REPORT

The National Flood Insurance Program's Market Penetration Rate

Estimates and Policy Implications

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Adrian Overton

Prepared as part of the 2001-2006 Evaluation of the
National Flood Insurance Program

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PREFACE

Flooding is a major source of loss to individuals and businesses in the United States. Private insurers have historically been unable to provide flood insurance at affordable rates, and until the establishment of the National Flood Insurance Program (NFIP) in 1968, the primary recourse for flood victims was government disaster assistance. Congress adopted the NFIP in response to the ongoing unavailability of private insurance and continued increases in federal disaster assistance. The Federal Emergency Management Agency (FEMA), which is part of the U.S. Department of Homeland Security, is currently conducting a major evaluation of the program's goals and performance (see following page).

This report contributes to that evaluation by developing more reliable estimates of the proportion of single-family homes (SFHs) (excluding condominiums) that have flood insurance (the market penetration rate); by identifying factors that determine the market penetration rate; and by examining some of the opportunities for, and the potential benefits of, increasing the market penetration rate. This research was sponsored by FEMA through a prime contract with the American Institutes for Research.

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EVALUATION OF THE NATIONAL FLOOD INSURANCE PROGRAM

The NFIP Evaluation is comprised of a series of reports prepared by the American Institutes for Research (AIR) and selected subcontractors under a contract managed by AIR. These reports assess questions identified and prioritized by a steering committee about the National Flood Insurance Program. Individual reports will be posted on the FEMA website as they are finalized. The website URL is http://www.fema.gov/nfip/nfipeval.shtm. The reports in the Evaluation are:

The Evaluation of the National Flood Insurance Program – Final Report
American Institutes for Research and Evaluation Advisory Committee

Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard. Galloway, Baecher, Plasencia, Coulton, Louthain, and Bagha, Water Policy Collaborative, University of Maryland.

Assessing the National Flood Insurance Program's Actuarial Soundness. Bingham, Charron, Messick and Kirschner, Deloitte Consulting.

Costs and Consequences of Flooding and the Impact of the National Flood Insurance Program. Sarmiento and Miller, Pacific Institute of Research and Evaluation.

Developmental and Environmental Impacts of the National Flood Insurance Program: A Review of Literature. Rosenbaum, University of Florida.

The Developmental and Environmental Impact of the National Flood Insurance Program: A Summary Research Report. Rosenbaum, University of Florida.

An Evaluation of Compliance with the National Flood Insurance Program Part A: Achieving Community Compliance. Monday, Grill, Esformes, Eng, and Kinney, American Institutes for Research.

An Evaluation of Compliance with the National Flood Insurance Program Part B: Are Minimum Building Requirements Being Met? Mathis and Nicholson, Dewberry.
Evaluation of the National Flood Insurance Program's Building Standards. Jones, Coulbourne, Marshall, and Rogers, Christopher Jones and Associates.

Managing Future Development Conditions in the National Flood Insurance Program. Blais, Nguyen, Tate, Dogan, ABSG Consulting; and Mifflin and Jones.

The National Flood Insurance Program's Environmental Reviews: An Assessment of FEMA's Implementation of NEPA and Executive Order 11988. Rosenbaum, University of Florida.

The National Flood Insurance Program's Mandatory Purchase Requirement: Policies, Processes and Stakeholders. Tobin and Calfee, American Institutes for Research.

The National Flood Insurance Program's Market Penetration Rate: Estimates and Policy Implications. Dixon, Clancy, Seabury, and Overton, RAND Corporation.

Performance Assessment and Evaluation Measures for Periodic Use by the National Flood Insurance Program. Miller, Langston, and Nelkin, Pacific Institute of Research and Evaluation.

State Roles and Responsibilities in the National Flood Insurance Program. Mittler, Morgan, Shapiro, and Grill, American Institutes for Research.

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An immense amount of data was assembled for the project, and the project would not have succeeded without the hard and careful work of people in several different organizations. William Lopez at First American Real Estate Solutions (FARES) worked over a long period to pull the sample of property parcels. Bruce Spowart at FARES helped move the project forward. Mark Green at Transamerica Flood Data Services (now part of FARES) arranged for rapid completion of flood determinations. Tim Scoville and the staff at the NFIP's Bureau and Statistical Agent (BSA) were very responsive to our many data requests. They quickly turned around requests, were always willing to spend time explaining the data, and took great care in determining whether there were flood insurance policies at the property parcels in our sample. We also want to thank Don Zocchi at the BSA for developing measures of the time since the last major flood event in each of the 100 communities in our sample. Becky Brantley and her colleagues in the Office of Disaster Assistance at the Small Business Administration were helpful in providing historical data on disaster loans for flooding events.

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Claude Berrebi at RAND and Warren Kriesel in the University of Georgia's Department of Agricultural Economics provided technical reviews of the draft report. We thank them for their detailed and insightful comments. Very helpful comments on the draft report were also provided by Chad Berginnis, Ohio state floodplain manager; Don Griffin, Property Casualty Insurers Association of America; Larry Larson, Association of State Floodplain Managers; Edward Thomas, Michael Baker Corporation; and French Wetmore, French & Associates, Ltd.

1. EXECUTIVE SUMMARY

1.1. Introduction

Flooding is a major source of loss to individuals and businesses in the United States. Private insurers have historically been unable to provide flood insurance at affordable rates, and flood coverage is excluded from standard homeowner policies. Until the establishment of the National Flood Insurance Program (NFIP) in 1968, the primary recourse for flood victims was government disaster assistance. Congress adopted the NFIP in response to the ongoing unavailability of private insurance and continued increases in federal disaster assistance.

Early in the program, the federal government found that making insurance available, even at subsidized rates for *existing* buildings, did not provide sufficient incentive for communities to join the NFIP or for individuals to purchase flood insurance. In response, Congress passed the Flood Disaster Protection Act of 1973, which requires federally insured or regulated lenders to require flood insurance as a condition of granting or continuing a loan when the building and the improvements securing it are in the Special Flood Hazard Area (SFHA) of a community participating in the NFIP. This mandatory purchase requirement was strengthened by the National Flood Insurance Reform Act of 1994. Currently, over 20,000 communities across the United States participate in the program (roughly 75 percent of all communities in the United States), and over 4.5 million flood policies are in place.

The Federal Emergency Management Agency (FEMA), which administers the NFIP and is part of the U.S. Department of Homeland Security, is currently conducting a major evaluation of the program's goals and performance.

This report contributes to that evaluation by (1) developing more reliable estimates of the proportion of single-family homes (SFHs) that have flood insurance (the market penetration rate); (2) identifying factors that determine the market penetration rate; and (3) examining some of the opportunities for, and potential benefits of, increasing the market penetration rate. Flood insurance on nonresidential and other types of residential structures is not examined in this report.

1.2. Methods for Estimating the Market Penetration Rates

Estimates of the market penetration rate for flood insurance and compliance with the mandatory purchase requirement have been sketchy. Data on the number of policies are readily available, but reliable information on the number of structures in SFHAs and on the number of structures with mortgages subject to the mandatory purchase requirement has been lacking. This study is the first to use property parcel data from a sizable number of communities to construct better estimates of the number of SFHs in SFHAs and to identify SFHs with mortgages.

We selected a stratified, random sample of 100 NFIP communities for the study. The sample was stratified by geographic region, source of flooding in the community (coastal versus riverine), and community size. For each of the 100 communities, data on a random sample of approximately 750 property parcels (75,000 total) was purchased from First American Real Estate Solutions (FARES). FARES collects and standardizes publicly available property parcel information from tax assessors across the country. Tax assessor records provide a rich source of information on each parcel, including land-use type (SFH, apartment building, commercial, industrial, public use, etc.), value of the land and improvements, date of construction, date of last property transfer, and amount of mortgage on the property (usually at the time of the last sale). Because approximately two-thirds of the property parcels in the 100 communities are SFHs that are not condominiums and because determining whether there is an NFIP policy at the parcel for this type of land use is more straightforward than for other types of land use, this study focuses on SFHs that are not condominiums.

Property parcel records with complete addresses were sent to Transamerica Flood Hazard Certification, Inc. (now part of FARES) to determine the NFIP community and flood zone in which the parcel lies. The records were then sent to the NFIP's Bureau and Statistical Agent (BSA) to determine whether there was a federal flood insurance policy in force on the parcel.

Overall, the analysis is based on 5,472 SFHs in SFHAs and 22,195 SFHs in NFIP communities but not in SFHAs. Statistical weights were used to extrapolate findings from the sample to the number in the nation as a whole.

1.3. Findings

Our findings fall into six categories: (1) market penetration rates, (2) compliance with the mandatory purchase requirement, (3) the type and amount of coverage among those households that buy flood insurance, (4) factors that determine market penetration rate, (5) the impact of increasing market penetration on disaster assistance and on community compliance with NFIP requirements, and (6) the effect of growth in the number of policies on the annual variability of overall NFIP losses.

1.3.1. Market Penetration Rates

The results of the analysis suggest that, overall, about one-half of SFHs in SFHAs nationwide have flood insurance policies. An estimated 49 percent have NFIP policies, and once a rough estimate of the number of policies underwritten by private insurers is added in, the market share rises to between 50 and 52 percent.

We project that there are approximately 3.6 million SFHs in SFHAs nationwide with a 95 percent confidence interval for the projection that runs from 2.9 to 4.2 million. Comparison of the projected number of policies in SFHAs nationwide based on the study sample and the actual number of policies recorded by the BSA suggests that our point estimate of the number of SFHs in SFHAs nationwide may be 10 to 15 percent low. Thus, the actual number of SFHs in SFHAs nationwide may lie in the upper portion of the 2.9 to 4.2 million confidence interval.

Even though approximately one-third of NFIP policies are written outside SFHAs, the market penetration rate outside SFHAs is only about 1 percent.

Market penetration rate appears to vary a great deal across the four geographic regions investigated in this study. The market penetration rates in the South and the West are considerably higher (approximately 60 percent) than in the Northeast or Midwest (20 to 30 percent). However, because the sample size of SFHs in the Midwest is modest, conclusions about the market penetration rate in this region should be considered tentative. Similarly, the market penetration rate in the Northeast is estimated with a considerable degree of uncertainty.

The SFHs in SFHAs are highly concentrated in the South. Nearly 60 percent of SFHs in SFHAs nationwide are in the South, even though less than one-quarter of homes in NFIP communities nationwide are in the South.

1.3.2. Compliance with the Mandatory Purchase Requirement

Results from previous studies imply that approximately 50 to 60 percent of SFHs in SFHAs are subject to the mandatory purchase requirement. It is not possible to make precise estimates of the percentage of homes complying with the mandatory purchase requirement based on the data assembled for this study because data limitations create uncertainty about whether a home has a mortgage and whether the mortgage is subject to the mandatory purchase requirement. Under plausible assumptions, the compliance rate with the mandatory purchase requirement in the South and West is 80 to 90 percent. The compliance rate appears considerably lower in the Northeast and Midwest, where it is on the order of 45 to 50 percent. However, compliance rates are estimated with considerable uncertainty in these regions. Across the nation as a whole, compliance with the mandatory purchase requirement appears to be 75 to 80 percent.

The analysis does not provide any strong evidence that compliance declines as mortgages age. Thus, it appears that once banks adopt procedures to enforce the mandatory purchase requirement, the policies are equally effective for new and for older loans.

Market penetration rates are low for homes that are not subject to the mandatory purchase requirement. The analysis suggests that the market penetration rate for such homes is likely on the order of 20 percent.

1.3.3. Type and Amount of Coverage

Flood insurance can be purchased for damage to the structure and/or the contents inside the structure (e.g., furniture), although the mandatory purchase requirement is rarely applied to contents. In the South, 75 percent of homes with structure polices also have contents coverage, but outside the South, the share ranges from 16 percent in the Midwest to 49 percent in the Northeast.

Over 75 percent of homes that have flood insurance carry coverage that exceeds the improved value of the property parcel listed in county tax assessor records.[1] However, these improved values may not closely reflect the true improved value of the structure. Further

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[1]The improved value of the property is the value of the property less the value of the raw land.

investigation is needed into how the various measures of improved property value correspond to true improved value before conclusions can be reached about the amount of flood insurance coverage relative to the improved value of the property. About 14 percent of the 1.99 million SFHs with flood insurance carry the maximum $250,000 in structure coverage offered by the NFIP.

Nearly one-half of SFHs in SFHAs with mortgages and flood insurance carry coverage that exceeds the reported value of the mortgage. Once homes with coverage equal to the maximum available from the NFIP are added in, at least 61 percent of such homes carry enough coverage to satisfy the mandatory purchase requirement. The percentage that satisfies the coverage component of the mandatory purchase requirement will be higher once homes at which the amount of coverage exceeds improved value are included,[2] but further investigation into the reliability of the data on improved value is necessary before such calculations can be made.

1.3.4. Factors That Determine the Market Penetration Rate

Our analysis has identified several key factors that underlie the decision to purchase insurance. Consistent with economic theory, as well as with past studies of the demand for flood insurance, the decision to purchase insurance is affected by the price of insurance, although the effect is not particularly strong, at least over the range of prices observed in the sample.

The number of SFHs in a community's SFHA has a significant impact on the market penetration in the community. Market penetration is 16 percent in communities with 500 or fewer homes in the SFHA, 56 percent in communities with 501 to 5,000 homes in the SFHA, and 66 percent in communities with more than 5,000 homes in the SFHA. The low market penetration rate in communities with relatively few homes in the SFHA is consistent with hypotheses that insurers market flood insurance less aggressively in such communities and that there are fewer agents in these communities familiar with the program and enthusiastic about writing policies. In addition, the results suggest that the mandatory purchase requirement is less vigorously enforced in communities with few structures in the SFHA.

The probability of purchasing insurance is also much lower in communities that have a lower share of SFHs in the SFHA than in communities with a higher share of homes in the SFHA (29 percent in communities where 10 percent or less of homes are in SFHA, 54 percent in communities where 11 to 50 percent are in the SFHA, and 73 percent for communities where more than 50 percent are in the SFHA). Such a pattern might be the result of lower awareness of flood risk in communities with a lower percentage of homes in the SFHA. It may also be the result of less interest by flood insurance agents in promoting flood insurance and in learning how to write flood policies when a smaller share of their clients is in the SFHA.

The probability of purchasing insurance is substantially higher in communities subject to coastal flooding than in communities that are not (63 percent versus 35 percent). The demand for

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[2]The mandatory purchase requirement requires that flood insurance be covered for the lesser of (1) the outstanding principal balance of the loan; (2) the maximum amount of coverage offered by the NFIP; and (3) the depreciated value of the structure, when the loan balance exceeds the value of the structure.

flood insurance may be lower in communities not subject to coastal flooding because there is less appreciation for flood risk or because the type of coverage offered by flood insurance policies is less attractive in these usually inland areas. In particular, stakeholders interviewed for this study suggested that limited basement coverage in NFIP policies makes flood insurance less attractive in inland areas where basements are more common.

Similarly, market penetration is greater in the South than in other parts of the country even when other factors are controlled for (such as size of community and the source of flooding). The effect is most noticeable for homes less likely to be subject to the mandatory purchase requirement. These results may reflect greater appreciation of flood risk in the South beyond the differences in risk perception captured by other factors.

As evident from the findings on compliance with the mandatory purchase requirement above, the mandatory purchase requirement is a critical determinant of whether an SFH in the SFHA has flood insurance. The findings suggest that compliance with the mandatory purchase requirement is lower in communities with 500 or fewer homes in the SFHA, communities where less than 50 percent of homes are in the SFHA, and communities not subject to coastal flooding.

1.3.5. The Impact of Increasing Market Penetration Rates on Disaster Assistance and on Community Compliance with NFIP Requirements

Flood insurance was introduced in part to reduce government disaster assistance payments, and we find some empirical evidence that higher market penetration rates are associated with lower amounts of disaster assistance. However, the impact is not large and is statistically significant only for that relatively small part of overall disaster assistance that most overlaps with the insurance coverage available from the NFIP. This makes it unlikely that increasing flood insurance market penetration would cause substantial reductions in disaster assistance, unless flood insurance policies were broadened to cover other types of losses, particularly temporary housing assistance. One possible reason for the lack of relationship is that people who receive disaster assistance by and large do not have the means to buy flood insurance. If this were the case, the variation in the percentage of structures with flood insurance (within the ranges observed in this sample) would have little affect on the group of people that receives most disaster assistance and, consequently, on disaster assistance overall.

We found little evidence of a strong relationship between market penetration rates and compliance with floodplain management requirements. We did find that higher market penetration rates are associated with more favorable Building Code Effectiveness Grading Schedule (BCEGS) scores, which assesses a community's building codes and the resources the community uses to enforce them. However, the results using our other measures of compliance either were statistically insignificant or showed a negative relationship between market penetration and compliance with floodplain management requirements. In some cases, other factors, such as the size of the community or the region in which it is located, had more impact on the measure of compliance than market penetration rate.

1.3.6. The Effect of Growth in the Number of Policies on the Annual Variability of NFIP Losses

We examined how the geographic distribution of insurance coverage for flood losses affects risk to the NFIP as measured by the variability of losses. Our measure of risk focused not on the size of predicted losses, because these can be covered by higher premiums; rather, we focused on the variability, or predictability, of losses. Variability is a better measure of risk to the NFIP because a higher variability indicates an increased possibility that losses will be higher than premiums (or vice versa).

The geographic distribution of policies can affect the variability of losses in two ways. One the one hand, some areas may have more or fewer variable outcomes. On the other hand, flood losses in different areas might be correlated with each other (perhaps because of weather patterns). Correlations across regions create the potential to manage overall variability, analogous to reducing variability in overall returns by investing in two ventures whose returns are negatively correlated. We use historical data on flood losses to examine the correlation in losses and then study how increasing the number of policies in one region would affect the variability of overall losses.

Generally, our results show that geography does matter for determining the variability of overall NFIP losses. Different regions of the country do appear to have both positive and negative correlations with each other. These correlations lead to different effects on the variability of overall losses depending on where policy growth occurs. Our results suggest that the NFIP could limit the effects of policy growth on loss variability by focusing efforts to increase market penetration outside the Southeastern part of the county and the Gulf States. Market penetration rates are already higher in the South than in other parts of the country, which perhaps creates another argument for focusing efforts to expand the policy base outside the South. It should be noted, however, that there might be more important objectives for expanding market penetration other than reducing the variability in losses. The effects we discuss here must be considered in the context of the overall objectives of the NFIP when deciding on the appropriate targets for increasing penetration.

1.4. Implications of Findings for Setting Targets for Market Penetration Rates

The findings of this study raise several issues that are important for NFIP managers and policymakers to consider as they evaluate alternative targets for market penetration rates and strategies for achieving them. The low market penetration rate in communities with relatively few structures in the SFHA presents a potential marketing opportunity for the NFIP. But while communities with fewer than 500 SFHs in the SFHA present a growth opportunity for the NFIP, the sheer number of such communities (roughly 95 percent of the 20,000 communities in the NFIP have fewer than 500 structures in the SFHA) makes it difficult to develop effective strategies to increase their market penetration rates. Policymakers need to better understand why market penetration rates in these communities are so low and should evaluate the costs and expected payoffs of strategies that increase market penetration in them. Similarly, market penetration rates are lower in communities where a smaller share of homes are in the SFHA; as a result, policymakers need to investigate the costs and benefits of strategies to increase market penetration in these communities.

It is also important to better understand why the market penetration rate is so much lower in communities not subject to coastal flooding (mainly inland communities) than in communities subject to coastal flooding and what can be done to increase it. An estimated 1.7 million SFHs are in the SFHAs of inland communities. NFIP managers should examine features of NFIP policies that make them less attractive in inland areas (e.g., limited basement coverage), whether residents in inland areas systematically underestimate risk, or whether the nature of the risk in inland areas (e.g., lower variance of losses) makes flood insurance relatively less attractive than in coastal areas.

The results of this study suggest that the decision to purchase flood insurance is not particularly sensitive to the price of flood insurance, at least over the range of flood insurance prices currently observed. Thus, in developing strategies to achieve market penetration targets, NFIP managers do not need to be overly focused on how moderate changes in insurance premiums (e.g., 25 percent or less) would affect market penetration rates. However, large changes in prices may well have proportionately much larger impacts on market penetration rates than the findings in this study suggest.

Financial regulators and NFIP managers should evaluate whether and how to improve compliance with the mandatory purchase requirements in important submarkets. Our results suggest some significant gaps in compliance with the mandatory purchase requirement. Policymakers and NFIP managers should explore how to improve compliance in communities that have a relatively low number or proportion of homes in the SFHA, that are not subject to coastal flooding, and that are in the Northeast.

