A COMPARATIVE STUDY OF SINGLE FAMILY AND MULTIFAMILY HOUSING RECOVERY FOLLOWING 1992 HURRICANE ANDREW IN MIAMI-DADE COUNTY, FLORIDA

A Dissertation

by

JING-CHEIN LU

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2008

Major Subject: Urban and Regional Sciences

A COMPARATIVE STUDY OF SINGLE FAMILY AND MULTIFAMILY HOUSING RECOVERY FOLLOWING 1992 HURRICANE ANDREW IN MIAMI-DADE COUNTY, FLORIDA

A Dissertation

by

JING-CHEIN LU

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Approved by:

Chair of Committee,	Walter Gillis Peacock
Committee Members,	Michael K. Lindell
	Carla S. Prater
	Daniel Z. Sui
Head of Department,	Forster Ndubisi

August 2008

Major Subject: Urban and Regional Sciences

ABSTRACT

A Comparative Study of Single Family and Multifamily Housing Recovery Following

1992 Hurricane Andrew in Miami-Dade County, Florida. (August 2008)

Jing-Chein Lu, B.S., National Taiwan University; M.S., National Taiwan University

Chair of Advisory Committee: Dr. Walter Gillis Peacock

Anecdotal evidence in disaster studies suggests that multifamily housing takes longer to recover than single family homes, but almost no studies have provided quantitative evidence to clarify this “multifamily home lag” phenomenon. This research examines the recovery of single family, duplex, and apartment complex housing in south Miami-Dade County, Florida, after 1992 Hurricane Andrew to determine if there is indeed a "multifamily home lag." This research also provides a better understanding of the factors influencing the recovery trajectories of these three housing types.

The findings of this research indicate that duplexes and apartment buildings have slower recovery trajectories than single family dwellings. In addition, rental housing, housing that sustained higher levels of damage, and single family dwellings and duplexes located in predominately non-Hispanic Black neighborhoods show significantly slower recovery trajectories. The analyses specific to apartment buildings also finds that apartment buildings with fewer than 10 units have significantly slower

recovery trend than apartment buildings with more than 50 units.

ACKNOWLEDGEMENTS

I particularly thank my committee chair, Dr. Walter Gillis Peacock, for his excellent guidance, educational and financial support, and for providing a stimulating learning environment for my studies at Texas A&M University. I would like to thank my advisory committee members: Dr. Michael Lindell, for his enlightenment and valuable suggestions, Dr. Carla Prater for her advice and encouragement, and Dr. Daniel Sui for his recommendations for my research.

Many thanks to my lab-mates in the Hazard Reduction and Recovery Center, especially Jie-Ying Wu, Yang Zhang, Zhenghong Tang, and Yi-Sz Lin, for their suggestions, support and encouragement when I experienced difficulties in my studies. Thanks also to Carleen Cook who helped me edit a huge number of revisions.

My deepest appreciation to my mother and sisters for their financial support and encouragement. And most of all, thanks to my wife, Yihui Yu, for her tolerance and support for my study and taking care of my lovely kids, Annie and Andy.

TABLE OF CONTENTS

Page

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

Page

CHAPTER I

INTRODUCTION

In the past two decades, several devastating natural disasters have occurred in urban areas of the United States causing serious post disaster housing problems. Several post-disaster housing phenomena have been found by researchers. For example, financial capability has been found to be the most important factor in housing recovery (Bolin 1993; Bolin 1994; Comerio 1998; Wu and Lindell 2004). The majority of recovery funding in the U.S. has come from insurance settlements; government assistance programs have also played an important role for victims without sufficient insurance funding (Comerio 1997; Comerio 1998; Wu and Lindell 2004). Research has also noted that households with different socioeconomic characteristics had different capability for acquiring insurance settlements and government loans; therefore, housing recovery has varied in households with different income, race/ethnicity, and political networks (Bolin 1990; Bolin 1993; Bolin 1994; Comerio 1997; Peacock, Morrow et al. 1997; Comerio 1998; Peacock, Dash et al. 2006).

Comerio (1998) and Wu (2003) found that although most damaged single-family housing recovered within two to three years, multifamily housing usually took longer to recover. In addition, when compared to single family homes, multifamily housing usually had more complex damage, faced more difficulties in receiving insurance settlements and government disaster assistance, and had to cope with different decision making processes (Comerio 1997; Comerio 1998; Wu and Lindell 2004). Although

---

This dissertation follows the style of *Disasters*.

recover than single family homes, almost no studies have provided quantitative evidence to clarify this “multifamily home lag” phenomenon, initially emphasized by Comerio (1998).

Assuming that this lag exists, the question becomes what factors are determining this “multifamily home lag” phenomenon? When compared to the demographics and neighborhood characteristics of single family housing, multifamily housing tends to house a disproportionate share of vulnerable low income minorities located in relatively disadvantaged neighborhoods (Bolin 1993). This socio- demographic housing pattern raises an unanswered question: Is the “multifamily home lag” primarily a direct effect of housing type or is it just a proxy for the social vulnerability of its occupants? If the known social vulnerability factors related to housing recovery are controlled, will the housing recovery trajectories of single family and multifamily still be different?

It is important to clarify the differences between single family and multifamily housing recovery for both disaster research and policy application. Comerio (1998) found that current housing recovery policies favor owner-occupied single family housing. However, multifamily housing is as important as single family housing in many communities, especially metropolitan areas. Multifamily housing forms a significant proportion of housing stock and hosts the majority of renters in urban areas. By providing various residential options, multifamily housing creates vital diverse communities. If government disaster assistance programs are designed to provide a “safety net” to minimize the gap between housing recovery need and household capabilities, then understanding the difference between single family and multifamily housing recovery is critical to improve current disaster assistance programs. If the "multifamily home lag" is due to general social vulnerability, then specialized policies targeting these vulnerability factors are needed. However, if "multifamily home lag" is the effect of housing type after controlling income and ethnicity factors, then different policies for multifamily housing recovery are required.

To distinguish between direct and indirect effects of housing type, this research compares the differences between single family and multifamily housing recovery. Specifically, this research will examine single family, duplex, and apartment complex housing recovery in south Miami-Dade County, Florida, after 1992 Hurricane Andrew to better understand the recovery trajectories and effects of known factors influencing these three housing types.

This research hypothesizes that, in general, multifamily housing (duplexes and apartments in this research) recovers more slowly than single family housing after controlling factors such as income, ethnicity, sale, and tenure status. Furthermore, low income, ethnicity minority, frequent sale, and renter-occupied status are also anticipated to have negative impacts on the housing recovery of multifamily housing as well as on single family housing. A series of analytical models has been presented in this research to examine these hypotheses.

The following chapters will review the literature of housing recovery highlighting factors known to influence housing recovery, particular attention will be paid to the different patterns of decision making and recovery patterns of single family and multifamily housing. Chapter III will describe the data, analytical models, and research hypotheses. Chapter IV will compare the housing recovery trajectories of single family homes, duplexes, and apartment buildings. Chapter V will refine the analytical model to examine the housing recovery trajectories of apartment buildings by size. Chapter VI will conclude the research findings and discuss research limitation, theoretical contribution, and policy implications.

CHAPTER II

LITERATURE REVIEW

2.1 GENERAL PATTERNS OF HOUSING RECOVERY IN THE U.S.

2.1.1 Post-disaster housing recovery as a market-driven process

The term "housing recovery" implies improvement of victims' post-disaster housing status to some level of acceptability (Quarantelli 1999). From the aspects of residential function and urban planning, this research is focused on the restoration of housing, thus, "housing recovery" in this research primarily means the repair or rebuilding of residential structures damaged by natural disasters.

Many researchers have suggested that housing recovery in the U.S. is primarily a market-driven process. Occupants of damaged homes and owners of damaged rental properties have to supply their own resources such as savings and acquire external resources such as insurance monies and private capital to finance housing recovery (Quarantelli 1982; Bolin 1994; Peacock and Ragsdale 1997; Comerio 1998; Lindell and Prater 2003). The government also provides several disaster aid programs such as SBA loans and grants from FEMA and HUD that act as a "safety net" to facilitate housing recovery (Comerio 1998). The types of government disaster assistance programs will be reviewed in Section 2.2.3.

Under resource constrained circumstances, pre-disaster inequalities and normal market failure can be amplified in the recovery period. In general, renters, low income, and minority households take longer to recover to pre-disaster housing status (Haas, Kates et al. 1977; Bates 1982; Bolin 1982; Quarantelli 1982; Bolin 1985; Bates and

Peacock 1987; Bates and Peacock 1989; Oliver-Smith 1990; Blaikie 1994; Peacock, Dash et al. 2006). Neighborhood and community characteristics also play significant roles in housing recovery (Dash, Peacock et al. 1997; Bolin and Stanford 1998; Cross 2001; Kamel and Loukaitou-Sideris 2004). Factors affecting housing recovery will be discussed in Section 2.3.

2.1.2 Housing recovery funding patterns of two major urban disasters in the U.S.

Financing for housing repair is the most important determinant of housing recovery in the U.S. (Comerio 1998; Wu and Lindell 2004). Funding for housing recovery comes from two major sources: household resources and external assistance. Household resources include personal savings, earnings (victims may work overtime or have multiple jobs to increase income), and finance from market. External assistance include charity from relatives, friends, and NGOs (including religious groups), insurance settlements, and aid (grants and loans) from government disaster assistance programs. In order to comprehend the patterns of housing recovery funding resources, the 1992 Hurricane Andrew and 1994 Northridge earthquake are compared below.

1992 Hurricane Andrew

According to Comerio (1998), Hurricane Andrew destroyed or damaged 107,800 single family homes, apartments, condominiums, and mobile homes in south Dade County, and 135, 446 housing units in the entire Dade County area. The estimated losses in Florida were $22,649 million. Housing related loss was $15,866 million, where residential structure damage totaled $10,481 million and residential contents damage amounted to $5,385 million.

Table 2.1 Insurance Settlements and Government Disaster Aid for Housing Recovery in the 1992 Hurricane Andrew and 1994 Northridge Earthquake

1992 Hurricane Andrew	(Million USD)	1994 Northridge earthquake	(Million USD)
Estimated damage	15866	Estimated damage	12651
Residential Structures	10481	Residential Buildings	12651
Residential Contents	5385		
Insurance Settlements	11085	Insurance Settlements (Sept 1996)	7808
Home Owners	9973		
Fire Policies	932		
Mobile Homes	180		
Government Programs	911	Government Programs	5591
FEMA Individual Family Grant	198	FEMA Individual Family Grant	214
FEMA Minimum Home Repair	N.A.	FEMA Minimum Home Repair	841
SBA Home Loans	399	SBA Home and Renter Loans	2481
SBA Rental Housing Loans	100	SBA Business Loans	1449
National Flood Insurance	18	National Flood Insurance	
HUD CDBG/Home	196	HUD CDBG/Home	605
FEMA Temporary Rental Housing	*141*	*FEMA Temporary Rental Housing*	*381*
HUD Section 8 Vouchers	*183*	*HUD Section 8 Vouchers*	*200*

Note: FEMA Temporary Rental Housing and HUD Section 8 Vouchers are for reference. They are temporary housing programs and not counted in the amount of government programs (for home repair and rebuilding) in this table.

Source: Comerio, 1997, 1998

Total insurance settlements in Florida were $11,085 million, with $9,973 million from home owners insurance, $932 million from fire policies, and $180 million from mobile home insurance. Funding for housing repair or rebuilding was $911 million from the $1,235 million federal housing assistance ($339.2 million from FEMA, about $498.8

million from SBA loans, $18 million from National Flood Insurance, and $379 million from HUD were for general assistance. Additional $141 million from FEMA Temporary Rental Housing and $183 million HUD Section 8 Vouchers were specifically for temporary housing).

Generally speaking, insurance was the primary funding source for permanent housing recovery following Hurricane Andrew. However, government assistance programs also played an important role in housing recovery.

1994 Northridge earthquake

In 1994, the Northridge earthquake affected 7,000 single family homes, 49,000 multifamily dwelling units, and 5,000 mobile homes red- or yellow-tagged. According to Comerio (1997; 1998), the damage to residential buildings was $12,651 million, consisting of 49% of total damage ($25,700 million). However, the residential damage was undervalued due to underestimating minor residential damage (Comerio 1997).

As of September 1996, estimated insurance claims paid were $7.808 million, which came from earthquake-only policies, earthquake riders on home-owner policies, earthquake riders on fire policies, earthquake riders on mobile home policies, earthquake riders on condominium policies and earthquake riders on rental policies. Public funding for housing repair or rebuilding was $5,591 million out of $6,171 million in federal housing assistance ($1,436 million from FEMA, $3,930 million from SBA loans, and $805 million from HUD).

As was the case with Hurricane Andrew, insurance was the primary source for permanent housing recovery in the case of the Northridge earthquake. However, government disaster assistance programs played a more important role in the Northridge earthquake than in Hurricane Andrew.

2.1.3 Government disaster assistance programs

Government disaster assistance programs in the U.S. have developed through many disasters in the U.S. and have been designed to provide a "safety net" to minimize the gap between housing recovery need and household capability, the latter including personal funding, insurance compensation, and charity (Bolin 1993; Bolin 1994; Comerio 1998; Peacock, Dash et al. 2006). Funding from government disaster assistance programs is the second most important financial source following insurance settlements and was quite important in some disasters such as the Northridge earthquake.

According the 1998 Stafford Act (Disaster Relief and Emergency Assistance Amendments, Public Law # 100-707, now amended as the Disaster Mitigation Act, 2000, Public Law # 106-390), the federal government has to provide housing assistance to individuals or households, including temporary housing, home repairs, and replacement. The primary federal agencies providing permanent housing recovery assistance are FEMA, SBA, and HUD (Bolin 1993; Comerio 1998; Peacock, Dash et al. 2006).

Funding from FEMA (Federal Emergency Management Agency)

In terms of housing repair and rebuilding, FEMA provides two assistance programs. The first is the Minimal Home Repair grant (maximum $5,000, but maximum $10,000 in the case of the 1994 Northridge earthquake) to repair housing with minor damage, and thus, minimize the number of dislocated households. The second is the Individual and

Family Grant program (maximum $10, 000, adjusted annually to reflect CPI changes) that matches federal and state funds for housing replacement. IFG is only available if the household losses cannot be fully covered by other programs, and owners of rental property are not entitled to these two grants. Comerio (1998) notes that typically, the amounts were between $2,000 and $3,000 from these two programs, and were commonly used to compensate minor repairs and personal property losses in the Northridge earthquake.

Funding from SBA (Small Business Administration)

SBA loans provided the major part of housing recovery funding from the public sector. SBA provides three types of loans for housing recovery: 1) home-owner disaster loan program for home owners suffering from housing damage; 2) renter disaster loan program for renters with losses; and 3) individual business disaster loan program for businesses with damaged rental properties. Approval and loan amounts are based on capability of repayment rather than significance of need. In 1989, the maximum was $144,000 for home owners and $500,000 for businesses. In 1994, these amount rose to $288,000 and $1,500,000 respectively (Comerio 1998).

Funding from HUD (Department of Housing and Urban Development)

HUD disaster assistance programs provide a different source of support for housing recovery. The Community Development Block Grant (CDBG) program and the HOME Investment Partnerships program provided by HUD and administered by local governments are lenders of last resort to provide assistance to low-income home owners and apartment owners who do not qualify for other assistance programs.

In a small scale disaster such as a localized flood, government disaster assistance programs might perform the "safety net" well. However, in large urban disasters such as Hurricane Andrew and the Northridge earthquake, the "safety net" exhibited limitations and inefficiencies for correcting market failures (Comerio 1998). In addition, government assistance related to permanent housing recovery favors single family home owners that with creditworthiness to repay their loans. Kamel and Loukaitou-Sideris (2004) also suggest that government assistance is critical to housing recovery at the neighborhood level. Unfortunately, however, neighborhoods with lower incomes and a higher proportion of minorities receive less assistance and experience greater population and housing unit losses.

2.2 DIFFERENCES BETWEEN SINGLE FAMILY AND MULTIFAMILY HOUSING RECOVERY

2.2.1 Different housing recovery trajectories between single family and multifamily homes

The phenomenon of multifamily housing--primarily apartment complexes and condominiums--taking longer to recover than single family housing has been reported in several disaster studies (Comerio 1997; Comerio 1998; Wu 2003; Wu and Lindell 2004). Wu (2003) examined rebuilding permits issued by the City of Los Angeles between January 1994 and November 1996 and found about 50% of the rebuilding permits for single family homes during that 35-month period were issued within six months after the

Northridge earthquake. However, fewer than 30% of the rebuilding permits for apartments and condominiums were issued during the same time frame. By January 1995, one year after the Northridge earthquake, about 84% of the single family homes permits had been issued, but only 52% of the apartment permits and 45% of the condominiums permits were issued during that period.

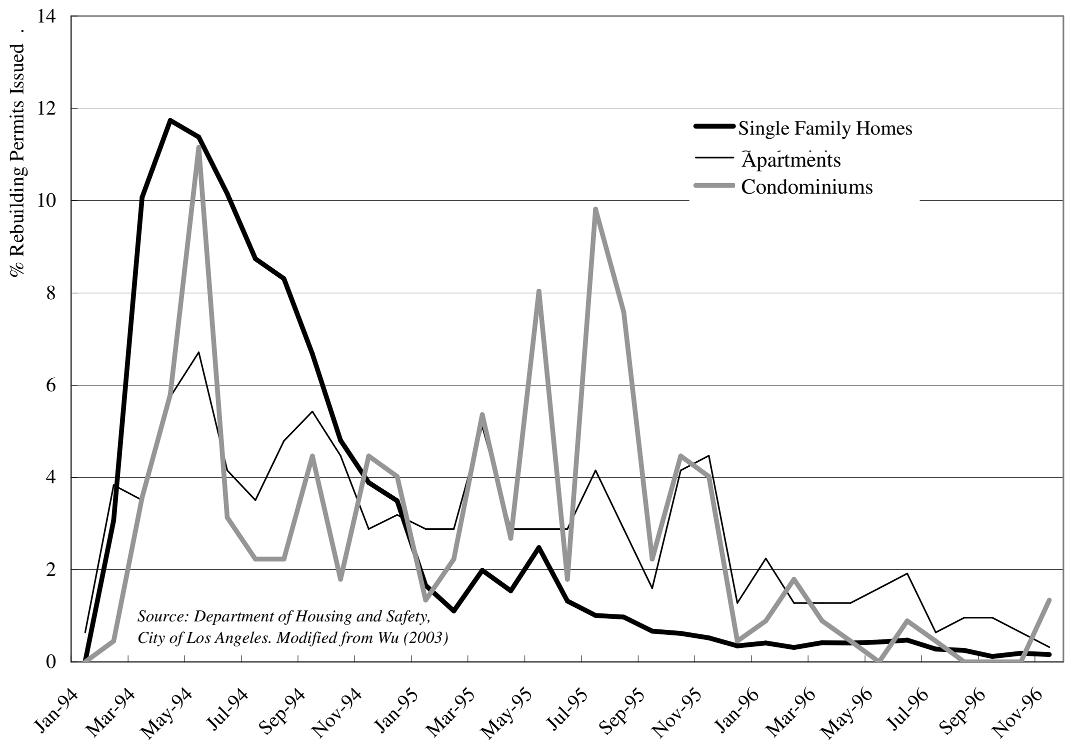

Figure 2.1 Percentage of Rebuilding Permits Issued in the City of Los Angeles

Comerio (1997; 1998) also provided anecdotal evidence that in Los Angeles, only 10,000 out of 60,000 seriously damaged units were still not repaired two years after the earthquake. However, focusing on apartment buildings, 30 percent of the apartment owners repaired their damaged properties within one year after the Northridge earthquake; and only 75 percent of the vacated units had been repaired or rebuilt three years after the event. The pattern of "multifamily home lag" is evident in the Northridge earthquake.

Many factors can delay the recovery of multifamily housing. Factors used to predict social vulnerability, such as lower-income, higher minority composition, and renter-occupied status are associated with multifamily housing. Moreover, the collective decision making processes necessary for the owners of condominiums and investors of apartment complexes to reach consensus for housing recovery take longer to achieve (Comerio 1998). In addition, the single family homeowner-inclined government disaster assistance programs also exaggerate the difference between the recovery of single family and multifamily housing (Comerio 1998; Kamel and Loukaitou-Sideris 2004).

Most of the literature regarding the slower recovery trajectory of multifamily housing is anecdotal. Other studies have provided empirical data on housing recovery but the indicators are available only at an aggregated level (e.g., Wu, 2003). There does not appear to be any research that has applied systematic quantitative methods to compare the recovery trajectories of different types of housing while at the same time accounting for factors that may influence housing recovery. To distinguish the roles of housing type and other factors in the "multifamily home lag" phenomenon, a study is needed to model and estimate housing recovery trajectories of different housing types. It is especially important to integrate data on housing type and known socioeconomic factors at the structure level.

2.2.2 Different housing recovery decisions for different types of housing

The path of housing recovery involves various forms. Homeowners can either repair damaged homes or try to sell the property without significant reconstruction. The considerations included in housing recovery decisions are quite different according to housing type and tenure status (Comerio 1998). Each of the primary housing types is addressed below.

Single family housing

The owners of single family homes can either rebuild or sell their original homes and buy new homes after a disaster. In terms of repairing their homes, three sets of considerations must be satisfied. The first is building characteristics: Can the characteristics of the rebuilt home (e.g. number of bedrooms, space, layout, and design) meet family demands after reconstruction? The second is location: Do the perceived characteristics of the neighborhood (environment, crime etc.), neighborhood services (school, shopping, and entertainment, etc.), and proximities to work and other neighborhood services meet the needs of the households? The third is investment rationality: Do the households have the financial capability to rebuild the damaged homes? Can this investment be justified financially in regard to appreciation and tax deductions when compared to other alternatives? In general, personal preferences and financial concerns of impacted households will affect their decisions to relocate or repair/rebuild the damaged home (Comerio 1998).

If single family homes are renter-occupied, then the decision making process is quite different from that of owner-occupied homes. The major concerns of rental property replacement are investment rationality and funding availability (Comerio 1998). If the owners can make a profit after deducting the cost of replacement from the rent, and if the funding for replacement is available, owners tend to rebuild their rental properties. However, their decisions are driven by profit rather than social needs (Comerio, Landis, and Rofâe, 1994, Comerio 1998).

Duplex

An ordinary duplex is a dwelling with two side-by-side living units that share a wall and have separate entrances. Although having two living units, duplexes are usually purchased as a single piece of property. Owners can either live in one of the units and rent out the other or rent out both units. If the owners of duplexes rent out both units, their housing recovery decisions are similar to those of single family rental homes. Owners who live in one of the units have the mixed considerations of both resident and landlord. For example, if duplex owners cannot acquire sufficient funding to repair both units, they may first repair the unit that they use and delay repair of the rental unit.

Townhouse and condominium

The decisions are more complex for townhouse and condominium owners. The decisions for repairing or reconstruction are not only dependent on building, location, and investment considerations, but also rely on the decisions of neighbors who legally own portions of the land and building. Regarding townhouse or condominium reconstruction, every owner of the property has personal preferences and financial concerns. However, collective opinions for repairing are usually divergent, which make it difficult to reach consensus (Comerio 1998; Wu 2003).

Apartment building

An apartment building is a building complex with multiple rental units. Housing recovery decisions for apartments are similar to other rental properties but must deal with multiple units. How to utilize their available resources and gain maximum revenue are the major concerns for apartment owners. If they do not have funding for rebuilding, or they cannot make a profit by investing in rebuilding, then apartment housing recovery will be delayed.

The ownership configuration of an apartment building affects housing recovery decisions. Apartments with only one owner are repaired based on the investment rationality and funding availability of the single owner; however, apartments operated by businesses with joint partnership will not be repaired if the partners cannot reach consensus.

2.2.3 Discrepant external funding for single family and multifamily housing recovery

Funding for repairing or rebuilding a damaged structure is the most important factor in the progress of housing recovery (Quarantelli 1982; Bolin 1994; Peacock and Ragsdale 1997; Comerio 1998; Lindell and Prater 2003; Wu and Lindell 2004; Peacock, Dash et al. 2006). In the U.S., most housing repair funding comes from external sources that include insurance settlements and government disaster assistance (Comerio 1997; Comerio 1998; Wu and Lindell 2004; Peacock, Dash et al. 2006).

Single family dwellings are more likely to have disaster insurance than multifamily dwellings (Comerio 1997). Thus, a greater proportion of multifamily dwellings are not eligible to receive insurance settlements for housing repair than single family dwellings. If the pattern of insurance settlements differs for single family and multifamily homes, government disaster assistance programs that are designed to provide a "safety net," will tend to exaggerate this imbalanced need for assistance; for example, apartment owners are not eligible for FEMA Minimum Home Repairs, and FEMA Individual Family Grant. So in terms of government disaster assistance, the owners of apartments can only apply for SBA business loans or work with local governments to acquire loans from HUD (Comerio 1997; Comerio 1998; Kamel and Loukaitou-Sideris 2004). In the case of the Northridge earthquake, most apartment owners were forced to rely on personal funding to rebuild damaged properties because less than 50% of the significantly damaged multifamily homes received assistance from government loan programs (Comerio 1997).

2.3 FACTORS AFFECTING HOUSING RECOVERY TRAJECTORY

There are many factors that can affect housing recovery trajectory such as household demographic composition, household fiscal resources, tenure status, damage condition, disaster impact, characteristics of the surrounding community, housing needs and preference, housing alternatives, capability for relocation, and external assistance as discussed in disaster literature (Bolin 1994; Comerio 1997; Dash, Peacock et al. 1997; Wu 2003; Kamel and Loukaitou-Sideris 2004; Peacock, Dash et al. 2006; Zhang 2006). These factors are not independent but interrelated.

In order to clarify these interrelated factors and their influence on housing recovery, the following section groups them as housing, social-demographic, and other factors. Each of these is discussed in terms of its relationship to housing recovery trajectories.

2.3.1 Housing condition and ownership related factors

Damage

Housing damage level is one of the important determinants of a housing recovery trajectory but it is generally taken for granted in disaster research. In general, housing with major damage takes longer to recover than housing with minor damage, not only because of the time difference to repair heavily damaged homes and slightly damaged homes, but also because owners of less damaged homes need less funding to repair the damage and tend to fix this damage as soon as possible to minimize further cost. In addition, current disaster assistance programs in the U.S. are inclined to favor single family home owners with minor damage (Bolin 1993; Comerio 1997; Bolin and Stanford 1998; Comerio 1998; Kamel and Loukaitou-Sideris 2004). Furthermore, the level of housing damage is related to pre-disaster housing condition, which is associated with housing type, household income, and race/ethnicity composition (Peacock and Girard 1997; Peacock, Dash et al. 2006).

Housing type

As discussed in the previous subsection (Section 2.2), housing types differ in their recovery requirements and external assistance, which may induce different recovery trajectories. For example, Wu (2003) compared the percentage of rebuilding permits issued by Los Angeles due to the impact of the Northridge earthquake and concluded that apartments and condominiums recover more slowly than single family housing. Comerio (1997) also noted that in the Northridge earthquake, apartments were less likely to be covered by insurance than single family homes, and less than half of the significantly damaged multifamily units received government assistance. Regarding condominiums, recovery was delayed due to lack of consensus among condominium households (Comerio 1998; Wu 2003). Housing type is also correlated with other factors related to housing recovery such as tenure status, neighborhood income and race/ethnicity composition. For example, when comparing single family homes with duplexes, single family homes tend to be owner-occupied and located in high income Anglo neighborhoods.

Tenure status

Zhang (2006) found that owner-occupied single family housing had more rapid recovery than rental occupied single family housing after Hurricane Andrew. Part of the reason is that current government assistance programs are partial to owner-occupied housing replacement. Rental properties and second homes do not qualify for Minimum Home Repair Program and Individual and Family Grant Program (Comerio 1997; Comerio 1998; Kamel and Loukaitou-Sideris 2004).

Recovery decisions of owner- and renter-occupied housing are also different. Housing recovery decisions for owner occupied housing is associated with owners' financial concerns and housing need. But the recovery decisions for rental property recovery are mainly based on profit making, not on the need of the tenants (Comerio

1998). Both the ability to finance the reinvestment and consideration about raising rents without losing tenants can affect housing recovery of rental properties.

Sales

Sales influenced housing recovery in single family housing following Hurricane Andrew (Zhang 2006). Households lacking financial resources to repair damaged homes may take the assistance and insurance settlements that they can collect, sell their property, and relocate to another residence (Peacock, Dash et al. 2006). Post-disaster speculation can also encourage households with recovery resources to sell their properties. Some households can use the disaster as an opportunity to move out and leave the damaged homes without significant improvement. For example, a significant proportion of Anglo households moved from Hispanic neighborhoods in south Miami-Dade to Anglo neighborhoods in counties north of Miami-Dade after Hurricane Andrew (Girard and Peacock 1997; Peacock, Dash et al. 2006). Because a housing sale can postpone home repair, it usually delays housing recovery.

Apartment building size

Apartment building size (i.e. number of units) also influences recovery. Small apartments appear to experience greater difficulty than larger apartments in securing mortgage financing during normal time (Segal 2003). Since housing recovery in the U.S. is primarily a market-driven process, this unequal financial capability between small and large apartments will probably exist during the recovery period if there is no government intervention.

However, under certain circumstance, such as greater damage level and lower occupancy rate for large apartment buildings, large apartment buildings may have more difficulty in recovery than small apartment buildings. For example, in the case of the Northridge earthquake, Comerio (1997) observed that larger apartments faced more problems than small properties (fewer than 10 units, owned by a single individual living in the building). In Northridge, small apartment buildings tended to have less damage and higher occupancy rates which qualified owners for SBA loans. However, large apartment buildings were usually owned by multiple investors, and one investor may also own shares of several apartment buildings. The owners of a large apartment building may need extra effort to reach an agreement on housing recovery. In addition, SBA loans also limited the amount for one individual and the loans were judged on the capability of repayment. Because of complex ownership and SBA loan limitation, many large apartment buildings were not able to receive SBA loans.

2.3.2 Household socio-demographic and neighborhood factors

Recovery resources

Research suggests that financing for housing repair or rebuilding is the most important factor in housing recovery (Comerio 1997; Comerio 1998; Wu 2003; Wu and Lindell 2004; Peacock, Dash et al. 2006). Insurance settlements, government aid, and household saving are the three major funding sources for housing recovery in the U.S. (Comerio 1998; Wu and Lindell 2004). Owners who receive sufficient housing recovery funding recover faster than those with delayed funding. The amounts of insurance settlements and governmental aid are theoretically related to level of housing damage (i.e. the higher the damage, the greater the external assistance). However, the availability of insurance, the amount of the insurance reimbursements, and SBA loan qualification are also related to home owner's and neighborhood income and race/ethnicity (Bolin 1993; Bolin 1994; Peacock and Girard 1997; Bolin and Stanford 1998; Kamel and Loukaitou-Sideris 2004; Peacock, Dash et al. 2006; Zhang 2006).

Household income

Household income is important to housing recovery in many ways. First, household income is related to the level of housing damage because low-income households have a high likelihood of living in older housing structures with less stringent building codes, lower quality design, coarser construction materials and practices, and less maintenance (Bolin 1994; Comerio 1997; Peacock and Girard 1997; Bolin and Stanford 1998; Peacock, Dash et al. 2006). Second, household income also affects access to financing for housing recovery. Households with higher incomes tend to have more personal savings, better disaster damage insurance coverage and settlements, and better chances of getting SBA loans approved (Bolin 1993; Bolin 1994; Comerio 1997; Peacock and Girard 1997; Bolin and Stanford 1998; Comerio 1998; Peacock, Dash et al. 2006). In general, the pattern of discrepant housing quality, recovery funding, and housing recovery decision structure among different household income groups can cause slower housing recovery for lower income households.

Household race and ethnicity

Household race/ethnicity is correlated with household income in the U.S., as well as to damage level, financing for housing recovery, and recovery decisions and patterns. Generally speaking, minority groups such as African Americans and Hispanics face greater difficulty in housing recovery than Anglos because African American and Hispanic households tend to live in lower quality housing, have lower incomes, and receive insufficient or no insurance settlements (Bolin 1993; Peacock and Girard 1997; Bolin and Stanford 1998). In addition, the disproportionate damage patterns and financial capability associated with race/ethnicity can also affect the eligibility of SBA loans for different race/ethnicity groups because loan approval is dependent on the capability of repayment. Even at the same household income level, households of different race/ethnicity may have different outcomes for housing recovery. Poor language skills, education, and political networking can put minority groups at a disadvantage in obtaining public assistance (Peacock, Dash et al. 2006).

Income and race/ethnicity are correlated; if both of them are controlled, race/ethnicity typically has a stronger correlation with home damage, insurance coverage and settlements. For example, in analyses predicting Hurricane Andrew home damage and sufficient insurance settlement adequacy, Peacock and Girard (1997) found that income was not statistically significant whereas race/ethnicity was statistically significant in their models.

Neighborhood characteristics

Neighborhood characteristics also influence housing recovery trajectories. A neighborhood's income level and racial/ethnic composition reflects its collective social capital (Dash, Peacock et al. 1997; Peacock and Girard 1997). By using their social networks, high income Anglo neighborhoods have greater capability to compete for resources than low income, Black neighborhoods (Bolin and Stanford 1998; Peacock, Zhang et al. 2005; Peacock, Dash et al. 2006).

Kamel and Loukaitou-Sideris (2004) found that neighborhoods with a higher proportion of rental properties and renters, lower income, and a higher proportion of minority and immigrant populations were at a disadvantage in acquiring government disaster assistance. The housing recovery of Florida City after Hurricane Andrew was sluggish due to pre-disaster neighborhood characteristics (low income minority community) and ineffective local government response to disaster impacts (Dash, Peacock et al. 1997).

In the U.S., housing tends to be segregated, so neighborhoods are relatively homogeneous with respect to income and race/ethnicity. Thus, owner-occupied homes, neighborhood income and race/ethnicity are reasonable proxies for homeowners' income and race/ethnicity if household level data are unavailable.

2.3.3 Summary

According to the literature review above, housing recovery trajectory can be explained by the causal model shown in Figure 2.2. In general, the process of housing recovery, referred to as the recovery trajectory in this study, is related to the mobilization of recovery resources, damage, and sales. For example, if damaged homes are sold without significant improvement, then the recovery trajectory will be flatter (i.e., the time for recovery will be extended). Homes with minor damage require less funding and repair, therefore, the housing recovery will be more rapid. Homeowners with their own funding can start rebuilding earlier than those who must wait for insurance settlements and other external sources of assistance.

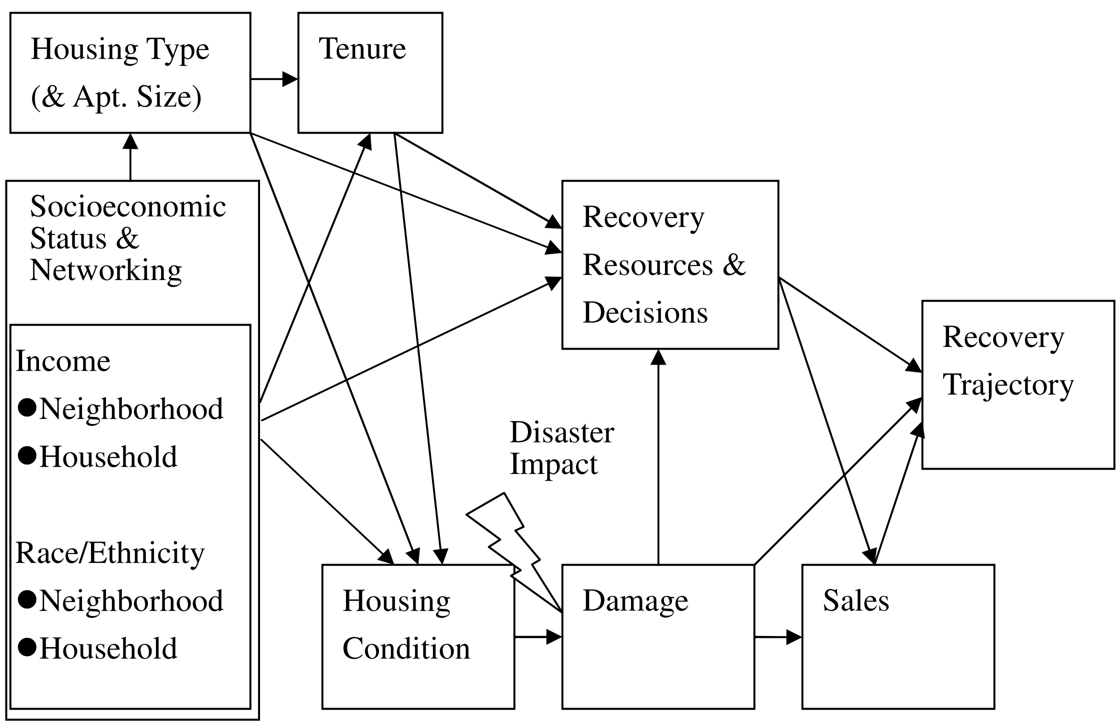

Figure 2.2 Casual Model of Housing Recovery

Sale of a structure is likely to result from a combination of owners' decisions, recovery resources, and damage. Owners with high damage and less recovery resources may not able to rebuild their damaged home and tend to sell them. Post-disaster speculation also promotes home sales for those who consider relocation to preferred neighborhoods. Selling homes without significant improvement usually delays housing recovery. Houses built under lower quality building codes, with lower quality materials using poor construction practices and poor maintenance are likely to suffer greater damage than others. In addition, housing condition is found associated with income, housing type, and tenure status (Peacock and Girard 1997; Peacock, Dash et al. 2006).

Financial capability for housing recovery is also found to be related to damage, housing type, tenure, and household and neighborhood socioeconomic characteristics. A home with substantial damage may receive more external resources such as insurance settlements and government disaster assistance. However, eligibility for these external resources is also associated with housing type, tenure status, and household and collective socioeconomic status and networking. (Bolin 1993; Comerio 1997; Oliver and Shapiro 1997; Peacock and Girard 1997; Bolin and Stanford 1998; Comerio 1998; Lindell and Prater 2003; Flippen 2004; Kamel and Loukaitou-Sideris 2004; Wu and Lindell 2004; Peacock, Zhang et al. 2005; Peacock, Dash et al. 2006; Zhang et al., 2007). Owner-occupied single family housing located in Anglo and high income neighborhoods usually recovers faster than renter-occupied housing in minority and low income neighborhoods. In addition, income, race/ethnicity, housing type, and tenure status are also correlated (Bolin 1994; Comerio 1998; Peacock, Dash et al. 2006). For example, on average, Blacks have less income than Anglos, and this economic constraint forces a greater proportion of Blacks to reside in rental multifamily housing.

In conclusion, housing recovery trajectories are shaped by many correlated physical and socioeconomic factors. However, not all of the data for these influential factors are available from secondary data; for example, data about recovery resources of homeowners are usually unavailable. In order to compare housing recovery trajectories of different types of housing, modified analytical models are needed. Chapter III will describe these analytical models and data preparation.

CHAPTER III

RESEARCH DESIGN

3.1 CONCEPTUAL MODEL AND RESEARCH HYPOTHESES

3.1.1 Measurement of housing recovery

Disaster research uses several approaches to measure housing recovery. Bolin and colleagues used household income, home size, and housing conveniences to measure household recovery (Bolin 1983; Bolin and Bolton 1986). If the damaged home has returned to the same size and same housing conveniences prior to the disaster, then the household is treated as having finished housing recovery. Bates and colleagues developed the Domestic Assets Index to measure household recovery following the Guatemalan earthquake (Bates 1982; Bates and Peacock 1987; Bates and Peacock 1992). The domestic assets index was an index of the economic value of household material assets related to housing functions (e.g. shelter, lighting etc.). Recovery is achieved when the domestic assets index meets or exceeds the expected level of domestic assets if the disaster had not occurred.

Different from measuring housing recovery through housing functions, several studies of the economic effects of natural disasters and other studies on housing recovery used building value assessment from property appraisal data as a measure of disaster impact and housing recovery (Silva, Kruse et al. 2003; Silva, Kruse et al. 2004; Peacock, Zhang et al. 2005; Zhang 2006; Ewing, Kruse et al. 2007; Zhang, Peacock et al. 2007). Silva and colleagues used the average market value of damaged homes compared with the average market value of undamaged home to assess housing damage and reconstruction related to the 1999 Oklahoma City tornado (Silva, Kruse et al. 2003). The appraisal value before and after the tornado were also used to represent housing damage (Silva, Kruse et al. 2004). Zhang et al. (2007) applied the appraised building value (after logarithmic transformation) from tax appraisal data to model housing recovery of single family homes after Hurricane Andrew. The building value was assessed using housing characteristics such as size, rooms, age, and materials, excluding contents and land value to reflect the depreciation due to damage and the appreciation of repair. Once the post-disaster building value reached or exceeded the pre-disaster building value, the single family home was said to have achieved housing recovery.

This research will follow the approach of Zhang et al. (2007), using building value from appraisal data as the measurement of housing recovery. A logarithmic transformation is applied to building value to induce a normal distribution. The details will be discussed in the section on variables (Section 3.2.3.).

3.1.2 Conceptual framework

The time sequence of housing recovery processes for a damaged residential structure is presented in Figure 3.1. After a disaster, a residential structure may suffer damage which is reflected in decreased building value. If a damaged home is owner-occupied, the household has to decide whether to stay or relocate based on their preference and financial capability. If the household decides to relocate, they sell the home and take whatever money they can get, including insurance settlements and government assistance, to move to new permanent housing. If the damaged structure is a rental property, then the owner's investment decision will determine whether to keep or give up the property.

If the household or the new owner decides to stay, or the owner of the rental property decides to keep the building, it is necessary to mobilize insurance settlements, government assistance, household funding, and other possible resources (e.g. bank loans) to repair the damaged home. The owner applies for a building permit, contracts constructors, and then starts the home repair. During the repair, the function and amenity of housing returns, and the building value is increased to reflect this improvement. When the building value reaches the pre-disaster level, the damaged home is treated as recovered.

The time required for recovery of a damaged residential structure depended on many physical and social factors such as level of damage and capability of mobilizing recovery resources as presented in the casual model in Chapter II. In brief, housing recovery trajectories can be modeled by damage, number of sales, and financial capability for recovery. However, recovery resources data is unavailable at the household level, so a modified conceptual model is needed to model housing recovery trajectory.

