	(-109.37)
d1991	-7.771	-7.728	-8.402	0.751	-7.355
	(-133.81)	(-136.71)	(-15.94)	(9.65)	(-110.18)
d1992	-7.513	-7.473	-8.152	1.001	-7.108
	(-132.02)	(-134.91)	(-15.47)	(12.99)	(-108.11)
d1993	-7.299	-7.256	-7.255	1.218	-6.895
	(-130.98)	(-133.77)	(-134.17)	(15.88)	(-106.38)
d1994	-6.962	-6.919	-6.917	-6.915	-6.562
	(-125.39)	(-128.04)	(-128.46)	(-128.56)	(-101.77)
d1995	-6.765	-6.732	-6.729	-6.728	-6.393
	(-144.48)	(-147.69)	(-148.2)	(-148.31)	(-113.76)
d1996	-6.546	-6.533	-6.530	-6.529	-6.205
	(-150.78)	(-154.59)	(-155.08)	(-155.22)	(-117.27)
d1997	-6.325	-6.300	-6.297	-6.297	-5.973
	(-125.02)	(-127.94)	(-128.34)	(-128.45)	(-102.35)
d1998	-6.059	-6.041	-6.049	-6.047	-5.688
	(-69.67)	(-71.24)	(-71.73)	(-71.79)	(-63.63)
d1999	-5.701	-5.676	-5.675	-5.674	-5.446
	(-132.86)	(-135.88)	(-136.37)	(-136.48)	(-115.4)
d2000	-5.541	-5.522	-5.522	-5.521	-5.609
	(-149.01)	(-152.58)	(-153.16)	(-153.26)	(-154.06)

Table F.3 Repeat Sales: Event Dates, Depreciation Adjusted

	dvote	dlist	dclose	dbuild	dopen
	lndep_ratio	lndep_ratio	lndep_ratio	lndep_ratio	lndep_ratio
d2001	-5.452	-5.420	-5.420	-5.421	-5.514
	(-132.98)	(-135.85)	(-136.36)	(-136.5)	(-137.43)
_cons	-5.296	-5.278	-5.280	-5.281	-5.250
	(-198.3)	(-203.06)	(-203.98)	(-204.2)	(-202.05)
F-stat	751.89	789.36	773.96	798.08	800.6
Prob > F	0	0	0	0	0
R-squared	0.8272	0.8341	0.8354	0.8356	0.84
Root MSE	0.533706	0.52268	0.52066	0.52029	0.51334

Table F.4 Repeat Sales Model: Event Dates

	Vote	List	Close
Event	0.139061	0.186331	-0.09601
	(1.54)	(2.10)	(-0.19)
Noise65	-0.013849	0.024726	0.063676
	(-0.07)	(0.19)	(0.56)
Noise3	-0.146915	0.012852	0.295729
	(-0.46)	(0.06)	(1.89)
MAdist1	0.1070701	0.133565	0.267897
	(0.56)	(0.92)	(2.23)
MAdist2	0.226329	0.244079	0.288262
	(1.59)	(2.43)	(3.60)
MAdist3	0.1201507	0.240237	0.29608
	(0.58)	(2.14)	(3.50)
MAdist4	0.4094119	0.282046	0.226904
	(2.74)	(2.63)	(2.44)
MAdist5	0.2159986	0.270559	0.25188
	(1.63)	(2.78)	(3.69)
MAdist6	-0.02492	0.079992	0.180599
	(-0.20)	(1.07)	(3.42)
ManorRd2	-0.468308	-0.2462	-0.25684
	(-2.36)	(-1.68)	(-1.93)
ManorRd3	-0.263816	-0.17844	-0.16782
	(-1.46)	(-1.23)	(-1.45)
mills	-0.089589	-0.0854	-0.08079
	(-3.72)	(-3.55)	(-3.37)
d1980	-0.056758	(dropped)	-0.27606
	(-0.54)		(-0.53)
d1981	0.0110407	0.06872	-0.20647
	(0.11)	(0.68)	(-0.39)
d1982	0.0356464	0.090184	-0.18444
	(0.38)	(0.97)	(-0.35)
d1983	(dropped)	0.054144	-0.2204
		(0.52)	(-0.42)
d1984	0.2978727	0.354952	0.077763
	(3.37)	(4.08)	(0.15)
d1985	0.2849018	0.350918	0.086877

Table F.4 Repeat Sales Model: Event Dates

	Vote	List	Close
	(3.37)	(4.23)	(0.17)
d1986	0.1936977	0.248469	-0.02095
	(2.13)	(2.77)	(-0.04)
d1987	-0.113374	0.105827	-0.1606
	(-1.57)	(1.18)	(-0.31)
d1988	-0.295372	-0.09402	-0.36596
	(-4.53)	(-1.12)	(-0.70)
d1989	-0.380106	-0.17003	-0.44266
	(-6.33)	(-2.12)	(-0.85)
d1990	-0.49224	-0.28091	-0.55212
	(-8.40)	(-3.54)	(-1.06)
d1991	-0.474168	-0.47291	-0.5285
	(-8.49)	(-8.48)	(-1.02)
d1992	-0.399487	-0.39819	-0.46068
	(-7.30)	(-7.28)	(-0.89)
d1993	-0.395171	-0.39391	-0.39096
	(-7.38)	(-7.36)	(-7.33)
d1994	-0.310175	-0.30908	-0.30614
	(-5.81)	(-5.80)	(-5.76)
d1995	-0.388443	-0.38737	-0.3851
	(-8.63)	(-8.61)	(-8.60)
d1996	-0.353422	-0.35235	-0.34914
	(-8.47)	(-8.45)	(-8.40)
d1997	-0.316073	-0.31459	-0.31158
	(-6.50)	(-6.47)	(-6.44)
d1998	-0.41243	-0.42528	-0.43273
	(-4.93)	(-5.08)	(-5.20)
d1999	-0.243709	-0.24293	-0.24129
	(-5.91)	(-5.89)	(-5.88)
d2000	-0.172775	-0.17289	-0.17256
	(-4.83)	(-4.84)	(-4.85)
d2001	-0.155482	-0.15545	-0.15522
	(-3.94)	(-3.95)	(-3.96)
Constant	0.2962928	0.293721	0.291657
	(11.54)	(11.45)	(11.42)

Table F.4 Repeat Sales Model: Event Dates

	Vote	List	Close
Number of obs	5374	5374	5374
F-stat	811.85	796.67	824.29
Prob > F	0	0	0
R-squared	0.8338	0.8353	0.84
Adj R-squared	0.8328	0.8343	0.839
Root MSE	0.52305	0.52067	0.51329

Table F.5 All Sales: Event Dates

Only Environmental Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	**dlist**	**dclose**	**dbuild**	**dopen**
Event Dummy	0.2871	-0.1209	-0.1931	-0.1204	-0.6584
	(5.28)	(-2.68)	(-7.50)	(-2.68)	(-28.29)
gba	0.0003	0.0003	0.0003	0.0003	0.0003
	(45.58)	(45.73)	(45.83)	(45.82)	(45.73)
tla	2.07E-06	2.07E-06	2.06E-06	2.06E-06	2.06E-06
	(11.02)	(11.00)	(10.98)	(10.98)	(10.98)
age	-0.0126	-0.0122	-0.0121	-0.0120	-0.0122
	(-21.17)	(-20.52)	(-20.25)	(-20.14)	(-20.48)
agesq	0.0002	0.0002	0.0002	0.0002	0.0002
	(19.69)	(18.89)	(18.66)	(18.54)	(18.94)
bath2	0.0530	0.0523	0.0507	0.0507	0.0503
	(5.61)	(5.54)	(5.37)	(5.37)	(5.33)
bath3	0.0754	0.0748	0.0731	0.0733	0.0728
	(6.00)	(5.96)	(5.82)	(5.84)	(5.80)
fire	0.0193	0.0193	0.0199	0.0202	0.0205
	(2.41)	(2.41)	(2.49)	(2.52)	(2.56)
pool	0.1108	0.1097	0.1091	0.1094	0.1090
	(9.48)	(9.40)	(9.35)	(9.37)	(9.34)
spa	0.1032	0.1024	0.1016	0.1018	0.1027
	(5.35)	(5.32)	(5.28)	(5.29)	(5.34)
garage	0.1050	0.1033	0.1035	0.1039	0.1036
	(10.44)	(10.28)	(10.30)	(10.34)	(10.31)
carport	0.1312	0.1291	0.1285	0.1282	0.1255
	(10.49)	(10.33)	(10.29)	(10.26)	(10.03)
manuf	-0.5436	-0.5689	-0.5883	-0.5875	-0.5843
	(-2.47)	(-2.61)	(-2.70)	(-2.70)	(-2.69)
masonry	0.0617	0.0674	0.0677	0.0666	0.0655
	(1.51)	(1.65)	(1.66)	(1.63)	(1.60)
brick	0.0483	0.0493	0.0489	0.0489	0.0481
	(7.42)	(7.58)	(7.52)	(7.53)	(7.40)
hsgrad	-0.3940	-0.3965	-0.4015	-0.4075	-0.4891
	(-2.33)	(-2.35)	(-2.38)	(-2.41)	(-2.88)
bchdeg	-0.3518	-0.3654	-0.3679	-0.3711	-0.4032
	(-2.37)	(-2.47)	(-2.48)	(-2.51)	(-2.71)
grddeg	1.8318	1.8595	1.8725	1.8578	1.9442