Market penetration rates remain very low among homes not subject to the mandatory purchase requirement, and attention should be paid to what might be done to increase penetration in this segment of the market. The reluctance of homeowners to purchase flood insurance has been an ongoing problem for the NFIP and was the primary reason for adoption of the mandatory purchase requirement. The low rate among homes that are not subject to the mandatory purchase requirement suggests that little has changed over the years and points to the importance of the mandatory purchase requirement in maintaining the market penetration rates that are observed today. While increasing market penetration rates in the voluntary market will continue to be a challenge, NFIP managers should continue to assess strategies and the costs of these strategies. Offering increased options for the types of the losses that are covered and the amount of coverage available might make flood insurance more attractive in the voluntary market.

1.5. Moving Forward

This study has provided additional information on the current state of the market for flood insurance and identified opportunities for increasing market penetration rates. It has demonstrated the feasibility and power of using property parcel data based on county tax assessor records to estimate market penetration rates. It has also attempted to identify some of the benefits of increasing market penetration. However, a number of important gaps remain in the research community's understanding of market penetration rates, compliance rates, and their determinants; we provide a list of fruitful topics for additional research at the conclusion of the report. For example, it would be fruitful to further investigate why the market penetration rate is so much lower in communities with relatively few homes or a relatively low proportion of homes in the SFHA. The number of communities in this study was relatively limited, and better estimates of market penetration in particular geographic regions or other submarkets could be developed by extending the study to additional communities.

While a substantial number of SFHs in SFHAs across the nation have flood insurance, an equally large number do not. As policymakers and NFIP managers evaluate goals for growth in the number of policies and strategies for achieving them, they should consider both the costs and benefits of different goals. Benefits should be measured against overall social objectives for the program and costs should be broadly defined. It should not be automatically assumed that the goal should be universal or nearly universal NFIP coverage. For example, high market penetration rates may not be desirable if the cost of achieving them is high and if, as the results of this study suggest, they do not much reduce disaster assistance relief nor induce greater compliance with NFIP requirements. However, higher market penetration rates may be socially desirable to the extent that failures on the demand side of the market (e.g., homeowners systematically underestimating flood risk) or on the supply side of the market (e.g., few insurance agents with experience writing flood policies in small communities or prices in some regions that do not reflect actuarial risk) limit the desirability or restrict the accessibility of flood insurance.

As this report has illustrated, many complex considerations need to be addressed in setting goals for policy growth and market penetration rate. Thus, it may be infeasible to develop analytically based goals. Rather, a more practical approach may be to work to remove imperfections on the supply and demand sides of the market and let market penetration fall where it may. Even so, careful thought must still be given to how much investment is warranted to remove different market imperfections.

2. INTRODUCTION

2.1. Background on the National Flood Insurance Program

Flooding is a major source of loss to individuals and businesses in the United States. Private insurers have historically been unable to provide flood insurance at affordable rates in the marketplace, and until the establishment of the National Flood Insurance Program (NFIP) in 1968, the primary recourse for flood victims was government disaster assistance.[3] Congress adopted the program in response to the ongoing unavailability of private insurance and continued increases in federal disaster assistance.

The NFIP makes flood insurance available to homeowners, renters, and businesses in communities that participate in the NFIP. In return, participating communities agree to adopt and enforce a floodplain management program aimed at reducing their flood losses. The central requirement of the flood management program is that new residential construction in Special Flood Hazard Areas (SFHAs) be elevated at or above the level water would reach in a flood that occurs with 1 percent annual chance (the base flood elevation, or BFE).[4] Existing residential structures that are built below BFE must also be raised to BFE if they are more than 50 percent damaged by flood. New nonresidential construction in the SFHA must either be elevated or floodproofed against the 1 percent annual chance flood (FEMA, 2002, p. 13) and must be upgraded if they do not meet these requirements and are more than 50 percent damaged by flood.

Early in the program, the federal government found that making insurance available, even at subsidized rates for *existing* buildings, was not a sufficient incentive for communities to join the NFIP or for individuals to purchase flood insurance. In the early 1970s, only 95,000 flood insurance policies were in force and only a few thousand communities participated in the program (FEMA, 2002, p. 3). In response, Congress passed the Flood Disaster Protection Act of 1973, which obligates federally regulated lenders to require flood insurance as a condition of granting or continuing a loan when the buildings and improvements securing it are in the SFHA of a community participating in the NFIP. Loans on homes in SFHAs sold to government-sponsored enterprises such as Fannie Mae and Freddie Mac are also subject to this mandatory purchase requirement. The Act prohibits federal agencies from providing financial assistance for acquiring or constructing buildings and from providing certain disaster assistance in the SFHA of any community that did not join in the NFIP by July 1, 1975, or within one year of being

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[3]The catastrophic nature of flooding and private insurers' inability "to develop an actuarial rate structure that could adequately reflect the risk to which flood-prone properties were exposed" are given as the main reasons that the private sector could not provide insurance at a price that a substantial number of people were willing to pay (FEMA, 2002, p.1).

[4]Special Flood Hazard Areas are areas identified on FEMA's Flood Insurance Rate Maps (FIRMs) that have at least a 1 percent chance of flooding in any given year. The SFHA does not necessarily cover all flood-prone areas in a community. For example, upstream development may have enlarged the area that has a 1 percent chance of flooding beyond that demarked by the most recent FIRM.

identified as flood-prone (FEMA, 2002, p. 3).[5] The mandatory purchase requirement was strengthened by the National Flood Insurance Reform Act of 1994.

The number of communities participating in the program and the number of policyholders grew dramatically as a result of these two laws. Currently, over 20,000 communities participate in the program, and over 4.5 million flood policies are in place. To make the program more self-supporting, FEMA started to reduce subsidies in the 1980s (Kriesel and Landry, 2004, p. 417).

The NFIP offers a maximum $250,000 in structure coverage and up to $100,000 in contents coverage for residential buildings and individual condominium units.[6] Nonresidential buildings are eligible for up to $500,000 building coverage and $500,000 contents coverage (FEMA, 2002, p. 25).

The Federal Emergency Management Agency (FEMA), which administers the NFIP and is part of the U.S. Department of Homeland Security, is currently conducting a major evaluation of the program's performance and goals.[7] FEMA began the evaluation of the NFIP in 2001, the first evaluation since the program's inception. The evaluation assesses the NFIP in the following six areas:

- Occupancy and use of floodplains
- Costs and consequences of flooding
- Insurance rating and indemnity functions
- Floodplain management and enforcement
- Hazard identification and risk assessment
- Marketing and communications (AIR, 2002, p. 5).

The purpose of the overall evaluation is to develop data and information needed to formulate better policies for floodplain management, risk assessment, and insurance, and to support long-term planning and policymaking for the NFIP.

2.2. Objective of this Study

This study contributes to the overall FEMA evaluation of the NFIP by addressing issues related to the NFIP's insurance rating and indemnity functions. More specifically, this report contributes to that evaluation by (1) developing more reliable estimates of the proportion of households that have purchased federal flood insurance (the market penetration rate); (2)

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[5]FEMA has no role in enforcing the mandatory purchase requirement. That responsibility belongs to the federal agencies that regulate lenders, the government-sponsored enterprises, and the federal agencies that guarantee mortgages.
[6]Residential condominium buildings can purchase up to $250,000 times the number of units and up to $100,000 in commonly owned contents coverage per building (FEMA, 2002, p. 25).
[7]FEMA assumed responsibility for the NFIP when the agency was established in 1979 (Browne and Hoyt, 2000, p. 298). The U.S. Department of Housing and Urban Development administered the NFIP prior to 1979.

identifying factors that determine the market penetration rate; and (3) examining some of the opportunities for, and potential benefits of, increasing the market penetration rate.

From an insurance perspective, the NFIP's primary purpose is to insure those at risk against flood losses, and a key part of any evaluation of the program is to determine how well it has done so. A first step in evaluating the NFIP's performance in this dimension is to develop an accurate estimate of the market penetration rate for flood insurance and examine how it varies across different market segments. To date, NFIP's estimates of the market penetration rate have been based primarily on structure counts derived from surveys of participating communities.[8] Many observers, however, believe these structure counts are inaccurate.[9] This study develops estimates of market penetration rate based on a new and richer set of data. It estimates market penetration rate by assembling information on a sample of property parcels in randomly selected NFIP communities across the United States. The information is drawn from tax assessor records, flood determination companies,[10] and the NFIP's policies-in-force database. These data allow for more detailed analysis of market penetration rate and investigation of the degree of compliance with the mandatory purchase requirement. The analysis of market penetration rate in this study is restricted to SFHs, which, as will be shown in Chapter 3, account for over 60 percent of the structures in NFIP communities.

The report also provides analysis that will assist NFIP managers and policymakers more generally to evaluate alternative goals for the market penetration rate and the strategies for achieving them. The study identifies factors that are associated with high and low market penetration rates across communities and identifies opportunities for increasing the market penetration rate. It also examines some of the potential benefits of increasing the market penetration rate. In particular, the study examines the relationship between the market penetration rate and the amount of federal disaster assistance and whether higher market penetration rates are associated with better community compliance with the NFIP's floodplain management requirements. Finally, the study examines how increases in the number of policies in different regions of the country would likely affect the variability of total annual NFIP claims payments.

2.3. Organization of this Report

The next chapter discusses the methods used for estimating the NFIP market penetration rate. Chapter 4 reports estimates of the market penetration rate by geographic region and inside and outside of SFHAs. The chapter also examines compliance with the mandatory purchase

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[8]The NFIP sends a brief "Biennial Survey" to every community participating in the program. Survey questions include data on the number of building permits granted for new structures in the SFHA and the estimated number of structures in the SFHA. The surveys are in principle supposed to be fielded every two years, but the last two surveys were in 1998 and 2003.

[9]Anecdotal evidence suggests that the sophistication of the methods used to estimate structure counts varies across communities. Some communities use GIS data or tax map overlays in determining the number of structures in the SFHA, while others merely guess.

[10]Flood determination companies determine whether a structure is in an SFHA based on flood maps developed by the NFIP.

requirement and the market penetration rate among homes that are not subject to the mandatory purchase requirement. Chapter 5 explores the factors that determine the market penetration rate, such as the size of the community, the source of flooding, insurance premiums, and historical loss payments, and identifies opportunities for increasing market penetration rates. Chapter 6 investigates some of the benefits of increasing the market penetration rate. It examines the relationship between the market penetration rate and disaster assistance and between market penetration rate and measures of community compliance with the requirements of the NFIP. Chapter 7 examines the geographic variability of flood losses and explores how growth in the number of policies in different parts of the country would affect the annual variability of overall NFIP losses. Chapter 8 discusses policy implications of the study findings and identifies promising topics for additional research.

3. METHODS USED TO ESTIMATE THE MARKET PENETRATION RATE FOR FLOOD INSURANCE

Existing estimates of the proportion of structures in SFHAs nationwide that have flood insurance are based on the number of policies in force and estimates of the number of structures in SFHAs. The problem with this approach is that there is substantial uncertainty about the number of structures in SFHAs. Also, this type of aggregate data makes it difficult to examine how market penetration varies by type of structure (single-family home, other residential, commercial, etc.) and other characteristics of the property or the community in which the property lies. To develop better estimates of market penetration rates and the factors that determine whether property owners buy flood insurance, we assembled data on a random sample of property parcels spread across a sizable number of communities. This chapter describes the methods used to create the parcel database and to extrapolate findings from the sample to the nation as whole.

3.1. Selection of NFIP Communities for Study

There were 20,010 communities participating in the NFIP as of September 2004 (FEMA, 2004a). Most communities in the NFIP are cities, towns, villages, parishes, boroughs, or counties.[11] NFIP members must have land-use planning authority in their jurisdictions.[12] Typically, cities that belong to the NFIP represent the area corresponding to city boundaries, and counties belonging to the NFIP represent the unincorporated parts of the county. One hundred NFIP communities were randomly selected for this study. To increase the statistical precision of the analysis, NFIP communities were stratified by region, primary source of flooding (coastal versus riverine), and an initial estimate of the number of structures in the SFHA. Using procedures described below, communities were selected from each of the strata.

The communities selected for this study were chosen from the 19,283 communities that were present in the "census" data file of the NFIP's Community Information System (CIS) as of March 2003 (excluding five communities in Puerto Rico, the Virgin Islands, Guam, and American Samoa, and communities that had been suspended from the program). Over one-half of the difference between the 19,283 communities in the CIS census data file and the 20,010 currently participating in the NFIP results from the absence from the census data file of 386 out of the 956 communities in Maine. These communities are unorganized territories that participate in the NFIP under the auspices of the Maine Land Use Commission. Most are comprised of

[11]More precisely, community "means any State or area or political subdivision thereof, or any Indian tribe or authorized tribal organization, or Alaska Native village or authorized native organization, which has authority to adopt and enforce floodplain management regulations for the areas within its jurisdiction" 44 CFR Ch. 1 Section 59.1 (10-1-01 edition).

[12]According to NFIP staff, there are 1,855 mapped communities (the flood zones in these communities have been mapped) that do not participate in the NFIP and 5,000 to 6,000 unmapped communities that do not participate in the NFIP. These communities are thought to have small populations by and large. Moreover, some of the unmapped communities may not have land-use planning authority and, consequently, not meet the definition of an NFIP community (Robinson, 2005).

forest company lands or islands without year-round populations (Robinson, 2004). Thus, these communities likely have few SFHs, which means that excluding them from consideration will likely have little effect on our estimates of the number of SFHs in NFIP communities or the market penetration rate. The difference between the number of communities in the CIS census file and the number of communities currently participating in the CIS is also explained in part by an increase in the number of participating communities since March 2003. These communities are typically very small.

Table 3.1 reports the distribution of the 19,283 communities by region, source of flooding, and size. Classification of the communities by region and source of flooding is based on information in the CIS.[13] The four regions used in this study are aggregations of the 10 FEMA regions. A map of FEMA regions is included as Appendix 1, and the four regions used in the study are defined in Table 3.1. Flood source applies to the entire community, and distinguishes communities subject to coastal sources of flooding from communities that are not.[14] Distinguishing communities by flood source for the most part can be thought of as dividing the four regions into inland and coastal areas. Communities are grouped by size based on the number of structures in the SFHA using data from the 1998 Biennial Report.[15] Even though the structure-count data from the Biennial Report are thought to be inaccurate for many communities, the data are useful for grouping communities into the broad size categories used here. Missing values on structure counts in the Biennial Report (structure counts equal to zero even though the community reported that people lived in the SFHA) were imputed, and structure counts that appeared unreasonably high given population estimates were adjusted.[16,17]

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[13]The CIS census data file contains estimates of the population and number of structures by community, but values are missing for some communities.

[14]The riverine-coastal variable in the CIS database "indicates whether the community is subject to coastal flooding. Coastal flooding includes flooding from any body of water subject to tidal fluctuations and includes large numbers of communities on estuaries. For example, Albany, New York is a coastal community since the Hudson River is tidal within city limits" (FEMA, 2003, p. 9). Communities classified as coastal can also be subject to flooding from rivers that are not associated with tidal fluctuations. Coastal communities may or may not include "V" flood zones. V flood zones are areas that are inundated by tidal floods with velocity.

[15]Results from the 2003 Biennial Report were not available at the time the sample for this study was selected.

[16]When the number of structures in the SFHA was zero even though the population reported in the SFHA was positive, the number of structures was imputed by multiplying the population reported in the CIS database by the average number of structures per capita in the SFHA for the remaining communities in the NFIP. These modifications were done for 625 communities. For the few communities where the number of structures in the SFHA was unrealistically large relative to population, the number of structures was replaced using the average number of structures per capita and SFHA population.

[17]As of September 30, 2004, the NFIP estimated that there were 7.92 million structures (residential and non-residential) in the SFHAs of NFIP communities, and 7.75 million once Puerto Rico, Virgin Islands, Guam, and American Samoa were excluded (FEMA, 2004a).

TABLE 3.1: Characteristics of Communities Participating in the NFIP[1]

	Communities		Structures in SFHA[2]	
	Number	Percent of Total	Millions of Structures	Percent of Total
Region[3]				
Northeast	6,668	35	1.44	19
South	4,822	25	3.75	50
Midwest	6,425	33	1.22	16
West	1,368	7	1.12	15
Total U.S.	19,283	100	7.53	100
Source of Flooding in Community				
Not subject to coastal flooding	17,501	91	4.13	55
Subject to coastal flooding	1,782	9	3.41	45
Total U.S.	19,283	100	7.53	100
Structures in SFHA				
<=1,000	18,154	94	1.99	26
1,001 to 10,000	1,036	5	2.82	37
>10,000	93	0.5	2.73	36
Total U.S.	19,283	100	7.53	100

[1]As of March 2003; excludes communities in Puerto Rico, Virgin Islands, and Guam.

[2]Number of total structures in the SFHA (1–4 family structures plus all other structures) based on the 1998 Biennial Report after imputing missing values and adjusting unreasonably high structure counts.

[3]Northeast = FEMA regions 1, 2, and 3; South =FEMA regions 4 and 6; Midwest = FEMA regions 5, 7, and 8; West= FEMA regions 9 and 10.

The bottom set of rows in Table 3.1 shows that 0.5 percent of the communities in the NFIP account for over one-third of the structures in SFHAs according to the Biennial Report. Small communities are large in number but account for only one-quarter of the structures in SFHAs. Given this concentration, better statistical precision will result if the larger communities are oversampled relative to their incidence in the overall population of communities. The effect of different sample allocations on the expected variance of estimates of the market penetration rate was quantitatively simulated. Based on the results, the sample of 100 communities was allocated across the three size strata roughly in proportion to the reported number of structures in each of the strata.[18] Within each size stratum, communities were allocated to cells representing the different combinations of geographic region and source of flooding in proportion to the number of communities in each cell.[19]

Communities were then selected from each cell randomly, with the selection probability proportional to the estimated number of structures in the SFHA of the community.[20] Selecting communities proportional to the number of structures in the SFHA and then selecting an equal number of property parcels (defined below) from each community reduces the effect of clustering in the sample.[21] The communities selected for the sample were restricted to (1)

[18]Because of its unique characteristics and the limited size of the sample, New York City was not eligible for selection. Thus, the extrapolations in this study to the nation as a whole do not include New York City.

[19]Multiplying the number of region and source-of-flooding strata results in eight cells for each of the three size categories (24 cells total). The number of communities in three of the cells was small, so the communities in these cells were combined with other cells reducing the total number of cells to 21.

[20]The SAS Surveyselect procedure was used to select the sample.

[21]Clustering refers to the fact that the individual property parcels are not spread across all communities in the NFIP but clustered into the 100 sampled communities.

communities in the First American Real Estate Solutions (FARES) database of property parcels and (2) communities where the address field in the FARES database was populated for at least 50 percent of the parcels in the community. At the time of the study, 7,095 of the 19,283 NFIP communities met these criteria.

Table 3.2 displays the resulting sample of communities by region, source of flooding, and size. The communities are listed and mapped in Appendix 2. As can be seen by comparing Tables 2.1 and 2.2, the sample includes about 37 percent of NFIP communities with more than 10,000 structures in the SFHA according to the 1998 Biennial Survey, about 4 percent of those with between 1,000 and 10,000 structures, and 0.2 percent of those with fewer than 1,000.

TABLE 3.2: Characteristics of 100 Communities Selected for the Sample

	Number of Communities
Region	
Northeast	19
South	47
Midwest	18
West	16
Source of Flooding in Community	
Subject to coastal flooding	49
Not subject to coastal flooding	51
Structures in SFHA According to Biennial Report	
<=1,000	29
1,000 to 10,000	37
>10,000	34

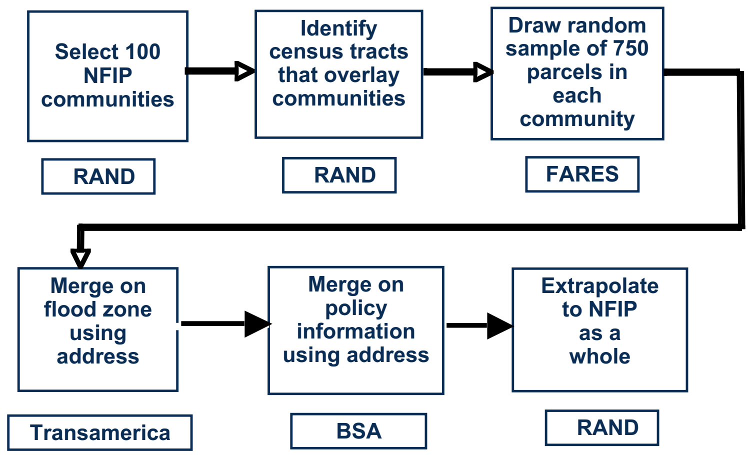
3.2. Assembling Parcel Data

For each of the 100 communities selected for the study, data on a random sample of approximately 750 property parcels was purchased from FARES. FARES collects and standardizes publicly available property parcel information from tax assessors across the country. Tax assessor records provide a rich source of information on each parcel, including the following variables:

- Land-use type (single-family home, apartment building, commercial, industrial, public use, etc.)
- Value of land and improvements
- Date of construction
- Date of last property transfer
- Amount of mortgage on the property (usually at the time of most recent sale).