Based on the literature review in Chapter II, household financial capability of housing recovery and decision is related to housing type, tenure status, and household and neighborhood socioeconomic characteristics such as income and race/ethnicity. Income and race/ethnicity data at the household level are also unavailable from secondary data; however, if neighborhood (block group) level data are applied, they may not only represent the features of neighborhood socio-demography and political

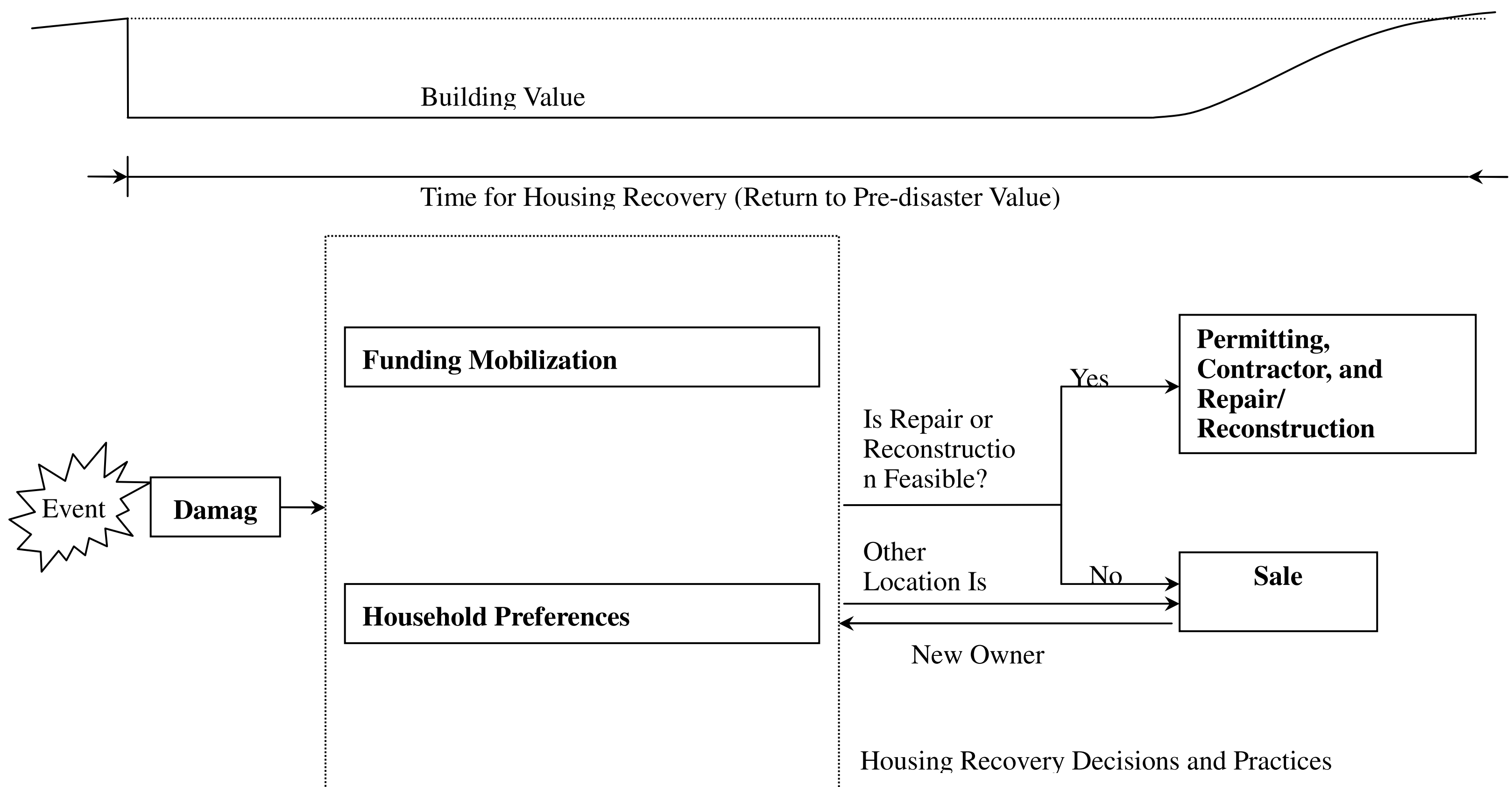

Figure 3.1 Time Sequence of Permanent Housing Recovery

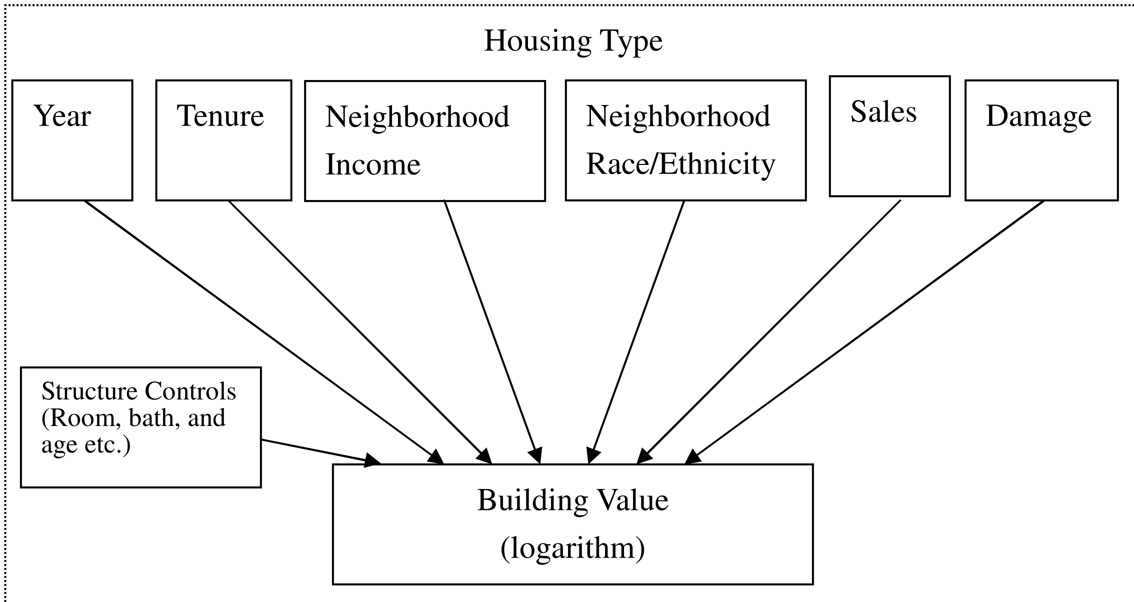

Figure 3.2 Causal Model of Housing Recovery Trajectory

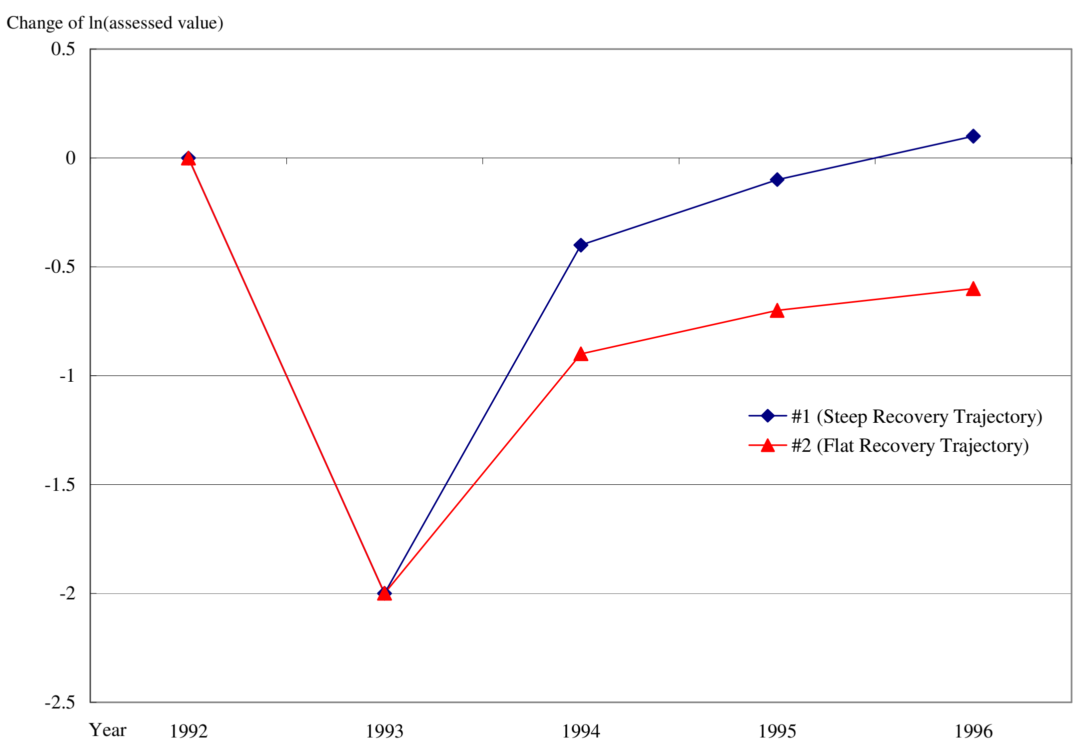

Figure 3.3 Temporal Model of Housing Recovery Trajectory

networking but also capture some of the household socioeconomic characteristics.

Tenure status, neighborhood income, neighborhood race/ethnicity, damage, sales, and structural controls (e.g. number of bedrooms, bathrooms, building age, etc.) and year dummy variables can be employed in panel data methods to model assessed values for each housing type before and after a disaster (Figure 3.2). The coefficients of year dummy variables reflect the differences in building values from the base year after controlling other variables. The coefficients of other independent variables show the overall effect net from other independent variables on building value during the time frame of analysis. Details of the model interpretation will be explained in Chapter IV.

The housing recovery trajectory of each housing type can be drawn by using the year dummy coefficients that represent the difference in the housing recovery measurement (log building value) between a certain year and the base year, 1992. The recovery of different housing types can be compared in terms their year dummy coefficients and housing recovery trajectory patterns. Figure 3.3 shows the hypothetical housing recovery trajectories of two housing categories (e.g. #1 for single family homes and #2 for apartment buildings). Housing Category 1 and Category 2 had the same initial value (as indicated by the 1992 assessed value) and the damage level (as indicated by the 1993 assessed value). Housing Category 1 had a steeper recovery trajectory than Housing Category 2 after 1993 and reached the pre-disaster level between 1995 and 1996. By contrast, Housing Category 2 had a flatter recovery trajectory and had not reached pre-disaster level by 1996. In this hypothetical case, Housing Category 1 had a steeper recovery trajectory, and recovered faster than Housing Category 2.

3.1.3 Research hypotheses

In order to differentiate the housing recovery trajectories of different types of housing (e.g. single family homes, duplexes, and apartments) and to confirm the effects of known factors on these different types of housing, this research examines the following research hypotheses:

H1: Single family homes will have a steeper housing recovery trajectory than duplexes and apartment buildings after controlling housing, neighborhood, and damage factors.

Government disaster assistance programs are inclined to favor single family housing recovery. Without the same "safety net" available to single family housing, the owners of duplexes and apartment buildings need alternative sources of funding for housing recovery. In addition, apartment building owners' disagreements about housing recovery can also delay the initiation of housing repair. Thus, single family housing will have a faster housing recovery trajectory than duplexes and apartment buildings.

H2: Neighborhoods with higher income levels will have a positive effect on the recovery trajectories in all housing types after controlling other housing, neighborhood, and damage factors.

The time required for housing recovery is dependent on the building owner's capability to mobilize recovery funding. Many factors affect funding mobilization and neighborhood income is one of them. A neighborhood's income level reflects its collective social network and political power, so households in high income neighborhoods have a greater capability to compete for resources than households in low income neighborhoods. Neighborhood income level can also affect current rents (due to owners' expectation of higher future housing appreciation), which drives business decisions for increased re-investment.

Neighborhood household income can also capture part of income's effects at the household level. Wealthy households are more likely to have property insurance and qualify for SBA loans, which makes it easier for them to mobilize recovery funding than poor households. Compared to households in poor neighborhoods, households in wealthy neighborhoods tend to recover faster.

The values of buildings of the same size and age are also affected by neighborhood income because of different designs, materials, and decorations applied to the homes in different neighborhoods. For example, homes located in wealthy neighborhoods tend to have more building value when compared to homes of the same size (number of bedrooms and baths) and age located in poor neighborhoods because the former are more likely to have more fancy designs, better materials, and finer decorations.

The general recovery trajectory of homes in wealthy neighborhoods is steeper than homes in poor neighborhoods because homes in wealthy neighborhoods are expected to recovery faster after controlling other explanatory variables. The steeper recovery trajectory for homes in wealthy neighborhoods (with higher building values) means that the difference is increased in the recovery period. For example, Figure 3.4 shows two hypothetical housing recovery trajectories in which Building #1 is located in a wealthy neighborhood and Building #2 is located in a poor neighborhood. The greater difference between these two housing recovery trajectories shows that neighborhood income level shortens the housing recovery period.

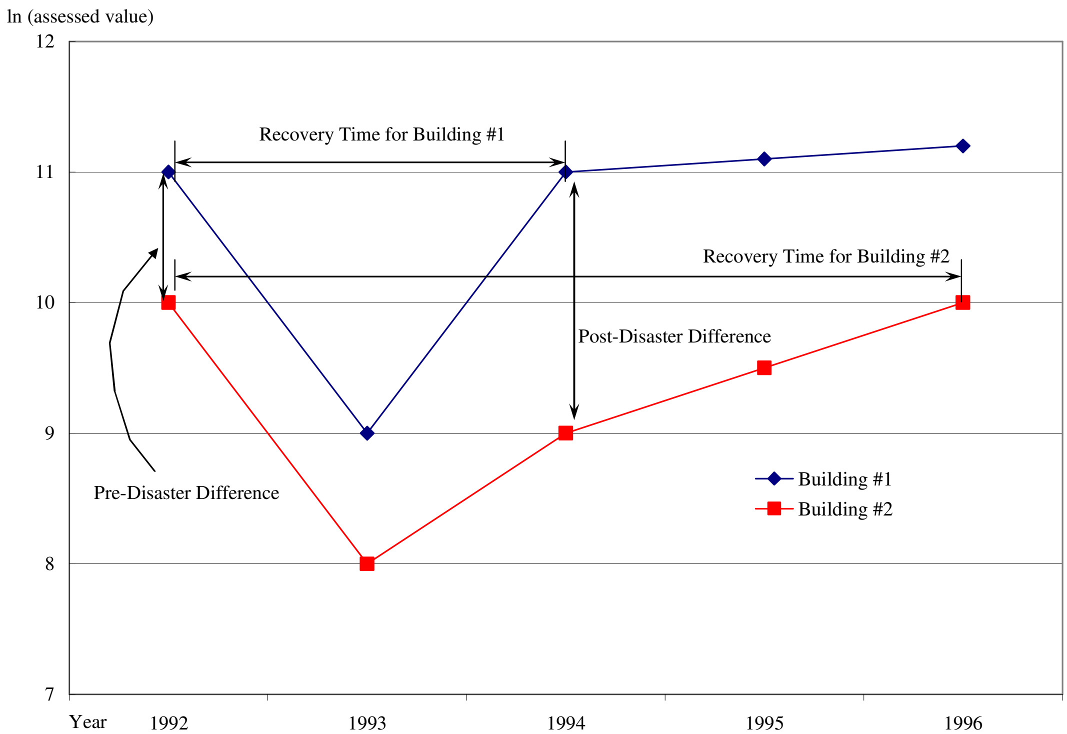

Figure 3.4 Hypothetical Housing Recovery Trajectories of Housing Categories with Different Characteristics

H3.1: Neighborhood non-Hispanic Black composition will have a negative effect on the recovery trajectories in all housing types after controlling other housing, neighborhood, and damage factors.

Capability to mobilize recovery funding is also related to neighborhood non-Hispanic Black composition. Similar to neighborhood income level, a neighborhood's non-Hispanic Black composition represents its capacity to use sociopolitical networking to compete for disaster recovery attention and resources. Neighborhood non-Hispanic Black composition can also affect rent (due to owners' expectations of lower future housing appreciation) which drives business decisions for decreased re-investment.

A neighborhood's non-Hispanic Black composition also captures the effects of residential segregation. In general, Black households tend to experience more difficulties in obtaining housing recovery funding than Anglo households. Because of disadvantages in getting recovery resources, all housing types in predominately non-Hispanic Black neighborhoods will have slower housing recovery. Thus, non-Hispanic Black neighborhoods are expected to have flatter housing recovery trajectories than neighborhoods with a low proportion of non-Hispanic Black.

H3.2: Neighborhood Hispanic composition will have a negative effect on the recovery trajectories in all housing types after controlling other housing, neighborhood, and damage factors.

Although Cuban Americans have achieved economic and political success in the Miami area (Grenier and Stepick 1992; Portes and Stepick 1993), the Hispanic population, in general, more likely to have difficulty in mobilizing recovery resources when compared to the Anglo population. For example, the percentage of households receiving insufficient insurance settlements was greater for Hispanic households than for Anglo households (Portes and Stepick 1993; Peacock and Girard 1997), and this household race/ethnicity effect might be captured by neighborhood race/ethnicity composition. Similar to neighborhoods with high levels of non-Hispanic Blacks, all types of buildings in predominately Hispanic neighborhoods will have a flatter housing recovery trajectory.

H4: Owner-occupied status will have a positive effect on housing recovery trajectories in single family homes and duplexes after controlling other housing, neighborhood, and damage factors.

Although some small apartment building owners live on the property, most of the units in apartment buildings are rented. All apartment building cases are treated as rental-occupied and not possible to verify this hypothesis.

Due to government disaster assistance policies' preferential treatment of homeowners, the owners of owner-occupied housing receive more aid from the "safety net." Besides, the recovery decisions of owner-occupied buildings are based on their housing needs, not only on investment profitability. Thus, owner-occupied single family homes and duplexes are expected to have steeper housing recovery trajectories than renter-occupied homes. In other words, owner-occupied status will have a positive effect on housing recovery in single family homes and duplexes.

H5: Post-disaster sales will have a negative effect on housing recovery trajectories in all housing types after controlling other housing, neighborhood, and damage factors.

Post-disaster sales frequently happen when the owners have an opportunity to relocate to more preferred neighborhoods or the owners are forced to leave due to insufficient housing recovery funding. The damaged homes are usually sold before any significant repairs are performed, and the time needed for home sales will delay the time before starting repairs. Therefore, single family homes, duplexes, and apartment buildings with frequent post-disaster sales will have slower housing recovery.

H6. Housing damage level will have a negative effect on housing recovery in all housing types after controlling other housing, neighborhood, and damage factors.

Homes with serious damage need more financial and labor inputs for repair, which will extend the recovery period. Other than the damage itself, the amount of insurance settlements and government assistance are positively related to damage level.

H7: Size of apartment building will affect its housing recovery after controlling other housing, neighborhood, and damage factors.

Research shows that size of an apartment building is related to the ability of the owner to mobilize funding and therefore can be expected to affect the progress of apartment housing recovery. The influence of apartment building size on housing recovery may be dependent on the post-disaster situation and may have different results from case to case.

Small apartment buildings appear to experience greater difficulty in securing mortgage financing during normal times. Under a laissez faire recovery, the phenomena happening during normal times are expected to happen during the recovery period. If owners of large apartment buildings have greater capability to mobilize recovery funding in general, then large apartment buildings have steeper housing recovery trajectories. Inconsistent results such as the experience of the 1994 Northridge earthquake showed that small apartments had a better capability for financing housing recovery because these buildings tended to have less damage and higher occupancy rates that made owners more qualified for SBA loans. Due to inconsistent findings, the direction of influence of apartment building size is undetermined.

3.2 DATA AND VARIABLES

3.2.1 Study area

The cases used in this research are single family homes, duplexes, and apartment buildings in south Miami-Dade County (south of Kendall Drive, or SW 88th Street), Florida, and the unit of analysis is the building structure. There are four major reasons why housing recovery in south Miami-Dade County, Florida after Hurricane Andrew provides a valuable opportunity for comparing housing recovery trajectories and examining the effects of underlying socioeconomic factors among different housing types.

First, Hurricane Andrew was one of the five major urban disasters in the U.S. since the 1989 Loma Prieta earthquake. There were 125,000 housing units (not buildings) damaged with 74,000 units uninhabitable; this ranked as the second largest housing impact of any natural disaster other than Hurricane Katrina (Zhang 2006). This timing is also appropriate for a housing recovery study because Hurricane Andrew happened in 1992, over 15 years ago, which means that the recovery process should have run their course.

Second, although perceived as a single family dwelling's disaster for Hurricane Andrew, it also affected many duplexes and apartment buildings. According to the Miami-Dade appraisal data, there were about 60,000 single family dwellings with an average damage level of 54%, over 1,700 duplexes with an average damage level of 60%, and approximately 20,000 living units in 600 apartment buildings with an average damage level of 57% in south Miami-Dade. The variety of housing types in this area provides valuable information for housing recovery comparison by type.

Third, the variety of socioeconomic composition in the south Miami-Dade area also presents interesting material for this research to examine the effect of social vulnerability factors on housing recovery. For example, racial/ethnic composition was diverse in south Miami-Dade County--about 30.6% Hispanic, 18.1% Black, and 51.3% Anglo in 1990, based on 1990 Census (Morrow 1997). This area also included wealthy and poor neighborhoods where neighborhood median household income ranged from $6,500 to $150,000. About 10% of single family dwellings and 30% of duplexes in south Miami-Dade were renter-occupied, which also provides useful information to examine the influence of tenure status on housing recovery.

Fourth, Peacock and colleagues from the Hazard Reduction and Recovery Center (HRRC) at Texas A&M University have collected extensive data related to Hurricane Andrew and have produced extensive research findings regarding housing recovery of single family dwellings in south Miami-Dade. By selecting the same study area, this research can take advantage of this previous research and expand current housing recovery research.

3.2.2 Data collection and preparation

The data used in this research comprise three major parts: the property appraisal database, the 1990 Census, and GIS layers of Miami-Dade County, Florida.

The property appraisal data were provided by the Miami-Dade County Property Appraiser's Office. The property value can be presented as building value, land value, and total value separately or total value only depending on the use types of the properties. For residential property, only single family homes, duplexes, apartment buildings, mixed-use residential buildings, and mobile homes are appraised for their building values and land values separately, other residential types such as condominiums, cluster homes, and townhouses are assessed for total values only.

The property values are assessed by property appraisers during the first half year, and the initial property appraisals are sent to all property owners in late August and early September. Property owners can challenge the appraisals during the following months, and the adjustments can be made through December (Zhang, Peacock et al. 2007).

In 1992, appraisals were made in the first half of the year, and the initial property appraisals were mailed out around the time Hurricane Andrew hit (late August, 1992). For many impacted homeowners, property’s appraised value was far above its market value after Hurricane Andrew. At first, there was discussion about adjusting the values after the hurricane, but the assessments stood due to the difficulty of reassessing all damaged structures during the few months left in 1992 (Zhang, Peacock et al. 2007).

Therefore, the appraisal values of 1992 reflect the appraised values during January 1992 to June 1992, about 2 to 8 months before Hurricane Andrew.

Due to the dispute about the disparity in the 1992 appraisal, Miami-Dade County promised that the assessment in the subsequent years would reflect the actual property values at the time, including depreciation due to damage and appreciation due to repair. During 1993 and many years after, property appraisers performed detailed inspections of properties in south Miami-Dade which was beneficial for reflecting the actual value of properties after Hurricane Andrew. In addition, a state constitutional amendment (Amendment 10, stated that the assessed value of any property with a Homestead Exemption would be capped at 3% or the consumer price index, CPI, whichever is less, after 1996) also provided an extra incentive to ensure that the appraisal accurately reflected the value of the property.

The selected variables in this dataset are: building value, property address, tax bill mailing address, housing type (County Land Use Code, CLUC), number of bedrooms, number of bathrooms, number of half baths, building year, sale date (up to 3 records each year), and floor area from 1992 to 1996. The cases used in this research include only the records of single family dwellings, duplexes, and apartment buildings because they have building value data to reflect the housing recovery trajectory after Hurricane Andrew. Cluster homes, condominiums, and townhouses only have total values, not separate building values. Total value of a property includes land value, so it cannot provide an accurate housing recovery trajectory.

The neighborhood socioeconomic characteristics have been extracted from 1990

Census Summary Tape File 1 (STF1, 100-percent data) and Summary Tape File 3 (STF3, sample data) via American FactFinder. Census data are aggregated at different geographic levels, among which block, block group, and tract are the spatial units below the county level. On average, there are about 15 single family dwellings within a block. Although the block is the smallest census data level, many important characteristics such as household income and Hispanic data are unavailable at this level. A block group comprises one to dozens of adjacent blocks, for average of about 28 blocks per block group in south Miami-Dade. The block group data might not capture household characteristics as well as the block data, but socioeconomic data are more plentiful at block group level than block level. The tract is the largest geographic unit among these three levels, but it is too coarse to apply in this research (an average of about 3.5 block groups per tract in south Miami-Dade County).

The 1990 Census has a 2-year time lapse from the time of Hurricane Andrew's impact, which is important because several demographic changes occurred from 1990 to 1992. However, interpolating 1990 and 2000 Census data cannot appropriately estimate 1992 socioeconomic characteristics because dramatic demographic changes after Hurricane Andrew have been confirmed by disaster research (Smith 1996; Smith and McCarty 1996; Morrow and Peacock 1997). In addition, many factors related to the capability to mobilize housing recovery resources were predetermined by the socioeconomic status one or two years before Hurricane Andrew. For example, property insurance underwritten before Hurricane Andrew had a relationship with socioeconomic characteristics before the event. The application for a SBA loan might use data one or two years before the event, but not data after the event to evaluate the ability to repay. Therefore, the 1990 Census data are more appropriate for modeling housing recovery.

In summary, the data used in this research are at the block group level, including the total population (P001), race (P006), Hispanic origin (P009), Hispanic origin by race (P010), and median household income in 1989 (P080A). Race/ethnicity data (P006, P009, P010) are recalculated as non-Hispanic Black, Hispanic, and other according to the proportion in that block group. The majority of the GIS layers are from the FIU Library Geographic Information Systems and Remote Sensing Center. The GIS layers include property centroid, road network, and 1990 Census block and block group boundaries.

The property central points south of Kendall Drive (SW 88th Street, extending to Key Biscayne) were selected and spatially linked with the corresponding block group boundaries to create a property block group look-up table by using ArcGIS 9. The property block group look-up table is then used in SPSS to merge the census variables with the property appraisal data.

In order to differentiate owner-occupied status from renter-occupied, second, or vacant homes, the property address and tax bill mailing address are compared. If both of the addresses are the same (minor differences were tolerated, e.g. Street vs. St.) in the same year, then the record is coded as owner-occupied. The sale dates are calculated and reorganized into the number of sales from August of the previous year to July of the current year. For example, the variable, 1993 sales, represents the number of sales one year after Hurricane Andrew, which is the number of sales from August 1992 to July

1993.

CLUC (the county land use code) does not always indicate that an actual structure exists on the parcel. For example, a parcel classified as 0001 (single family home) might be a single family home, a home under construction with only a foundation in place, or an empty parcel designated as for single family occupancy. These cases are, of course, not relevant for the research purpose. Parcels were assumed to have a structure on them if they had: 1) a 1992 building value equal to or greater than $5,000, 2) a number of bedrooms equal to or greater than one for single family homes, equal to or greater than two for duplexes, and equal to or greater than three for apartment buildings, 3) a number of baths equal to or greater than one for single family homes, equal to or greater than two for duplexes, and equal to or greater than three for apartment buildings, 4) a floor area equal to or greater than 500 square feet. In addition, the cases should remain the same use type from 1992 to 1996. However, vacant status is allowed because vacant land is not unusual during housing reconstruction. The cases with a significant housing type change are excluded (e.g. changing from single family home to office).

In summary, the unit of analysis of this research is the building structure. Only single family home, duplex, apartment building cases and appraisal data from 1992 to 1996 were used in this research. The cases that cannot meet the minimum criterion of having a real structure and the cases with significant land use type change were also excluded. The 1990 Census data at the block group level were imputed to each case to represent neighborhood characteristics.

3.2.3 Variables

Dependent variables

Because of the timing of property appraisal (the first half of each year), the 1992 value represents the housing state 8 to 2 months before Hurricane Andrew (August 1992), the 1993 value represents the housing state 5 to 10 months after event, the 1994 value 17 to 22 months after the event, the 1995 value 29 to 34 months after the event, and the 1993 value 41 to 46 months after the event.

Assessed building values are positive skewed, so a log transformation is adopted to induce a normal distribution in the dependent variable. In addition, the logarithm transformation of dependent variable provides either a semi-elasticity model (for ordinary independent variable, e.g. $\ln(y) = \beta_0 + \beta_1 x$) or a constant elasticity model (for logarithmic independent variable, e.g. $\ln(y) = \beta_0 + \beta_1 \ln(x)$). In a semi-elasticity model, the coefficient of an independent variable indicates the percent change in the dependent variable corresponding to one unit change in the explanatory variable. In a constant elasticity model, the coefficient of an independent variable shows the percent change in dependent variable corresponding to 1% change in the explanatory variable.

Independent variables

The independent variables consist of two major categories: housing characteristics at structure level and neighborhood socioeconomic characteristics at block group level. The housing characteristics such as size, which will be measured by either number of bedrooms and number of bathrooms, or log square footage (for apartment analysis), and building age in 1992 will serve as control variables. Additional housing characteristics that are of theoretical significance include tenure status (1 for owner-occupied, 0 for renter-occupied) and number of sales in each year to examine their effects on housing recovery value change. Damage percentage is calculated by subtracting 1993 building values from 1992 building values and then divided by 1992 building values (100 * (1992 values – 1993 values) / 1992 values) to assess its impact on different types of housing. A housing type variable is created for type comparison. For apartment analysis, cases are categorized as tri/four-plex (3 to 4 units), small apartment (5 to 10 units), mid-size apartment (11 to 50 units), and large apartment (51 and more units) to facilitate apartment size comparison.

Table 3.1 List of Explanatory Variables

Variable	Description	Time	Source	Level
bedrm	Bedroom number	92	Tax	Structure
bath	Bathroom number (full bath=1, half bath=0.5)	92	Tax	Structure
lnbldsqft	Natural log of building square footage	92	Tax	Structure
bldage	Building age in 1992	92	Tax	Structure
own	Homeownership. Owner=1, otherwise, 0	92-96	Tax	Structure
n_sale	Number of sale transactions	93-96	Tax	Structure
MHHIncmK	Median household income in 1989	90	Census	Blk. Gp
bg_p_wt	Anglo proportion in the block gp	90	Census	Blk. Gp
bg_p_blk	Non-Hispanic Black percentage in the block gp	90	Census	Blk. Gp
bg_p_his	Hispanic percentage in the block gp	90	Census	Blk. Gp
bg_p_oth	Other race percentage in the block gp	90	Census	Blk. Gp
dmg	Building damage percentage (1993 building value / 1992 building value)	93	Tax	Structure

Note: 1. Tax: Property appraisal data; Census: 1990 Census; Blk Gp: block group.
2. 1990 Census sample data asked 1989 household income.

Block group level data include median household income, percentage of Anglo, percentage of non-Hispanic Black, percentage of Hispanics, and percentage of other races. Block group median household income is used to reflect neighborhood socioeconomic (it also captures part of the household financial characteristics) for housing type comparison control. It is also employed to examine Hypothesis 2. The percentages of Anglo, non-Hispanic Black, Hispanic, and other races cover 100 % of the race/ethnicity composition of the block group. Like median household income data, race/ethnicity composition data are applied for housing type comparison and the Hypothesis 3 test. The details of the independent variables are listed in Table 3.1.

3.2.4 Single family, duplex, and apartment building characteristics before Hurricane Andrew and damage due to Hurricane Andrew

Single family homes, duplexes, and apartment buildings in south Miami-Dade County, Florida, had different spatial patterns and different neighborhood characteristics before Hurricane Andrew. In general, single family homes were widespread and dominated the residential landscape in south Miami except for Hammocks, Country Walk, Three Lakes, and West Perrine (Figure 3.5). Duplexes were relatively clustered in Homestead, Florida City, West Perrine, and the vicinity of South Dixie Highway (Figure 3.6), although some duplexes were located in ordinary neighborhoods. Apartment buildings were clustered in Homestead, Florida City, and the vicinity of South Dixie Highway and Kendall Drive (Figure 3.7). In addition, the average sizes of apartment buildings in Homestead (12.55 units) and Florida City (7.10 units) were smaller than the average size of apartment buildings in the remainder of the areas (70.50 units) and overall average size (34.21 units, S.D 79.25 units).

In general, apartment buildings had more bedrooms and bathrooms, larger square footage, and higher building values, but had lower building values per square foot than single family homes and duplexes. On average, single family homes were 2,041 ft^2 with 3.3 bedrooms and 2.0 bathrooms, duplexes were 1,969 ft^2 with 4.2 bedrooms and 2.5 bathrooms, and apartment buildings were 26,969 ft^2 with 51.1 bedrooms and 41.4 bathrooms (Table 3.1). Although single family homes had fewer bedrooms and bathrooms than duplexes, they had similar floor areas and higher building values. In terms of average building age, single family homes (24.0 years old) were newer than duplexes (30.7 years old) and apartment buildings (30.5 years old). The building values for single family homes, duplexes, and apartment buildings were, as might be expected, very different, with the average single family homes being valued at $63,085, duplexes at $44,937, and apartment buildings at $662,512 in 1992. Single family homes also had a distinct ownership pattern from duplexes, where 90% of single family homes were owner-occupied, but only 30% of duplexes were owner-occupied.

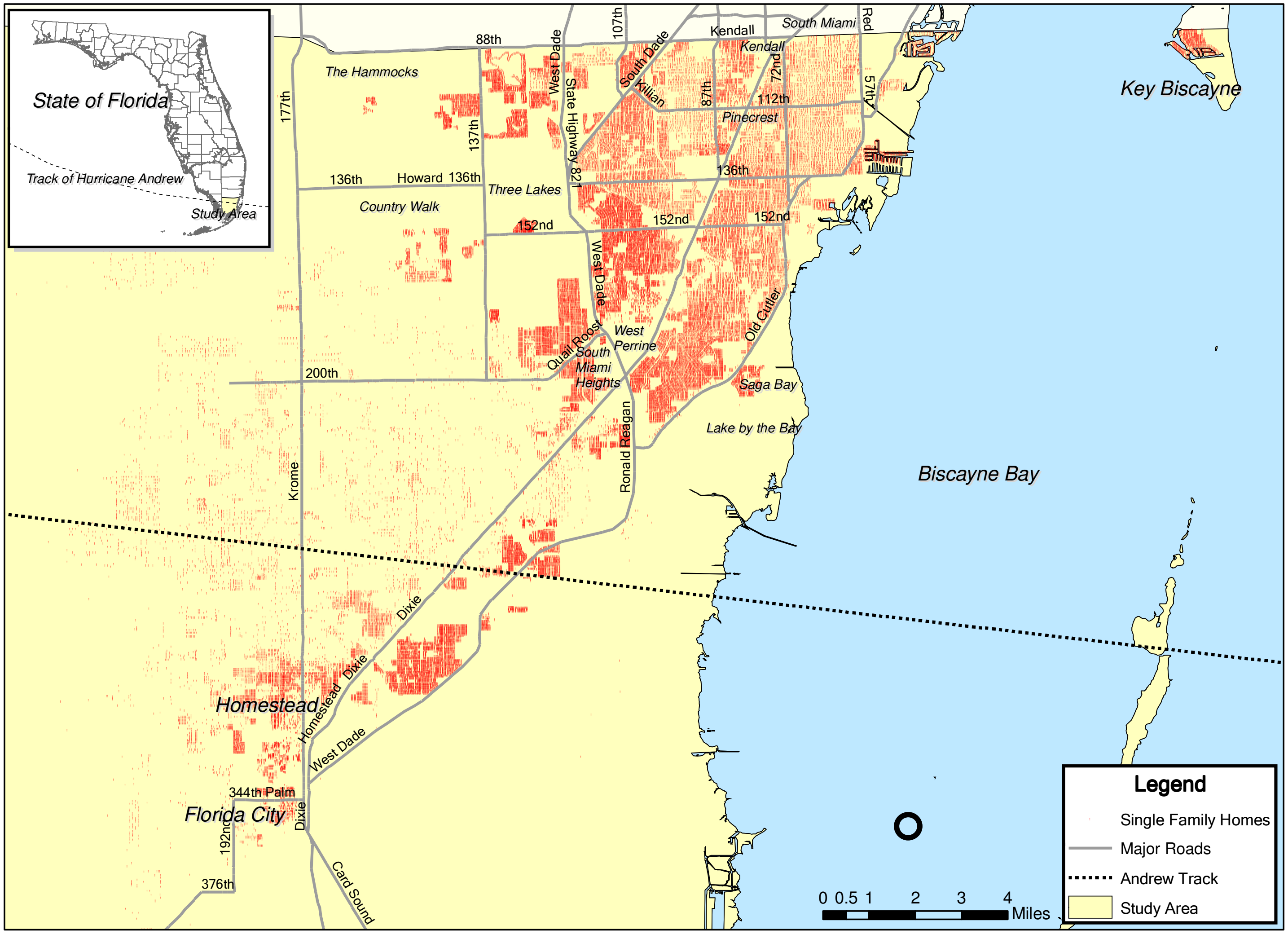

Figure 3.5 Spatial Pattern of Single Family Housing in South Miami-Dade County, Florida

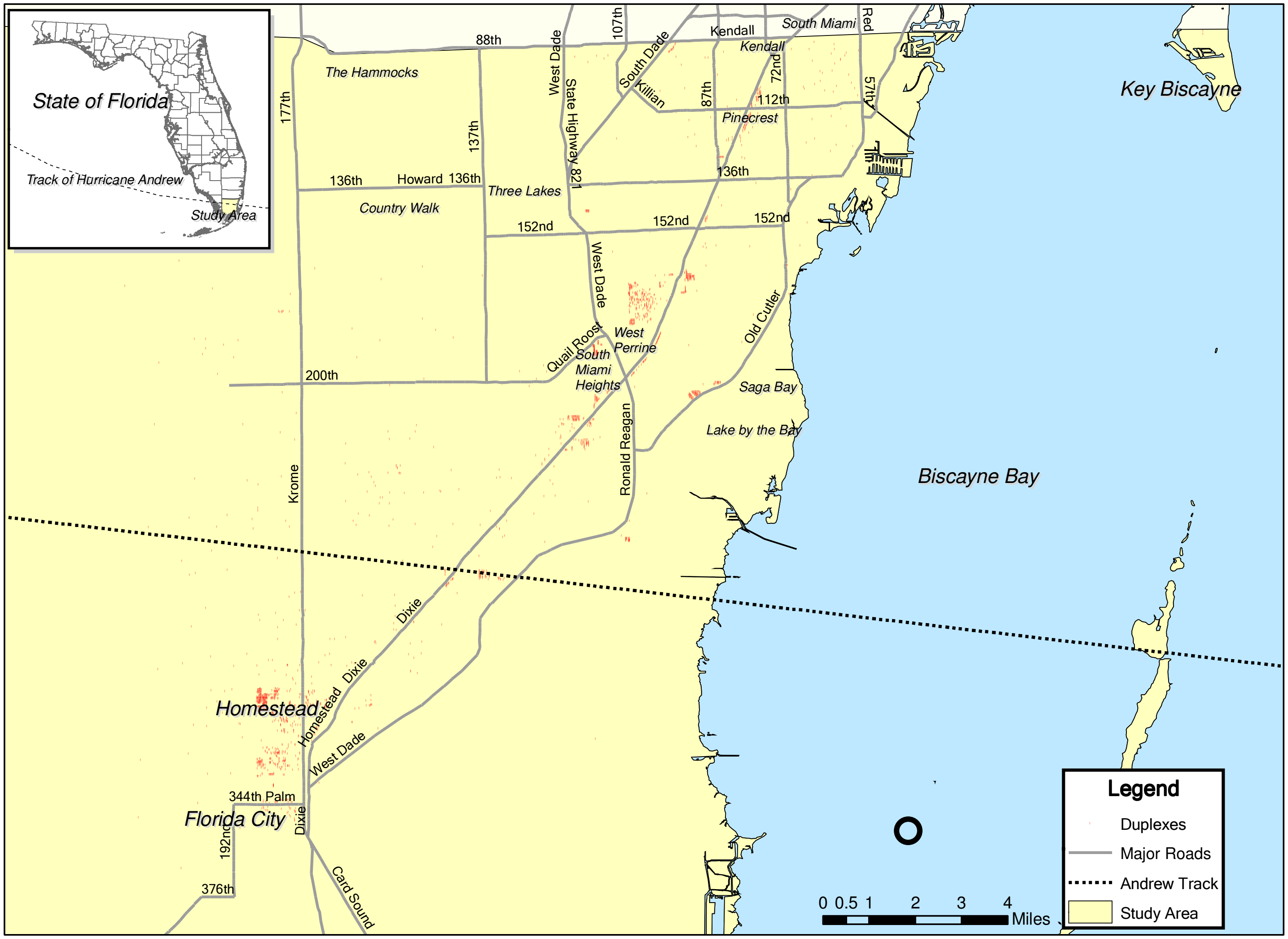

Figure 3.6 Spatial Pattern of Duplex in South Miami-Dade County, Florida

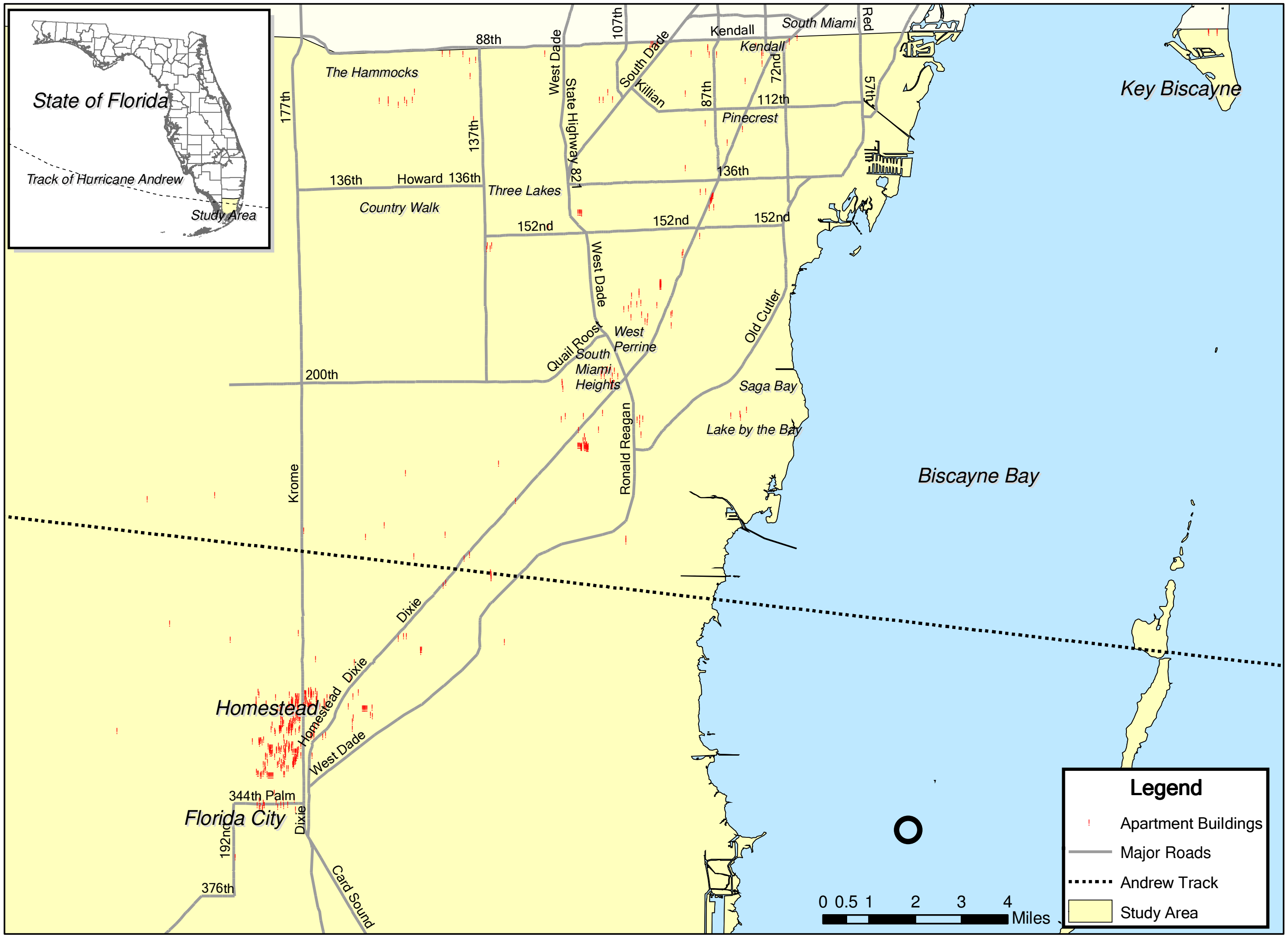

Figure 3.7 Spatial Pattern of Apartment in South Miami-Dade County, Florida

Table 3.2 Descriptive Statistics of Pre-Hurricane Andrew Housing and Neighborhood Characteristics by Housing Type

		Single Family (n = 60299)	Duplex (n = 1746)	Apartment (n = 546)
Building Value (K)	Mean	63.09	44.94	662.51
	S.D.	58.20	38.47	1875.93
	Min.	0.50	5.76	6.79
	Max.	1358.29	1048.68	14107.54
Bedrooms	Mean	3.31	4.18	51.06
	S.D.	0.75	1.21	123.09
	Min.	1.00	2.00	3.00
	Max.	10.00	14.00	1200.00
Bathrooms	Mean	1.99	2.45	41.38
	S.D.	0.70	0.83	104.16
	Min.	1.00	2.00	3.00
	Max.	9.00	11.00	846.00
Building SQ Footage (K)	Mean	2.04	1.97	26.97
	S.D.	0.93	0.94	66.88
	Min.	0.51	0.60	0.85
	Max.	15.76	12.66	468.91
Building Age	Mean	23.97	30.74	30.53
	S.D.	11.77	14.21	13.82
	Min.	1.00	2.00	2.00
	Max.	92.00	83.00	86.00
Tenure (Owner=1)	Mean	0.90	0.30	
	S.D.	0.30	0.46	
	Min.	0.00	0.00	
	Max.	1.00	1.00	
Med. Household Income (K)	Mean	46.33	29.88	21.16
	S.D.	22.20	20.16	12.28
	Min.	5.00	0.00	5.00
	Max.	150.00	150.00	83.32
Anglo (%)	Mean	54.01	38.46	27.87
	S.D.	23.52	28.27	24.35
	Min.	0.27	0.27	0.27
	Max.	94.83	92.28	94.83
Non Hispanic Black (%)	Mean	16.66	33.50	39.63
	S.D.	22.99	34.56	35.15
	Min.	0.00	0.00	0.00
	Max.	99.06	99.06	99.06

Table 3.2 Continued

		Single Family (n = 60299)	Duplex (n = 1746)	Apartment (n = 546)
Hispanic (%)	Mean	26.86	26.57	31.37
	S.D.	15.64	18.22	19.62
	Min.	0.67	0.67	0.67
	Max.	68.00	68.00	68.00
Other (%)	Mean	2.47	1.48	1.14
	S.D.	1.77	1.42	1.12
	Min.	0.00	0.00	0.00
	Max.	21.37	21.37	8.43
Damage (%)	Mean	53.86	60.24	56.80
	S.D.	36.93	34.64	36.10
	Min.	0.00	0.00	0.00
	Max.	100.00	100.00	100.00

The neighborhood characteristics of single family homes, duplexes, and apartment buildings are also quite different. The average neighborhood median household incomes were $46,335, $29,885, and $21,160 for single family homes, duplexes, and apartment buildings, respectively. The average neighborhood race/ethnicity percentage for single family homes were 54% Anglo, 17% non-Hispanic Black, 27% Hispanics, and 2% other races. The neighborhood race/ethnicity proportions for duplexes were 38% Anglo, 34% non-Hispanic Black, 27% Hispanics, and 1% other races. Apartment buildings were located in neighborhoods with a greater proportion of minorities. The average race/ethnicity proportions were 28% Anglo, 40% non-Hispanic Black, 31% Hispanics, and 1% other races. These distinctive statistics suggest that single family homes were inclined to be located in high income, predominately Anglo neighborhoods; on the other hand, duplexes and apartment buildings were more common in low income, predominately minority neighborhoods.

