THE RELATIONSHIP BETWEEN REHABILITATION CODES AND HOUSING PRICES

A Thesis
submitted to the Faculty of the
Graduate School of Arts and Sciences at Georgetown University
in partial fulfillment of the requirements for the
degree of
Master of Public Policy
in the Georgetown Public Policy Institute

By

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Washington, DC
April 14, 2006
ABSTRACT

This study examines New Jersey’s rehabilitation code and uses a difference-in-difference estimator to measure the effect of the code on housing prices relative to two control states. The primary results indicate that the rehabilitation code significantly raises home value. However, these results are not reliable measures of the effect of the rehabilitation code. Two forms of model misspecification have likely led to biased estimates of the rehabilitation code coefficient. I was unable to find the proper functional form relating home value to the independent variables, and I could not control for certain factors that likely influence housing prices. When my model included two extra controls, the association between the rehabilitation code and home value became negative, which suggests that the original estimates are upwardly biased. The variation in the treatment coefficient also suggests that determinants of housing price were varying differently in New Jersey than in the control states during the study period. This makes it difficult to reliably measure an unbiased treatment effect using a difference-in-difference strategy and raises doubts about both the primary and secondary estimates.
Thank you to my advisor, Alison Aughinbaugh, for her guidance and support throughout this project.
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Chapter 1. Introduction

Housing policy analysts currently face two ongoing issues. The first issue concerns the aging of the housing stock. Nearly 30 percent of housing in the United States was built before 1950. Another 50 percent was built between 1950 and 1980. The aging housing stock has led communities and homeowners to place more emphasis on the reuse and renovation of existing structures. The renovation of existing structures is particularly important in urban areas that have high levels of old housing, limited open space, and a desire to limit sprawl.

A second pressing policy issue concerns the effect of housing and land use regulation on the housing market. Many communities have grappled with how to

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2 Ibid.
promote sensible development while ensuring affordable housing prices. A number of scholars have suggested, however, that laws designed to promote orderly development have raised housing prices by restricting housing supply. These laws include zoning restrictions, subdivision regulations, and growth boundaries.

Building codes are one type of regulation that allegedly restricts housing investment. While building codes serve the admirable purpose of promoting safe building construction, some argue that code requirements unnecessarily raise construction costs and therefore raise housing prices. This view has been suggested for many years, but only a few quantitative studies have sought to measure the proposed impact.

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The concern that building codes unnecessarily raise construction costs is particularly acute when the codes are applied to older buildings. Modern codes are designed with new construction in mind, yet nearly every jurisdiction applies them to renovations as well. The renovation of an existing building can therefore require questionable upgrades to modern standards, and these costs can restrict rehabilitation activity.

Newly-developed rehabilitation codes are the product of the two concurrent policy issues discussed above: the aging of the housing stock and the desire to remove certain regulatory restrictions from the housing market. Rehabilitation codes are building codes specifically designed for the renovation of existing buildings. In 1998, New Jersey became the first state to implement such a code. The code was designed to promote development and reuse of existing buildings, particularly in urban


10 Listokin and Hattis 30-31, 40-42; Burby, Salvesen, and Creed 1-3; Kapsch 5-6; Hattis 10-11.

11 Burby, Salvesen, and Creed 2, 5-7; Listokin and Hattis 30-31.

12 Listokin and Hattis 30-31.
areas, while preserving open space and limiting sprawl.\textsuperscript{13} Lawmakers also hoped that by increasing rehabilitation activity the code would bring “untapped” or underutilized buildings into the housing market.\textsuperscript{14} A number of states and localities have since followed New Jersey’s lead.\textsuperscript{15}

The purpose of this study is to examine the relationship between rehabilitation codes and housing prices. As discussed above, some scholars contend that building codes raise housing prices by increasing construction costs. This study seeks to examine whether rehabilitation codes lead to a discernable reduction in housing price. Rehabilitation codes can potentially lower housing prices by reducing the need for costly compliance with modern codes when rehabilitation projects are undertaken and by bringing unused structures back into the supply of housing.

The examination of the potential savings that the rehabilitation code offers relative to traditional building codes is complicated by the possibility that the rehabilitation code also promotes quality changes. Rehabilitation activity that restores vacant and dilapidated buildings can improve the quality of the housing stock and

\footnotesize{\begin{itemize}
\item \textsuperscript{13} Connolly 1-3.
\item \textsuperscript{14} Ibid.
\item \textsuperscript{15} Since 1998, Maryland; New York; Rhode Island; Minnesota; Wilmington, Delaware; and Wichita, Kansas have adopted their own rehabilitation codes. See Listokin and Hattis 30-31. Thirteen additional states have adopted a model code designed for existing buildings. See Philip Mattera, “Breaking the Codes: How State and Local Governments are Reforming Building Codes to Encourage Rehabilitation of Existing Structures,” Jan 2006: 18-19. Online. Internet. 12 Apr. 2006. Available: http://www.goodjobsfirst.org/pdf/breaking%20the%20codes.pdf.
\end{itemize}}
neighborhood aesthetics. Prices generally rise with improved quality.16 Ideally, this study would measure the relationship between rehabilitation codes and housing prices, holding quality constant. That is, the models would measure the potential price reduction that the rehabilitation code provides in achieving a certain level of quality relative to having an unreformed building code. While it is impossible to perfectly control for quality, my models control for many important characteristics to get as close as possible to an unbiased estimate given available data.

This study focuses on New Jersey’s rehabilitation code and uses a difference-in-difference estimator to measure the effect of the code on housing prices relative to two control states, Pennsylvania and Connecticut. The primary results indicate that the rehabilitation code significantly raises prices. I do not believe, however, that these results are reliable measures of the effect of the code. Two forms of model misspecification have likely led to biased estimates of the rehabilitation code coefficient. First, I was unable to find the proper functional form relating housing price to the independent variables in my model. Second, my original models could not control for certain factors that likely influence housing price. When I added two

omitted variables, state population density and homeowner vacancy rate, to my original models using supplemental data, the association between the rehabilitation code and housing prices became negative. This supports the suspicion that the original estimates are biased and inconsistent.

More troubling, the inconsistency of the treatment estimate when variables are added to the model suggests that social and economic conditions affecting housing prices were changing differently in the treatment and control states during the treatment period. These changes make it difficult to reliably measure the effect of the rehabilitation code using a difference-in-difference strategy. The possibility that unobservable social and economic factors were changing differently in the control and treatment states makes even the estimates from the second set of models unreliable.

The quality of the housing stock and neighborhoods also raises an omitted variable concern. My models could not fully control for quality because of data limitations. The positive relationship measured in the original model may reflect an upward bias in the treatment estimate caused by improvements in neighborhood aesthetics or housing stock quality that increased rehabilitation may have prompted.

This paper proceeds in seven parts. Chapter 2 describes the traditional application of building codes to existing structures and New Jersey’s rehabilitation
code reform. Chapter 3 examines the theoretical and empirical literature on the relationship between building codes and housing prices, and initial research relating to New Jersey’s rehabilitation code. Chapter 4 details my methodology and model. Chapter 5 describes my data. Chapter 6 presents my results. Chapter 7 discusses the results and problems that make the results unreliable, and offers suggestions for improved future study. Chapter 8 concludes.
Chapter 2. Background on Building and Rehabilitation Codes

Some background on building codes, and rehabilitation code reform, is helpful to understanding the discussions that follow. This section describes what building codes are and how they are typically applied to existing structures. It also details the basic building code regimes of the states examined in this study and the reforms implemented by New Jersey’s rehabilitation code.

General Information

Building codes establish minimum construction standards. These standards include requirements for a building’s “structural system, fire safety, general safety, enclosure, interior environment, and materials.” In the United States, the insurance industry initially established building safety standards. The first legal requirements for the safety of buildings date from the tenement reform movement at the turn of the 19th century.

In the decades that followed, three model building code associations formed and began promulgating model codes to assist governments with increasingly complex

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17 Listokin and Hattis 23.
18 Ibid. at 24-28.
19 Ibid.
construction standards.\textsuperscript{20} State and local jurisdictions adopted these codes, sometimes with amendments. Each model code organization was associated with a geographic region of the country until the organizations merged to form the International Code Council in 1994. The ICC issued its first complete set of building codes in 2000, which 44 states have adopted in varying degrees.\textsuperscript{21}

\textit{Building Codes and Existing Buildings}

Building codes are designed with new construction in mind.\textsuperscript{22} However, before New Jersey’s rehabilitation code, nearly every jurisdiction applied new construction standards to renovations as well.\textsuperscript{23} Code officials have traditionally applied new construction standards to rehabilitation projects through the “25/50 percent rule.”\textsuperscript{24} This rule mandates that an existing building be brought up to new building code standards if the cost of the rehabilitation work exceeds 50 percent of the building’s value.\textsuperscript{25} If the rehabilitation work amounts to 25 to 50 percent of a

\textsuperscript{20} Ibid.
\textsuperscript{21} Ibid. at 28-29.
\textsuperscript{22} Listokin and Hattis 30-31, 40-42; Burby, Salvesen, Creed 1-3; Kapsch 5-6; Hattis, “Existing Buildings,” 10-11.
\textsuperscript{23} Listokin and Hattis 30-31, 40-42; Burby, Salvesen, Creed 1-3; Kapsch 5-6; Hattis, “Existing Buildings,” 10-11.
\textsuperscript{25} Listokin and Hattis 34; Hattis, “Smart Codes,” 8-9; Hattis, “Existing Buildings,” 10-11; Syal and Shay 2-3.
building’s value, then all of the rehabilitated parts of the building have to comply with current code standards.\textsuperscript{26} Finally, if rehabilitation costs are less than 25 percent of a building’s value, then building officials have discretion to determine how much of the building needs to comply with current standards.\textsuperscript{27}

The three building code organizations dropped the 25/50 percent rule from their model codes in the early 1980s, but the rule has persisted in many jurisdictions.\textsuperscript{28} A 1998 study by the United States Department of Housing and Urban Development (HUD) revealed that 38 percent of jurisdictions surveyed still used a trigger mark requiring an entire building to meet new construction standards if the rehabilitation work exceeds a certain threshold, usually 50 percent, of the building’s value.\textsuperscript{29} Another 16.4 percent of surveyed jurisdictions did not have triggers, but indicated that they still found such cut-offs “useful rules-of-thumb.”\textsuperscript{30} New Jersey used the 25/50 percent rule until it instituted its rehabilitation code in 1998.\textsuperscript{31} The state also had an

\textsuperscript{26} Syal and Shay 3-4; Hattis, “Existing Buildings,” 11.
\textsuperscript{27} Syal and Shay 3-4; Hattis, “Existing Buildings,” 11.
\textsuperscript{28} Hattis, “Smart Codes,” 8.
\textsuperscript{30} Hattis, “Smart Codes,” 8; United States Department of Housing and Urban Development 9.
additional rule requiring full compliance with certain modern standards if the project affected more than 5 percent of a building’s floor area.\textsuperscript{32}

When the model code organizations dropped the 25/50 percent rule in the early 1980s, they began issuing guidelines for the application of new construction standards to existing buildings.\textsuperscript{33} These instructions call for officials to flexibly apply new code standards to existing buildings, but they provide little specific guidance for how this should be done.\textsuperscript{34} This leaves code requirements for rehabilitation projects largely to the discretion of code officials.\textsuperscript{35} Moreover, the instructions keep the basic premise of the 25/50 percent rule that existing buildings should be judged against new construction standards.\textsuperscript{36} The lack of specific guidance for existing buildings has led to inconsistent and arbitrary application of modern code requirements to rehabilitation projects in jurisdictions that follow these model codes.\textsuperscript{37} As noted below, model code instructions for existing buildings have improved only in the last three years, but most states have not yet adopted these reformed standards.\textsuperscript{38}

\textsuperscript{32} Syal and Shay 3-4.
\textsuperscript{33} Hattis, “Smart Codes,” 6-8; International Code Council 1-3.
\textsuperscript{34} International Code Council 1-3.
\textsuperscript{35} Ibid.
\textsuperscript{36} Hattis, “Smart Codes,” 7; Connolly 2.
\textsuperscript{37} Hattis, “Smart Codes,” 6-8; International Code Council 3-4.
\textsuperscript{38} See infra text accompanying note 54.
Building codes for new construction are revised over time and new requirements are added. As a result, older buildings typically do not meet current code standards. Thus, rehabilitation work often requires costly upgrades to modern standards when officials apply new construction standards to renovation projects. The discretion granted to building officials by the 25/50 percent rule and by the mode code guidelines can also add costs to rehabilitation activity. The discretion disrupts planning because developers cannot assess the costs of their projects in advance.