Property parcel records with complete addresses were then sent to Transamerica Flood Hazard Certification, Inc. (which FARES purchased in the middle of this study) to determine the NFIP community and flood zone in which the parcel lies. Finally, the parcels were sent to the NFIP's Bureau and Statistical Agent (BSA) to determine whether there was a flood policy in force on the parcel. Figure 3.1 provides a schematic of the process.

FIGURE 3.1: Process for Assembling Parcel Data



FARES was provided with a list of the year 2000 census tracts that overlay each of the selected communities. Geographic information system (GIS) software was used to identify which census tracts overlay digitized NFIP maps of the selected communities, or for those communities where no digitized map was available, the area designated by the Bureau of the Census for the community.[22] Care was taken to ensure that the list of Census tracts was, if anything, over-inclusive so that all areas in the communities were covered.

The authors worked closely with FARES to draw the property parcels from each community. All types of land use were eligible for selection, other than those marked as vacant land. Overall, FARES provided data on 74,368 parcels. Of these, approximately 12 percent were missing information on street name, street number, or city name. The remaining 88 percent were sent to Transamerica for flood-zone determinations. Transamerica identified the flood zone and NFIP community for each parcel based on the address. Transamerica was unable to determine flood zone or community for about 4 percent of the records it received.

The BSA used its address-matching software to determine whether there was an NFIP policy at the address. The address matches were performed between February and April 2004. Flood policies are often written for particular condominium or commercial units, and the unit numbers can create problems for address matching. To better understand the problems unit numbers create for address matching, the BSA was asked to do the matches first ignoring unit number and second including unit number.

[22]Digitized maps were available for 94 of the communities in the sample. The maps were predominately the NFIP's Q3 maps, although a handful of Digital Flood Insurance Rate Maps (DFIRMs) were available and used instead. The accuracy of the flood zones on the Q3 maps has frequently been questioned. For this study, however, the Q3 maps were used only to identify the overall community boundary, not the flood zones.

3.3. Overview of Parcel Data

Table 3.3 shows the land use of the property parcels in the sample as reported by FARES. Over 85 percent of the parcels are residential, and of these, at least two-thirds are SFHs (including townhouses or row houses).[23] Because a high percentage of the parcels in the 100 communities are SFHs and because determining whether there is a NFIP policy at these parcels is more straightforward than it is for other land uses (there are few complications with unit numbers, for example), we restrict our attention to SFHs.

TABLE 3.3: Land Use of Property Parcels in Sample As Reported by FARES

Land Use	Parcels	Percentage of Total
Residential	64,952	87
Single-family homes*	42,547	57
Condominiums	8,718	12
Other	5,908	8
Not elsewhere classified	7,779	10
Commercial	2,834	4
Industrial	1,007	1
Agricultural	1,913	3
Public	2,018	3
Other	1,644	2
Total	74,368	100

*Includes properties classified by FARES as row houses or townhouses.

The sample of parcels contained a number of missing values for variables required in the analysis. It also contained values for some variables that had to be parsed into the categories used in the analysis. For example, residential uses "not elsewhere classified" had to be split into SFHs and other residential uses. Appendix 3 describes the statistical techniques used to impute missing values and to parse variable values.

Table 3.4 shows the number of parcels used in our analysis of SFHs after filling in missing values. Because parts of some Census tracts that FARES used to select the sample lay outside the boundaries of the 100 NFIP communities in the study, only a portion of the 49,056 SFHs (after missing values were imputed) are in the 100 communities selected for study. Approximately 55 percent of the SFHs (27,667) are in the sample of communities. Of these, 5,472 (20 percent) are in the SFHAs. Analysis of market penetration inside the SFHA is based on these 5,472 observations. Analysis of market penetration outside the SFHA uses the 22,195 observations in the 100 communities but outside their SFHAs.

[23]The *Not Elsewhere Classified* category also includes single-family homes in communities that do not distinguish between different types of residential land use.

TABLE 3.4: Sample Size

	Parcels
Number of property parcels purchased from FARES	74,368
Single-family homes after missing values imputed	49,056
Single-family homes in correct NFIP community	27,667
Single-family homes in SFHA	5,472
Single-family homes outside SFHA	22,195

3.4. Method for Extrapolating Findings to the Nation As a Whole

Statistical weights were used to extrapolate findings from the sample of property parcels to the nation as a whole (excluding communities suspended from the NFIP, New York City, and communities in Puerto Rico, Virgin Islands, Guam, and American Samoa). An overview of the methods used to project the number of the structures in and out of the SFHAs of NFIP communities and the market penetration rate nationwide is presented below. Details are found in Appendix 4.

The market penetration rate for SFHs was estimated in three ways:

1. Address matching
2. BSA policy totals for the entire NFIP
3. BSA policy totals for the sampled communities.

In the first approach, the BSA searched its policies-in-force database to determine whether there was a policy at each of the SFHs in the sample. The BSA concluded that a home had a flood insurance policy if its address in the parcel database matched an address in the policies-in-force database. Difficulties in matching homes with policies using addresses may mean that market penetration rates based on address matching understate the true market penetration rate.

The second approach for estimating the market penetration rate does not rely on address matching. Data on the number of policies on single-family homes in the BSA's database, disaggregated by region and flood zone, are used. The estimate of the number of SFHs (in and out of the floodplain) is calculated using the sampling probabilities for each home in the sample. The market penetration rate is then calculated by dividing the number of policies by the projected number of SFHs. Market penetration rates calculated using this approach are referred to as market penetration rates based on BSA policy totals. This second approach for determining the market penetration rates is preferable to the first in some ways, but it has an important drawback: The policies-in-force database can be disaggregated only in a limited number of dimensions (e.g., region and source of flooding). As a result, market penetration rates cannot be calculated for many of the community and parcel attributes examined in the study.

The third approach uses BSA data on the number of policies in each of the 100 communities in the sample. The number of policies in the sample communities is extrapolated nationwide using sampling weights for each of the communities in the sample (as opposed to weights for each of the parcels). The resulting projections are combined with estimates of the number of SFHs using the method described above to determine market penetration rates. This approach relies on actual data on the number of policies in each community, so estimates using it are referred to as estimates based on BSA policy totals by community. Like the second approach, this approach avoids address matching, but it also allows calculation of market penetration rates broken down by attributes developed in this study for the 100 communities in the sample. For example, the relation between market penetration rate and the percentage of the community that is urban is investigated below. To do this analysis, it was necessary to determine the percentage of each of the 100 communities in the study that is urban, but not the percentage of every community in the NFIP that is urban. A disadvantage of this approach is that it does not allow analysis of market penetration rates using parcel-level information. Some of our analyses, such as analysis of compliance with the mandatory purchase requirement, require variables available only on the parcel records provided by FARES.

3.5. Validation of BSA Method for Determining Whether A Flood Policy Exists at Sampled Structures

A random sample of 1,000 single-family home parcels was selected to validate the accuracy of the BSA method for determining whether a flood policy exists at the SFHs in the sample. We independently determined whether there was a flood policy at each parcel and compared the results to what BSA found. To determine whether there was a policy at the parcel, we geocoded all the addresses for the relevant states in the BSA policies-in-force file as well as the addresses for the 1,000 sample parcels using GIS software. Our findings on whether there was a policy at the parcel agreed with BSA's findings for over 95 percent of the parcels.[24] The remaining 5 percent of parcels were divided roughly evenly between those where the BSA found a policy at the address but we did not and those where we found a policy at the address but BSA did not.[25] The analysis was done only for SFHs. The agreement rate could possibly be lower for other land uses. The results give us high confidence in the accuracy of the BSA methodology, although it is possible that while the two address matching approaches are consistent, both missed (or improperly made) some matches. In the analysis that follows, results using BSA policy totals and BSA policy totals by community are also reported, along with results based on address matching, as a way to check that findings are not driven by inaccurate address matching.

3.6. Stakeholder Interviews

We conducted interviews with eight individuals with extensive experience on the insurance side (as opposed to the floodplain management side) of the NFIP. The interviews provided an understanding of the factors that drive market penetration rates. Interviewees were also asked what could be done to increase market penetration rates in various submarkets and who should take the lead on such efforts.

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[24]Single-family homes rarely include unit numbers, so the results did not depend on whether BSA matches included unit numbers.

[25]The results are as follows: match found by both BSA and RAND: 421; no match found by either BSA or RAND: 568; match found by BSA but not RAND: 22; match found by RAND by not BSA: 25

Participants were selected from three groups involved in the placement of flood insurance policies: Write-Your-Own (WYO) companies, insurance agents, and mortgage lenders.[26] The participants were selected so that different parts of the country were represented. All had worked in the flood insurance business for many years. All those asked to be interviewed agreed to participate, and all gave permission to be identified in this report (reflected in the Acknowledgments).

The interviews were conducted by phone using an interview protocol with questions that allowed open-ended responses and follow-up questions by the interviewers. The interviews took 60 to 90 minutes each and were conducted in October 2004.

[26]WYO companies are insurers that issue NFIP policies and adjust claims under their own names. WYO companies receive an expense allowance from the NFIP and remit premium income in excess of claims to the federal government. The premium charged for NFIP flood coverage by a WYO company is the same as that charged for policies written directly by the NFIP (FEMA, 1999, p. 2).

4. THE MARKET PENETRATION RATE FOR FLOOD INSURANCE

This chapter presents findings on the number of SFHs in SFHAs and the market penetration rates for flood insurance. Findings on compliance with the mandatory purchase requirement, as well as variation of the market penetration and compliance rates by geographic region, are also presented. These findings suggest both challenges and opportunities for increasing the number of homes with flood insurance. The chapter closes by examining the amount of coverage purchased relative to the value of the home and whether homeowners subject to the mandatory purchase requirement purchase enough coverage to satisfy the requirement. These results provide insight into the opportunities and challenges for increasing the amount of coverage on homes that are already insured.

4.1. Market Penetration Rate for Single-Family Homes

Table 4.1 presents estimates of the number of SFHs, the number of flood insurance policies, and the market penetration rate in communities that participate in the NFIP.[27] The estimates exclude condominiums and are reported by geographic region and for homes inside and homes outside of SFHAs. The first column of numbers in Table 4.1 reports the sample sizes on which the estimates are based. The estimates of the number of SFHs with policies and the market penetration rate are based on address matching and the results are extrapolated nationwide using the methods discussed in Chapter 3.

4.1.1. The Number of SFHs in NFIP Communities and in SFHAs

As shown in the bottom row of Table 4.1, the projected number of SFHs in NFIP communities nationwide is 79.2 million with a 95 percent confidence interval running from 59.3 to 99.1 million.[28] As shown in the top panel of Table 4.1, nearly 3.6 million (4.5 percent) of noncondominium SFHs are in SFHAs.[29] Single-family homes in SFHAs are concentrated in the South: 2.1 million, or nearly 60 percent of the 3.6 million total. Estimated market penetration rates are reported in the penultimate column of Table 4.1. The market penetration rate in SFHAs is 49 percent nationwide with a 95 percent confidence interval running from 42 to 56 percent. Market penetration rates are much higher in the South and the West (approximately 60 percent) than in the Northeast and Midwest. Possible reasons for these differences are investigated in Chapter 5.

[27]As discussed in Chapter 3, the nationwide projections exclude communities suspended from the NFIP, New York City, and communities in Puerto Rico, Virgin Islands, Guam, and American Samoa.

[28] If the data collection and analysis were done afresh for repeated random samples of communities and parcels, the resulting estimates would fall in the 95 percent confidence interval 95 percent of the time. The confidence intervals reported here are generated by the SAS Surveymeans procedure and account for the stratification used to select the sample of 100 communities and the clustering of parcels in the communities.

[29] The 95 percent confidence interval for the percentage of single-family homes in SFHAs runs from 3.4 percent to 5.6 percent.

TABLE 4.1: Market Penetration Rate for SFHs Based on Address Matching

Location	Sample Size[1]	Number of Single-Family Homes (millions)	95% CI[2]	Number of Single-Family Homes with Policies (millions)	95% CI	Market Penetration Rate (percent)	95% CI
Inside SFHA							
Northeast	631	0.77	[0.45, 1.10]	0.22	[0.10, 0.34]	28	[11, 46]
South	4,069	2.06	[1.56, 2.57]	1.27	[0.89, 1.64]	61	[54, 69]
Midwest	193	0.45	[0.25, 0.65]	0.10	[0.05, 0.15]	22	[15, 30]
West	579	0.29	[0.10, 0.47]	0.17	[0.04, 0.30]	60	[51, 68]
Total U.S.	5,472	3.57	[2.94, 4.20]	1.76	[1.36, 2.16]	49	[42, 56]
Outside SFHA							
Northeast	5,572	20.4	[10.6, 30.2]	0.11	[0. 0.23]	0.6	[0, 1.1]
South	7,487	15.4	[5.6, 25.2]	0.46	[0.27, 0.65]	3	[0.8, 5]
Midwest	4,912	28.0	[15.4, 40.5]	0.11	[0.03, 0.20]	0.4	[0.1, 0.7]
West	4,224	11.9	[2.1, 21.7]	0.12	[0, 0.25]	1	[0.6, 2.5]
Total U.S.	22,195	75.6	[55.9, 95.4]	0.81	[0.55, 1.07]	1	[0.7, 1.4]
Anywhere in NFIP Community							
Northeast	6,203	21.2	[11.0, 31.3]	0.33	[0.10, 0.57]	2	[0.6, 2.5]
South	11,556	17.5	[7.5, 27.4]	1.73	[1.28, 2.17]	10	[4, 16]
Midwest	5,105	28.4	[15.8, 41.0]	0.21	[0.09, 0.34]	1	[0.3, 1.2]
West	4,803	12.2	[2.4, 21.9]	0.29	[0.11, 0.47]	2	[0.8, 4]
Total U.S.	27,667	79.2	[59.3, 99.1]	2.56	[2.03, 3.09]	3	[2, 4]

[1]Denotes the number of observations on which the estimates are based.

[2]95–percent statistical confidence interval for estimate.

The estimate of the total number of SFHs in NFIP communities nationwide (79.2 million) is consistent with the number of SFHs reported by the Bureau of the Census. The Bureau's American Housing Survey reports that there were 81.2 million homes (attached and detached) in the United States in 2001 (U.S. Bureau of the Census, 2004a). The Census estimate would increase to roughly 84.9 million if projected to 2004 (the date corresponding to the projections in Table 4.1), using the average growth rate in SFHs between 1990 and 2000.[30] The Census number includes condominiums and cooperatives,[31] homes outside NFIP communities,[32] homes outside the 50 states and the District of Columbia, and homes in New York City[33]; thus, the total must be

[30] The number of single-family homes in the United States grew at a compound annual rate of 1.5 percent between 1990 and 2000 (based on data from the decennial Census).

[31] According to the Bureau of the Census, 6.6 million housing units in the United States are condominiums or cooperatives. In the BSA's policy-in-force database, 14 percent of condominiums with flood insurance policies are classified as single-family homes. Thus, removing condos might reduce the total for single-family homes by approximately 0.9 million.

[32]There are no hard data, but NFIP staff believe that the percentage of single-family homes in the United States that are in NFIP communities is in the high 90s (Robinson, 2005). There is only one large city in the United States (San Francisco) that is not in the NFIP. If 3 percent of homes were outside of NFIP communities, the number of single-family homes in NFIP communities falls to 81.5 million after condos are excluded (0.97 x (84.9 – 0.9 million)).

[33]According to the 1998 Biennial report, there were approximately 600,000 1- to 4-family structures in New York City and 1.2 million 1- to 4-family structures in American Samoa, Guam, Puerto Rico, and the Virgin Islands.

reduced to be compared with the projections here. Estimates of the appropriate reductions reduce the 84.9 million estimate to 79.7 million, which is close to the 79.2 million projection here.[34]

While the projection for the number of SFHs in NFIP communities is consistent with other data, the estimate of the number of SFHs in SFHAs is somewhat lower than those reported in or implied by other studies. PricewaterhouseCoopers (PWC) estimated that there were 6.2 million residential structures in SFHAs in 1997 (PWC, 1999, p. 1–4). Separate estimates were not provided for SFHs. The figures in Table 3.3 suggest that between 58 percent and 65 percent of residential parcels are SFHs (excluding condominiums).[35] Once these percentages are applied, the PWC projection falls to between 3.6 million and 4.0 million homes in 1997, and the range rises to perhaps 4.0 to 4.4 million if growth between 1997 and 2004 is factored in.[36] The point estimate for the projection of the number of SFHs in SFHAs based on the sample studied here is 10 percent below the bottom of this range.

However, the PWC study used a less precise method for determining the number of structures in the floodplain than the study here. PWC started with the number of residential structures by Census block group and then estimated the number of structures in SFHAs according to the percentage of a block group's area that was in the SFHA. Variation of geographic features within block groups makes it highly unlikely that structures are evenly distributed within a block group; assuming that they are introduces unknown error into estimates of the number of structures in SFHAs.

Tobin and Calfee collected data from seven large national flood determination companies on flood determinations done between 1997 and 2003 (2005, p. 118). They found that 5.5 percent of determinations were in SFHAs, higher than the 4.5 percent reported here.[37] When applied to the projection here for the total number of SFHs in NFIP communities (79.2 million), the Tobin and Calfee findings imply that 4.4 million SFHs are in SFHAs. The point estimate developed here is about 18 percent lower than the 4.4 million homes implied by the Tobin and Calfee findings.

There are reasons to expect the findings of Tobin and Calfee to overstate the proportion of homes in SFHAs nationwide. First, there is no guarantee that their findings are representative of the nation as a whole. The determinations analyzed were those requested by lending institutions between 1997 and 2003 for residential mortgages. Thus, homes in the South or coastal areas may be overrepresented, where growth in recent years has been faster and the

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[34]The estimate of the number single-family homes based on the American Housing Survey drops to 79.7 million once the 84.9 million estimate is reduced by all the factors considered. This result assumes that all 1- to 4-family homes in New York City, American Samoa, Guam, Puerto Rico, and the Virgin Islands are single-family homes.

[35]Fifty-eight percent of the residential parcels provided by FARES are classified as single-family homes. Ten percent are in the "not elsewhere classified category," which could include single-family homes. The proportion of residential parcels outside the "not elsewhere classified" category that are single-family homes is 74 percent. If we assume that the same percentage applies to the "not elsewhere classified" category, then including the "not elsewhere classified" category increases the percent of residential parcels that are single-family homes to 65 percent (58 percent plus 7 percent).

[36]See footnote 30 for this chapter.

[37]The Tobin and Calfee estimate does fall within in 95 percent confidence interval for the 4.5 percent estimate.

proportion of land in SFHAs is higher than in many other parts of the country. Second, flood determination companies may have a slight tendency to error on the side of including properties in an SFHA. It is reasonable to expect that the consequences are more severe for mistakenly determining that a home is outside an SFHA than for mistakenly determining that it is in an SFHA. Thus, one might expect official flood determinations to slightly overstate the percent of homes in SFHAs.[38]

One can gain further insight into the estimate of the number of SFHs developed here by comparing projections of the number of flood policies based on the study sample with the number of policies according to the BSA's policies-in-force database.[39] Projections of the number of policies based on address matching from Table 4.1 are repeated in Table 4.2. Also included in Table 4.2 are projections of the number of flood insurance policies for structure coverage nationwide based on the number of policies on non-condo, SFHs in each of the 100 communities according to the BSA (labeled "Based on BSA Policy Totals By Community"), as well as data on (not estimates of) the number of policies in each region and for the nation as a whole according to the BSA (labeled "Based on BSA Policy Totals").[40,41] The estimate of the number of policies in SFHAs based on address matching (1.76 million) is 12 percent lower than the BSA's total (2.00 million) or projections based on the number of policies in each of the 100 communities (2.00 million).[42,43]

There are a number of reasons why the projection of the number of SFHs based on the sample here could be somewhat low. FARES data on the parcels in some of the communities may be incomplete or not reflect recent growth. (Such an undercount would affect the weight on each observation in the affected communities.) An undercount of the number of policies could also be the result of a failure to identify policies at some of the SFHs in the sample because of difficulties with address matching. However, the validation described in Chapter 3 of the address matching done by the BSA provides confidence that homes in the sample with policies were not missed by address matching. Finally, estimates of the number of policies nationwide based on address matching and on BSA data may diverge because of disagreements between the property parcel and BSA databases over a parcel's land use, flood zone, or NFIP community. The analysis

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[38]The flood zones of the properties in this study are also based on flood determinations done by a flood determination company. However, we requested that the determinations be done with "zero buffer," meaning that even if the computer mapping program determined that a property was 5 feet outside the SFHA, it was considered outside the SFHA. Typically flood determination companies manually review the electronic flood determinations that fall within a certain distance of a change in flood zone (for example 250 feet). During this manual review, there may be tendency to err on the side of including properties in the SFHA.