On average, damage from Hurricane Andrew created a loss of 53.9% of building value in single family homes. Duplexes had the greatest damage levels, 60.2%, and apartment buildings had an average building value loss of 56.8%.

3.3 ANALYTIC METHODS

Three data analysis steps are encompassed in this research. The first step compares the average building values of single family homes, duplexes, and apartment buildings for every year from 1992 to 1996. In addition, the percentages of housing that had not reached recovery level are also calculated. This analysis provides an initial pattern of housing damage and recovery pattern for each housing type.

The second step analyzes the correlations between the independent variables and the dependent variables. This analysis offers preliminary information about how each independent variable correlated with building value through time. The correlation table also reveals the relationships between damage and other independent variables.

The third step adopts a series of random effect panel models to assess the yearly change in building value under the control of independent variables and examines the effects of independent variables on building value through the analysis time frame (1992 to 1996). Robust standard error estimation is applied to adjust for heteroskedasticity and use of structure and neighborhood level variables. The general models are:

$$\ln(\text{bld vl})_{it} = \beta_0 + \Sigma\beta_j \, Y_{jit} + \Sigma\beta_k \, H_{kit} + \Sigma\beta_l \, N_{lit} + \nu_{it} \qquad [1]$$

$$\ln(\text{bld vl})_{it} = \beta_0 + \Sigma\beta_j \, Y_{jit} + \Sigma\beta_k \, H_{kit} + \Sigma\beta_l \, N_{lit} + \Sigma Y_j \, (\Sigma\beta_m \, H_{kit} + \Sigma\beta_n \, N_{lit}) + \nu_{it} \qquad [2]$$

where the dependent variable, $\ln(\text{bld vl})_{it}$, is the natural log of the building value for building i in year t (1992 to 1996). Y_{jit} are the year dummy variables, 1 for the indicated year, 0 otherwise. β_j represent the partial regression coefficients after controlling other variables in year j. H_{kit} and N_{lit} are structure and neighborhood variables with coefficients β_k and β_l. Y_{jit} in model [2] represent the year dummy variables interacting with building and neighborhood variables with coefficients β_m and β_n reflecting their differential effects from the base year (1992). Error term ν_{it} is a composite error term including the unobserved effect a_i inherent in dependent variable through time and a unique error component u_{it}.

Model [1] is a design for providing a concise effect for housing recovery trajectory (change of building value) and explanatory variable effects through time for each specific housing type. Model [2] applies year--explanatory variable interaction terms to provide more information about yearly effects of the explanatory variables in each housing type. The detail of these models and the explanation of coefficients will be discussed in Chapters IV and V.

CHAPTER IV

COMPARISON OF HOUSING RECOVERY BY BUILDING TYPE

4.1 AVERAGE VALUE CHANGE AND INTERCORRELATION ANALYSES

4.1.1 Average building value change after Hurricane Andrew

Tables 4.1, 4.2, and 4.3 present the average building value, absolute and percentage loss or gain relative to 1992, and the percentages of housing that have not reached pre-disaster building value for all structure types. The average building value of all structure types dropped precipitously between the 1992 appraisal (2-8 months before Hurricane Andrew) and the 1993 appraisal (5-10 months after Hurricane Andrew). This dramatic drop in value represents the damage caused by Hurricane Andrew. The average building value of single family homes dropped from $63,112 to $33,958 (46.2% decrease), with nearly all (98.6%) of single family homes suffering some degree of damage. The average building value of duplexes had a greater proportional decrease (54.9%), from their 1992 value of $44,937 to their 1993 value of $20,283. Similar to single family homes, nearly all (98.7%) duplexes suffered varied damage. The average building value of apartment buildings declined from $662,512 to $321,304 (51.5% decrease), and again, 98.0% of apartment buildings suffered damage.

Table 4.1 Average Single Family Housing Value before and after Hurricane Andrew

	92	93	94	95	96
Avg. Value	63112	33958	63338	67992	72336
Loss/Gain		-29154	225	4880	9224
% Loss/Gain		-46.2%	0.4%	7.7%	14.6%
Avg. of % Loss/Gain		-53.5%	1.9%	9.2%	17.9%
% of Housing Units Below 92		98.6%	29.6%	18.8%	14.1%

Table 4.2 Average Duplex Housing Value before and after Hurricane Andrew

	92	93	94	95	96
Avg. Value	44937	20282	40622	43717	45324
Loss/Gain		-24655	-4315	-1219	388
% Loss/Gain		-54.9%	-9.6%	-2.7%	0.9%
Avg. of % Loss/Gain		-60.2%	-12.4%	-4.6%	-1.9%
% of Housing Units Below 92		98.7%	40.4%	32.9%	30.4%

Table 4.3 Average Multifamily Housing Value before and after Hurricane Andrew

	92	93	94	95	96
Avg. Value	662512	321304	574325	670363	714854
Loss/Gain		-341207	-88187	7852	52343
% Loss/Gain		-51.5%	-13.3%	1.2%	7.9%
Avg. of % Loss/Gain		-56.7%	-6.5%	13.4%	16.2%
% of Structure Below 92		98.0%	48.9%	24.4%	23.3%
% of Housing Units Below 92		95.3%	47.2%	24.6%	22.8%

By the 1994 appraisal (17-22 months after Hurricane Andrew), the average building value of single family homes returned and slightly exceeded the average pre-disaster value by $168, yielding an average of $63,338. It is important to note that average value can be influenced by extreme cases, especially given the skewed building value distribution. While the average 1994 value suggests that the “average” home has met or exceeded its 1992 value and hence is recovered, it must be interpreted with caution since this could reflect the fast restoration and improvement of expensive housing and yet hide the sluggish recovery of ordinary housing. Indeed, 29.6% of single family homes had not yet reached pre-disaster building value even though the average building value had reached pre-disaster level in 1994. The recovery trend of duplexes and apartment buildings was relatively sluggish when compared to single family homes. In 1994, the average building value for duplexes was $40,622, while it was still $4,315 or 9.6% less than the 1992 average. The 1994 apartment average was $574,325, again $88,187 or 13.3% less than the 1992 value. In addition, compared to single family homes, a much greater proportion of duplexes and apartment buildings was still below pre-disaster building values in 1994-- 40.4% for duplexes and 48.9% for apartment buildings.

In 1995 (29-34 months after Hurricane Andrew), the average building value of single family homes had a $4,880, or 7.7%, gain when compared to the 1992 appraisal. However, one still finds that 18.8% of single family homes had not yet reached their pre-disaster values. The average building value of apartment buildings had exceeded pre-disaster levels, with a $7,852 (1.2%) gain in 1995 when compared to 1992, but the average building value of duplexes was still $1,219 (2.7%) below pre-disaster level. It is important to note that 32.9% of duplexes and 24.4% of apartment buildings had building values below their 1992 levels.

In 1996 (41-46 months after Hurricane Andrew), single family homes displayed the greatest gains ($9,224, 14.6%) over the 1992 values of these three housing types.

Apartment buildings were in the middle, displaying a 7.9% ($52,343) average building value increase over 1992. Duplexes had the lowest average building increase, registering only a 0.9% ($388) value gain by 1996[1]. Although all of the average building values of single family homes, duplexes, and apartment buildings exceeded pre-disaster levels in 1996, one still finds that 14.1% of single family homes, 30.4% of duplexes, and 23.3% of apartment buildings had not reached their pre-disaster building value.

These value change patterns before and after Hurricane Andrew tentatively indicate that, in general, single family homes had a more rapid recovery than duplexes and apartment buildings. However, before Hurricane Andrew, these three housing types had different building configurations and were located in neighborhoods with different social networks and social capital. If these factors are controlled, do we still see the difference among housing types in terms of housing recovery? How do other known vulnerability factors influence the recovery of single family homes, duplexes, and apartment buildings?

4.1.2 Factors associated with building value and damage

Building value

Tables 4.4, 4.5, and 4.6 present the correlation tables of major variables for single family homes, duplexes, and apartment buildings. Numbers of bedrooms, baths, and building square footage have a positive correlation with log building value. Housing variables (number of bedrooms, bathrooms, and log building square footage) were highly correlated with log building values before the disaster (1992), but the magnitude

[1] The 1996 losses/gains calculated by averaging proportional loss/gain of each structure in 1996 are also statistically different among single family homes, duplexes, and apartment buildings.

of their correlations attenuated after 1993. This is to be anticipated because of extensive housing damage after Hurricane Andrew. It is consistent with expectations that building age has a negative relationship with log building value in these three types of housing because older housing tend to have building value depreciation.

Owner-occupied status has a negative correlation with log building value. The stronger correlations in single family housing from 1994- 1996 indicate that owner-occupied housing experienced greater value gains; however, the lower 1994 to 1996 coefficients when compared to the 1992 coefficient in the duplex table show that the overall effect of tenure status on housing recovery is weaker in duplexes. Sales have a negative correlation with log building values in single family housing, especially after Hurricane Andrew. This suggests that post-disaster sales delayed housing recovery in single family housing. However, there is no significant relationship between sales and log building values for duplexes[2]. For apartments, sales have a positive correlation with the log value before disaster and a negative correlation with the 1995 log value[3]. The negative correlation suggests that housing recovery for apartment buildings with sales was slower in 1995.

In terms of neighborhood factors, income has a positive relationship with log building value in all housing types. This result fits the general experience because as noted earlier homes in wealthy neighborhoods tend to be larger, more decorated, and better maintained, therefore have higher building values. Anglo percentage has a positive

---

[2] On average, duplexes had 0.02 less sales in 1992, 0.06 less sales in 1993, 0.03 more sales in 1994, and no statistical difference in 1995 and 1996 when compared to the number of sales in single family housing.
[3] The numbers of sales of single family homes and apartment buildings have no statistical difference except 1995, in which apartment building had 0.04 more sales than single family homes.

correlation and non-Hispanic Black percentage has a negative correlation with log building values throughout all the years in these three types of housing. This is consistent because race is also correlated with income in the U.S., where Anglos tend to be more affluent than Blacks. In general, housing values for all housing types in predominately Anglo neighborhoods are greater than those in predominately non-Hispanic Black neighborhoods. Neighborhood Hispanic percentage has a different correlation with building value for different housing types. The weak negative correlations in single family housing suggest single family housing in Hispanic neighborhoods had lower value. For duplexes, no correlation before the hurricane and a positive correlation post-event indicate that, in general, duplexes in Hispanic neighborhoods gained value more after the hurricane. The positive correlations in apartment buildings show that apartment buildings in Hispanic neighborhoods had greater building values. Neighborhood other races percentage had positive correlations in these housing types. A general attenuation was observed in the relationships between neighborhood characteristics and building value, excepting Hispanic percentage and building value for duplexes. This suggests increasing heterogeneity of building values within neighborhoods right after the hurricane and decreasing heterogeneity afterward.

Table 4.4 Correlation Table of Major Variables, Single Family Homes

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1.	ln 92 bld vl																
2.	ln 93 bld vl	.54**															
3.	ln 94 bld vl	.52**	.43**														
4.	ln 95 bld vl	.59**	.40**	.75**													
5.	ln 96 bld vl	.60**	.39**	.68**	.87**												
6.	Room	.60**	.26**	.31**	.36**	.37**											
7.	Bath	.76**	.40**	.38**	.43**	.44**	.65**										
8.	ln bld sq ft	.94**	.53**	.47**	.54**	.55**	.60**	.75**									
9.	Bld age	-.49**	-.06**	-.27**	-.32**	-.34**	-.34**	-.33**	-.33**								
10.	Tenure	.16**	.14**	.21**	.22**	.21**	.13**	.10**	.16**	-.10**							
11.	Sale	-.02**	-.07**	-.09**	-.06**	-.03**	-.03**	-.01**	-.03**	-.03**	-.16**						
12.	Income	.57**	.42**	.30**	.33**	.34**	.33**	.50**	.60**	-.08**	.11**	-.02**					
13.	Anglo	.45**	.34**	.24**	.27**	.28**	.17**	.35**	.50**	-.04**	.08**	.02**	.59**				
14.	Non-His Blk	-.40**	-.31**	-.22**	-.26**	-.27**	-.15**	-.30**	-.42**	.17**	-.07**	-.03**	-.46**	-.77**			
15.	Hispanic	-.10**	-.08**	-.05**	-.03**	-.04**	-.05**	-.10**	-.15**	-.16**	-.02**	.02**	-.22**	-.38**	-.30**		
16.	Other race	.13**	.10**	.08**	.09**	.10**	.06**	.10**	.12**	-.22**	.04**	.02**	.06**	.03**	-.19**	.11**	
17.	Damage	-.28**	-.87**	-.29**	-.25**	-.23**	-.11**	-.22**	-.31**	-.09**	-.10**	.08**	-.32**	-.23**	.24**	.01**	-.08**

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Table 4.5 Correlation Table of Major Variables, Duplexes

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1.	ln 92 bld vl																
2.	ln 93 bld vl	.38**															
3.	ln 94 bld vl	.44**	.51**														
4.	ln 95 bld vl	.46**	.45**	.84**													
5.	ln 96 bld vl	.47**	.42**	.77**	.91**												
6.	Room	.53**	.16**	.20**	.22**	.26**											
7.	Bath	.62**	.20**	.22**	.25**	.25**	.57**										
8.	ln bld sq ft	.76**	.31**	.35**	.37**	.38**	.50**	.59**									
9.	Bld age	-.43**	-.23**	-.29**	-.34**	-.33**	-.26**	-.18**	-.15**								
10.	Tenure	.26**	.11**	.16**	.14**	.16**	.04	.20**	.29**	.19**							
11.	Sale	.04	.00	.00	-.03	.00	-.01	.04	.04	-.01	.03						
12.	Income	.50**	.27**	.24**	.23**	.22**	.15**	.40**	.44**	-.01	.31**	.06*					
13.	Anglo	.51**	.24**	.29**	.28**	.30**	.14**	.33**	.47**	.00	.30**	.08**	.72**				
14.	Non-His Blk	-.45**	-.27**	-.32**	-.31**	-.33**	-.07**	-.25**	-.40**	.04	-.24**	-.11**	-.54**	-.85**			
15.	Hispanic	.04	.13**	.14**	.13**	.14**	-.09**	-.06*	.01	-.05*	-.02	.09**	-.12**	.03	-.55**		
16.	Other race	.27**	.09**	.14**	.16**	.16**	.04	.17**	.19**	-.18**	.11**	.04	.42**	.34**	-.34**	.04	
17.	Damage	-.23**	-.79**	-.37**	-.30**	-.27**	-.07**	-.14**	-.20**	.06*	-.09**	-.03	-.30**	-.21**	.26**	-.16**	-.09**

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Table 4.6 Correlation Table of Major Variables, Apartment Buildings

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1.	ln 92 bld vl																
2.	ln 93 bld vl	.52**															
3.	ln 94 bld vl	.56**	.55**														
4.	ln 95 bld vl	.53**	.52**	.91**													
5.	ln 96 bld vl	.57**	.49**	.84**	.90**												
6.	Room	.77**	.42**	.40**	.39**	.41**											
7.	Bath	.77**	.44**	.41**	.39**	.41**	.98**										
8.	ln bld sq ft	.98**	.48**	.51**	.48**	.53**	.79**	.78**									
9.	Bld age	-.61**	-.47**	-.54**	-.48**	-.51**	-.41**	-.42**	-.53**								
10.	Tenure																
11.	Sale	.09*	.00	-.07	-.09*	-.03	.05	.06	.08	-.05							
12.	Income	.47**	.34**	.33**	.33**	.35**	.36**	.37**	.46**	-.20**		.01					
13.	Anglo	.38**	.27**	.25**	.26**	.29**	.19**	.20**	.35**	-.12**		.02	.70**				
14.	Non-His Blk	-.45**	-.29**	-.33**	-.33**	-.35**	-.24**	-.25**	-.41**	.24**		-.04	-.56**	-.84**			
15.	Hispanic	.30**	.17**	.25**	.25**	.25**	.17**	.17**	.26**	-.26**		.06	.09*	.23**	-.72**		
16.	Other race	.58**	.23**	.38**	.36**	.37**	.45**	.47**	.57**	-.31**		-.03	.66**	.54**	-.51**	.18**	
17.	Damage	.02	-.63**	-.28**	-.27**	-.23**	.00	-.02	.06	.03		.09*	-.23**	-.22**	.22**	-.12**	-.09*

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

The positive income-Anglo correlation (row 13 column 12) and negative income-Black correlation coefficients (row 14 column 13) in these three types of housing also confirm this income-race relationship in the U.S--Anglo neighborhoods tend to be more wealthy and Black neighborhoods are more likely to be poorer. Hispanic percentage has a different effect in single family and multifamily housing (duplexes and apartment buildings), being negative for single family and positive for multifamily housing. This indicates that Hispanic neighborhoods had less income in single family housing neighborhoods, but greater income in multifamily housing neighborhoods.

Damage

Proportional building damage in all building types was associated with several housing and neighborhood socioeconomic factors (Tables 4.4- 4.5). Single family homes and duplexes with lower building values, smaller building square footage, and renter-occupied status suffered greater proportional building damage. This correlation is consistent with the literature and probably occurred because housing with these characteristics tends to incorporate poorer building materials, substandard construction practices, lower standards of building codes, and less maintenance. Interestingly, the negative damage-building age coefficient in single family analysis implies that newer single family housing had greater proportional damage. This result is inconsistent with anticipation, but the track of Hurricane Andrew might explain this because it passed the newer single family housing developments. Unlike the pattern of single family homes or duplexes, proportional damage did not correlate with pre-disaster log building value, size (room, bath, and log building square footage), and building age in apartment building correlation analysis.

All building types in low income neighborhoods had higher proportional building damage due to the negative correlations. The damage- neighborhood Hispanic proportion correlation coefficients were inconsistent among building types. Single family homes had a very weak positive correlation, but duplexes and apartment buildings had negative correlation coefficients. The consistent negative damage-neighborhood Anglo proportion correlation coefficients and positive damage-neighborhood non-Hispanic Black proportion correlation coefficients also reveal distinctly different damage patterns in Anglo and non-Hispanic Black neighborhoods. Housing in predominately non-Hispanic Black neighborhoods tended to incur greater damage than housing in predominately Anglo neighborhoods.

These correlation analyses provide information about the overall relationship between log building values and explanatory variables. However, these results do not help us understand the impacts or effects specific independent variables had on building value through the impact and recovery period. The following sections utilize random effects panel models to compare the housing recovery trajectories of all these housing types and to examine the effects of explanatory variables on these housing trajectories.

4.2 HOUSING RECOVERY TRAJECTORY COMPARISON BY BASIC MODEL

4.2.1 Separated models and their results

The analysis of housing recovery for all these housing types will begin by examining the most basic model that simply assesses the loss and recovery trajectories of each housing type as captured by the average logged values from 1992 through 1996. Even though these analyses do not control other factors, it does provide a point of comparison for subsequent analyses. The layout of analytical models for theses housing types is:

$$\ln (BV)_{it} = \beta_0 + \delta_1 \, yr93_{it} + \delta_2 \, yr94_{it} + \delta_3 \, yr95_{it} + \delta_4 \, yr96_{it} + \nu_{it} \qquad [3]$$

where BV is building value, *i* indicates the building and *t* indicates year (1992 to 1996), yr93, yr94, yr95, and yr96 are the year dummy variables (1 for the given year, 0 otherwise). ν_{it} is the composite error term.

In this analytical model, β_0, the constant, represents the average log building value of 1992 and δ_1 represents the difference of average log building value between 1993 and 1992. In other words, the average 1993 log building value can be calculated by adding β_0 and δ_1. In the same way, the average 1994 log building value is $\beta_0 + \delta_2$, the average 1995 log building value is $\beta_0 + \delta_3$, and the average 1996 log building value is $\beta_0 + \delta_4$. Most important, each of the δ values is a semi-elasticity; hence $100(e^{\delta} - 1)$ represents the percent increase or decrease in average value of structures when compared to their 1992 value for each of the years 1993-1996. Table 4.7 presents three separate models for each type of housing along with the values for the respective coefficients, robust standard errors, and p values associated with δ_1 (yr93), δ_2 (yr94), δ_3 (yr95), δ_4 (yr96), and β_0 (1992, base year). The "R^2 within" indicates proportion of the within-group variance in the dependent variable, that is the log building value from 1992 to 1996 in each case, accounted for by the independent variables. The "R^2 between" indicates proportion of the between-group variance in the dependent variable, the difference of log building value between cases, accounted for by the independent variables. And finally, the "R^2 overall" indicates proportion of the total variance in the log building value accounted for by the independent variables in the model.

Table 4.7 Results of Basic Models

	Single Family			Duplex			Apartment		
ln (BV)	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	-1.6709	0.0071	0.000	-2.1477	0.0526	0.000	-2.0522	0.1084	0.000
yr94	-0.1899	0.0042	0.000	-0.8567	0.0451	0.000	-0.9738	0.0906	0.000
yr95	-0.0375	0.0035	0.000	-0.6271	0.0415	0.000	-0.8087	0.0966	0.000
yr96	0.0542	0.0035	0.000	-0.6599	0.0465	0.000	-0.8180	0.1052	0.000
β_0	10.8260	0.0032	0.000	10.5477	0.0385	0.000	11.6337	0.1039	0.000
R^2 within		0.3486			0.1980			0.1365	
R^2 between		0.0000			0.0000			0.0000	
R^2 overall		0.1872			0.0860			0.0454	

Single family model

The 1993 coefficient $\delta_1 = -1.6709$ in the single family model means that the 1993 average log building value decreased by 1.6709 when compared to the 1992 average building value, which represents a 81.2% loss in value. Obviously this decrease in value between 1992 and 1993 reflects the impact of Hurricane Andrew and is substantially higher than that estimate by simply comparing averages as was done in Table 4.1. It must be recalled that the percentage in Table 4.1 was the percent loss based on the average values, which are substantially influenced by extreme values in the housing distribution. Hence, estimates from Table 4.7 may well better capture the overall sense of loss experienced by "typical" buildings in the center of the distribution. The estimate for the 1994 coefficient δ_2 = -0.1899 is also negative but its magnitude is less than that of the 1993 (δ_1) coefficient. This suggests that in 1994 the average single family structure value was still less than in 1992, but it is now only 17.3% less. This finding suggests that substantial recovery was underway between 1993 and 1994 resulting in the average values substantially increasing as housing was nearing its pre-impact value. The value of the 1995 coefficient δ_3 = -0.0375, again remains negative, but is quite close to 0. This suggests that, on average, single family homes in 1995 had only 3.7% lower values than in 1992. While this value is statistically significant, it lacks practical significance. Thus, one can argue that recovery was substantially achieved, on average, by 1995. Furthermore, the estimate of the 1996 coefficient δ_4 = 0.0542 which is positive and indicates that the 1996 average assessed value was actually 5.6% higher than the 1992 value, implying that if indeed recovery had not occurred in 1995, it certainly had been exceeded for single family housing by 1996.

These results are again different from those attained by using simple average building values (Table 4.1), which suggested that pre-disaster levels, and hence recovery, was reached between 1994 and 1995. Nonetheless, as was also seen in Table 4.1, substantial proportions of housing had not yet reached pre-disaster levels in 1994 and 1995. This inconsistency is due to the different distribution patterns of building value and log building value. Methods employing average building value are sensitive to absolute value change, but methods using average log building value emphasize proportional change. More importantly, the averages for the level or normal values are highly sensitive to extremes in building values. As a result, highly valued homes, which research suggests will suffer less damage proportionally, will retain higher values. Also, the significant improvement of luxury properties after a disaster can make the average building values exceed the pre-disaster levels while at the same time a greater proportion of low-value housing may remain severely damaged and even uninhabitable. Hence, models using log building values may more accurately reflect the recovery process for the majority of structures.

In brief then, this analysis of single family homes suggests that there were major losses (81.2%) in the value of single family structures due to the destructive effects of Hurricane Andrew. However, during the year following Andrew, major gains, were made in the rebuilding efforts such that by 1994 average values were only 17.3% less than pre-event values. These gains in the value of single family structures reflect rebuilding and recovery efforts. By 1995, values were very nearly back to their pre-event levels with a difference of only 3.7% and by 1996 they were actually higher than pre-event values with an average gain of 5.6%.

Duplex model

A somewhat different picture emerges when examining the model for duplexes. The year 93 coefficient, -2.1477, indicates that duplexes lost just over 88% of their value due to the impact of Hurricane Andrew. That is, duplexes suffered slightly more damage than did single family structures. The value of the 1994 coefficient, δ_2 = -0.8567, indicates that in 1994 the average value of duplex structures was still 57.5% below its 1992 values.

In turn, this suggests that duplexes did not experience anywhere near the substantial recovery of value that was experienced among single family structures. Also unlike in the single family model, the 1995 coefficient (δ_3) of indicates that duplexes were still 46.6% below their 1992 value, suggesting very slow recovery trajectories for these structures, particularly when compared to single family homes. Indeed, the coefficient for 1996, δ_4 = -.6599, indicates that, on the whole, these structures were 48.3% lower than their 1992 value. This surprising drop in value from 1995 to 1996 may well reflect the further overall loss in value of these structures as some of these structures remained abandoned, and therefore suffered additional loss in value due to deterioration. It might also reflect the removal of the damaged remains of these structures as parcels were cleared of the remains of damaged and, possibly, abandoned structures.

On the whole, duplexes present a very different picture from single family dwellings. Duplexes lost just over 88% of their value due to Hurricane Andrew’s impact, a figure somewhat higher than the losses for single family homes. Furthermore, duplexes did gain back a good deal of their value, but in 1995 they were still nearly 58% below their 1992 value. This suggests rather modest recovery when compare to the quite considerable gains for single family structures. Even more interesting was the observation that from that point on, the gains were very limited, as indicated by flat recovery trajectories and even additional losses by 1996. Even 1996, duplexes had not achieved from Hurricane Andrew. This pattern is quite different from that of single family structures, which were nearly at recovery levels by 1995 and surpassed them by 1996.

Apartment model

The final model in Table 4.7 is for apartment complexes of all sizes. Overall, simply including dummy variables for each year accounts for 13.7% of the within variance, suggesting again that simply allowing the major changes across these years of hurricane impact and recovery processes captures a good deal of the variation of each observation from 1992 to 1996. The coefficient (δ_1) -2.0522, associated with the 1993 dummy variable indicates that apartment complexes lost just over 87% of their value due to hurricane Andrew's impact. This figure is again somewhat higher than that of single family structures, and quite comparable though slightly lower than the impact on duplexes. By 1994 apartment complexes had experienced some movement toward recovery. Specifically the 1994 coefficient, $\delta_2 = -0.9738$, suggests that some gains due to rebuilding and repairs had been made in that values were now only 62.2% below their 1992 values. Here again, as with duplexes, the gains were rather modest, particularly when compared to those experienced by single family structures. Nevertheless, some gains were being made on average. By 1995 modest gains continue, again indicating movement toward recovery is being registered. Specifically, the coefficient for the 1995 dummy variable, $\delta_3 = -0.8087$, suggests that apartment complexes were now at about 55.5% of their pre-Andrew levels. Clearly, this is not anywhere near the recovery levels that were experienced by single family structures and there were also somewhat lower than those of duplexes. Finally, the coefficient associated with the final year, 1996, $\delta_4 = -0.8180$, suggests that much like duplexes, apartment complexes actually lost ground. They fell slightly from their 1995 level to 55.9% of their 1992 values. As was the case for duplexes, this is probably due to damaged structures continuing to deteriorate if maintenance repairs were not made and other damaged structures being torn down. Anecdotal reports suggested that there were large apartment complexes that simply deteriorated behind fences cordoning them off from surrounding neighborhoods. They remained eyesores for years and filled the surrounding areas with the musty smell of mildew.

In conclusion, apartments had more damage than single family homes due to Hurricane Andrew and therefore suffered a greater proportional building value loss between 1992 and 1993. Apartments did experience a somewhat rapid jump in value between 1993 and 1994, suggesting repair and rebuilding effort were under way, but this was not as dramatic as the process made by duplexes and single family homes. Apartments continued movement toward recovery but at a slow pace between 1994 and 1995. Unlike single family homes, apartments did not reached pre-disaster level by 1996. Similar to duplexes, the heavily damaged apartments had a sluggish recovery process, even losing ground slightly between 1995 and 1996. On the whole, the apartment trajectory is quite similar to, but even slower, than that of duplexes.

4.2.2 Pooled model and its results

The separate models for each housing type clearly indicate that duplexes and apartments recovered at slower rates than did single family homes. However, strictly speaking, these models to not statistically test whether there are indeed differences in the recovery trajectories among the three different housing types. It could, of course, be argued that since the data are quite representative of the population of impacted structures in south Miami-Dade and the "sample" size is so large, that statistical testing is less critical than are overall assessments of the substantive differences reflected by the coefficients across models. The above analyses certainly suggest that there were quite substantial differences in the recovery trajectories among housing types, particularly when comparing duplexes and apartments to single family structures. Nevertheless, this section offers a formal test to assess if there are significant differences among types of housing.

Duplex and apartment dummy variables and duplex/apartment year interaction terms will be employed to conduct this test, which essentially is a test for heterogeneous year effects across housing types. In other words, the basic logic of this test is to assess whether or not allowing for differential effects of the year dummies across housing types significantly enhances the models.[4] This test can be performed in a variety of ways, but it essentially amounts to running two models, one with and one without a set of interaction terms that allow for the effects of the year dummies to vary across housing types and then determining if the interactions do indeed enhance the models performance[5]. The two models are:

---

[4] It might also be argued that this test should conducted by either 1) beginning with year dummies and then testing if the inclusion of housing type dummies enhances the model or alternatively 2) conducting a Chow-test for the inclusion of housing types dummy *and* interaction terms between housing type and year dummies. . This would truly test whether these subsamples should be "pooled" in the first place. However, the former would be a rather trival test in that it simply amounts to testing to see if there are value differences among single family, duplexes and apartment complexes, single family dwellings are self-evident. The latter would also test for differences in base values between housing types and differences in recovery trajectories. However, the critical question here is if there are differences in recovery trajectories. Hence including the trivial and self-evident test for value differences among structures at the same time as trajectory differences are tested would bias the test toward a significant finding. Therefore, the more conservative test, only for year interactions, is performed.

[5] This test is actually conducted by reforming a Wald test to determine if the combined set of added coefficients (the interaction terms) add significantly to the model.

$\ln (BV)_{it} = \beta_0 + \delta_1 Du + \delta_2 Apt + \delta_3\ yr93_{it} + \delta_4\ yr94_{it} + \delta_5\ yr95_{it} + \delta_6\ yr96_{it} + \nu_{it}$

[4]

$\ln (BV)_{it} = \beta 0 + \delta 1Du + \delta 2Apt + \delta 3\ yr93it + \delta 4\ yr94it + \delta 5\ yr95it + \delta 6\ yr96it + \delta 7(Du * yr93it) + \delta 8(Du * yr94it) + \delta 9(Du * yr95it) + \delta 10(Du * yr96it) + \delta 11(Apt * yr93it) + \delta 12(Apt * yr94it) + \delta 13(Apt * yr95it) + \delta 14(Apt * yr96it) + \nu it$ [5]

where *i* is for structure *i* and *t* is for year *t* (1992 to 1996), yr93, yr94, yr95, and yr96 are the year dummy variables (1 for the specified year, otherwise 0), Du and Apt are the housing type dummy variables for duplex and apartment structures respectively, and ν_{it} is the composite error term.

This test compares the trajectories of both duplexes and apartments to the single family structures, which is the excluded or comparison group. Hence, in addition to equations [4] and [5], a third model will also be run with apartments as the comparison (excluded) group, which will allow for an assessment of a difference between the recovery trajectories of duplexes and apartment buildings. That model is:

$\ln (BV)_{it} = \beta_0 + \delta_1 Du + \delta_2 Sf + \delta_3\ yr93_{it} + \delta_4\ yr94_{it} + \delta_5\ yr95_{it} + \delta_6\ yr96_{it} + \delta_7(Du * yr93_{it}) + \delta_8(Du * yr94_{it}) + \delta_9(Du * yr95_{it}) + \delta_{10}(Du * yr96_{it}) + \delta_{11}(Sf * yr93_{it}) + \delta_{12}(Sf * yr94_{it}) + \delta_{13}(Sf * yr95_{it}) + \delta_{14}(Sf * yr96_{it}) + \nu_{it}$ [6]

where SF is the housing type dummy variable for single family structures and the other variables are as defined above.

Table 4.8 reports the results for the basic model that combines all three housing types (see columns 1-3), the interaction model using single family dwelling as the comparison (see columns 4-6), and the interaction using apartments as the comparison (see columns 7-9). It is interesting to note that in the basic model (Table 4.8, columns 1-3) closely mirrors the results of the single family model in Table 4.7, which should not be surprising, since the vast majority of the observations in the model are single family structures. Nevertheless, on the whole, the results do suggest that, when considering all forms of structures together, on average most structures did indeed surpass their 1992 values by 1996, suggesting overall recovery levels have been reached. However, the results from both interaction models do confirm that the damage and recovery trajectories of apartments and duplexes were substantially and statistically significantly different from single family homes.

Table 4.8 Results of Pooled Basic Models

	Restricted Model			SF as Comparison			Apt. as Comparison		
ln(BV)	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
SF							-0.8077	0.0811	0.000
Du	-0.7678	0.0412	0.000	-0.2783	0.0348	0.000	-1.0860	0.0881	0.000
Apt	0.2460	0.0894	0.006	0.8077	0.0811	0.000			
yr93	-1.6875	0.0070	0.000	-1.6709	0.0071	0.000	-2.0522	0.1090	0.000
yr94	-0.2154	0.0044	0.000	-0.1899	0.0042	0.000	-0.9738	0.0948	0.000
yr95	-0.0606	0.0037	0.000	-0.0375	0.0035	0.000	-0.8087	0.1015	0.000
yr96	0.0267	0.0038	0.000	0.0542	0.0035	0.000	-0.8180	0.1103	0.000
sf_yr93							0.3814	0.1093	0.000
sf_yr94							0.7839	0.0949	0.000
sf_yr95							0.7712	0.1016	0.000
sf_yr96							0.8722	0.1104	0.000
du_yr93				-0.4769	0.0531	0.000	-0.0955	0.1211	0.430
du_yr94				-0.6668	0.0457	0.000	0.1171	0.1051	0.265
du_yr95				-0.5897	0.0419	0.000	0.1815	0.1098	0.098
du_yr96				-0.7141	0.0470	0.000	0.1581	0.1199	0.187
apt_yr93				-0.3814	0.1093	0.000			
apt _yr94				-0.7839	0.0949	0.000			
apt _yr95				-0.7712	0.1016	0.000			
apt _yr96				-0.8722	0.1104	0.000			
β_0	10.8445	0.0034	0.000	10.8260	0.0033	0.000	11.6337	0.0810	0.000
R^2 within		0.3337			0.3358			0.3358	
R^2 between		0.0140			0.0140			0.0140	
R^2 overall		0.1803			0.1813			0.1813	

Focusing on the second model (Table 4.8, columns 4-6), which compares the duplex and apartment recovery trajectories to those of single family homes, it should be noted that all of the year interaction terms for both duplexes and apartments are statistically significant. Indeed, the statistical test for the combined inclusion of these variables in the model was significant[6], suggesting that the recovery trajectories of both were statistically different from single family housing. More important, the magnitudes for both types (duplexes and apartments) of interactions terms are negative for all years. The negative interaction coefficients for 1993 for both duplexes (du_yr93 and apt_yr93) indicate that duplexes lost on average nearly 38% more than single family homes while apartments lost nearly 32% more. Most significantly, the rather large significant negative coefficients associated with the 1994, 1995, and 1996 indicate that both duplexes and apartment buildings had recovery trajectories significantly lower and slower than those of single family structures. Indeed the gap between each of these two housing types and single family homes was substantially higher in 1996 than it had been at any other point.

Figure 4.1 provides a graphical interpretation of these differences. It ignores the substantial differences in values between each housing type suggested by the type dummy coefficients and instead focuses on the year coefficients and changes in those coefficients through the period from 1993 to 1996. So, for example, the values indicated in 1993 are the year 1993 dummy coefficient (δ_1 -1.6709) for single family housing, the 1993 year dummy coefficient plus the duplex 1993 year dummy interaction coefficient ($\delta_1 + \delta_7$ or -1.6709 -.4769 = -2.1478) for duplexes, and the 1993 year dummy plus the apartment 1993 year dummy interaction coefficient ($\delta_1 + \delta_{11}$ = -1.6709 -.3814 = -2.0523) for apartments. The resulting trend lines clearly portray the rather substantial differences of single family recovery trajectories from those of duplexes and apartments. The single family structure again surpass the zero line, indicating gains and hence recovery by 1996,

---

6 The Wald test with 8 d.f. was 585.49 with a probability of far less than .001.

while the others languish substantially below recovery levels. Indeed, one can clearly see the dip taken by both multifamily and duplexes by 1996.

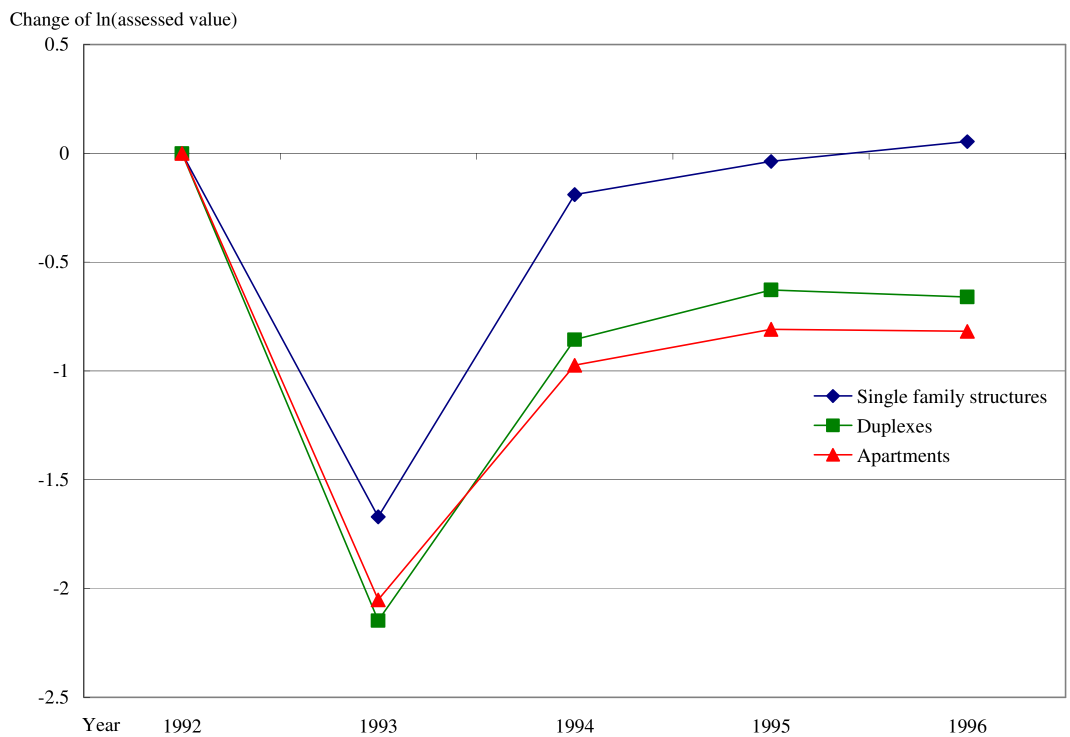

Figure 4.1 Housing Recovery Trajectories of Single Family Structures, Duplexes, and Apartments, Basic Model

The results portrayed in Figure 4.1 suggest that there may also be differences between duplexes and apartments (multi-family) structures as well, with the overall recovery trajectory of duplexes being slightly better than that of apartments. However, the results from the final model displayed in Table 4.8 suggest otherwise. Specifically the final model includes dummies for both single family and duplex structures, allowing for comparisons to be made to apartments. Of most significance in this model are the four non-significant duplex-year interaction terms. These non-significant coefficients suggest that there are no statistically significant differences between duplexes and apartments in the percent losses and gains over this period.

In conclusion, this pooled basic model demonstrates that duplexes and apartments experienced greater damage and recovered more sluggishly than single family homes. In addition, while single family homes continued improving and reached pre-disaster (recovery) levels between 1995 and 1996, the overall recovery of duplexes and apartments did not improve at comparable rates. Indeed, neither duplexes nor apartments reach, recovery levels by 1996. Furthermore, during the recovery period modeled in this analysis (1994-6), the recovery gap between single family and all multifamily (duplex and apartment) structures expanded. Lastly, because the recovery of multifamily structures stalled in 1996, there were not substantive differences between the recovery trajectories of duplexes and apartments.

4.3 HOUSING RECOVERY TRAJECTORY COMPARISON INCLUDING SOCIOECONOMIC FACTORS

In this section the recovery trajectories are modeled including a complement of socioeconomic variables and a set of housing control variables. These additional variables are composed of data on the structure itself and neighborhood level characteristics. The structure level factors include tenure status and the numbers of sales each year. The neighborhood (block group) level data include median household income in thousands of dollars and neighborhood race/ethnicity composition, indicating the proportions of Anglo, non-Hispanic Black, Hispanic, and other races. Of course, as noted earlier, an ideal model, would also include both household and neighborhood characteristics. Unfortunately household characteristics data were not available and could not be determined from the tax appraisal data. Hence, these neighborhood income and race/ethnicity data represent not only neighborhood influence but also some of the household income and race/ethnicity effects since the secondary structure level data are not available. In addition, numbers of bedrooms, baths, and building age in 1992 are also employed in these models as controls.

The analytical model for the three housing types is:

$$\ln(BV)_{it} = \beta_0 + \delta_1\, yr93_{it} + \delta_2\, yr94_{it} + \delta_3\, yr95_{it} + \delta_4\, yr96_{it} + \beta_5\, rooms_{it} + \beta_6\, baths_{it} + \beta_7\, bldage_{it} + \delta_8\, own_{it} + \beta_9\, sales_{it} + \beta_{10}\, income_{it} + \beta_{11}\, Black_{it} + \beta_{12}\, Hispanic_{it} + \beta_{13}\, other_{it} + \nu_{it} \quad [7]$$

where *i* indicates structure *i*,and *t* indicates is for year (1992 to 1996), yr93, yr94, yr95, and yr96 are the year dummy variables (1 for the specified year, otherwise, 0). Room is the number of bedrooms, bath is number of bathrooms (0.5 for half bath), bldage is building age at 1992, own is a dummy variable indicating owner occupied housing (1 for owner- occupied and 0 for renter- occupied), and income is median household income in thousands for the block group where the structure is located. The racial/ethnic composition of the block group in which a home is located is assessed in terms of the percentage of Black (non Hispanic Black), Anglo (non Hispanic, non Black, and non-other), Hispanic (regardless of racial identity) or other non-specified racial/ethnic groups. Since the sum of the percentage of these four groups sum to unity, only three categories can be included in a model simultaneously. Thus, the coefficients indicate differences from the excluded category. And finally, the ν_{it} is the composite error term.

In this analytical model, δ values are utilized to indicate a coefficient associated with a dummy or indicator variable and β's are employed for standard or regular continuous variables. Since the dependent variable is again the natural log of structure value, all of the coefficients can be interpreted as semi-elasticity, meaning that they can be interpreted as the proportion change (or percentage change if multiplied by 100) in structure value, given a unit change in the independent variable. However, this is an approximation; the technically correct percentage change should be computed as follows: $100(\text{Exp}(\beta) - 1)$ or $100(\text{Exp}(\delta) - 1)$. Finally, with the exception of the year dummies, these coefficients capture the overall effect of these variables through the impact and recovery period through 1996. For example, the coefficient associated with income estimates the net effects of income from through the entire impact and recovery period, from 1992 through 1996. Hence they are capturing the overall effect income has on the changes in a homes value throughout the period.

Table 4.9 presents the results from the housing recovery model with a full complement of socio-economic and control variable. Results for each of the three housing types are presented separately. The presentation of separate models is justified because analysis of a pooled model, allowing the effects of the socio-economic and control variables to vary among housing types, suggested that the processes were sufficiently different to run separate models for each housing type.[7] In each of separate models presented in Table 4.9, the proportion Anglo (white non-Hispanic) is excluded from the model, hence ethnic comparisons are in reference to this group. Moreover, the apartment model is also missing the "owner" occupied indicator variable, since category is meaningless in the context of apartment buildings.