The tradition of applying new construction standards to existing buildings developed when older buildings had not been constructed according to basic safety standards. Indeed, the original purpose of the 25/50 percent rule was to discourage the reuse of these older unsafe buildings. But the wisdom of deterring reuse is questioned now that today’s housing stock consists of older buildings that were subject to building code standards when they were constructed. As one group of scholars noted in regard to the 25/50 percent rule, the threshold approach “may have made sense 75 years ago, when a large number of existing buildings met no building

40 Hattis, “Existing Buildings,” 10; Burby, Salvesen, and Creed 3-6.
42 Connolly 1-3; Kapsch 5-6; International Code Council 3; Fischer 12-13.
43 Burby, Salvesen, and Creed 6; Syal and Shay 1; Hattis, “Existing Buildings,” 11.
44 Burby, Salvesen, and Creed 6; Syal and Shay 1; Hattis, “Existing Buildings,” 11.
code standards whatsoever, but it seem[s] counterproductive in an era when the building stock consists largely of buildings built to basic code standards….”

Thus, in the eyes of rehabilitation code supporters, the application of new construction standards to existing buildings adds unnecessary costs to rehabilitation projects by requiring upgrades that add little or no safety to the building. One anecdote is illustrative. A non-profit group rehabilitating a building in New Jersey prior to the rehabilitation code reform had to spend thousands of dollars widening a stairway by 3/4 of an inch and replacing windows that were 5/8 of an inch too small. The building code required compliance with new construction standards despite the fact that the windows and stairway had been functional for nearly a century.

Policy analysts showed concern for the building code regime for existing buildings as early as the late 1970s. At that time, HUD promulgated guidelines for localities interested in simplifying the application of codes to rehabilitation work. The HUD guidelines prompted the model code organizations to delete the 25/50 percent rule, as mentioned above. However, the HUD guidelines were not actual rehabilitation codes and, as the discussion above indicates, they have not been

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45 Burby, Salvesen, and Creed 6.
46 Connolly 1-3, 6; Fischer 12-13; Kapsch 5-6.
47 Listokin and Hattis 34.
48 Ibid.
49 Syal and Shay 5; Kapsch 5-6.
effective in improving code standards for rehabilitation work.\(^{50}\) As noted, by 1998, most jurisdictions still followed the 25/50 percent rule or used similar triggers as “rules-of-thumb.” Moreover, the few pages of instructions for existing buildings offered by the model codes have not solved the predictability and arbitrariness problems of the 25/50 percent rule.\(^{51}\)

The persistent problems created by the 25/50 percent rule and the model code instructions has led reformers to call for building code standards specifically designed for rehabilitation projects. A number of states and localities have now developed such standards, which they call “rehabilitation codes” or “smart codes.”\(^{52}\) New Jersey was the first state to implement a rehabilitation code in 1998, and its code has served as a model for others.\(^{53}\) In 2003, the ICC also added a rehabilitation code to its set of building code models, which 13 states have adopted.\(^{54}\)

This study focuses on New Jersey’s rehabilitation code. New Jersey’s rehabilitation code aims to ensure public safety, like traditional building codes, while making rehabilitation more affordable and predictable.\(^{55}\) The code seeks to achieve these goals by eliminating the need for existing buildings to meet certain new

\(^{50}\) Syal and Shay 5; Kapsch 5-6.


\(^{52}\) See supra note 15.

\(^{53}\) Listokin and Hattis 30-31.

\(^{54}\) Ibid.; Mattera 18-19.

\(^{55}\) Burby, Salvesen, and Creed 2, 6-7; Connolly 3-6.
construction standards that do not appreciably add to the safety of a building. For instance, the code would permit 28-inch or 30-inch doors, when current codes for new construction require 32-inch doors.56

Additionally, the rehabilitation code removes the arbitrary cutoffs of the 25/50 percent rule and no longer ties the need for compliance with modern standards to the cost of the rehabilitation work.57 Instead, the code ties compliance with modern standards to the nature of the work being undertaken.58 This distinction allows renovation of superficial, but costly, components without triggering compliance with new construction standards.59 Substantive changes in a building’s structural, mechanical, plumbing, and fire protection elements are needed to trigger compliance with new code standards.60

Finally, compared to traditional codes, the rehabilitation code more clearly defines the types of rehabilitation work that a project might undertake.61 It then gives more detailed descriptions of the building code requirements for each category of work.62 Reformers believe that this improved categorization allows both builders and

56 Connolly 6.
57 Burby, Salvesen, and Creed 6-7; Connolly 4.
58 Burby, Salvesen, and Creed 6-7; Connolly 4.
59 Burby, Salvesen, and Creed 6-7.
60 Ibid.
61 Hattis, Smart Codes,” 10-12.
62 Ibid.; Connolly 4-6.
code officials to consistently predict the building code requirements for rehabilitation projects.\textsuperscript{63}

*Building Code Regimes of New Jersey, Connecticut, and Pennsylvania*

The difference-in-difference strategy used by this study requires the control states, Pennsylvania and Connecticut, to have consistent building code standards during the time period examined, 1995 to 2003. New Jersey should also have consistent building code standards, other than the rehabilitation code reform, during the study period. Consistent code regimes are needed for the regression models to pick up the effect of the rehabilitation code alone, and not other code changes. A brief review of the building code regimes of these states is therefore important.

The Building Officials and Code Administrators (BOCA) model code was the basis for building code standards in all three states during the 1990s, with some variation in the version that each state adopted.\textsuperscript{64} BOCA issued an updated model code every three years, until its codes were superseded by the ICC models after the model code organizations merged.\textsuperscript{65} New Jersey used the 1993 BOCA code from 1995 to 1998, and the 1996 BOCA code from 1998 to 2003.\textsuperscript{66} In 2003, it adopted the

\textsuperscript{63} Hattis, Smart Codes,” 10-12; Connolly 4-6.
\textsuperscript{64} Listokin and Hattis 27.
\textsuperscript{65} Ibid. at 29; United States Department of Housing and Urban Development 7-8.
\textsuperscript{66} New Jersey Department of Community Affairs, Division of Codes and Standards.
As noted above, New Jersey followed the 25/50 percent rule until 1998, even after the BOCA codes deleted the provision.


Ideally, for the purposes of this study, each state would have kept the same version of either the BOCA or ICC codes throughout the examination period. This

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67 Ibid.
study assumes that the routine three-year model code updates have only a negligible effect on the housing market. Additionally, this study does not address possible code variations at the local level.\textsuperscript{72} The results are thus further limited by the assumption that significant local variation did not occur. Despite these limitations, the state-level focus of this study has allowed for a closer examination of code requirements than prior national surveys could achieve.\textsuperscript{73} Moreover, a recent study of New Jersey’s rehabilitation code, detailed below, supports the selection of Pennsylvania and Connecticut as controls.

\begin{flushright}
\textsuperscript{73} \textit{Ibid.}
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Chapter 3. Literature on the Impact of Building and Rehabilitation Codes

Building codes have been the subject of economic literature and empirical research for at least the last fifty years. This section provides an overview of the primary rationales for legally mandating construction standards, the theoretical arguments for how the codes affect housing prices, and the limited quantitative estimates of the impact. It then discusses the possible impacts of the rehabilitation code reform and the initial empirical studies of New Jersey’s rehabilitation code.

Two potential market failures provide the traditional justifications for building code regulations. First, building codes are defended on the ground that the housing market suffers from asymmetric information.74 Under this view, consumers lack the information needed to determine whether a building is constructed adequately. Building code standards formulated by construction experts give consumers the assurance of a certain level of safety.75 Second, building codes are justified on the theory that they minimize the negative externalities of shoddy construction.76 According to this argument, a poorly constructed building imposes costs on its

74 Oster and Quigley 363-64.
75 Ibid.
76 Ibid.
neighborhood by, for example, burdening emergency services and increasing the risk of fire spreading to adjacent properties.

Building codes have advanced beyond correcting the most egregious safety threats of tenement housing that prompted legally-mandated building requirements. With this advancement, some analysts have questioned whether detailed construction requirements are justified and whether building codes might be interfering with housing market efficiency. Indeed, a number of national commissions included building codes in their examinations of whether housing regulations are unnecessarily raising housing prices.

The Douglas Commission in 1968 was the first major commission on housing regulatory issues. It concluded that building codes were mandating unnecessary housing costs and impeding housing development. In 1982, President Reagan’s Commission on Housing reiterated this concern about potential barriers to efficiency created by regulatory requirements, including building codes. It recommended limiting land use regulations in order to increase housing supply and lower costs. In 1991, a national commission again concluded that a collection of housing regulations

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77 Ibid.
78 Oster and Quigley 364-65; Listokin and Hattis 37-39.
79 Schill 13.
80 Ibid.; Kelly 360; Oster and Quigley 364-65; Listokin and Hattis 37-39.
impeded affordable housing development. This report, titled “Not in My Back Yard (NIMBY),” recommended that Congress condition federal funds to states on the removal by state and local governments of “regulatory barriers to affordable housing.”

Economic theory provides an explanation for how building codes might affect housing prices. Building codes can raise housing prices by requiring more labor and preventing the use of cheaper materials as builders construct homes. This makes construction more expensive, which would reduce the supply of new housing units and raise their price. There is also a positive cross-price elasticity of demand between new and existing units. Thus, if building codes for new construction raise the price of new homes, they also likely raise the price of existing homes.

Despite the attention that national commissions have given to building codes for a number of decades, analysts still debate the impact that building codes have in practice. Some literature contends that the impact of building codes is large in magnitude. One commentator states that building codes, zoning laws, and subdivision regulations are “significantly responsible for the present crisis in affordable housing.”

82 Schill 13-14.
83 Muth 713-14; Listokin and Hattis 33-36.
84 Muth 713-14; Listokin and Hattis 33-36; Choppin 2039-41, 2050.
85 Noam 396; Listokin and Hattis 36.
housing. Another writer contends that building codes account for a “measurable portion of housing cost increases.” The opposing view claims that any impact of building codes on housing prices has been vastly overstated. One scholar contends that “the common allegation that house prices are appreciably higher than they otherwise would be because of building codes” has not been supported by empirical research.

Indeed, part of the debate over the effect of building codes stems from the limited amount of empirical research. The few econometric studies that have been done on the subject suggest that building codes have a small positive effect on price. A 1976 study by Muth and Wetzler and a 1983 study by Noam are the primary references.

Muth and Wetzler examined the effect of local building codes on housing prices. The authors evaluated data on home transactions from the Federal Housing Administration, using metropolitan areas as the unit of observation. The FHA dataset provided average characteristics of home transactions financed by the agency’s mortgages for selected metropolitan areas. The authors examined which

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86 Choppin 2039, 2041.
87 Kelly 349, 360.
88 Muth 691, 713-14.
89 Listokin and Hattis 42.
90 Muth and Wetzler 57.
91 Ibid. at 58.
metropolitan areas had enacted locally-modified or locally-drafted building codes instead of a regional or national model code.92 The authors were therefore examining the effect of locally-adopted or locally-modified codes on housing costs relative to the unamended regional or national model codes. The underlying assumption was that local building codes were stricter than the model codes.93

Muth and Wetzler chose average construction cost per unit square footage as the form of their dependent variable.94 Their regression controlled for the average characteristics of homes in each city, including the average number of stories and bedrooms, and the fraction of homes that had basements.95 The authors also included characteristics of the metropolitan areas that could potentially impact price, such as region of the country, inspectors per capita, and quantity of building permits issued.96

The authors found that locally-modified building codes were not significantly associated with housing costs. They excluded the locally-drafted code variable from their model after initial results showed that the variable was negatively associated with housing costs and thus had the “wrong sign.”97 The authors concluded that local

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92 Ibid. at 60.
93 Ibid.
94 Ibid. at 59.
95 Ibid. at 58.
96 Ibid. at 59-60.
97 Ibid. at 63.
building codes have, at most, a small effect on housing costs relative to the model codes.\textsuperscript{98}

Four years later, Noam questioned the conclusions reached by Muth and Wetzler. Noam doubted their underlying assumption that local codes were stricter than national codes.\textsuperscript{99} He maintained, in contrast, that many local codes have fewer restrictions than national codes.\textsuperscript{100}

Noam set out to develop a more effective measure of the building code “treatment.” He measured the effect of the codes through a “regulatory restrictiveness” variable. Noam defined this variable through a model: regulatory restrictiveness was a function of housing values, income, firm concentration, unionization, political conservatism, and regional strictness levels.\textsuperscript{101} He then used the regulatory restrictiveness variable as an independent variable in his housing price model. One noteworthy feature of his two-step model is that it allows for a simultaneous relationship between housing prices and building code restrictiveness.\textsuperscript{102}

Noam focused on the locality as the unit of observation, and used survey data on 1,100 communities. His regression used log of median household price as the dependent variable and controlled for factors that affect the supply and demand of

\textsuperscript{98} Ibid. at 64.
\textsuperscript{99} Noam 395.
\textsuperscript{100} Ibid.
\textsuperscript{101} Ibid. at 397-98.
housing. Demand factors included median household income and population. Supply factors included construction volume per capita and homeowner vacancy rate. The model also included other explanatory variables, such as housing “quality,” geographic region, and whether the locality is urban, rural, or suburban.¹⁰³

Noam’s results indicated that there was a statistically significantly positive relationship between the strictness of building codes and housing values.¹⁰⁴ To further explain his results, Noam defined a “strict” code as one that contained fourteen code requirements identified in the Douglas Commission report.¹⁰⁵ His model predicted that a strict code raised housing prices by $1,060, or 4.9 percent of the national mean housing price at that time, relative to a code with a mean level of restrictions.¹⁰⁶ Noam calculated the mean national strictness to be 4.37. He arrived at this figure by totaling the number of code restrictions that a locality used out of the fourteen identified by the Douglas Commission, and weighting this number by the estimated costs of each restriction.¹⁰⁷

¹⁰² Ibid. at 396-97.
¹⁰³ Ibid. at 395, 397-99.
¹⁰⁴ Ibid. at 399.
¹⁰⁵ Ibid. at 398-99.
¹⁰⁶ Ibid. at 399.
¹⁰⁷ Ibid. at 398.
Some scholars have praised Noam’s approach to measuring the impact of building codes on housing prices. They suggest that his model can serve as an example for future research. Given the varying claims about the impact of building codes and the age of the two econometric studies on the topic, new econometric research that reflects the current building code regime would be welcomed.