[39]Policies that provide coverage for only the contents of a single-family home (as opposed to the structure) are rare and are excluded from this analysis.

[40]The different methods for extrapolating findings from the sample are described in Chapter 2.

[41]The BSA policy totals exclude policies in New York City and in U.S. territories. There are 9,590 policies on single-family homes excluding condominiums in New York City and 39,246 such policies in the U.S. territories.

[42]There are currently about 4.5 million flood insurance policies in force and 3.8 million contracts in force. (Flood insurance contracts can cover multiple condominium units, and each condominium unit is counted separately in the policies-in-force total.) For single-family homes excluding condominiums, the number of contracts in force is the same as the number of policies in force in the BSA database.

[43]The percentage of policies in SFHAs according to our projections based on address matching (68 percent as can be calculated from Table 3.2) is very close to the percent according to the BSA (67 percent).

in Appendix 5 shows that agreement between the two databases is high but that properties in the BSA policies-in-force database are slightly more likely to be categorized as SFHs, located in the SFHA, and identified as being in the 100 communities selected for this study. Together, these differences could explain between one-quarter and one-half of the 12-percent difference in the two figures on the number of policies (1.76 and 1.99 million). It is not known whether the BSA data on land use, flood zone, or NFIP community are more accurate than those provided by FARES or Transamerica.

TABLE 4.2: Comparison of the Number of Policies and Market Penetration Rate Based on Address Matching and BSA Policies-in-Force Data

Extrapolation Method	Northeast	South	Midwest	West	Total U.S.
Inside SFHA					
Based on Address Matching					
Policies (millions)	0.22	1.27	0.10	0.17	1.76
Market penetration rate (percent)	29	61	22	60	49
Based on BSA Policy Totals by Community					
Policies (millions)	0.27	1.37	0.16	0.19	2.00
Market penetration rate (percent)	35	67	36	67	56
Based on BSA Policy Totals					
Policies (millions)	0.29	1.36	0.14	0.21	2.00
Market penetration rate (percent)	38	66	31	72	56
Outside SFHA					
Based on Address Matching					
Policies (millions)	0.11	0.46	0.11	0.12	0.81
Market penetration rate (percent)	0.6	3	0.4	1	1
Based on BSA Policy Totals by Community					
Policies (millions)	0.12	0.49	0.10	0.08	0.78
Market penetration rate (percent)	0.6	3.2	0.3	0.7	1.0
Based on BSA Policy Totals					
Policies (millions)	0.12	0.73	0.05	0.09	0.98
Market penetration rate (percent)	0.6	4.7	0.2	0.8	1.3

The percentage difference between the projection of the number of policies using address matching and the number of policies nationwide according to the BSA is similar to the percentage difference between the projection of the number of SFHs in SFHAs made here and those implied by other studies. Taken together, the results suggest the actual number of SFHs in SFHA may lie in the upper portion of the 95 percent confidence interval for the 3.6 million estimate (which runs from 2.9 to 4.2 million homes).

4.1.2. The Market Penetration Rate

Table 4.2 also reports estimates of market penetration using address matching, BSA policy totals by community, and BSA policy totals nationwide. The estimates of market penetration rate based on address matching are not affected by any possible undercount of the number of SFHs in SFHAs. The higher rates when estimates are based on BSA policy totals (56 percent nationwide for both BSA policy totals by community and BSA policies totals nationwide) may result from undercounts of the number of SFHs. While there is good reason to be confident in the estimates of market penetration based on address matching, we continue to report market penetration estimates based on NFIP policy totals in the remainder of the report. Comparing estimates based on NFIP policy totals can allay concerns that differences in market penetration observed across regions or communities result from systematic variation in the difficulty of address matching.

As discussed above, market penetration rate varies a great deal across the four geographic regions investigated in this study. However, the sample size of SFHs in the Midwest is modest; thus, conclusions about the market penetration rate in this region should be considered tentative. Similarly, the market penetration rate in the Northeast is estimated with a considerable degree of uncertainty. (See last column of Table 4.1.)

The estimates of market penetration rate have thus far considered only federal flood insurance. There are a modest number of flood insurance policies underwritten by private insurers, but little information is available about the size of the private market. Kriesel and Landry found that 4 percent of residential properties in coastal communities located mainly in the South had flood insurance policies that were not backed by the NFIP (Kriesel and Landry, 2004, p.413). Current estimates put the number of policies underwritten by private insurers between 100,000 and 200,000, and the vast majority of these are thought to be written in SFHAs.[44] This range amounts to 5 to 10 percent of flood policies on SFHs, excluding condominiums, in SFHAs.[45] An unknown percentage of the private policies are so-called deficiency or gap policies that provide additional coverage on properties that already have NFIP policies but do not carry enough coverage to satisfy the mandatory purchase or lender requirements. Such gap policies do not increase the total number of SFHs with insurance policies. Some of the policies are also written on condominium units and other properties than SFHs. If 25 percent of private policies were gap policies and another 15 percent were written on structures other than SFHs, including private policies would increase the market penetration rate in SFHAs by approximately 3 to 6 percent. The 4 percent estimate by Kriesel and Landry falls within this range. Adding these polices to those provided by the NFIP would raise the estimate of market penetration rate using address matching from 49 to 50 to 52 percent.[46]

The point estimates of market penetration rate developed here are higher than those in recent studies. Kriesel and Landry (2004) found a NFIP market penetration rate of 49 percent for residential properties located in coastal communities mainly in the South. As shown in Table 4.1, the point estimate for the South here is 61 percent using the address matching, and the confidence interval runs from 54 to 69 percent. PWC (1999, p. 6–2) concluded that the market penetration rate in 1997 was 28 percent for residential structures in SFHAs nationwide, lower than the 49 percent estimated here. Both these studies cover all residential properties, not just SFHs, and it could be that market penetration rates for SFHs are higher than for other residential properties. Market penetration rates also appear to have risen somewhat since 1997 when the

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[44]This range is based on discussions with FEMA staff and initial findings of an ongoing RAND study of the private insurance market.

[45]As shown in Table 4.2, there are 2 million NFIP insurance contracts in force on non-condo, single-family homes in SFHAs.

[46]1.03 x 0.49 = 0.50 and 1.06 x 0.49 = 0.52.

PWC data were collected, although the rise is unlikely to be large enough to explain much of the difference between the PWC estimates and the results here.[47]

4.2. Compliance with the Mandatory Purchase Requirement

Property owners in SFHAs of participating communities are required to purchase flood insurance (AIR, 2003, p. 1)[48] if they:

a) borrow money from federally insured, regulated, or supervised lenders (hereafter referred to as federally regulated lenders) and have loans that are secured by property in a SFHA;
b) hold loans secured by property in a SFHA that have been sold to the Federal National Mortgage Association or the Federal Home Loan Mortgage Corporation on the secondary market; or
c) have received federal financial assistance for construction or acquisition of an improvement located in an SFHA.

4.2.1. Identifying Homes Subject to the Mandatory Purchase Requirement

The property parcel data obtained from FARES provides information about the mortgage on the parcel. However, the mortgage information is incomplete. The biggest problem is that data on mortgages are spotty prior to the mid-1990s (Lopez, 2004). Prior to the mid-1990s, the absence of mortgage information on a FARES property record might mean that there is no mortgage on the home or only that the information is missing. A second potential problem is that while sometimes updated since the last sale, mortgage information usually reflects the mortgage in place at the time of the last sale. Since the last sale, the homeowner might have paid off the mortgage or even taken on a mortgage if the home was bought without one. Third, the database does not identify whether a mortgage is subject to the mandatory purchase requirement. Finally, the FARES database does not record whether there are home equity loans on the property. Such loans can trigger the mandatory purchase requirement even in the absence of a mortgage.

Given the lack of complete data on the loans on a property, SFHs in the sample were split into two groups: homes where the probability of having a mortgage is high and other homes. Table 4.3 summarizes the rules for classifying homes. A mortgage due date was provided for some observations in the sample. If the mortgage due date was in 2004 or later, the property was considered likely to have a mortgage. A high percentage of mortgages have terms of at least 15

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[47]The number of NFIP policies on non-condo single-family homes grew 14 percent between 1997 and 2002. Figures interpolated from the 1990 and 2000 Census suggest that single-family homes grew by 7 percent over the same period. Market penetration rates may thus have increased 7 percent, but such an increase would only raise PWC's market penetration rate from 28 to 30 percent.

[48] The Small Business Administration requires proof of flood insurance before granting a disaster assistance loan on properties outside the SFHA if flooding caused the applicant's losses and if the cause of the flooding would have been covered by federal flood insurance and the borrower owns the property (Tobin and Calfee, 2005). Thus, flood insurance can be required for some properties outside the SFHA. However, for this analysis, only properties in the SFHA are considered.

years,[49] so the probability that homes with mortgage origination dates in 1989 or later were still mortgaged at the time of the study was considered to be high.[50] Some mortgages issued more than 15 years previously may have been paid off, but approximately two-thirds of mortgages have terms of 28 or more years (U.S. Bureau of the Census, 2003). There were no homes in the database with a mortgage origination date prior to 1974 (30 years prior to the study), so the likelihood that the mortgage was still in place was also considered to be high for homes with mortgages issued prior to 1989.

TABLE 4.3: Rules Used to Classify SFHs by Likelihood of Having a Mortgage

Mortgage Due Date	Most Recent Sales Date	Mortgage Origination Date	Number of Observations	Identified as Having a Mortgage with High Probability
Observations with mortgage due date				
>= 2004	any value	any value	1,763	Yes
<2004	any value	any value	41	No
Observations without mortgage due date				
—	—	>= 1989	92	Yes
—	—	< 1989	23	Yes
—	>= 1995	>= 1989	251	Yes
—	>= 1995	< 1989	2	Yes
—	< 1995	>= 1989	254	Yes
—	< 1995	< 1989	228	Yes
—	>= 1995	—	745	No
—	—	—	958	No
—	< 1995	—	1,115	No

—not available

Most homes that have a mortgage are subject to the mandatory purchase requirement, but not all. Informed stakeholders contacted during this study believed a very high percentage (90 to 95 percent) of mortgages are subject to the mandatory purchase requirement. In their analysis of the mandatory purchase requirement, Tobin and Calfee (2005, p. 31) conclude that 77 percent or more of total mortgage debt outstanding was held by financial entities subject to the mandatory purchase requirement. Thus, a high percentage of homes for which the probability of having a mortgage has been identified as high will likely be subject to the mandatory purchase requirement.

While it is reasonable to be confident that most homes identified as having a mortgage with high probability actually do have a mortgage and are subject to the mandatory purchase requirement, there is considerable uncertainty about the whether the other homes are subject to the mandatory purchase requirement. For some, there is simply not enough information to determine the likelihood of having a mortgage (e.g., homes for which the mortgage due date, most recent sales date, and mortgage origination date are missing). For others (like those with most recent sales date in 1995 or later and no mortgage origination date), the probability of a mortgage may be low, but there could still be a home-equity loan on the property that triggers the mandatory purchase requirement. Homes where the probability of having a mortgage could not

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[49]According the American Housing Survey, 93 percent of primary mortgages on owner-occupied units have terms of 13 years or greater at the time of origination or assumption (U.S. Bureau of the Census, 2003).

[50]Of course, some of these homeowners could have paid off their mortgages before the mortgage due date.

be identified as high are thus referred to as homes where the probability of having a mortgage is low or uncertain.

Data on percentage of homes nationwide that have mortgages suggest that a considerable number of homes not identified above as having a mortgage with high probability indeed have a mortgage. Tobin and Calfee concluded that between 63 and 65 percent of owner-occupied housing units (both single-family and other) were mortgaged or carried a home equity line of credit (2005, p. 23). Even if all the homes where the probability of having a mortgage identified here is high actually did have a mortgage, then still roughly 40 percent of the remaining homes would carry a mortgage or line of credit.[51]

Estimates of (1) the percentage of homes with mortgages or home equity loans and (2) the percentage of mortgages and home equity loans subject to the mandatory purchase requirement can be used to provide a rough estimate of the percentage of SFHs subject to the mandatory purchase requirement. Drawing on the discussion above, 80 to 90 percent is a plausible range for the percentage of homes in SFHAs with a mortgage or home equity lines of credit that are subject to the mandatory purchase requirement. If 63 to 65 percent of homes have a mortgage or home equity line of credit, then 50 to 60 percent of SFHs in SFHAs are subject to the mandatory purchase requirement. Purchase of flood insurance for the remaining 40 to 50 percent of homes in SFHAs is voluntary.

4.2.2. Compliance with the Mandatory Purchase Requirement

The market penetration rate based on address matching for homes with a high probability of having a mortgage is 67 percent with a 95 percent confidence interval that runs from 59 to 75 percent (the first row of Table 4.4).[52] The second group of rows in Table 4.4 shows that the estimated market penetration rate for homes that likely have mortgage is much higher in the South and the West than in the other regions of the country. Limited sample sizes in the Northeast and Midwest, however, mean that the market penetration rates in these areas are estimated with considerable uncertainty (as reflected in the confidence intervals). The bottom group of rows in Table 4.4 shows the market penetration rate by region for homes where the likelihood of having a mortgage is low or uncertain. As expected, the market penetration rates are consistently lower than for homes where the likelihood is high. This issue will be further examined in Chapter 5.

The compliance rate with the mandatory purchase requirement may be higher than the market penetration rates shown in Table 4.4 because, as noted above, not all mortgages are subject to the mandatory purchase requirement and some homeowners have policies underwritten by private insurers. To give a sense of how much higher the compliance rate might

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[51]If 63 percent to 65 percent of homes have mortgages or home equity lines of credit, then approximately 2.28 million of the 3.56 single-family homes in SFHAs have mortgages or equity lines of credit. If all 1.39 million that are likely to have a mortgage actually have a mortgage, then approximately 0.89 million of the remaining 2.17 million homes have a mortgage, or roughly 40 percent.

[52]Market penetration rates for homes with mortgages cannot be calculated using BSA policy totals because the BSA database does not contain information on whether there is a mortgage on properties with an NFIP policy.

TABLE 4.4: Market Penetration Rate by Likelihood of Having a Mortgage and Compliance Rate with the Mandatory Purchase Requirement for SFHs in SFHAs

	Sample Size	Number of Single-Family Homes (millions)	95% CI	Market Penetration Rate	95% CI	Compliance Rate Under Plausible Assumptions
Likelihood of Having a Mortgage						
High	2,613	1.39	[1.04, 1.75]	67	[59, 75]	78
Low or uncertain	2,859	2.18	[1.81, 2.54]	38	[32, 44]	—
Homes Where Likelihood of Having a Mortgage is High (over 80 percent subject to the mandatory purchase requirement)						
Northeast	187	0.161	[0.062, 0.259]	44	[8, 80]	51
South	2,088	1.001	[0.669, 1.332]	72	[64, 80]	81
Midwest	35	0.084	[0.013, 0.154]	37	[10, 63]	43
West	303	0.148	[0.037, 0.260]	76	[65, 87]	88
Homes Where Likelihood of Having a Mortgage is Low or Uncertain (30 to 40 percent subject to the mandatory purchase requirement)						
Northeast	444	0.611	[0.345, 0.877]	24	[12, 37]	—
South	1,981	1.063	[0.834, 1.292]	51	[44, 59]	—
Midwest	158	0.366	[0.224, 0.508]	19	[10, 28]	—
West	276	0.137	[0.052, 0.222]	42	[31, 52]	—

be than the market penetration rate, the final column of Table 4.4 reports compliance rates for homes likely to have a mortgage assuming that:

1. The number of policies underwritten by private insurers is 7 percent of the number underwritten in SFHAs by the NFIP.[53]
2. 85 percent of mortgages in SFHAs are subject to the mandatory purchase requirement
3. The market penetration rates for homes that have mortgages but are not subject to the mandatory purchase requirement is 38 percent (the market penetration rate for homes where the probability of a mortgage is low or uncertain).

The results show that compliance with the mandatory purchase requirement could conceivably be 78 percent for the nation as a whole and exceed 80 percent in the South and the West.[54] The compliance rate appears much lower in the Northeast and Midwest, but no strong conclusions can be made because of the considerable uncertainty in the estimated market penetration rates for these regions. A larger sample size is needed to make more definitive conclusions.

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[53]Policies in the private market are usually “forced-placed” by lenders to comply with the mandatory purchase requirement. For this calculation, we assume that all private policies are written to comply with the mandatory purchase requirement. As discussed above, private policies are estimated to be 5 to 10 percent of NFIP policies in SFHAs, and perhaps 25 percent of these are gap policies and an additional 15 percent are not on single-family homes. If the mandatory market is 55 percent of the overall market and private policies are 7 percent of NFIP policies, including the private market would increase the number of policies written on properties in SFHAs subject to the mandatory purchase requirement by roughly 7.5 percent (7*(1-0.40)/0.55).

[54]To determine the market penetration rate for homes where the likelihood of a mortgage is high and that are subject to the mandatory purchase requirement, we solve $0.67 = 0.85x + 0.15*0.38$ for x, where x is the market penetration rate. The result is then multiplied by 1.075 to account for policies written by private insurers. The same method is used to calculate market penetration rate in each region.

These findings on compliance are based on a set of mortgages that appear to be somewhat newer than mortgages overall. Of the 2,613 SFHs in the SFHA in our database where the mortgage likelihood is high, 25 percent have been in place 10 years or more and 12 percent have been in place 15 years or more. The American Housing Survey finds that 33 percent of mortgages have been in place 10 years or more and that 17 percent have been in place 15 years or more (U.S. Bureau of the Census, 2003). The missing homes with older mortgages are presumably in the category where the likelihood of having a mortgage is low or uncertain. The analysis in Chapter 5 provides no evidence that market penetration rate for homes with mortgages declines as the mortgage ages. Thus, the compliance rate may not fall when homes with older mortgages are included. Potentially more important for interpreting the findings on compliance rate is the possibility that homes subject to the mandatory purchase requirement that are in the low and uncertain mortgage-likelihood category have other characteristics that are associated with low compliance.[55] Sufficient data are not available to determine whether or how much compliance rates would fall if homes subject to the mandatory purchase requirement in the low and uncertain category were included in the analysis.

A 2002 study by the GAO concluded that compliance with the mandatory purchase requirement was high at mortgage origination, but that insufficient information was available to determine whether compliance fell off during the life of the loan (GAO, 2002). The findings here suggest that compliance for new and older mortgages combined is reasonably good in the South and the West, but that there is reason to be concerned about compliance in the Northeast and Midwest. As discussed above, however, small sample sizes limit the conclusions that can be drawn about the Northeast and Midwest.

In 2000, FEMA's Office of Inspector General released a study that examined compliance with the mandatory purchase requirement in 16 NFIP communities spread across ten states. The study found an overall compliance rate of 90 percent, but the report noted that compliance nationwide was probably much lower because a disproportionate number of coastal communities were represented in the sample and coastal communities tend to have higher market penetration rates (FEMA, 2000).[56] The findings here suggest that nationwide the compliance rate is more likely on the order of 75 to 80 percent nationwide.

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[55]For example, these homes may be disproportionately in small communities that (as we will see in Chapter 4) have lower market penetration rates. Mortgage data on property tax records may be more incomplete in small communities.

[56]Other studies have examined compliance rates. Kunreuther (1996) cites a 1990 GAO finding that 79 percent of victims of a 1989 Texas flood who were required to buy insurance did not, implying a compliance rate of 21 percent. The GAO study was completed prior to the 1994 legislation that considerably strengthened the mandatory purchase provisions. In addition, there is undoubtedly variation in compliance rates across communities, and findings for one community are not necessarily representative of communities as a whole. PricewaterhouseCoopers (1999) assumed that 50 percent of homes with new mortgages buy flood insurance, 20 percent of noncompliant homes in any year are forced by their lenders to buy flood insurance, and 10 percent of homes that are compliant in one year are noncompliant in the following year. The compliance rates resulting from these assumptions are likely on the order of 55 to 60 percent, but the assumptions are not based on solid empirical data.