Table 4.9 Results of Socioeconomic Control Models. Anglo as Base Group

	Single Family			Duplex			Apartment		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	-1.6510	0.0070	0.000	-2.1413	0.0534	0.000	-2.0160	0.1064	0.000
yr94	-0.1844	0.0042	0.000	-0.8651	0.0462	0.000	-0.9576	0.0887	0.000
yr95	-0.0299	0.0035	0.000	-0.6325	0.0426	0.000	-0.7815	0.0969	0.000
yr96	0.0610	0.0034	0.000	-0.6605	0.0466	0.000	-0.8089	0.1027	0.000
rooms	0.1175	0.0063	0.000	0.1745	0.0452	0.000	0.0017	0.0031	0.589
baths	0.4301	0.0069	0.000	0.1233	0.0510	0.016	0.0043	0.0036	0.230
bldage	-0.0117	0.0004	0.000	-0.0422	0.0037	0.000	-0.0768	0.0095	0.000
own occ.	0.4251	0.0120	0.000	0.3726	0.0582	0.000			
sales	-0.1244	0.0065	0.000	-0.0941	0.0553	0.089	-0.3532	0.1250	0.005
income (K)	0.0088	0.0002	0.000	0.0107	0.0022	0.000	0.0315	0.0105	0.003
Black (%)	-0.0066	0.0002	0.000	-0.0134	0.0018	0.000	-0.0102	0.0052	0.051
His. (%)	-0.0042	0.0003	0.000	0.0028	0.0026	0.289	0.0014	0.0076	0.858
Other (%)	0.0147	0.0022	0.000	-0.0616	0.0423	0.145	-0.0098	0.1457	0.946
β_0	9.2645	0.0275	0.000	10.8586	0.2823	0.000	13.4434	0.7269	0.000
R^2 within		0.3520			0.1981			0.1399	
R^2 between		0.4196			0.3144			0.5085	
R^2 overall		0.3833			0.2638			0.3861	

[7] A formal test again utilizing a pooled model with interaction terms allowing for differential effects across housing types was conducted to determine if the effects of the combined set of socio-economic and control variables were different among housing types. The results ($\chi 2$ = 8163.4, 25 *df*, and p<.0001) suggested that there are indeed statistically significant differences among housing types. These results are presented in Appendix 1.1.

On the whole these models perform substantially better than models in Table 4.8 with only dummy year indictor variables. When compared with the basic models (Table 4.7), the overall R^2 for the single family model increases from 18.72% to 38.33%. Not surprisingly, the majority of this gain is in accounting for variation between observations. Similar and substantial gains are registered in both the duplex and apartment models, with the former increasing to 26.38% from 8.6%, and the latter increasing to 38.61% from only 4.54%. A quick examination of the coefficients associated with the year dummies across models suggests substantially different recovery trajectories, even after controlling for other housing and neighborhood characteristics. Again, it appears that single family structures reach and surpassed recovery levels by 1996, although the gain is only 6.3% above the pre-Andrew value. However, for duplexes the 1996 value indicates that they are 48.3% less than their pre-Andrew values, while apartments are nearly 55.5% below their pre-Andrew level. Clearly again, the recovery trajectories for all multi-family structures (duplexes and apartments) are much slower.

Owner occupied single family dwellings and duplexes faired significantly better than rental housing throughout this period. Owner occupied single family housing was nearly 53% higher than rental housing and the difference for duplexes was also a quite substantial 45% higher[8]. These findings suggest that owner occupied housing, as anticipated, faired much better, performing substantially better through the period, when compared to rental housing.

Sales clearly had detrimental consequences throughout this period for all forms of

[8] The t-test for the difference between ownerships effects between single family and duplexes was not significantly different. See fully interactive model in Appendix 1.1.

housing; however the detrimental effects were particularly evident among apartments. For a single family structure each sale resulted in a nearly 12% drop in value from its pre-Andrew assessment. Among duplexes, the retarding effect of sales was quite similar, resulting in a 9% loss for each sale.[9] These findings indicate that multiple sales do indeed significantly reduce recovery levels. However, they are relatively small compared to the consequences of sales for apartment buildings. In the later case, each sale results in a 29.8% reduction in value when compared a structure's pre-Andrew level. This rather substantial negative effect indicates post-disaster sales significantly slow the recovery process. Of course, one might argue that, if these sales had not occurred, many apartment buildings would have never been rebuilt. For example, it may be that the owners were simply unwilling or unable to rebuild. Hence, selling the property to an entity willing and able to rebuild is a positive event. Nevertheless, regardless of the longer term consequences, it is clear that sales substantially extend the recovery period, particularly for apartment buildings.

For all three housing types, neighborhood median income has a positive effect on recovery, although the effects differ noticeably between apartments and other forms of housing. For single family structures the effect is .88% for every 1000 dollars in median income and just slightly more than 1% for every 1000 dollars for duplexes.[10] Remembering that average median income was $46,330 with a range of $5,000 to $150,000 for single family homes and $29,880 with a range of $0 to $150,000 for

---

[9] Again, results from the t-test comparing the negative effects of sales for duplexes with single family structures suggest that these differences (12% compared to 9%) are not statistically different (see the pooled model in Appendix 1.1).

[10] The t-test again suggests that these effects are not statistically different from each other. See Appendix 1.1.

duplexes, these differences can be substantial. Among apartment building, however the effect was 3.2% per 1000 dollars, an amount that is both statistically and substantively significant for it implies that apartment complexes in higher income neighborhoods are much more likely to recover than those in lower income areas. Results from the pooled model also suggest that the effects for apartments are statistically different from those of both the duplex and single family models. On the whole then, housing in higher income areas recovered at substantially higher rates, particularly among apartment complexes.

The consequences of neighborhood racial and ethnic composition vary among housing types, but there are also some consistent patterns as well. The most consistent pattern is the negative impact of the non-Hispanic Black percentage. For all housing types, a larger Black neighborhood percentage had a negative effect, although the effects were more pronounced for multi-family structures. Specifically for single family housing every percent increase in non-Hispanic Black composition, results in a reduction of .66% in value through the recovery period. Given the high concentration of Blacks in some neighborhoods, this could well amount to a significantly slower recovery. The negative consequences are 1.35% for duplexes and 1.01% for apartment buildings. The findings from the interactive model (see Appendix 1.1) suggest that the effect for duplexes is significantly different from that of single family homes, but not apartment complexes. On the whole, these findings are consistent with the expectations from the literature, which suggest that housing in predominantly Black areas would be slower to recover. The findings for Hispanic neighborhood composition are only significant in the model for single family model. The findings suggest that single family homes in increasingly

Hispanic areas also fared worse, with a relative loss of .41% for every percent increase in Hispanic composition. However, the Hispanic percentage has no significant consequences in the duplex and apartment models. While the "other" category represents a very small portion of the ethnic/racial composition for the overall area as well as in any particular neighborhood (block-group) in the area (mean value is 2% for single family homes and 1% for duplexes and apartment buildings), it has a positive significant effect in single family model of 1.48% for one percent increase in "other" composition. Interestingly, while the results for single coefficients in the pooled model must be interpreted with caution, they suggest that the only significant racial/ethnic differences between duplexes and single family housing is that duplexes in more predominately Black and "other" areas fared worse, while those in more predominately Hispanic areas faired better than single family structures. There were not statistically significant differences between single family houses and apartments and either duplexes or apartments. However, it should also be noted that while single family housing was widely distributed throughout the area, as noted from Figures 3.5-7, the distribution of apartment buildings and even duplexes, were much more concentrated in lower income and minority areas in the first place. These distributional differences make comparisons, particularly with respect to ethnic/racial differences more problematic.

On the whole, these findings are consistent with many of the expectations derived from the literature, although they are not completely consistent across all forms of housing. Ownership does have a favorable consequence for recovery of both single family and duplex structures. Sales significantly retard the recovery process, particularly for apartments. Neighborhood income level has the expected positive effect on recovery across all housing types, although it is particularly pronounced in apartment. The results are somewhat inconsistent with respect to ethnic/racial effects although all housing types located in predominantly non-Hispanic Black areas were much slower to recover and a similar pattern was found with respect to Hispanic percentage in the single family model.

4.4 HOUSING RECOVERY TRAJECTORIES CONTROLLING FOR DAMAGE

The damage control model compares housing recovery trajectories by controlling damage, and comparing damage influences on these three types of housing. When summing year dummy coefficients and damage coefficients, the combined values reflect the average log building value change for a given damage level in different years. Two types of models were run in this analysis: a fixed damage effect model and a year-variant damage effect model. Both of these models include a damage term in addition to the socioeconomic control model, one with damage only, and the other one with damage and 3 damage year-interaction terms for 1994- 96. The analytical models for all three housing types are:

$$\begin{aligned}\ln (BV)_{it} = {} & \beta_0 + \beta_1 \, yr93_{it} + \delta_2 \, yr94_{it} + \delta_3 \, yr95_{it} + \delta_4 \, yr96_{it} + \beta_5 \, rooms_{it} + \beta_6 \, baths_{it} \\ & + \beta_7 \, bldage_{it} + \delta_8 \, own_{it} + \beta_9 \, sale_{it} + \beta_{10} \, income_{it} + \beta_{11} \, Black_{it} \\ & + \beta_{12} \, Hispanic_{it} + \beta_{13} \, other_{it} + \beta_{14} \, dmg_{it} + \quad + \nu_{it} \qquad [8]\end{aligned}$$

, and

$$\ln (BV)_{it} = \beta_0 + \beta_1 \text{ yr93}_{it} + \beta_2 \text{ yr94}_{it} + \beta_3 \text{ yr95}_{it} + \beta_4 \text{ yr96}_{it} + \beta_5 \text{ rooms}_{it} + \beta_6 \text{ baths}_{it} + \beta_7 \text{ bldage}_{it} + \delta_8 \text{ own}_{it} + \beta_9 \text{ sale}_{it} + \beta_{10} \text{ income}_{it} + \beta_{11} \text{ Black}_{it} + \beta_{12} \text{ Hispanic}_{it} + \beta_{13} \text{ other}_{it} + \beta_{14} \text{ dmg}_{it} + \delta_{15} \text{ yr94 dmg}_{it} + \delta_{16} \text{ yr 95 dmg}_{it} + \delta_{17} \text{ yr96 dmg}_{it} + \nu_{it} \quad [9]$$

where *i* indicates structure *i* and *t* indicate year (1992 to 1996); yr93, yr94, yr95, and yr96 are the year dummy variables (1 for the specified year, otherwise, 0). Room is number of bedrooms, bath is number of bathrooms (0.5 for half bath), bldage is building age at 1992, own is 1 for owner- occupied and 0 for renter- occupied, and income is median household income of the block group in thousand dollars. Black indicates the proportion of Black in the block group; Hispanic indicates the proportion of Hispanic in the block group; and other indicates the proportion of other races in the block group. Finally, dmg is percentage of damage and ν_{it} is the composite error term.

In this analytical model, year dummy coefficients δ_1 to δ_4 again are semi-elasticity so 100 times this coefficient can be roughly[11] interpreted as the percent difference between the value of the home in the year associated with the independent indicator variable and 1992. The remaining coefficients can be interpreted in a similar manner, but this discussion will however employ the technically correct transformation of these semi-elasticities ($100(e^{\delta} -1)$ or $100(e^{\beta} -1)$). Table 4.12 presents the models including damage and Table 4.13 presents the results for the models including both damage and the damage-year interactions. Here again separate models are presented, rather than a

[11] Again the technically correct percentage is yielded by $100(e^{\delta} -1)$. This corrected value will be employed throughout.

single pooled model, because statistical testing indicated that the models for the three housing types are significantly different from each other (see Appendix 1.3).

Focusing first on the models with only the damage variable added it can be see that the R^2 values for these models increased substantially (and statistically) over the models including only socio-economic and control variables. The overall R^2 for the single family model increases from .383 in socio-economic model to .486, with similar gains registered in the duplex (.2638 to .376) and apartment (.386 to .456). Perhaps the most obvious difference between these models and those not including damage is that the coefficients associated with the year dummy or indicator measures are all positive for 1994 and beyond. However, these models now include a direct measure of damage; hence these coefficients reflect the relatively uninteresting gains for those very few structures that sustained no damage from Hurricane Andrew. Of greater interest are the findings for the effects of damage itself as well as how the other effects might have changed after damage is included in the models.

Table 4.10 Housing Recovery Models Including Damage

ln_bv	Single Family Coef.	Robust Std. Err.	P>|z|	Duplex Coef.	Robust Std. Err.	P>|z|	Apartment Coef.	Robust Std. Err.	P>|z|
yr93	-0.8301	0.0062	0.000	-0.4559	0.0549	0.000	-0.3696	0.1094	0.001
yr94	0.6388	0.0055	0.000	0.8213	0.0542	0.000	0.6915	0.1148	0.000
yr95	0.7930	0.0055	0.000	1.0537	0.0568	0.000	0.8662	0.1134	0.000
yr96	0.8840	0.0055	0.000	1.0253	0.0596	0.000	0.8412	0.1216	0.000
room	0.1254	0.0052	0.000	0.1531	0.0395	0.000	0.0047	0.0029	0.099
bath	0.3349	0.0058	0.000	0.1285	0.0447	0.004	0.0011	0.0033	0.726
bldage93	-0.0191	0.0003	0.000	-0.0393	0.0032	0.000	-0.0767	0.0086	0.000
own	0.3475	0.0108	0.000	0.3476	0.0538	0.000			
sale_	-0.1055	0.0061	0.000	-0.0937	0.0534	0.079	-0.3048	0.1221	0.013
income (K)	0.0043	0.0002	0.000	-0.0039	0.0020	0.049	0.0134	0.0095	0.156
Black (%)	-0.0048	0.0002	0.000	-0.0148	0.0016	0.000	-0.0069	0.0048	0.152
His. (%)	-0.0055	0.0002	0.000	-0.0077	0.0023	0.001	-0.0002	0.0069	0.971
Other (%)	-0.0040	0.0018	0.024	-0.0241	0.0377	0.522	0.1017	0.1343	0.449
dmg	-0.0153	0.0001	0.000	-0.0280	0.0009	0.000	-0.0291	0.0019	0.000
β_0	9.9334	0.0233	0.000	11.5561	0.2488	0.000	13.5895	0.6653	0.000
R^2 within	0.3856			0.2602			0.2070		
R^2 between	0.6028			0.4655			0.5857		
R^2 overall	0.4860			0.3763			0.4598		

Table 4.11 Housing Recovery Models Including Damage and Damage-Year Interactions

	Single Family			Duplex			Apartment		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	0.7654	0.0046	0.000	1.2040	0.0536	0.000	0.9096	0.1035	0.000
yr94	0.1986	0.0051	0.000	0.5448	0.0523	0.000	0.3042	0.1083	0.005
yr95	0.1994	0.0041	0.000	0.3639	0.0511	0.000	0.4942	0.1157	0.000
yr96	0.2407	0.0037	0.000	0.3263	0.0601	0.000	0.3441	0.1334	0.010
Room	0.1268	0.0056	0.000	0.1539	0.0411	0.000	0.0048	0.0028	0.089
Bath	0.3366	0.0059	0.000	0.1241	0.0433	0.004	0.0011	0.0032	0.723
bldage93	-0.0189	0.0004	0.000	-0.0396	0.0033	0.000	-0.0767	0.0088	0.000
Own	0.3247	0.0107	0.000	0.4047	0.0505	0.000			
sale_	-0.0217	0.0048	0.000	-0.0723	0.0492	0.142	-0.2847	0.1186	0.016
MHHIncmK	0.0045	0.0002	0.000	-0.0041	0.0018	0.028	0.0134	0.0091	0.142
Black (%)	-0.0048	0.0002	0.000	-0.0146	0.0016	0.000	-0.0069	0.0048	0.155
His. (%)	-0.0055	0.0002	0.000	-0.0076	0.0023	0.001	-0.0003	0.0069	0.970
Other (%)	-0.0036	0.0019	0.060	-0.0242	0.0357	0.499	0.1026	0.1253	0.413
Dmg	-0.0451	0.0001	0.000	-0.0556	0.0012	0.000	-0.0516	0.0025	0.000
yr94dmg	0.0380	0.0001	0.000	0.0321	0.0015	0.000	0.0294	0.0030	0.000
yr95dmg	0.0408	0.0001	0.000	0.0390	0.0014	0.000	0.0291	0.0032	0.000
yr96dmg	0.0417	0.0001	0.000	0.0392	0.0015	0.000	0.0313	0.0033	0.000
β_0	9.9283	0.0241	0.000	11.5554	0.2506	0.000	13.5881	0.6726	0.000
R^2 within		0.6537			0.3593			0.2626	
R^2 between		0.6019			0.4665			0.5856	
R^2 overall		0.6296			0.4200			0.4782	

As expected, the consequences of damage are highly significant in each of the models. In the single family model the damage coefficient suggests that the housing value dropped 1.52% for every percent of damage. The effects were even more dramatic for duplexes where the effect was a 2.76% loss and for apartments where the loss was

2.87%. Even more interesting are the estimates of damage consequences that allow the effects to moderate through the recovery period (see Table 4.11). Specifically, it can be expected that, in response to resources such as aid and insurance funding, the impacts of damage would attenuate through time. Instead, we see very different patterns among housing types. As expected, single family structures reveal a rather significant attenuation through time, particularly between 1993 and 1994. While the effects of damage in 1993 is -4.5109 suggesting a 4.41% loss for every percent in damage, the net effect drops to .34% loss by 1996. However, among apartments and duplexes the damage effects remain substantial, even in 1996. Among duplexes and apartments the impacts are -5.41% and -5.03% in 1993 and the net effects only attenuate to -2.32% for duplexes and -2.20% for apartments in 1994. Even in 1996, the net effect for duplexes is still -1.63% and -2.01% for apartments.[12] The differences in these effects between both apartments and duplexes from single family housing is substantial and quite evident in Figure 4.2, shows the net percentage effects of damage throughout the recovery period for all three housing types. The consequences of damage remain substantial for multifamily structures, just as suggested by Comerio (1997; 1998).

[12] Statistical testing suggests that these differences (-1.63% to -2.01%) are not statistically significant.

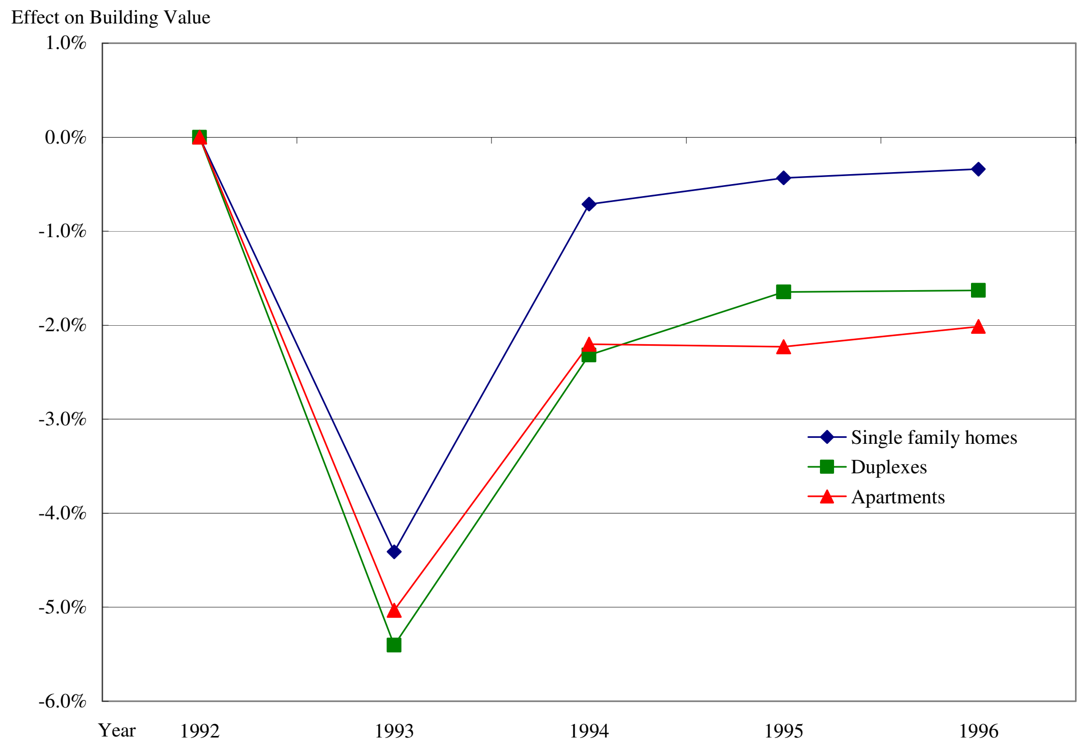

Figure 4.2 Net Exponentiated Damage Effects for Single Family Homes, Duplexes, and Apartments, 1993-1996

After controlling for damage, there were some alterations in the effects with respect to some of the other variables across housing types. Focusing on the results presented in Table 4.13, it can be seen that owner occupied housing still recovers more quickly. Indeed, while there was a slight attenuation in positive effect for single family housing when compared to models without controlling for damage, the effect is actually slightly stronger among duplexes. Sales continues to have a negative effect, although here again the effects are attenuated after controlling for damage. Each sale results in a loss of only 2.1% for single family housing and a non-significant effect for duplexes. However, apartments experienced a spectacular loss in value of nearly 25%. Income continues to have a positive effect throughout the period for single family housing, although the effect is roughly half (.45% per 1000 dollars) of what it had been in models not controlling for damage. This suggests that the larger effect in previous models was potentially due to less damage suffered by housing in higher income neighborhoods in the first place. Surprisingly, income has a negative effect for duplexes, suggesting that this form of housing fared worse in higher income areas. In the apartment model the income effect remained positive at 1.3%, but was not statistically significant.

The consequences of racial/ethnic composition are again varied across models. The most consistent pattern is again the negative consequences of non-Hispanic Black neighborhood percentage throughout the period. Among single family structures, for every percent increase (.01) in non-Hispanic Black population, housing values are .47% lower and for duplexes the negative effect is a good deal and (significantly) larger, increasing to -1.45% for one percent increase. In the apartment model the impact is -.68% for one percent increase in non-Hispanic Black population, although, as with the case of income, the coefficient is not significant. The consequences of Hispanic percentage are also negative in the single family model, at -.55%, and this is statistically different from Black effect. Similarly, the effect is negative in the duplex model, -.75%, although not greater than the Black coefficient. The Hispanic effect is not significant in the apartment model and the consequences of "other" ethnic/racial groups are not significant in any of the models. Overall then, it is clear that minority status has overall negative effects for the impact and recovery period for all housing types, and is particularly evident among single family structures and duplexes.

While the above analysis allows for the effects of damage to vary across years, the following analysis will focus on changes in the effects of the other variables throughout the impact and recovery period.

4.5 OWNER OCCUPANCY, SALES AND SOCIO-ECONOMIC EFFECT THROUGHOUT THE IMPACT AND RECOVERY PERIOD

The models above provided an overall assessment of the effects of owner occupancy, sales and socio-economic factors throughout the entire impact and recovery period when simultaneously controlling for damage. In the final model, damage itself was allowed to vary and the results suggested an attenuation of the damage effect, particularly among single family housing as resources were utilized to rebuild housing. Nonetheless, damage remains highly important in multifamily structure models (duplex and apartment) perhaps due to the relatively scarce resources available for rebuilding. The following will assess for differential effects of ownership, sales, and the other socio-economic factors by allowing them to vary throughout the impact and recovery periods.

The literature suggests that some factors may gain or lose importance during recovery period, although it offers very little guidance. For example, Peacock and Girard (1997) found ethnic differences in damage following Hurricane Andrew, with minorities in general and Hispanics in particular, suffering greater levels of damage. Damage differences also appeared to be clustered in neighborhoods yielding differences among areas related to ethnic/racial concentrations. Their findings suggest that concentrations of minorities, particularly Hispanic, will have higher consequences during the impact period, relative to pre-impact. The literature also suggests that low income and minority areas will receive fewer recovery resources and it is likely that some resources will arrive early while others will arrive later. In particular, emergency aid from FEMA's individual and family grant (IFG) and minimum home repair (MHR) is likely to come early, while SBA loans are likely to come later. Similarly, the timing of insurance is likely to be based on the quality of the insurance and to be related to owner occupancy. Thus, owner occupancy might be anticipated to have heighted importance in the recovery period, simply because programs target owner occupied housing rather than rental housing. It might also be anticipated that the relative influence of some factors should diminish through time, returning to pre-impact levels, as normal market processes reestablish themselves. Unfortunately, while the literature hints at these timing differences, it offers no concrete guidance for systematic hypotheses regarding changes in impact through time. Therefore, the following exploratory analyses may provide guidance to future research on impact and recovery.

The longitudinal nature of the data and analysis strategy adopted allows for an assessment of effects of the independent variables throughout the impact and recovery period. Specifically, by generating a complement of interaction terms between the year dummy variables and ownership, sales, income, and ethnic/racial composition, the differential impacts for each year can be estimated in relation to the 1992 base year. The model to be estimated is:

$$\ln(BV)_{it} = \beta_0 + \delta_1\,yr93_{it} + \delta_2\,yr94_{it} + \delta_3\,yr95_{it} + \delta_4\,yr96_{it} + \beta_5\,rooms_{it} + \beta_6\,baths_{it} + \beta_7\,bldage_{it} + \beta_8\,own_{it} + \beta_9\,sales_{it} + \beta_{10}\,income_{it} + \beta_{11}\,Black_{it} + \beta_{12}\,Hispanic_{it} + \beta_{13}\,other_{it} + \beta_{14}\,dmg_{it} + \delta_{15}(yr93 * tenure_{it}) + \delta_{16}(yr93 * sale_{it}) + \delta_{17}(yr93 * income_{it}) + \delta_{18}(yr93 * Black_{it}) + \delta_{19}(yr93 * Hispanic_{it}) + \delta_{20}(yr93 * other_{it}) + \delta_{21}(yr94 * tenure_{it}) + \delta_{22}(yr94 * sale_{it}) + \delta_{23}(yr94 * income_{it}) + \delta_{24}(yr94 * Black_{it}) + \delta_{y25}(yr94 * Hispanic_{it}) + \delta_{26}(yr94 * other_{it}) + \delta_{27}(yr94 * dmg_{it}) + \delta_{28}(yr95 * tenure_{it}) + \delta_{29}(yr95 * sale_{it}) + \delta_{30}(yr95 * income_{it}) + \delta_{32}(yr95 * Black_{it}) + \delta_{33}(yr95 * Hispanic_{it}) + \delta_{34}(yr95 * other_{it}) + \delta_{35}(yr95 * dmg_{it}) + \delta_{y36}(yr96 * tenure_{it}) + \delta_{37}(yr96 * sale_{it}) + \delta_{38}(yr96 * income_{it}) + \delta_{39}(yr96 * Black_{it}) + \delta_{40}(yr96 * Hispanic_{it}) + \delta_{41}(yr96 * other_{it}) + \delta_{42}(yr96 * dmg_{it}) + \nu_{it} \quad [10]$$

Table 4.12 presents the models for all three housing types[13] that allow for the effects of owner occupancy, sales, income and ethnic/racial status to vary throughout the impact and recovery period. The gains in R^2 provide by the damage and damage year interactions (see Table 4.15) are very modest in all three models (single family model (.39%), duplex (.97%) and apartment (1.12%). Nevertheless, given the sample sizes all are models are a statistical improvement over the corresponding models in Table 4.15. Even a cursory scan of these models indicates that there are a substantial number of

[13] A statistical test was conducted to determine if these models performed significantly different from each other to warrant not pooling all three housing types together into a single model. Specifically a fully interactive model was run allowing the effects of each of the standard and the year interactive variables to vary among housing types. The test was significant ($\chi^2 = 11464.21$ with 77 df, $p \leq .0000$) suggesting that separate models are appropriate.

interaction terms that are statistically and as will be seen below, substantively significant. The following section will discuss each factor separately across housing types.

Table 4.12 Models Allowing for Differential Effects Through Time by Housing Type

	Single Family			Duplex			Apartment		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	1.1907	0.0227	0.000	1.9349	0.2204	0.000	1.1130	0.5906	0.060
yr94	-0.1447	0.0287	0.000	1.3052	0.2149	0.000	-1.1024	0.6178	0.074
yr95	-0.1691	0.0262	0.000	0.9279	0.2104	0.000	-0.9414	0.6548	0.151
yr96	-0.0991	0.0252	0.000	1.1293	0.2302	0.000	-1.0365	0.6381	0.104
Rooms	0.1269	0.0055	0.000	0.1545	0.0412	0.000	0.0047	0.0028	0.089
Baths	0.3359	0.0059	0.000	0.1238	0.0432	0.004	0.0012	0.0032	0.714
bldage93	-0.0188	0.0004	0.000	-0.0396	0.0033	0.000	-0.0767	0.0088	0.000
Own	0.0391	0.0083	0.000	0.2301	0.0545	0.000			
yr93_own	0.0396	0.0141	0.005	0.0773	0.0837	0.356			
yr94_own	0.5248	0.0208	0.000	0.2541	0.0851	0.003			
yr95_own	0.4508	0.0202	0.000	0.2109	0.0804	0.009			
yr96_own	0.4478	0.0211	0.000	0.3396	0.0819	0.000			
sales	-0.0096	0.0057	0.090	0.0196	0.0755	0.795	-0.2737	0.1241	0.027
yr93_sales	0.0229	0.0095	0.016	-0.0015	0.1160	0.990	0.2706	0.1999	0.176
yr94_sales	-0.1299	0.0166	0.000	-0.1520	0.1342	0.257	-0.3824	0.2972	0.198
yr95_sales	-0.0197	0.0129	0.126	-0.0623	0.1186	0.600	-0.0866	0.3061	0.777
yr96_sales	0.0037	0.0119	0.753	-0.2145	0.1499	0.152	0.0420	0.3930	0.915
income	0.0063	0.0001	0.000	0.0053	0.0017	0.002	0.0012	0.0085	0.888
yr93_inc	-0.0039	0.0002	0.000	-0.0112	0.0027	0.000	0.0140	0.0118	0.235
yr94_inc	-0.0023	0.0002	0.000	-0.0112	0.0023	0.000	0.0098	0.0098	0.314
yr95_inc	-0.0014	0.0002	0.000	-0.0099	0.0022	0.000	0.0155	0.0102	0.130
yr96_inc	-0.0016	0.0002	0.000	-0.0138	0.0025	0.000	0.0231	0.0109	0.035

Table 4.12 Continued

ln_bv	Single Family Coef.	Single Family Robust Std. Err.	Single Family P>|z|	Duplex Coef.	Duplex Robust Std. Err.	Duplex P>|z|	Apartment Coef.	Apartment Robust Std. Err.	Apartment P>|z|
Black (%)	-0.0036	0.0001	0.000	-0.0049	0.0014	0.001	-0.0110	0.0046	0.017
yr93_blk	-0.0029	0.0002	0.000	-0.0034	0.0019	0.073	0.0022	0.0053	0.678
yr94_blk	-0.0003	0.0002	0.165	-0.0146	0.0020	0.000	0.0092	0.0059	0.118
yr95_blk	-0.0008	0.0002	0.000	-0.0128	0.0020	0.000	0.0074	0.0063	0.245
yr96_blk	-0.0017	0.0002	0.000	-0.0178	0.0022	0.000	0.0023	0.0062	0.708
His. (%)	-0.0040	0.0002	0.000	-0.0034	0.0022	0.123	-0.0110	0.0067	0.103
yr93_his	-0.0080	0.0003	0.000	-0.0061	0.0029	0.038	-0.0039	0.0073	0.597
yr94_his	-0.0005	0.0003	0.140	-0.0054	0.0030	0.071	0.0207	0.0076	0.007
yr95_his	0.0010	0.0002	0.000	-0.0037	0.0029	0.202	0.0204	0.0084	0.015
yr96_his	0.0002	0.0002	0.371	-0.0052	0.0030	0.086	0.0171	0.0083	0.039
Other (%)	-0.0067	0.0016	0.000	-0.0648	0.0318	0.042	0.0958	0.0892	0.283
yr93_oth	-0.0011	0.0023	0.633	-0.0161	0.0621	0.795	-0.3840	0.1575	0.015
yr94_oth	0.0039	0.0029	0.181	0.0432	0.0389	0.266	0.1853	0.0880	0.035
yr95_oth	0.0042	0.0025	0.095	0.0801	0.0368	0.029	0.1215	0.0964	0.208
yr96_oth	0.0091	0.0026	0.001	0.0946	0.0302	0.002	0.1130	0.0962	0.240
Dmg	-0.0455	0.0001	0.000	-0.0576	0.0013	0.000	-0.0530	0.0026	0.000
yr94dmg	0.0384	0.0002	0.000	0.0355	0.0016	0.000	0.0311	0.0032	0.000
yr95dmg	0.0413	0.0001	0.000	0.0423	0.0015	0.000	0.0313	0.0034	0.000
yr96dmg	0.0424	0.0001	0.000	0.0432	0.0016	0.000	0.0349	0.0034	0.000
β_0	10.0464	0.0226	0.000	10.9409	0.2460	0.000	14.3523	0.6577	0.000
R^2 within		0.6593			0.3812			0.2925	
R^2 Between		0.6039			0.4669			0.5874	
R^2 Overall		0.6335			0.4297			0.4894	
N's	301495 obs., 60299 groups			8730 obs., 1746 groups			2730 obs., 546 groups		

4.5.1. Effects of housing variables

Owner occupied housing

Housing occupied by a homeowner, whether single family or duplex, fared much better throughout the impact and recovery period. Prior to the hurricane, owner occupied single family housing was valued approximately 4% higher than rental housing, while owner occupied duplexes were valued approximately 25% higher than their rental counterparts. Single family owner occupied housing fared significantly better than their rental counterparts after Hurricane Andrew's impact, showing with a net gain of 4% and a total differential of 8.2%. Owner occupied duplexes on the other hand, did not retain any more of their value, suggesting less damage than rentals. As noted in the literature review, the expectation was that owner occupied housing would fare much better, particularly in the recovery process, and the substantial gains of owner occupied housing are consistent with this expectation. For single family structures, there was a statistically and substantively significant jump of 69%, resulting in a major 75.8% differential over rental housing in the year following Andrew. For duplexes, the jump was not as dramatic, but a significant and substantial 28.9%, yielding a net gain over rental housing of 62.3%. Single family owner occupied housing maintained its edge over rental housing for the remainder of the period, with total differentials of 63.2% in 1995 and 62.7% in 1996.[14] Among duplexes, total differentials were 55.4% in 1995 and grew further in 1996 to 76.8%.[15]

[14] Statistical test suggest that the coeffieients for 1995 and 1996 among single family homes were not statistically different from each other.

[15] While the coefficients for the 1994 through 1996 owner interaction terms are statistically different from the base 1992, indicating substantial gains for owner occupied duplexes, the coefficients themselves are not statistically different from each other.

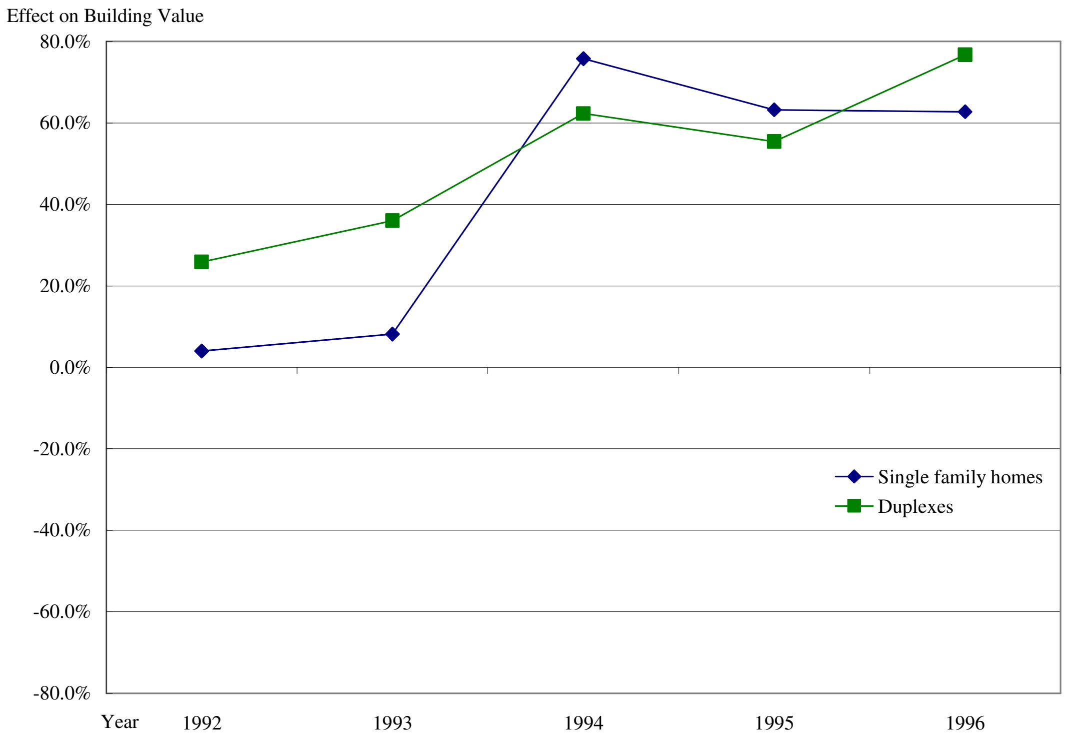

Figure 4.3 Total Owner Occupancy Effects

Figure 4.3 graphically displays the total owner occupancy effects for both single family and duplex structures from 1992 through 1996. While there were clear and significant differentials prior to the impact of Hurricane Andrew, these differentials grew substantially throughout the recovery period reaching a maximum of nearly 76% for single family homes by 1994 and of 77% for duplexes, but not reached until 1996. These differentials suggest that owner occupied housing recovered at a much more rapid rate than rental housing, resulting in rather substantial net differentials remaining even by 1996. On the whole then, these finds are clearly consistent with the expectations associated with hypothesis 4.

Sales

While the overall effect of sales was negative throughout the period for all forms of housing, the results from these models suggest that there were considerable variations in the actual effects. For single family structures, sales showed essentially no effect on value in 1992, the coefficient was not significant, and surprisingly, sales were actually associated with a slight net increase of 1.3% in 1993. However, in 1994 each sale was associated with a 13% decline and a net 2.9% decline in 1995. While the coefficient associated with the sales by 1996 interaction is significant and positive, the net effect of sales was again zero. These findings suggest that, during the critical periods of recovery for single family houses, 1994 and 1995, the effects were negative, slowing recovery significantly during that period

In the duplex model with only a total sales effect (see Table 4.12), sales showed a negative effect, but it was not statistically significant. In the current model, the net effects for each year from 1992 – 1996 are 2.0%, 1.8%, -12.4%, -4.2%, and -17.7%. However, here again, none of the effects was significant. On the whole therefore, the results are inconclusive.

In the apartment model, the findings indicate that every sale decreased building value by 23.9%, 0.3%, 48.1%, 30.3%, and 20.7% for each year from 1992 to 1996, respectively. However, none of the interaction terms, testing for incremental changes in the years following the hurricane, are statistically significant. This suggests there was little overall change. The 1992 base effect was statistically significant, suggesting a negative consequence of sales prior to the hurricane. When net effects are consider and tested for significance, it appears that sales had no effect on value in 1993, 1995 and

1996. Only in 1994 was the net effect negative (-.656) and statically significant[16] at the .05 level. These results suggest that sales already had a negative effect on apartment building value before Hurricane Andrew and continued to be negative in 1994, the year following the storm. However, the analysis does not indicate that this was significantly different than the pre-existing negative effect. These results are, at best, equivocal with respect to the negative effects of sales after the hurricane, yielding no support for the Hypothesis 5.

Figure 4.4 graphically portrays the 1992 effects of sales and the net effects of sales in subsequent years. However, this graph must be interpreted with caution. While the negative effects of sales appear to be more significant among duplexes and apartments, the findings suggest that the negative effect of sales is only statistically significant among single family homes. It was not for duplexes and, among apartments, there was already a negative effect of sales prior to the hurricane in the southern sections of Miami-Dade County. On the whole, Hypothesis 5 is only partially confirmed; post-disaster sales only have a significantly negative effect on single family housing recovery.

[16] The net effect coefficient for 1994 was -.6561 (48.1%), with a standard error of .2691, producing at z of -2.44 ($p \leq .05$).

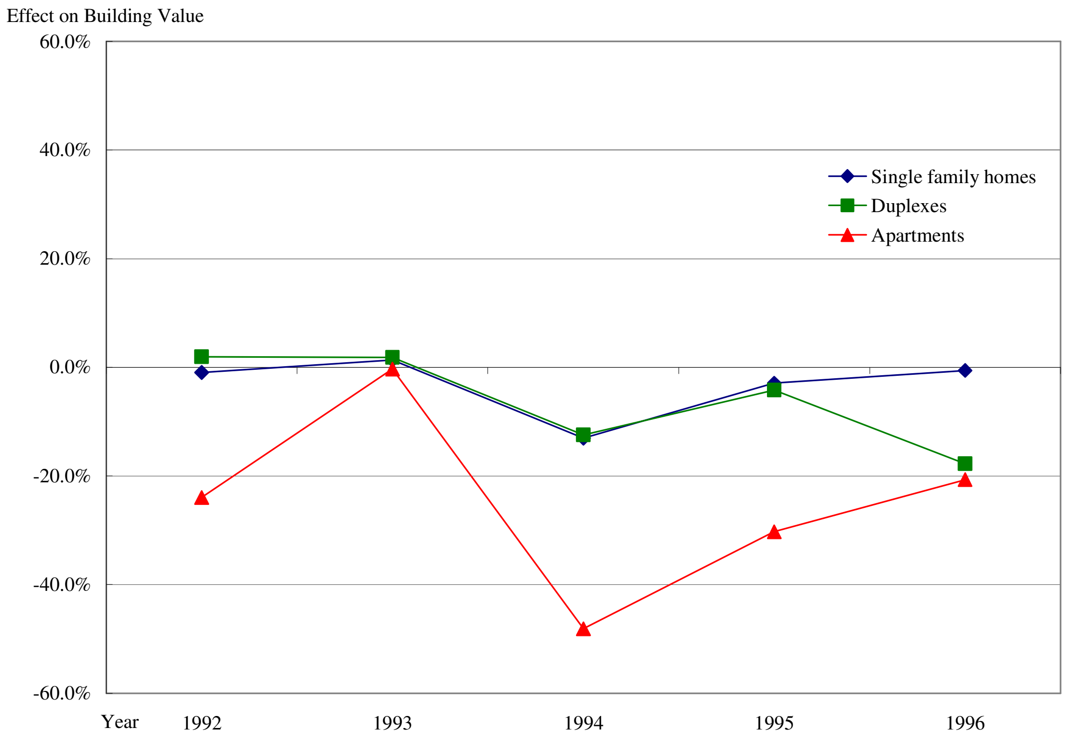

Figure 4.4 Sale Effects on Building Value

4.5.2. Effects of socio-demographic variables

Neighborhood income

The findings with respect to impacts of neighborhood income are somewhat surprising, particularly given the results from the models assessing only overall impacts through the period. These confirmed the expected positive effect with some qualifications. In the single family model, neighborhood income does indeed have a positive significant effect in 1992 that suggests, not surprisingly, that the values of homes increases by .63% for every 1000 dollars in median neighborhood income. However, surprisingly, the change in this effect is negative and significant for the impact year of 1993, and each of the recovery period years of 1994 through 1996. The net effects for 1993 through 1996 are 0.24%, 0.40%, 0.49%, and 0.47% after controlling other factors and these net effects are all statistically significant.[17] These findings suggest that housing in higher income level neighborhoods retained more of their value (suffered less structural damage), and recovered more quickly than did housing in lower income areas. However, the findings also suggest that the gains were not higher than the normal differentials experienced for higher income areas. Indeed, relatively speaking, the "normal" differentials between higher income areas and their lower income counterparts may well have attenuated over the impact and recovery period. It is important to note that the difference effects did attenuate until the last two years, with each successive year being smaller than the next, although the coefficients for the final two years being equivalent. In summary, the result of the single family housing model support Hypothesis 2 that neighborhood income level has a positive effect during the recovery period, although there was no heightened positive effect.

The results are even more inconsistent with the expected impacts of income when examining the duplex model. In 1992, income has the expected positive effect suggesting that the value of duplexes in richer neighborhoods is higher by .53% for every 1000 dollars in median income. However, the difference coefficients from 1993 to 1996 are all negative and statistically significant. Even more surprising is that the net effects of income for the entire period are negative. From 1993, on for every $1,000 increase in neighborhood income, the value of a duplex significantly decreases by 0.59%, 0.58%, 0.45%, and 0.84% for each year. It is important to note that the differences

---

[17] The z-test were 10.14, 14.78, 19.49, and 18.94 which were all statistically significant at least at the .001 level.

among the difference coefficients are not statistically significant. Thus, the overall conclusion is that the negative effects from 1993-1996 are essentially constant; they do not attenuate, but rather remain stable. This finding clearly contradicts the expectation of the literature that income has a positive effect, perhaps accentuated, on general housing recovery.