Table F.5 All Sales: Event Dates

Only Environmental Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
	(9.89)	(10.04)	(10.09)	(10.01)	(10.41)
forbrn	-0.3225	-0.3574	-0.3699	-0.3770	-0.3435
	(-1.57)	(-1.74)	(-1.80)	(-1.83)	(-1.65)
popbl	-0.5491	-0.5566	-0.5571	-0.5562	-0.5237
	(-11.13)	(-11.27)	(-11.27)	(-11.25)	(-10.33)
popna	1.5913	1.6688	1.7110	1.6713	1.7253
	(2.12)	(2.22)	(2.28)	(2.22)	(2.29)
popap	-0.5159	-0.5018	-0.4986	-0.4929	-0.4867
	(-2.07)	(-2.02)	(-2.00)	(-1.98)	(-1.94)
popoth	-0.2377	-0.2220	-0.2203	-0.2241	-0.2224
	(-2.93)	(-2.73)	(-2.71)	(-2.76)	(-2.72)
vacant	-0.0437	-0.0453	-0.0287	-0.0185	0.0179
	(-0.35)	(-0.36)	(-0.23)	(-0.15)	(0.14)
ownocc	-0.0102	-0.0130	-0.0126	-0.0120	-0.0083
	(-0.36)	(-0.46)	(-0.44)	(-0.42)	(-0.29)
78617	-0.4551	-0.4559	-0.4541	-0.4541	-0.4484
	(-4.39)	(-4.40)	(-4.39)	(-4.39)	(-4.33)
78653	-0.1726	-0.1721	-0.1726	-0.1743	-0.1690
	(-2.05)	(-2.05)	(-2.05)	(-2.07)	(-2.01)
78701	0.3798	0.3789	0.3823	0.3781	0.3641
	(2.38)	(2.38)	(2.40)	(2.37)	(2.29)
78702	-0.5959	-0.5936	-0.5939	-0.5948	-0.5752
	(-13.48)	(-13.43)	(-13.44)	(-13.45)	(-12.90)
78703	0.1795	0.1727	0.1708	0.1731	0.1594
	(5.90)	(5.67)	(5.60)	(5.67)	(5.15)
78704	0.0785	0.0779	0.0778	0.0780	0.0839
	(2.95)	(2.93)	(2.92)	(-2.93)	(3.14)
78705	0.0512	0.0561	0.0660	0.0678	0.0972
	(0.92)	(1.01)	(1.19)	(1.22)	(1.74)
78719	-0.5451	-0.5450	-0.5428	-0.5430	-0.5322
	(-1.45)	(-1.46)	(-1.45)	(-1.45)	(-1.42)
78721	-0.3514	-0.3421	-0.3359	-0.3361	-0.3027
	(-7.70)	(-7.51)	(-7.37)	(-7.37)	(-6.52)
78722	-0.0492	-0.0463	-0.0425	-0.0417	-0.0013
	(-1.26)	(-1.19)	(-1.09)	(-1.07)	(-0.03)
78723	-0.1650	-0.1567	-0.1509	-0.1495	-0.1097

Table F.5 All Sales: Event Dates

Only Environmental Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
	(-6.48)	(-6.15)	(-5.89)	(-5.83)	(-4.06)
78724	-0.0110	-0.0028	-0.0008	-0.0024	-0.0228
	(-0.28)	(-0.07)	(-0.02)	(-0.06)	(-0.56)
78725	-0.3368	-0.3423	-0.3428	-0.3444	-0.3092
	(-3.35)	(-3.42)	(-3.42)	(-3.44)	(-3.07)
78727	-0.0982	-0.0960	-0.0951	-0.0961	-0.0945
	(-5.44)	(-5.31)	(-5.27)	(-5.32)	(-5.23)
78731	0.0333	0.0309	0.0299	0.0313	0.0201
	(1.54)	(1.43)	(1.38)	(1.45)	(0.93)
78735	-0.1845	-0.1843	-0.1835	-0.1831	-0.1823
	(-7.72)	(-7.72)	(-7.69)	(-7.67)	(-7.63)
78739	-0.0585	-0.0559	-0.0544	-0.0547	-0.0555
	(-2.56)	(-2.45)	(-2.38)	(-2.40)	(-2.43)
78741	-0.2556	-0.2499	-0.2463	-0.2471	-0.2329
	(-7.48)	(-7.32)	(-7.21)	(-7.23)	(-6.64)
78742	-0.6828	-0.6836	-0.6758	-0.6804	-0.6572
	(-5.05)	(-5.06)	(-5.00)	(-5.04)	(-4.84)
78744	-0.3594	-0.3606	-0.3597	-0.3601	-0.3592
	(-15.73)	(-15.79)	(-15.75)	(-15.77)	(-15.69)
78745	-0.1904	-0.1909	-0.1901	-0.1908	-0.1828
	(-10.42)	(-10.45)	(-10.40)	(-10.44)	(-9.97)
78746	0.1042	0.1020	0.1008	0.1013	0.0924
	(5.14)	(5.03)	(4.97)	(4.99)	(4.53)
78747	-0.0124	-0.0136	-0.0139	-0.0136	-0.0100
	(-0.37)	(-0.40)	(-0.41)	(-0.40)	(-0.29)
78748	-0.1971	-0.1960	-0.1946	-0.1953	-0.1908
	(-10.80)	(-10.74)	(-10.66)	(-10.7)	(-10.44)
78749	-0.1363	-0.1347	-0.1337	-0.1345	-0.1308
	(-8.51)	(-8.42)	(-8.36)	(-8.41)	(-8.17)
78751	0.1098	0.1270	0.1384	0.1469	0.1747
	(3.59)	(4.14)	(4.49)	(4.74)	(5.37)
78752	-0.0251	-0.0211	-0.0182	-0.0128	0.0288
	(-0.78)	(-0.66)	(-0.57)	(-0.40)	(0.85)
78753	-0.1837	-0.1830	-0.1821	-0.1829	-0.1791
	(-9.22)	(-9.19)	(-9.14)	(-9.18)	(-8.98)
78754	-0.1656	-0.1645	-0.1627	-0.1640	-0.1571

Table F.5 All Sales: Event Dates

Only Environmental Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	**dlist**	**dclose**	**dbuild**	**dopen**
	(-4.25)	(-4.22)	(-4.18)	(-4.21)	(-4.03)
78756	0.1471	0.1495	0.1511	0.1560	0.1876
	(5.37)	(5.43)	(5.43)	(5.60)	(6.33)
78757	0.0968	0.0977	0.0983	0.0990	0.1054
	(5.04)	(5.09)	(5.12)	(5.16)	(5.47)
78758	-0.1259	-0.1256	-0.1249	-0.1261	-0.1229
	(-6.93)	(-6.91)	(-6.88)	(-6.94)	(-6.76)
manoise65	-0.0321	0.0306	-0.0450	-0.0952	-0.0167
	(-0.24)	(0.35)	(-0.62)	(-1.46)	(-0.49)
manoise3	0.1649	-0.0323	-0.1649	-0.1305	-0.1032
	(0.80)	(-0.24)	(-1.48)	(-1.33)	(-1.96)
madist1	0.0913	-0.0210	-0.0193	-0.0230	-0.0759
	(0.64)	(-0.21)	(-0.23)	(-0.28)	(-1.69)
madsit2	-0.1501	-0.1969	-0.1541	-0.1152	-0.0460
	(-1.42)	(-2.68)	(-2.53)	(-2.06)	(-1.47)
madist3	-0.1031	-0.1967	-0.1242	-0.1242	-0.1038
	(-0.74)	(-2.53)	(-2.00)	(-2.30)	(-3.33)
madist4	-0.2446	-0.1602	-0.1168	-0.1117	-0.1341
	(-2.26)	(-2.13)	(-1.90)	(-1.98)	(-4.45)
madist5	-0.2232	-0.1630	-0.1038	-0.1126	-0.0994
	(-2.40)	(-2.72)	(-2.31)	(-2.74)	(-4.11)
madist6	0.0569	-0.0384	-0.0564	-0.0510	0.0342
	(0.74)	(-0.85)	(-1.66)	(-1.67)	(1.92)
manorrd2	0.3502	0.2730	0.1512	0.1107	-0.0493
	(2.65)	(2.75)	(1.75)	(1.38)	(-1.16)
manorrd3	0.2359	0.1887	0.1196	0.0932	0.0252
	(2.41)	(2.83)	(2.19)	(1.88)	(0.90)
abiaroute2	0.0625	-0.0932	-0.0867	-0.0477	-0.0540
	(0.60)	(-1.25)	(-1.49)	(-0.92)	(-1.84)
abiaroute3	-0.1426	-0.1925	-0.1730	-0.1596	-0.0596
	(-2.07)	(-4.56)	(-5.01)	(-5.07)	(-3.31)
cbd1	0.0463	0.0609	0.0687	0.0783	0.0746
	(0.87)	(1.14)	(1.29)	(1.46)	(1.38)
cbd2	0.0773	0.0815	0.0826	0.0838	0.0790
	(2.85)	(3.00)	(3.04)	(3.09)	(2.89)
cbd3	0.0603	0.0606	0.0605	0.0611	0.0591

Table F.5 All Sales: Event Dates

Only Environmental Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
	(3.07)	(3.09)	(3.09)	(3.12)	(3.01)
ut1	0.2413	0.2518	0.2443	0.2432	0.2369
	(4.27)	(4.46)	(4.33)	(4.31)	(4.16)
ut2	0.1230	0.1307	0.1325	0.1313	0.1289
	(4.52)	(4.80)	(4.86)	(4.81)	(4.64)
ut3	0.0930	0.0979	0.0996	0.1004	0.0998
	(5.75)	(6.05)	(6.15)	(6.20)	(6.01)
d1980	(dropped)	0.2657	0.2652	0.2672	0.2720
		(4.91)	(4.91)	(4.95)	(5.04)
d1981	-0.0330	0.2390	0.2415	0.2422	0.2485
	(-0.48)	(4.57)	(4.62)	(4.64)	(4.77)
d1982	0.0125	0.2860	0.2885	0.2900	0.2878
	(0.19)	(6.25)	(6.32)	(6.36)	(6.34)
d1983	-0.0188	0.2548	0.2571	0.2591	0.2624
	(-0.27)	(4.68)	(4.73)	(4.77)	(4.83)
d1984	0.2905	0.5625	0.5622	0.5625	0.5687
	(4.84)	(14.19)	(14.20)	(14.22)	(14.40)
d1985	0.2971	0.5803	0.5852	0.5859	0.5829
	(5.21)	(16.75)	(16.91)	(16.94)	(16.90)
d1986	0.2583	0.5380	0.5396	0.5385	0.5420
	(4.17)	(12.81)	(12.87)	(12.85)	(12.95)
d1987	0.1121	0.3979	0.3987	0.3975	0.3895
	(1.81)	(9.51)	(9.54)	(9.52)	(9.34)
d1988	0.1758	0.1640	0.1659	0.1666	0.1742
	(4.99)	(4.65)	(4.71)	(4.73)	(4.95)
d1989	0.1026	0.0973	0.0972	0.0972	0.1005
	(3.29)	(3.12)	(3.12)	(3.12)	(3.23)
d1991	0.0037	0.0031	0.0036	0.0030	0.0029
	(0.13)	(0.11)	(0.13)	(0.11)	(0.11)
d1992	0.0848	-0.0609	0.0812	0.0807	0.0819
	(3.25)	(-1.43)	(3.11)	(3.09)	(3.14)
d1993	0.0813	-0.0647	0.0777	0.0781	0.0807
	(3.19)	(-1.54)	(3.05)	(3.07)	(3.17)
d1994	0.2175	0.0714	(dropped)	0.2181	0.2174
	(8.49)	(1.69)		(8.52)	(8.50)
d1995	0.2650	0.1188	0.0472	0.1209	0.2667