The theoretical and empirical literature on the impact of rehabilitation codes is less developed than for building codes generally because of the relative novelty of codes specific to rehabilitation. An analysis of the possible impact of a rehabilitation code should begin by considering the effect of requiring compliance with new construction standards for rehabilitation projects. This study focuses on New Jersey’s rehabilitation code and therefore examines in particular the possible impact of moving from the 25/50 percent rule to a rehabilitation code. As noted above, in 1998, most jurisdictions either adhered to such triggers or used them as guidelines.

The discussion that follows, however, should have significance even for those jurisdictions that no longer expressly use the 25/50 percent rule. As the previous section detailed, the model code approach that supplanted the 25/50 percent rule still purportedly adds arbitrary costs and unpredictability to rehabilitation work. Thus,

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108 Listokin and Hattis 57.
109 Ibid.
110 Ibid. at 46; Schill 6, 15.
111 See supra text accompanying notes 28-30.
while the theoretical discussion that follows places special emphasis on the 25/50 percent rule, one can view it more generally as an examination of the effect of applying new construction standards to rehabilitation projects in often unpredictable ways.

First, we should consider the possible impact of the rehabilitation code on rehabilitation activity. The threshold method of the 25/50 percent rule requires greater compliance with new standards the more one invests in a rehabilitation project. On its face, then, the rule makes greater investment in a rehabilitation project more costly.\textsuperscript{112} Moreover, according to some code officials, the costs of upgrading an older building to new construction standards are often prohibitively expensive.\textsuperscript{113} Thus, theory suggests that replacing traditional codes with a more flexible and less stringent rehabilitation code would increase the rehabilitation of existing buildings.

Indeed, the Douglas, Reagan, and NIMBY national commissions each concluded that applying codes for new construction to rehabilitation would limit renovation of older units.\textsuperscript{114} If the application of modern standards to older buildings does deter rehabilitation, then this traditional approach undermines the fundamental goal of building codes, which is to ensure a basic level of housing safety and condition. Commentators have singled out the 25/50 percent rule for its likely effect

\textsuperscript{112} Listokin and Hattis 34.
\textsuperscript{113} Connolly 2, 4; Kapsch 5-6.
in this regard. They call the rule “perverse” on the theory that it deters people from making needed restorations to their deteriorating housing units.\textsuperscript{115}

The theoretical effect of rehabilitation codes on housing prices may be more complicated than the projected effect of building codes on housing prices detailed above. In the long run, where the supply of housing is elastic, rehabilitation codes could potentially lower housing prices by increasing the supply of housing. Under one theory, depreciation “reduces the quantity of housing services that a given housing unit provides over time.”\textsuperscript{116} Thus, the 25/50 percent rule, and traditional building codes more generally, potentially lower the housing supply by limiting the rehabilitation of buildings.\textsuperscript{117} The rehabilitation code makes rehabilitation projects less costly by not inflexibly requiring full upgrades to modern standards, and this cost reduction per unit can be viewed as a supply shift out.

Measuring the direct impact of the rehabilitation codes on housing prices is complicated by potential changes in neighborhood aesthetics and housing stock quality that the code reform might bring. For instance, one supporter of New Jersey’s rehabilitation code suggested that the code would promote the redevelopment of

\textsuperscript{114} Listokin and Hattis 40-41.
\textsuperscript{115} Listokin and Hattis 34.
\textsuperscript{116} Schill 9.
\textsuperscript{117} Ibid.
dilapidated and vacant buildings in urban areas.\textsuperscript{118} As he noted, vacant and semi-vacant buildings “tend to attract crime…and foster a public perception of community decline.”\textsuperscript{119} Crime and vacancy are likely to be negatively associated with home prices, because they reduce demand for living in a neighborhood with those problems. The commentator captured the negative demand influence succinctly by noting that “nobody wants vacant or deteriorating buildings in the neighborhood.”\textsuperscript{120} Thus, if rehabilitation codes potentially restore under-utilized buildings to the housing supply, this may also increase housing demand in the communities where rehabilitation takes place. Outward shifts of both the supply and demand curves make the final price change ambiguous.

The supporters of New Jersey’s rehabilitation code would likely note that the improvement of neighborhood aesthetics in dilapidated urban areas is a desirable and, indeed, intended goal of code reform.\textsuperscript{121} In theory, New Jersey’s rehabilitation code allows for the achievement of a desired level of urban revitalization at a potentially lower price than the same level of urban renewal under the old 25/50 percent rule. This potential effect on price is what the present study seeks to measure. In other

\textsuperscript{118} Fischer 12-13.
\textsuperscript{119} Ibid. at 13.
\textsuperscript{120} Ibid. at 12.
\textsuperscript{121} Ibid. at 12-13; Connolly 1-2.
words, it attempts to measure the effect of the rehabilitation code on housing price, relative to the 25/50 percent rule, holding quality constant.

The effect of New Jersey’s rehabilitation code on the housing market is just beginning to be studied empirically. Initial non-econometric studies and anecdotal evidence suggests that the codes lower the costs of rehabilitation projects, promote rehabilitation activity, and reclaim abandoned buildings. The first econometric study of the rehabilitation code found that it increased the number of rehabilitation projects, but did not increase total rehabilitation investment. The initial results of these econometric and non-econometric studies are detailed below.

Non-econometric studies have sought to estimate how much typical rehabilitation projects would cost under the new rehabilitation code compared to the traditional 25/50 percent rule. The National Association of Home Builders Research Center concluded that the cost of a rehabilitation project would be as much as 20 percent lower under the rehabilitation code.\(^\text{122}\) Similarly, New Jersey estimated that the rehabilitation code reduced costs of building renovation by 10 to 40 percent.\(^\text{123}\) These cost savings would not necessarily lead to an equal reduction in housing price because code compliance is only one part of construction costs and supply alone does

\(^{122}\) Listokin and Hattis 42.
\(^{123}\) Ibid.; Fischer 16.
not determine price. Nevertheless, the projected cost savings has the potential to lead to lower housing prices.

Non-econometric studies also found an increase in rehabilitation activity after New Jersey implemented the rehabilitation code in 1998. Supporters of the rehabilitation code attribute at least part of this increase to the code reform. New Jersey, for example, found that rehabilitation activity in its five largest cities grew from $176 million in 1996 to $287 million in 1999. Similarly, another survey argued that the codes increased rehabilitation activity by 25 percent.

Anecdotal evidence also suggests that the code helped to restore abandoned structures, or “untapped” housing stock, to the market. New Jersey, for example, notes that developers rehabilitated a building that had stood vacant for eight years into an apartment complex for low and moderate income senior citizens. It estimates that the rehabilitation code saved the developers $391,000, or one-quarter of the project’s total cost. The state suggests that savings like this allow communities and

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124 Oster and Quigley 365.
125 Syal and Shay 9; Connolly 7; Listokin and Hattis 42.
126 Connolly 7; Listokin and Hattis 42.
127 Listokin and Hattis 42.
128 Connolly 7.
129 Ibid.
non-profit housing developers to “stretch” each dollar further,\textsuperscript{130} and therefore presumably use their budgets to provide more housing.

The initial indications of apparent success are encouraging, but more research is needed to conclusively determine the effect of the rehabilitation code on the housing market.\textsuperscript{131} As a group of scholars have noted, the non-econometric surveys fail to control for time effects and other factors that could have been driving the increase in rehabilitation activity.\textsuperscript{132} For instance, the code reform occurred during a good economy when interest rates were low and open space was decreasing in the suburbs. These factors would have likely increased rehabilitation activity, even without the rehabilitation code.\textsuperscript{133} Moreover, the jump in rehabilitation activity in 1998 relative to 1996 could have been the result of builders holding off on their projects until the code reform was adopted.\textsuperscript{134}

Indeed, an unpublished HUD study questioned the initial positive assessments of the code.\textsuperscript{135} In 2001, HUD surveyed all New Jersey municipalities and found that the code did not impact rehabilitation activity statewide.\textsuperscript{136} New Jersey officials maintain, however, that the study improperly included suburban jurisdictions with

\begin{itemize}
\item[\textsuperscript{130}] Ibid.
\item[\textsuperscript{131}] Burby, Salvesen, and Creed 8-9.
\item[\textsuperscript{132}] Ibid.
\item[\textsuperscript{133}] Ibid.
\item[\textsuperscript{134}] Ibid.
\item[\textsuperscript{135}] Ibid. at 9.
\end{itemize}
relatively new housing.\textsuperscript{137} The muted statewide effect could have been concealing increased activity in areas with older housing stock.

An econometric study by researchers at the University of North Carolina (UNC) provides the most rigorous examination of the effect of New Jersey’s rehabilitation code to date. Burby, Salvesen, and Creed examined whether the rehabilitation code increased rehabilitation activity. Unlike HUD, however, these scholars focused on localities in which at least 25 percent of the housing stock was built before 1940, to ensure that opportunities for rehabilitation existed.\textsuperscript{138}

The UNC study also improved upon non-econometric studies by attempting to partial out time effects, such as changes in the economy and interest rates. The researchers tried to control for factors that change over time by comparing rehabilitation activity in New Jersey to activity in New York, Connecticut, and Pennsylvania before and after the code reform.\textsuperscript{139} They also used a model that included variables that can influence rehabilitation activity, such as enforcement approach of the locality, population growth rate, and household income.\textsuperscript{140} Their

\textsuperscript{136} Ibid.  
\textsuperscript{137} Ibid.  
\textsuperscript{138} Ibid.  
\textsuperscript{139} Ibid. at 10-11.  
\textsuperscript{140} Ibid. at 12-14.
rehabilitation activity data came from the New Jersey government and United States Census Bureau.\textsuperscript{141}

The UNC study found that the rehabilitation code increased the number of annual residential rehabilitation projects by 120 per jurisdiction relative to control jurisdictions.\textsuperscript{142} The study also revealed, however, that the code reform did not change the value of rehabilitation activity taking place.\textsuperscript{143} According to the researchers, these results suggest that the rehabilitation code primarily benefits small rehabilitation projects rather than large ones.\textsuperscript{144}

One final study, not specifically about rehabilitation codes, offers insight into the possible effect of the rehabilitation code reform on the housing market in New Jersey. Burby, May, Malizia and Levine (“Burby-May”) examined the effect that building code philosophies had on the ability of cities to attract construction activity.\textsuperscript{145} Their econometric analysis concluded that, over a ten year period beginning in 1985, a city could have attracted nearly 9 percent more single-family housing relative to suburban areas by using a “business-friendly” code philosophy.\textsuperscript{146}

\textsuperscript{141} Ibid. at 12.
\textsuperscript{142} Ibid. at 15-16.
\textsuperscript{143} Ibid. at 19.
\textsuperscript{144} Ibid.
\textsuperscript{146} Ibid. at 6.
A business-friendly approach included using verbal, rather than written, notices for code offenses and not using automatic sanctions to achieve compliance.\footnote{Ibid. at 20-21.}

The Burby-May study examined the ability of cities to capture development from the suburbs, but its findings raise an interesting hypothesis about the possible effect of the rehabilitation code on housing supply in New Jersey. The researchers suggested that one business-friendly strategy was to allow deviations from code standards when the standards made “little sense” as applied.\footnote{Ibid. at 20-21.} This strategy is similar to the rehabilitation code, which attempts to limit the arbitrary application of new construction standards to rehabilitation projects. The Burby-May study thus suggests that New Jersey may have positioned itself to attract more residential development by implementing a more flexible, “business-friendly,” code for rehabilitation work.