In the apartment model, income is not statistically significant in 1992, and it remains non-significant through 1993-1995. In the final year, 1996, the difference coefficient is positive and significant, suggesting apartment buildings in upper income areas have recovery values higher than those in lower income areas. Indeed, the net effect is 2.46% for every $1,000 increase in neighborhood median household income. In light of the extraordinarily slow recovery rates for apartment buildings, the fact that a positive increase in not registered until 1996 is perhaps not surprising. However this is but one year for this whole recovery period, so it must be interpreted with some caution. The result of the apartment model shows that neighborhood income did not have a notable effect on housing value from 1992 to 1995, and the only significantly positive effect was in 1996, three years after the disaster impact. On the whole findings for apartment model support for hypothesis 2.

Figure 4.5 displays the base (1992) and net exponential effects for neighborhood income for all three housing types. This graph also must be viewed with caution. While the net effects for apartments seem dramatic, it is only in the final year that there is a statistically significant net effect. The effects for duplexes are significant, but in the opposite direction of expectations. Finally, while the net effect for single family homes is positive, it does not represent an accentuated or increasingly positive effect of income on recovery.

Similar to the single family housing model, damage also absorbs the income effect: the income effect is positive in the socioeconomic control model, but becomes to negative when including damage. In conclusion, the results in the duplex model do not support Hypothesis 2 that neighborhood income level has a positive effect during the recovery period.

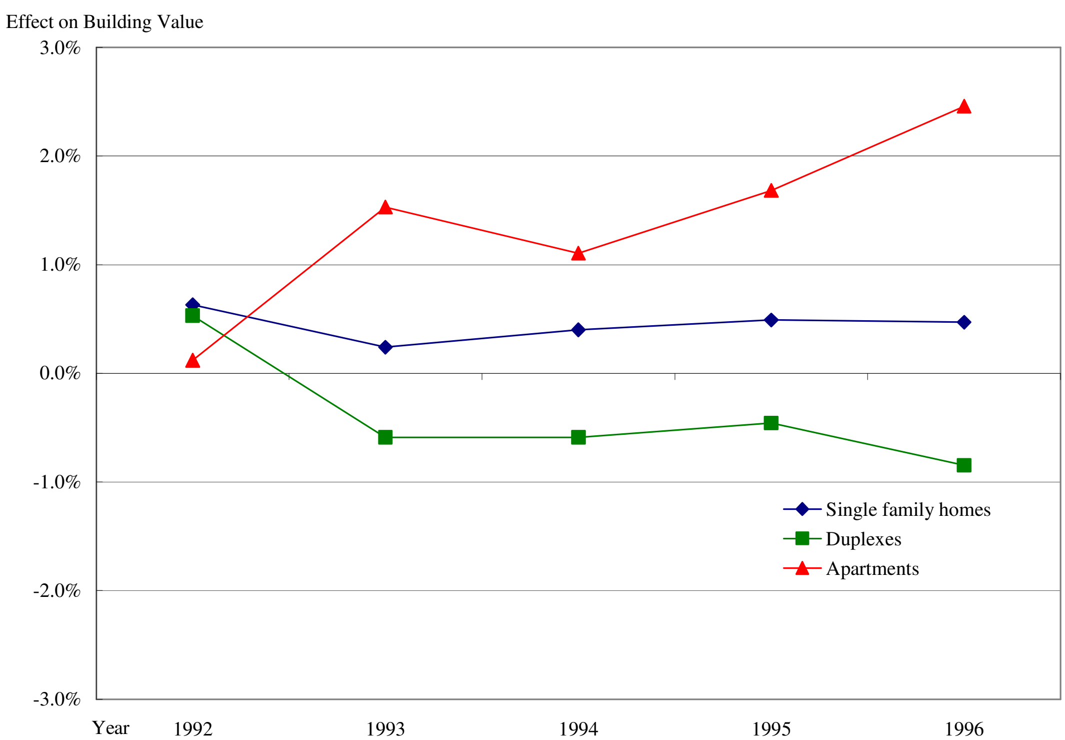

Figure 4.5 Neighborhood Household Income Effect on Building Value

The results for the effects of neighborhood income are not consistent with the expectations found in the literature. For the most part we do not see accentuated positive effects and in the case of duplexes the effects are completely opposite to those expected. While some of the literature does suggest positive neighborhood income effects, it should be noted that most of the literature focuses on the impacts of household income, not neighborhood income. Thus, one obvious explanation for these disconfirming findings is that neighborhood income does not accurately reflect the financial capabilities nor the effects of a household's income for two major reasons: First, income data at the neighborhood level does not reflect the financial capability for every single household nor the actual direct effects of household income for housing recovery. Second, and particularly with respect to duplexes, about 70% of duplexes in this study area are renter-occupied and, as a result, neighborhood income cannot possibly capture the economic status and resources of the owners of these structures. A similar argument might be made about the "owners" of apartment buildings, be they individuals or businesses. Third, and related to the large number of rental duplexes, it may well be that the models for duplexes (particularly rentals) and apartments do not capture at all the nature of the business decisions being made by these owners. Hence, factors like neighborhood income will operate in a very different matter. It is, in part, because of this that the next chapter will focus exclusively on the recovery process of apartments.

Neighborhood race/ethnicity composition

In the single family housing model, every 1% increase in neighborhood non-Hispanic Black composition decreased building value significantly by 0.4%, 0.7%, 0.4%, 0.4%, and 0.5% in 1992-1996 if Anglo composition is the comparison. If comparing yearly results with the base year, 1992, the differences in 1993, 95, and 96 are all negative and statistically significant at the 0.01 level. This pattern shows that housing in Black neighborhoods suffered greater damage and had slightly slower housing recovery in 1995 and 1996 after controlling other factors. Although the magnitude of negative effect is not high, this result confirms Hypothesis 3.1 that non-Hispanic Black composition has a negative effect on housing recovery in single family homes.

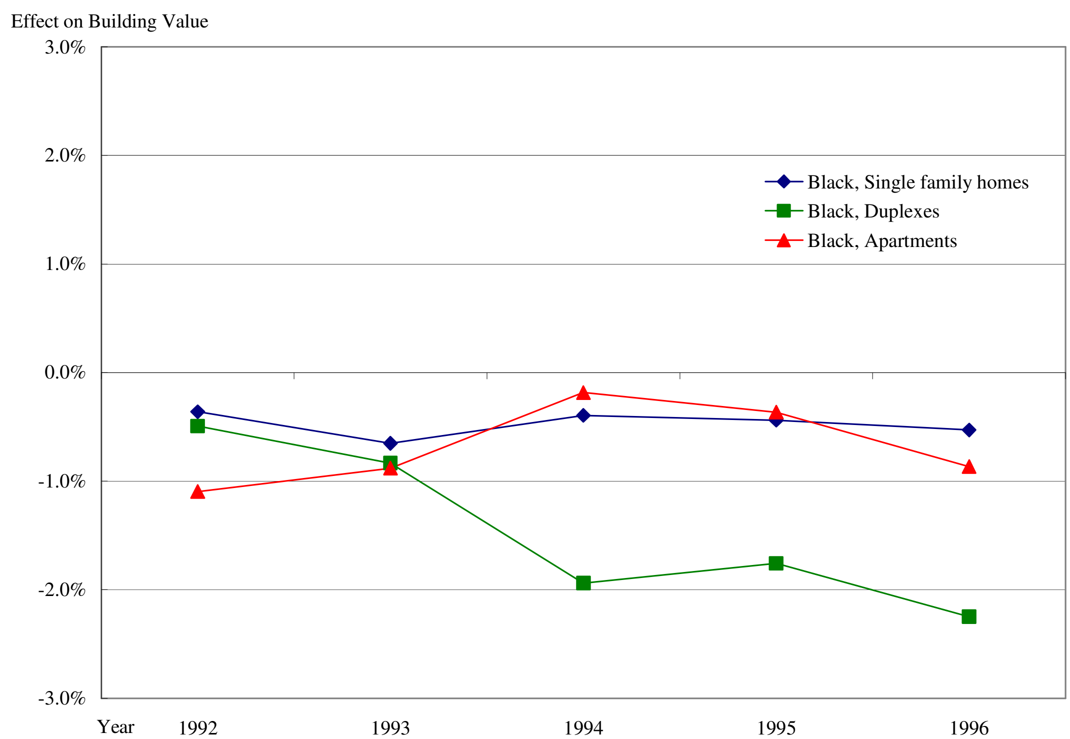

Figure 4.6 Effect of Neighborhood Black Composition on Building Value

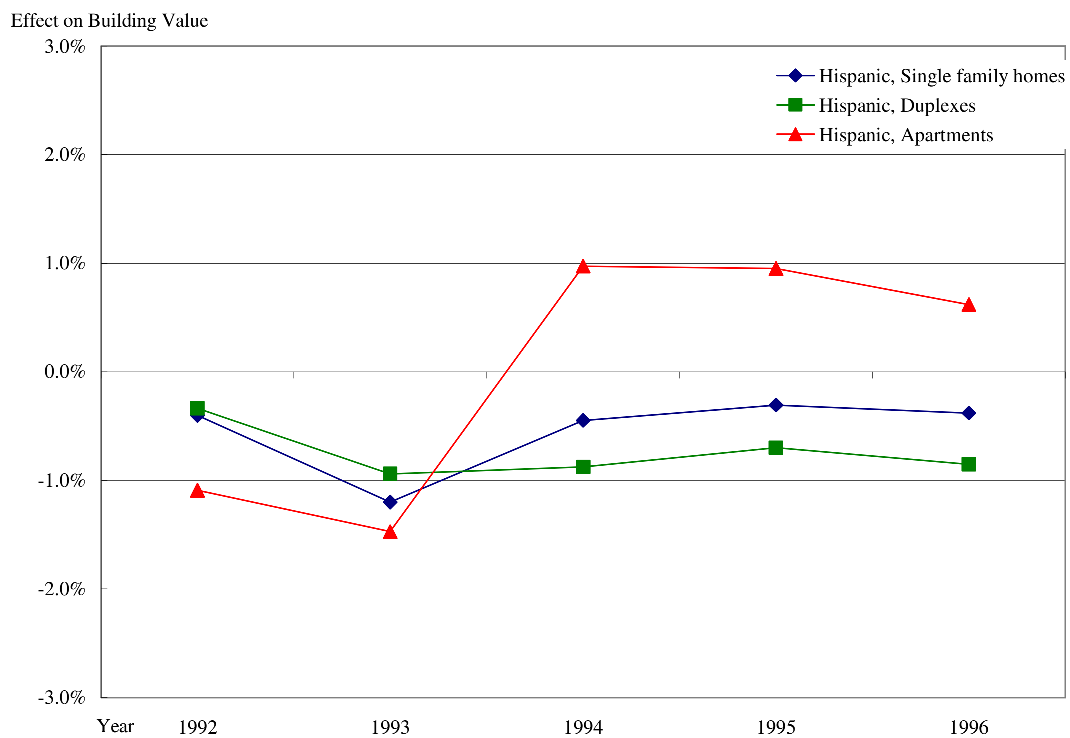

Figure 4.7 Neighborhood Hispanic Composition Effect on Building Value

For neighborhoods with a high percentage of Hispanics, every 1% increase decreased building value by 0.4%, 1.2%, 0.4%, 0.3%, and 0.4% in 1992-1996 when Anglo composition is the comparison. This effect on building is negative and statistically significant at 0.01 level. However, when compared with base year, the result shows a different pattern. The significantly negative coefficient for the yr93 interaction term shows that housing in Hispanic neighborhoods suffered greater impacts from Hurricane Andrew. The insignificant coefficients for the yr94 and yr96 interaction terms imply that the percentage of Hispanics did not amplify the inequity that existed prior to the disaster. Furthermore, the significantly positive coefficient for the yr95 interaction term indicates that the difference between Hispanic and Anglo composition effects decreased in 1995. The result here supports Hypothesis 3.2 that Hispanic composition has a negative effect on the recovery trajectory in single family homes, but no amplified negative effect on housing recovery period.

For duplexes, every 1% increase in non-Hispanic Black composition decreased building value by 0.5%, 0.8%, 1.9%, 1.8%, and 2.2% in 1992-1996. When comparing the yearly coefficient with base the year (1992), all of the year interaction term coefficients are negative and statistically significant at the 0.001 level except the 1993 year interaction term, which is only significant at the 0.1 level. In general, this difference was amplified after the impact period and increased during recovery, which means that the non-Hispanic Black percentage had a negative effect on the duplex housing recovery as stated in Hypothesis 3.1.

Effects of neighborhood Hispanic percentage on building was -0.3%, -0.9%, -0.9%, -0.7%, and -0.9% on building value for every 1% increase in a neighborhood’s Hispanic population. When compared with the base year, the significantly negative yr93 interaction term coefficient indicates that duplexes in neighborhoods with higher Hispanic compositions had greater damage in general. These results provide support for Hypothesis 3.2 that neighborhood Hispanic composition had a negative effect on duplex housing recovery.

For apartments, the neighborhood non-Hispanic Black population percentage had a negative effect on building value prior to the disaster. However, it did not have a significantly negative effect from 1993 to 1996. In addition, when examining the coefficients for yr93, yr94, yr95 and yr96 interaction terms, statistical tests do not show that they are significantly different from zero. Therefore, neither positive nor negative effects of neighborhood non-Hispanic Black composition on apartment housing recovery are confirmed.

Neighborhood Hispanic composition had a marginally negative effect (-1.1%) on building value prior to disaster. The negative effect did not change significantly right after the disaster impact, but the negative effect decreased and showed no difference from predominately Anglo neighborhoods in 1994-1996. This result shows that neighborhood Hispanic composition does not have a significantly amplified negative effect on apartment housing recovery.

In summary, neighborhood race/ethnicity composition had different effects on housing recovery in single family homes, duplexes, and apartments. Neighborhood non-Hispanic Black predominance had amplified negative effects on housing recovery in single family homes and duplexes, but not in apartments. Therefore, Hypothesis 3.1, neighborhood non-Hispanic Black composition has a negative effects on housing recovery is only partially confirmed. For the effects of neighborhood Hispanic predominance, no negative effect is observed in apartments. Thus, Hypothesis 3.2, neighborhood Hispanic composition has negative effects on housing recovery in all housing types, is not applicable to apartment buildings.

CHAPTER V

COMPARISON OF HOUSING RECOVERY BY SIZE OF APARTMENT BUILDING

5.1 AVERAGE VALUE CHANGE AND INTERCORRELATION ANALYSES

5.1.1 Descriptive statistics and average building value change analysis of apartment housing recovery

Apartments are an important type of housing in many communities, especially in metropolitan areas, because they form a significant proportion of the total housing stock and house the majority of renters. In this research, apartment is a category with diverse building characteristics. An apartment building is defined as a multi-unit rental dwelling made of three or more apartments operated as a business to make a profit by rent collection. Apartment buildings, especially ones with few units, may be owned and operated by landlords who also live in one unit of the building, or owned and operated by outside enterprises that collect capital from investors. In terms of housing recovery, decision-making processes and capability of mobilizing recovery funding may be associated with business scale (or apartment building size); therefore, housing recovery trajectories of different sized apartment buildings may be different.

Understanding apartment housing recovery is important, but little research has focused on the housing recovery of apartment buildings of different sizes. The limited among of research available shows inconsistent results in apartment operation or recovery. Segal (2003) found that, under normal conditions, apartment buildings with fewer than 50 units usually face more financing difficulties than apartment buildings with more than 50 units. However, the experience of the 1994 Northridge earthquake showed that small apartments (fewer than 10 units, owned by a single individual living in the building) had better capability for financing housing recovery (Comerio, 1997). What was the recovery progress of different sized apartment buildings after Hurricane Andrew? Did the apartment buildings of different size categories have different housing recovery trajectories?

The analytical approach in Chapter IV is duplicated in this chapter to examine whether the apartment buildings of different size categories have different housing recovery trajectories. The only exception is that numbers of bedroom and bathroom used in Chapter IV are replaced by log square footage in the panel analyses.

According to previous research, size of 10- and 50-unit property sizes are meaningful breakpoints for examining size effect on apartment building recovery because these numbers might be the critical thresholds for different decision making and financial capability (Comerio, 1997; Segal, 2003). Triplexes/fourplexes are also distinguished from other apartment categories because thy account for nearly half of the total apartment properties and have parameters that are different from buildings of 5- to 10-unit. Thus, the size categories used in the analysis are: triplex and fourplex (3 to 4 units), small apartment building (5 to 10 units), medium apartment building (11 to 50 units), and large apartment building (51 or more units) to compare their housing recovery trajectories using large apartment building as the comparison group.

In the 546 apartment buildings in south Miami-Dade County, Florida, there are 251 triplexes or fourplexes, 113 small apartment buildings, 102 medium apartment buildings, and 80 large apartment buildings. The living units of the apartment properties range from 3 to 690 (Table 5.1). These four types of apartment buildings not only differ in size, but also in age and local neighborhood characteristics[18]. In general, large apartment buildings were newly built with an average age of 15.14 years in 1993. Medium apartment buildings were in the middle with an average age of 28.95 years. Triplexes/ fourplexes and small apartment buildings were relatively old with an average age of 34.55 and 33.94 years, respectively, in 1993. When compared on neighborhood median household income and race/ethnicity composition, large apartment buildings were located in neighborhoods with higher income levels and higher Anglo and Hispanic population percentages, but triplexes/fourplexes and small apartment buildings tended to be located in predominately Black neighborhoods with lower income levels.

[18] One-Way ANOVA tests performed and confirmed these differences.

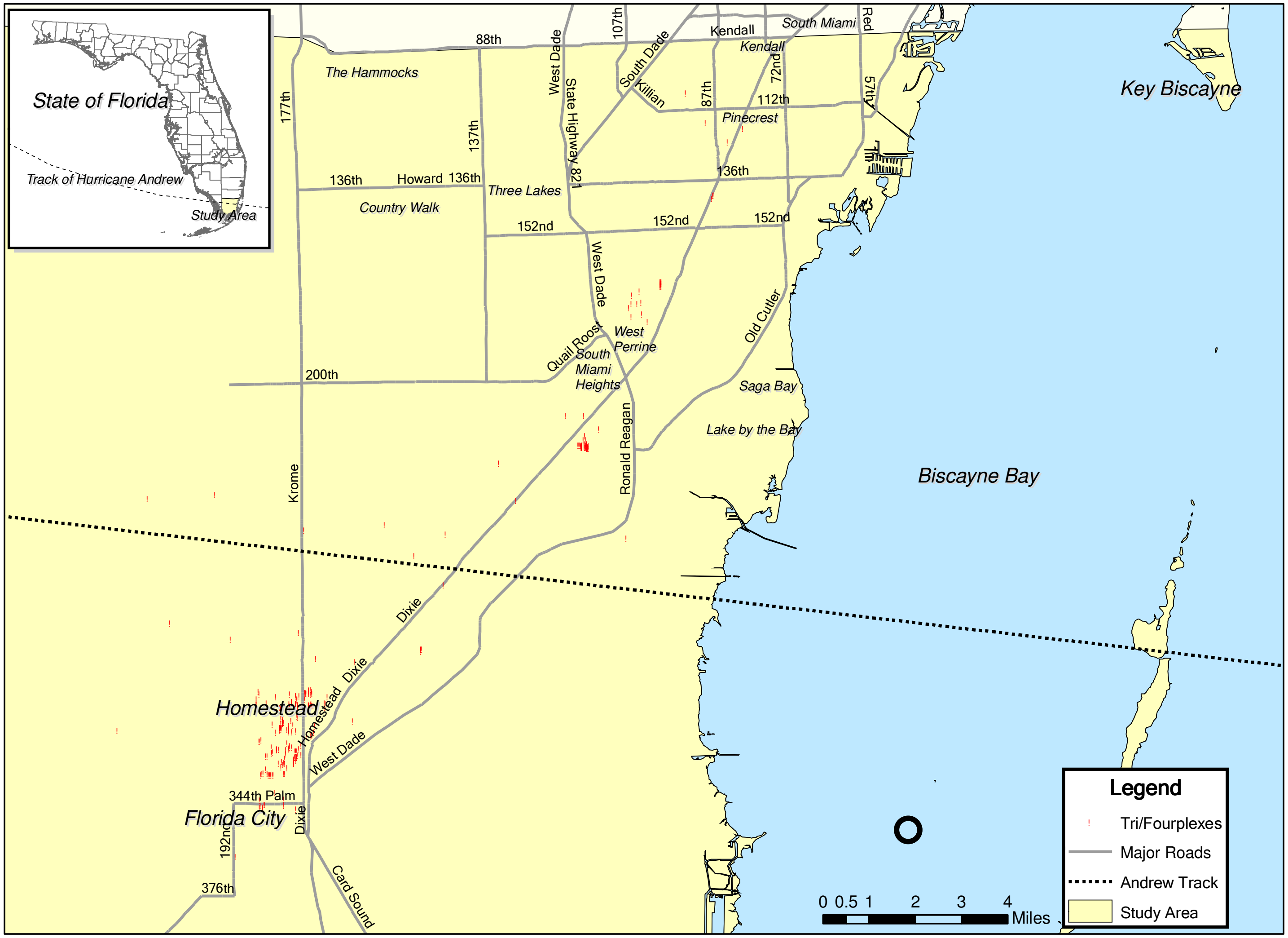

Figure 5.1 Spatial Pattern of Triplexes/Fourplexes in South Miami-Dade County, Florida

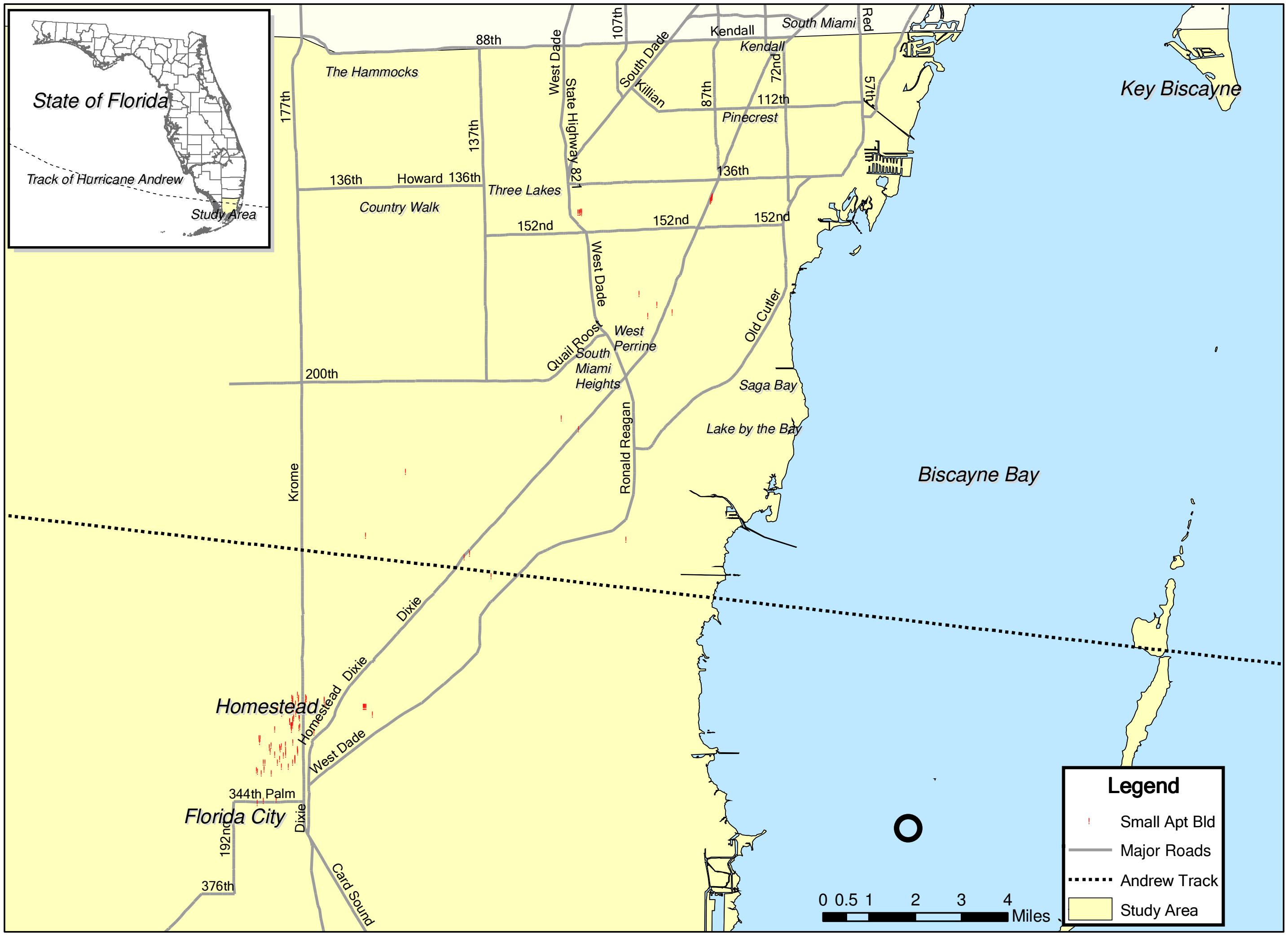

Figure 5.2 Spatial Pattern of Small Apartment Buildings in South Miami-Dade County, Florida

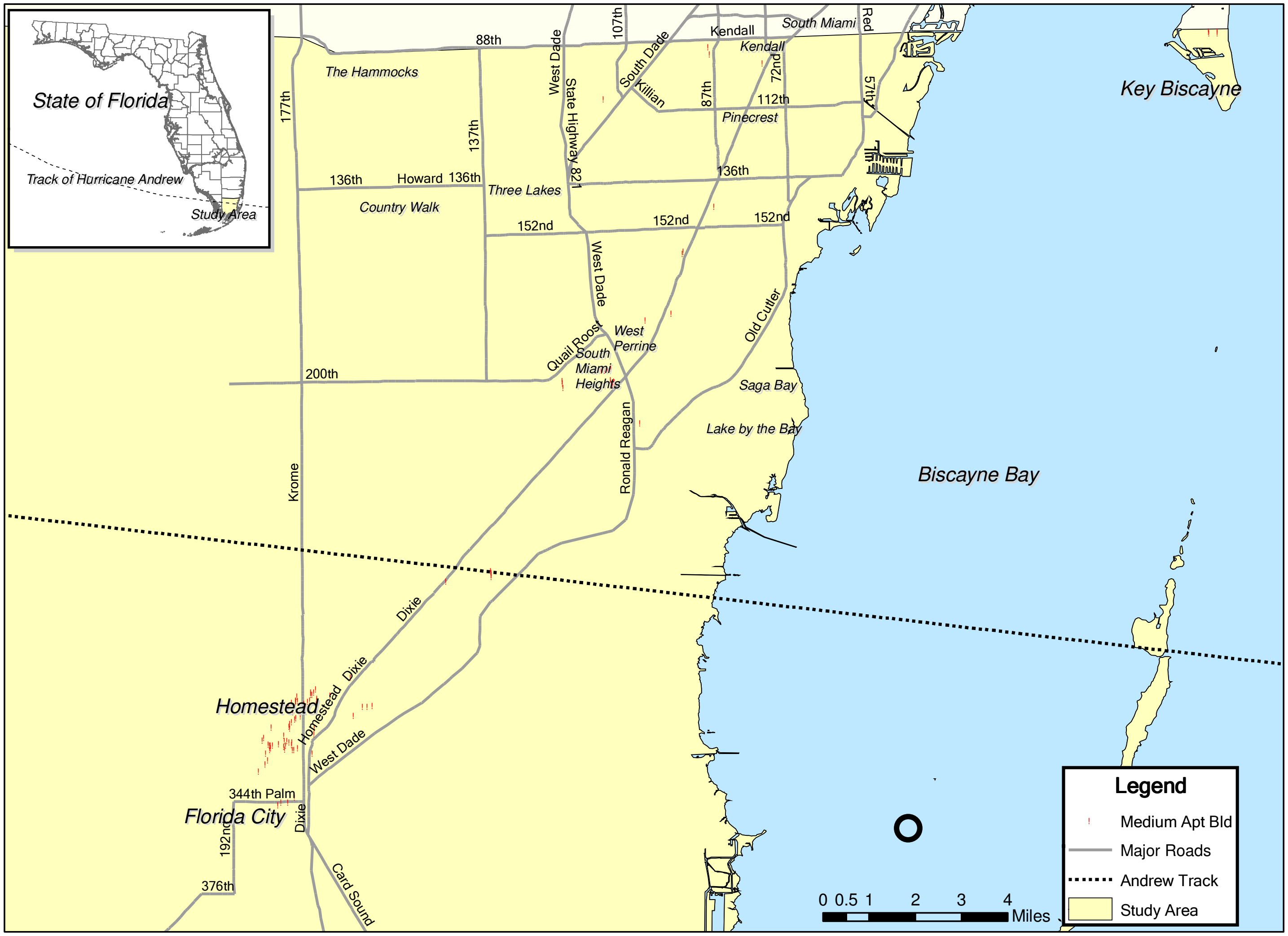

Figure 5.3 Spatial Pattern of Medium Apartment Buildings in South Miami-Dade County, Florida

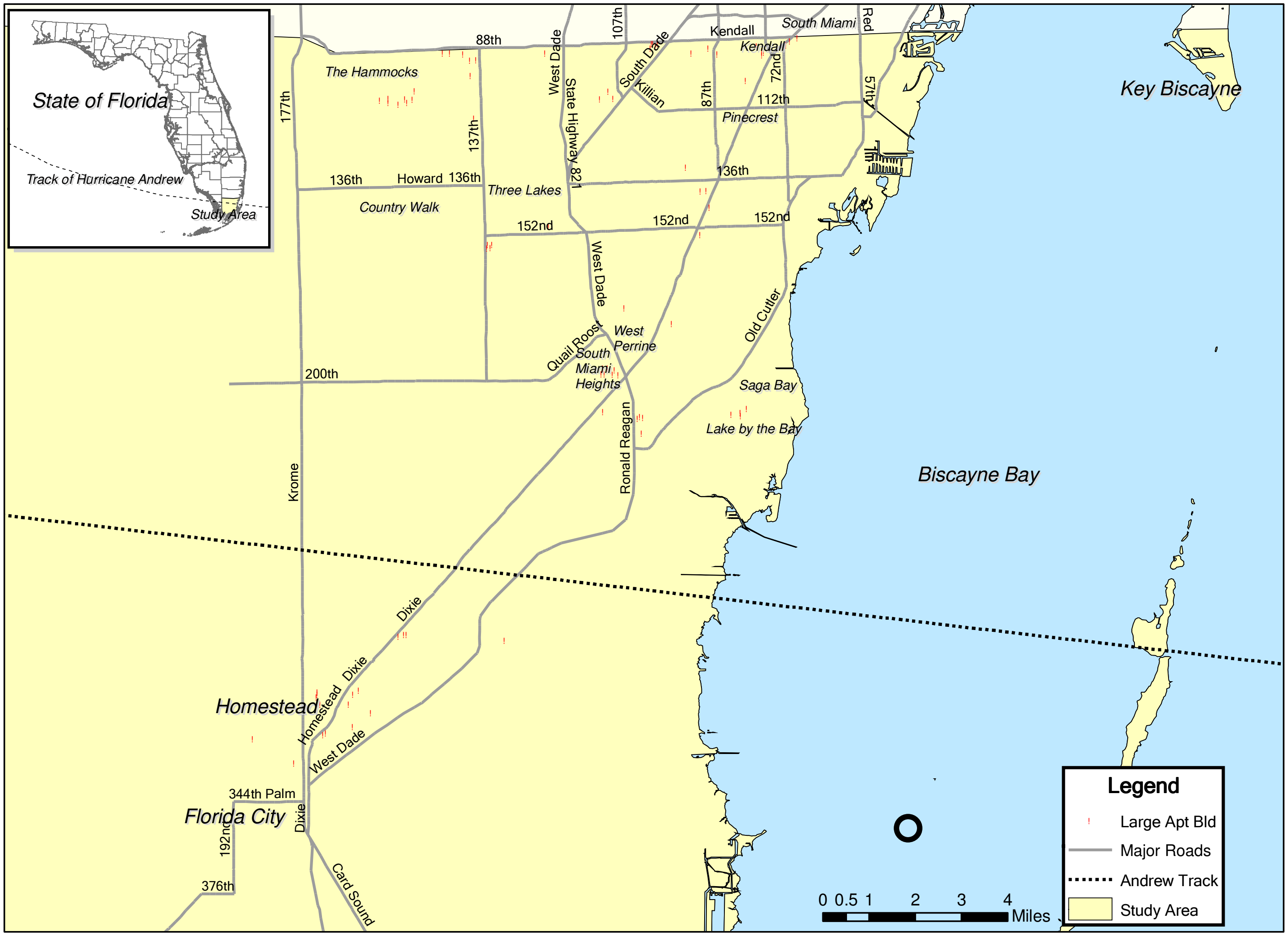

Figure 5.4 Spatial Pattern of Large Apartment Buildings in South Miami-Dade County, Florida

Table 5.1 Descriptive Statistics of Pre-Hurricane Andrew Housing and Neighborhood Characteristics by Apartment Type

		Triplexes/ Fourplexes (n=251)	Small Apartment Buildings (n=113)	Medium Apartment Buildings (n=102)	Large Apartment Buildings (n=80)
Building Value (K)	Mean	45.13	78.67	281.50	3910.03
	S.D.	22.57	73.86	202.02	3413.20
	Min.	6.79	8.67	32.51	318.66
	Max.	256.05	738.89	1093.32	14107.54
Living Units	Mean	3.75	7.08	22.66	183.16
	S.D.	0.43	1.62	11.26	128.50
	Min.	3.00	5.00	11.00	51.00
	Max.	4.00	10.00	50.00	690.00
Bedrooms	Mean	6.23	7.08	32.57	272.80
	S.D.	1.81	1.62	20.68	212.05
	Min.	3.00	5.00	11.00	57.00
	Max.	12.00	10.00	124.00	1200.00
Bathrooms	Mean	3.93	7.10	24.12	229.31
	S.D.	0.60	1.77	14.75	179.65
	Min.	3.00	3.00	4.00	51.00
	Max.	8.00	12.00	96.00	846.00
Building SQ Footage (K)	Mean	2.70	4.65	14.78	150.17
	S.D.	0.85	3.85	9.90	112.09
	Min.	0.85	1.51	2.52	30.82
	Max.	6.81	41.94	58.20	468.91
Building Age	Mean	34.55	33.94	28.95	15.14
	S.D.	12.72	12.48	12.17	9.18
	Min.	3.00	5.00	3.00	2.00
	Max.	86.00	66.00	73.00	35.00
Med. Household Income (K)	Mean	18.07	19.69	22.01	31.85
	S.D.	10.73	11.93	12.43	11.26
	Min.	8.16	5.00	8.16	9.65
	Max.	83.32	61.79	61.79	61.79
Anglo (%)	Mean	23.84	24.16	29.27	43.98
	S.D.	25.87	23.62	21.33	16.20
	Min.	0.27	0.27	0.71	1.60
	Max.	94.83	84.09	83.38	75.73
Non Hispanic Black (%)	Mean	48.65	43.67	32.53	14.65
	S.D.	37.63	35.45	28.17	16.41
	Min.	0.00	0.00	0.22	1.39
	Max.	99.06	99.06	94.33	92.64

Table 5.1 Continued

		Triplexes/ Fourplexes (n=251)	Small Apartment Buildings (n=113)	Medium Apartment Buildings (n=102)	Large Apartment Buildings (n=80)
Hispanic (%)	Mean	26.78	31.21	36.90	38.92
	S.D.	20.93	20.88	15.61	13.28
	Min.	0.67	0.67	4.66	5.28
	Max.	62.95	60.18	68.00	68.00
Other (%)	Mean	0.73	0.96	1.29	2.45
	S.D.	0.71	1.19	1.18	0.98
	Min.	0.00	0.00	0.00	0.34
	Max.	4.10	8.43	4.18	4.10
Damage (%)	Mean	49.93	60.02	70.01	56.94
	S.D.	34.92	35.58	34.65	37.59
	Min.	0.00	0.00	0.00	0.00
	Max.	100.00	100.00	100.00	100.00

Tables 5.2, 5.3, 5.4, and 5.5 list the average building values, post-disaster values total percentage of loss/gain compared to the pre-disaster level, average percentage of loss/gain and percentage of buildings which had not reached pre-disaster level, by size of apartment building. Nearly all of the apartment buildings suffered varied damage from Hurricane Andrew, giving all the four apartment categories a substantial average value loss in the 1993 appraisal. Medium apartment buildings had the highest damage of 61.9%, but the less damaged category, triplexes/fourplexes, still suffered 46.8% damage.

In the 1994 appraisal, the average building value of these four categories rose, approaching but not exceeding pre-disaster levels. However, about half, 50.6% of the triplexes/fourplexes, 47.8% of the small apartment buildings, 49.0% of the medium apartment buildings, and 45.0% of the large apartment buildings had not reached their pre-disaster levels. In the 1995 appraisal, the average building value of triplexes/fourplexes, small apartment buildings, and large apartment buildings reached their 1992 levels, but medium apartment buildings were still 2% below their pre-disaster levels. In the 1996 appraisal, the average building in all apartment categories had reached its pre-disaster level with a 6.8% to 17.1% gain in value. However, about a quarter of the apartment buildings, 21.1% of the triplexes/fourplexes, 25.7% of the small apartment buildings, 24.5% of the medium apartment buildings, and 25.0% of the large apartment buildings had not reached pre-disaster levels. Analyzing the results of average building value, it seems that triplexes/fourplexes, small apartment buildings, and large apartment buildings had a relatively faster housing recovery and reached pre-disaster levels by 1995. Medium apartment buildings had a relatively flat recovery trajectory when compared to other apartment categories; their average building value reached pre-disaster level by 1996, one year after other categories.

Table 5.2 Average Building Values of Triplex/Fourplex (3-4 Living Units) before and after Hurricane Andrew

	92	93	94	95	96
Avg. Value	45128	24027	42593	51713	51280
Loss/Gain		-21101	-2535	6585	6152
% Loss/Gain		-46.8%	-5.6%	14.6%	13.6%
Avg. of % Loss/Gain		-49.9%	-0.9%	22.3%	22.0%
% of Buildings Below 92		99.6%	50.6%	20.3%	21.1%

Table 5.3 Average Building Values of Small Apartment Building (5-10 Living Units) before and after Hurricane Andrew

	92	93	94	95	96
Avg. Value	78669	29984	68226	87757	85751
Loss/Gain		-48684	-10443	9088	7082
% Loss/Gain		-61.9%	-13.3%	11.6%	9.0%
Avg. of % Loss/Gain		-60.0%	-10.0%	9.3%	6.7%
% of Buildings Below 92		99.1%	47.8%	24.8%	25.7%

Table 5.4 Average Building Values of Medium Apartment Building (11-50 Living Units) before and after Hurricane Andrew

	92	93	94	95	96
Avg. Value	281495	91127	236400	275797	329498
Loss/Gain		-190368	-45095	-5698	48003
% Loss/Gain		-67.6%	-16.0%	-2.0%	17.1%
Avg. of % Loss/Gain		-69.9%	-15.3%	-0.1%	11.6%
% of Buildings Below 92		97.1%	49.0%	34.3%	24.5%

Table 5.5 Average Building Values of Large Apartment Building (51 and More Units) before and after Hurricane Andrew

	92	93	94	95	96
Avg. Value	3910026	1958979	3388353	3937381	4176758
Loss/Gain		-1951047	-521673	27355	266732
% Loss/Gain		-49.9%	-13.3%	0.7%	6.8%
Avg. of % Loss/Gain		-56.2%	-8.1%	8.5%	17.6%
% of Buildings Below 92		92.5%	45.0%	23.8%	25.0%

Similar to the comparison by housing type, this average building value analysis by apartment building size may not reflect the actual levels of recovery because reaching the pre-disaster “average” building value may be the effect of rapid restoration of high value apartment buildings with no recovery of low value apartment buildings. In addition, different sized apartment buildings had different ages, neighborhood characteristics, and damage levels. If age, neighborhood characteristics, and damage are controlled, does size of apartment building matter in terms of housing recovery? Panel analyses of apartment buildings are presented in Sections 5.2 to 5.4 to confirm the different housing recovery trajectories of different size categories.

5.1.2 Factors associated with building value and damage

Building value

Tables 5.6, 5.7, 5.8, and 5.9 list the correlation matrixes of major variables for triplexes/fourplexes, small, medium, and large apartment buildings. In general, the numbers of bedrooms, baths and square footage have positive correlations with the 1992 log building value in all of the apartment size categories. These three variables were either uncorrelated or the correlations attenuated more markedly with 1993-96 log building values due to Hurricane Andrew's impact and the lack of investment after the disaster. Building age had a negative correlation with log building values of triplexes/ fourplexes, small, and medium apartment buildings in most years because older housing tends to have value depreciation. However, building age was uncorrelated with log building value after the disaster impact for large apartment buildings. This is because large apartment buildings had a relatively narrow age range and the value variation was reduced by damage. Sales did not have a correlation before and immediately after the disaster for small, medium, and large apartment buildings. However, it had a significant negative effect on triplexes/ fourplexes on log building values from 1994-96.

Neighborhood median household income was positively correlated with log building value for small, medium, and large apartment buildings, which is consistent with expectations because apartment buildings in wealthy neighborhoods tend to have higher values than those of similar size in poor neighborhoods. However, due to the influence of disaster damage, neighborhood income was uncorrelated with log building value from 1993-95 in the triplexes/fourplexes correlation table. In general, neighborhood Anglo and Hispanic population percentage showed positive effects and neighborhood Black population percentage showed a negative effect on log building value in most of the correlation coefficients for triplexes/fourplexes, small, and medium apartment buildings. This is also plausible because Black neighborhoods are relatively poor and demand for high-class apartments with high rent is low. However, race/ethnicity composition had no significant effect on log value of large apartment buildings because they were clustered in Anglo and Hispanic neighborhoods.