Table F.5 All Sales: Event Dates

Only Environmental Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
	(11.78)	(2.95)	(2.88)	(3.00)	(11.88)
d1996	0.3130	0.1668	0.0953	0.1689	0.3130
	(14.20)	(4.17)	(6.03)	(4.22)	(14.22)
d1997	0.3066	0.1603	0.0886	0.1622	0.3069
	(12.03)	(3.82)	(4.37)	(3.87)	(12.06)
d1998	0.1476	(dropped)	-0.0729	(dropped)	0.1594
	(3.29)		(-1.73)		(3.55)
d1999	0.5061	0.3590	0.2868	0.3601	0.5099
	(22.09)	(8.88)	(16.98)	(8.92)	(22.28)
d2000	0.6111	0.4641	0.3919	0.4653	-0.0635
	(28.03)	(11.67)	(25.58)	(11.71)	(-6.34)
d2001	0.6743	0.5274	0.4552	0.5286	(dropped)
	(29.09)	(13.02)	(26.46)	(13.05)	
_cons	10.9869	11.1310	11.1984	11.1255	11.6499
	(202.03)	(172.61)	(214.16)	(172.59)	(224.44)
Number of obs	21387	21387	21387	21387	21387
F-stat	427.52	428.71	429.23	429.47	429.82
Prob > F	0	0	0	0	0
R-squared	0.6561	0.6567	0.657	0.657	0.6573
Root MSE	0.37408	0.37374	0.3736	0.37352	0.37342

Table F.6 All Sales: Event Dates

All Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
Event Dummy	(dropped)	-0.5150	(dropped)	-0.1315	(dropped)
		(-1.76)		(-0.63)	
gba	0.0003	0.0003	0.0003	0.0003	0.0003
	(4.00)	(7.79)	(9.68)	(10.74)	(25.36)
tla	2.28E-06	-5.60E-07	3.17E-07	-3.62E-07	1.38E-06
	(0.46)	(-0.44)	(0.37)	(-0.47)	(4.60)
age	-0.0028	-0.0093	-0.0112	-0.0115	-0.0130
	(-0.36)	(-2.41)	(-4.02)	(-4.64)	(-13.00)
agesq	0.0001	0.0001	0.0002	0.0002	0.0002
	(0.35)	(2.01)	(4.15)	(4.56)	(10.78)
bath2	0.1114	0.1312	0.1225	0.1125	0.0889
	(1.20)	(2.38)	(2.96)	(3.03)	(5.39)
bath3	0.1463	0.1784	0.2161	0.1855	0.1290
	(1.18)	(2.51)	(4.06)	(3.91)	(6.04)
fire	0.1461	0.0847	0.0773	0.0624	0.0343
	(2.11)	(2.01)	(2.36)	(2.07)	(2.50)
pool	0.0970	0.1154	0.1547	0.1605	0.1445
	(0.88)	(1.92)	(3.48)	(4.00)	(7.62)
spa	0.1234	0.1002	0.1242	0.1369	0.1105
	(0.69)	(1.20)	(1.95)	(2.32)	(3.70)
garage	0.0683	0.1057	0.1036	0.1169	0.1138
	(0.72)	(1.84)	(2.36)	(2.96)	(6.55)
carport	-0.0191	0.0854	0.0769	0.0897	0.1261
	(-0.16)	(1.12)	(1.36)	(1.77)	(5.67)
manuf	-0.5310	-0.6327	-0.6153	-0.6270	-0.5166
	(-0.78)	(-1.01)	(-1.02)	(-1.05)	(-1.82)
masonry	-0.5141	-0.2802	-0.1137	-0.0694	0.0077
	(-0.97)	(-1.01)	(-0.50)	(-0.36)	(0.10)
brick	0.0405	0.0735	-0.0238	-0.0016	0.0415
	(0.63)	(2.05)	(-0.89)	(-0.07)	(3.81)
hsgrad	1.0587	-0.3194	-2.3704	-1.6272	-1.0271
	(0.65)	(-0.34)	(-3.27)	(-2.47)	(-3.47)
bchdeg	-0.6718	-0.2452	-1.1496	-0.7770	-0.4740
	(-0.46)	(-0.30)	(-1.85)	(-1.37)	(-1.84)

Table F.6 All Sales: Event Dates

All Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	**dlist**	**dclose**	**dbuild**	**dopen**
grddeg	3.6149	2.0767	0.9452	1.4704	2.1336
	(2.10)	(2.06)	(1.23)	(2.11)	(6.69)
forbrn	-0.6336	0.1597	2.0188	1.0652	-0.3875
	(-0.29)	(0.14)	(2.23)	(1.29)	(-1.06)
popbl	0.1015	-0.4581	-0.6274	-0.4256	-0.5356
	(0.16)	(-1.31)	(-2.23)	(-1.68)	(-5.33)
popna	-2.3910	0.5902	4.4593	4.6307	2.8954
	(-0.37)	(0.15)	(1.43)	(1.62)	(2.23)
popap	-0.6316	-1.4393	-4.2046	-2.7989	-0.5218
	(-0.22)	(-1.02)	(-3.860	(-2.83)	(-1.19)
popoth	0.1216	-0.2947	-1.1033	-0.8101	-0.2041
	(0.15)	(-0.62)	(-2.97)	(-2.44)	(-1.40)
vacant	0.4373	0.3312	-0.3307	-0.3228	0.0619
	(0.36)	(0.44)	(-0.58)	(-0.62)	(0.28)
ownocc	-0.0865	-0.0052	0.2363	0.2013	0.0255
	(-0.31)	(-0.03)	(2.04)	(1.91)	(0.53)
78617	-0.0236	0.2885	0.1833	0.2525	-0.2794
	(-0.04)	(0.63)	(0.42)	(0.59)	(-1.37)
78653	(dropped)	0.2814	0.4650	0.4829	0.0822
		(0.44)	(1.41)	(1.63)	(0.59)
78701	(dropped)	2.2818	2.4769	2.3840	0.8717
		(3.28)	(3.84)	(3.77)	(3.00)
78702	-0.2777	-0.5770	-1.0499	-1.0507	-0.7455
	(-0.50)	(-1.82)	(-4.11)	(-4.62)	(-8.45)
78703	0.0000	0.2185	0.0941	0.0930	0.1113
	(-1.34)	(1.27)	(0.72)	(0.77)	(2.05)
78704	-0.0807	0.0381	-0.0370	-0.0104	0.0532
	(-0.38)	(0.28)	(-0.35)	(-0.11)	(1.17)
78705	-2.1199	0.0681	-0.1493	-0.1058	0.0179
	(-2.52)	(0.18)	(-0.59)	(-0.46)	(0.18)
78719	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
78721	-1.3980	-1.0945	-1.0932	-1.0201	-0.4333
	(-2.53)	(-3.02)	(-3.75)	(-3.81)	(-4.33)

Table F.6 All Sales: Event Dates

All Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
78722	0.2091	-0.1931	-0.4179	-0.3884	-0.0605
	(0.32)	(-0.54)	(-1.50)	(-1.64)	(-0.64)
78723	-0.1580	-0.1119	-0.2603	-0.2803	-0.1290
	(-0.33)	(-0.42)	(-1.31)	(-1.63)	(-1.82)
78724	-0.3929	-0.3634	-0.3080	-0.4750	0.0772
	(-0.75)	(-1.29)	(-1.30)	(-2.26)	(1.06)
78725	-0.4743	-0.3137	-0.0407	-0.3949	-0.3361
	(-0.59)	(-0.47)	(-0.09)	(-1.10)	(-1.96)
78727	-0.1183	-0.0961	-0.0999	-0.0740	-0.0780
	(-0.66)	(-1.01)	(-1.41)	(-1.15)	(-2.56)
78731	-0.1655	-0.0571	0.0254	-0.0311	-0.0270
	(-0.97)	(-0.51)	(0.29)	(-0.40)	(-0.74)
78735	-0.1054	-0.0502	-0.0202	-0.0647	-0.2336
	(-0.41)	(-0.37)	(-0.19)	(-0.66)	(-5.99)
78739	0.0678	0.0546	0.0188	0.0466	0.0047
	(0.23)	(0.37)	(0.19)	(0.53)	(0.12)
78741	-0.4210	-0.1691	-0.1701	-0.1449	-0.2356
	(-1.06)	(-0.74)	(-0.95)	(-0.90)	(-3.69)
78742	-0.3053	-0.2524	-1.1546	-1.1659	-0.6380
	(-1.55)	(-2.12)	(-1.90)	(-1.94)	(-2.84)
78744	-0.1760	-0.1297	-0.2289	-0.2706	-0.3349
	(-1.11)	(-1.37)	(-2.45)	(-3.18)	(-8.53)
78745	0.1062	0.1075	-0.1542	-0.1371	-0.1446
	(0.60)	(1.05)	(-2.12)	(-2.06)	(-4.63)
78746	-0.4657	-0.1842	-0.0472	-0.0060	0.0326
	(-1.98)	(-1.15)	(-0.60)	(-0.08)	(0.96)
78747	-0.1552	-0.0716	-0.0601	-0.0371	0.0377
	(-0.87)	(-0.74)	(-0.51)	(-0.33)	(0.66)
78748	-0.2012	-0.0951	-0.3757	-0.3145	-0.1741
	(-1.36)	(-1.12)	(-5.12)	(-4.71)	(-5.63)
78749	-0.3558	-0.0463	-0.0777	-0.0680	-0.0891
	(-0.69)	(-0.16)	(-1.23)	(-1.19)	(-3.29)
78751	0.0005	-0.0761	-0.1158	-0.0371	0.0706
	(0.00)	(-0.30)	(-0.54)	(-0.20)	(0.91)