4.3. Market Penetration for Homes Not Subject to the Mandatory Purchase Requirement

The market penetration rate based on address matching for homes in SFHAs where the likelihood of having a mortgage is low or uncertain is 38 percent (the second row of Table 4.4). As discussed above, a substantial proportion of homes in this category probably have mortgages. Thus, the market penetration rate for homes that are not subject to the mandatory purchase requirement is almost certainly less than 38 percent. If, as projected above, the compliance rate is 78 percent for homes subject the mandatory purchase requirement, 55 percent of homes are subject to the mandatory purchase requirement, and the overall market penetration rate is 51 percent (including policies underwritten by insurers other than the NFIP), then market penetration among homes not subject to the mandatory purchase requirement would be 18 percent.[57] Even if compliance with the mandatory purchase requirement were only 67 percent, market penetration for homes not subject to the mandatory purchase requirement still would be only slightly over 30 percent.

A low market penetration rate for homeowners who are not required to purchase flood insurance is consistent with the findings from other studies. In their sample of residential properties in coastal areas primarily in the South, Kriesel and Landry (2004, p. 413) found that only 22 percent of homeowners for whom insurance was not required elected to purchase coverage.

4.4. Type and Amount of Coverage

We have examined the probability of buying flood insurance policies with structure coverage but have not examined contents coverage or the amount of insurance that is bought. In this section, we examine the prevalence of contents coverage, the amount of structure coverage relative to various measures of property value, and whether the amount of coverage satisfies the requirements of the mandatory purchase requirement. These investigations provide insight into opportunities for the NFIP to increase the amount of insurance held by those who already have it.

4.4.1. Prevalence of Contents Coverage

Table 4.5 tabulates the number of SFHs in SFHAs that have structure coverage (with or without contents coverage) and the number of policies that provide coverage for both structure and contents. The totals are calculated using the BSA policies-in-force database (as of May 2004) and thus are not subject to statistical uncertainty. The last column of Table 4.5 shows the percentage of structure policies that also include contents coverage. The percentage is considerably higher in the South than in other parts of the country.

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[57] 0.55*78 + 0.45*18 = 51.

TABLE 4.5: Prevalence of Contents Coverage Among SFHs in the SFHA with Structure Coverage

	Policies With Structure Coverage (millions)	Structure Policies That Also Include Contents Coverage (millions)	Percent of Policies with Contents Coverage
Northeast	0.29	0.14	49
South	1.36	1.02	75
Midwest	0.14	0.02	16
West	0.20	0.04	19
Total U.S.	1.99	1.22	61

SOURCE: BSA policies-in-force database.

The mandatory purchase requirement is rarely applied to the contents, so the decision to purchase contents coverage is almost always voluntary.[58] The low fraction of policyholders with contents coverage outside the South suggests that homeowners outside the South do not believe that the price of contents coverage is attractive relative to perceived expected losses.[59] The low percentage of policies with contents coverage in the West and Midwest suggests marketing opportunities for the NFIP, but the costs and likely payoffs of such marketing campaigns need to be examined.

4.4.2. Amount of Structure Coverage Relative to Property Value

Flood insurance policies pay the costs to replace property damaged by floods (up to the policy limits) if the homeowner buys coverage equal to 80 percent or more of the replacement cost of the home or at the NFIP coverage limit ($250,000). If the homeowner buys less than this amount, he or she receives the actual cash value of the damaged property (which accounts for depreciation). Thus, a homeowner is fully insured if he or she buys coverage equal to 80 percent or more of building replacement cost.

The property parcel database contains data on the total value and improved value of each parcel. Improved value measures the value of structures and other improvements on the property but excludes the value of the land. Total value includes improved value and land value. The property values are obtained from county tax or assessment authorities, and FARES distinguishes between the following measures of value reported by county authorities:

- Assessed Value. Assessed values are used to calculate property taxes and may have little relation to the market value of the land or improvements.
- Market Value. Property values that are based on market value are periodically updated to account for changes in price levels in the surrounding community.
- Appraised Value. Appraised values are based on the findings of a property appraiser.

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[58]Lenders may require contents coverage if the contents serve as collateral for a portion of the loan or because such placement is explicitly permitted by the loan documents (Tobin and Calfee, 2005). Even though lenders can require contents coverage in certain circumstances, it appears that few do so (Tobin, 2004).

[59]It could also be that insurance agents are less aggressive about recommending or informing their clients about contents coverage outside the South.

Typically, counties report one measure of property value, although a county can, for example, report both assessed value and appraised value for the properties in its jurisdiction.[60] We have not investigated how closely the figures on improved or total value in the property parcel database track true market value.[61] In many counties, assessed value, for example, may seriously understate true market value. In others, assessed value may be fairly close to true market value.[62] Even if figures on property value do approximate true market value, those figures would then presumably be less than replacement cost, although whether they would be less than 80 percent of replacement cost is uncertain.[63] Thus, no solid conclusions can be drawn for property tax assessor data on what percentage of homeowners are buying coverage equal to or in excess of 80 percent of replacement cost. The following statistics, however, do provide a sense of how flood coverage compares with the property values reported in property tax assessor databases.

Table 4.6 shows the percentage of policyholders with structure coverage greater than various measures of reported property value. The analysis is restricted to homes in SFHAs that have been sold since 1999 because of concern that improved values for homes sold earlier are not as accurate a measure of true market value.[64] The average amount of coverage (weighted using the sampling weights) across the 1,217 homes is $151,000.

As shown in the second column of the top set of three rows in Table 4.6, a high percentage of SFHs in SFHAs with flood insurance have structure coverage greater than assessed value (78 percent) or market value (81 percent) of the improvements. A lower percentage (51 percent) carry coverage that exceeds appraised value, although the difference should be interpreted with caution because the sample size for appraised value is small. The third column of Table 4.6 shows the percentage of homes in the sample that carry the maximum amount of structure coverage available from the NFIP. The last column shows that percentage of homes with coverage greater than the measure of improved value or at the NFIP coverage limit. The percentage is high for all measures of value.

The bottom three rows of Table 4.6 present results using total property value rather than improved property value. Over 44 percent of property owners carry coverage greater than reported total property value or equal to the NFIP policy limit (the last column).

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[60]For example, only assessed value is reported for all the single-family homes in the sample in California. Market value is reported for all single-family homes in Florida.

[61]The true market value of an improved structure should be the depreciated value of the structure (as opposed to its replacement cost).

[62]For example, when a home is sold in California, the assessed value is set at the sales price, so assessed value will likely be a good measure for at least total value for homes recently sold. However, because of California's Proposition 13, home value increases by only a small percentage each year unless there is a remodel or the home is sold again. Thus, the assessed value will likely increasingly diverge from the true market value as time since the last sale passes.

[63]What is more, not all improvements are insurable (e.g., agricultural improvements). Only those improvements that are insurable should be considered in assessing the gap between NFIP coverage and property value.

[64]For the single-family homes included in Table 4.6, only one measure of property value was reported for each home.

TABLE 4.6: Structure Coverage Relative to Various Measures of Property Value for SFHs in SFHAs*

	Sample Size	Percentage with Coverage >= Measure of Value	Percentage with Coverage = $250K	Percentage with Coverage >= Measure of Value or Coverage = $250K
Improved Value				
Assessed	149	78	28	83
Market	991	81	15	89
Appraised	77	51	59	90
Total Value				
Assessed	149	46	28	56
Market	991	30	15	44
Appraised	77	15	59	70

*Based on single-family homes in the sample last sold in 1999 or later with structure coverage and data on improved value.

Data suggest that a modest number of homeowners would buy more flood insurance if the $250,000 coverage limit were increased. The BSA policies-in-force database shows that across all 1.99 million policies written on SFHs in the SFHA, 14 percent carry the maximum amount of coverage. The percentage of policyholders that would increase coverage if the limits were raised is thus 14 percent or less, but Table 4.6 does not provide any good guidance on how much less.

4.4.3. Relation Between Amount of Coverage and Requirements of the Mandatory Purchase Requirement

The mandatory purchase requirement requires that flood insurance be purchased in an amount at least equal to the outstanding principal balance of the loan up to the coverage limits of the NFIP ($250,000 for SFHs), with one important provision: When the outstanding balance of the loan exceeds the value of the structure, insurance is required only up to the depreciated value of the structure (FEMA, 1999 pp. 23, 27).

Table 4.7 summarizes the amount of coverage relative to reported mortgage amount and improved value for SFHs in the SFHA with both a mortgage and flood insurance. Of the 999 such homes, 48 percent carry coverage exceeding the value of the mortgage at the time of the last sale and 61 percent carry coverage exceeding the value of the mortgage or at the NFIP policy limit. Thus, at least 61 percent of the SFHs in the sample in SFHAs with mortgages and flood insurance carry enough insurance to satisfy the requirements of the mandatory purchase requirement. The percentage could be much higher because the amount of a mortgage can exceed the value of the structure. The last three rows of Table 4.7 show that over 90 percent of SFHs sold in the last 5 years with mortgages and insurance carry coverage that exceeds the reported value of the mortgage, equals the NFIP policy limit, or exceeds the reported improved value. The accuracy of the data on improved value needs to be assessed before conclusions can be drawn on how much compliance with the coverage component of the mandatory purchase requirement exceeds 61 percent.

TABLE 4.7: Structure Coverage Relative to Requirements of the Mandatory Purchase Requirement for SFHs in the SFHA*

	Sample Size	Percent
Percentage with coverage >= mortgage amount	999	48
Percentage with coverage >= mortgage amount or coverage = $250,000	999	61
Percentage with coverage >= mortgage amount or coverage = $250K or coverage >= improved value		
Assessed	135	89
Market	815	93
Appraised	49	92

*Based on single-family homes in sample last sold in 1999 or later with structure coverage and data on improved value.

4.5. Summary

The results of the analysis suggest that overall, about one-half of SFHs in SFHAs nationwide have flood insurance policies. An estimated 49 percent have NFIP policies, and once a rough estimate of the number of policies underwritten by private insurers is added in, the market share rises to 50 to 52 percent.

The projected number of SFHs in SFHAs nationwide comes to 3.6 million with a 95 percent confidence interval that runs from 2.9 to 4.2 million. Comparison of the number of policies in SFHAs nationwide projected using the sample of homes analyzed in this study and the actual number recorded by the BSA suggests that the point estimate for the number of SFHs in SFHAs nationwide may be 10 to 15 percent low. Thus, the actual number of SFHs in SFHAs nationwide may lie in the upper portion of the 2.9 to 4.2 million confidence interval. Even though approximately one-third of NFIP policies are written outside SFHAs, the market penetration rate outside SFHAs is about 1 percent.

Market penetration rate varies a great deal across the four geographic regions investigated in this study. The market penetration rate in the South and the West (approximately 60 percent) is considerably higher than in the Northeast or Midwest (20 to 30 percent). However, because the sample size of SFHs in the Midwest is modest, conclusions about the market penetration rate in this region should be considered tentative. Similarly, the market penetration rate in the Northeast is estimated with a considerable degree of uncertainty.

The number of SFHs in SFHAs is highly concentrated in the South. Nearly 60 percent of SFHs in SFHAs nationwide are found to be in the South, even though the results show that less than one-quarter of homes in NFIP communities nationwide are in the South.

Results from previous studies imply that approximately 50 to 60 percent of SFHs in SFHAs are subject to the mandatory purchase requirement. Precise estimates of the percentage of homes complying with the mandatory purchase requirement are not possible because limitations on the mortgage data in the property parcel file create uncertainty about whether a home has a mortgage and whether the mortgage is subject to the mandatory purchase requirement. Under plausible assumptions, the compliance rates with the mandatory purchase requirement in the South and West could be 80 to 90 percent. The compliance rate appears considerably lower in the Northeast and Midwest, where it on the order of 45 to 50 percent. Overall, the compliance with the mandatory purchase requirement may by 75 to 80 percent nationwide.

Market penetration rates are low for homes that are not subject to the mandatory purchase requirement. The analysis in this chapter suggests that the market penetration rate for such homes is likely on the order of 20 percent. The difference between market penetration rate for homes subject to the mandatory purchase requirement and those that are not is further examined in the next chapter.

Overall, the findings on the market penetration suggest substantial opportunities to increase the number of policies in place and to improve compliance with the mandatory purchase requirement in the Northeast and the Midwest. Substantial opportunities for policy growth also remain among homes not subject to the mandatory purchase requirement in all parts of the country.

Substantial opportunities also exist for increasing the number of households with contents coverage outside the South. The data on home values were insufficient to determine what percent of households are fully insured for flood, although findings on the percentage of single-family homeowners that buy the maximum amount of coverage offered by the NFIP suggest that a modest percent (14 percent or less) of homeowners would increase coverage if the NFIP coverage ceiling were raised. The findings do suggest that homeowners subject to the mandatory purchase requirement buy enough coverage to satisfy the coverage component of the requirement.

5. FACTORS THAT DETERMINE THE MARKET PENETRATION RATE FOR FLOOD INSURANCE IN SPECIAL FLOOD HAZARD AREAS

The previous chapter presented nationwide estimates of market penetration rate and compliance rate with the mandatory purchase requirement nationwide and examined variation of the rates by geographic region but did not explore what drives the differences in market penetration rates. This chapter examines the factors that underlie the decision of a homeowner to purchase insurance. Economic principles and interviews with key stakeholders are used to identify the key underlying factors, and empirical proxies are developed for the most important factors. Statistical procedures (regression analysis) are then used to examine the importance of each factor, holding constant the influence of other observable factors. The results of the analysis identify what community and parcel characteristics are associated with low market penetration rates and provide insight into opportunities for increasing the market penetration rate.

5.1. The Economics of the Flood Insurance Market

The market penetration rate for flood insurance and the rate of compliance with the mandatory purchase requirement are determined by the behavior of a number of different actors. Homeowners decide to buy insurance or are told that they must buy flood insurance by lenders. The NFIP sets the price for flood insurance and underwrites policies purchased at that price. Banks and government regulators enforce the mandatory purchase requirement, and private insurance companies train agents, advertise, and write policies on behalf of the NFIP. Below, the key factors that underlie the demand for flood insurance, the price structure for flood insurance, and the interaction between demand and price that leads to outcomes in the flood insurance market are described.

5.1.1. Demand for Flood Insurance

Recent studies by Kriesel and Landry (2004) and Browne and Hoyt (2000) have identified the following factors as important in a property owner's demand for flood insurance:

- Price of insurance per dollar of coverage
- The probability distribution for losses expected by the property owner during the policy period
- Existence of a loan subject to the mandatory purchase requirement
- Availability of disaster relief if flood insurance is not purchased[65]
- Risk aversion of the property owner
- Wealth of the property owner.[66]

[65]Taxpayers who itemize tax deductions can deduct a portion of uninsured flood losses from their taxable income. Such deductions can also be thought of as a type of disaster assistance.
[66]Both Kriesel and Landry and Browne and Hoyt draw on Smith's (1968) formulation of a household's decision to purchase insurance. For a more recent general formulation of the demand for insurance, see Schlesinger (2000).

Standard economic theory holds that, absent a mandatory purchase requirement, a homeowner will buy insurance if the price of insurance is attractive given his or her perception of the probability distribution for losses during the policy period (net of government assistance) and aversion to risk.[67]

The analysis here extends the standard model in two ways. First, it addresses the extent to which the mandatory purchase requirement is enforced.[68] While properties subject to the mandatory purchase requirement are in principle all supposed to be insured, enforcement in the real world is incomplete. The desirability of flood insurance will determine whether homeowners purchase insurance when the requirement is not enforced and the degree to which they attempt to avoid compliance when the requirement is only partially enforced.[69] Second, the model acknowledges that flood insurance may be less readily available in some communities. Small communities, for example, may have fewer agents (relative to population) that are familiar with how to write flood insurance than larger ones.

5.1.2. The Price of Flood Insurance

The NFIP sets the price for flood insurance. In the SFHA, there are separate pricing schedules for SFHs constructed before the FIRM for the community was first issued (so called pre-FIRM structures) and for homes constructed after the FIRM was issued (post-FIRM structures).[70] Rates also vary by the flood zone in which the home lies. The rate for pre-FIRM SFHs varies according to whether the home includes a basement or enclosure below the lowest floor of living space and whether there are multiple floors, but the rate does not depend on the elevation of the building relative to the BFE.[71] The rate for post-FIRM SFHs depends on whether there is a basement or enclosure, whether there is more than one floor, and also on the elevation of the lowest floor relative to the BFE.[72] Rates for post-FIRM structures built at BFE are comparable to those for pre-FIRM structures, but post-FIRM rates for structures built one foot or more above the BFE are much lower than pre-FIRM rates (FEMA, 2004b, pp. RATE–2, RATE–4).[73] If the post-FIRM rate is lower than the pre-FIRM rate, the owner of a pre-FIRM

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[67]Risk aversion is usually thought to be related to wealth, with wealthier individuals thought to be less risk averse.

[68]Recall from Chapter 3 that 50 to 60 percent of single-family homes in SFHAs are thought to be subject to the mandatory purchase requirement.

[69]For example, homeowners may choose lenders that enforce the requirement less vigorously.

[70]The FIRM delineates the SFHA for the community.

[71]The base flood elevation is the elevation water is predicted to reach in the flood that occurs with a 1 percent annual chance.

[72]Not all structures in the SFHA pay rates according to their flood zone or elevation relative to the BFE according to the current FIRM. When the FIRM in a community changes (for example by expanding the area in the SFHA or changing the BFE), homeowners can choose to have the insurance premium determined by the flood zone and BFE from the original FIRM as long as there is no interruption in coverage (FEMA, 2004b, p. RATE-22).

[73]The rate for a pre-FIRM single-family home with no basement or enclosure as of October 2004 was $0.76 per hundred dollars of structure coverage for the first $50,000 of coverage and $0.34 per hundred dollars for additional coverage up to the $250,000 limit. For post-FIRM homes at the BFE, the rate was $0.98 for the first $50,000 of coverage and $0.08 for additional coverage, $0.32 and $0.08 for homes 2 feet above the BFE, and $0.24 and $0.08 for homes built 4 feet above the BFE (FEMA, 2004b, p. RATE-2, RATE-4).

structure can choose the post-FIRM rate (FEMA, 2004b, p. RATE–19). Thus, many owners of pre-FIRM structures built one foot or more above BFE may choose the post-FIRM rate.[74] Within the SFHA, there are separate rates for homes subject to damage by tidal floods with high velocity wave action (so-called V zones).[75] These zones are in coastal communities, but are limited in geographic area and account for about 2 percent of NFIP policies in SFHAs. The NFIP rate schedules do not vary from one geographic region of the United States to another.

PricewaterhouseCoopers (1999) concluded that post-FIRM structures pay actuarial rates, although variation across regions was not examined (PWC, 1999, p. 1-2). PWC found, in contrast, that there are subsidies for many, but not all, pre-FIRM residential structures. PWC found that premiums were greater than actuarial rates for pre-FIRM structures at or above the BFE but below actuarial rates for structures below the BFE. For pre-FIRM structures below BFE, PWC concluded that the rates charged were about one-third of their actuarial levels, on average (PWC, 1999, pp. 5–5 to 5–12).[76] While rates are not favorable for pre-FIRM structures above BFE, many pre-FIRM structures above the BFE may pay post-FIRM rates, because, as noted above, pre-FIRM homeowners can choose post-FIRM rates.[77]

5.1.3. Equilibrium in the Market For Flood Insurance

Economic theory suggests that over time, homeowners in SFHAs will adjust the amount of flood insurance purchased to the price charged, the accessibility of insurance, and how strictly the mandatory purchase requirement is enforced. In turn, the NFIP will adjust rates to meet its revenue requirements.[78] The resulting market penetration rates may differ substantially across the country. In those areas where a larger share of homeowners believe that price (which does not vary by location, all else being equal) is high relative to their perception of the probability distribution for losses or where enforcement of the mandatory purchase requirement is lax, market penetration rates will be lower than in areas where the price is thought to be lower relative to the probability distribution of losses or enforcement is strict.

Market penetration rates may be less sensitive to price for homes subject to the mandatory purchase requirement than for those that are not, but some sensitivity will likely

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[74]To be able to compare the pre-FIRM and post-FIRM rates, the homeowner would need to know the elevation of the home. Homeowners may be unaware of their elevation and thus not able to compare the two rates. To qualify for a post-FIRM rate, the homeowner would have to obtain an elevation certificate. Elevation certificates typically cost $300 to $500 and may deter a pre-FIRM homeowner from applying for a post-FIRM rate.

[75]There are also separate rates for homes in "AO" zones and "unnumbered Zone A."

[76]The study concluded that approximately 45 percent of pre-FIRM residential structures were at or above the BFE and that approximately 25 percent were 3 or more feet below BFE. The remaining 30 percent of structures were 1 or 2 feet below BFE (PWC, 1999, p. 5-4).