The present study seeks to contribute to the literature by providing the first examination of the possible effect of New Jersey’s rehabilitation code on housing prices. The goal is to examine whether a potential increase in housing supply, suggested by initial accounts of lower rehabilitation costs and of untapped buildings being restored to the housing stock, has affected housing prices. The study is also relevant to the debates over whether building codes act as barriers to affordable housing. An unbiased measure of the price effect of the 25/50 percent rule relative to
the new rehabilitation code would contribute to those discussions. The study must be on guard, however, for whether development spurred by the rehabilitation code possibly improved neighborhood and unit amenities. Such changes could potentially spur more demand for living in New Jersey, which would counteract the price effect of a supply shift.
Chapter 4. Methodology and Conceptual Model

Methodology

This study measures the effect of New Jersey’s rehabilitation code on housing prices by using a difference-in-difference estimation strategy. This approach compares housing prices in New Jersey, before and after the rehabilitation code was implemented, to housing prices for those same years in control states that did not implement such a code. New Jersey implemented its code in 1998. I employ 1995 as the “pre-treatment” wave of the study and 2003 as the “post-treatment” wave, and Pennsylvania and Connecticut as control states.

As discussed above, the effect of the rehabilitation code cannot be measured simply by comparing New Jersey’s housing prices before and after the rehabilitation code reform. This approach fails to control for factors that affect housing prices that could have been changing over the same time period. These factors include a growing economy and population. Nor can one simply compare housing prices in New Jersey after the reform was implemented to housing prices in comparable states that did not implement rehabilitation codes. This strategy fails to control for state effects, the different characteristics of each state that affect housing prices.

The difference-in-difference approach measures the impact of the rehabilitation code on housing prices while controlling for time and state effects. The
key assumption required to get an unbiased treatment estimate is that housing price
determinants that are omitted from the models did not change differently in New
Jersey than in the control states.\textsuperscript{149} For example, the treatment estimate will be biased
if unobserved housing demand factors were stronger in New Jersey than in the control
states between the two survey waves.

The assumption required for internal validity of the difference-in-difference
estimate is strong and likely does not hold absolutely. I have selected neighboring
states as controls in order to minimize the risk that this important assumption does not
hold. Neighboring states are more likely to experience the same or similar economic
and social changes.

The assumption that variables affecting housing prices did not vary differently
in New Jersey than in the control states is checked using available data. The next
chapter describes my sample in detail, but some red flags raised by the descriptive
statistics are noted here. Table 1 describes the age of the housing stock in New Jersey,
Pennsylvania, and Connecticut in my sample. The table indicates that each state has a
relatively old housing stock. In my sample, more than 25 percent of the housing stock
in each state was built before 1940. This suggests that there are comparable
opportunities for the rehabilitation of existing buildings in each state.

\textsuperscript{149} Jeffrey M. Wooldridge, \textit{Introductory Econometrics: A Modern Approach} 2nd ed.
But other characteristics of the housing markets in each state raise concerns about the internal validity of the difference-in-difference estimate. Table 2 provides descriptive statistics for key characteristics of each state before and after 1998. In my sample, the average household income grew noticeably more in New Jersey than in Pennsylvania and Connecticut. The table also contains supplemental data from the 1990 and 2000 Censuses on state population density and homeowner vacancy rate. Though these decennial figures are not ideal because they do not directly correspond to my pre-treatment and post-treatment waves, they suggest that New Jersey may have had a much tighter housing market during at least part of my study period. The table indicates that New Jersey experienced a larger growth in population density than Pennsylvania and Connecticut. The state also had a noticeable drop in homeowner vacancy rate, which is the percentage of the non-rental housing stock that is vacant and for sale.

Research indicates that household income and population density are positively associated with housing prices, and that homeowner vacancy rate is

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negatively associated with housing prices.\textsuperscript{152} Thus, Table 2 indicates that observable
determinants of housing price were varying differently in New Jersey than in the
control states between the treatment waves. This raises the concern that unobservable
housing price determinants were varying differently in New Jersey than in the control
states. I consider this threat to internal validity when scrutinizing the results. As
discussed below, I also use the supplemental data to control for the observable
changes in population and homeowner vacancy rate in a second set of models.

This study uses a standard method for organizing the difference-in-difference
model. First, I pooled housing price data from New Jersey and control states in 1995
and 2003. I then created a geographic indicator variable (“rehab code”), which is
equal to one if the unit is located in New Jersey, and a treatment wave indicator
variable (“posttreatwave”), which is equal to one if the unit was surveyed in 2003.
The interaction of these two variables gives the difference-and-difference variable.
Finally, I run an OLS model with all three variables to obtain an estimate of the
difference-in-difference coefficient.

The study addresses the threats to internal validity discussed above through a
number of checks on robustness. First, I estimate the difference-in-difference model

\textsuperscript{152} Noam 400; Phillips and Goodstein 339-41.

Apr. 2006. Available:
http://www.census.gov/hhes/www/housing/hvs/annual01/ann01def.html.
with and without controlling for observable determinants of housing price. If the treatment effect changes greatly when controls are added to the model, then there is reason to worry that unobservable characteristics also changed differently over time in each state.

Second, as noted above, population density and homeowner vacancy rate likely affect housing prices. My primary data set does not allow me to control for these factors. The difference-in-difference estimator is likely to be upwardly biased when these variables are omitted because New Jersey experienced more population growth and a larger drop in homeowner vacancy rate than the control states. After running my primary models, I use the decennial census data to examine how the treatment effect changes when these variables are added to the model. This allows for further consideration of whether unobservable determinants of housing price were varying differently in New Jersey than in the control states.

Models

The literature on housing price models has not settled upon what functional form is preferable. Most of the literature agrees that a nonlinear functional form is preferred over a linear one. The scholarship suggests that the relationship between housing price and many independent variables is likely to be non-linear and that a
non-linear form potentially reduces heteroskedasticity of the error terms.\textsuperscript{154} Studies vary, however, in the type of non-linear form used. Some researchers prefer a semi-log form, with log of home value as the dependent variable.\textsuperscript{155} Others utilized a log-log form, in which the independent variables are also logged.\textsuperscript{156}

Given the lack of agreement on functional form, this study employed both the semi-log and log-log forms. The dependent variable for both forms is the log of the market value of the housing unit, including yard. The log-log models contain log formations of all non-indicator variables.

As a secondary approach, I also attempted a linear model, similar to that used by Muth and Wetzler in their analysis of building codes, described above. Unlike other studies, the authors favored a linear model and used construction cost per unit square footage as the dependent variable.\textsuperscript{157} My data set did not allow me to calculate construction cost per unit square footage. I had to estimate the market value of the housing unit and yard per unit square footage as my dependent variable. I ran the model with the full set of independent variables, excluding only unit square footage.

\textsuperscript{155} Goodman and Thibodeau 25.
\textsuperscript{156} Noam 397; Clark and Nieves 244.
The independent variables were in level form. When reviewing the results, I examine how each functional form (log-log, semi-log, and linear) performed in a functional form misspecification test.

Another functional form issue is whether the effect of the rehabilitation code on housing prices varies by housing age. Interactions of the difference-in-difference variable with home age indicator variables allows for such variation. I ran one of my primary models, the log-log form, with these age interactions to test the hypothesis that the rehabilitation code effect varies based on the age of the home.

Figures 1 and 2 describe my primary regression models. Figure 1 details the semi-log and log-log OLS models. I ran these OLS models in order to compare the coefficients I obtained on certain notable housing characteristics to previous OLS housing price models. These OLS models are estimated using the pooled pre-treatment and post-treatment sample. Thus, in these non-difference-in-difference OLS models, the “rehab code” coefficient is not the isolated effect of the rehabilitation code on housing prices, but rather the effect that being located in New Jersey has on the market value of the unit.

Figure 2 details the semi-log and log-log difference-in-difference models. The effect of the rehabilitation code on housing prices is given by $\beta_{\text{Diff-in-Diff}}$, the coefficient

\footnote{Muth and Wetzler 59.}
on the difference-in-difference variable (rehabcode*posttreatmentwave). Figure 2 also contains the difference-in-difference models with age interactions.

Both figures reveal the categories of independent variables that my models use. The literature continues to discuss the appropriate set of characteristics to include in a housing price model.\textsuperscript{158} The goal is to adequately control for variation in characteristics and quality.\textsuperscript{159} Like most housing price studies, my models control for characteristics of the home and neighborhood using available data.\textsuperscript{160} Home characteristics include the number of rooms, bedrooms, and bathrooms in the unit. Neighborhood characteristics include whether schools are satisfactory and whether crime is a problem. My models also include characteristics of the homeowner that could be correlated with home values, such as household income and whether the household uses public transportation. The note to Table 3 details the full set of controls used in most of my models.

As noted above, data limitations do not allow my primary models to control for certain variables that influence the housing market. These include factors such as population and homeowner vacancy rate, which other studies included in their

\textsuperscript{158} Wallace 39; Goodman and Thibodeau 25.
\textsuperscript{159} Wallace 39.
\textsuperscript{160} Goodman and Thibodeau 26.
models. After estimating my primary results, I used decennial census data to add state population density and homeowner vacancy rate to selected models.

Figure 1: OLS Model Specifications

**Semi-log Model:**

\[ \text{Log\_value} = \beta_0 + \beta_1\text{rehabcode (NJ)} + \beta_2\text{post-treatment wave} + \beta_3\text{home characteristics} + \beta_4\text{homeowner characteristics} + \beta_5\text{neighborhood characteristics} + u \]

**Log-log Model:**

\[ \text{Log\_value} = \beta_0 + \beta_1\text{rehabcode (NJ)} + \beta_2\text{post-treatment wave} + \beta_3\text{indicator home, homeowner, and neighborhood characteristics} + \beta_4\text{log\_non-indicator home, homeowner, and neighborhood characteristics} + u \]

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\[161\] Noam 400; Phillips and Goodstein 339-41.
**Figure 2: Difference-in-Difference Model Specifications**

**Semi-log Model:**

\[
\text{Log\_value} = \beta_0 + \beta_1 \text{rehabcode (NJ)} + \beta_2 \text{post-treatment wave} + \beta_{\text{Diff-n-Diff}} \text{rehabcode*post-treatment wave} + \beta_3 \text{home characteristics} + \beta_4 \text{homeowner characteristics} + \beta_5 \text{neighborhood characteristics} + u
\]

**Log-log Model:**

\[
\text{Log\_value} = \beta_0 + \beta_1 \text{rehabcode (NJ)} + \beta_2 \text{post-treatment wave} + \beta_{\text{Diff-n-Diff}} \text{rehabcode*post-treatment wave} + \beta_3 \%\text{indicator home, homeowner, and neighborhood characteristics} + \beta_4 \%\text{log_non-indicator home, homeowner, and neighborhood characteristics} + u
\]

**Semi-log Model with Age Interactions:**

\[
\text{Log\_value} = \beta_0 + \beta_1 \text{rehabcode (NJ)} + \beta_2 \text{post-treatment wave} + \beta_{\text{Diff-in-Diff}} \text{rehabcode*post-treatment wave} + \beta_3 \text{home characteristics} + \beta_4 \text{homeowner characteristics} + \beta_5 \text{neighborhood characteristics} + \beta_6 \text{home age*rehabcode*post-treatment wave} + u
\]

**Log-log Model with Age Interactions:**

\[
\text{Log\_value} = \beta_0 + \beta_1 \text{rehabcode (NJ)} + \beta_2 \text{post-treatment wave} + \beta_{\text{Diff-in-Diff}} \text{rehabcode*post-treatment wave} + \beta_3 \%\text{indicator home, homeowner, and neighborhood characteristics} + \beta_4 \%\text{log_non-indicator home, homeowner, and neighborhood characteristics} + \beta_6 \text{home age*rehabcode*post-treatment wave} + u
\]
Chapter 5. Description of Data Set

Data

This study uses data from the 1995 and 2003 American Housing Surveys (AHS) to measure the dependent and independent variables in my models. The AHS is a biennial national household survey of housing quality that provides data on a range of housing characteristics. Every four years, the AHS targets certain metropolitan areas, which provides a large number of observations for the selected areas. The AHS is an unbalanced panel survey; it has followed the same panel of homes since 1983, but units drop out and others are added each survey period.

The AHS provides information on the owner’s assessment of the market value of the unit, including the yard. I use the log of this variable as my dependent variable in my primary regressions. The AHS also includes information on the characteristics of the home, neighborhood, and homeowner, which my model uses as independent variables.