Table F.6 All Sales: Event Dates

All Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
78752	-0.2787	-0.1481	-0.1382	-0.0654	-0.0053
	(-1.57)	(-1.39)	(-0.73)	(-0.39)	(-0.07)
78753	-0.0360	0.0435	-0.0742	-0.0975	-0.1313
	(-0.09)	(0.15)	(-0.90)	(-1.29)	(-3.84)
78754	-0.0436	0.0174	0.1530	0.0870	-0.0541
	(-0.13)	(0.08)	(0.69)	(0.49)	(-0.80)
78756	-0.0751	-0.0090	0.1030	0.1249	0.1305
	(-0.46)	(-0.09)	(0.71)	(0.99)	(2.28)
78757	-0.1321	-0.0834	0.0557	0.0567	0.1032
	(-0.88)	(-0.93)	(0.71)	(0.80)	(3.12)
78758	-0.0544	-0.0106	-0.0004	-0.0155	-0.0789
	(-0.22)	(-0.07)	(-0.01)	(-0.24)	(-2.55)
manoise65	0.1536	0.0470	-0.0409	-0.0859	-0.0414
	(0.43)	(0.20)	(-0.32)	(-0.75)	(-0.87)
manoise3	0.0987	0.1592	-0.0567	-0.0827	-0.1151
	(0.20)	(0.51)	(-0.29)	(-0.49)	(-1.57)
madist1	0.0685	0.0020	0.1875	0.2352	0.0371
	(0.17)	(0.01)	(0.79)	(1.12)	(0.43)
madsit2	0.2760	0.0304	0.0325	0.0713	0.0855
	(0.63)	(0.12)	(0.17)	(0.43)	(1.24)
madist3	-0.3417	-0.1216	0.0424	0.0200	0.0112
	(-0.95)	(-0.54)	(0.22)	(0.12)	(0.17)
madist4	-0.0936	0.0696	-0.0772	-0.0455	-0.0547
	(-0.30)	(0.38)	(-0.46)	(-0.31)	(-0.92)
madist5	0.0674	0.1120	0.0054	-0.0041	-0.0042
	(0.39)	(1.13)	(0.04)	(-0.04)	(-0.09)
madist6	-0.1551	0.0754	0.0646	0.0818	0.0963
	(-0.47)	(0.35)	(0.89)	(1.28)	(3.41)
manorrd2	-0.2640	0.0144	0.2034	0.1169	-0.1081
	(-0.84)	(0.08)	(1.16)	(0.72)	(-1.58)
manorrd3	0.2946	0.1256	0.1863	0.1180	-0.0261
	(1.09)	(0.79)	(1.45)	(1.01)	(-0.54)
abiaroute2	0.0736	-0.0166	0.0386	0.0668	0.0070
	(0.36)	(-0.16)	(0.32)	(0.64)	(0.16)
abiaroute3	(dropped)	-0.2758	-0.0652	-0.0618	-0.0056

Table F.6 All Sales: Event Dates

All Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
		(-0.77)	(-0.84)	(-0.89)	(-0.19)
cbd1	-0.0381	0.0075	-0.0030	0.1988	0.1395
	(-0.13)	(0.05)	(-0.01)	(0.92)	(1.47)
cbd2	-0.1154	-0.0087	0.1071	0.0852	0.0388
	(-0.61)	(-0.08)	(0.92)	(0.79)	(0.80)
cbd3	2.5226	0.2404	0.1073	0.0912	0.0424
	(3.41)	(0.66)	(1.31)	(1.21)	(1.24)
ut1	-0.0158	-0.0403	0.2208	0.2706	0.2805
	(-0.06)	(-0.24)	(0.79)	(1.06)	(2.77)
ut2	-0.0720	-0.0010	-0.0179	-0.0304	0.0833
	(-0.41)	(-0.01)	(-0.14)	(-0.26)	(1.65)
ut3	-0.0238	0.2888	0.0778	0.0701	0.1038
	(-0.20)	(3.20)	(1.06)	(1.06)	(3.44)
d1980	-0.0560	0.2402	0.2460	0.2593	0.2733
	(-0.48)	(2.76)	(-2.83)	(3.02)	(3.89)
d1981	-0.0083	0.2902	0.2021	0.2092	0.2376
	(-0.07)	(3.81)	(2.41)	(2.52)	(3.50)
d1982	(dropped)	0.2933	0.2678	0.2730	0.2799
		(3.27)	(3.66)	(3.78)	(4.74)
d1983	0.2397	0.5553	0.2543	0.2568	0.2601
	(2.34)	(8.45)	(2.93)	(2.99)	(3.68)
d1984	0.2536	0.5672	0.5289	0.5368	0.5604
	(2.60)	(9.75)	(8.33)	(8.55)	(10.90)
d1985	0.2467	0.5476	0.5429	0.5524	0.5706
	(2.32)	(7.95)	(9.74)	(10.05)	(12.71)
d1986	0.0837	0.4067	0.5414	0.5376	0.5388
	(0.78)	(5.91)	(8.12)	(8.15)	(9.90)
d1987	0.1872	0.1675	0.3710	0.3821	0.3914
	(3.24)	(2.90)	(5.57)	(5.81)	(7.22)
d1988	0.1760	0.1087	0.1559	0.1679	0.1788
	(3.44)	(2.14)	(2.78)	(3.03)	(3.91)
d1989	-0.0003	0.0049	0.0861	0.0892	0.1013
	(-0.01)	(0.11)	(1.75)	(1.83)	(2.51)
d1991	0.0893	0.3177	-0.0060	-0.0035	0.0055
	(2.09)	(4.67)	(-0.14)	(-0.08)	(0.16)

Table F.6 All Sales: Event Dates

All Variables Interact with Event Dummy

(t-statistics in parentheses)

	dvote	dlist	dclose	dbuild	dopen
d1992	0.0874	0.3158	0.0655	0.0689	0.0844
	(2.09)	(4.69)	(1.57)	(1.68)	(2.49)
d1993	0.2252	0.4536	0.0788	0.0788	0.0858
	(5.36)	(6.72)	(1.94)	(1.96)	(2.60)
d1994	0.2527	0.4811	0.4074	0.2081	0.2197
	(6.87)	(7.45)	(1.83)	(5.14)	(6.61)
d1995	0.2691	0.4975	0.4349	0.4811	0.2735
	(7.46)	(7.75)	(1.97)	(7.69)	(9.36)
d1996	0.3144	0.5428	0.4513	0.4975	0.3182
	(7.55)	(8.06)	(2.04)	(8.00)	(11.11)
d1997	-0.2284	(dropped)	0.4966	0.5428	0.3198
	(-3.11)		(2.24)	(8.32)	(9.64)
d1998	0.3762	0.6046	-0.0462	(dropped)	0.1576
	(10.09)	(9.32)	(-0.20)		(2.69)
d1999	0.4774	0.7058	0.5584	0.6046	0.5185
	(13.50)	(11.06)	(2.52)	(9.62)	(17.35)
d2000	0.5074	0.7358	0.6596	0.7058	0.9572
	(13.50)	(11.32)	(2.98)	(11.42)	(10.42)
d2001	11.4995	11.2711	0.6896	0.7358	0.9872
	(332.48)	(177.78)	(3.11)	(11.68)	(10.68)
_cons	10.9869	11.5888	11.3173	11.2711	11.0196
	(202.03)	(469.98)	(21.21)	(183.49)	(120.16)
Number of obs	21386	21386	21386	21386	21386
F-stat	18.4	28.54	40.15	44.89	165.79
Prob > F	0	0	0	0	0
R-squared	0.0707	0.1108	0.1506	0.1654	0.4226
Root MSE	0.61402	0.60146	0.58788	0.58273	0.48468

APPENDIX G: DIFFERENCE MODELS

Table G.1 Regression Results for Single Difference Models

Both Airports - Corrected (t-statistics in parentheses)

	preVote	preList	preClose	preBuild	preOpen	Final
gba	0.000287	0.0002945	0.0002149	0.0002668	0.0002606	0.0003303
	(7.89)	(11.22)	(6.56)	(8.33)	(29.93)	(35.18)
tla	2.43E-06	-0.00000092	0.00000341	-0.00000219	0.00000147	0.00000299
	(0.99)	(-1.28)	(2.1)	(-2.57)	(5.03)	(11.49)
age	-0.00323	-0.0114352	-0.0169357	-0.0084795	-0.0106995	-0.0079949
	(-0.82)	(-3.89)	(-4.61)	(-2.52)	(-11.87)	(-8.69)
agesq	5.48E-05	0.0001297	0.0003161	0.0001202	0.0001124	0.0000935
	(0.64)	(2.84)	(5.01)	(2.27)	(7.99)	(8.04)
dbath2	0.10839	0.0934638	0.200687	0.0780279	0.0783717	0.0119354
	(2.33)	(2.07)	(3.89)	(1.39)	(5.32)	(0.9)
dbath3	0.139136	0.1507311	0.334098	0.0613787	0.1087411	0.0084502
	(2.24)	(2.72)	(5.08)	(0.91)	(5.71)	(0.47)
dfire	0.147089	0.0671685	0.0142729	0.0008347	0.0305278	0.0046072
	(4.21)	(1.93)	(0.35)	(0.02)	(2.46)	(0.4)
dpool3	0.077152	0.0962254	0.249355	0.1959832	0.134005	0.0542092
	(1.39)	(2.17)	(4.66)	(3.49)	(7.89)	(3.05)
dspa	0.125898	0.1329356	0.0922553	0.1421836	0.0917735	0.092768
	(1.42)	(2.46)	(1.16)	(1.44)	(3.28)	(2.95)
dgarage	0.06195	0.1088596	0.0835296	0.1816683	0.124772	0.0793545
	(1.3)	(2.37)	(1.52)	(3.17)	(7.84)	(5.69)
dcarport	-0.02536	0.1160452	0.1167437	0.0991244	0.1424108	0.0902062
	(-0.41)	(1.89)	(1.64)	(1.31)	(7.01)	(5.3)
dmanuf	-0.67576	(dropped)	(dropped)	(dropped)	-0.4188638	(dropped)
	(-1.97)				(-1.79)	
dmasonry	-0.5046	-0.1684565	0.1649879	-0.1035322	0.1530835	0.0681341
	(-1.91)	(-0.74)	(0.5)	(-0.41)	(2.26)	(1.27)
dbrick	0.039422	0.086298	-0.1329954	0.0926327	0.063724	0.0626335
	(1.22)	(3.32)	(-4.02)	(2.79)	(6.49)	(6.62)
hsgrad	0.010961	-0.0069862	-0.0477758	0.0151627	-0.0082374	0.0044173
	(1.34)	(-0.9)	(-4.86)	(1.51)	(-3.06)	(1.8)