[77] In this study, we do not examine whether rates are actuarially fair (i.e., premiums are equal to expected losses plus claims processing and other administrative costs and an average return on capital).

[78]The NFIP can borrow money from the U.S. Treasury when claim payments exceed reserves, but it is required to repay the Treasury. Being required to repay the Treasury does not mean that, overall, the rates charged by the program are actuarially fair. Congress directly covers the costs of the flood map modernization project, and the NFIP may not be building an adequate reserve to cover the costs of large events (see FEMA, 2004c). Examination of these issues is beyond the scope of this study.

remain. Higher prices will presumably increase the incentives for homeowners to evade the mandatory purchase requirement.

Overall, how we interpret the effect of various factors on the observed demand for flood insurance will be different for homes subject to the mandatory purchase requirement and for homes that are not. Among homes not subject to the mandatory purchase requirement, these factors can be interpreted as traditional demand parameters. The interpretation is less clear for homes subject to the mandatory purchase requirement. If everyone has the same ability to avoid compliance, then the estimated parameters will reflect demand parameters. If, however, the ability to avoid compliance differs across household or community characteristics, then the factors in the model will more likely capture differences in the ability of individuals to bypass the mandatory purchase requirement.

5.2. Proxies for the Determinants of Market Penetration

To better understand what factors drive the decision to purchase flood insurance, one would ideally like to develop measures for all the factors in the demand function for insurance. However, data on all the variables that enter the demand function could not be collected for the sample of SFHs studied here. In particular, data on the elevation on the lowest floor for each of the properties in the sample were unavailable. For post-FIRM structures, insurance rates depend on elevation, and elevation is presumably also an important factor underlying a homeowner's perceived probability distribution for losses for both pre- and post-FIRM structures. Because of these data limitations, proxies were developed for the primary factors postulated to drive the demand for flood insurance. Then, statistical techniques were used to examine the effect of the proxy variables on the homeowner's decision to purchase insurance holding other factors constant.

Proxy variables for the factors that influence the demand for insurance were developed, except for the availability of disaster relief. The effect of disaster relief on the purchase of flood insurance was not examined because disaster assistance in principle should not vary by geographic location, and the cross-sectional (as opposed to time-series) data analyzed here do not allow examination of how disaster assistance and market penetration rates are related over time. (The relationship between market penetration rate and disaster assistance is examined in Chapter 6.)

Below, the proxies for each factor are described. Table 5.1 lists the proxies and the factors to which they are relevant. The table denotes whether the variable characterizes the community where the home is located (community-level variable) or describes individual homes (parcel-level variable). For community-level variables, all the homes in the sample for that community have the same value for the variable. The choice of variables and expectations about their relation to market penetration were based on past studies, observations made by the stakeholders interviewed for this study, and the availability of data.

TABLE 5.1: Proxies for Factors that Underlie the Decision to Purchase Flood Insurance

		Factors that Underlie Decision to Purchase Flood Insurance[2]				
Proxies	Type[1]	Price of Insurance	Perception of Risk	Existence of Mandatory Purchase Requirement	Enforcement of MPR and Accessibility of Insurance	Household Wealth
Price of Flood Insurance						
Predicted premiums per $100 of coverage	P	X				
CRS Participation						
CRS Class	C	X	X			
Measures of Past Flood Losses						
Claims payments per $100 dollars of coverage	P		X			
Time since last Flood Insurance Claims Office (FICO) event	C		X			
Mortgage Status of Home						
Likelihood of mortgage	P			X		
Time since mortgage start	P			X		
Measures of Community Size and Insurance Resources						
Number of homes in the SFHA	C		X		X	
Percentage of homes in SFHA	C		X		X	
Distance from city with population >= 500,000	C				X	
Measures of Homeowner Wealth						
Improved value of property	P					X
Variables that Capture Residual Effects						
Geographic Region	C		X	X	X	
Source of Flooding in Community	C		X	X	X	
Whether home built pre- or post-FIRM	P		X			

[1]C=community-level variable; P=parcel-level variable
[2]X=proxy relevant to the factor listed in the column head.

Table 5.2 shows the observed relationship between market penetration rate and the various variables. These relationships are not causal. A relationship between market penetration rate and a variable may result from changes in the values of other variables that are correlated with the variable in question. Later in this chapter, we examine the effect of each variable on the decision to purchase insurance, holding other variables constant.

5.2.1. The Price of Insurance

Data from the BSA's policies-in-force database were used to determine the price per $100 of coverage for those properties in the sample with insurance. Prices were calculated only for building coverage, and the price is the average over the total amount of building coverage purchased for the property.[79] Statistical techniques were used to predict the price of building coverage for homes in the sample without insurance. A relationship between price and factors that enter the NFIP rate schedules (such as whether the house was built pre- or post FIRM, whether it has a basement, whether it is in a CRS community, and whether the improved value of the home is greater than $50,000) and other variables discussed below was estimated for the homes with insurance in the sample and then used to predict the price for homes without insurance. (See Appendix 6 for details.) For all 5,472 homes in the sample, the price averaged $0.27 per $100 dollars of coverage.

5.2.2. Perception of Risk

Claims Payments per $100 of Coverage. Payments on NFIP insurance policies may be a good proxy for the flood risk perceived by a homeowner. The BSA provided data on the claims paid and the amount of flood insurance coverage in force between 1982 and 2002 on non-condo, SFHs by state, whether or not the community was subject to coastal flooding, and whether the home was constructed pre- or post-FIRM (1982 was as far back as the BSA was able to provide data). Claims payments and amount of coverage in force were adjusted for inflation using the consumer price index and expressed in year 2004 dollars. Average claim payments per $100 of coverage were calculated separately for each of the 200 permutations of state, source of flooding, and whether the home was constructed pre- or post-FIRM. Each home in the sample was then assigned a value for claims payments per $100 of coverage based on its state, source of flooding, and FIRM status. Average claims payments were calculated by state rather than for individual communities because a homeowner's perception of risk likely depends not only on the flood experiences in his or her own community but on nearby communities as well.

This proxy is an imperfect measure of the risk perceived by the owners of the SFHs in the sample for two reasons. First, it captures claims payments only to homeowners that bought insurance and may not be reflect the perceived risk of those who did not buy insurance. Second,

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[79]The policies-in-force database reports total premium paid for building and contents coverage combined. Enough information was included on the file to subtract out the price of the contents coverage. Insurance rates are higher for the first $50,000 of coverage than for additional coverage (a declining block-rate structure). The calculated price is the building premium divided by building coverage and thus is the average price for the amount purchased.

TABLE 5.2: Market Penetration Rate for Single-Family Homes in SFHAs by Community and Parcel Characteristic

Characteristic	Sample Size	Number of Single-Family Homes (millions)	95% CI	Market Penetration Rate Based on Address Matching (percent)	95% CI	Market Penetration Rate Based on BSA Policy Totals by Community (percent)
Time Since Last FICO Event (years)						
<=5	3,683	1.81	[1.30, 2.31]	62	[54, 69]	70
>5 and <=10	1,247	0.75	[0.60, 0.90]	53	[39, 67]	63
>10	381	0.45	[0.37, 0.53]	31	[28, 34]	40
No FICO event	161	0.56	[0.33, 0.80]	19	[12, 26]	15
Percent of Homes in SFHA						
<= 10	551	1.57	[1.18, 1.96]	29	[21, 37]	37
>10 and <=50	1,509	0.85	[0.75, 0.95]	54	[48, 60]	61
> 50	3,412	1.15	[0.74, 1.56]	73	[71, 75]	78
CRS Class						
CRS Class 10 or not in CRS	843	1.61	[1.22, 2.00]	30	[21, 40]	37
Class 8–9	2,900	1.06	[0.81, 1.30]	65	[57, 73]	72
Class 1–7	1,729	0.91	[0.47, 1.34]	65	[58, 71]	69
Years Since Mortgage Origination for Homes that Likely Have a Mortgage[1]						
<=1	297	0.14	[0.09, 0.18]	70	[52, 87]	—[2]
>1 and <=6	1,263	0.69	[0.52, 0.87]	66	[54, 78]	—
>6 and <=11	545	0.34	[0.26, 0.42]	67	[55, 79]	—
>11	504	0.22	[0.13, 0.31]	70	[63, 77]	—
Number of Single–Family Homes in SFHA						
<=500	236	0.98	[0.62, 1.35]	16	[8, 25]	30
>500 and <=5,000	1,394	1.12	[0.91, 1.32]	56	[48, 65]	56
>5,000	3,842	1.47	[1.04, 1.89]	66	[59, 72]	74
Distance form city with pop. >= 500,000 (miles)						
>=0 and <=100	1,282	1.31	[0.93, 1.69]	35	[25, 46]	44
>100 and <=200	1,220	0.74	[0.48, 1.00]	41	[25, 58]	49
> 200	2,970	1.52	[1.07, 1.98]	65	[59, 70]	69
Home Value ($1000s)						
<=50	1,111	1.02	[0.83, 1.21]	36	[28, 44]	—[2]
>50 and <=100	2,004	1.13	[0.81, 1.45]	53	[43, 64]	—
>100	1,969	1.13	[0.86, 1.40]	57	[45, 68]	—
Missing	388	0.29	[0.12, 0.46]	50	[33, 67]	—
Source of Flooding in Community						
Subject to coastal flooding	4,014	1.85	[1.42, 2.27]	63	[56, 70]	69
Not subject to coastal flooding	1,458	1.72	[1.24, 2.21]	35	[24, 45]	42
Date Home Built						
Pre-Firm	3,033	1.99	[1.53, 2.46]	46	[38, 54]	—[2]
Post-Firm	2,052	1.15	[0.89, 1.40]	57	[49, 65]	—
Unknown	387	0.43	[0.27, 0.60]	45	[29, 62]	—

[1]Four homes were missing mortgage origination date.

[2]Estimates of market penetration rates based on BSA policy totals by community are only calculated for community-level variables.

it is an average across homes that bought insurance and does not capture variation in elevation across homes within a state, flood source, and FIRM-status group. The mandatory purchase requirement will tend to mute any bias that exists in applying results from homes with insurance to those without insurance to the extent that homes subject to the mandatory purchase requirement are randomly distributed across different elevations in the SFHA (which seems reasonable). For all 5,472 homes in the sample, claims payments averaged $0.09 per $100 of coverage.

Time Since Last FICO Event. A flood may serve as a reminder of a flood threat in the community, increasing the risk of flood losses perceived by the homeowners in the community. Market penetration rates are thus expected to be higher in communities with recent flood events than in communities where the last flood event was long ago or where there has never been a major flood.

The NFIP assigns Flood Insurance Claims Office (FICO) numbers to track the claims associated with major flood events. Events with FICO numbers are usually presidentially declared disasters or FEMA emergency disaster declarations. However, presidentially declared disasters do not automatically result in the creation of a FICO number. A FICO number may not be created for a disaster that results in few insured flood losses (Scoville, 2004). For each of the 100 NFIP communities in the study, staff at the BSA determined the date of the last FICO event, if any. The BSA searched for FICO events from May 2004 back to 1978 when the FICO system was established. Communities for which FICO numbers were not found are classified as not having a FICO event.

Communities are split into four groups based on the time since the last FICO event. Table 5.2 shows that, as expected, market penetration based on address matching drops as the date since the last FICO event recedes. A similar pattern is observed for market penetration rate calculated using BSA policy totals by community (see last column of Table 5.2).[80] The consistency of the results provides reassurance that the pattern in market penetration is not just the result of variation in the difficulty of address matching across communities.

Percentage of Homes in SFHA. Awareness of flooding in communities with a high percentage of SFHs in the SFHA may be greater than in communities with a low percentage of homes in the SFHA for two primary reasons. First, public agencies in communities with a greater proportion of homes in the SFHA may devote more resources to educating residents about the flood threat than public agencies in other communities because the threat is relevant to a larger proportion of the community. Second, even absent greater efforts by public agencies in communities with a larger proportion of SFHs in the SFHA, residents in the SFHAs of such communities may have a greater appreciation for the flood risk because flooding may have had a more significant impact on their community.

Based on our projections on the number of SFHs in and out of the SFHA in each of the 100 sampled communities, communities were divided into three groups depending on the fraction of SFHs in the SFHA. As shown in Table 5.2, market penetration rates are considerably higher in communities with a higher percentage of homes in the SFHA.

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[80]The market penetration rates in Table 5.2 are not estimated using BSA policy totals for all NFIP communities nationwide (the second method in Chapter 3) because the values of some of the variables were constructed only for the 100 communities in the sample and are not known for all NFIP communities.

Community Rating System Class. The Community Rating System (CRS) recognizes community efforts beyond the NFIP's minimum floodplain management requirements. Communities are awarded points for public information, mapping and regulation, flood damage reduction, and flood preparedness programs (FEMA, 2000).[81] The number of points determines a community's CRS class (classes run from 1 to 10 with Class 1 requiring the most points). Communities participating in the CRS receive discounts on the flood insurance premiums. Discounts range from 5 percent for communities in Class 9 to 45 percent for communities in Class 1. Market penetration rates may be higher in CRS communities because of lower insurance rates and activities, such as education efforts, that increase consumer awareness of flood risks.[82] CRS activities that reduce flood damage may reduce perceived risk, countering the effects of lower prices and greater public education.

Based on the number of observations in each CRS class, homes in communities in CRS class 8 and 9 were grouped together and homes in communities in CRS classes 1 through 7 were grouped together. (There were no communities in the sample in classes 1, 2, and 3.) Because they receive no discount in rates and the number of credits earned is small, communities in CRS class 10 are combined with communities not in the CRS. (There is only one such community in the sample.)

As shown in Table 5.2, there are an estimated 1.06 million SFHs in communities with CRS class 8–9, 0.91 million in communities with CRS class 1–7, and 1.61 SFHs that are in communities that are either not in the CRS or in CRS class 10. The market penetration rate based on either address matching or BSA policy totals by community is substantially higher in CRS communities in class 9 and below than in communities not in the CRS or in CRS class 10. The regression analysis below will allow us to investigate how CRS participation affects market penetration once the effects of price and other variables, such as the number of homes in the SFHA, are controlled for.

5.2.3. Existence of Mandatory Purchase Requirement

Existence of Mortgage. The methods used to identify those homes that likely have mortgages were discussed in Chapter 4, and as shown in Table 4.4, the market penetration rate for homes likely to have mortgages is higher than for homes where the probability of having a mortgage was low or uncertain.

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[81]Credits for flood damage reduction are provided for activities such as floodplain management planning, acquisition and relocation of flood-prone buildings, floodproofing or elevating pre-FIRM buildings in the floodplain, and inspection and removal of debris from drainage systems. Flood preparedness programs include flood warning, levee maintenance, and dam safety programs (FEMA, 2000).

[82]Communities in the CRS are not required to implement particular programs, but can choose from the suite of alternatives that can be awarded CRS credits. Thus, a community may not necessary undertake education efforts that increase consumer awareness of flood risks. For example, 7 percent of communities in CRS classes 9 or lower do not send out information about flood hazards and flood insurance to flood-prone residents or all residents in a community (CRS activity 330) or require real estate agents to advise potential purchasers of flood-prone property about the flood hazard (CRS activity 340) (based on CRS activity data provided by Rich Tobin, American Institutes for Research, December 2004).

Time Since Mortgage Start. Compliance may decline if the originating bank does not have procedures to monitor whether flood insurance is maintained during the life of the loan or when mortgages are sold to other financial institutions.[83]

For the 2,613 homes in the sample likely to have a mortgage (see Table 4.4), the mortgage origination date on the property parcel file was used to group homes by age of mortgage. Homes with mortgages a year old or less were grouped together to reflect the fact that insurance policies issued at loan origination are good for one year. Subsequent age cutoffs were made in five-year increments. As shown in Table 5.2, there is no consistent relationship between time since mortgage origination date and market penetration rate. It should be noted that because the property parcel data provide a snapshot of homes at one point in time, homes with older mortgages are also homes with a longer time since the initial required purchase of flood insurance. Thus, any decline in market penetration rate as the loan ages could either be caused by a decline in compliance with the mandatory purchase requirement as the loan ages or an increase in compliance at loan origination over time.

5.2.4. Accessibility of Insurance and Enforcement of Mandatory Purchase Requirement

Several variables were developed that are hypothesized to be associated with accessibility of insurance and the vigor with which the mandatory purchase requirement is enforced. As shown in Table 5.1, the variables developed focus on the size of the community and amount of urban influence. It is reasonable to expect that these variables will be associated with both accessibility and enforcement, though perhaps to varying degrees.

Number of Homes in the SFHA. Flood insurance may be less accessible in communities with relatively few homes in the SFHA because there may be fewer agents (per capita) that are knowledgeable about flood risks or know how to write flood insurance. Interviews with stakeholders conducted during this study suggested that flood insurance policies are more difficult to write than other types of insurance policies and that agents in small communities without substantial numbers of SFHA structures frequently do not want to invest in learning how to write flood insurance if they only write a few policies a year. Insurers may spend fewer resources promoting flood insurance or recruiting agents in communities with fewer SFHA structures because the return on investment is expected to be low. It may thus be more difficult for a homeowner in a small community to find an agent willing to write flood insurance, reducing the ease of buying a flood policy. Insurance agents in small communities may also be less likely to discuss flood risks with their clients, reducing homeowner perception of risk.

The mandatory purchase requirement may also be less well enforced in communities with fewer structures in the SFHA. Communities with few homes in the SFHA are often smaller communities overall. Smaller banks may be more common in smaller communities, and government monitoring of compliance with the mandatory purchase requirements at small banks may be less frequent. Market penetration rates for homes with mortgages in small communities

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[83] Banks that do not have procedures to monitor whether flood insurance is maintained would be liable for civil monetary penalties. The threat of such penalties may induce banks to carefully monitor compliance over the life of the loan, resulting in no drop-off rate in compliance as the loan ages.

may be lower than in larger communities, even if compliance rates with the mandatory purchase requirement are the same. Such a situation could occur if, as might be expected, fewer banks in smaller communities are federally regulated and, thus, subject to the mandatory purchase requirement.

Size categories for the number of SFHs in the SFHA were selected based on the clustering of communities when ranked by projected number of SFHs in the SFHA. Table 5.2 shows that market penetration rates based on address matching are dramatically lower for communities with 500 or fewer homes in the SFHA (16 percent in communities with 500 or fewer versus 66 percent in communities with greater than 5,000). The difference declines somewhat when market penetration rates are calculated using BSA policy totals by community (perhaps because street addresses are less standard in small communities and address matching is more difficult), but the differences remain large. Roughly 25 percent of the SFHs in SFHAs are spread across the large number of communities with less than 500 homes in the SFHA (see Column 2).

The differences in market penetration by the number of structures in the floodplain could be driven not by the number of homes in the SFHA, but by factors that are associated with it. For example, it appears that homes are less likely to be mortgaged in smaller communities. The probability of having a mortgage is high for only 22 percent of homes in communities with 500 or fewer single-family home in the SFHA verses 32 percent in communities with between 500 and 5,000 homes in the SFHA and 55 percent in communities with more than 5,000 homes in the SFHA.

Percentage of Homes in the SFHA. As discussed above, the percentage of homes in the SFHA may be inversely related to the perception of risk in the communities. It also seems plausible that that insurance may be less accessible in communities that have a small proportion of homes in the SFHA. Insurance agents may not want to invest the time in learning how to write NFIP policies in communities where only a small proportion of their business is in SFHAs.

Distance from Large Urban Areas. Given community size,[84] efforts by banks to enforce the mandatory purchase requirement may be less closely monitored in communities that are further from major urban areas.[85] It may also be common for insurance agents in rural areas to be less familiar with the NFIP because outreach by insurers and the NFIP may be more costly and less frequent in these areas.[86]

Geographic information software was used to determine the distance between the center of each community in the sample and the central business district of the nearest city with a

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[84]Note that together, the number of homes in the SFHA and the percentage of homes in the SFHA determine the overall number of homes in an NFIP community.
[85]There are NFIP communities with few homes in the SFHA that are in densely populated metropolitan areas as well as in remote rural areas.
[86]To maintain their licenses, insurance agents are required to take a certain number continuing education courses each year. However, they are free to choose what courses to take, and there is no requirement that they take course on flood insurance.

population of at least 500,000. Table 5.2 compares the market penetration rates for communities in varying distance bands from large cities. Contrary to expectations, the market penetration is higher for cities farther away from large cities. A different relationship may emerge, however, once other factors are held constant, such as the proportion of structures in the SFHA.[87]

5.2.5. Measures of Homeowner Wealth

Improved Value of Property. Higher home value increases the value of property subject to loss, increasing expected loss, other things equal, and likely increasing market penetration rates. Higher home values are correlated with homeowner income. Higher income may thus lead to higher market penetration rates because of increased ability to afford insurance, although higher incomes may mean that the homeowner is less risk averse, possibly reducing the demand for flood insurance.