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As detailed above, this study examines housing prices in New Jersey, Pennsylvania, and Connecticut before and after New Jersey implemented its code. The national AHS survey locates most units only by the geographic area of the country in which they are located. Researchers can pinpoint state location only for units located in specified metropolitan areas that AHS identifies.

My sample is comprised of units located in the metropolitan areas of New Jersey, Pennsylvania, and Connecticut. The New Jersey metropolitan areas included in my sample are Atlantic City, Bergen-Passaic, Jersey City, Middlesex-Somerset-Hunterdon, Monmouth-Ocean, Newark, Trenton, and Northern New Jersey. Pennsylvania and Connecticut metropolitan areas make up the non-rehabilitation code control group. The Pennsylvania metropolitan areas included are Allentown-Bethlehem-Easton, Erie, Lancaster, Pittsburgh, Scranton, and center-city Philadelphia. The Connecticut metropolitan areas included are Bridgeport, Hartford, New Haven, Stamford, and Waterbury. As noted above, and as detailed in Table 1, the housing stock in both New Jersey and the control states in my sample is relatively old.
suggesting that all three states have comparable opportunities for a rehabilitation code to impact the housing market.

By necessity, observations with missing values for the dependent variable were excluded. Thus, the sample is further limited to owner-occupied housing for which the owner gave an assessment of the market value of the home. These limitations yield 640 pre-treatment observations and 755 post-treatment observations for New Jersey. The sample contains 778 pre-treatment observations and 775 post-treatment observations for the control group of Pennsylvania and Connecticut.
Chapter 6. Results

OLS Models

This study first ran a traditional OLS model of the relationship between housing market value and various housing characteristics. The “rehabilitation code” coefficient in these non-difference-in-difference models simply denotes that the unit is located in New Jersey. It does not isolate the impact of the rehabilitation code as the difference-in-difference model does.

These OLS models are useful because they allow a comparison of the effects of certain home characteristics on housing price estimated in my models with the estimates for those same characteristics in previous OLS studies of housing prices. Table 3 provides the results of the OLS semi-log model. Model 1 is the OLS model with no controls for any housing characteristics other than survey year and whether the unit is located in New Jersey. Holding survey year constant, the model predicts that homes in New Jersey have an approximately 92.2 percent higher value than a unit in the control states (p < 0.01).\footnote{The approximate change in the dependant variable becomes increasingly inaccurate in logarithmic models as the coefficient estimate of the independent variable becomes larger. The exact percentage change in the predicted \( y \) is 100 *\( (e^{\hat{\beta}} - 1) \). See Wooldridge 187-88. Footnotes throughout this chapter provide the exact predicted percentage change in home value for large coefficient estimates. Here, Model 1 predicts that homes in New Jersey are 151.4 percent higher in value than homes in the control states.}

\footnote{The approximate change in the dependant variable becomes increasingly inaccurate in logarithmic models as the coefficient estimate of the independent variable becomes larger. The exact percentage change in the predicted \( y \) is 100 *\( (e^{\hat{\beta}} - 1) \). See Wooldridge 187-88. Footnotes throughout this chapter provide the exact predicted percentage change in home value for large coefficient estimates. Here, Model 1 predicts that homes in New Jersey are 151.4 percent higher in value than homes in the control states.}
Model 2 adds a full set of housing, neighborhood, and homeowner characteristics to the OLS semi-log model. Model 2 shows that, controlling for the full set of independent variables, homes in New Jersey are predicted to have an approximately 48.9 percent higher value than homes in the control states. The coefficients on a number of the independent variables in Model 2 are smaller than the values obtained by another housing price model. For example, my results show that home value is predicted to increase by about 2.8 percent for each additional room a unit contains, holding other variables in the model constant (p < 0.05). In contrast, a recent housing price hedonic model using data from the 1999 AHS predicted that each additional room increased home value by about 12.9 percent (p < 0.01).

The prior study, however, controlled for a much smaller set of characteristics than my model and used national data. For instance, it did not include household income and the number of dining rooms. These variables may be positively correlated with both number of rooms and market value. In that case, the prior study’s estimate of the effect of rooms is upwardly biased, and it is not surprising that the estimate is larger than in my study.

Table 4 provides the results of the OLS log-log model. Model 1 simply replicates for reference the regression of home value on unit location and survey year.

166 The exact predicted difference in home value is 63.1 percent.
167 Crone, Nakamura, and Voith 32.
Model 2 adds a full set of controls, with non-indicator variables logged. Holding other variables in the model constant, a home in New Jersey is predicted to be approximately 40.3 percent higher in value than a home in the control states.\(^\text{168}\)

The log-log model performs better than the semi-log model in explaining the variation in the dependent variable. The log-log model explains 48.4 percent of the variation in the log of home value, compared to the 44.6 percent explanatory power of the semi-log model. In addition, more independent variables are statistically significant in the log-log model. For example, the log of bathrooms and log of household income are statistically significant, while their linear versions were not significant in Table 3.

Table 4 also provides an opportunity to compare the variable coefficients in my model to other studies that used the log-log functional form. Model 2 indicates that a one percent increase in household income is associated with about a 0.11 percent decrease in home price (p < 0.10). The negative association is out of line with a previous study and intuition. Noam found that a one percent increase in income is associated with about a 0.09 percent increase in home value.\(^\text{169}\) Noam’s estimate was,

\(^\text{168}\) The exact predicted difference in home value is 49.6 percent.
\(^\text{169}\) Noam 400.
however, not statistically significant, and therefore cannot be distinguished from zero.\footnote{\textit{Ibid.}}

More importantly, the negative sign of household income in my model is the result of other controls that were not included in Noam’s regression. My models contain both household and family income, which overlap significantly, but are different for some homes in the sample. Thus, the household income variable in my models must be considered alongside the family income variable. When family income is dropped from Model 2, the coefficient on household income becomes positive, as previous research and intuition predict.

\textit{Difference-in-Difference Models}

The primary results of this study, the difference-in-difference models, are presented in Tables 5 and 6. The difference-in-difference coefficient in each table provides the estimate of the effect of the rehabilitation code on home value.

Table 5 provides the results of the difference-in-difference semi-log model. Model 1 is a difference-in-difference model that does not control for any characteristics of the home, neighborhood, or homeowner. The results indicate that the rehabilitation code is associated with statistically significantly higher home values (p < 0.01). Specifically, the code is predicted to raise home values by approximately

\footnote{\textit{Ibid.}}
Model 2 from the same table adds the full set of controls to the model in semi-log form. When these variables are held constant, the rehabilitation code is predicted to raise home value by approximately 27.0 percent (p < 0.01). These results are contrary to expectation, which will be discussed below.

Table 6 presents the results of the log-log difference-in-difference specification. Model 1 simply duplicates for reference the difference-in-difference model without controls. Model 2 controls for the full set of independent variables, with all non-indicator variables logged. Holding these variables constant, the rehabilitation code raises home value by approximately 25.4 percent (p < 0.01). Again, this positive association is contrary to expectation.

Table 6 indicates that, as in the OLS models, the log-log functional form explains more of the variation in the log of home value than the semi-log form. The adjusted R-squared for the difference-in-difference log-log model is 0.486, compared to an adjusted R-squared of 0.449 for the difference-in-difference semi-log model. Also, the log formations of a number of variables that were not significant in the semi-log model are significant in the log-log model. For instance, the log of bathrooms and log of household income are statistically significant, while their linear versions were not significant in the semi-log model of Table 5.

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171 The exact predicted increase in home value is 33.8 percent.
172 The exact predicted increase in home value is 31.0 percent.
Table 7 presents the results of adding age interactions to the semi-log and log-log difference-in-difference models. These models contain interactions of the difference-in-difference variable with the indicator variables for home age. The interactions allow the effect of the rehabilitation codes on home value to vary with age.

Model 1 is the full semi-log model from Table 5 with age interactions added. The interaction coefficients are not statistically significant. Thus we reject the hypothesis that the effect of the rehabilitation code on home value varies by home age category. The interactions also did not add to the explanatory power of the semi-log model. The adjusted R-squared of the semi-log model with interactions, 0.449, is the same as adjusted R-squared of the semi-log model without interactions in Table 5.

Model 2 is the full log-log model from Table 6 with age interactions added. Again, the interaction coefficients are not statistically significant, which indicates that the association of the rehabilitation code with home value does not vary by home age. As with Model 1, the interactions did not add to the explanatory power of the model. The adjusted R-squared of the log-log model with interactions, 0.486, is the same as the adjusted R-squared of the log-log model without interactions.

The exact predicted increase in home value is 28.9 percent.
Functional Form Tests

All of the models detailed above fail a functional form misspecification test. I tested each model using Ramsey’s Regression Specification Error Test (RESET). RESET examines whether a selected functional form adequately captures nonlinearities in the relationship between the dependent and independent variables.\(^{174}\) It does this by adding polynomial formulations of the OLS fitted values (\(y\_hats\)) into the original model. I used a RESET program that adds squared, cubic, and quartic forms of the fitted values to each model. The fitted value polynomials represent the nonlinear functions of the independent variables.\(^{175}\) Thus, if the fitted value polynomials are significant when added to the model, this indicates that the selected functional form has missed important nonlinearities in the relationship between the dependent and independent variables.\(^{176}\)

The log-log specifications of the OLS and difference-in-difference models perform slightly better on the RESET test than their semi-log counterparts. But, even for the log-log models, RESET rejects the null hypothesis that the models correctly capture non-linearities. All polynomial levels are rejected at \(p < 0.01\) for all models.

First, we examine the results for the OLS models more closely. In the semi-log model with controls, all polynomial forms of the fitted values are highly

\(^{174}\) Wooldridge 292-93.  
\(^{175}\) Ibid.  
\(^{176}\) Ibid.
significant (p < 0.0001 for each polynomial form). In the log-log model with controls, all the polynomial forms are still highly significant, though the squared fitted value has a slightly larger p-value (p = 0.0026 for squared form, p < 0.0001 for cubic and quartic form) than the squared fitted value of the semi-log model.

The difference-in-difference models follow a similar pattern. In the semi-log model with controls, all polynomial forms of the fitted values are highly significant (p < 0.0001 for each polynomial form). In the log-log model with controls, all polynomials are highly significant, but the squared fitted value has a slightly larger p-value (p = 0.0002 for squared fitted value, p < 0.0001 for the cubic and quartic form). Finally, both the log-log and semi-log interaction models show highly significant misspecifications (p < 0.0001 for each polynomial form). As the section below discusses, incorrect functional forms biases the coefficient estimates.

Alternate Linear Functional Form

The linear difference-in-difference model patterned after the Muth and Wetzler study indicated that the rehabilitation code is positively associated with home value per unit square footage. This model was run on a smaller sample of observations that did not have missing values for unit square footage. As described above, the model

\[ \text{Ibid.} \]
contained level formulations of the full set of independent variables, excluding unit square footage. The results predicted that the rehabilitation code raises home value per unit square footage by about 72 dollars, holding other variables in the model constant ($p < 0.01$).

RESET also revealed a functional form problem with this model. For the linear model, the squared fitted value is insignificant at the 5 percent level, but the higher order polynomials are highly significant ($p = 0.0665$ for squared fitted value, $p < 0.0001$ for the cubic and quartic form). I also ran the log-log and semi-log models on this smaller sample, to compare the performance of each functional form on the same observations. The RESET scores are still highly significant for these models when they are run on the smaller sample. Thus, all three functional forms fail to adequately capture non-linearities in the relationship between home value and the controls.

**Models with Extra Controls**

The threats to internal validity noted above and the unexpected sign of the rehabilitation code effect led me to merge Census data into the AHS to attempt to control for factors that may be biasing the results. I added these extra controls for state population density and homeowner vacancy rate to the log-log versions of OLS and difference-in-difference regressions. I selected the log-log form over the semi-log
form because the full log models had more explanatory power and had slightly better
RESET scores than their semi-log counterparts. I preferred the log-log form over the
linear model because it is more common in the literature and because the linear model
still tested positive for functional form misspecification.

Table 8 provides the results of adding the extra controls to the OLS log-log
model. Model 1 duplicates the original OLS log-log model for reference. Model 2
shows that the effect of being located in New Jersey becomes negative when state
population density is added (p < 0.01). The population density variable is positively
associated with home value and highly statistically significant (p < 0.01). Model 3
indicates that the effect of being located in New Jersey is also negative, though less so
than in Model 2, when both state population density and homeowner vacancy rate are
held constant (p < 0.10). Population density again has a positive and significant
association with home value (p < 0.01). Homeowner vacancy rate has a significant
negative association with home value (p < 0.01). These results suggest that
determinants of housing price that the original model omitted are likely driving the
higher New Jersey home values observed in Model 1.