Table G.1 Regression Results for Single Difference Models

Both Airports - Corrected (t-statistics in parentheses)

	preVote	preList	preClose	preBuild	preOpen	Final
bchdeg	-0.00387	-0.0034007	-0.022983	0.007951	-0.0013193	-0.000627
	(-0.51)	(-0.56)	(-2.91)	(0.89)	(-0.56)	(-0.29)
grddeg	0.031375	0.0228065	-0.0024613	0.0345025	0.0225515	0.0189116
	(3.35)	(2.89)	(-0.25)	(3.08)	(7.69)	(6.77)
forbrn	-0.00618	0.0039827	0.0591812	-0.039728	-0.0157114	-0.0006704
	(-0.56)	(0.43)	(5.15)	(-3.15)	(-4.72)	(-0.23)
popbl	0.001161	-0.0088179	-0.0125164	-0.0020069	-0.0041176	-0.0043455
	(0.37)	(-2.96)	(-2.71)	(-0.4)	(-4.61)	(-5.7)
popna	-0.01057	0.0329661	0.1002295	0.0182775	0.028382	-0.0031418
	(-0.32)	(1)	(2.43)	(0.41)	(2.41)	(-0.29)
popap	-0.00511	-0.0203782	-0.089597	0.0407894	0.0084232	-0.0035268
	(-0.35)	(-1.88)	(-6.4)	(2.69)	(2.12)	(-0.99)
popoth	-0.00017	-0.0045278	-0.025417	0.0100213	0.0015309	-0.0006815
	(-0.04)	(-1.2)	(-5.06)	(1.77)	(1.13)	(-0.56)
vacant	0.005628	0.0011734	-0.0130671	-0.0013913	0.0009264	0.0005657
	(0.93)	(0.18)	(-1.65)	(-0.17)	(0.46)	(0.32)
ownocc	-0.00072	-0.0004732	0.0049	0.0006102	-0.0007226	-0.0002061
	(-0.51)	(-0.42)	(3.25)	(0.37)	(-1.62)	(-0.5)
d78617	0.00158	(dropped)	(dropped)	(dropped)	-0.9007389	-0.3996283
	(0)				(-2.75)	(-3.28)
d78653	(dropped)	0.4190061	0.4653934	0.6192656	0.0846445	-0.5237036
		(1.23)	(1.27)	(1.44)	(0.6)	(-4.46)
d78701	2.216434	(dropped)	(dropped)	(dropped)	0.7070765	-0.2331117
	(5.26)				(2.08)	(-1.17)
d78702	-0.01943	-0.5039953	-1.914725	-0.563268	-0.6079492	-0.5220619
	(-0.06)	(-1.85)	(-4.95)	(-1.19)	(-7.47)	(-7.76)
d78703	0.338992	0.0423734	-0.0343111	0.3138738	0.1680366	0.1787476
	(1.96)	(0.32)	(-0.2)	(1.47)	(3.39)	(3.89)
d78704	-0.0012	0.0752335	-0.103817	0.2342378	0.0933151	0.1458794
	(-0.01)	(0.72)	(-0.74)	(1.25)	(2.25)	(3.76)
d78705	(dropped)	-0.1477291	-0.4428707	1.136527	0.0946336	0.1953552
		(-0.38)	(-1.67)	(1.81)	(1.03)	(2.4)
d78719	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	-0.4474321
						(-1.18)
d78721	-1.33867	-0.4073917	-0.77757	-0.3862599	-0.1752669	-0.3497715

Table G.1 Regression Results for Single Difference Models
Both Airports - Corrected
(t-statistics in parentheses)

	preVote	**preList**	**preClose**	**preBuild**	**preOpen**	**Final**
	(-4.64)	(-0.83)	(-1.56)	(-0.58)	(-1.85)	(-4.79)
d78722	0.244336	-0.0753266	-0.3983766	-0.090884	0.0782322	-0.0541205
	(0.7)	(-0.22)	(-0.79)	(-0.26)	(0.9)	(-0.77)
d78723	-0.21877	0.2807601	-0.2272767	-0.2097269	-0.0414244	-0.1704624
	(-0.91)	(1.01)	(-0.86)	(-0.73)	(-0.63)	(-3.21)
d78724	-0.4153	0.0467286	-0.0046734	-0.8122495	0.1636697	-0.2980246
	(-1.59)	(0.2)	(-0.01)	(-2.13)	(2.62)	(-4.88)
d78725	-0.44935	(dropped)	-0.1055028	-1.468064	-0.226403	-0.1753029
	(-1.09)		(-0.19)	(-3.69)	(-1.46)	(-1.15)
d78727	-0.11247	-0.0826514	-0.0094968	0.0045962	-0.0737081	-0.1025465
	(-1.26)	(-1.21)	(-0.11)	(0.05)	(-2.66)	(-3.86)
d78731	-0.08075	-0.1270488	0.1349262	-0.2534298	-0.0166642	0.0626284
	(-0.81)	(-1.44)	(1.22)	(-2.12)	(-0.5)	(1.9)
d78735	-0.06401	-0.0704227	0.1337538	-0.3829145	-0.2591489	-0.0774653
	(-0.5)	(-0.74)	(0.99)	(-2.47)	(-8)	(-2.06)
d78739	0.101311	0.0528738	-0.0681714	0.1550974	0.060711	-0.1372322
	(0.68)	(0.5)	(-0.6)	(1.41)	(1.81)	(-4.11)
d78741	-0.35792	0.258324	0.0095752	-0.1738231	-0.1279344	-0.1759012
	(-1.46)	(0.98)	(0.04)	(-0.56)	(-1.84)	(-2.82)
d78742	(dropped)	(dropped)	(dropped)	(dropped)	-0.132394	-0.4425343
					(-0.47)	(-2.21)
d78744	-0.10307	-0.1679257	-0.1171921	-0.8887748	-0.2483805	-0.3053983
	(-0.7)	(-1.2)	(-0.74)	(-4.65)	(-5.42)	(-7.45)
d78745	-0.13982	-0.1058193	-0.1477368	-0.0978325	-0.1258756	-0.2229983
	(-1.72)	(-1.39)	(-1.57)	(-0.98)	(-4.37)	(-8.23)
d78746	0.175953	0.0216786	-0.2560393	0.2170699	0.0525852	0.1908662
	(1.81)	(0.29)	(-2.51)	(1.86)	(1.7)	(6.13)
d78747	-0.41404	0.2282576	0.2094392	0.0519413	0.1558854	-0.108926
	(-3.41)	(1.59)	(1.43)	(0.21)	(2.79)	(-2.23)
d78748	-0.1255	-0.0466269	-0.5909202	-0.0605934	-0.088184	-0.1886173
	(-1.39)	(-0.66)	(-6.32)	(-0.6)	(-3.15)	(-6.92)
d78749	-0.1768	-0.0276518	0.0122676	-0.0787518	-0.0861312	-0.1720412
	(-2.37)	(-0.42)	(0.16)	(-0.95)	(-3.49)	(-7.25)
d78751	-0.38182	0.273486	-0.0384199	0.2679504	0.1819529	0.037551
	(-1.43)	(0.97)	(-0.13)	(0.98)	(2.52)	(0.63)

Table G.1 Regression Results for Single Difference Models
Both Airports - Corrected
(t-statistics in parentheses)

	preVote	preList	preClose	preBuild	preOpen	Final
d78752	0.001693	0.1473663	-0.2210648	0.3294841	0.0762728	-0.0616002
	(0.01)	(0.56)	(-0.97)	(1.22)	(1.18)	(-1.12)
d78753	-0.25148	-0.0811177	0.1007411	-0.150288	-0.1315501	-0.2389592
	(-2.8)	(-0.99)	(0.9)	(-1.3)	(-4.25)	(-8.18)
d78754	-0.01452	0.1152618	0.5285423	-0.1342048	-0.0645318	-0.2517681
	(-0.07)	(0.49)	(1.5)	(-0.68)	(-1.13)	(-4.59)
d78756	0.096772	0.2545953	0.0826103	0.2244657	0.1865941	0.1763133
	(0.53)	(1.42)	(0.5)	(1.27)	(3.6)	(3.67)
d78757	-0.05021	0.036371	0.110732	0.0186548	0.1092204	0.0808649
	(-0.6)	(0.44)	(1.09)	(0.17)	(3.61)	(2.83)
d78758	-0.11082	-0.0179253	0.1052187	-0.0547723	-0.0981291	-0.1881084
	(-1.46)	(-0.25)	(1.1)	(-0.55)	(-3.45)	(-7)
d1980	-0.02537					
	(-0.43)					
d1981	-0.05864					
	(-1.01)					
d1982	-0.01441					
	(-0.26)					
d1983						
d1984	0.238269					
	(4.68)					
d1985	0.251237					
	(5.16)					
d1986	0.241098					
	(4.56)					
d1987	0.081477	0.3310107				
	(1.52)	(1.98)				
d1988		0.1643407				
		(5.35)				
d1989		0.0985567				
		(3.68)				
d1990						
d1991		-0.0094268				

Table G.1 Regression Results for Single Difference Models
Both Airports -
Corrected
(t-statistics in
parentheses)

	preVote	preList	preClose	preBuild	preOpen	Final
		(-0.33)				
d1992			0.0680969			
			(1.93)			
d1993			0.0536125			
			(1.47)			
d1994				-0.0248923		
				(-0.78)		
d1995					-0.1261351	
					(-6.28)	
d1996					-0.0839082	
					(-4.26)	
d1997					-0.0767368	
					(-3.4)	
d1998					-0.2486129	
					(-6.32)	
d1999						-0.0928607
						(-9.08)
d2000						
d2001						0.0665122
						(6.6)
dcbd1	(dropped)	-0.4846961	-0.0123901	0.260653	-0.0157914	0.1670081
		(-1.51)	(-0.04)	(0.96)	(-0.16)	(2.28)
dcbd2	0.053444	-0.028636	0.1642561	-0.3260626	0.0581898	0.1279845
	(0.35)	(-0.24)	(1.1)	(-1.66)	(1.27)	(3.23)
dcbd3	-0.10923	0.0535848	0.181229	-0.2662677	0.0263061	0.0952056
	(-1.1)	(0.66)	(1.71)	(-1.82)	(0.83)	(3.42)
dut1	0.264144	0.6950504	0.0104064	0.3555266	0.2258459	0.2301284
	(0.8)	(2.26)	(0.03)	(0.74)	(2.46)	(2.87)
dut2	-0.22103	0.0370998	-0.0039679	0.0874537	0.0753612	0.1994283
	(-1.37)	(0.27)	(-0.02)	(0.46)	(1.66)	(4.8)
dut3	-0.17296	0.0886977	0.119842	0.1150324	0.0802475	0.0830076
	(-1.77)	(1.1)	(1.36)	(1.16)	(2.94)	(3.25)
madist1	0.224481	-0.2649745	0.0495152	0.3697379	-0.0005213	-0.1011856
	(0.91)	(-0.81)	(0.14)	(1.13)	(-0.01)	(-1.57)