As shown in Table 5.2, the projected market penetration rate is lower for homes worth less than $50,000 than for other homes.[88] Just under 30 percent of SFHs in SFHAs are valued at less than $50,000.[89]

5.2.6. Variables that Capture Residual Effects

Variables were included in the statistical model that capture factors that influence the decision to buy insurance but are not picked up by other variables. For example, market penetration rate may be lower in the Northeast than in the South, even after price, claims payments per $100 of coverage, and other variables are controlled for. The lower rate may reflect, for example, less enforcement of the mandatory purchase requirement or lower appreciation of risk in the Northeast, beyond levels indicated by the other variables that proxy for such effects. The residual effects associated with geographic region, source of flooding, and whether the home was built pre- or post-FIRM were examined.

Geographic Region. Market penetration rates in the SFHA by region were presented in Chapter 4 (as shown in Table 4.2). Market penetration rates are higher in the South than in the Northeast.

Source of Flooding in Community. Identification of communities that are subject to coastal flooding is based on information in the NFIP's Community Information System (CIS). Communities are considered subject to coastal flooding if they are exposed to flooding by any body of water subject to tidal fluctuations (including bays and estuaries). Even though a community may be subject to coastal flooding, the primary source of flooding in the community

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[87]The relation between market penetration rate and distance from the community to business or city center of the nearest city with population of at least 100,000, 200,000, or 500,000 was also investigated. The results were similar to those discussed below for the ERS measure of urban influence.

[88]The data available on home value are described in Chapter 3.

[89]Data from the Bureau of the Census on median household income and average per-capita income at the block group level were also investigated as measures of homeowner wealth. However, no relationship was found between these variables and market penetration rate in this parcel-level analysis.

can be a river or stream. As can be seen in Table 5.2, there are a projected 1.85 million SFHs in the SFHAs of coastal communities, just over 50 percent of all SFHs in SFHAs.

Homeowners in communities subject to coastal flooding are typically close to the ocean, and the proximity to large bodies of water may serve as constant reminders of flood risk. Consistent with this hypothesis, the market penetration rate is substantially higher in coastal communities than in inland communities; however, whether these difference persist after differences in insurance prices and loss payments per $100 of coverage in force and other variables are controlled for remains to be seen.

Whether Home Built Pre-FIRM or Post-FIRM. To determine whether the homes sampled for this study were built pre- or post-FIRM, the date of construction recorded on the property parcel database was compared to the date of the initial FIRM as reported in the NFIP's CIS.[90] Construction date was missing for 7 percent of the properties, and these properties are grouped separately (the *unknown* category in Table 5.2). As can be seen in Table 5.2, 63 percent of SFHs in SFHAs that could be classified as pre- or post-FIRM were constructed pre-FIRM.[91] The market penetration rates for pre- and post-FIRM structures do not differ a great deal, and the 95 percent confidence intervals for each estimate are rather wide.

5.3. Influence of Various Factors on the Market Penetration and Compliance Rates

A logistic regression model was used to examine how the various variables described above affect the probability that the owner of a single-family home in a SFHA will purchase flood insurance. As discussed in Appendix 6, the outcome of interest in a logistic model is a dichotomous variable (in this case whether or not flood insurance was purchased for the home). The logistic model developed here estimates the natural logarithm of the odds that insurance is purchased on a home given the community and property characteristics included in the model.[92] The analysis allows us to identify the effects of each variable on the probability of purchasing insurance given the values of the remaining variables.

The results of the analysis are summarized in Table 5.3. The first column of the table shows results for the overall market for flood insurance. The second column reports results for homes where the likelihood that there is a mortgage is high. Based on the findings in Chapter 4, we expect that roughly 85 percent of the homes in this category are subject to the mandatory

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[90]Initial FIRMs for most communities were issued between the mid-1970s and the end of the 1980s. Approximately 75 percent of communities in the NFIP received an initial FIRM between 1975 and 1989. Initial FIRMs continued to be issued through 1990s, and approximately 10 percent of communities did not have a FIRM as of the end of 2003.
[91]Based on data collected in 1997, PricewaterhouseCoopers (1999, p. 1-4) estimated that 65 percent of structures in the SFHA (both residential and nonresidential) were pre-FIRM.
[92]The odds of an event is the probability that an event occurs divided by the probability that it does not occur. Thus, if an event occurs with probability of 0.6, the odds ratio is 1.5 (0.6/0.4). The odds of an event and the probability of an event are fairly similar in magnitude for probabilities less than 0.25.

TABLE 5.3: Effects of Community and Parcel Characteristics on Market Penetration Rate When One Characteristic is Varied and Others are Held Constant (odds ratios)

Variable	All Single-Family Homes in SFHA (N=5,472)	Homes Where Likelihood of Mortgage High (N=2,613)	Homes Where Likelihood of Mortgage Low or Uncertain (N=2,859)
Price of Insurance			
Natural logarithm of price (dollars per $100 of coverage)	0.728^{+}	0.593	0.641**
Time Since Last FICO event (years)			
<=10 years	1.503	0.763	1.687^{+}
>10 years	reference	reference	reference
Claims Payments			
Natural logarithm of claims payments (cents per $100 of coverage, 1982–2002)	1.059	0.770^{+}	1.196^{+}
CRS Status			
Not in CRS or in CRS Class 10	reference	reference	reference
CRS Class 1–9	0.928	1.046	1.055
Likelihood of mortgage			
Likely	2.168**	—	—
Uncertain	reference	—	—
Time since mortgage origination[1]			
<=1 years	—	reference	—
> 1 & <=6 years	—	1.317	—
>6 & <=11 years	—	1.610	—
>11 years	—	0.950	—
Single-Family Homes in SFHA			
<=500	0.394^{+}	0.450	0.461^{+}
>500 an <=5,000	1.289	1.459	1.407
>5,000	reference	reference	reference
% of Home in SFHA			
<=50%	0.559**	0.473**	0.677^{+}
>50%	reference	reference	reference
Extent of Urban Influence			
Log of distance to city with pop. >= 500K (miles)	0.938	0.912	0.888
Value of Home			
Natural logarithm of improved value	1.174^{+}	0.858	1.294**
Source of Flooding in Community			
Subject to coastal flooding	reference	reference	reference
Not subject to coastal flooding	0.653**	0.404**	0.681^{+}
Geographic Region			
Northeast	0.507^{+}	0.508	0.488*
South	reference	reference	reference
Midwest	0.714	1.480	0.590
West	0.843	1.524	0.577^{+}
When Home Built			
Pre-FIRM	1.105	1.900^{+}	0.868
Post-FIRM	reference	reference	reference

$^{+}$ Significantly different from 1.00 with 90 percent probability; * significantly different from 1.00 with 95 percent probability; ** significantly different from 1.00 with 99 percent probability.

[1]Only included for homes where the probability of a mortgage is high.

purchase requirement. Findings in Column 2 are thus likely influenced to a relatively small extent by homes not subject to the mandatory purchase requirement. The last column of the table shows the results for homes where the likelihood of having a mortgage is low or could not be determined. As discussed in Chapter 4, perhaps 40 percent of the homes in this group have mortgages, and if 85 percent of these are subject to the mandatory purchase requirement, then approximately one-third of the homes in this group are subject to the mandatory purchase requirement.

The table shows the odds ratios for the estimated effects of each variable on market penetration rate. The odds ratio is the ratio of the odds of purchasing insurance for two different values of the variable in question. For some variables, the table shows the odds ratio for each value of the variable relative to a reference category. For such variables, the reference category is identified in Table 5.3. For example, Table 5.3 shows that the odds of buying insurance is 50.3 percent higher in communities that have experienced a FICO event in the last ten years than in communities that have not, other things equal. For the other variables (such as price of insurance), the odds ratio shows the ratio of the odds when the variable in question is increased by one unit. For example, the table shows that when the natural logarithm of price is increased by one (which corresponds to approximately a 170 percent increase in price), the odds of purchasing flood insurance falls by 27 percent (1.00 – 0.728 = 0.27).

An odds ratio equal to 1.00 implies that the variable in question has no impact on market penetration rate relative to the reference category. For example, if compliance with the mandatory purchase requirement were complete (and all homes where the probability of having a mortgage is high were subject to the mandatory purchase requirement), then the odds ratios in the second column on Table 5.3 would all be 1.00. If the mandatory purchase requirement had some, but not complete effect, then one would expect the odds ratios in Column 2 to be closer to one than the odds ratios in Column 3 (the effects of each variable on the probability of purchasing insurance would be attenuated).

Odds ratios sometimes closely approximate the relative risk of two different states (e.g. the ratio of the probability of purchasing insurance for homeowners with a mortgage to the probability of purchasing insurance for homeowners without a mortgage). Odds ratios and relative risks will be similar when the initial probability is low and the odds ratio is not far from one. However, in this study, the probability of the event of concern (purchasing insurance) is not always low, and as will be seen below, the odds ratios are not always close to unity. Thus, the odds ratios in Table 5.3 do not translate directly into relative probabilities. Odds ratios will overstate any effect size: The odds ratio is smaller than the relative risk for odds ratios less than one and bigger than the relative risk for odds ratios greater than one (Davies et al., 1998). While odds ratio must be interpreted with care, they are easier to interpret than the coefficients of the logistic regression.

Cross hatches and asterisks in the table denote when the odds ratio is statistically different from 1.00 at various levels of statistical confidence. The variable categories were collapsed when initial analysis showed that the odds ratios for the two categories were close in value and there was no analytical reason to maintain a finer distinction. For example, the odds ratios for variables that indicate that a FICO event occurred less than 5 years ago and between 5 and 10 years ago were similar. The odds of purchasing insurance in a community that has had a FICO event in the last 10 years is thus compared with odds of purchasing insurance in a community that has not had such an event.

5.3.1. Effects of the Price of Flood Insurance and Risk Perception

Table 5.3 shows that as the price of insurance increases, the probability of purchasing insurance falls (i.e., the odds ratio is less than one). The demand for insurance, however, is not particularly sensitive to price. The price elasticity of demand over the entire market (interpreted here as the percent change in the probability of purchasing insurance divided by the percent change in price) implied by the odds ratio is only –0.06. At the lower and upper bounds of the 95 percent confidence interval for the estimated effect of price on the decision to purchase insurance, the elasticity is –0.13 and 0.01, respectively.[93]

As expected, demand is more sensitive to price among homes where the likelihood of a mortgage is low or uncertain than for the market as a whole (see the last column of Table 5.3), but the effect is still not large. The elasticity for this segment of the flood insurance market is –0.08, with the elasticity ranging from –0.01 to –0.10 over the 95 percent confidence interval for the estimate of the coefficient on price.[94]

Previous studies have found that the decision to purchase flood insurance is not very sensitive to price, although the effects are larger than the estimate here. Brown and Hoyt put the elasticity at–0.11, and Kriesel and Landry estimated an elasticity of –0.26 (Brown and Hoyt, 2000; Kriesel and Landry, 2004). The average of these two recent estimates and the –0.06 estimate from above (–0.14) does not suggest that increases in the price of flood insurance will have a substantial impact on market penetration rate: A 25 percent increase in the price of insurance would cause market penetration rates to fall by 7 percent. If the market penetration rate were initially 50 percent, this large price increase would only cause it to fall to 48 percent. It is important to note, however, that the estimate for elasticity found here is most relevant to price changes over the range of prices observed in the sample. Very large price changes could cause proportionately much larger changes in market penetration.

It should also be noted that the estimates of price elasticity developed in this study depend importantly on how well the perception of risk is characterized. (The price elasticity is intended to measure the effect of increasing price, holding perceived risk of the household constant.) It is not known how the proxies used for risk in this analysis might cause the estimated price elasticity to diverge from its true value, so care should be taken interpreting the findings on

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[93]To calculate the elasticity, the probability of purchasing insurance is predicted for each observation in the sample using the estimated logistic model and the observed values of each of the right-hand-side variables in the model. The price of insurance is then decreased 1 percent, and the probability of purchasing insurance recalculated. The implied elasticity is then the weighted mean of the differences in probability (using the sampling weights for each of the observations).

[94]Contrary to expectations, the odds ratio for price for homes where the likelihood of a mortgage is high is less than for homes where the probability of a mortgage is low or uncertain. However, the odds ratio for homes where the likelihood of a mortgage is high is estimated with considerable uncertainty and is not statistically different from one.

price elasticity. The estimates of elasticity here should be combined with those from other studies when developing ranges for the likely price elasticity for the decision to purchase insurance.

As expected, variables likely correlated with perceived flood risk in the community have an impact on market penetration, at least among homes that are less likely to be subject to the mandatory purchase requirement. As shown in the last column of Table 5.3, the probability of purchasing insurance increases if there has been a FICO event in the last 10 years (the odds ratio on FICO events—1.687—is greater than one and the difference from one is statistically significant) and increases as claims payments per dollar of coverage over the last 20 years increase (odds ratio on claims payments is 1.196 and statistically significant). Surprisingly, the odds ratios for these two variables are less than one for homes that likely have a mortgage, although the FICO odds ratio is not statically different than one. It is not obvious why market penetration would if anything be lower in riskier areas for homes subject to the mandatory purchase requirement than in less risky areas.[95]

The results provide no evidence that participation in the CRS induces higher market penetration rates apart from the effects of lower price. Once insurance price is controlled for, the odds ratios on CRS participation are not statistically different than one. CRS programs are either not effective, or program elements that tend to increase perceived flood risk (such as mailouts on flood risk and the importance of flood insurance) balance out CRS program elements that reduce perceived flood risk (such as better maintenance of storm drains). Thus, the large differences in market penetration by CRS class reported in Table 5.2 appear to result from lower price and from the fact that CRS communities tend to have more SFHs in the SFHA than non-CRS communities. As discussed below, the market penetration rate is higher is communities with more SFHs in the SFHA.

5.3.2. Effects of the Mandatory Purchase Requirement

Once other factors are controlled, whether a home has a mortgage has a large impact on the probability of purchasing insurance. As shown in the first column of Table 5.3, the odds ratio for homes that likely have mortgages relative to those where the likelihood is low or uncertain is large (2.168) and statistically different than one. This analysis does not distinguish between mortgages subject to the mandatory purchase requirement and mortgages that are not. In addition, as discussed in Chapter 4, a substantial proportion of homes where the likelihood of a mortgage is low or uncertain may actually be subject to the mandatory purchase requirement. Thus, the odds ratio for the probability of purchasing insurance for homes subject to mandatory purchase requirement relative to those that are not may be even higher than the 2.168 reported in Table 5.3.

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[95]One possible explanation for this result is that areas with higher flood losses are areas that are less likely to comply with the floodplain management requirements of the NFIP and are also less likely to enforce the mandatory purchase requirement. Thus, in the mandatory market, where we would expect a weaker relationship between perceived risk and flood purchase, the lower compliance could actually drive a negative observed relationship.

The results do not suggest that the compliance rate with the mandatory purchase requirement falls as loans age. For homes that likely have mortgages, the estimated probability of having a mortgage is higher for mortgages between 1 and 11 years old than for mortgages one year old or less, and only slightly lower for mortgages over l1 years old. However, none of the differences are statistically significant. A larger sample size may uncover any trend that may exist in compliance rate as loans age.

5.3.3. Effects of Variables that May Be Associated with Accessibility and Enforcement of the Mandatory Purchase Requirement

One of the most noteworthy findings of the analysis is the low probability of purchasing insurance in communities with 500 or fewer SFHs in the SFHA relative to communities with more homes in the SFHA. For both the full sample and the two subsets examined, the odds ratios for communities with less the 500 homes in the SFHA are substantially less than one and of comparable magnitude. The odds ratio is not significantly different than one for homes that likely have a mortgage, but the consistency of the estimates in each of the three regressions suggest that the effect also occurs for these homes. The low odds ratio in communities with less than then 500 SFHs in the floodplain is consistent with hypotheses that insurers market flood insurance less aggressively in communities with fewer homes in the SFHA and that there are fewer agents familiar with the program and enthusiastic about writing policies in these communities. The results also suggest that the mandatory purchase requirement is less vigorously enforced in communities with relatively few homes in the SFHA. It should be noted, however, that if fewer mortgages are subject to the mandatory purchase requirement in communities with few structures in the SFHA (for example, because the communities are more frequently served by small, state-regulated banks), then a lower penetration rate for homes with mortgages in these communities does not necessarily mean a lower compliance rate with the mandatory purchase requirement.

The percentage of a community's homes that is in the SFHA also has a substantial effect on the probability of purchasing insurance. It was hypothesized above that such an effect might be because of lower awareness of flood risk in such communities or less interest by flood insurance agents in learning how to write flood policies when a smaller share of their clients are in SFHAs. The low odds ratio for homes subject to the mandatory purchase requirement suggests that enforcement of the mandatory purchase requirement in communities where a lower proportion of homes are in the SFHA may also be less stringent.

The results for the logistical regression suggest that the market penetration rate declines as distance from large urban areas increases, but the effect is neither large nor statistically significant. It is possible that a statistically significant effect would be found if the sample size were larger (although it may well still be small in magnitude); however, the results so far provide no compelling support for hypotheses that barriers to information about flood risks, impediments to learning how to write flood insurance policies, or reduced enforcement of the mandatory purchase requirement reduce market penetration rates in communities far from urban areas.[96]

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[96]Similar results either were found between market penetration and an measure of urban influence developed by the U.S. Department of Agriculture's Economic Research Service (ERS). The ERS classifies counties into nine

5.3.4. Effects of Variables Associated with Wealth

As expected, the home value has a positive effect on market penetration rates in the overall market. The odds ratio for homes that likely have a mortgage is much closer to one (0.86) and not statistically different than one. This result suggests that home value is not relevant to efforts by banks or regulators to enforce, or attempts by homeowners to evade, the mandatory purchase requirement.

5.3.5. Effects of Variables that Capture Residual Effects

The probability of purchasing insurance is substantially higher in communities subject to coastal flooding than in communities that are not, even when other variables are controlled for. The result holds both for homes likely to have a mortgage and for homes where the likelihood of a mortgage is low or uncertain. The results could be explained by systematic differences in risk perception in the two sets of communities. Stakeholders interviewed for this study suggested that homeowners in communities subject to coastal flooding have a greater appreciation of flood risk relative to homeowners in inland communities because the proximity of water is a constant reminder of this risk. The results could also be explained by systematic differences in the perceived benefits of flood insurance in the two sets of communities. For example, losses may be more variable in coastal areas, increasing the demand for flood insurance by risk-averse individuals. The types of coverage offered by the NFIP may also be less attractive to homeowners in inland communities. For example, NFIP policies provide only limited basement coverage, and if basements are more common in inland communities, homeowners there would be less likely to buy policies. Some stakeholders noted that limited basement coverage is a common complaint in the Midwest.

Even after other factors are controlled for, geographic region is associated with the probability of purchasing insurance. The effect is most consistent among homes where the likelihood of a mortgage is low or uncertain. Market penetration is lower for such homes in the Northeast, Midwest, and West than in the South, with two of the three odds ratios statistically significant. The regional variables could reflect lower perceived risk outside the South, beyond the difference in risk perception captured by the other variables.

No consistent results were found on the effect of whether the home was built before or after the initial FIRM for the community was issued after other variables were controlled for. The odds ratio is not statistically different from one for homes where the likelihood of a mortgage is low or uncertain. It is statistically greater than one for homes that likely have a mortgage, but not statistically different from one for the market as whole.

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categories based on the size of the metropolitan statistical area (in the case of the metropolitan counties) and adjacency to MSAs and the size of the size of the largest city in the county (in the case of non-metropolitan counties). As with distance from large cities, the estimated odds ratios were less than one for homes in counties outside major metropolitan areas relative to homes in major metropolitan counties, but the odds ratio were not statistically different from one. Description of the ERS Urban Influence Codes can be found in *Technical Documentation with Field Numbers for the Area Resource File,* February 2003 Release, National Center for Health Workforce Analysis, Bureau of Health Professions, Health Resources and Services Administration, Department of Health and Human Services.

5.4. SUMMARY

The analysis in this chapter has identified several key factors that underlie the decision to purchase insurance. Consistent with economic theory, as well as with past studies of the demand for flood insurance, the decision to purchase insurance is affected by the price of insurance, although the effect is not particularly strong.