Table 9 provides the results of adding extra controls to the difference-in-
difference log-log model. Model 1 duplicates the original difference-in-difference
log-log model for reference. Model 2 shows that the effect of the rehabilitation code
on home value becomes less positive when state population density is added. Holding
state population density constant along with the other variables, the rehabilitation code
is predicted to raise home value by approximately 17.8 percent, compared to about
a 25.4 percent increase without the extra control. Model 3 indicates that the effect of
the rehabilitation code on home value becomes negative when both state population
density and homeowner vacancy rate are held constant. Holding the variables in
Model 3 constant, the rehabilitation code is predicted to lower home value by
approximately 33.5 percent.

The variation in the rehabilitation code estimate when these additional controls
are added to the model suggests that the original treatment estimate is upwardly biased
due to omitted variables. The results indicate that population density is positively
associated with home value and location in New Jersey, and that homeowner vacancy
rate is negatively associated with both home value and location in New Jersey. Thus,
the rehabilitation code estimate decreases when population density is added to the
model, and drops further when homeowner vacancy is held constant.

These fluctuations also raise doubts about whether the key assumption for
internal validity of the difference-in-difference estimator has been met. The variation
indicates that observable determinants of home value varied differently in New Jersey.

---

177 The exact predicted increase in home value is 19.5 percent.
178 The exact predicted decrease in home value is 39.8 percent.
than in the control states. One should therefore worry that unobserved determinants of home value might also have varied differently in New Jersey than in the control states, which would bias the treatment estimate.

Importantly, the coefficient for whether a unit is located in New Jersey ("rehabilitation code") is highly significant in the original difference-in-difference log-log model and the model with population density added (Table 9, Models 1 and 2). It is significant at the five percent level when both population density and homeowner vacancy rate are included (Table 9, Model 3). This “New Jersey” coefficient measures the effect of being located in New Jersey that is not related to the rehabilitation code or other controls in the models. The statistical significance of this coefficient indicates that the models have not fully captured the housing characteristics that vary by state and determine home value. Again, this raises the possibility that the treatment estimate is biased due to uncontrolled determinants of home value varying differently in New Jersey than in the control states.

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179 Wooldridge 435.
Chapter 7. Discussion

The attempt to measure the unbiased effect of the rehabilitation code on housing prices did not succeed. The results suggest that two forms of model misspecification may have biased the estimates of the rehabilitation code coefficient. First, the decennial Census data suggests that New Jersey may have experienced a much tighter housing market than the control states during part of my study. As noted above, New Jersey experienced a larger growth in population density and a greater drop in homeowner vacancy rate than either Pennsylvania or Connecticut. Greater population density and a lower homeowner vacancy rate are associated with higher home prices. The omission of these factors from the original models upwardly biases the rehabilitation code estimate, as the regressions with extra controls demonstrate.

There are other housing market factors, such as new construction starts, labor market conditions, and economic growth, that my models did not include. I do not feel confident that these variables changed consistently in New Jersey and the control states, given the fluctuation in the treatment effect when population and homeowner vacancy rate are added to the models. Moreover, given this variation, I believe that unobservable determinants of housing price, like perception of the attractiveness of New Jersey relative to other states, may not have been constant throughout the study.
period. In sum, the rehabilitation code is likely endogenous, making its coefficient estimate biased.

Second, I was unable to find the proper functional form relating housing price to the independent variables in my model. Ramsey’s RESET can identify functional form problems. Unfortunately, however, the test does not provide guidance on what alternate functional forms would correctly capture the relationship between the dependent and independent variables.\textsuperscript{180} I used the primary functional forms for housing models found in the literature, but each model tested positive for misspecification. Misspecification of this kind generally leads to biased coefficient estimates, because it suggests that non-linear formations of the independent variables have been improperly omitted from the regression.\textsuperscript{181} In other words, the functional form problem indicates that the independent variables are correlated with both the error term and the dependent variable, which causes bias.

In addition to the problems noted above, we can also consider the possibility of changes in neighborhood amenities and housing stock quality that might have accompanied increased rehabilitation activity in New Jersey. As noted above, rehabilitation activity could theoretically improve neighborhood aesthetics and average housing stock quality by removing vacant and dilapidated buildings. Better

\textsuperscript{180} Wooldridge 294.
\textsuperscript{181} Wooldridge 289-90.
neighborhoods could stimulate housing demand, which would raise prices. Quality improvements are also associated with higher prices.\textsuperscript{182}

The quality issue is, in fact, another omitted variable problem. The positive relationship measured in the original model may reflect an upward bias in the treatment estimate caused by possible neighborhood and housing stock quality improvements in New Jersey that were not controlled for in the models. As discussed above, my models attempted to measure the effect of the rehabilitation code on housing price, holding quality constant. But they only roughly controlled for certain aspects of quality, particularly neighborhood aesthetics. Neighborhood quality included only variables for whether the neighborhood had satisfactory schools, safe water, and problems with crime. Thus, my models may not indicate the effect of the rehabilitation code on housing prices while holding quality constant.

Finally, housing prices are likely to be autocorrelated, particularly in an unbalanced panel dataset used here. Autocorrelation refers to a correlation between the error terms in the time periods studied.\textsuperscript{183} My model did not use standard errors that correct for autocorrelation. In most cases, the standard errors from difference-in-difference OLS models that do not correct for autocorrelation seriously understate the

\textsuperscript{182} Schill 7; Kelly 349; Fischel 1141; Wallace 34.
\textsuperscript{183} Wooldridge 334, 845.
correct standard deviations of the coefficients.\textsuperscript{184} Autocorrelation therefore leads to overconfidence in rejecting the null hypothesis that a selected factor has no effect on the dependent variable.\textsuperscript{185} The possibility of autocorrelation in my sample thus raises doubts about the statistical significance levels found in the tables. My results likely overstate the statistical significance of various factors, including the effect of the rehabilitation code on home values.

I was unable to reliably measure the effect of New Jersey’s rehabilitation code on housing prices and therefore cannot draw policy conclusions about the code. Nevertheless, future study of rehabilitation codes is warranted. The aging of the housing stock and the question of whether regulatory policies raise housing prices will continue to be important issues in the housing policy field. The rehabilitation codes enacted in New Jersey and other states are relevant to the discussion of these two critical policy issues.

Given the value of additional research, I offer a number of improvements upon my study that may lead to a better estimate of the effect of the rehabilitation code on housing prices. First, future researchers could attempt to better control for quality by using more of the neighborhood quality variables available in the AHS or by locating

a dataset that has more detailed information on neighborhood aesthetics. Similarly, a future study should attempt to locate data for other important housing market factors that my models did not include, such as new construction activity, size of the labor force, unemployment, and economic growth.

Second, an improved study should use standard errors that correct for heteroskedasticity and autocorrelation. My primary models tested positive for heteroskedastic error terms. Moreover, as discussed above, a panel dataset of housing prices likely has autocorrelated error terms. Future researchers should use corrected standard errors to ensure that their statistical conclusions are valid.

Third, future researchers should try other nonlinear functional forms to attempt to find the correct relationship between housing prices and housing characteristics. This may include experimenting with polynomial formations of some independent variables. For example, one hedonic housing price model included squared, cubic, and quartic formations of home age.\textsuperscript{186} Interpreting coefficients can become difficult with complex nonlinear forms. Simplicity should be sacrificed, however, if the sacrifice yields a functional form that does not bias the coefficient estimates.

Finally, a future study of rehabilitation codes might allow for a longer time window for the rehabilitation codes to have an effect. The supply of housing may be

\textsuperscript{185} Ibid. at 254-61, 273.
relatively inelastic over short time periods because of the time that it takes to plan and implement construction projects. Future research might examine the effect of a rehabilitation code more than five years after the date of enactment. A longer timeframe can have a downside, however. If a difference-in-difference strategy is used, the longer period may increase the threat to internal validity because determinants of housing prices may be more likely to change differently in the treatment and control states over longer periods of time. A researcher would also have to be careful to locate comparable states that did not enact rehabilitation codes throughout the study period. Pennsylvania and Connecticut, for instance, enacted model rehabilitation codes after my study period concluded. These states could therefore not serve as control states to New Jersey over a longer time period.

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186 Goodman and Thibodeau 31-33.
188 See *supra* note 71.
Chapter 8. Conclusion

My study did not succeed in obtaining an unbiased estimate of the effect of the rehabilitation code on housing prices. The original models showed that the rehabilitation code was associated with higher home values, but they did not control for important housing market factors. When the models controlled for state population density and homeowner vacancy rate, the effect of rehabilitation code on home values became negative. The variation in the treatment estimate when the model included extra controls suggests that the original estimates were upwardly biased and that housing factors changed differently in New Jersey than in the control states. Systematic changes in the treatment and control states make it difficult to achieve unbiased estimates through a difference-in-difference procedure. Despite the difficulties this study encountered, the continuing discussion of the effect of regulatory policies on the housing market and the aging of the housing stock make rehabilitation codes a worthy focus of scholarly research. Future research can build upon this study by running models that contain a more complete set of housing market factors and by attempting more advanced functional forms.
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Online. Internet. 8 Apr. 2006. Available:


Table 1. Age of Housing Stock in Sample, 2003: Percentage of Structures Built by Period

<table>
<thead>
<tr>
<th></th>
<th>New Jersey</th>
<th>Pennsylvania</th>
<th>Connecticut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-1940</td>
<td>25.4</td>
<td>48.9</td>
<td>29.2</td>
</tr>
<tr>
<td>1940-1969</td>
<td>35.5</td>
<td>35.0</td>
<td>44.3</td>
</tr>
<tr>
<td>1970-1989</td>
<td>23.3</td>
<td>11.9</td>
<td>23.9</td>
</tr>
<tr>
<td>Post-1989</td>
<td>15.8</td>
<td>4.1</td>
<td>2.7</td>
</tr>
<tr>
<td>N</td>
<td>755</td>
<td>662</td>
<td>113</td>
</tr>
</tbody>
</table>

Table 2. Notable Characteristics by State, pre-treatment and post-treatment

<table>
<thead>
<tr>
<th></th>
<th>New Jersey</th>
<th>Pennsylvania</th>
<th>Connecticut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Household Income (dollars)</td>
<td>77,113</td>
<td>107,042</td>
<td>48,294</td>
</tr>
<tr>
<td>Average Unit Square Footage</td>
<td>2,197</td>
<td>2,367</td>
<td>2,110</td>
</tr>
<tr>
<td>Average Number of Bedrooms Per Unit</td>
<td>3.06</td>
<td>3.18</td>
<td>2.99</td>
</tr>
<tr>
<td>State population density (persons per square mile)</td>
<td>1042</td>
<td>1134</td>
<td>265</td>
</tr>
<tr>
<td>State homeowner vacancy rate (percent)</td>
<td>2.5</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>N</td>
<td>640</td>
<td>755</td>
<td>678</td>
</tr>
</tbody>
</table>

SOURCE: Information on household income, unit square footage, and number of bedrooms per unit comes from my sample of the 1995 and 2003 American Housing Surveys. The state population density and homeowner vacancy rate information comes from the 1990 and 2000 U.S. Censuses. The dollar values for household income are in 2003 dollars.
Table 3. Association of Rehabilitation Code with Housing Price (Log of Home Value): OLS Semi-log Model

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation code</td>
<td>0.922***</td>
<td>0.489***</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>0.188***</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Number of rooms</td>
<td>0.028**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td></td>
</tr>
<tr>
<td>Number of bedrooms</td>
<td>0.026</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td></td>
</tr>
<tr>
<td>Number of bathrooms</td>
<td>0.034</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td></td>
</tr>
<tr>
<td>Unit square footage</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>Fireplace in unit (No) (Yes)</td>
<td></td>
<td>0.150***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.038)</td>
</tr>
<tr>
<td>Annual real estate taxes</td>
<td></td>
<td>0.000***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
</tr>
<tr>
<td>Household income</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
</tr>
<tr>
<td>N</td>
<td>2,948</td>
<td>2,948</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.198</td>
<td>0.446</td>
</tr>
</tbody>
</table>

NOTE: Standard errors in parentheses. *p< .1, **p< .05, ***p< .01. Each model includes an intercept. In addition to the variables listed in the table, Model 2 also controls for additional housing characteristics (number of half bathrooms, kitchens, living rooms, dining rooms, floors in unit and number of units in building; whether unit has garage, dishwasher, clothes dryer, washing machine, garbage disposer, hot and cold water, central air conditioning, room air conditioning; whether there is a mortgage on unit, whether quality of unit is adequate; costs of home insurance, electricity, water and sewage, gas, garage removal, and routine maintenance; lot size; conceptual set of age indicators), neighborhood characteristics (satisfactory schools, safe water, whether crime is a problem), and homeowner characteristics (family income, homeowner’s race and gender, whether unit is homeowner’s first home, whether someone in home uses public transportation, whether household receives pension or social security, whether household receives welfare, whether household receives child support). They include missing observation indicators for every variable except number of baths, half baths, bedrooms, kitchens, living rooms, rooms, dining rooms; the number of units in building; age of unit; and whether unit has a clothes dryer, dishwasher, fireplace, washing machine, garbage disposal, and hot and cold water.
Table 4. Association of Rehabilitation Code with Housing Price (Log of Home Value): OLS Log-Log Model