Table G.1 Regression Results for Single Difference Models
Both Airports - Corrected
(t-statistics in parentheses)

	preVote	preList	preClose	preBuild	preOpen	Final
madist2	0.200514	-0.4395802	-0.2151265	0.1399207	0.0671563	0.0655258
	(0.97)	(-1.57)	(-0.86)	(0.55)	(1.09)	(1.31)
madist3	0.364192	-0.3765675	-0.0839095	-0.0820167	-0.0057852	0.0479522
	(1.65)	(-1.45)	(-0.35)	(-0.34)	(-0.1)	(0.99)
madist4	-0.30449	-0.3241363	-0.0053455	-0.052886	-0.1008616	-0.0374217
	(-1.68)	(-1.34)	(-0.02)	(-0.24)	(-1.9)	(-0.9)
madist5	-0.05111	-0.1512096	-0.0206482	-0.0467862	-0.0339367	0.0297622
	(-0.32)	(-0.87)	(-0.14)	(-0.27)	(-0.79)	(0.86)
madist6	0.085029	0.1017846	0.014124	0.0488866	0.1196263	0.0290061
	(0.96)	(1.25)	(0.17)	(0.59)	(4.84)	(1.25)
manorrd2	-0.20767	0.288517	0.0200514	-0.0484669	-0.2126014	-0.1433534
	(-1.26)	(1.55)	(0.07)	(-0.14)	(-3.54)	(-2.85)
manorrd3	-0.29235	0.2049377	0.4121979	-0.0369173	-0.1374699	-0.0783156
	(-1.85)	(1.44)	(2.32)	(-0.19)	(-3.19)	(-2.25)
abiaroute2	0.375782	0.0344021	-0.1482598	0.0798771	0.0527516	0.017671
	(2.41)	(0.22)	(-0.84)	(0.47)	(1.24)	(0.49)
abiaroute3	0.158463	-0.025772	-0.0939997	-0.0772786	0.037757	0.0563218
	(1.44)	(-0.29)	(-0.85)	(-0.67)	(1.35)	(2.28)
manoise65	-0.06118	0.1174489	0.0283267	-0.2645826	-0.0560713	0.0455588
	(-0.5)	(0.74)	(0.12)	(-1.64)	(-1.28)	(1.37)
manoise3	0.157581	0.0231441	-0.0535476	-0.1549001	-0.2058776	0.1112666
	(0.86)	(0.09)	(-0.19)	(-0.59)	(-3.03)	(2.22)
abia_dist1	(dropped)	(dropped)	-0.7911345	(dropped)	-0.0029161	-0.3223977
			(-1.54)		(-0.01)	(-1.67)
abia_dist2	(dropped)	-0.1927188	-0.5402685	(dropped)	-0.2407211	-0.4097155
		(-0.45)	(-1.29)		(-2.39)	(-4.56)
abia_dist3	0.051216	-0.0917506	0.1322909	0.4368151	-0.067714	-0.0993581
	(0.16)	(-0.49)	(0.63)	(1.09)	(-1.06)	(-1.63)
abia_dist4	-0.20566	-0.0792785	0.0049734	0.528533	-0.1360678	-0.100072
	(-1.43)	(-0.61)	(0.03)	(3.11)	(-3.24)	(-2.69)
abia_dist5	-0.12097	-0.0442246	-0.0429251	0.2151928	-0.0488789	-0.0964313
	(-0.99)	(-0.42)	(-0.34)	(1.52)	(-1.51)	(-3.4)
_cons	10.78443	10.91086	11.95849	10.5402	11.32314	11.32259
	(42.47)	(49.58)	(42.25)	(34.01)	(138.8)	(151.96)

Table G.1 Regression Results for Single Difference Models
Both Airports - Corrected
(t-statistics in parentheses)

	preVote	preList	preClose	preBuild	preOpen	Final
N	787	977	1361	805	7107	10349
Adj R^2	0.6914	0.7500	0.6025	0.6284	0.7153	0.6364

Table G.2 Difference-in-Differences Results

lnprice	Coef.	Std.Err.	t	P>|t|	[95% Conf. Interval]	
gba	0.000282	6.14E-06	45.94	0	0.00027	0.000294
tla	2.01E-06	1.87E-07	10.72	0	1.64E-06	2.37E-06
age	-1.17E-02	6.04E-04	-19.35	0	-0.01288	-1.05E-02
agesq	0.000144	8.29E-06	17.34	0	0.000128	0.00016
dbath2	0.052395	0.00948	5.53	0	0.033812	0.070977
dbath3	0.074733	0.012536	5.96	0	0.05016	0.099305
dfire	0.020008	0.008031	2.49	0.013	0.004265	0.03575
dpool3	0.107087	0.011616	9.22	0	0.084318	0.129855
dspa	0.09913	0.019148	5.18	0	0.061599	0.136662
dgarage	0.099921	0.010081	9.91	0	0.080162	0.11968
dcarport	0.120818	0.012555	9.62	0	0.096209	0.145427
dmanuf	-0.50823	0.2184	-2.33	0.02	-0.93631	-0.08015
dmasonry	0.07924	0.041252	1.92	0.055	-0.00162	0.160097
dbrick	0.048308	0.006472	7.46	0	0.035622	0.060994
pcthsgrad	-0.29096	0.173046	-1.68	0.093	-0.63014	0.048222
pctbchdeg	-0.33439	0.151559	-2.21	0.027	-0.63146	-0.03732
pctgrddeg	2.074098	0.192355	10.78	0	1.697068	2.451127
pctforbrn	-0.28231	0.212469	-1.33	0.184	-0.69877	0.134143
pctpopbl	-0.43911	0.056415	-7.78	0	-0.54969	-0.32854
pctpopna	1.327101	0.763179	1.74	0.082	-0.16879	2.822989
pctpopap	-0.49528	0.254095	-1.95	0.051	-0.99333	0.002762
pctpopoth	-0.14178	0.086189	-1.64	0.1	-0.31071	0.02716
pctvachs	-0.00925	0.128108	-0.07	0.942	-0.26035	0.24185
pctownocc	0.009634	0.028667	0.34	0.737	-0.04655	0.065823
d78617	-0.33835	0.10433	-3.24	0.001	-0.54284	-0.13386
d78653	-0.17067	0.083878	-2.03	0.042	-0.33508	-0.00627
d78701	0.306719	0.159353	1.92	0.054	-0.00562	0.619063
d78702	-0.59539	0.050003	-11.91	0	-0.6934	-0.49738
d78703	0.154044	0.032215	4.78	0	0.090899	0.217188
d78704	0.096061	0.026889	3.57	0	0.043356	0.148766
d78705	0.094632	0.058554	1.62	0.106	-0.02014	0.209403
d78719	-0.44803	0.373201	-1.20	0.23	-1.17953	0.283476
d78721	-0.38085	0.056167	-6.78	0	-0.49094	-0.27076
d78722	-0.02002	0.053129	-0.38	0.706	-0.12415	0.084119

Table G.2 Difference-in-Differences Results

lnprice	Coef.	Std.Err.	t	P>|t|	[95% Conf. Interval]	
d78723	-0.14138	0.039828	-3.55	0	-0.21944	-0.06331
d78724	-0.09642	0.042527	-2.27	0.023	-0.17978	-0.01307
d78725	-0.20157	0.10627	-1.90	0.058	-0.40987	0.006725
d78727	-0.09718	0.018103	-5.37	0	-0.13266	-0.0617
d78731	0.004921	0.022132	0.22	0.824	-0.03846	0.048301
d78735	-0.18617	0.02389	-7.79	0	-0.23299	-0.13934
d78739	-0.06054	0.022765	-2.66	0.008	-0.10516	-0.01592
d78741	-0.14685	0.044899	-3.27	0.001	-0.23485	-0.05884
d78742	-0.38286	0.16632	-2.30	0.021	-0.70886	-0.05686
d78744	-0.30006	0.029395	-10.21	0	-0.35768	-0.24245
d78745	-0.18934	0.018591	-10.18	0	-0.22578	-0.1529
d78746	0.091444	0.020699	4.42	0	0.050873	0.132015
d78747	-0.02201	0.033812	-0.65	0.515	-0.08828	0.044267
d78748	-0.19676	0.018494	-10.64	0	-0.23301	-0.16051
d78749	-0.13828	0.016113	-8.58	0	-0.16986	-0.10669
d78751	0.074216	0.044516	1.67	0.095	-0.01304	0.16147
d78752	-0.02943	0.040282	-0.73	0.465	-0.10838	0.049529
d78753	-0.19382	0.020222	-9.58	0	-0.23345	-0.15418
d78754	-0.15702	0.038953	-4.03	0	-0.23337	-0.08067
d78756	0.164229	0.033479	4.91	0	0.098608	0.229849
d78757	0.080387	0.019677	4.09	0	0.041818	0.118956
d78758	-0.13249	0.018335	-7.23	0	-0.16842	-0.09655
d1980	0.306649	0.201983	1.52	0.129	-0.08925	0.70255
d1981	0.278244	0.201507	1.38	0.167	-0.11673	0.673212
d1982	0.330002	0.199856	1.65	0.099	-0.06173	0.721734
d1983	0.299841	0.201947	1.48	0.138	-0.09599	0.695672
d1984	0.603653	0.198586	3.04	0.002	0.21441	0.992896
d1985	0.608581	0.197625	3.08	0.002	0.221221	0.99594
d1986	0.58086	0.198998	2.92	0.004	0.190809	0.97091
d1987	0.428273	0.192187	2.23	0.026	0.051573	0.804974
d1988	0.165636	0.035257	4.70	0	0.09653	0.234742
d1989	0.09575	0.031072	3.08	0.002	0.034847	0.156653
d1991	0.004162	0.033157	0.13	0.9	-0.06083	0.069153
d1992	0.075493	0.043317	1.74	0.081	-0.00941	0.160397
d1993	0.021916	0.043874	0.50	0.617	-0.06408	0.107912
d1994	0.007202	0.054064	0.13	0.894	-0.09877	0.113173