Table 5.6 Correlation Table of Major Variables, Triplexes/Fourplexes (3-4 Units)

		1.	2.	3.	4.	5.	6.	7.	8.	9.	11.	12.	13.	14.	15.	16.	17.
1.	ln 92 bld vl																
2.	ln 93 bld vl	.35**															
3.	ln 94 bld vl	.37**	.41**														
4.	ln 95 bld vl	.29**	.44**	.90**													
5.	ln 96 bld vl	.28**	.41**	.85**	.94**												
6.	Room	.39**	.06	.03	.00	.00											
7.	Bath	.37**	.07	.16*	.16*	.14*	.31**										
8.	Ln bld sq ft	.80**	.12	.17**	.09	.11	.37**	.36**									
9.	Bld age	-.51**	-.38**	-.42**	-.37**	-.33**	-.27**	-.15*	-.12								
11.	Sale	.08	-.03	-.18**	-.18**	-.18**	.08	.04	.05	-.02							
12.	Income	.34**	.12	.11	.11	.12*	-.06	.14*	.38**	.11	.00						
13.	Anglo	.36**	.19**	.16*	.18**	.20**	-.07	.05	.40**	.12*	-.08	.73**					
14.	Non-His Blk	-.37**	-.20**	-.17**	-.17**	-.19**	.11	.03	-.34**	-.03	.03	-.55**	-.84**				
15.	Hispanic	.22**	.12*	.10	.09	.10	-.11	-.12*	.1	-.11	.04	.08	.26**	-.74**			
16.	Other race	.27**	.04	.04	.04	.05	.03	-.03	.30**	.05	-.02	.59**	.56**	-.51**	.18**		
17.	Damage	-.19**	-.76**	-.36**	-.38**	-.36**	.04	.02	-.07	.11	.01	-.21**	-.31**	.35**	-.24**	-.12*	

** Correlation is significant at the .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed).

Table 5.7 Correlation Table of Major Variables, Small Apartment Buildings (5-10 Units)

		1.	2.	3.	4.	5.	6.	7.	8.	9.	11.	12.	13.	14.	15.	16.	17.
1.	ln 92 bld vl																
2.	ln 93 bld vl	.27**															
3.	ln 94 bld vl	.55**	.61**														
4.	ln 95 bld vl	.58**	.55**	.92**													
5.	ln 96 bld vl	.55**	.47**	.79**	.86**												
6.	Room	.44**	-.08	.15	.22*	.23*											
7.	Bath	.48**	.09	.31**	.32**	.34**	.58**										
8.	Ln bld sq ft	.89**	.12	.34**	.37**	.34**	.45**	.47**									
9.	Bld age	-.52**	-.45**	-.56**	-.50**	-.49**	-.19*	-.24**	-.25**								
11.	Sale	.15	-.01	.00	-.02	.05	-.05	-.03	.13	-.08							
12.	Income	.19*	.22*	.21*	.22*	.23*	.27**	.01	.14	-.07	.17						
13.	Anglo	.35**	.11	.19*	.23*	.20*	.23*	.08	.29**	-.06	.18	.68**					
14.	Non-His Blk	-.49**	-.18*	-.35**	-.38**	-.30**	-.15	-.11	-.34**	.26**	-.18	-.43**	-.82**				
15.	Hispanic	.42**	.19*	.37**	.37**	.29**	-.02	.10	.25**	-.36**	.09	-.07	.23*	-.74**			
16.	Other race	.15	-.02	.14	.14	.14	.15	.00	.11	-.04	.04	.61**	.63**	-.48**	.04		
17.	Damage	-.08	-.76**	-.38**	-.34**	-.33**	.21*	.05	.02	.13	.10	-.30**	-.23*	.27**	-.19*	-.16	

** Correlation is significant at the .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed).

Table 5.8 Correlation Table of Major Variables, Medium Apartment Buildings (11-50 Units)

		1.	2.	3.	4.	5.	6.	7.	8.	9.	11.	12.	13.	14.	15.	16.	17.
1.	ln 92 bld vl																
2.	ln 93 bld vl	.29**															
3.	ln 94 bld vl	.43**	.24*														
4.	ln 95 bld vl	.33**	.15	.74**													
5.	ln 96 bld vl	.48**	.17	.73**	.83**												
6.	Room	.64**	.30**	.20*	.19	.35**											
7.	Bath	.68**	.30**	.26**	.19	.38**	.85**										
8.	Ln bld sq ft	.93**	.27**	.35**	.29**	.46**	.79**	.82**									
9.	Bld age	-.59**	-.16	-.38**	-.21*	-.35**	-.27**	-.29**	-.48**								
11.	Sale	.03	.00	-.05	-.16	.05	.00	.05	0.0	-.02							
12.	Income	.39**	.23*	.23*	.26**	.33**	.25*	.32**	.38**	-.20*	-.20*						
13.	Anglo	.52**	.24*	.20*	.15	.27**	.21*	.31**	.42**	-.23*	.06	.64**					
14.	Non-His Blk	-.58**	-.16	-.32**	-.30**	-.39**	-.23*	-.30**	-.48**	.28**	.01	-.51**	-.83**				
15.	Hispanic	.32**	-.01	.28**	.32**	.30**	.11	.10	.26**	-.18	-.07	.01	.12	-.64**			
16.	Other race	.35**	-.29**	.26**	.24*	.30**	.23*	.23*	.39**	-.23*	-.25**	.50**	.28**	-.28**	.04		
17.	Damage	-.09	-.69**	-.32**	-.26**	-.21*	-.08	-.07	-.07	-.01	.12	-.38**	-.20*	.13	.03	.04	

** Correlation is significant at the .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed).

Table 5.9 Correlation Table of Major Variables, Large Apartment Buildings (50 and More Units)

		1.	2.	3.	4.	5.	6.	7.	8.	9.	11.	12.	13.	14.	15.	16.	17.
1.	ln 92 bld vl																
2.	ln 93 bld vl	.52**															
3.	ln 94 bld vl	.35**	.48**														
4.	ln 95 bld vl	.33**	.43**	.97**													
5.	ln 96 bld vl	.38**	.28*	.78**	.80**												
6.	Room	.79**	.32**	.27*	.25*	.31**											
7.	Bath	.84**	.40**	.30**	.29**	.32**	.95**										
8.	Ln bld sq ft	.95**	.46**	.32**	.32**	.37**	.82**	.84**									
9.	Bld age	-.39**	-.08	-.19	-.18	-.20	-.24*	-.31**	-.31**								
11.	Sale	.04	-.09	-.14	-.12	-.06	.08	.11	.06	.03							
12.	Income	.42**	.39**	.35**	.33**	.34**	.29**	.36**	.41**	-.17	-.05						
13.	Anglo	-.03	.08	-.04	-.06	-.10	-.16	-.12	-.04	.12	-.03	.57**					
14.	Non-His Blk	-.13	-.13	.02	.02	.03	-.03	-.09	-.09	.15	-.09	-.50**	-.67**				
15.	Hispanic	.16	.02	-.02	.03	.06	.22	.23*	.13	-.30**	.15	-.13	-.43**	-.39**			
16.	Other race	.50**	.53**	.48**	.43**	.37**	.30**	.40**	.43**	-.31**	-.09	.74**	.41**	-.45**	-.01		
17.	Damage	-.23*	-.77**	-.38**	-.31**	-.23*	-.07	-.14	-.16	-.06	.15	-.34**	-.15	.28*	-.12	-.48**	

** Correlation is significant at the .01 level (2-tailed). * Correlation is significant at the .05 level (2-tailed).

Damage

Damage levels differed by apartment category. Triplexes/fourplexes had the smallest damage, 49.9% (Table 5.1), of four apartment categories. Small apartment buildings had 60.0% damage, and medium apartment buildings suffered the greatest damage of 70.0% of all apartment categories. Large apartment buildings had a 56.9% value loss in 1993. The damage to medium apartment buildings is different from triplexes/fourplexes at the 0.05 level by Turkey HSD and differs from other categories at the 0.05 level by LSD.

Building age does not show a positive correlation with damage as expected in all of the categories. Neighborhood income level shows a moderately negative correlation with damage (-21% to -38%) in all four size categories. This implies that apartment buildings in wealthy neighborhoods had less damage. This is consistent with expectations because apartment buildings in wealthy neighborhoods tend to incorporate better building materials, higher design standards, and enhanced maintenance to make the properties more attractive and profitable. Neighborhood Anglo proportion had a significantly negative correlation with damage in triplexes/fourplexes, small, and medium apartment buildings, but no significant correlation in large apartment buildings. Neighborhood non-Hispanic Black proportion had a significant negative correlation with damage in triplexes/fourplexes, small, and large apartment buildings, but was insignificant in medium apartment buildings. Neighborhood Hispanic proportion also had a significant negative correlation with damage in triplexes/fourplexes and small apartment buildings, but was insignificant in medium and large apartment buildings. Although not all race/ethnicity composition coefficients are significant at the 0.05 level, these results show that either apartment buildings in non-Hispanic Black neighborhoods tend to have greater damage or apartment buildings in Anglo or Hispanic neighborhoods tend to have less damage.

5.2 HOUSING RECOVERY TRAJECTORY COMPARISON BY BASIC MODEL

The first step in this analysis will again, as in Chapter IV, be to run a set of basic models for each apartment category with only year dummy variables to establish baseline damage and recovery trajectories. A pooled model was also estimated to test for difference in overall damage and recovery trajectories (see Appendix 1.5). Across size categories, this analysis indicated that trajectories were significantly different hence, only the separate models are discussed here. The analytical model for each apartment category is:

$$\ln (BV)_{it} = \beta_0 + \delta_1 \, yr93_{it} + \delta_2 \, yr94_{it} + \delta_3 \, yr95_{it} + \delta_4 \, yr96_{it} + \nu_{it} \qquad [11]$$

Table 5.10 lists the values, robust standard errors, and p values for δ_1 (yr93), δ_2 (yr94), δ_3 (yr95), δ_4 (yr96), and β_0 (constant) in triplexes/fourplexes, small, medium, and large apartment building models.

Table 5.10 Results of Basic Models, Comparison by Size of Apartment Building

	Triplex/Fourplex			Small Apartment			Medium Apartment			Large Apartment		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	-1.6480	0.1425	0.000	-2.3580	0.2325	0.000	-2.8475	0.2791	0.000	-1.8744	0.2511	0.000
yr94	-0.8827	0.1181	0.000	-1.1252	0.2112	0.000	-1.0036	0.1897	0.000	-1.0078	0.2659	0.000
yr95	-0.7382	0.1286	0.000	-0.8233	0.2086	0.000	-1.0558	0.2453	0.000	-0.6940	0.2607	0.008
yr96	-0.8523	0.1428	0.000	-1.2603	0.2660	0.000	-0.6501	0.2225	0.003	-0.2998	0.2197	0.172
cons	10.6132	0.1136	0.000	11.0680	0.2111	0.000	12.2673	0.1373	0.000	14.8265	0.2100	0.000
R-sq: within		0.1065			0.1592			0.2148			0.1393	
Between		0.0000			0.0000			0.0000			0.0000	
overall		0.0435			0.0618			0.1177			0.0580	

Triplex/fourplex model

Triplexes/fourplexes had the smallest β_1, -1.6480, of all apartment building categories reflecting a 80.8% loss in value. The coefficient, $\beta_2 = -0.8827$, shows the log building value change in 1994 was 58.6% below the pre-disaster level. However, this was a relative gain when compared to 1993, showing triplex/fourplex recovery from 1993 to 1994. The negative $\beta_3 = -0.7382$ indicates that, in 1995, the average log building value of triplexes/fourplexes was still below the 1992 level by 52.2%. In addition, the small increment from 1994 to 1995 (only a 6.4% gain) also reveals a sluggish recovery trajectory during this time. The 1996 coefficient β_4 is more negative than β_3, which means the average log building value in 1996 was even lower than that of 1995. This reduction could be a result of some damaged triplexes/ fourplexes not having any significant improvement but having retained some building value from 1993 to 1995. These buildings were torn down in 1996, then their building values would have become 0[19] and decreased the average log building value in that year.

Examining the trajectory of average building value in Section 5.1 and Table 5.2 suggests that the average building value of triplexes/fourplexes reached its pre-disaster level by 1995. However, the result from this basic model indicates that triplexes/fourplexes were still below pre-disaster level. This inconsistency occurred because of different distribution patterns of building value and log building value. The log building value distributions from 1993 to 1996 were a tri-modal that have one major peak defined by recovered structures two secondary peaks of a) heavily damaged/no recovery and b) torn down (0 building value). These disparate recovery outcomes within

[19] For the cases with no building value, their log building value were modified to 0.

triplexes/fourplexes induce a slower recovery trend reflected in the basic model analysis compared to the average values. However, the result obtained for the panel model analysis by applying log building value presents a more consistent picture of overall housing recovery.

In summary, triplexes/fourplexes had a dramatic average log building value decrease between 1992 and 1993 due to Hurricane Andrew, although they were the least damaged in the apartment categories. The average log building value returned quickly between 1993 and 1994, became sluggish between 1994 and 1995, and slightly decreased in 1996. Triplexes/fourplexes had still not reached their pre-disaster values by 1996, the end of this research peirod.

Small apartment building model

The δ_1 (-2.3580) for small apartment buildings indicates that, in general, small apartment buildings suffered a greater proportional value loss from Hurricane Andrew than triplexes/fourplexes and large apartment buildings. Specifically, this coefficient indicates that small apartment buildings lost 90.5% of their value. In 1994, small apartment buildings had a rapid average log building value return of 1.1328 (-1.1252 – (-2.3580)), but the δ_2 value also indicates that they were far below (67.5%) the 1992 level. The δ_3 value when compared to δ_2 indicates that recovery continued from 1994 to 1995, but the small increment (0.3019) in 1995 also indicates that recovery was not as rapid as the previous year. Indeed values were still 56.1% lower than in 1992. The finding that δ_4 was more negative than δ_3 is similar to the pattern for triplexes/fourplexes. Due to the increasing numbers of building demolitions, the average log building value of

1996 is smaller than the 1995 value.

The housing recovery trajectory of small apartment buildings shows that these buildings did not reach their pre-disaster levels by 1996. This also is inconsistent with the result of the average building value analysis that showed small apartment buildings reached their 1992 levels by 1995. As before, this inconsistency is also to the different distributions of building value and log building value. The log building value distributions from 1993 to 1996 show a tri-modal pattern similar to that of triplexes/ fourplexes. The result from basic model analysis may be a more accurate description of the actual housing recovery than the result of the average building value analysis because a significant proportion of small apartment buildings were still below pre-disaster level in 1996.

In brief, small apartment buildings had a precipitous decrease in log building value between 1992 and 1993 due to Hurricane Andrew, and they were the second most damaged of all apartment size categories. The average log building value rose rapidly between 1993 and 1994, became sluggish between 1994 and 1995, and slightly decreased in 1996. During the period of this research, small apartment buildings did not reach pre-disaster level, and had the greatest proportional value loss of all apartment categories in 1996.

Medium apartment building model

Medium apartment buildings suffered the greatest damage of all the apartment size categories as shown by δ_1 = -2.8475 which was the greatest log building value decrease and indicates a 94.2% loss. However, medium apartment buildings had a strongest return of all categories from 1993 to 1994. During this time, the increment of average log building value was 1.8239 (-1.0036 – (2.8475)). The coefficient (δ_2) indicates a loss from 1992 of 63.3%, which indicates a gain of nearly 31%. In 1995, the average log building value was 0.0022 (-1.0058 – (-1.0036)) which was smaller than the 1994 log building value--suggesting that the recovery gains were lost. This decrease was due to an increase in the number of demolished buildings that again decreased the overall log building value. In 1996, the average log building value had a 0.3557 (-0.6501 – (-1.0058)) gain over 1995, indicating that medium apartment buildings resumed their recovery on a moderate path from 1995 to 1996 with 1996 values being only 47.8% below 1992 values. Medium apartment buildings have the second largest δ_4 value, which indicates that their housing recovery may be better than triplexes/fourplexes and small apartment buildings even though they initially had the greatest damage level.

This basic model shows that medium apartment buildings also had not recovered by 1996 because the average log building value was still 47.8% below that of 1992. The result from average value analysis shows that, in 1996, the average value of medium apartment buildings had exceeded their pre-disaster levels. Similar to triplexes/fourplexes and small apartment buildings, this inconsistency is due to the logarithmic distribution better capturing changes across the spectrum. Again, the results of this analysis may be more consistent with general housing recovery experience because 25% of medium apartment buildings had still not reached pre-disaster value in 1996.

The housing recovery trajectory shows that medium apartment buildings had the greatest log building value loss between 1992 and 1993, but returned dramatically between 1993 and 1994, became slightly decreased between 1994 and 1995, and kept increasing in 1996. During the period of this research, medium apartment buildings had not yet reached pre-disaster level. However, the recovery trajectory of medium apartment buildings also shows that they had the second greatest retained building value in 1996.

Large apartment building model

The value of δ_1 = -1.8744 in large apartment buildings shows that the average damage level of large apartment buildings was between triplexes/fourplexes and small apartment buildings, indicating a 84.7% loss. However, large apartment buildings were significantly less damaged than medium apartment buildings without considering other housing and socioeconomic factors. Similar to other apartment categories, large apartment buildings had a rapid return from 1993 to 1994; by 1994 these structures were only 63.5% below their 1992 values. The average log building value of large apartment buildings kept increasing from 1994 to 1995 with the largest increment of 0.3138 (-0.6940 – (-1.0078)) among all apartment categories. The coefficient (-0.6940) suggests that by 1995 losses from 1992 were reduced to 50%. The 0.2942 (-0.2998 – (-0.6940)) increment between δ_4 and δ_3 shows that the average log building value of large apartment buildings continued increasing from 1995 to 1996. This was similar to medium apartment buildings, but different from triplexes/fourplexes and small apartment buildings. This increment suggests that large apartment owners kept their investments in their buildings from 1995 to 1996. It is worthwhile to note that the test of δ_4 is no different from 0 at the 0.1 level, implying that large apartment building can be treated as reaching pre-disaster levels in 1996. Large apartment buildings are the only apartment category that approached recovery levels by 1996!

The result from the basic model is again inconsistent with the result of average value analysis (Table 5.5), which indicates that the average building value of large apartment buildings exceeded its pre-disaster level in 1995. This inconsistency is also caused by the different distribution of values before and after logarithmic transformation. However, the test of δ_4 indicates that large apartment buildings had approached pre-disaster level in 1996.

In summary, the housing recovery trajectory of large apartment buildings shows that they had a precipitate drop due to hurricane impact, but not as negative as medium apartment buildings. The average log building value had a significant return between 1993 and 1994 and kept increasing from 1994 to 1996. In 1996, large apartment buildings could be treated as having reached pre-disaster levels since the log building value was not significantly different from the pre-disaster level.

Overall there were a number of expected similarities with respect to the recovery trajectories among the different types of apartment complexes, however there were also some surprising differences. The recovery trajectories patterns for each form of apartment are displayed graphically in Figure 5.5. Not surprisingly, there were major losses for each form of apartment building due to Hurricane Andrew, although there were some variations in the extent of that impact as well. Generally all made substantial gains during the first year of the recovery but there was much less improvement between

1994 and 1995. However, quite divergent trajectories are evident in the last year, with large apartment buildings continuing to improve—nearly reaching full recovery and medium apartments also substantially improving. The trajectory for triplexes/fourplexes remained flat, and small apartments, actually lost ground. On the whole then, only large apartment buildings reached recovery levels, with median apartment buildings lagging somewhat, and the trajectories of small apartment buildings and triplex/fourplex structures in question.

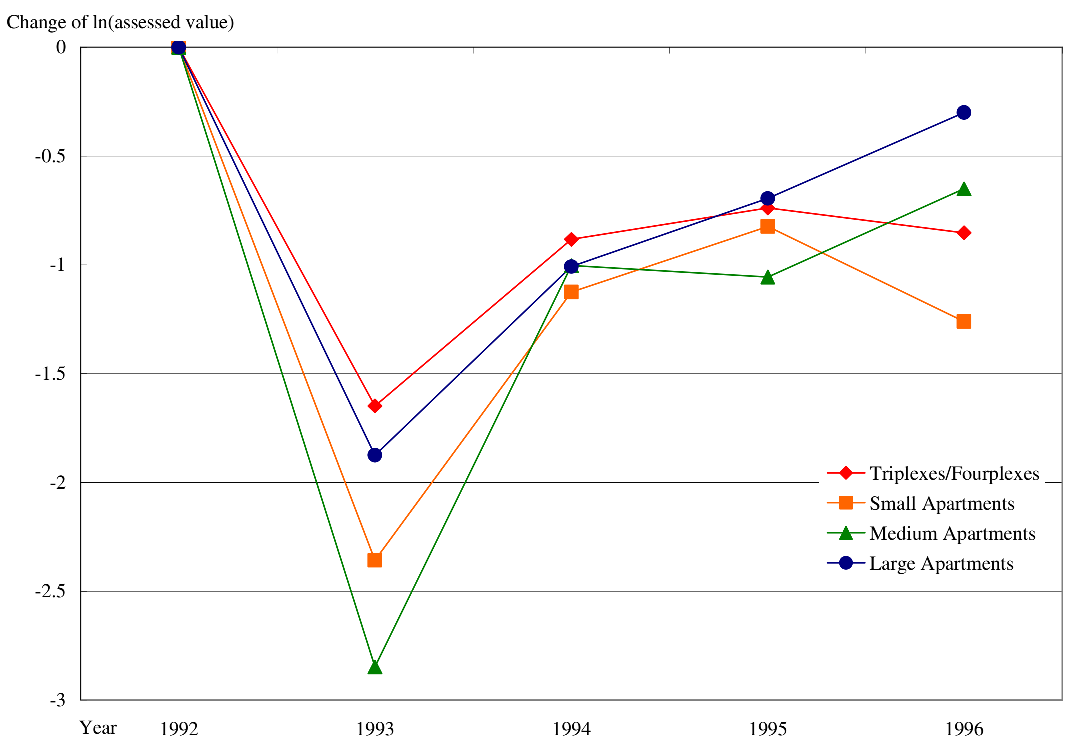

Figure 5.5 Housing Recovery Trajectories of All Apartment Types, Basic Model

5.3 HOUSING RECOVERY TRAJECTORY COMPARISON INCLUDING SOCIOECONOMIC FACTORS

The descriptive statistics for each size of apartment building show that different apartment sizes had distinct housing and neighborhood characteristics before Hurricane Andrew. Large apartment buildings were newer buildings and tended to be located in Anglo neighborhoods when compared to triplexes/fourplexes and small apartment buildings. Furthermore, and most important as discussed in the literature review, socio-economic factors as well as other housing characteristics are likely to have impacts on the impact and recovery. Therefore, as with the general housing analysis in Chapter IV, this chapter will extend the analysis of apartment recovery by estimating a socioeconomic and control model in order to compare impact and recovery trajectories by adjusting the inherently different housing and neighborhood characteristics. Two levels of data, structure and neighborhood, are included in this socioeconomic control model. Unlike in the previous chapter, the data upon which these models will be built have much smaller sample sizes. In addition, the inclusion of both bedrooms and bathrooms, which is standard and appropriate particularly when modeling single family homes, creates a collinearity issue, especially in medium and large apartment models. Interestingly, substituting the floor area (log square feet) of these structures showed slightly higher R^2 values. Hence, log building square footage is substituted for the numbers of bedrooms or bathrooms in the apartment models. In addition, owner-occupancy is dropped from this analysis because it was difficult to determine from the original folio data and probably has a constant value (zero) in the larger apartment complexes. The neighborhood (block group) level data include median household income and neighborhood race/ethnicity composition, indicating proportions of Anglo, non-Hispanic Black, Hispanic, and other races. The model for comparison of the apartments is:

$$\ln(BV)_{it} = \beta_0 + \delta_1\ yr93_{it} + \delta_2\ yr94_{it} + \delta_3\ yr95_{it} + \delta_4\ yr96_{it} + \beta_5\ ln\_bldft_{it} + \beta_6\ bldage_{it} + \beta_7\ sale_{it} + \beta_8\ income_{it} + \beta_9\ Black_{it} + \beta_{10}\ Hispanic_{it} + \beta_{11}\ other_{it} + \nu_{it} \quad [12]$$

where ln_bldft is log building square footage, bldage is building age at 1992, and the other variables are as defined previously.

Neighborhood related coefficients (β_8 to β_{11}) should be interpreted with caution. Apartment buildings tended to be geographically clustered, and different apartment building sizes were located in distinct neighborhoods. For example, large apartment buildings tended to be located in more affluent Anglo neighborhoods (along Kendell Dr. and S. Dixie Hwy) when compared with triplexes/fourplexes (Homestead and Florida City). In addition, after classifying the cases into four apartment building categories, there are only a small number of observations in some categories (251 triplexes/fourplexes, 113 small apartments, 102 medium apartments, and 80 large apartments). The spatial distribution and numbers of cases might make the neighborhood coefficients particularly sensitive to slight variations in the values of individual cases.

Table 5.11 Results of Separated Socioeconomic Models, Comparison by Apartment Building Size

	Triplex/Fourplex			Small Apartment			Medium Apartment			Large Apartment		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	-1.6209	0.1454	0.000	-2.2865	0.2457	0.000	-2.8239	0.2792	0.000	-1.8627	0.2485	0.000
yr94	-0.8719	0.1202	0.000	-1.1252	0.2142	0.000	-0.9823	0.1917	0.000	-0.9842	0.2699	0.000
yr95	-0.7174	0.1314	0.000	-0.7978	0.2175	0.000	-1.0251	0.2555	0.000	-0.6881	0.2660	0.010
yr96	-0.8369	0.1463	0.000	-1.2859	0.2711	0.000	-0.6430	0.2171	0.003	-0.3057	0.2275	0.179
ln_bld_ft	0.0893	0.4276	0.835	1.1185	0.4221	0.008	0.8958	0.2680	0.001	0.5915	0.3310	0.074
bldage93	-0.0731	0.0144	0.000	-0.0866	0.0211	0.000	-0.0271	0.0193	0.162	0.0112	0.0197	0.570
sale_	-0.2269	0.2235	0.310	-0.5772	0.2229	0.010	-0.2409	0.2488	0.333	-0.4714	0.2796	0.092
income (K)	0.0064	0.0141	0.651	0.0588	0.0264	0.026	0.0418	0.0159	0.009	0.0382	0.0267	0.153
Black (%)	-0.0239	0.0061	0.000	0.0055	0.0130	0.673	0.0020	0.0105	0.847	0.0502	0.0217	0.021
His. (%)	-0.0231	0.0096	0.016	0.0266	0.0207	0.199	0.0240	0.0161	0.134	0.0342	0.0214	0.110
Other (%)	-0.3627	0.2385	0.128	-0.1330	0.3306	0.687	-0.2154	0.2193	0.326	1.0458	0.3278	0.001
β_0	14.3776	3.7570	0.000	2.6553	4.2524	0.532	3.0624	2.7888	0.272	1.9795	2.9707	0.505
R^2 within		0.1068			0.1688			0.2167			0.1507	
R^2 between		0.2926			0.4518			0.3496			0.4568	
R^2 overall		0.2167			0.3420			0.2768			0.3293	

To compare the consequences of these structural, socioeconomic, and sales variables on the impact and recovery trajectories, a pooled model was run first, to test if these factors as a group accounted for differences in the recovery trajectories of the four apartment size types. The results were indeed significant[20], suggesting that different processes were occurring among these types of apartments (see Appendix 1.6). Table 5.11 presents the regression coefficients, robust standard errors, and P values for coefficients of independent variables in socioeconomic and control models for triplexes/fourplexes and small, medium, and large apartment buildings.

Triplex/fourplex model

The value of δ_1 indicates the impact of Hurricane Andrew in 1992 for triplexes/fourplexes by assessing the difference in 1993's value from its 1992 base. As would be expected, the value δ_1 = -1.6209 is the most negative value among all of the year dummy coefficients, indicating an 80.2% loss in value. However, the δ_1 of triplexes/fourplexes is the smallest in all of the apartment building categories after controlling housing and socioeconomic factors. This demonstrates that if building age and numbers of sales were the same, triplexes/fourplexes would have less damage when compared to larger apartments in the same neighborhood. The coefficient δ_2 = -0.8719 indicates that the 1994 value is 58.6% lower than 1992. This suggests that a substantial improvement was completed between 1993 and 1994. In between 1994 and 1995, housing recovery for these apartments became sluggish. The coefficientδ_3 = -7174

[20] Again a Wald test for linear restrictions was run yielding a $\chi 2$ of 80.48, with 33 df, with a probability of $\leq .001$.

indicates that these apartments were still 51.2% below their 1992 value, which in turn suggests only a 7.4% recovery from initial impact. Making matters ever worse, the 1996 coefficient δ_4 is even more negative (-.8369 or -.56.7%) than δ_3, which means the average log building value in 1996 was even lower than that of 1995. The cause of this decrease from 1995 to 1996 in the socioeconomic control model is similar to that of the basic model. Clearly, even after controlling for socioeconomic and other controls, triplexes/fourplexes failed to reach recovery in 1996.

Sales did not have a significant effect on building values of triplexes/fourplexes from 1992 to 1996. Neighborhood income has a positive effect of .64% per thousand dollars of median income. Although the net effect of per thousand dollars is small, the accumulated effect of income is 12.2% for the average medium income ($18,000) and 70.05 for the maximum income ($83,000) in building values of triplexes/fourplexes. Both non-Hispanic Black and Hispanic neighborhood compositions had overall negative effects on building values: every 1% increase in non-Hispanic Black and Hispanic population decreased building values by 2.39% and 2.29% respectively. These effects are not significantly different from each other, and both clearly have substantial negative consequences for housing in predominantly minority areas.

In summary, after considering overall housing (building age, number of sales) and neighborhood effects (income and race/ethnicity), triplexes/fourplexes had a dramatic average log building value decrease between 1992 and 1993. Their average log building value bounced back substantially between 1993 and 1994, but became sluggish between 1994 and 1995.The average log building value decreased due to lack of investment in some of the triplexes/fourplexes, and had not reached pre-disaster level by 1996. In light of the large negative consequences of minority status, it is clear that this form of housing was substantially slower at recovery.

Small apartment building model

After adding housing and neighborhood variables, the δ_1 = -2.2865 of small apartment buildings is the second smallest of the apartment building sizes. This indicates that small apartment building had greater damage than triplexes/fourplexes and large apartment buildings with same building age and number of sales in the same neighborhood. In 1994, small apartment buildings had a substantial average log building value return of 1.1613 (-1.1252 – (-2.2865)). However, the substantial negative value of $\delta 2$ also indicates that small apartment buildings were still far below their pre-disaster level in 1994. In 1995, the average log building value kept increasing, although the trend was not as strong as that of 1994. The increment of log building value from 1994 to 1995 was 0.3274 (–0.7978 - (-1.1252)). However, the recovery trajectory became worse in 1996 because of the more negative value of δ_4 when compared to δ_3 (and also δ_2). This phenomenon is similar to the result shown in the basic model which was due to the demolition by 1996 of small apartment buildings that lacked reinvestment. In addition, when compared with the large apartment model, the substantial value of negativeδ_4 indicates that the housing recovery of small apartment buildings was not as good as that of large apartment buildings.

Sales had a negative effect on building value from 1992 to 1996, with sale decreasing building value by 43.85%. This implies that sales delayed housing recovery progress. As expected, neighborhood income had an overall positive effect on building value; every $1000 increment in neighborhood income increased building value by 6.06%. Unlike the results of triplexes/fourplexes, both neighborhood non-Hispanic Black and Hispanic composition had no overall negative effect on the building value of small apartment buildings.

In summary, after controlling overall housing and neighborhood effects, small apartment buildings had a rapid log building value decrease between 1992 and 1993. The impact was the second greatest among the four apartment building sizes. The average log building value had a decent recovery from 1993 to 1994 and a moderate recovery trend from 1994 to 1995. However, the recovery trend became worse in 1996 due to the clean up of properties lacking reinvestment. During the period of this research, small apartment buildings had not reached pre-disaster level, and had the greatest proportional value loss among all of the apartment categories in 1996.

Medium apartment building model

After controlling housing and neighborhood factors, the $\delta_1 = -2.8239$ of medium apartment buildings is the most negative among all of the apartment building sizes. This means that medium apartment building had greater damage when compared to other apartment buildings with the same building age and number of sales in the same neighborhood. Although they were the most seriously damaged, medium apartment buildings had the strongest recovery trend among all of the categories from 1993 to 1994, where the increment of average log building value was 1.8416 (-0.9823 – (-2.8239)). In 1995, the average log building value had a slight decrement of 0.0428 (-1.0251 –

(-0.9823)) because of the increased number of demolitions in 1995. In 1996, average log building value had a moderate increment of 0.3821 (-0.6430 – (-1.0251)), showing that medium apartments continued their housing recovery from 1995 to 1996. When compared to the δ_4 coefficients in other apartment category models, medium apartments had the second largest δ_4 value. This shows that housing recovery of medium apartments was better than triplexes/fourplexes and small apartments in 1996, even though medium apartments had the greatest initial damage. However, the distinct difference between 0 and negativeδ_4 indicates that medium apartment buildings had not reached pre-disaster level by 1996.

Sales and neighborhood non-Hispanic Black and Hispanic percentages had no overall negative effects on building values of medium sized apartments. Only neighborhood income had an overall positive effect on building value in the medium apartment model: every $1000 increment in neighborhood income increased building value by 4.27%.

In summary, medium apartments suffered more impact during Hurricane Andrew than other apartment size when controlling building age, number of sales, and neighborhood characteristics. Medium apartments had a strong recovery trend from 1993 to 1994. Although the overall recovery trend was degraded by some demolished properties from 1994 to 1995, it continued to gain building value from 1995 to 1996. Medium apartment buildings had not reached pre-disaster level within the time frame of this research, but their recovery trajectory also shows that they had higher level of housing recovery than triplexes/fourplexes and small apartment buildings by 1996.

Large apartment building model

After controlling structure and neighborhood variables, the value of δ_1 = -1.8627 is negative, which shows the impact of Hurricane Andrew on 1993 log building value. The ranking of δ_1 here is unaltered from that of the basic model, indicating the damage level of large apartment buildings is between that of triplexes/fourplexes and small apartment buildings that have comparable structural and neighborhood characteristics. Large apartment buildings had a decent recovery trend with a log building value increment of 0.8785 (-0.9842 – (-1.8627)) from 1993 to 1994. Their log building value continued to increase during the following years, with increments of 0.2961 (-0.6881 – (-0.9842)) from 1994 to 1995 and 0.3824 (-0.3057 – (-0.6881)) from 1995 to 1996. Just as in the basic model, the β_4 here is negative but the statistical test shows no difference from 0, suggesting large apartment buildings had reached their pre-disaster level in 1996.

Sales had a marginally negative effect on building value from 1992 to 1996. Every sale decreased building value by 37.59%, which implies that sales delayed recovery. Contrary to other research, neighborhood non-Hispanic Black composition had an overall positive effect on large apartment recovery. This inconsistent result may be caused by the clustered distribution of large apartment buildings; further investigation is needed to verify this effect. Neighborhood income and Hispanic percentage had no effect on building value in the large apartment building model.

In summary, after controlling housing (age and sales) and neighborhood (income and race/ethnicity) factors, the housing recovery trajectory of large apartment buildings shows a precipitate log building value drop in 1993 due to the impact of Hurricane Andrew. It is the only continuously positive recovery trajectory in these four apartment building categories. In addition, large apartment buildings had nearly achieved their pre-disaster level by 1996, which is the only apartment size category that can be considered recovered.

5.4 COMPARISON OF HOUSING RECOVERY TRAJECTORIES BY INCLUDING DAMAGE

The analyses here add damage to the model including socioeconomic factors to compare housing recovery trajectories and examine damage influences on the four apartment size categories. There are two types of models: fixed damage effect model and year-variant damage effect model. The former model includes damage only, and the latter has damage by year-interaction terms. The damage invariant model is:

$$\ln(BV)_{it} = \beta_0 + \delta_1\, yr93_{it} + \delta_2\, yr94_{it} + \delta_3\, yr95_{it} + \delta_4\, yr96_{it} + \beta_5\, ln\_bldft_{it} + \beta_6\, bldage_{it} + \beta_7\, sale_{it} + \beta_8\, income_{it} + \beta_9\, Black_{it} + \beta_{10}\, Hispanic_{it} + \beta_{11}\, other_{it} + \beta_{12}\, dmg_{it} + \nu_{it} \quad [13]$$

The year-variant model is:

$$\ln(BV)_{it} = \beta_0 + \delta_1\, yr93_{it} + \delta_2\, yr94_{it} + \delta_3\, yr95_{it} + \delta_4\, yr96_{it} + \beta_5\, ln\_bldft_{it} + \beta_6\, bldage_{it} + \beta_7\, sale_{it} + \beta_8\, income_{it} + \beta_9\, Black_{it} + \beta_{10}\, Hispanic_{it} + \beta_{11}\, other_{it} + \beta_{12}\, dmg_{it} + \beta_{13}\, yr94dmg_{it} + \beta_{14}\, yr95dmg_{it} + \beta_{15}\, yr96dmg_{it} + \nu_{it} \quad [14]$$

Table 5.12 Results of Damage Effect Models. Damage Invariant

	Triplex/Fourplex			Small Apartment			Medium Apartment			Large Apartment		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	0.0002	0.1533	0.999	-0.1231	0.2363	0.602	-0.7747	0.2906	0.008	-0.4989	0.2007	0.013
yr94	0.7453	0.1703	0.000	1.0533	0.2407	0.000	1.0680	0.2488	0.000	0.3779	0.2370	0.111
yr95	0.9022	0.1644	0.000	1.3753	0.2437	0.000	1.0208	0.2846	0.000	0.6765	0.2402	0.005
yr96	0.7814	0.1806	0.000	0.8980	0.2647	0.001	1.4140	0.2751	0.000	1.0605	0.2461	0.000
ln_bld_ft	0.3657	0.3596	0.309	1.4421	0.3819	0.000	0.8549	0.2302	0.000	0.6261	0.3126	0.045
bldage93	-0.0629	0.0117	0.000	-0.0815	0.0181	0.000	-0.0300	0.0173	0.083	-0.0128	0.0186	0.491
sale_	-0.2817	0.2274	0.215	-0.4556	0.2085	0.029	-0.1282	0.2311	0.579	-0.4061	0.2722	0.136
income (K)	0.0003	0.0121	0.981	0.0265	0.0236	0.262	0.0030	0.0135	0.824	0.0374	0.0253	0.139
Black (%)	-0.0126	0.0055	0.023	0.0060	0.0110	0.585	-0.0013	0.0091	0.888	0.0482	0.0205	0.019
His. (%)	-0.0189	0.0082	0.022	0.0160	0.0179	0.373	0.0218	0.0137	0.111	0.0208	0.0202	0.304
Other (%)	-0.2297	0.1965	0.242	-0.0691	0.3009	0.818	0.0069	0.1897	0.971	0.6063	0.2836	0.032
dmg	-0.0323	0.0032	0.000	-0.0363	0.0039	0.000	-0.0294	0.0034	0.000	-0.0240	0.0036	0.000
β_0	11.2051	3.1179	0.000	0.6582	3.8108	0.863	4.2796	2.3632	0.070	3.5814	2.8347	0.206
R^2 within		0.1903			0.2524			0.2536			0.2002	
R^2 between		0.4652			0.5805			0.5041			0.5213	
R^2 overall		0.3529			0.4531			0.3668			0.3875	

Table 5.13 Results of Damage Effect Models. Year-Variant

ln_bv	Triplex/Fourplex Coef.	Robust Std. Err.	P>|z|	Small Apartment Coef.	Robust Std. Err.	P>|z|	Medium Apartment Coef.	Robust Std. Err.	P>|z|	Large Apartment Coef.	Robust Std. Err.	P>|z|
yr93	0.9691	0.1475	0.000	1.1695	0.2159	0.000	1.3009	0.2630	0.000	0.6011	0.1874	0.001
yr94	0.2920	0.1663	0.079	0.6884	0.2112	0.001	0.5008	0.1906	0.009	0.4551	0.1831	0.013
yr95	0.6270	0.1804	0.001	0.7629	0.2189	0.000	0.4779	0.3208	0.136	0.4275	0.1783	0.017
yr96	0.5536	0.2240	0.013	0.6070	0.2961	0.040	0.4404	0.1895	0.020	0.1577	0.1452	0.277
ln_bld_ft	0.3668	0.3574	0.305	1.4422	0.3750	0.000	0.8523	0.2301	0.000	0.6248	0.3156	0.048
bldage93	-0.0628	0.0120	0.000	-0.0815	0.0179	0.000	-0.0300	0.0183	0.102	-0.0130	0.0180	0.473
sale_	-0.2969	0.2207	0.178	-0.4195	0.1950	0.031	-0.0448	0.2253	0.842	-0.3668	0.2833	0.195
income (K)	0.0003	0.0118	0.978	0.0263	0.0221	0.235	0.0033	0.0132	0.800	0.0374	0.0259	0.148
Black (%)	-0.0126	0.0055	0.022	0.0061	0.0109	0.580	-0.0011	0.0094	0.911	0.0483	0.0216	0.026
His. (%)	-0.0189	0.0082	0.022	0.0160	0.0177	0.368	0.0222	0.0142	0.119	0.0207	0.0208	0.320
Other (%)	-0.2296	0.1941	0.237	-0.0681	0.2760	0.805	0.0109	0.1788	0.951	0.6055	0.2867	0.035
dmg	-0.0517	0.0040	0.000	-0.0579	0.0048	0.000	-0.0592	0.0055	0.000	-0.0433	0.0054	0.000
yr94dmg	0.0285	0.0046	0.000	0.0277	0.0062	0.000	0.0378	0.0065	0.000	0.0179	0.0076	0.019
yr95dmg	0.0249	0.0052	0.000	0.0318	0.0064	0.000	0.0374	0.0075	0.000	0.0237	0.0079	0.003
yr96dmg	0.0239	0.0055	0.000	0.0265	0.0073	0.000	0.0436	0.0067	0.000	0.0352	0.0066	0.000
β_0	11.1924	3.1359	0.000	0.6540	3.6958	0.860	4.2628	2.4009	0.076	3.6002	2.7751	0.195
R^2 within		0.2383			0.2959			0.3217			0.2600	
R^2 between		0.4655			0.5805			0.5046			0.5213	
R^2 overall		0.3727			0.4699			0.4044			0.4124	

Tables 5.12 and 5.13 list the coefficients, robust standard errors, and p values of corresponding independent variables of damage invariant and year-variant models for triplexes/fourplexes, small, medium, and large apartment buildings. The most distinct difference between these models and those without damage is that the year dummy coefficients are all positive for 1993 and beyond. This pattern is the same as that in the recovery trajectory comparison by housing types. The positive year dummy coefficients reflect only the relative gains for the very few structures that had no damage from Hurricane Andrew, and do not reflect the trajectories of overall housing recovery patterns of the four apartment size categories. The focus of these models is the effects of damage itself as well as how the other effects might be altered after damage is included in the models.

In general, damage has a significantly negative effect in each apartment size category from 1993 to 1996 (Table 5.12). In the triplex/fourplex model, the damage coefficient indicates that the housing value dropped 3.18% for every percent of damage. The effects were slightly greater for small apartment buildings where the effect was a 3.56% loss, but smaller for medium and large apartment buildings where the effects were 2.90% and 2.37% loss, respectively. The results in Table 5.13 show different yearly patterns among size categories. Damage had relatively attenuated effects on medium and large apartment buildings. The damage effect was 5.0%, -5.6%, -5.7%, and -4.2% losses for triplexes/fourplexes, small, medium, and large apartment buildings, respectively for every percent in damage in 1993. The damage effect for medium and large apartment buildings dropped to 1.5% and 0.8% losses[21] for every percent in damage in 1996, but at the same time the net loss effect for triplexes/fourplexes and small apartment buildings was still 2.7% and 3.1% .. Figure 5.6 illustrates the net percentage effecs of damage throughout the recovery period for all apartment size categories. The damage effect of medium and large apartment buildings decreased through time, but the attenuation for triplexes/fourplexes and small apartment buildings remained static from 1994 to 1996. This implies a relative lack of recovery resources for triplexes/fourplexes and small apartment buildings during the recovery period.

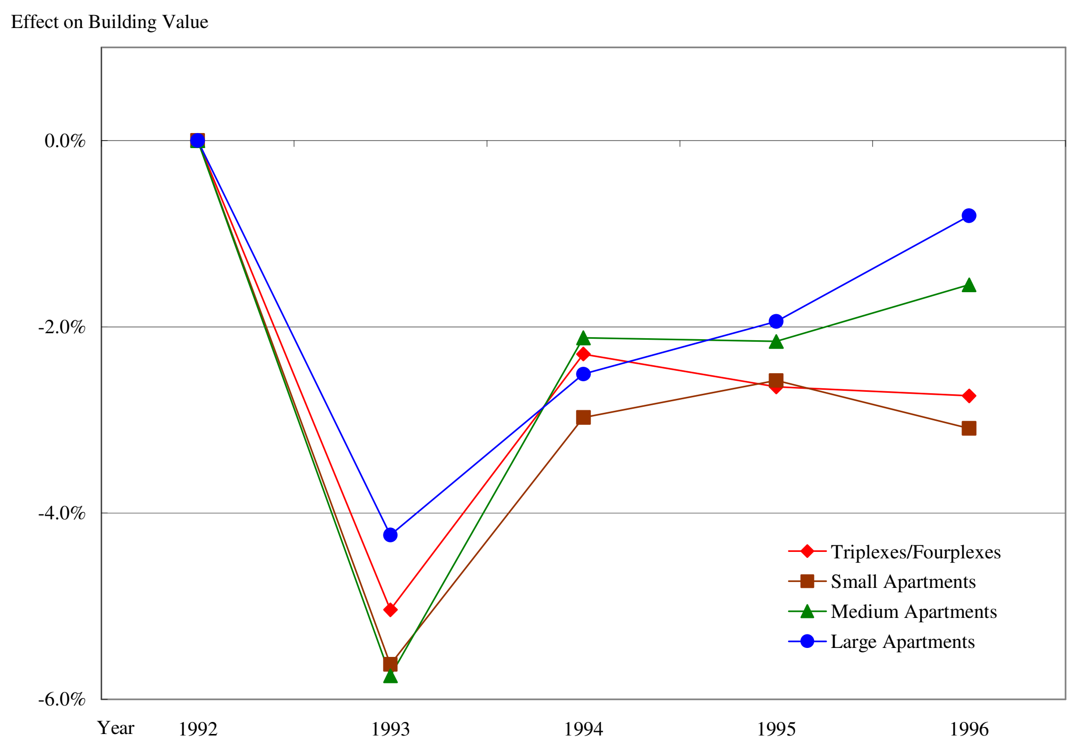

Figure 5.6 Net Exponentiated Damage Effects for Four Apartment Size Categories

[21] Statistical testing suggests that damage effect for medium and large apartment buildings in 1996 (-1.5% and -0.8%) are distinct from 0.

After controlling for damage, there were some alterations to the effects with respect to some of the other variables across size categories. In the year-variant model (Table 5.13), sales only has a negative effect in small apartment buildings but not in other size categories. The effect of sales for small apartment buildings decreased from 43.9% loss for every sale in socioeconomic model to 34.3% in year-variant damage model. Income effect has a positive effect on small and medium apartment buildings in the socioeconomic model, but becomes insignificant after including damage. This indicates that if the damage level is considered, neighborhood income level would have no effect on housing recovery trajectories for all four size categories. The effects of racial/ethnic percentages are different among size categories. Non-Hispanic Black percentage presents a negative effect on triplexes/fourplexes, a positive effect on large apartments, and no effect on small and medium apartment buildings. For every percent increase in the non-Hispanic Black population, housing values are 1.22% lower for triplexes/fourplexes, but 4.95% higher for large apartment buildings. The results of Hispanic percentage are also negative in the triplex/fourplex model where every percent increase in Hispanic population, housing values is 1.87% lower. The Hispanic effect is not significant in other size categories, and the consequences of "other" ethnic/racial groups are not significant except for large apartment models.