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation code</td>
<td>0.922***</td>
<td>0.403***</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>0.188***</td>
<td>-0.044</td>
</tr>
<tr>
<td></td>
<td>(0.188)</td>
<td>(0.055)</td>
</tr>
<tr>
<td>Ln of number of rooms</td>
<td>0.305***</td>
<td>0.213***</td>
</tr>
<tr>
<td></td>
<td>(0.118)</td>
<td>(0.078)</td>
</tr>
<tr>
<td>Ln of number of bedrooms</td>
<td>-0.009</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.099)</td>
<td></td>
</tr>
<tr>
<td>Ln of number of bathrooms</td>
<td>0.041</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td></td>
</tr>
<tr>
<td>Ln of unit square footage</td>
<td>0.041</td>
<td>0.111***</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Fireplace in unit (No) (Yes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ln of annual real estate taxes</td>
<td>0.135***</td>
<td>-0.110*</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.058)</td>
</tr>
<tr>
<td>Ln of household income</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>2,948</td>
<td>2,948</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.198</td>
<td>0.484</td>
</tr>
</tbody>
</table>

NOTE: Standard errors in parentheses. *p< .1, **p< .05, ***p< .01. Each model includes an intercept. In addition to the variables listed in the table, Model 2 also controls for the additional variables and missing observation indicators listed in the note to Table 3 above. In Table 4, the non-indicator variables listed in the note to Table 3 are logged.
Table 5. Association of Rehabilitation Code with Housing Price (Log of Home Value): Difference-in-Difference Semi-log Model

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference-in-Difference (Rehab x Post-treatment)</td>
<td>0.291***</td>
<td>0.270***</td>
</tr>
<tr>
<td></td>
<td>(0.070)</td>
<td>(0.067)</td>
</tr>
<tr>
<td>Rehabilitation code</td>
<td>0.770***</td>
<td>0.343***</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.053)</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>0.051</td>
<td>-0.090</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.062)</td>
</tr>
<tr>
<td>Number of rooms</td>
<td></td>
<td>0.029**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.013)</td>
</tr>
<tr>
<td>Number of bedrooms</td>
<td>0.021</td>
<td>(0.023)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of bathrooms</td>
<td>0.035</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.030)</td>
</tr>
<tr>
<td>Unit square footage</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
</tr>
<tr>
<td>Fireplace in unit (No)</td>
<td></td>
<td>0.153***</td>
</tr>
<tr>
<td>(Yes)</td>
<td></td>
<td>(0.038)</td>
</tr>
<tr>
<td>Annual real estate taxes</td>
<td></td>
<td>0.000***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
</tr>
<tr>
<td>Household income</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
</tr>
<tr>
<td>N</td>
<td>2,948</td>
<td>2,948</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.202</td>
<td>0.449</td>
</tr>
</tbody>
</table>

NOTE: Standard errors in parentheses. *p<.1, **p<.05, ***p<.01. Each model includes an intercept. In addition to the variables listed in the table, Model 2 also controls for the additional variables and missing observation indicators listed in the note to Table 3 above.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference-in-Difference</td>
<td>0.291***</td>
<td>0.254***</td>
</tr>
<tr>
<td>(Rehab x Post-treatment)</td>
<td>(0.070)</td>
<td>(0.064)</td>
</tr>
<tr>
<td>Rehabilitation code</td>
<td>0.770***</td>
<td>0.262***</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.053)</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>0.051</td>
<td>-0.140**</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Ln of number of rooms</td>
<td></td>
<td>0.308***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.118)</td>
</tr>
<tr>
<td>Ln of number of bedrooms</td>
<td>-0.029</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.098)</td>
<td></td>
</tr>
<tr>
<td>Ln of number of bathrooms</td>
<td>0.208***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td></td>
</tr>
<tr>
<td>Ln of unit square footage</td>
<td></td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.033)</td>
</tr>
<tr>
<td>Fireplace in unit (No)</td>
<td></td>
<td>0.114***</td>
</tr>
<tr>
<td>(Yes)</td>
<td></td>
<td>(0.037)</td>
</tr>
<tr>
<td>Ln of annual real estate taxes</td>
<td></td>
<td>0.127***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.017)</td>
</tr>
<tr>
<td>Ln of household income</td>
<td></td>
<td>-0.111*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.058)</td>
</tr>
<tr>
<td>N</td>
<td>2,948</td>
<td>2,948</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.202</td>
<td>0.486</td>
</tr>
</tbody>
</table>

NOTE: Standard errors in parentheses. *p< .1, **p< .05, ***p< .01. Each model includes an intercept. In addition to the variables listed in the table, Model 2 also controls for the additional variables and missing observation indicators listed in the note to Table 3 above. In Table 6, the non-indicator variables listed in the note to Table 3 are logged.
Table 7. Association of Rehabilitation Code with Housing Price (Log of Home Value): Difference-in-Difference Models with Age Interactions

<table>
<thead>
<tr>
<th></th>
<th>Model 1 Semi-log</th>
<th>Model 2 Log-log</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference-in-Difference (Rehab x Post-treatment)</td>
<td>0.336** (0.132)</td>
<td>0.421*** (0.127)</td>
</tr>
<tr>
<td>Rehabilitation code</td>
<td>0.342*** (0.053)</td>
<td>0.262*** (0.053)</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>-0.084 (0.062)</td>
<td>-0.137** (0.060)</td>
</tr>
<tr>
<td>Age of Housing Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Built after 1990)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Built pre-1940</td>
<td>0.036 (0.098)</td>
<td>0.046 (0.094)</td>
</tr>
<tr>
<td>Built 1940 to 1960</td>
<td>0.080 (0.098)</td>
<td>0.052 (0.095)</td>
</tr>
<tr>
<td>Built 1970 to 1990</td>
<td>0.036 (0.099)</td>
<td>0.018 (0.096)</td>
</tr>
<tr>
<td>Interaction of Age Indicators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>with Rehab Code (Age x Diff-in-Diff)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Built after 1990)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Built pre-1940</td>
<td>-0.066 (0.136)</td>
<td>-0.214 (0.132)</td>
</tr>
<tr>
<td>Built 1940 to 1960</td>
<td>-0.025 (0.132)</td>
<td>-0.142 (0.127)</td>
</tr>
<tr>
<td>Built 1970 to 1990</td>
<td>-0.168 (0.137)</td>
<td>-0.213 (0.132)</td>
</tr>
<tr>
<td>N</td>
<td>2,948</td>
<td>2,948</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.449</td>
<td>0.486</td>
</tr>
</tbody>
</table>

NOTE: Standard errors in parentheses. *p<.1, **p<.05, ***p<.01. Each model includes an intercept. Model 1 adds age interactions to Model 2 of Table 5. Model 2 adds age interactions to Model 2 of Table 6.
Table 8. Association of Rehabilitation Code with Housing Price (Log of Home Value): OLS Log-Log Models with Extra Controls

<table>
<thead>
<tr>
<th></th>
<th>Model 1 (Original)</th>
<th>Model 2 (One Extra Control)</th>
<th>Model 3 (Two Extra Controls)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation code</td>
<td>0.403***</td>
<td>-0.345***</td>
<td>-0.202*</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.113)</td>
<td>(0.119)</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>-0.044</td>
<td>-0.085</td>
<td>-0.179***</td>
</tr>
<tr>
<td></td>
<td>(0.055)</td>
<td>(0.054)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Ln of number of rooms</td>
<td>0.305***</td>
<td>0.330***</td>
<td>0.330***</td>
</tr>
<tr>
<td></td>
<td>(0.118)</td>
<td>(0.118)</td>
<td>(0.117)</td>
</tr>
<tr>
<td>Ln of number of bedrooms</td>
<td>-0.009</td>
<td>-0.027</td>
<td>-0.044</td>
</tr>
<tr>
<td></td>
<td>(0.099)</td>
<td>(0.098)</td>
<td>(0.098)</td>
</tr>
<tr>
<td>Ln of number of bathrooms</td>
<td>0.213***</td>
<td>0.241***</td>
<td>0.233***</td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td>(0.077)</td>
<td>(0.077)</td>
</tr>
<tr>
<td>Ln of unit square footage</td>
<td>0.041</td>
<td>0.041</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.032)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Fireplace in unit (No)</td>
<td>0.111***</td>
<td>0.084***</td>
<td>0.090***</td>
</tr>
<tr>
<td>(Yes)</td>
<td>(0.037)</td>
<td>(0.037)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Ln of annual real estate taxes</td>
<td>0.135***</td>
<td>0.127***</td>
<td>0.121***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.017)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Ln of household income</td>
<td>-0.110*</td>
<td>-0.107*</td>
<td>-0.107*</td>
</tr>
<tr>
<td></td>
<td>(0.058)</td>
<td>(0.058)</td>
<td>(0.057)</td>
</tr>
<tr>
<td>Population density of state</td>
<td>0.001***</td>
<td>0.001***</td>
<td>0.001***</td>
</tr>
<tr>
<td>Homeowner vacancy rate of state</td>
<td>0.000</td>
<td>-0.186***</td>
<td>0.000</td>
</tr>
</tbody>
</table>

SOURCE: State population density and housing vacancy information are from the 1990 and 2000 U.S. Census. All other variables are from the 1995 and 2003 American Housing Surveys.

NOTE: Standard errors in parentheses. *p< .1, **p< .05, ***p< .01. All models include intercepts. The original model, in the first column, is Model 2 from Table 4. In the second column, Model 2 adds state population density to the original model. Model 3 adds state population density and state homeowner vacancy rate to the original model.

<table>
<thead>
<tr>
<th></th>
<th>Model 1 (Original)</th>
<th>Model 2 (One Extra Control)</th>
<th>Model 3 (Two Extra Controls)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference-in-Difference</td>
<td>0.254***</td>
<td>0.178***</td>
<td>-0.335**</td>
</tr>
<tr>
<td>(Rehab x Post-treatment)</td>
<td>(0.064)</td>
<td>(0.065)</td>
<td>(0.171)</td>
</tr>
<tr>
<td>Rehabilitation code</td>
<td>0.262***</td>
<td>-0.389***</td>
<td>0.062</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.114)</td>
<td>(0.180)</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>-0.140**</td>
<td>-0.149**</td>
<td>-0.176***</td>
</tr>
<tr>
<td></td>
<td>(0.060)</td>
<td>(0.059)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Ln of number of rooms</td>
<td>0.308***</td>
<td>0.330***</td>
<td>0.331***</td>
</tr>
<tr>
<td></td>
<td>(0.118)</td>
<td>(0.117)</td>
<td>(0.117)</td>
</tr>
<tr>
<td>Ln of number of bedrooms</td>
<td>-0.029</td>
<td>-0.040</td>
<td>-0.043</td>
</tr>
<tr>
<td></td>
<td>(0.098)</td>
<td>(0.098)</td>
<td>(0.098)</td>
</tr>
<tr>
<td>Ln of number of bathrooms</td>
<td>0.208***</td>
<td>0.235***</td>
<td>0.234***</td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td>(0.077)</td>
<td>(0.077)</td>
</tr>
<tr>
<td>Ln of unit square footage</td>
<td>0.039</td>
<td>0.039</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.032)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Fireplace in unit (No) (Yes)</td>
<td>0.114***</td>
<td>0.088**</td>
<td>0.090**</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.037)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Ln of annual real estate taxes</td>
<td>0.127***</td>
<td>0.123***</td>
<td>0.121***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.017)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Ln of household income</td>
<td>-0.111*</td>
<td>-0.108*</td>
<td>-0.105*</td>
</tr>
<tr>
<td></td>
<td>(0.058)</td>
<td>(0.057)</td>
<td>(0.057)</td>
</tr>
<tr>
<td>Population density of state</td>
<td>0.001***</td>
<td>0.001***</td>
<td>0.001***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.130)</td>
</tr>
<tr>
<td>Homeowner vacancy rate of state</td>
<td>-0.422***</td>
<td>-0.422***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.130)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>2.948</td>
<td>2.948</td>
<td>2.948</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.486</td>
<td>0.493</td>
<td>0.495</td>
</tr>
</tbody>
</table>

SOURCE: State population density and housing vacancy information are from the 1990 and 2000 U.S. Census. All other variables are from the 1995 and 2003 American Housing Surveys.
NOTE: Standard errors in parentheses. *p< .1, **p< .05, ***p< .01. All models include intercepts.
The original model, in the first column, is Model 2 from Table 6. In the second column, Model 2 adds state population density to the original model. Model 3 adds state population density and state homeowner vacancy rate to the original model.
### Appendix: Univariate Statistics