Table G.2 Difference-in-Differences
Results

lnprice	Coef.	Std.Err.	t	P>|t|	[95% Conf. Interval]	
d1995	0.076226	0.07875	0.97	0.333	-0.07813	0.230581
d1996	0.123223	0.078636	1.57	0.117	-0.03091	0.277356
d1997	0.118194	0.079659	1.48	0.138	-0.03794	0.274331
d1998	-0.02958	0.087771	-0.34	0.736	-0.20161	0.14246
d1999	0.239592	0.081806	2.93	0.003	0.079247	0.399938
d2000	0.332686	0.082438	4.04	0	0.171102	0.494271
d2001	0.397335	0.082809	4.80	0	0.235023	0.559648
dcbd1	0.06862	0.055529	1.24	0.217	-0.04022	0.17746
dcbd2	0.088632	0.028588	3.10	0.002	0.032598	0.144666
dcbd3	0.062442	0.020052	3.11	0.002	0.023139	0.101744
dut1	0.232053	0.058487	3.97	0	0.117414	0.346693
dut2	0.120809	0.029544	4.09	0	0.0629	0.178718
dut3	0.078983	0.017786	4.44	0	0.04412	0.113846
manoise65	-0.0228	0.130915	-0.17	0.862	-0.2794	0.233804
manoise3	0.140984	0.206606	0.68	0.495	-0.26398	0.545948
madist1	0.114609	0.146859	0.78	0.435	-0.17325	0.402464
madist2	-0.13749	0.109977	-1.25	0.211	-0.35305	0.078075
madist3	-0.05106	0.142023	-0.36	0.719	-0.32943	0.227318
madist4	-0.24846	0.111651	-2.23	0.026	-0.4673	-0.02961
madist5	-0.23085	0.095273	-2.42	0.015	-0.41759	-0.04411
madist6	0.085693	0.077986	1.10	0.272	-0.06717	0.238551
manorrd2	0.284222	0.135992	2.09	0.037	0.017668	0.550776
manorrd3	0.194559	0.09937	1.96	0.05	-0.00021	0.389332
abia_dist1	-0.653	0.41888	-1.56	0.119	-1.47404	0.168038
abia_dist2	0.104621	0.382551	0.27	0.784	-0.64521	0.854449
abia_dist3	0.037436	0.15728	0.24	0.812	-0.27084	0.345716
abia_dist4	-0.07263	0.072815	-1.00	0.319	-0.21536	0.070088
abia_dist5	-0.14759	0.064243	-2.30	0.022	-0.27351	-0.02167
abiaroute2	-0.03984	0.137112	-0.29	0.771	-0.30859	0.228914
abiaroute3	-0.14925	0.071247	-2.09	0.036	-0.2889	-0.0096
dlist	0.0637	0.194994	0.33	0.744	-0.3185	0.445902
dclose	0.061308	0.197886	0.31	0.757	-0.32656	0.449179
dbuild	0.27303	0.200548	1.36	0.173	-0.12006	0.666119
dopen	0.23009	0.208878	1.10	0.271	-0.17933	0.639508
dfinal	0.296332	0.21038	1.41	0.159	-0.11603	0.708693
list_madist1	-0.33607	0.246475	-1.36	0.173	-0.81918	0.14704

Table G.2 Difference-in-Differences Results

lnprice	Coef.	Std.Err.	t	P>|t|	[95% Conf. Interval]	
list_madist2	-0.12781	0.153872	-0.83	0.406	-0.42941	0.17379
list_madist3	-0.19195	0.17674	-1.09	0.277	-0.53838	0.154471
list_madist4	0.109987	0.158779	0.69	0.489	-0.20123	0.421206
list_madist5	0.089859	0.130019	0.69	0.489	-0.16499	0.344707
list_madist6	-0.15922	0.102003	-1.56	0.119	-0.35915	0.040714
close_madi~1	-0.20017	0.212408	-0.94	0.346	-0.6165	0.21617
close_madi~2	0.077844	0.153545	0.51	0.612	-0.22312	0.378805
close_madi~3	0.035364	0.171305	0.21	0.836	-0.30041	0.371135
close_madi~4	0.310673	0.152293	2.04	0.041	0.012168	0.609178
close_madi~5	0.17982	0.110663	1.62	0.104	-0.03709	0.396727
close_madi~6	-0.15409	0.090205	-1.71	0.088	-0.3309	0.022714
build_madi~1	-0.27957	0.245724	-1.14	0.255	-0.7612	0.20207
build_madi~2	0.132074	0.169235	0.78	0.435	-0.19964	0.463787
build_madi~3	-0.11955	0.173143	-0.69	0.49	-0.45892	0.219825
build_madi~4	0.16406	0.165689	0.99	0.322	-0.1607	0.488824
build_madi~5	0.161487	0.125989	1.28	0.2	-0.08546	0.408435
build_madi~6	-0.11982	0.09773	-1.23	0.22	-0.31138	0.07174
open_madist1	-0.1895	0.151856	-1.25	0.212	-0.48715	0.108144
open_madist2	0.147659	0.111868	1.32	0.187	-0.07161	0.36693
open_madist3	0.009204	0.143755	0.06	0.949	-0.27257	0.290975
open_madist4	0.103539	0.114706	0.90	0.367	-0.12129	0.328372
open_madist5	0.138926	0.095778	1.45	0.147	-0.04881	0.326659
open_madist6	0.019698	0.079882	0.25	0.805	-0.13688	0.176272
final_madi~1	-0.14128	0.148176	-0.95	0.34	-0.43171	0.149159
final_madi~2	0.253544	0.109432	2.32	0.021	0.039049	0.468039
final_madi~3	0.139658	0.14156	0.99	0.324	-0.13781	0.417125
final_madi~4	0.244466	0.111413	2.19	0.028	0.026087	0.462844
final_madi~5	0.31187	0.094805	3.29	0.001	0.126045	0.497695
final_madi~6	-0.02154	0.079115	-0.27	0.785	-0.17661	0.133528
list_manor2	-0.14806	0.203788	-0.73	0.468	-0.5475	0.251382
list_manor3	-0.01355	0.143276	-0.09	0.925	-0.29438	0.267285
close_manor2	-0.67583	0.229371	-2.95	0.003	-1.12542	-0.22625
close_manor3	-0.30325	0.133288	-2.28	0.023	-0.56451	-0.042
build_manor2	-0.47427	0.268336	-1.77	0.077	-1.00023	0.05169
build_manor3	-0.29342	0.143242	-2.05	0.041	-0.57418	-0.01265
open_manor2	-0.39459	0.143867	-2.74	0.006	-0.67658	-0.1126

Table G.2 Difference-in-Differences Results

lnprice	Coef.	Std.Err.	t	P>|t|	[95% Conf. Interval]	
open_manor3	-0.23947	0.102598	-2.33	0.02	-0.44057	-0.03837
final_manor2	-0.44899	0.140109	-3.20	0.001	-0.72361	-0.17436
final_manor3	-0.30535	0.10044	-3.04	0.002	-0.50222	-0.10848
vote_route2	0.028693	0.182116	0.16	0.875	-0.32827	0.385653
vote_route3	-0.03156	0.100869	-0.31	0.754	-0.22927	0.166148
close_route2	0.008375	0.168487	0.05	0.96	-0.32187	0.338623
close_route3	0.064431	0.091208	0.71	0.48	-0.11434	0.243205
build_route2	0.24234	0.176265	1.37	0.169	-0.10315	0.587832
build_route3	0.117118	0.10267	1.14	0.254	-0.08412	0.318359
open_route2	0.040283	0.141082	0.29	0.775	-0.23625	0.316814
open_route3	0.149681	0.073503	2.04	0.042	0.00561	0.293752
final_route2	0.081986	0.138537	0.59	0.554	-0.18956	0.35353
final_route3	0.22512	0.072067	3.12	0.002	0.083863	0.366376
list_noise65	0.140246	0.198915	0.71	0.481	-0.24964	0.530136
list_noise3	-0.26563	0.292483	-0.91	0.364	-0.83892	0.307658
close_noi~65	-0.16023	0.197707	-0.81	0.418	-0.54775	0.227294
close_noise3	-0.51423	0.276884	-1.86	0.063	-1.05694	0.028485
build_noi~65	-0.26535	0.178403	-1.49	0.137	-0.61503	0.084335
build_noise3	-0.08728	0.293249	-0.30	0.766	-0.66207	0.487514
open_noise65	0.054333	0.137994	0.39	0.694	-0.21614	0.324811
open_noise3	-0.22252	0.217855	-1.02	0.307	-0.64953	0.204494
final_noi~65	0.009752	0.13408	0.07	0.942	-0.25305	0.272559
final_noise3	-0.09183	0.211495	-0.43	0.664	-0.50638	0.322714
vote_abiad1	(dropped)					
vote_abiad2	(dropped)					
vote_abiad3	0.105974	0.294446	0.36	0.719	-0.47116	0.683111
vote_abiad4	0.074542	0.096187	0.77	0.438	-0.11399	0.263076
vote_abiad5	0.172247	0.086075	2.00	0.045	0.003534	0.34096
close_abiad1	(dropped)					
close_abiad2	-0.82058	0.465542	-1.76	0.078	-1.73307	0.09192
close_abiad3	-0.03635	0.200043	-0.18	0.856	-0.42845	0.35575
close_abiad4	0.012003	0.097576	0.12	0.902	-0.17925	0.20326
close_abiad5	0.02492	0.079818	0.31	0.755	-0.13153	0.181369
build_abiad1	(dropped)					
build_abiad2	-1.36524	0.542487	-2.52	0.012	-2.42856	-0.30192
build_abiad3	-0.1925	0.402926	-0.48	0.633	-0.98227	0.597263

Table G.2 Difference-in-Differences Results

lnprice	Coef.	Std.Err.	t	P>|t|	[95% Conf. Interval]	
build_abiad4	-0.03102	0.109119	-0.28	0.776	-0.2449	0.182862
build_abiad5	-0.11523	0.0965	-1.19	0.232	-0.30438	0.073914
open_abiad1	0.769841	0.473972	1.62	0.104	-0.15918	1.698862
open_abiad2	-0.41106	0.387881	-1.06	0.289	-1.17133	0.34922
open_abiad3	-0.08674	0.16393	-0.53	0.597	-0.40805	0.234576
open_abiad4	-0.04198	0.072827	-0.58	0.564	-0.18473	0.100762
open_abiad5	0.06076	0.06505	0.93	0.35	-0.06674	0.188262
final_abiad1	0.333163	0.430789	0.77	0.439	-0.51122	1.177543
final_abiad2	-0.4958	0.385247	-1.29	0.198	-1.25091	0.259311
final_abiad3	-0.14958	0.162253	-0.92	0.357	-0.46761	0.168444
final_abiad4	-0.00302	0.071745	-0.04	0.966	-0.14364	0.137605
final_abiad5	0.105569	0.063835	1.65	0.098	-0.01955	0.23069
_cons	10.88848	0.202704	53.72	0	10.49116	11.28579

Left out dummy for MA variables is B4Vote; left out dummy for ABIA is B4List

Source	SS	df	MS		
				Number of obs =	21386
				F(186, 21199) =	223.76
Model	5739.47	186	30.85735	Prob > F =	0.0000
Residual	2923.38	21199	0.13790157	R-squared =	0.6625
				Adj R-squared =	0.6596
Total	8662.84	21385	0.40508967	Root MSE =	.37135

APPENDIX H: RELATIONSHIP LOGIT MODELS

This appendix does not introduce a theoretically-specified model, nor one that represents the causal structure that accounts for the airport re-location decision. Rather, this model follows Anderton, *et al.* (1994) and Baden and Coursey (2002) and employs logit regressions to suggest whether the relationships between the demographic variables in the model confound the simple comparisons presented thus far. The results are logistic regression odds for presence. When the odds ratios are less than one, an increase in the demographic variable would lower the odds that the tract contains one of the environmental variables. Five separate models are run with a dichotomous dependent variable indicating (1) whether or not a house was within three miles of the new airport, (2) whether or not a house was within three miles of the old airport, (3) whether or not the house was impacted by noise at the old airport, (4) whether or not a house was on the main routes to the new airport, and (5) whether or not a house was on the main route to the old airport. The independent variables are the demographic variables from the with-without tables, though percent white is the left-out dummy variable to avoid over-specification of the model. The results are given in Tables H.6 – H.10.