While the above analysis allows for the effects of damage to vary across years, the following analysis will focus on changes in the effects of sales, neighborhood income, and race/ethnicity throughout the impact and recovery period.

5.5. SALES AND SOCIO-ECONOMIC EFFECTS THROUGHOUT THE IMPACT AND RECOVERY PERIOD

The models above provide an overall assessment of the effects of sales and neighborhood socio-economic factors throughout the entire impact and recovery period when simultaneously controlling for damage. The following will assess for differential effects of sales and other socio-economic factors in different sized apartment buildings by allowing them to vary throughout 1992 to 1996. Specifically, by generating a complement of interaction terms between the year dummy variables and sales, income, and ethnic/racial composition, the differential impacts for each year can be estimated in relation to the 1992 base year. The model to be estimated is:

$$\begin{aligned}
\ln(\mathrm{BV})_{it} = {} & \beta_0 + \delta_1\, \mathrm{yr93}_{it} + \delta_2\, \mathrm{yr94}_{it} + \delta_3\, \mathrm{yr95}_{it} + \delta_4\, \mathrm{yr96}_{it} + \beta_5\, \mathrm{rooms}_{it} + \beta_6\, \mathrm{baths}_{it} \\
& + \beta_7\, \mathrm{bldage}_{it} + \beta_8\, \mathrm{own}_{it} + \beta_9\, \mathrm{sales}_{it} + \beta_{10}\, \mathrm{income}_{it} + \beta_{11}\, \mathrm{Black}_{it} + \beta_{12} \\
& \mathrm{Hispanic}_{it} + \beta_{13}\, \mathrm{other}_{it} + \beta_{14}\, \mathrm{dmg}_{it} + \delta_{15}\, (\mathrm{yr93} * \mathrm{sale}_{it}) + \delta_{16}\, (\mathrm{yr93} * \\
& \mathrm{income}_{it}) + \delta_{17}\, (\mathrm{yr93} * \mathrm{Black}_{it}) + \delta_{18}\, (\mathrm{yr93} * \mathrm{Hispanic}_{it}) + \delta_{19}\, (\mathrm{yr93} * \\
& \mathrm{other}_{it}) + \delta_{20}\, (\mathrm{yr94} * \mathrm{sale}_{it}) + \delta_{21}\, (\mathrm{yr94} * \mathrm{income}_{it}) + \delta_{22}\, (\mathrm{yr94} * \mathrm{Black}_{it}) \\
& + \delta_{y23}\, (\mathrm{yr94} * \mathrm{Hispanic}_{it}) + \delta_{24}\, (\mathrm{yr94} * \mathrm{other}_{it}) + \delta_{25}\, (\mathrm{yr94} * \mathrm{dmg}_{it}) + \delta_{26} \\
& (\mathrm{yr95} * \mathrm{sale}_{it}) + \delta_{27}\, (\mathrm{yr95} * \mathrm{income}_{it}) + \delta_{28}\, (\mathrm{yr95} * \mathrm{Black}_{it}) + \delta_{29}\, (\mathrm{yr95} * \\
& \mathrm{Hispanic}_{it}) + \delta_{30}\, (\mathrm{yr95} * \mathrm{other}_{it}) + \delta_{31}\, (\mathrm{yr95} * \mathrm{dmg}_{it}) + \delta_{32}\, (\mathrm{yr96} * \mathrm{sale}_{it}) \\
& + \delta_{33}\, (\mathrm{yr96} * \mathrm{income}_{it}) + \delta_{34}\, (\mathrm{yr96} * \mathrm{Black}_{it}) + \delta_{35}\, (\mathrm{yr96} * \mathrm{Hispanic}_{it}) + \\
& \delta_{36}\, (\mathrm{yr96} * \mathrm{other}_{it}) + \delta_{37}\, (\mathrm{yr96} * \mathrm{dmg}_{it}) + \nu_{it} \qquad [15]
\end{aligned}$$

Table 5.14 Models Allowing for Differential Effects through Time by Apartment Size Categories

	Triplex/Fourplex			Small Apartment			Medium Apartment			Large Apartment		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	1.5706	0.7172	0.029	-0.1694	1.5818	0.915	3.5942	1.3476	0.008	0.5014	1.8721	0.789
yr94	0.9707	0.8310	0.243	-3.3067	1.7709	0.062	-0.9076	1.4071	0.519	-5.0547	2.4848	0.042
yr95	1.8022	0.7739	0.020	-2.5391	1.8387	0.167	-3.6997	2.3516	0.116	-5.3551	2.5726	0.037
yr96	2.0024	0.7810	0.010	-3.6918	2.2990	0.108	-3.3745	1.5733	0.032	-4.1965	2.2145	0.058
ln_bld_ft	0.3484	0.3577	0.330	1.4044	0.3933	0.000	0.8980	0.2401	0.000	0.6291	0.2920	0.031
bldage93	-0.0630	0.0119	0.000	-0.0819	0.0183	0.000	-0.0287	0.0182	0.115	-0.0121	0.0180	0.501
n_sale	0.1134	0.2520	0.653	-0.3809	0.2377	0.109	-0.2511	0.2143	0.241	-0.4765	0.2180	0.029
yr93_sale	0.2431	0.3822	0.525	-0.0178	0.3802	0.963	-0.3278	0.3234	0.311	0.6311	0.3937	0.109
yr94_sale	-1.0560	0.5867	0.072	-0.4221	0.6665	0.527	-0.1049	0.5760	0.855	0.1463	0.3328	0.660
yr95_sale	-0.6386	0.6453	0.322	0.2962	0.4090	0.469	0.1560	0.5356	0.771	0.1649	0.6928	0.812
yr96_sale	-0.5725	0.5405	0.290	0.2983	0.8009	0.710	1.3988	0.4230	0.001	-0.3753	1.1729	0.749
income (K)	0.0076	0.0126	0.547	-0.0110	0.0189	0.561	-0.0023	0.0102	0.823	0.0082	0.0211	0.698
yr93_inc	-0.0154	0.0156	0.326	0.0413	0.0236	0.081	0.0061	0.0249	0.808	0.0040	0.0213	0.849
yr94_inc	-0.0046	0.0166	0.782	0.0444	0.0234	0.058	-0.0216	0.0178	0.225	0.0367	0.0290	0.205
yr95_inc	-0.0066	0.0156	0.672	0.0469	0.0241	0.052	0.0152	0.0316	0.631	0.0472	0.0280	0.092
yr96_inc	-0.0096	0.0173	0.579	0.0663	0.0311	0.033	0.0293	0.0253	0.246	0.0550	0.0254	0.030
Black (%)	-0.0073	0.0050	0.143	-0.0067	0.0130	0.604	-0.0057	0.0066	0.381	0.0081	0.0173	0.638
yr93_blk	0.0015	0.0067	0.829	0.0155	0.0121	0.202	-0.0133	0.0102	0.193	0.0186	0.0160	0.243
yr94_blk	-0.0039	0.0079	0.620	0.0200	0.0150	0.183	0.0063	0.0122	0.608	0.0666	0.0245	0.007
yr95_blk	-0.0090	0.0071	0.203	0.0101	0.0155	0.513	0.0217	0.0191	0.255	0.0651	0.0252	0.010

Table 5.14 Continued

ln_bv	Triplex/Fourplex Coef.	Triplex/Fourplex Robust Std. Err.	Triplex/Fourplex P>|z|	Small Apartment Coef.	Small Apartment Robust Std. Err.	Small Apartment P>|z|	Medium Apartment Coef.	Medium Apartment Robust Std. Err.	Medium Apartment P>|z|	Large Apartment Coef.	Large Apartment Robust Std. Err.	Large Apartment P>|z|
yr96_blk	-0.0134	0.0080	0.095	0.0187	0.0192	0.332	0.0108	0.0134	0.421	0.0480	0.0210	0.022
His. (%)	-0.0096	0.0077	0.210	-0.0201	0.0200	0.315	-0.0049	0.0096	0.608	0.0110	0.0171	0.519
yr93_his	-0.0094	0.0096	0.328	0.0154	0.0194	0.428	-0.0249	0.0156	0.111	-0.0153	0.0162	0.346
yr94_his	-0.0056	0.0099	0.568	0.0621	0.0221	0.005	0.0374	0.0188	0.047	0.0138	0.0227	0.545
yr95_his	-0.0140	0.0101	0.166	0.0509	0.0228	0.025	0.0726	0.0291	0.013	0.0265	0.0229	0.248
yr96_his	-0.0173	0.0102	0.090	0.0570	0.0294	0.052	0.0540	0.0198	0.006	0.0265	0.0182	0.146
Other (%)	-0.0234	0.2397	0.922	-0.0132	0.1251	0.916	-0.0513	0.0863	0.552	0.1965	0.2371	0.407
yr93_oth	-0.1380	0.2786	0.620	-0.4540	0.2148	0.035	-1.0825	0.3050	0.000	0.1695	0.2820	0.548
yr94_oth	-0.2270	0.2782	0.414	0.1079	0.1646	0.512	0.4678	0.1421	0.001	0.9995	0.3524	0.005
yr95_oth	-0.3059	0.2851	0.283	0.0102	0.1901	0.957	0.4411	0.1856	0.017	0.7969	0.3415	0.020
yr96_oth	-0.2831	0.2882	0.326	0.0421	0.2962	0.887	0.4485	0.1582	0.005	0.3029	0.2615	0.247
dmg	-0.0543	0.0046	0.000	-0.0611	0.0055	0.000	-0.0535	0.0049	0.000	-0.0470	0.0063	0.000
yr94dmg	0.0308	0.0056	0.000	0.0351	0.0064	0.000	0.0282	0.0061	0.000	0.0281	0.0075	0.000
yr95dmg	0.0281	0.0061	0.000	0.0399	0.0064	0.000	0.0299	0.0079	0.000	0.0331	0.0073	0.000
yr96dmg	0.0282	0.0065	0.000	0.0354	0.0079	0.000	0.0394	0.0060	0.000	0.0419	0.0061	0.000
β_0	10.5408	3.1059	0.001	3.3440	3.9591	0.398	5.1693	2.5389	0.042	6.4456	2.8000	0.021
R^2 within		0.2562			0.3627			0.4725			0.3318	
R^2 between		0.4715			0.5816			0.4940			0.5310	
R^2 overall		0.3836			0.4967			0.4822			0.4480	

Table 5.14 presents the results for all four size types[22] that allow for the effects of sales, income and ethnic/racial status to vary throughout the impact and recovery period. The gains in R^2 between theses models and year-variant models (Table 5.13) are somewhat obvious, and the post-estimation also confirms that the increments of R^2s are significant. The following part will discuss each factor separately across size types of apartment buildings.

Sales

In the previous section, the results of year-variant models (Table 5.13) indicate that sales had no overall effect from 1992 to 1996 for all four size categories. The result of net sale effect in each year shows that sales had no effect on triplexes/fourplexes and small apartment buildings, but effected building values of large and medium apartment buildings.

In the triplex/fourplex model, the results indicate that every sale influenced building value by 12.0%, 42.8%, -61.0%, -40.9%, and -36.8% for each year from 1992 to 1996, respectively. However, none of the interaction terms, testing for incremental changes in the years following the hurricane, are statistically significant. This suggests there was little overall change. The 1992 base effect was insignificant, suggesting no consequence of sales prior to the hurricane. When net effects are considered and tested for significance, it appears that sales also had no effect on value from 1993 to 1996. These

[22] A statistical test was conducted to determine if these models performed significantly different from each other to warrant not pooling all three housing types together into a single model. Specifically a fully interactive model was run allowing the effects of each of the standard and the year interactive variables to vary among housing types. The test was significant (χ^2 = 244.57 with 105 df, p $\leq$.0000) suggesting that separate models are appropriate.

results suggest that sales had neither a negative nor a positive effect on triplexes/fourplexes during the impact and recovery period.

In the small apartment model, the coefficients indicate that sales had a negative effect on building value in all years. Every sale decreased building value by 31.7%, 32.9%, 55.2%, 8.1%, and 7.9% for each year from 1992 to 1996, respectively. However, a statistical test shows that all sale coefficients are not significant which indicates that sales did not have a negative effect on triplexes/fourplexes during the impact and recovery period.

In the medium apartment model, results indicate that every sale influenced value of medium apartment buildings by -22.2%, -43.9%, -30.0%, -9.1%, and 215.1% for each year from 1992 to 1996, respectively. The test of net effect in each year shows that sales had a significant effect on building value in 1993 and 1996. The results imply that sales delayed the recovery immediately after the disaster, but the negative effect attenuated and turned to facilitate recovery of medium apartment buildings in 1996.

In large apartment buildings, sale coefficients indicate that every sale influenced value of large apartment buildings by -37.9%, 16.7%, -28.1%, -26.8%, and -57.3% for each year from 1992 to 1996, respectively, but none of the coefficients are statistically significant. This indicates that sales had a negative effect prior to the disaster, but no effect on large apartment buildings during the recovery period.

Figure 5.7 illustrates the net effects of sales in subsequent years in all size categories. This graph must be interpreted with caution because the effect of sales is only statistically significant in medium apartments in 1993 and 1996 and large apartments in

1992. In summary, sales had no significant effect on the recovery trajectories of triplexes/fourplexes, small, and large apartment buildings after Hurricane Andrew, but had a negative effect in 1993 and a positive effect in 1996 in the medium apartment model. The positive sale effect on medium apartment buildings in 1996 might be due to ownership transfers from owners who had no sufficient recovery funding to owners who were able to repair damaged medium apartment buildings.

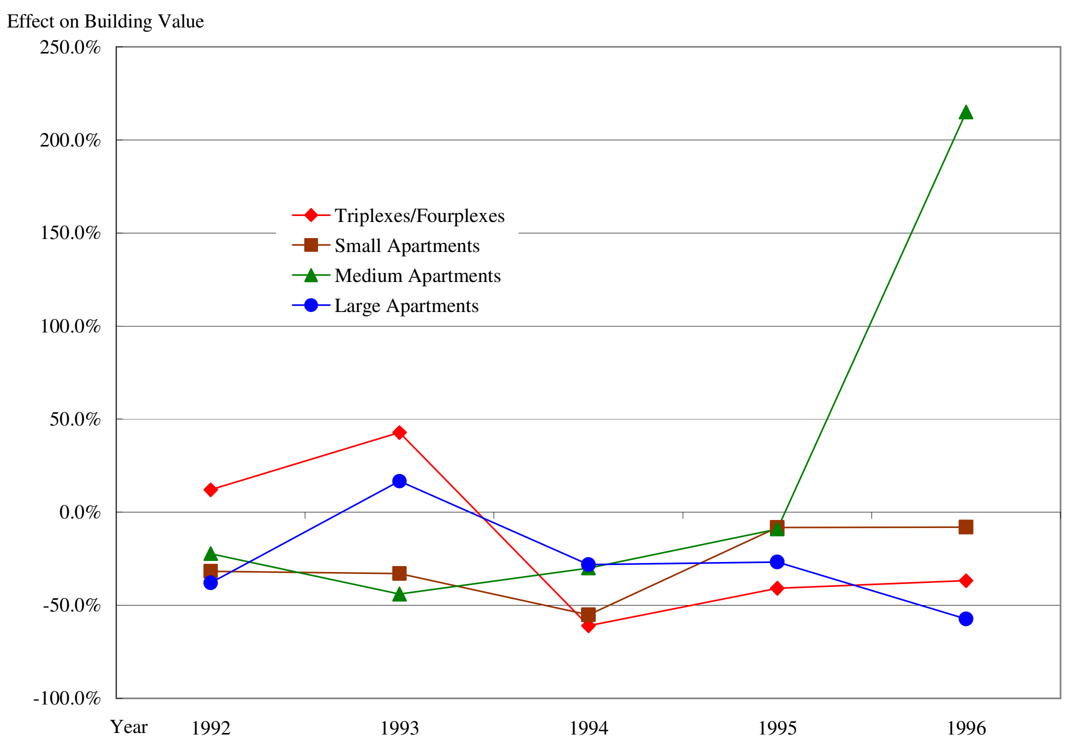

Figure 5.7 Sale Effects on Building Value, by Size Categories

Neighborhood income

Neighborhood income had no effect on building value prior to the disaster in triplex/fourplex, small, and medium apartment models. When examining the yr93, yr94, yr95 and yr96 interaction terms in these three models, all the effects of neighborhood income in 1993 to 1996 are not different from those of 1992 except the effect in 1996 in small apartment model. In addition, statistical tests do not show that any the net neighborhood income effect in 1993 to 1996 is significantly different from zero. The result of the triplex/fourplex, small, and medium apartment models shows that neighborhood income did not have a notable effect on housing values before and after the disaster.

In the large apartment model, neighborhood income does not show a significant effect on building value in 1992, and it remains non-significant throughout 1993-1995. However, both the 1996 difference and net effect coefficients are positive and significant. The net effect indicates a 6.5% increase in building value for every $1,000 increase in neighborhood median household income in 1996. The result of the large apartment model shows that neighborhood income did not have a notable effect on housing value from 1992 to 1995, and the only significantly positive effect was in 1996, three years after the disaster.

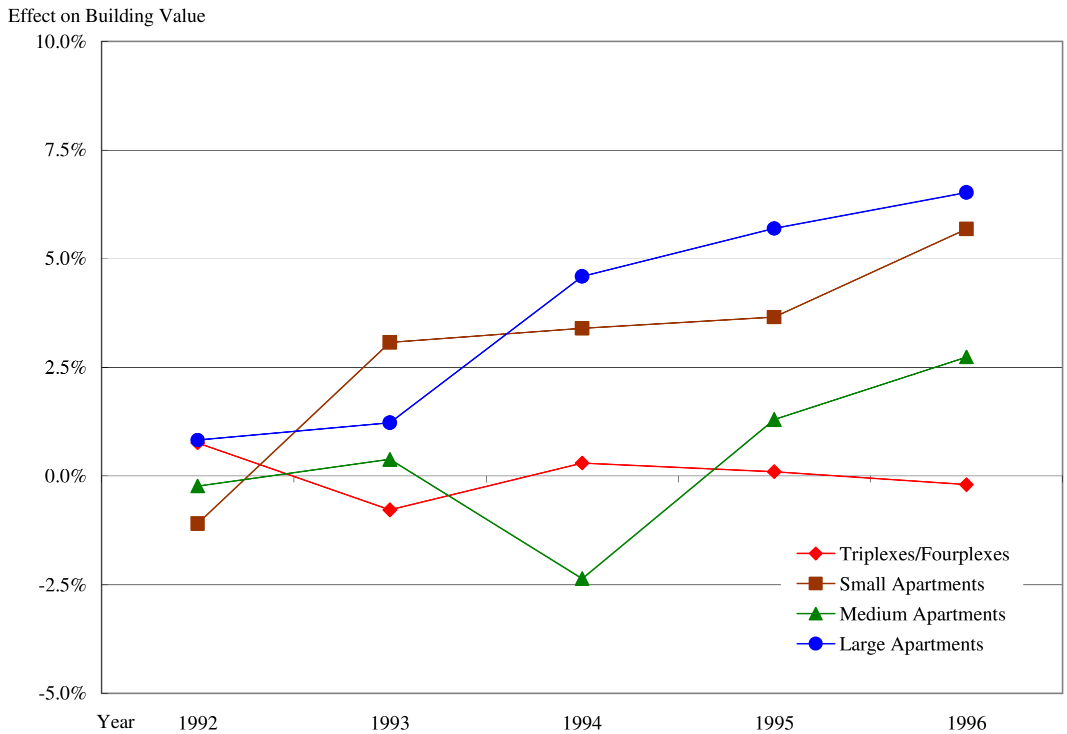

Figure 5.8 Neighborhood Household Income Effect on Building Value

Figure 5.8 shows the net effect of every $1,000 neighborhood income increase in 1992 to 1996 for all size categories. This graph must be interpreted with caution because the effect of neighborhood income is only statistically significant in large apartments in 1996. It is not consistent with the expectations found in the literature when no significantly positive neighborhood income effect was found in these models (except for large apartment in 1996). As discussed in Chapter IV, census income data at the neighborhood level does not capture the financial capability of apartment owners. In these apartment models, neighborhood income coefficients reflect the owners' re-investment decision in terms of location characteristics rather than reveal the capability of recovery funding mobilization of apartment owners.

Neighborhood race/ethnicity composition

In the triplex/fourplex model, the neighborhood non-Hispanic Black population percentage had no significantly negative effect on building value prior to the disaster. The tests of year-interaction coefficients of 1993 to 1996 also indicate that the effects before and after the disaster were not significantly different. However, when examining the net effects (combining coefficients of base year and the specific year-interaction) in 1993-1996, the results show that the neighborhood non-Hispanic Black population percentage had a negative effect on building in 1995 and 1996. Every 1% increase in Black population decreased building value significantly by 1.6% and 2.0% in 1995 and 1996 when compared to Anglo composition. Similar to the effect of percentage of neighborhood non-Hispanic Black population , the neighborhood Hispanic population percentage had neither a significant effect before the disaster nor dramatic change after the disaster. However, the tests of net effects (combining coefficients of base year and the specific year-interaction) in 1993 to 1996 show that the neighborhood Hispanic population percentage also had a negative effect on building value in 1995 and 1996. Every 1% increase in Hispanic population decreased building value by 2.3% and 2.7% in 1995 and 1996 if Anglo is the comparison. In summary, tests of the neighborhood non-Hispanic Black and Hispanic percentages show no significantly heightened negative effect on building value after the disaster. However, net yearly effects indicate that the triplexes/fourplexes in the predominately non-Hispanic Black and Hispanic neighborhoods had lower building values than those in predominately Anglo neighborhoods in 1995 and 1996.

In the small apartment model, the neighborhood non-Hispanic Black population percentage had no significantly negative effect on building value before the disaster. All the tests of the year-interactions indicate no notable change in effects after the disaster. In addition, when examining the net effects in 1993-1996, the tests do not show that the effects are distinct from zero. Therefore, neither positive nor negative effects of neighborhood non-Hispanic Black percentage on small apartment housing recovery are confirmed. Neighborhood Hispanic composition also had no significant effect on building value in small apartment model prior to the disaster. The effect of Hispanic percentage had a significantly or marginally positive change after 1994. This implies that small apartments in predominately Hispanic neighborhoods had relatively steeper recovery trajectories after 1994. However, none of the net effect of neighborhood Hispanic composition from 1993 to 1996 is significant from zero which indicates no dramatic building value difference in neighborhoods with different Hispanic percentages from 1992 to 1996 if other factors are controlled.

The tests of coefficients in the medium apartment model indicate that neighborhood non-Hispanic Black percentage had neither a significant effect on building value prior to Hurricane Andrew nor an amplified effect after the disaster. The results of net effect from 1993 to 1996 also indicate that none of the net effect of the neighborhood non-Hispanic Black percentage is significantly different from zero. Thus, no positive or negative effects of neighborhood non-Hispanic Black percentage on medium apartment recovery have been found. The results of neighborhood Hispanic percentage indicate no significant effect on building value prior to disaster, but the effect had a significantly positive change after 1994. This implies that medium apartments in predominately Hispanic neighborhoods had steeper recovery trajectories after 1994 when compared to Anglo neighborhoods. In addition, the results of the net effects also indicate that neighborhood Hispanic percentage had a significantly positive effect on building value in 1995 and 1996. Every 1% increase in neighborhood Hispanic population increased building value by 7.0% and 5.0% in 1995 and 1996.

Results in the large apartment model indicate that the neighborhood non-Hispanic Black percentage had no significant effect on large apartment building value before Hurricane Andrew. Surprisingly, the results indicate that neighborhood non-Hispanic Black percentage had an amplified positive effect during the recovery period. In addition, the results of net effects from 1994-1996 also show that every 1% increase in neighborhood non-Hispanic Black population significantly increased large apartment building value by 7.8%, 7.6%, and 5.8% in 1994-1996. The result here is not consistent with the expectation that neighborhood non-Hispanic Black percentage had a negative effect on housing recovery of large apartment buildings Regarding the effect of neighborhood Hispanic percentage, the results indicate no significant effect on building value before the disaster and no notable change in effect after the disaster when compared to 1992. In addition, the tests of the net effects in 1993 to 1996 do not show that the effects of neighborhood Hispanic percentage are significant from zero. Therefore, neighborhood Hispanic percentage had no effect on large apartment housing recovery.

Figures 5.9 and 5.10 compare the net effects of neighborhood non-Hispanic Black percentage and neighborhood Hispanic percentage in all apartment size categories from 1992 to 1996. These graphs also must be interpreted with caution because only some of the net effects of neighborhood non-Hispanic Black and Hispanic percentages are statistically significant. In conclusion, neighborhood non-Hispanic Black and Hispanic percentages had different effects on housing recovery in different sized apartment buildings. Neighborhood non-Hispanic Black predominance had a negative effect on housing recovery in triplexes/fourplexes, but had a positive effect in large apartments.

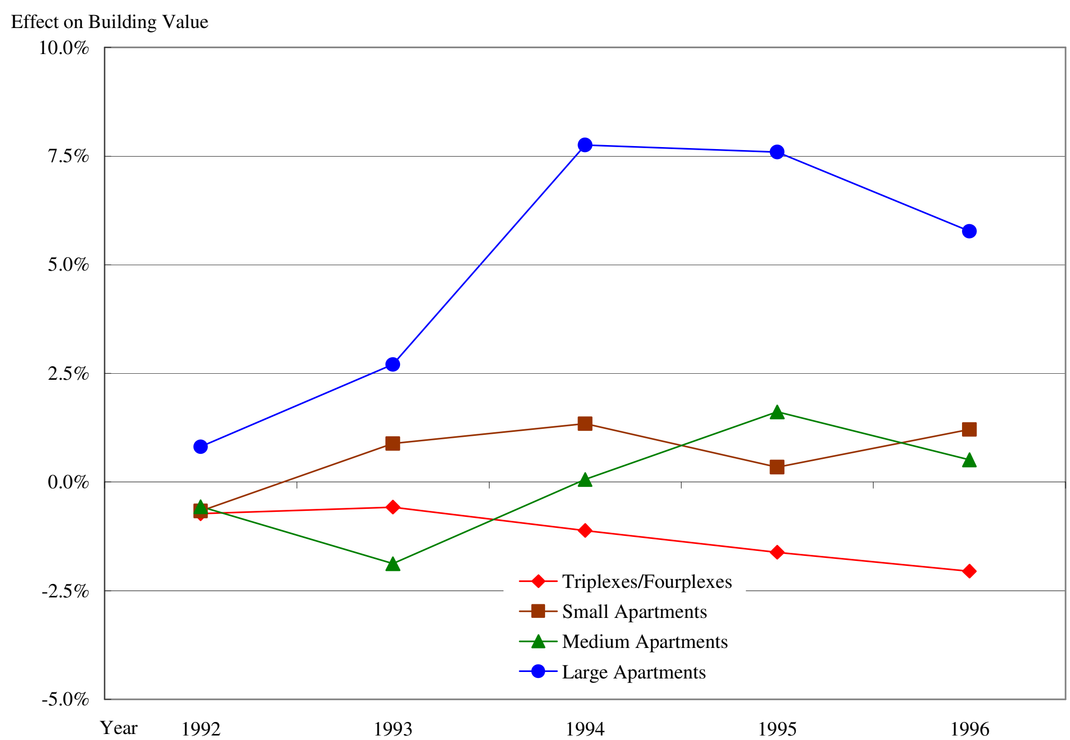

Figure 5.9 Effect of Neighborhood Black Composition on Building Value

For the effects of neighborhood Hispanic predominance, a negative net effect during the recovery period is observed in triplexes/fourplexes, but a positive net effect during the recovery period is found in small and medium apartments. Thus, the different effects of neighborhood race/ethnicity composition in different size categories show that the owners of different sized apartment buildings had different reinvestment capabilities associated to neighborhood race/ethnicity composition.

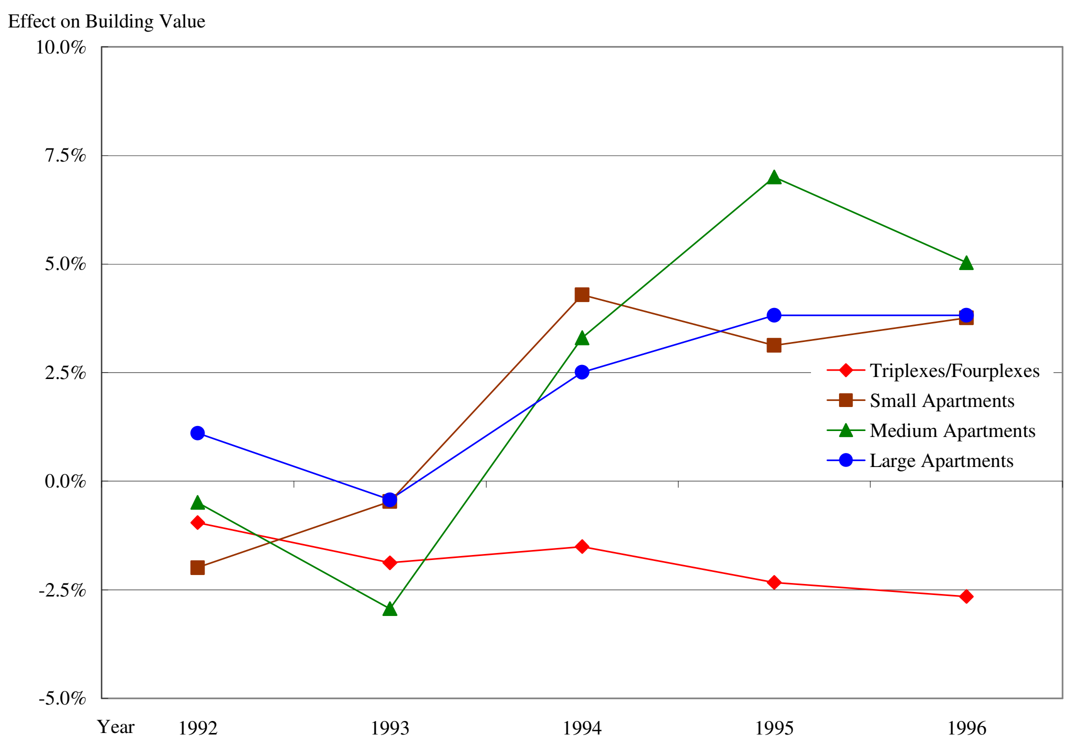

Figure 5.10 Neighborhood Hispanic Composition Effect on Building Value

CHAPTER VI

CONCLUSIONS

6.1 SUMMARY OF KEY FINDINGS

6.1.1 General results

This research uses a longitudinal dataset and applies descriptive statistics, correlation analysis, and panel models to test Comerio's "multifamily recovery lag" (1997; 1998) hypothesis which heretofore had been based on exclusively anecdotal evidence. By applying a quantitative approach, this research found strong and consistent support for the multifamily recovery lag hypotheses in south Miami-Dade County, Florida, after Hurricane Andrew.

In general, single family dwellings had recovered by 1996, about 3 years after impact, but duplexes and apartment buildings had not reached their pre-disaster levels by that time. By examining the housing recovery trajectories of single family dwellings, duplexes, and apartment buildings, single family dwellings had a continuous positive recovery trend from 1993 to 1996, but the recovery trajectories of duplexes and apartment buildings were distinct and slower than single family dwellings and they exhibited a much more sluggish trend from 1995 to 1996. In other words, housing type matters when considering the nature of housing recovery trends.

This research also undertook a more detailed examination of different types of apartment buildings. Type in this case was based on size and the determination of size categories was based in part on salient distinctions discussed in the literature and the empirical distribution of apartment sizes in south Miami-Dade. Large apartment buildings with 51 or more units were more resilient to disaster than apartment buildings with 10 or fewer units. In general, large apartment buildings had a positive housing recovery trend and approached their pre-disaster level by 1996, but the housing recovery trajectories of apartment buildings with 10 or fewer units were relatively static from 1995 to 1996 and were substantially below their 1992 levels. In summary, different sized apartment buildings have different housing recovery trajectories.

Throughout the process of examining the impact and recovery trajectories of different forms of housing, this research also examined effect of owner occupancy, number of sales, neighborhood income, and neighborhood race/ethnicity composition on housing recovery. The following section discussed specific hypotheses derived from the literature related to housing type and the above issues and the findings based on the analysis presented in this dissertation with respect to each hypothesis.

6.1.2 Hypothesis verification

Hypothesis 1 that single family dwellings will have a significantly better housing recovery trajectory than multifamily structures is supported by the basic, socioeconomic control, and separated damage control models in Chapter IV. Single family dwellings have a significantly better housing recovery trajectory than duplexes and apartment buildings by overall comparison, controlling socioeconomic factors, and adjusting for damage level. Most single family dwellings had recovered within 3 years after the impact of Hurricane Andrew but recovery of duplexes and apartment buildings lagged. This finding confirms the “multifamily home lag” phenomena suggested by disaster recovery literature (Comerio 1997; Bolin and Stanford 1998; Comerio 1998).

Hypothesis 2 that neighborhood income level will have a positive effect on recovery period in single family and duplex housing recoveries after controlling housing, neighborhood, and damage factors is not fully supported by the analysis in Chapter IV. Neighborhood median income had a positive effect on the housing value of single family dwellings in the recovery period. Neighborhood income effect was smaller than it was before the disaster for single family housing. This finding does not contradict the positive income effect at the household level suggested by previous disaster research, but proves that aggregated neighborhood income does not have an amplified positive effect on housing recovery of single family dwellings *after controlling other socioeconomic characteristics and damage*. For duplexes, the positive neighborhood income effect was reversed in the recovery period after controlling for damage, which is inconsistent with expectations. The 70% renter-occupied rate of duplexes limited the use of neighborhood income to model household financial capability. Neighborhood income level had a positive effect only on recovery of apartment buildings in 1996, but not in 1994 and 1995 which only partially supports this hypothesis.

Hypothesis 3.1 that a neighborhood's percentage of non-Hispanic Blacks will have a negative effect on housing recovery trajectories is partially supported. A neighborhood's non-Hispanic Black percentage had a negative effect on housing recovery of single family homes and duplexes, but no negative effect on apartment buildings. This indicates that single family dwellings and duplexes in Black neighborhoods had a disadvantage in mobilizing recovery resources and utilizing sociopolitical networking to compete for disaster recovery attention and resources. Hypothesis 3.2 that a neighborhood's Hispanic percentage will have a negative effect on recovery trajectories is partially supported. In general, neighborhood's Hispanic percentage had a negative effect for single family dwellings and duplexes, but had no effect on apartment buildings during recovery period. In addition, contrary to with expectation, the negative neighborhood Hispanic composition effect on single family dwellings and apartment buildings *decreased* during the recovery period. For duplexes, the heightened effect was not significant in 1995. This interesting finding about neighborhood Hispanic composition may be the product of the unique Cuban American context in Miami area.

Hypothesis 4 that owner-occupied status will have a positive effect on housing recovery in single family homes and duplexes is supported. The value increase for owner-occupied single family homes and duplexes after the hurricane was much higher than that of renter-occupied housing. In other words, rental properties take longer to recover. According to Federal disaster assistance programs, owners of rental properties were not qualified for the Minimal Home Repair grant. This finding confirms that government disaster assistance policies that are favorable home owners generate and exaggerate housing recovery differences between owner-occupied housing and rental properties.

Hypothesis 5 that post-disaster sales will have a negative effect on housing recovery is partially supported. Number of sales had a negative effect on single family dwellings and apartment buildings during some parts of the recovery period (1994 and 1995 for single family dwellings and 1994 for apartment buildings), but no significant heightened effect was found on duplexes.

Hypothesis 6 that damage level will have a negative effect on housing recovery is supported. This is quite plausible because homes with serious damage need more financial and labor input, which more time than is needed for slightly damaged homes. The results also show that damage had a less negative effect on single family dwellings than on duplexes and apartment buildings, suggesting that single family dwellings were more resilient than duplexes and apartment buildings. This also supports the Comerio's (1997; Comerio 1998) observation that owners of single family homes are more favored by government assistance programs than the owners of multifamily housing.

Hypothesis 7 that different sized apartment buildings will have different housing recovery trajectories is supported. Large apartments (51 or more units) approached pre-disaster levels in 1996, but those with 10 or fewer units had a significantly slower recovery. The result here is inconsistent with the findings of the Northridge earthquake that larger apartments faced more problems than small properties (Comerio 1997). This inconsistent result may be caused by the different contexts between Hurricane Andrew and the Northridge earthquake. First, from the lessons learned from the Loma Prieta earthquake and Hurricane Andrew, FEMA, HUD, and local governments cooperated with owners of rental properties to provide affordable housing after the Northridge earthquake, but this cooperation did not exist after Hurricane Andrew. Second, in the Northridge earthquake, larger apartment buildings suffered more complex damage than smaller apartment buildings, but this was not the case in Hurricane Andrew. Third, Los

Angeles had a soft housing market in 1994, which probably made owners of larger apartment buildings hesitant about reinvestment, but this was not the case in south Miami-Dade after 1992.

6.2 STUDY LIMITATIONS AND FUTURE RESEARCH

Without exception, this research has several limitations. First, multifamily homes should at least include duplexes, apartments, and condominiums. In addition, the recovery of townhouses (single family homes, attached) is similar to that of condominiums in housing recovery decisions. However, the housing value data in the property appraisal database presents only total value -- building value plus land value, for condominiums and townhouses. Some GIS techniques were applied to interpolate the land value to estimate the building value of these folios, but the building values obtained from the land value interpolation were not reliable. Thus, only the analyses of duplexes and apartments are included in this research. Townhouses and condominiums are important housing types in some metropolitan areas. In addition, their housing recovery involves collective decision making which is different from the housing recovery of single family homes, duplexes, and apartment buildings (Wu & Lindell, 2004). More research on the housing recovery process of townhouses and condominiums is needed to fulfill the comparison by housing type.

Second, some important factors at the individual structure level such as funding obtained from insurance settlements and government assistance programs, household income, and household race/ethnicity are not available from public secondary data.

Although the neighborhood income level and race/ethnicity can capture some of the effects of household demographics and external financial assistance, the results of the housing recovery models used in this research will not be as comprehensive as the results from models that include these important household data. For example, this research does not find the heightened positive effect of neighborhood income on housing recovery, but research suggested that household financial capability is an important factors related to housing recovery (Bolin 1982; Bolin 1993; Bolin 1994; Bolin and Stanford 1998; Comerio 1998). In addition, the characteristics of rental property owners may not be captured by the neighborhood characteristics from census data. In order to verify the effect of household and homeowner characteristics such as income, race/ethnicity, and post-disaster funding (household funding, government programs, and insurance settlements etc.), it is necessary to collect and integrate household level and homeowner data into analytical models.

Third, duplexes and apartment buildings had not recovered by 1996. However, due to the 3% Homestead Exemption cap (HEX, or CPI whichever is less) of Amendment 10 to the Florida Constitution, the data appraisal data after 1996 were capped by 3%. This regulation limits the validity of building value data after 1996. Therefore, this research can only demonstrate that duplexes and apartment buildings had a slower recovery trend than single family homes, but cannot estimate the time required for housing recovery of duplexes and apartment buildings. Future research will need to use alterative data sources for building values.

Fourth, housing recovery is a complex process. It is not only affected by micro scale factors such as damage, tenure status, household income, household race/ethnicity, homeowners' preference and financial capability, but also influenced by macro scale factors such as community damage pattern, social-demographic characteristics, inter-government (vertical and horizontal) collaboration, and public- private sector cooperation, etc. This research only controlled for some of the micro scale factors, but not the macro scale factors. Therefore, not all of the findings here can be directly applied to other disaster events if the macro factors are different. For example, larger apartment buildings had a faster recovery than smaller apartment buildings in this research, but that may not be the case if the impacted areas have a soft housing market and government agencies are engaged in providing affordable housing after a disaster. More research involving cross-disaster comparisons is needed to reveal the effect of macro scale factors on housing recovery.

6.3 THEORETICAL CONTRIBUTION AND POLICY IMPLICATIONS

The findings of this research fill some gaps in the housing recovery literature of disaster research. First, anecdotal evidence of the "multifamily home lag" phenomena has been provided in previous disaster research, but limited quantitative evidence has been reported. This research compares housing recovery trajectories of single family homes, duplexes, and apartment buildings by overall, socioeconomic, and damage models to confirm that multifamily housing recovers more slowly than single family housing. The findings of this research also respond to Comerio's (1998) suggestion for new urban housing recovery policies.

Second, the examination of socioeconomic factors in this research can provide some insights for social vulnerability research, especially for long term housing recovery. A number of social vulnerability mapping schemes have been proposed by the hazards and disasters communities. However, research on what factors can appropriately represent social vulnerability and the relative importance of these factors is limited. Based on the findings of this research, neighborhood income level is not as important as suggested in some of these models. By contrast, housing pattern, tenure status, and damage are important to long term housing recovery, but are not included in some of the vulnerability mapping literature that uses variable reduction techniques (Cutter, Mitchell et al. 2000; Cutter, Boruff et al. 2003). If only census data are available, the present study suggests that the percentage of multifamily housing, percentage of renter, and neighborhood race/ethnicity composition should be included in representing social vulnerability regarding long term housing recovery. If damage data are available, then incorporating this information can improve social vulnerability mapping.

The findings of this research also have several implications for improving current disaster assistance policies. First, damage has a negative effect on housing recovery even three years after a disaster. Thus, reducing damage *before* a disaster (mitigation) is important. Damage had a disproportionate effect on different housing types: damage effects on multifamily structures are more acute than on single family structures. Policies and programs for hazard mitigation in housing are needed, especially for multifamily housing. Tax deductions can be incentives for hazard mitigation, but special programs for generating cooperation with the owners of rental properties (especially for apartment buildings) is also important.

Second, disaster assistance such as the Minimal Home Repair grant is exclusively for owners of owner-occupied housing. In other words, owners of rental properties do not qualify for this government program. However, rental properties are also important in terms of social value; they are not only profit making businesses, but homes for disadvantaged populations. For example, the percentage of non-Hispanic Blacks and Hispanics populations in owner-occupied single family housing were only 43% in south Miami-Dade in 1990, but were 47% in renter-occupied single family housing and 71% in apartment buildings. This research proves that rental properties have a flatter recovery trajectory than owner-occupied housing. If disaster assistant programs are treated as a "safety net," then limited resources should be used where needed most--rental duplexes and apartment buildings without disaster insurance rather than owner-occupied single family dwellings with insurance. This is not to say that there should be increased public funding for disaster assistance that makes all structures, whether owner or renter-occupied, eligible for these programs. However, it is important to create an environment that promotes hazard mitigation and disaster recovery in housing. For example, the federal government can invest in risk estimation and disaster research and share the information with private insurance companies to design appropriate insurance policies. The government can also provide programs to increase the disaster insurance coverage rate of rental property and cooperate with local government to utilize limited disaster assistance resources to provide special assistance to maximize aid to those in need.

Third, state governments can use the information from this research to map social vulnerability regarding to long term housing recovery. Local governments can then initiate neighborhood redevelopment programs and hazard mitigation in housing programs to reduce future housing damage, and make extra efforts in vulnerable neighborhoods. If disasters occur, state governments can collaborate with local governments to produce social vulnerability maps regarding to long term housing recovery by using actual damage patterns to identify areas that are likely to experience slow recovery. Local governments can use the information and work with the federal government and homeowners (low-income and apartment owners) to decrease the overall hardships of slow housing recovery on poor and ethic minority households.

REFERENCES

Bates, F. L. (1982) *Recovery, Change, and Development: A Longitudinal Study of the Guatemalan Earthquake*. Dept of Sociology, University of Georgia, Athens, GA.

Bates, F. L. and W. G. Peacock (1987) Disasters and Social Change. In R. R. Dynes, B. Demarchi and C. Pelanda (Eds.), *The Sociology of Disasters*. Franco Angeli Press, Milan, Italy.

Bates, F. L. and W. G. Peacock (1989) Long Term Recovery. *International Journal of Mass Emergencies and Disasters* 7: 349-65.

Bates, F. L. and W. G. Peacock (1992) Measuring Disaster Impact on Household Living Conditions: The Domestic Assets Approach. *International Journal of Mass Emergencies and Disasters* 10: 133-60.

Blaikie, P. M. (1994) *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. Rutledge, London.

Bolin, R. C. (1982) *Long-term Family Recovery from Disaster*. Institute of Behavioral Science University of Colorado, Boulder.

Bolin, R. C. (1983) Recovery in Nicaragua and the U.S.A. *International Journal of Mass Emergencies and Disasters* 1: 123-44.

Bolin, R. C. (1985) Disasters and Long-Term Recovery Policy: A Focus on Housing and Families. *Policy Studies Review* 4(4): 709.

Bolin, R. C. (1990) *The Loma Prieta Earthquake: Studies of Short-term Impacts*. University of Colorado Institute of Behavioral Science, Natural Hazards Research and Applications Information Center, Boulder.