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>adeq cond</td>
<td>= 1 if unit condition is adequate</td>
<td>0.95</td>
<td>0.22</td>
<td>0</td>
<td>1</td>
<td>2,789</td>
</tr>
<tr>
<td>aircon</td>
<td>= 1 if unit has room air conditioning</td>
<td>0.57</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
<td>2,416</td>
</tr>
<tr>
<td>amte03</td>
<td>Average monthly cost of electricity</td>
<td>85.72</td>
<td>52.57</td>
<td>9</td>
<td>251</td>
<td>2,738</td>
</tr>
<tr>
<td>amtg03</td>
<td>Average monthly cost of gas</td>
<td>81.93</td>
<td>52.36</td>
<td>0</td>
<td>278</td>
<td>2,191</td>
</tr>
<tr>
<td>amti03</td>
<td>Annual cost of homeowners insurance</td>
<td>608.17</td>
<td>463.46</td>
<td>1</td>
<td>3,010</td>
<td>2,607</td>
</tr>
<tr>
<td>amtt03</td>
<td>Annual cost of garbage and trash</td>
<td>254.43</td>
<td>183.55</td>
<td>11</td>
<td>1,141</td>
<td>783</td>
</tr>
<tr>
<td>amtw03</td>
<td>Annual cost of water and sewage</td>
<td>468.12</td>
<td>305.72</td>
<td>0</td>
<td>2,040</td>
<td>2,340</td>
</tr>
<tr>
<td>amtx03</td>
<td>Annual real estate tax payment</td>
<td>2,992.00</td>
<td>3,476.93</td>
<td>0</td>
<td>17,550</td>
<td>2,049</td>
</tr>
<tr>
<td>asian</td>
<td>= 1 if homeowner is Asian only</td>
<td>0.03</td>
<td>0.18</td>
<td>0</td>
<td>1</td>
<td>2,756</td>
</tr>
<tr>
<td>baths</td>
<td>number of bathrooms</td>
<td>1.46</td>
<td>0.68</td>
<td>0</td>
<td>6</td>
<td>2,948</td>
</tr>
<tr>
<td>bedrms</td>
<td>number of bedrooms</td>
<td>3.04</td>
<td>0.98</td>
<td>0</td>
<td>10</td>
<td>2,948</td>
</tr>
<tr>
<td>black</td>
<td>= 1 if homeowner is black only</td>
<td>0.13</td>
<td>0.34</td>
<td>0</td>
<td>1</td>
<td>2,756</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Min</td>
<td>Max</td>
<td>N</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------</td>
<td>-----------</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>builtpre40s</td>
<td>= 1 if unit built before 1940</td>
<td>0.30</td>
<td>0.46</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>built40s60s</td>
<td>= 1 if unit built between 1940 and 1969</td>
<td>0.36</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>built70s80s</td>
<td>= 1 if unit built between 1970 and 1989</td>
<td>0.27</td>
<td>0.45</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>builtpost90s</td>
<td>= 1 if unit built after 1989</td>
<td>0.07</td>
<td>0.25</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>builtpre40s_diffint</td>
<td>(builtpre40s x treatment interaction) = 1 if unit built before 1940, located in NJ, and surveyed in 2003</td>
<td>0.07</td>
<td>0.25</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>built40s60s_diffint</td>
<td>(built40s60s x treatment interaction) = 1 if unit built between 1940 and 1969, located in NJ, and surveyed in 2003</td>
<td>0.09</td>
<td>0.29</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>built70s80s_diffint</td>
<td>(built70s80s x treatment interaction) = 1 if unit built between 1970 and 1989, located in NJ, and surveyed in 2003</td>
<td>0.06</td>
<td>0.24</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>builtpost90s_diffint</td>
<td>(builtpost90s x treatment interaction) = 1 if unit built after 1989, located in NJ, and surveyed in 2003</td>
<td>0.04</td>
<td>0.20</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Min</td>
<td>Max</td>
<td>N</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------</td>
<td>-----------</td>
<td>-----</td>
<td>------</td>
<td>----</td>
</tr>
<tr>
<td>centralair</td>
<td>= 1 if unit has central air conditioning</td>
<td>0.42</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>childsupport</td>
<td>= 1 if household received child support payments in last year</td>
<td>0.03</td>
<td>0.18</td>
<td>0</td>
<td>1</td>
<td>2,756</td>
</tr>
<tr>
<td>clothdry</td>
<td>= 1 if unit has clothes dryer</td>
<td>0.85</td>
<td>0.36</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>crsmnt03</td>
<td>Annual cost for routine maintenance</td>
<td>703.42</td>
<td>1,090.40</td>
<td>0</td>
<td>8,931</td>
<td>2,318</td>
</tr>
<tr>
<td>crimeneigh</td>
<td>= 1 if neighborhood has crime problem</td>
<td>0.21</td>
<td>0.41</td>
<td>0</td>
<td>1</td>
<td>2,680</td>
</tr>
<tr>
<td>CT</td>
<td>= 1 if unit located in Connecticut</td>
<td>0.07</td>
<td>0.6</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>dining</td>
<td>Number of dining rooms in unit</td>
<td>0.75</td>
<td>0.47</td>
<td>0</td>
<td>5</td>
<td>2,948</td>
</tr>
<tr>
<td>dishwash</td>
<td>= 1 if unit has working dishwasher</td>
<td>0.59</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>fireplace</td>
<td>= 1 if unit has fireplace</td>
<td>0.31</td>
<td>0.46</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>firsthome</td>
<td>= 1 if homeowner’s first home</td>
<td>0.34</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
<td>2,276</td>
</tr>
<tr>
<td>floors</td>
<td>Number of stories in building</td>
<td>2.83</td>
<td>1.59</td>
<td>1</td>
<td>21</td>
<td>2,150</td>
</tr>
<tr>
<td>garageinc</td>
<td>= 1 if unit has garage</td>
<td>0.62</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
<td>2,921</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Min</td>
<td>Max</td>
<td>N</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------</td>
<td>-------</td>
<td>-----------</td>
<td>-----</td>
<td>-----</td>
<td>---</td>
</tr>
<tr>
<td>garbdis</td>
<td>= 1 if unit has working garbage disposal</td>
<td>0.28</td>
<td>0.45</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>halfb</td>
<td>Number of half bathrooms in unit</td>
<td>0.50</td>
<td>0.57</td>
<td>0</td>
<td>3</td>
<td>2,948</td>
</tr>
<tr>
<td>homevacancy</td>
<td>Homeowner vacancy rate in state where unit is located</td>
<td>1.66</td>
<td>0.48</td>
<td>1.1</td>
<td>2.5</td>
<td>2,948</td>
</tr>
<tr>
<td>hotcoldwat</td>
<td>= 1 if unit has hot and cold running water</td>
<td>1.00</td>
<td>0.05</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>kitch</td>
<td>Number of kitchens in unit</td>
<td>1.02</td>
<td>0.16</td>
<td>0</td>
<td>3</td>
<td>2,948</td>
</tr>
<tr>
<td>living</td>
<td>Number of living rooms in unit</td>
<td>1.02</td>
<td>0.19</td>
<td>0</td>
<td>4</td>
<td>2,948</td>
</tr>
<tr>
<td>log_value03</td>
<td>Ln (value03)</td>
<td>11.81</td>
<td>1.06</td>
<td>0</td>
<td>13.4</td>
<td>2,948</td>
</tr>
<tr>
<td>lot</td>
<td>Square footage of lot</td>
<td>22,217.51</td>
<td>65,352.98</td>
<td>200</td>
<td>792,000</td>
<td>2,197</td>
</tr>
<tr>
<td>male</td>
<td>= 1 if householder is male</td>
<td>0.58</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
<td>2,756</td>
</tr>
<tr>
<td>mortgage</td>
<td>= 1 if there is mortgage on property</td>
<td>0.55</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
<td>2,756</td>
</tr>
<tr>
<td>NJ</td>
<td>= 1 if unit located in New Jersey</td>
<td>0.47</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>nunits</td>
<td>Number of units in building</td>
<td>4.21</td>
<td>36.03</td>
<td>1</td>
<td>919</td>
<td>2,948</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Min</td>
<td>Max</td>
<td>N</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------</td>
<td>-----------</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>other</td>
<td>= 1 if homeowner is a race other than black, asian, or white only</td>
<td>0.01</td>
<td>0.08</td>
<td>0</td>
<td>1</td>
<td>2,756</td>
</tr>
<tr>
<td>ovenstove</td>
<td>= 1 if unit has working oven or stove</td>
<td>0.98</td>
<td>0.15</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>pensionSS</td>
<td>= 1 if household received social security or pension benefits in last year</td>
<td>0.38</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>personspersqmi</td>
<td>Persons per square mile in state where unit is located</td>
<td>689.19</td>
<td>397.40</td>
<td>265</td>
<td>1,134</td>
<td>2,948</td>
</tr>
<tr>
<td>Phila</td>
<td>= 1 if unit located in Philadelphia, Pennsylvania</td>
<td>0.24</td>
<td>0.43</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>posttreatwave</td>
<td>= 1 unit surveyed in 2003</td>
<td>0.52</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>rehabcode</td>
<td>= 1 if unit located in NJ, the state with a rehabilitation code</td>
<td>0.47</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>RestPA</td>
<td>= 1 unit located in Pennsylvania, non-Philadelphia</td>
<td>0.21</td>
<td>0.41</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>rooms</td>
<td>Number of rooms in unit</td>
<td>6.49</td>
<td>1.93</td>
<td>1</td>
<td>16</td>
<td>2,948</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Min</td>
<td>Max</td>
<td>N</td>
</tr>
<tr>
<td>-------------------------------------------</td>
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<td>----</td>
</tr>
<tr>
<td>safewater</td>
<td>= 1 if water safe for drinking and cooking</td>
<td>0.95</td>
<td>0.23</td>
<td>0</td>
<td>1</td>
<td>2,872</td>
</tr>
<tr>
<td>schsat</td>
<td>= 1 if satisfied with public elementary school</td>
<td>0.89</td>
<td>0.32</td>
<td>0</td>
<td>1</td>
<td>729</td>
</tr>
<tr>
<td>treatment interaction (rehabcode x posttreatwave)</td>
<td>= 1 if unit located in NJ and surveyed in 2003</td>
<td>0.26</td>
<td>0.44</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>unitsf</td>
<td>Square footage of unit</td>
<td>2,305.22</td>
<td>1,867.11</td>
<td>99</td>
<td>10,421</td>
<td>2,227</td>
</tr>
<tr>
<td>usepublictran</td>
<td>= 1 if someone in household uses public transportation</td>
<td>0.27</td>
<td>0.45</td>
<td>0</td>
<td>1</td>
<td>2,026</td>
</tr>
<tr>
<td>value03</td>
<td>Current market value of unit, including yard, as assessed by owner</td>
<td>198,389.38</td>
<td>167,630.63</td>
<td>0</td>
<td>642,895</td>
<td>2,948</td>
</tr>
<tr>
<td>valuepersqft03</td>
<td>Current market value of unit, including yard, per unit square footage</td>
<td>129.45</td>
<td>198.44</td>
<td>0</td>
<td>6,494</td>
<td>2,227</td>
</tr>
<tr>
<td>zinc_03</td>
<td>Family income</td>
<td>72,502.30</td>
<td>89,844.64</td>
<td>0</td>
<td>2,430,000</td>
<td>2,756</td>
</tr>
<tr>
<td>zinc2_03</td>
<td>Household income</td>
<td>73,551.00</td>
<td>90,082.55</td>
<td>0</td>
<td>2,430,000</td>
<td>2,756</td>
</tr>
<tr>
<td>zmhbc03</td>
<td>Monthly housing costs</td>
<td>1,083.99</td>
<td>848.64</td>
<td>38</td>
<td>6,152</td>
<td>2,756</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Min</td>
<td>Max</td>
<td>N</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>------</td>
<td>-----------</td>
<td>-----</td>
<td>-----</td>
<td>---</td>
</tr>
<tr>
<td>washmach</td>
<td>= 1 if unit has working microwave</td>
<td>0.91</td>
<td>0.29</td>
<td>0</td>
<td>1</td>
<td>2,948</td>
</tr>
<tr>
<td>welfare</td>
<td>= 1 if household received welfare benefits in last year</td>
<td>0.03</td>
<td>0.16</td>
<td>0</td>
<td>1</td>
<td>2,756</td>
</tr>
<tr>
<td>white</td>
<td>= 1 if homeowner is white only</td>
<td>0.83</td>
<td>0.38</td>
<td>0</td>
<td>1</td>
<td>2,756</td>
</tr>
</tbody>
</table>

NOTE: Dollar values are measured in 2003 dollars.