Distance

The first logit model uses a dichotomous dependent variable indicating whether a house is located within three miles of the new airport. As would be expected from the with-without comparison of the means, increases in the median income would decrease the likelihood that the house is located within three miles of the old Air Force base, at the time when the AFB was chosen as the new site for the airport, and an increase in the percent of the census tract living below the poverty line or in the percent black, increases this likelihood. However, the sign on the percent Hispanic and foreign-born is the opposite of what is expected from the with-without comparison of the means. In both of these cases, the mean comparison shows significantly higher percentages of Hispanic and foreign-born households living in the area within three miles of the new airport, yet the multivariate effect finds a significant but negative relationship between these variables and the odds of the new airport being located within three miles.

Table H.1 Logit Results for ABIA Distance Model

ABIA Distance	Coef.	Odds Ratio	Std.Err.	z
Income	-0.6954	0.499	0.2278	-3.05
Poverty	0.0806	1.084	0.0081	9.99
Foreign-Born	-0.4721	0.624	0.0192	-24.57
Black	0.0071	1.007	0.0025	2.83
Native American	1.0861	2.963	0.0843	12.88
Asian Pacific	0.1863	1.205	0.0304	6.13
Other	0.3668	1.443	0.0133	27.5
Hispanic	-0.0547	0.947	0.0086	-6.32
Constant	2.0181	*	2.4330	0.83

A "z" statistic greater than 2.33 indicates significance at the 99% confidence level.

Even the percent black in a census tract has less of an impact than would be expected looking solely at the with-without comparison of the means. Odds ratios near one indicate a weak influence, making percent black, poverty, and Hispanic the least influential factors in this model. Percent American Indian or

Alaska Native have the most influence on the odds for the new airport distance, followed by income, "other," Asian or Pacific Islander, and foreign-born. Since distance to the new airport is a disamenity, this model finds some evidence of environmental injustice in intent, though the groups who bear most of the burden are not the groups traditionally cited in the literature.

Table H.2 Logit Results for Mueller Distance Model

Mueller Distance	Coef.	Odds Ratio	Std. Err.	z
Income	-2.7738	0.062	0.0096	-18.02
Poverty	0.1272	1.136	0.0084	17.12
Foreign-Born	0.1090	1.115	0.0145	8.37
Black	0.0396	1.040	0.0026	15.66
Native American	0.5246	1.690	0.1083	8.18
Asian Pacific	-0.5105	0.600	0.0107	-28.69
Other	0.3215	1.379	0.0211	20.97
Hispanic	-0.3613	0.697	0.0083	-30.18
Constant	28.1981	*	1.6647	16.94

A "z" statistic greater than 2.33 indicates significance at the 99% confidence level.

The second logit model uses a dichotomous dependent variable indicating a house is located within three miles of the old airport. As would be expected from the with-without comparison of the means, increases in the median income would decrease the likelihood that the house is located within three miles of the old airport. In this model, median income is the most influential factor in the location of the old airport, giving rise to injustice in outcome for the poor. Native American, Asian Pacific, other, and Hispanic follow in influence. Hispanic and Asian Pacific actually have a negative relationship to the old airport distance siting. Poverty, foreign-born, and black all have positive relationships to the old airport distance siting but they have the weakest influence, black being the least influential of all.

Noise

The third logit model uses a dichotomous dependent variable indicating a house is located under the noise contours of the old airport. As would be expected from the with-without comparison of the means, increases in the median income would decrease the likelihood that the house is located under a noise contour at the time when flights in and out of the airport were at their peak. An increase in the percent of the census tract living below the poverty line, in the percent foreign-born, black, Native American or other, increases this likelihood. However, similar to the distance contours around both airports, the sign on the percent Hispanic is the opposite of what is expected from the with-without comparison of the means. Once again income is the most influential factor, and Native American and Asian Pacific are the most influential race categories. While the odds ratios for percent black and percent with an income below the poverty line are close to even odds, this is based on a 1% increase. Looking at Table H.4, the percent difference between tracts with houses under the noise contours and other tracts, the mean percentage of blacks differs by over 19%. A 19% higher black population translates into an odds ratio of 1.853, a much larger effect.[68]

[68] $Exp(19 \times ln(1.033)) = 1.853$

Table H.3 Logit Results for Mueller Noise Model

Noise	Coef.	Odds Ratio	Std. Err.	z
Income	-0.8396	0.432	0.1342	-2.70
Poverty	0.0676	1.070	0.0120	6.02
Hispanic	-0.1924	0.825	0.0168	-9.42
Foreign-Born	0.2311	1.260	0.0241	12.10
Black	0.0323	1.033	0.0026	13.00
Native American	0.9995	2.717	0.3623	7.49
Asian Pacific	-0.2872	0.750	0.0196	-11.00
Other	0.1654	1.180	0.0308	6.33
Constant	3.4214	*	3.3316	1.03

A "z" statistic greater than 2.33 indicates significance at the 99% confidence level.

Noise plays a peculiar role for the old airport because the double-difference coefficients in the last period are not significantly different from zero. Thus, the groups impacted by noise neither lose nor gain when looking over the entire policy period in the model. However, assuming that noise had depressed the house prices in the pre-period of the model, these communities may still suffer from injustice in outcome because the house prices did not significantly increase when the airport noise ceased.

Route

The fourth logit model uses a dichotomous dependent variable indicating a house is located within a half-mile of the route to the old airport. Unlike the findings in the previous three models and what would be expected from the with-without comparison of the means, increases in the median income have no impact on the likelihood that the house is located within a half-mile of the route to the old airport, at the time when the old airport was still operating, though increases in the percent in poverty increase the likelihood of being on the route to the old airport. Once again increases in the percent Hispanic and Asian Pacific decrease the odds of being along the route and Native American, black, and foreign-born increase the odds. At the time of the 1990 census, being along the route to the airport had a positive effect on house prices, so the minority groups concentrated along the route gained from the original location of the airport. Once the airport changed locations, this advantage was replaced with sharp decrease in house prices, disproportionately affecting these poor and minority communities.

Table H.4 Logit Results for Mueller Route Model

Manor Rd	Coef.	Odds Ratio	Std. Err.	z
Income	0.0158	1.016	0.2500	0.06
Poverty	0.0942	1.099	0.0115	8.96
Hispanic	-0.0855	0.918	0.0193	-4.08
Foreign-Born	0.1085	1.115	0.0251	4.81
Black	0.1142	1.121	0.0039	32.79
Native American	0.9259	2.524	0.2873	8.14
Asian Pacific	-0.1167	0.890	0.0251	-4.14
Other	-0.1437	0.866	0.0273	-4.55
Constant	-4.6339	*	2.6952	-1.72

A “z” statistic greater than 2.33 indicates significance at the 99% confidence level.

Finally, the fifth logit model uses a dichotomous dependent variable indicating a house is located within a half-mile of the route to the new airport, where house prices gained the most as a result of the policy change. These odds ratios look similar to the odds for the old airport distance and noise models: increases in the median income would decrease the likelihood that the house is located within a half-mile of the route to the new airport. Poverty, foreign-born, and black all have positive relationships to the new airport route siting. Hispanic and Asian Pacific again have a negative relationship to the new airport route siting. Median income is that most influential factor in this model; Native American, percent in poverty, Asian Pacific, and other follow in influence. Once again, percent black has a small, but positive odds ratio based on a 1% change. Table H.6 reveals that the percent black differential on communities on the route to the new airport reveal more like a 16% difference, bringing the effective odds ratio to 1.795.

Table H.5 Logit Results for ABIA Route Model

ABIA route	Coef.	Odds Ratio	Std. Err.	z
Income	-1.2951	0.274	0.0520	-6.82
Poverty	0.1229	1.131	0.0084	16.46
Foreign-Born	0.0322	1.033	0.0127	2.63
Black	0.0340	1.035	0.0020	17.38
Native American	1.0950	3.003	0.2105	15.69
Asian Pacific	-0.1344	0.874	0.0136	-8.62
Other	0.0897	1.094	0.0139	7.08
Hispanic	-0.0763	0.927	0.0085	-8.30
Constant	8.7410	*	2.0253	4.32

A “z” statistic greater than 2.33 indicates significance at the 99% confidence level.

Together, these five models show that lower income groups, American Indian and Alaska Native, black, and often foreign-born, populations were most impacted by the airport change. These groups may represent communities least likely to engage in collective action activities against a noxious siting, either because they represent a small portion of the population or because they are least assimilated into the politics of the city. Surprisingly, the Hispanic population has a negative association with the airport variables in all five models; increasing the percent Hispanic in a tract actually decreases the likelihood that the tract will be impacted by one or more airport variables.

It is clear the old airport was sited in a low income community with significant minority populations, but it is not clear whether in net these populations were made better or worse off by the airport move since they were both positively and negatively affected. The same is true for the new airport. Given that these neighborhoods both have significantly different compositions than the rest of Austin, whether the net effect of the airport move is positive or negative for these groups determines whether the airport re-location cures injustice in outcome, or furthers injustice in intent.

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