Bolin, R. C. (1993) Post-earthquake Shelter and Housing Research Findings and Policy Implications. *Socioeconomic Impacts*. Central United States Earthquake Consortium, Memphis, TN. 107-31.

Bolin, R. C. (1994) *Household and Community Recovery after Earthquakes*. Institute of Behavioral Science University of Colorado, Boulder.

Bolin, R. C. and L. Stanford (1998) *The Northridge Earthquake: Vulnerability and Disaster*. Rutledge, London.

Comerio, M. C. (1997) Housing Issues after Disasters. *Journal of Contingencies and Crisis Management* 5(3): 166-78.

Comerio, M. C. (1998) *Disaster Hits Home: New Policy for Urban Housing Recovery*. University of California Press.

Comerio, M. C., J. D. Landis, and Y. Rofâe. (1994) *Post-disaster Residential Rebuilding*. University of California at Berkeley Institute of Urban and Regional Development, Berkeley.

Cross, J. A. (2001) Megacities and Small Towns: Different Perspectives on Hazard Vulnerability. *Environmental Hazards* 3: 63-80.

Cutter, S. L., B. J. Boruff, and W. L. Shirley. (2003) Social Vulnerability to Environmental Hazards. *Social Science Quarterly* 84(2): 242-61.

Cutter, S. L., J. T. Mitchell, and M. S. Scott. (2000) Revealing the Vulnerability of People and Places: A Case Study of Georgetown County, South Carolina. *Annals of the Association of American Geographers* 90(4): 713-37.

Dash, N., W. G. Peacock, and B. Morrow. (1997) And the Poor Get Poorer: A Neglected Black Community. In W. G. Peacock, B. H. Morrow and H. Gladwin (Eds.) *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster*. Rutledge, London.

Ewing, B. T., J. B. Kruse, Y. S. Wang. (2007) Local Housing Price Index Analysis in Wind-disaster-prone Areas. *Natural Hazards* 40(2): 463-83.

Flippen, C. (2004) Unequal Returns to Housing Investments? A Study of Real Housing Appreciation among Black, White, and Hispanic Households. *Social Forces* 82(4): 1523-51.

Girard, C. and W. G. Peacock (1997) Ethnicity and Segregation: Post Hurricane Relocation. In W. G. Peacock, B. H. Morrow and H. Gladwin (Eds.) *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster*. Rutledge, London.

Grenier, G. J. and A. Stepick (1992) *Miami Now!: Immigration, Ethnicity, and Social Change*. University Press of Florida, Gainesville.

Haas, J. E., R. W. Kates, and M. J. Bowden. (1977) *Reconstruction Following Disaster*. MIT Press.

Kamel, N. M. O. and A. Loukaitou-Sideris (2004) Residential Assistance and Recovery Following the Northridge Earthquake. *Urban Studies* 41(3): 533-62.

Lindell, M. K. and C. S. Prater (2003) Assessing Community Impacts of Natural Disasters. *Natural Hazards Review* 4(4): 176-85.

Morrow, B. (1997) Disaster in the First Person. In W. G. Peacock, B. H. Morrow and H. Gladwin (Eds.) *Hurricane Andrew: Ethnicity, Gender and the Sociology of*

Disaster. Rutledge, London.

Morrow, B. and W. G. Peacock (1997) Disasters and Social Change: Hurricane Andrew and the Reshaping of Miami? In W. G. Peacock, B. H. Morrow and H. Gladwin (Eds.) *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster*. Rutledge, London.

Oliver-Smith, A. (1990) Post Disaster Housing Reconstruction and Social Inequality: A Challenge to Policy and Practice. *Disasters* 14(1): 7-19.

Oliver, M. L. and T. M. Shapiro (1997) *Black Wealth/White Wealth: A New Perspective on Racial Inequality*. Routledge, New York.

Peacock, W. G., N. Dash, and Y. Zhang. (2006) Sheltering and Housing Recovery Following Disaster. In H. Rodriguez, E. L. Quarantelli and R. R. Dynes *Handbook of Disaster Research*. Springer, New York.

Peacock, W. G. and C. Girard (1997) Ethnic and Racial Inequalities in Hurricane Damage and Insurance Settlements. In W. G. Peacock, B. H. Morrow and H. Gladwin (Eds.) *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster*. Rutledge, London.

Peacock, W. G., B. H. Morrow, and H. Gladwin. (1997) *Hurricane Andrew : Ethnicity, Gender and the Sociology of Disasters*. Rutledge, London.

Peacock, W. G. and A. K. Ragsdale (1997) Social Systems, Ecological Networks, and Disasters: Toward a Socio-political Ecology of Disasters. In W. G. Peacock, B. H. Morrow and H. Gladwin (Eds.) *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster*. Rutledge, London.

Peacock, W. G., Y. Zhang, and N. Dash . (2005) *Single Family Housing Recovery after Hurricane Andrew in Miami-Dade County*. Hazard Reduction and Recovery Center, Texas A&M University, College Station, TX.

Portes, A. and A. Stepick (1993) *City on the Edge: The Transformation of Miami*. University of California Press, Berkeley.

Quarantelli, E. L. (1982) Sheltering and Housing after Major Community Disasters : Case Studies and General Observations. Disaster Research Center, Newark, Del.

Quarantelli, E. L. (1999) *The Disaster Recovery Process: What We Know And Do Not Know From Research*. Newark, Del.: Disaster Research Center.

Segal, W. (2003) Segmentation in the Multifamily Mortgage Market: Evidence from the Residential Finance Survey. *Journal of Housing Research* 13(2): 175-98.

Silva, D. G. D., J. B. Kruse, and Y. Wang. (2003) Catastrophe-induced Destruction and

Reconstruction. In *73rd Southern Economics Association Annual Conference*, San Antonio, TX.

Silva, D. G. D., J. B. Kruse, and Y. Wang. (2004) *Spatial Dependencies in Wind-Related Housing Damage*. Department of Economics, Texas Tech University, Lubbock, TX.

Smith, S. K. (1996) Demography of Disaster: Population Estimates after Hurricane Andrew. *Population Research and Policy Review* 15(5-6): 459-77.

Smith, S. K. and C. McCarty (1996) Demographic Effects of Natural Disasters: A Case Study of Hurricane Andrew. *Demography* 33(2): 265-75.

Wu, J. Y. (2003) *A Comparative Study of Housing Reconstruction after Two Major Earthquakes: The 1994 Northridge Earthquake in the United States and the 1999 Chi-Chi earthquake in Taiwan*. Texas A&M University, Landscape Architecture and Urban Planning, College Station, TX.

Wu, J. Y. and M. K. Lindell (2004) Housing Reconstruction After Two Major Earthquakes: The 1994 Northridge Earthquake in the United States and the 1999 Chi-Chi Earthquake in Taiwan. *Disasters* 28(1): 63.

Zhang, Y. (2006) *Modeling Single Family Housing Recovery after Hurricane Andrew in Miami-Dade County, FL*. Texas A&M University, Landscape architecture and urban planning, College Station, TX.

Zhang, Y., W. G. Peacock, and N. Dash. (2007) *Long-term Housing Recovery Following a Major Natural Hazard: The Case of Miami-Dade County after Hurricane Andrew*. Texas A&M University, Hazard Reduction and Recovery Center, College Station, TX.

APPENDIX

ADDITIONAL ANALYSIS RESULTS

Appendix 1.1: Pooled model with socioeconomic and control variables

	Restricted Model			SF as Comparison			Apt. as Comparison		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
sf							-4.1794	0.6303	0.000
du	0.0279	0.0345	0.418	1.5930	0.2520	0.000	-2.5864	0.6776	0.000
ap	0.9341	0.0781	0.000	4.1794	0.6303	0.000			
yr93	-1.6677	0.0070	0.000	-1.6511	0.0069	0.000	-2.0139	0.1060	0.000
yr94	-0.2101	0.0044	0.000	-0.1844	0.0042	0.000	-0.9567	0.0909	0.000
yr95	-0.0533	0.0037	0.000	-0.0300	0.0035	0.000	-0.7800	0.0998	0.000
yr96	0.0333	0.0037	0.000	0.0609	0.0034	0.000	-0.8084	0.1054	0.000
sf_yr93							0.3628	0.1062	0.001
sf_yr94							0.7723	0.0910	0.000
sf_yr95							0.7500	0.0998	0.000
sf_yr96							0.8693	0.1054	0.000
du_yr93				-0.4896	0.0540	0.000	-0.1268	0.1187	0.286
du_yr94				-0.6815	0.0474	0.000	0.0908	0.1024	0.375
du_yr95				-0.6030	0.0436	0.000	0.1470	0.1089	0.177
du_yr96				-0.7214	0.0477	0.000	0.1479	0.1156	0.201
ap_yr93				-0.3628	0.1062	0.001			
ap_yr94				-0.7723	0.0910	0.000			
ap_yr95				-0.7500	0.0998	0.000			
ap_yr96				-0.8693	0.1054	0.000			
rooms	-0.0049	0.0031	0.121	0.1176	0.0064	0.000	0.0017	0.0027	0.536
sf_rooms							0.1159	0.0069	0.000
du_rooms				0.0572	0.0405	0.158	0.1731	0.0401	0.000
ap_rooms				-0.1159	0.0069	0.000			
baths	0.0175	0.0036	0.000	0.4301	0.0070	0.000	0.0043	0.0031	0.167
sf_baths							0.4258	0.0077	0.000

ln_bv	Restricted Model Coef.	Robust Std. Err.	P>|z|	SF as Comparison Coef.	Robust Std. Err.	P>|z|	Apt. as Comparison Coef.	Robust Std. Err.	P>|z|
du_baths				-0.3093	0.0454	0.000	0.1165	0.0449	0.010
ap_baths				-0.4258	0.0077	0.000			
bldage93	-0.0231	0.0004	0.000	-0.0117	0.0004	0.000	-0.0768	0.0083	0.000
sf_bldage93							0.0651	0.0083	0.000
du_bldage93				-0.0307	0.0033	0.000	0.0344	0.0089	0.000
ap_bldage93				-0.0651	0.0083	0.000			
own	0.4266	0.0119	0.000	0.4231	0.0120	0.000	0.4231	0.0120	0.000
sf_own							-	-	-
du_own				-0.0153	0.0571	0.789	-0.0153	0.0571	0.789
ap_own				-	-	-			
sales	-0.1272	0.0066	0.000	-0.1238	0.0065	0.000	-0.3733	0.1299	0.004
sf_sale							0.2495	0.1301	0.055
du_sales				0.0204	0.0575	0.723	0.2699	0.1420	0.057
ap_sales				-0.2495	0.1301	0.055			
Income	0.0155	0.0002	0.000	0.0088	0.0002	0.000	0.0315	0.0090	0.000
sf_inc							-0.0227	0.0090	0.012
du_inc				0.0018	0.0019	0.352	-0.0209	0.0092	0.023
ap_inc				0.0227	0.0090	0.012			
Black (%)	-0.8007	0.0218	0.000	-0.6612	0.0201	0.000	-1.0165	0.4520	0.025
sf_blk							0.3554	0.4525	0.432
du_blk				-0.6718	0.1599	0.000	-0.3164	0.4791	0.509
ap_blk				-0.3554	0.4525	0.432			
His. (%)	-0.5420	0.0273	0.000	-0.4156	0.0256	0.000	0.1369	0.6588	0.835
sf_his							-0.5525	0.6593	0.402
du_his				0.7014	0.2337	0.003	0.1489	0.6985	0.831
ap_his				0.5525	0.6593	0.402			
Other (%)	0.9928	0.2407	0.000	1.4729	0.2224	0.000	-1.0276	12.3004	0.933
sf_oth							2.5005	12.3024	0.839
du_oth				-7.6428	3.6383	0.036	-5.1423	12.8253	0.688
ap_oth				-2.5005	12.3024	0.839			
β_0	10.5420	0.0234	0.000	9.2661	0.0279	0.000	13.4455	0.6296	0.000

ln_bv	Restricted Model Coef.	Robust Std. Err.	P>|z|	SF as Comparison Coef.	Robust Std. Err.	P>|z|	Apt. as Comparison Coef.	Robust Std. Err.	P>|z|
R^2 within		0.3369			0.3391			0.3391	
R^2 between		0.3445			0.4238			0.4238	
R^2 overall		0.3405			0.3798			0.3798	

Test for heterogeneous slopes: χ^2 = 8163.4 with 25 df. P ≤ .0000.

Appendix 1.2 Results of housing recovery models including socioeconomic and control variables. Non-Hispanic Black proportion excluded

	Single Family			Duplex			Apartments		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
yr93	-1.6510	0.0070	0.000	-2.1413	0.0534	0.000	-2.0160	0.1064	0.000
yr94	-0.1844	0.0042	0.000	-0.8651	0.0462	0.000	-0.9576	0.0887	0.000
yr95	-0.0299	0.0035	0.000	-0.6325	0.0426	0.000	-0.7815	0.0969	0.000
yr96	0.0610	0.0034	0.000	-0.6605	0.0466	0.000	-0.8089	0.1027	0.000
rooms	0.1175	0.0063	0.000	0.1745	0.0452	0.000	0.0017	0.0031	0.589
baths	0.4301	0.0069	0.000	0.1233	0.0510	0.016	0.0043	0.0036	0.230
bldage93	-0.0117	0.0004	0.000	-0.0422	0.0037	0.000	-0.0768	0.0095	0.000
own	0.4251	0.0120	0.000	0.3726	0.0582	0.000			
sales	-0.1244	0.0065	0.000	-0.0941	0.0553	0.089	-0.3532	0.1250	0.005
income	0.0088	0.0002	0.000	0.0107	0.0022	0.000	0.0315	0.0105	0.003
White (%)	0.6611	0.0198	0.000	1.3402	0.1797	0.000	1.0160	0.5212	0.051
His. (%)	0.2456	0.0261	0.000	1.6189	0.2066	0.000	1.1524	0.4281	0.007
Other (%)	2.1335	0.2181	0.000	-4.8247	4.1942	0.250	0.0313	14.4135	0.998
β_0	8.6034	0.0278	0.000	9.5184	0.2442	0.000	12.4275	0.3911	0.000
R^2 within		0.3520			0.1981			0.1399	
R^2 between		0.4196			0.3144			0.5085	
R^2 overall		0.3833			0.2638			0.3861	

Appendix 1.3 Pooled model with damage, socioeconomic, and control Variables

	Damage-Type Interactions			Damage-Year Interactions		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
du	1.6201	0.2131	0.000	1.6266	0.2444	0.000
ap	3.6534	0.5335	0.000	3.6590	0.6371	0.000
yr93	-0.8321	0.0062	0.000	0.7649	0.0046	0.000
yr94	0.6368	0.0055	0.000	0.1981	0.0051	0.000
yr95	0.7909	0.0055	0.000	0.1989	0.0041	0.000
yr96	0.8819	0.0055	0.000	0.2402	0.0037	0.000
du_yr93	0.3687	0.0550	0.000	0.4380	0.0537	0.000
du_yr94	0.1747	0.0547	0.001	0.3451	0.0529	0.000
du_yr95	0.2535	0.0572	0.000	0.1635	0.0516	0.002
du_yr96	0.1348	0.0602	0.025	0.0846	0.0605	0.162
ap_yr93	0.4130	0.1106	0.000	0.1335	0.1030	0.195
ap_yr94	0.0040	0.1166	0.972	0.0947	0.1099	0.389
ap_yr95	0.0251	0.1160	0.828	0.2841	0.1173	0.015
ap_yr96	-0.0919	0.1248	0.462	0.0925	0.1348	0.492
rooms	0.1255	0.0054	0.000	0.1268	0.0056	0.000
du_rooms	0.0283	0.0337	0.401	0.0272	0.0402	0.499
ap_rooms	-0.1209	0.0058	0.000	-0.1220	0.0062	0.000
baths	0.3351	0.0059	0.000	0.3366	0.0060	0.000
du_baths	-0.2107	0.0378	0.000	-0.2131	0.0423	0.000
ap_baths	-0.3338	0.0065	0.000	-0.3355	0.0067	0.000
bldage93	-0.0190	0.0003	0.000	-0.0189	0.0004	0.000
du_bldage93	-0.0206	0.0028	0.000	-0.0208	0.0032	0.000
ap_bldage93	-0.0577	0.0069	0.000	-0.0578	0.0083	0.000
own	0.3456	0.0109	0.000	0.3242	0.0107	0.000
du_own	0.0586	0.0514	0.254	0.0876	0.0511	0.087
ap_own	-	-	-	-	-	-
sales	-0.1054	0.0061	0.000	-0.0217	0.0048	0.000
du_sales	-0.0030	0.0561	0.957	-0.0526	0.0498	0.291
ap_sales	-0.2197	0.1315	0.095	-0.2666	0.1202	0.027

ln_bv	Damage-Type Interactions Coef.	Robust Std. Err.	P>|z|	Damage-Year Interactions Coef.	Robust Std. Err.	P>|z|
Income	0.0043	0.0002	0.000	0.0045	0.0002	0.000
du_inc	-0.0083	0.0017	0.000	-0.0085	0.0018	0.000
ap_inc	0.0097	0.0074	0.193	0.0090	0.0086	0.293
Black (%)	-0.4777	0.0169	0.000	-0.4787	0.0172	0.000
du_blk	-0.9879	0.1349	0.000	-0.9846	0.1541	0.000
ap_blk	-0.2222	0.3876	0.566	-0.2110	0.4587	0.646
His. (%)	-0.5520	0.0216	0.000	-0.5496	0.0210	0.000
du_his	-0.1973	0.1988	0.321	-0.2048	0.2225	0.357
ap_his	0.5328	0.5532	0.336	0.5248	0.6564	0.424
Other (%)	-0.3955	0.1824	0.030	-0.3616	0.1943	0.063
du_oth	-2.0408	3.0433	0.502	-2.0589	3.4444	0.550
ap_oth	10.1756	10.2808	0.322	10.5356	11.7764	0.371
dmg	-1.5264	0.0091	0.000	-4.5100	0.0106	0.000
yr94dmg				3.7955	0.0144	0.000
yr95dmg				4.0773	0.0126	0.000
yr96dmg				4.1706	0.0124	0.000
du_dmg	-1.2572	0.0877	0.000	-1.0441	0.1156	0.000
du_yr94dmg				-0.5838	0.1545	0.000
du_yr95dmg				-0.1786	0.1462	0.222
du_yr96dmg				-0.2545	0.1536	0.098
ap_dmg	-1.2901	0.1822	0.000	-0.6331	0.2498	0.011
ap_yr94dmg				-0.8593	0.3018	0.004
ap_yr95dmg				-1.1693	0.3255	0.000
ap_yr96dmg				-1.0405	0.3354	0.002
β_0	9.9334	0.0238	0.000	9.9283	0.0242	0.000
R^2 within		0.3749			0.6293	
R^2 between		0.5971			0.5962	
R^2 overall		0.4814			0.6133	

Test for heterogeneous slopes, Damage-Type Interactions: χ^2 = 7974.8 with 27 *df*. P ≤ .0000.

Test for heterogeneous slopes, Damage-Year Interactions: χ^2 = 7844.3 with 33 *df*. P ≤ .0000.

Appendix 1.4 Pooled model allowing for differential effects through time

ln_bv	Coef.	Robust Std. Err.	P>|z|
du	0.8942	0.1601	0.000
mf	4.3062	0.3092	0.000
yr93	1.1900	0.0263	0.000
yr94	-0.1453	0.0263	0.000
yr95	-0.1696	0.0263	0.000
yr96	-0.0996	0.0263	0.000
du_yr93	0.7463	0.1610	0.000
du_yr94	1.4511	0.1607	0.000
du_yr95	1.0977	0.1607	0.000
du_yr96	1.2294	0.1612	0.000
ap_yr93	-0.0897	0.3273	0.784
ap_yr94	-0.9683	0.3269	0.003
ap_yr95	-0.7827	0.3269	0.017
ap_yr96	-0.9445	0.3273	0.004
rooms	0.1269	0.0050	0.000
du_rooms	0.0277	0.0179	0.122
ap_rooms	-0.1222	0.0051	0.000
baths	0.3359	0.0059	0.000
du_baths	-0.2127	0.0272	0.000
ap_baths	-0.3347	0.0061	0.000
b_ag_v93	-0.0188	0.0003	0.000
du_b_ag_v93	-0.0208	0.0013	0.000
ap_b_av_v93	-0.0579	0.0024	0.000
own	0.0388	0.0117	0.001
yr93_own	0.0395	0.0148	0.008
yr94_own	0.5245	0.0150	0.000
yr95_own	0.4505	0.0151	0.000
yr96_own	0.4474	0.0151	0.000
du_own	0.1993	0.0499	0.000
du_yr93_own	0.0381	0.0614	0.535
du_yr94_own	-0.2708	0.0617	0.000

ln_bv	Coef.	Robust Std. Err.	P>|z|
du_yr95_own	-0.2387	0.0623	0.000
du_yr96_own	-0.1068	0.0629	0.090
ap_own	-	-	-
ap_yr93_own	-	-	-
ap_yr94_own	-	-	-
ap_yr95_own	-	-	-
ap_yr96_own	-	-	-
sales	-0.0095	0.0115	0.408
yr93_sales	0.0229	0.0135	0.090
yr94_sales	-0.1299	0.0151	0.000
yr95_sales	-0.0196	0.0146	0.178
yr96_sales	0.0038	0.0148	0.799
du_sales	0.0301	0.0803	0.708
du_yr93_sales	-0.0326	0.0943	0.730
du_yr94_sales	-0.0252	0.0957	0.792
du_yr95_sales	-0.0423	0.0955	0.658
du_yr96_sales	-0.2215	0.0977	0.023
ap_sales	-0.2646	0.1313	0.044
ap_yr93_sales	0.2550	0.1516	0.093
ap_yr94_sales	-0.2598	0.1608	0.106
ap_yr95_sales	-0.0691	0.1554	0.656
ap_yr96_sales	0.0190	0.1616	0.906
Income	0.0063	0.0002	0.000
yr93_inc	-0.0039	0.0003	0.000
yr94_inc	-0.0023	0.0003	0.000
yr95_inc	-0.0014	0.0003	0.000
yr96_inc	-0.0016	0.0003	0.000
du_Income	-0.0010	0.0018	0.589
du_yr93_inc	-0.0073	0.0020	0.000
du_yr94_inc	-0.0089	0.0020	0.000
du_yr95_inc	-0.0085	0.0020	0.000
du_yr96_inc	-0.0122	0.0020	0.000

ln_bv	Coef.	Robust Std. Err.	P>|z|
ap_Income	-0.0051	0.0055	0.358
ap_yr93_inc	0.0180	0.0062	0.004
ap_yr94_inc	0.0123	0.0062	0.047
ap_yr95_inc	0.0170	0.0062	0.006
ap_yr96_inc	0.0248	0.0062	0.000
Black (%)	-0.3603	0.0221	0.000
yr93_blk	-0.2944	0.0246	0.000
yr94_blk	-0.0339	0.0246	0.168
yr95_blk	-0.0783	0.0246	0.001
yr96_blk	-0.1702	0.0246	0.000
du_blk	-0.1315	0.1228	0.284
du_yr93_blk	-0.0505	0.1369	0.712
du_yr94_blk	-1.4298	0.1366	0.000
du_yr95_blk	-1.2019	0.1366	0.000
du_yr96_blk	-1.6102	0.1367	0.000
ap_blk	-0.7424	0.2523	0.003
ap_yr93_blk	0.5108	0.2793	0.067
ap_yr94_blk	0.9513	0.2790	0.001
ap_yr95_blk	0.8135	0.2791	0.004
ap_yr96_blk	0.3986	0.2792	0.153
His. (%)	-0.4010	0.0294	0.000
yr93_his	-0.8048	0.0326	0.000
yr94_his	-0.0462	0.0326	0.156
yr95_his	0.0955	0.0326	0.003
yr96_his	0.0217	0.0326	0.505
du_his	0.0679	0.1950	0.728
du_yr93_his	0.1953	0.2187	0.372
du_yr94_his	-0.4990	0.2187	0.022
du_yr95_his	-0.4639	0.2187	0.034
du_yr96_his	-0.5415	0.2188	0.013
ap_his	-0.6947	0.3763	0.065
ap_yr93_his	0.4187	0.4116	0.309

ln_bv	Coef.	Robust Std. Err.	P>|z|
ap_yr94_his	2.1134	0.4120	0.000
ap_yr95_his	1.9488	0.4117	0.000
ap_yr96_his	1.6915	0.4118	0.000
Other (%)	-0.6719	0.2310	0.004
yr93_oth	-0.1096	0.2550	0.667
yr94_oth	0.3890	0.2550	0.127
yr95_oth	0.4173	0.2550	0.102
yr96_oth	0.9148	0.2551	0.000
du_oth	-5.8046	1.8657	0.002
du_yr93_oth	-1.5066	2.0596	0.464
du_yr94_oth	3.9267	2.0607	0.057
du_yr95_oth	7.5967	2.0604	0.000
du_yr96_oth	8.5533	2.0620	0.000
ap_oth	10.2538	5.2560	0.051
ap_yr93_oth	-38.3476	5.7058	0.000
ap_yr94_oth	18.0515	5.6907	0.002
ap_yr95_oth	11.6307	5.6947	0.041
ap_yr96_oth	10.2858	5.6906	0.071
dmg	-4.5498	0.0107	0.000
yr94dmg	3.8363	0.0128	0.000
yr95dmg	4.1312	0.0128	0.000
yr96dmg	4.2351	0.0128	0.000
du_dmg	-1.2124	0.0676	0.000
du_yr94dmg	-0.2893	0.0814	0.000
du_yr95dmg	0.1012	0.0814	0.214
du_yr96dmg	0.0849	0.0814	0.297
ap_dmg	-0.7324	0.1123	0.000
ap_yr94dmg	-0.7264	0.1351	0.000
ap_yr95dmg	-1.0013	0.1350	0.000
ap_yr96dmg	-0.7412	0.1350	0.000
β_0	10.0463	0.0269	0.000
R^2 within		0.6362	

ln_bv	Coef.	Robust Std. Err.	P>|z|
R^2 between		0.5981	
R^2 overall		0.6178	

Test for heterogeneous slopes: χ^2 = 11464.2 with 77 *df*. P ≤ .0000.

Appendix 1.5 Pooled basic models, by apartment building size

ln_bv	Coef.	Robust Std. Err.	P>|z|
t_apt	-4.2133	0.2321	0.000
s_apt	-3.7585	0.2777	0.000
m_apt	-2.5593	0.2692	0.000
yr93	-1.8744	0.2500	0.000
yr94	-1.0078	0.2662	0.000
yr95	-0.6940	0.2609	0.008
yr96	-0.2998	0.2192	0.171
t_yr93	0.2264	0.2878	0.431
t_yr94	0.1251	0.2913	0.668
t_yr95	-0.0442	0.2911	0.879
t_yr96	-0.5524	0.2619	0.035
s_yr93	-0.4836	0.3402	0.155
s_yr94	-0.1174	0.3407	0.730
s_yr95	-0.1293	0.3350	0.699
s_yr96	-0.9605	0.3464	0.006
m_yr93	-0.9731	0.3745	0.009
m_yr94	0.0042	0.3245	0.990
m_yr95	-0.3618	0.3532	0.306
m_yr96	-0.3502	0.3076	0.255
β_0	14.8265	0.2039	0.000
R^2 within		0.1504	
R^2 between		0.3439	
R^2 overall		0.2796	

Test for heterogeneous slopes: $\chi^2 = 28.79$ with 12 *df*. $P \leq .0042$.

Appendix 1.6 Pooled socioeconomic models, by apartment building size

ln_bv	Coef.	Robust Std. Err.	P>|z|
t_apt	12.3908	4.6833	0.008
s_apt	0.6755	5.0886	0.894
m_apt	1.0834	4.3495	0.803
yr93	-1.8627	0.2474	0.000
yr94	-0.9843	0.2673	0.000
yr95	-0.6881	0.2635	0.009
yr96	-0.3057	0.2259	0.176
t_yr93	0.2432	0.2871	0.397
t_yr94	0.1130	0.2935	0.700
t_yr95	-0.0282	0.2952	0.924
t_yr96	-0.5304	0.2700	0.050
s_yr93	-0.4235	0.3482	0.224
s_yr94	-0.1409	0.3426	0.681
s_yr95	-0.1096	0.3420	0.749
s_yr96	-0.9803	0.3532	0.006
m_yr93	-0.9610	0.3730	0.010
m_yr94	0.0022	0.3266	0.995
m_yr95	-0.3366	0.3632	0.354
m_yr96	-0.3372	0.3098	0.276
ln_bldft	0.5915	0.3345	0.077
t_ln_bldft	-0.5016	0.5284	0.342
s_ln_bldft	0.5270	0.5273	0.318
m_ln_bldft	0.3044	0.4518	0.500
bldage93	0.0112	0.0199	0.575
t_bldage93	-0.0843	0.0242	0.001
s_bldage93	-0.0978	0.0286	0.001
m_bldage93	-0.0382	0.0295	0.195
sales	-0.4708	0.2767	0.089
t_sales	0.2319	0.3586	0.518
s_sales	-0.1094	0.3565	0.759
m_sales	0.2271	0.3747	0.544

ln_bv	Coef.	Robust Std. Err.	P>|z|
Income	0.0382	0.0270	0.157
t_inc	-0.0318	0.0301	0.291
s_inc	0.0206	0.0371	0.579
m_inc	0.0036	0.0325	0.913
Black (%)	5.0176	2.1882	0.022
t_blk	-7.4042	2.2637	0.001
s_blk	-4.4697	2.5264	0.077
m_blk	-4.8153	2.4914	0.053
His. (%)	3.4174	2.1581	0.113
t_his	-5.7261	2.3435	0.015
s_his	-0.7599	2.9474	0.797
m_his	-1.0166	2.8322	0.720
Other (%)	104.5834	33.1272	0.002
t_oth	-140.8576	40.2214	0.000
s_oth	-117.8925	45.9490	0.010
m_oth	-126.1394	41.8866	0.003
β_0	1.9796	3.0033	0.510
R^2 within		0.1548	
R^2 between		0.5875	
R^2 overall		0.4438	

Test for heterogeneous slopes: χ^2 = 80.48 with 00 *df*. P ≤ .0000.

Appendix 1.7 Pooled damage effect models, by size of apartment building

	Damage-Type Interactions			Damage-Year Interactions		
ln_bv	Coef.	Robust Std. Err.	P>|z|	Coef.	Robust Std. Err.	P>|z|
t_apt	7.6270	4.0564	0.060	7.5962	4.0358	0.060
s_apt	-2.9108	4.5632	0.524	-2.9346	4.4516	0.510
m_apt	0.6999	3.8607	0.856	0.6644	3.8287	0.862
yr93	-0.5033	0.1991	0.011	0.5965	0.1867	0.001
yr94	0.3734	0.2370	0.115	0.4505	0.1828	0.014
yr95	0.6721	0.2403	0.005	0.4229	0.1780	0.017
yr96	1.0561	0.2455	0.000	0.1532	0.1452	0.291
t_yr93	0.5022	0.2517	0.046	0.3714	0.2375	0.118
t_yr94	0.3697	0.2925	0.206	-0.1604	0.2490	0.520
t_yr95	0.2285	0.2918	0.434	0.2023	0.2555	0.428
t_yr96	-0.2766	0.3057	0.366	0.3983	0.2697	0.140
s_yr93	0.3721	0.3092	0.229	0.5659	0.2854	0.047
s_yr94	0.6718	0.3381	0.047	0.2309	0.2805	0.410
s_yr95	0.6952	0.3426	0.042	0.3330	0.2836	0.240
s_yr96	-0.1662	0.3617	0.646	0.4468	0.3306	0.177
m_yr93	-0.2805	0.3522	0.426	0.6955	0.3236	0.032
m_yr94	0.6852	0.3467	0.048	0.0413	0.2619	0.875
m_yr95	0.3399	0.3709	0.359	0.0481	0.3600	0.894
m_yr96	0.3479	0.3689	0.346	0.2791	0.2372	0.239
ln_bldft	0.6259	0.3019	0.038	0.6246	0.3040	0.040
t_ln_bldft	-0.2601	0.4588	0.571	-0.2577	0.4598	0.575
s_ln_bldft	0.8150	0.4745	0.086	0.8166	0.4722	0.084
m_ln_bldft	0.2295	0.4030	0.569	0.2281	0.4027	0.571
bldage93	-0.0127	0.0179	0.478	-0.0129	0.0174	0.458
t_bldage93	-0.0502	0.0211	0.018	-0.0500	0.0209	0.017
s_bldage93	-0.0689	0.0249	0.006	-0.0686	0.0245	0.005
m_bldage93	-0.0173	0.0267	0.516	-0.0171	0.0271	0.528
sales	-0.4056	0.2724	0.137	-0.3665	0.2831	0.195
t_sales	0.1120	0.3579	0.754	0.0593	0.3617	0.870
s_sales	-0.0498	0.3445	0.885	-0.0530	0.3448	0.878

ln_bv	Damage-Type Interactions Coef.	Robust Std. Err.	P>|z|	Damage-Year Interactions Coef.	Robust Std. Err.	P>|z|
m_sales	0.2647	0.3620	0.465	0.3131	0.3652	0.391
Income	0.0374	0.0244	0.126	0.0374	0.0249	0.134
t_inc	-0.0371	0.0271	0.171	-0.0370	0.0274	0.177
s_inc	-0.0108	0.0333	0.745	-0.0110	0.0328	0.737
m_inc	-0.0343	0.0290	0.238	-0.0339	0.0292	0.245
Black (%)	4.8238	1.9814	0.015	4.8295	2.0860	0.021
t_blk	-6.0834	2.0525	0.003	-6.0854	2.1528	0.005
s_blk	-4.2223	2.2488	0.060	-4.2244	2.3391	0.071
m_blk	-4.9530	2.2441	0.027	-4.9356	2.3507	0.036
His. (%)	2.0831	1.9566	0.287	2.0707	2.0023	0.301
t_his	-3.9717	2.1113	0.060	-3.9553	2.1546	0.066
s_his	-0.4826	2.6086	0.853	-0.4723	2.6341	0.858
m_his	0.0923	2.5299	0.971	0.1429	2.5957	0.956
Other (%)	60.7769	27.2930	0.026	60.7013	27.5084	0.027
t_oth	-83.7708	33.2089	0.012	-83.6798	33.3035	0.012
s_oth	-67.7058	39.6403	0.088	-67.5263	38.2172	0.077
m_oth	-60.2514	35.4917	0.090	-59.7415	34.6765	0.085
dmg	-2.3900	0.3556	0.000	-4.3232	0.5279	0.000
yr94dmg	-0.8382	0.4749	0.078	1.7944	0.7622	0.019
yr95dmg	-1.2262	0.5210	0.019	2.3698	0.7856	0.003
yr96dmg	-0.5381	0.5011	0.283	3.5196	0.6565	0.000
t_dmg	-2.3900	0.3556	0.000	-0.8425	0.6592	0.201
t_yr94dmg	-0.8382	0.4749	0.078	1.0517	0.8945	0.240
t_yr95dmg	-1.2262	0.5210	0.019	0.1217	0.9472	0.898
t_yr96dmg	-0.5381	0.5011	0.283	-1.1235	0.8594	0.191
s_dmg	-2.3900	0.3556	0.000	-1.4559	0.7124	0.041
s_yr94dmg	-0.8382	0.4749	0.078	0.9747	0.9861	0.323
s_yr95dmg	-1.2262	0.5210	0.019	0.8089	1.0140	0.425
s_yr96dmg	-0.5381	0.5011	0.283	-0.8710	0.9826	0.375
m_dmg	-2.3900	0.3556	0.000	-1.5825	0.7735	0.041
m_yr94dmg	-0.8382	0.4749	0.078	1.9818	0.9915	0.046

ln_bv	Damage-Type Interactions Coef.	Robust Std. Err.	P>|z|	Damage-Year Interactions Coef.	Robust Std. Err.	P>|z|
m_yr95dmg	-1.2262	0.5210	0.019	1.3646	1.0724	0.203
m_yr96dmg	-0.5381	0.5011	0.283	0.8423	0.9293	0.365
β_0	3.5764	2.7356	0.191	3.5950	2.6717	0.178
R^2 within		0.2221			0.2756	
R^2 between		0.6801			0.6803	
R^2 overall		0.5280			0.5458	

Test for heterogeneous slopes, damage-size interactions: χ^2 = 97.46 with 36 *df*. P ≤ .0000.

Test for heterogeneous slopes, damage-size-year interactions: χ^2 = 79.33 with *45df*. P ≤ .0012.

Appendix 1.8 Pooled model allowing for differential effects through time, by size of apartment building

ln_bv	Coef.	Robust Std. Err.	P>|z|
s_apt	-7.1962	4.8630	0.139
m_apt	-5.3932	4.1680	0.196
l_apt	-4.0952	4.1210	0.320
yr93	0.5012	1.8224	0.783
yr94	-5.0545	2.4414	0.038
yr95	-5.3549	2.5281	0.034
yr96	-4.1936	2.1734	0.054
t_yr93	1.0693	1.9612	0.586
t_yr94	6.0251	2.5828	0.020
t_yr95	7.1558	2.6475	0.007
t_yr96	6.1954	2.3136	0.007
s_yr93	-0.6700	2.3981	0.780
s_yr94	1.7477	3.0158	0.562
s_yr95	2.8126	3.1272	0.368
s_yr96	0.4997	3.1622	0.874
m_yr93	3.1305	2.2881	0.171
m_yr94	4.1359	2.8072	0.141
m_yr95	1.6280	3.4103	0.633
m_yr96	0.7897	2.6615	0.767
ln_bldft	0.6292	0.2831	0.026
t_ln_bldft	-0.2809	0.4557	0.538
s_ln_bldft	0.7751	0.4682	0.098
m_ln_bldft	0.2713	0.3861	0.482
b_ag_v93	-0.0122	0.0175	0.487
t_b_ag_v93	-0.0508	0.0211	0.016
s_b_ag_v93	-0.0698	0.0247	0.005
m_b_ag_v93	-0.0165	0.0264	0.532
n_sale	-0.4733	0.2126	0.026
yr93_sale	0.6304	0.3846	0.101

ln_bv	Coef.	Robust Std. Err.	P>|z|
yr94_sale	0.1446	0.3255	0.657
yr95_sale	0.1597	0.6808	0.815
yr96_sale	-0.3840	1.1537	0.739
t_nsale	0.5835	0.3292	0.076
t_yr93_sale	-0.3864	0.5429	0.477
t_yr94_sale	-1.2063	0.6785	0.075
t_yr95_sale	-0.7971	0.9449	0.399
t_yr96_sale	-0.1885	1.2772	0.883
s_nsale	0.0831	0.3156	0.792
s_yr93_sale	-0.6348	0.5400	0.240
s_yr94_sale	-0.5583	0.7449	0.454
s_yr95_sale	0.1500	0.7944	0.850
s_yr96_sale	0.6787	1.4090	0.630
m_nsale	0.1978	0.3190	0.535
m_yr93_sale	-0.9923	0.5158	0.054
m_yr94_sale	-0.1864	0.6719	0.781
m_yr95_sale	0.0363	0.8609	0.966
m_yr96_sale	1.8302	1.2373	0.139
Income	0.0082	0.0203	0.688
yr93_inc	0.0041	0.0207	0.845
yr94_inc	0.0367	0.0285	0.197
yr95_inc	0.0472	0.0275	0.086
yr96_inc	0.0550	0.0249	0.027
t_inc	-0.0006	0.0239	0.980
t_yr93_inc	-0.0194	0.0261	0.456
t_yr94_inc	-0.0413	0.0331	0.212
t_yr95_inc	-0.0538	0.0317	0.090
t_yr96_inc	-0.0646	0.0305	0.034
s_inc	-0.0191	0.0270	0.479
s_yr93_inc	0.0371	0.0311	0.234
s_yr94_inc	0.0076	0.0369	0.836
s_yr95_inc	-0.0003	0.0366	0.992

ln_bv	Coef.	Robust Std. Err.	P>|z|
s_yr96_inc	0.0113	0.0398	0.776
m_inc	-0.0104	0.0237	0.661
m_yr93_inc	0.0014	0.0325	0.965
m_yr94_inc	-0.0585	0.0336	0.082
m_yr95_inc	-0.0318	0.0412	0.441
m_yr96_inc	-0.0255	0.0350	0.466
Black (%)	0.8123	1.6653	0.626
yr93_blk	1.8652	1.5514	0.229
yr94_blk	6.6570	2.4125	0.006
yr95_blk	6.5065	2.4785	0.009
yr96_blk	4.7976	2.0603	0.020
t_blk	-1.5443	1.7382	0.374
t_yr93_blk	-1.7214	1.6928	0.309
t_yr94_blk	-7.0505	2.5431	0.006
t_yr95_blk	-7.4066	2.5805	0.004
t_yr96_blk	-6.1380	2.2154	0.006
s_blk	-1.4861	2.0657	0.472
s_yr93_blk	-0.3156	1.9580	0.872
s_yr94_blk	-4.6608	2.8403	0.101
s_yr95_blk	-5.4935	2.9233	0.060
s_yr96_blk	-2.9291	2.8183	0.299
m_blk	-1.3872	1.8396	0.451
m_yr93_blk	-3.2328	1.8754	0.085
m_yr94_blk	-6.0242	2.6914	0.025
m_yr95_blk	-4.3312	3.0934	0.161
m_yr96_blk	-3.7069	2.4379	0.128
His. (%)	1.0989	1.6478	0.505
yr93_his	-1.5296	1.5820	0.334
yr94_his	1.3775	2.2335	0.537
yr95_his	2.6537	2.2524	0.239
yr96_his	2.6514	1.7870	0.138
t_his	-2.0606	1.8160	0.257

ln_bv	Coef.	Robust Std. Err.	P>|z|
t_yr93_his	0.5913	1.8551	0.750
t_yr94_his	-1.9414	2.4482	0.428
t_yr95_his	-4.0520	2.4748	0.102
t_yr96_his	-4.3792	2.0645	0.034
s_his	-3.1062	2.5053	0.215
s_yr93_his	3.0663	2.4840	0.217
s_yr94_his	4.8289	3.1411	0.124
s_yr95_his	2.4347	3.2059	0.448
s_yr96_his	3.0539	3.4399	0.375
m_his	-1.5986	2.0088	0.426
m_yr93_his	-0.9871	2.2562	0.662
m_yr94_his	2.3729	2.8962	0.413
m_yr95_his	4.6184	3.6227	0.202
m_yr96_his	2.7694	2.6318	0.293
Other (%)	19.6290	22.8385	0.390
yr93_oth	16.9363	27.5764	0.539
yr94_oth	99.9482	34.6247	0.004
yr95_oth	79.6550	33.5559	0.018
yr96_oth	30.2851	25.6251	0.237
t_oth	-21.9711	33.0733	0.506
t_yr93_oth	-30.7628	39.3976	0.435
t_yr94_oth	-122.6494	44.6549	0.006
t_yr95_oth	-110.2492	44.2863	0.013
t_yr96_oth	-58.5789	38.8665	0.132
s_oth	-20.9632	25.6001	0.413
s_yr93_oth	-62.2972	34.6809	0.072
s_yr94_oth	-89.1436	38.4192	0.020
s_yr95_oth	-78.6084	38.6724	0.042
s_yr96_oth	-26.0514	39.2819	0.507
m_oth	-24.8644	25.1031	0.322
m_yr93_oth	-125.5303	40.7969	0.002
m_yr94_oth	-52.9574	37.4222	0.157

ln_bv	Coef.	Robust Std. Err.	P>|z|
m_yr95_oth	-35.4887	38.1840	0.353
m_yr96_oth	14.6527	29.9391	0.625
dmg	-4.7061	0.6141	0.000
yr94dmg	2.8099	0.7343	0.000
yr95dmg	3.3133	0.7178	0.000
yr96dmg	4.1864	0.5942	0.000
t_dmg	-0.7226	0.7664	0.346
t_yr94dmg	0.2680	0.9303	0.773
t_yr95dmg	-0.5079	0.9509	0.593
t_yr96dmg	-1.3712	0.8882	0.123
s_dmg	-1.4074	0.8164	0.085
s_yr94dmg	0.7036	0.9731	0.470
s_yr95dmg	0.6772	0.9610	0.481
s_yr96dmg	-0.6479	0.9919	0.514
m_dmg	-0.6210	0.7916	0.433
m_yr94dmg	-0.0156	0.9457	0.987
m_yr95dmg	-0.3259	1.0473	0.756
m_yr96dmg	-0.2593	0.8338	0.756
β_0	10.5409	3.1003	0.001
R^2 within		0.6362	
R^2 between		0.5981	
R^2 overall		0.6178	

Test for heterogeneous slopes: $\chi^2 = 244.57$ with 105 *df*. $P \leq .0000$.

VITA

Name: Jing-Chein Lu

Address: 10, Alley 3, Lane 36, Ding-Mei 1st St.,
Tainan City, Taiwan 700

Email Address: lujcpub@gmail.com

Education: B.S., Geology, National Taiwan University, 1994
M.S., Building & Planning, National Taiwan University, 1998
Ph.D., Urban and Regional Science, Texas A&M University, 2008