The mandatory purchase requirement is a critical determinant of whether a single-family home in the SFHA has flood insurance. The importance of the mandatory purchase requirement highlights the challenges that remain in selling flood insurance to homeowners who do not have to buy it. The findings suggest that compliance with the mandatory purchase requirement is lower in communities with 500 or fewer homes in the SFHA, communities where less than 50 percent of homes are in the SFHA, and communities not subject to coastal flooding. However, noncompliance with the mandatory purchase requirement could be overstated if homes with mortgages in these communities are less likely to be subject to the mandatory purchase requirement than homes in other communities. Further work on the difference in compliance rates across communities is warranted. The analysis does not provide any strong evidence that compliance declines as loans age. Thus, it appears that once banks adopt procedures to enforce the mandatory purchase requirement, the policies are equally effective for new and older loans.

The number of SFHs in a community's SFHA has a significant impact on the market penetration in the community. Market penetration is substantially lower in communities with 500 or fewer homes in the SFHA than in communities with more homes in the SFHA, and the effect persists when other community and individual characteristics are held constant. Similarly, market penetration rates are lower in communities where a lower percentage of structures are in the SFHA. For both the number and share of homes in the SFHA, the effects occur both for homes more likely subject to the mandatory purchase requirement and those that are not. The sheer number of small communities presents great challenges for any contemplated effort to increase market penetration in communities with relatively few homes or relatively lower proportion of homes in the SFHA. Extrapolations from the 100 communities examined here to the nation as a whole find that 94 percent of the roughly 20,000 communities in the NFIP have fewer than 500 SFHs in the floodplain. Overall these communities account for roughly 25 percent of SFHs in SFHAs nationwide. Developing strategies to increase the awareness of flood risk and/or the accessibility of flood insurance across such a large number of communities will be challenging. Similarly, it may be difficult, or expensive, to develop strategies that target communities where a lower share of homes are in the NFIP.

The substantially lower market penetration rate in communities not subject to coastal flooding persists even when other factors are controlled for. Market penetration is also lower outside the South when other factors are controlled for. Systematically lower risk perception in areas outside the South and in communities not subject to coastal flooding is a possible explanation, but further work is needed to better understand the source of the difference.

6. THE EFFECT OF INCREASING MARKET PENETRATION RATES ON DISASTER ASSISTANCE AND ON COMMUNITY COMPLIANCE WITH FLOODPLAIN MANAGEMENT REQUIREMENTS

In this chapter we explore empirically some of the potential benefits of increasing market penetration rates. In particular, we first examine whether higher market penetration rates lead to lower federal disaster assistance payments. Second, we look to see if there is any evidence that higher market penetration rates are associated with improved community compliance with floodplain management requirements of the NFIP. A higher market penetration rate may give a community a greater stake in the program and induce it to enforce the required standards for floodplain management more vigorously. Then again, standard economic theory argues that insurance and (individual) hazard mitigation efforts can be substitutes. Thus, the predicted effect of insurance on compliance is not clear and requires empirical analysis.[97]

As a practical matter, improving market penetration rates cannot be accomplished without some cost (whether through reducing, and therefore subsidizing, premiums, by spending money to educate consumers on their true levels of risk, or by more vigorously enforcing the mandatory purchase requirement). Nor are we capturing every possible benefit of flood insurance. A complete accounting of the costs and benefits of flood insurance is beyond the scope of this report, but the results of the analyses in this chapter will help inform the cost-benefit tradeoffs.

6.1. Background

The federal government makes disaster relief available when the President declares some kind of natural event to be a disaster. The governor of an affected state initiates the declaration process with a formal request for a declaration by the President.[98] Public officials estimate the extent of the damage caused by the disaster, and the President declares a disaster if the damages are deemed sufficiently beyond state and local capability to cope with the damage. States that receive disaster assistance must often comply with certain regulatory requirements to share costs or reduce the likelihood or magnitude of uninsured losses in the future. Federal disaster relief is provided primarily by FEMA and the Small Business Administration (SBA). FEMA provides disaster assistance in three general categories:

- individual assistance (for expenses not compensated by insurance or other relief)
- public assistance (assistance to state or local governments to repair public infrastructure or to defray disaster response costs)
- hazard mitigation assistance (assistance to reduce the vulnerability to future disasters).

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[97]In fact, the possible substitutability of insurance and compliance could lead to a negative correlation, because high market penetration could make compliance unnecessary (assuming that the requirements of FEMA are loosely enforced).

[98]Our information on the disaster declaration process is based on *A Guide to the Disaster Declaration Process and Federal Disaster Assistance* (Department of Homeland Security, 2003).

While any or all of these may be granted in a particular case, hazard mitigation is typically granted in every incident. The SBA makes low-interest loans available to businesses (both large and small) and individuals. Individuals and businesses are eligible for low-interest loans to repair property damage caused by floods. Small businesses are also eligible for economic injury disaster loans (EIDLs) to cover necessary operating expenses caused by reduced revenue resulting from the disaster.

In principle, it is easy to see how insurance coverage should reduce the need for subsidized loans and federal disaster assistance. Disaster assistance is, in essence, a social insurance program through which the government compensates victims of natural disasters for losses that are otherwise unrecoverable. If individuals and businesses are able to insure their losses from floods, they should have fewer unrecoverable losses and therefore have less need for disaster relief.

However, simply making flood insurance available to individuals is not sufficient to guarantee that disaster assistance payments will decline significantly (if at all). If, as suggested by Kunreuther (1984), individuals underestimate their risk of flood damage, then they might not purchase flood insurance even if it is available to them. In contrast, suppose that individuals do fully comprehend the risk of damage from floods but the premiums for flood insurance are subsidized.[99] The availability of insurance at subsidized rates could increase development in the floodplain to the point where disaster assistance payments actually increased.[100] Regardless of the impact on disaster assistance payments, flood insurance at subsidized rates could lead to development of property that is too "high risk," which would not be developed if flood insurance were not subsidized or available.

Because of the potential impact of flood insurance on development, it is necessary to bundle the public provision of the insurance with the appropriate regulatory controls. The key is to ensure that development occurs under the oversight of effective hazard mitigation and floodplain management provisions that balance the various economic and environmental factors that are important to society. These types of regulatory actions should allow individuals to receive appropriate protection from flood risks without imposing an excessive burden on taxpayers through disaster assistance.

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[99]Pasterick (1998, p. 134) argues that NFIP premiums are only 38 percent of what is necessary to cover the long-term expected losses. The subsidy noted by Pasterick is specifically only for pre-FIRM structures below the BFE. While there is no explicit subsidy for post-FIRM structures, there is an implicit one in that the NFIP does not charge the full risk premiums needed to fund the long-term expectation for losses. This issue is being studied in FEMA's ongoing evaluation of the NFIP.

[100]This assumes an underlying model where insurance coverage is partial and the government offers disaster assistance to cover the uninsured losses. With the NFIP, this could occur if disaster assistance was paid to cover damages that could not be recovered by flood insurance (such as damage to a basement). Additionally, greater development in the floodplain could lead to additional public infrastructure in these areas, which might increase the level of disaster assistance to state or local governments even if the direct assistance to individuals declined.

Despite its importance as a public policy issue, there has been relatively little study of the effect of the NFIP (including both the insurance and floodplain management components of the program) on disaster assistance and floodplain management. Browne and Hoyt (2000) developed an empirical model of the demand for flood insurance and included disaster assistance as an independent variable. Surprisingly, they found a positive relationship between the value of disaster assistance payments per capita and the prevalence of NFIP coverage. They explained this result by arguing that disaster assistance and flood insurance are likely both correlated with unobserved flood risk. This is certainly possible, but another explanation comes from a requirement of the SBA, which provides low-interest loans to the victims of flooding but also insists that recipients must purchase a flood insurance policy to receive assistance. Similarly, FEMA provides flood insurance (with the state responsible for paying part of the premium) to beneficiaries of family assistance grants.[101] While Browne and Hoyt attempt to use disaster assistance as a predictor for purchasing flood insurance, we reverse their analysis and focus on the number of flood insurance policies in force as a predictor of disaster assistance (with an attempt to control for the possible endogeneity between the two).

Evidence on the impact of the NFIP on compliance with floodplain management policies is also limited. Kriesel and Landry (2004) developed a demand model for flood insurance in coastal properties and found that participation in the NFIP is positively correlated with the existence of artificial shoreline protections (primarily seawalls). They interpreted this result, which is contrary to the normal prediction of economic theory that insurance and protection measures are substitutes, as occurring because the presence of shoreline protection increases individual awareness of flood risk. While this explanation is possible, an alternative one is that participation in the NFIP induces communities to take greater measures to reduce risk, either through regulation or to reduce community-wide premiums (through the CRS). Still, more direct evidence is needed to conclude that expanding flood insurance coverage will improve compliance with the NFIP's floodplain management requirements. We explore this issue in the latter part of this chapter using several different measures of compliance.

6.2. The Relation Between the Market Penetration Rate for Flood Insurance and Federal Disaster Relief

6.2.1. Data

As described above, disaster relief is available to individuals, businesses, and public agencies. We focus our analysis on individual and business assistance, because such payments are most likely to be responsive to changes in flood insurance coverage. We use two sources of data on the incidence and magnitude of disaster assistance payments. First, we use data from FEMA on disaster assistance. FEMA makes a number of different types of payments to individuals, mostly in the form of family assistance grants, reimbursement for temporary housing, and temporary unemployment assistance. Family assistance grants are available only to those who do not qualify for SBA loans. FEMA does not provide assistance to businesses.

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[101]FEMA and SBA can require flood insurance even for assistance or loan recipients outside the SFHA.

Table 6.1 lists FEMA's average annual disaster assistance payments by type of assistance from 1989–2002. The largest single component of disaster assistance is public assistance, at approximately $485 million per year. The second largest component is individual assistance, at about $264 million per year. Temporary housing assistance represents the largest part of individual assistance, more than twice the second largest component (family assistance grants). Payments for hazard mitigation average $111 million per year, about 12 percent of the total (closer to 13 percent if we ignore administrative costs).

TABLE 6.1: Average Annual Flood-Related FEMA Disaster Assistance Payments by Payment Type, 1989–2002

Payment Type	Payment ($ millions)*	Percent of Total
Public Assistance	485	52
Individual assistance	264	28
Temporary housing assistance	159	17
Family assistance grants	74	8
Temporary unemployment assistance	11	1
Mobile homes	8	<1
Inspection services	8	<1
Hazard mitigation assistance	111	12
Administration, mission assignments, and other	81	9
Total FEMA obligation	941	100

*Values are in year 2000 dollars.
SOURCE: FEMA, Financial Acquisition and Management Division.

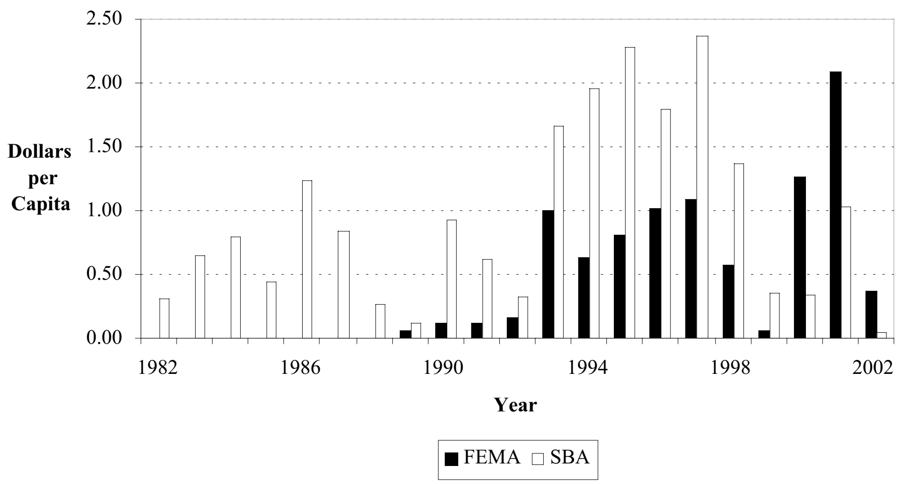
Our objective is to examine the impact of flood insurance policies on disaster assistance payments. However, it seems unlikely that flood insurance should have an effect on all components of disaster assistance. For instance, NFIP policies provide no coverage for temporary housing costs or unemployment. The component of individual assistance that should be most affected by flood insurance is assistance for emergency home repair and lost contents, which are provided by family assistance grants. Therefore, we consider separately the impact of flood insurance policies on family assistance grants and on total individual assistance. Even for family assistance grants, however, the effect of market penetration may not be great. Applicants for family assistance grants must first be turned down for SBA loans. Thus, applicants typically have low incomes and few assets. Thus, flood insurance coverage among this group is probably rare, which means that changes in overall market penetration rate would have little effect on their use of family assistance grants.

In addition to FEMA disaster assistance payments, we also use historical data on low-interest loans awarded to victims of flood damage from the SBA. The SBA was able to provide loan totals only for individuals and businesses combined, so we are not able to examine the relationship between NFIP market penetration rates and the use of low-interest loans by individuals separately from businesses.

The FEMA data are available from 1989 to 2002, while the SBA data are available from 1982 to 2002. Both are provided for individual disasters, but are aggregated to the state-year level (which is the unit of analysis).

Figure 6.1 illustrates the magnitude of federal disaster relief over time. The white bars represent the total per-capita dollar value of SBA loans in the United States. The black bars represent the per-capita value of FEMA's individual assistance payments. Individual assistance payments per capita are highly variable over time, with SBA loans varying from about $0.05 to about $2.40, and FEMA payments varying from about $0.06 to $2.20. The SBA loans are significantly larger than the FEMA payments in most years for which data on both are available, though we have no way of knowing how much of this reflects the fact that the SBA data include business loans.

FIGURE 6.1: Annual FEMA Individual Assistance and the Amount of SBA Loans for Flood-Related Losses (Dollars per Capita in Year 2000 Dollars)



From a societal standpoint, or at least from a taxpayer's perspective, the important issue might not be the effect of flood insurance on the total amount of SBA disaster loans but rather the cost of the loans after repayments have been made. The government recovers at least some of the SBA loans. Table 6.2 lists the subsidy rates for SBA disaster loans for each fiscal year from 1992 to 2002. (The SBA was unable to provide the subsidy rates prior to the Credit Reform Act of 1992.) The subsidy rate refers to the cost to taxpayers of SBA loans (includes below-market interest rates and loan defaults) divided by the total amount leant.[102] However, we do not include the subsidy rate in our statistical analyses, because we do not have data on the subsidy rate for the full length of our sample of SBA loans.[103]

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[102]To approximate the government cost of SBA loans, multiply the dollar value of the loans by the subsidy rate listed in Table 6.2. Some error could be introduced into our calculation because the subsidy rate applies to the fiscal year while the loan data refers to the year in which the disaster occurred.

[103]This is not a concern as long as the subsidy rate is fixed in a given year. This is because we examine the natural logarithm for the dollar value of loans and we include year fixed effects, so the effect of any year-to-year variation in the subsidy rate is captured in the year fixed effects.

TABLE 6.2: Annual SBA Subsidy Rates

Year	Subsidy Rate (percent)
1992	33.93
1993	20.58
1994	22.99
1995	31.54
1996	28.08
1997	20.02
1998	23.46
1999	22.36
2000	22.20
2001	17.46
2002	17.19

SOURCE: Small Business Administration, Office of Disaster Assistance.

While annual disaster relief per capita is highly variable, Figure 6.1 suggests that, if anything, both FEMA disaster assistance and SBA loans have tended to grow since 1982, even on a per-capita basis. While the NFIP may not have stopped the increase in disaster relief per capita over the last 20 years, it is still possible that the level of disaster assistance and the upward trends in recent years are lower than would have occurred had the NFIP not been in place.

To estimate the impact of flood insurance coverage on disaster assistance payments, it is necessary to select the appropriate measure of coverage. In principle, the best variable to use is the NFIP's market penetration rate. However, there are challenges to using market penetration rate as a measure at the state level. One difficulty is a lack of data on structures in the floodplain, which forces us to rely on the broader definition of market penetration rate: the number of policies per structure whether in or out of the SFHA. An additional problem is that, at the state level, we cannot distinguish between structures that are in communities that do not participate in the NFIP. This problem is mitigated, however, by the fact that only a small number of communities do not participate in the NFIP. Thus, for our definition of market penetration rate, we use the number of flood insurance policies written per single-family home (number of flood insurance policies on SFHs divided by number of SFHs) in a given state in a given year.

As in the rest of this report, we focus on market penetration rates for SFHs because of the problems matching multiple-unit residences and commercial policies to data on the number of structures. We include both contents and structure policies. The data on policies come from the NFIP and are aggregated to the state-year level.

Measuring insurance coverage as the number of flood insurance policies per single-family home is subject to some criticism because both our measures of disaster assistance include payments to those not living in SFHs. (FEMA data on disaster assistance include payments to renters or people living in multi-family structures, and the SBA data include loans to these individuals as well as to businesses.) Nevertheless, there is no reason to suspect that market penetration rate for SFHs in a community would not closely reflect the market penetration rate for other kinds of policies. Most of the unobserved characteristics we have discussed that affect the decision to purchase flood insurance (e.g., risk perceptions) likely apply to both SFHs and other types of structures in a community. Thus, the market penetration rate for SFHs should be correlated with the market share for other residential units and businesses.

There are factors other than flood insurance policies that must be considered when predicting disaster assistance payments. One of these is the size of losses from flood damage. Disaster assistance is intended to reimburse uninsured losses, so we expect that states with greater flood losses in a given year will have more payments for disaster assistance, other things being equal. To control for the size of flood losses, we use data on total annual precipitation in a given state and a given year. We expect severe flooding to occur more often in years that experience excessive rainfall (or possibly snowfall), suggesting that precipitation should be positively related to disaster assistance payments. The precipitation data are available historically for all 50 states from 1975 through 2000 from the National Climactic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA).[104]

Clearly, we would prefer a more direct measure of flood losses. The National Weather Service (NWS) does provide an estimate of flood-related losses that can be aggregated to the state-year level. Unfortunately, the NWS data do not include losses for floods that result from storm-surges, which is problematic for an analysis of disaster assistance (because storm-surges likely account for a significant portion of flooding from hurricanes). Rather than use a variable measured with error, we use precipitation to proxy for flood losses.[105] Precipitation is positively correlated with the NWS flood losses, suggesting it is a reasonable proxy.[106]

Another factor that could affect damage assistance payments is per-capita income, and it is included in our analysis. We take the Bureau of Economic Analysis (BEA) estimates of total personal income and divide by the Census estimates of population for each state in each year. We expect that, conditional on the size of losses, higher average income might mean less disaster assistance, because those with higher income should be able to better cover their losses (i.e., they self-insure). However, there also could be a particularly large need for disaster relief among the very poor who cannot afford insurance. Therefore, we also predict annual poverty rates for each state using the decennial census and investigate the effect of income per capita and poverty rate on disaster assistance.

Higher income areas could be associated with more valuable property, leading to higher losses and subsequently higher disaster assistance payments. Thus, to isolate the effect of income from property value on disaster assistance, we also include state-year level data on average housing prices. These data are based on the housing price index published by the Office of Federal Housing Enterprise Oversight (OFHEO). This index, which uses data on single-family mortgages from Fannie Mae and Freddie Mac, is designed to measure changes in the prices of SFHs.[107] It is available for all 50 states plus the District of Columbia and goes back to 1975. The

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[104]For more information, see http://www.ncdc.noaa.gov.

[105]An alternative specification would be to use precipitation as an instrument for losses. Instrumental variables analysis is beyond the scope of this report; thus, we focus on the reduced-form model.

[106]If we run a regression of NWS damage estimates against precipitation and the other independent variables used in our later analyses, we find that an increase in precipitation of 1 inch is associated with an increase in flood damages of $5.84 per member of the population in the sample with FEMA disaster assistance and $4.42 per member of the population in the sample with SBA disaster assistance. (Both are statistically significant at the 5 percent level.)

[107]For more information see www.ofheo.gov.

price index is converted to a price level by multiplying it by the national average price of single-family units in 1999 as reported by the American Housing Survey (AHS).[108] We lag the housing prices one year, because it is possible that disasters could have an impact on current-year housing prices.

In Table 6.3, we present summary statistics for some of the key variables in our analysis. The table presents data for 1989–2000, where we can estimate the effect of flood insurance on FEMA individual assistance, and the larger sample from 1982 to 2000 where we use only SBA loans. Note that the lack of data on annual precipitation after 2000 restricts our analysis to go only through the year 2000. The table shows that SBA loans are granted with much greater frequency than FEMA individual assistance, being present in about 50 to 60 percent of observations compared to just 30 percent. Not surprisingly, the per-capita value of SBA loans is also higher than that for FEMA individual assistance.

TABLE 6.3: Summary Statistics for the Analysis of the Relation Between Market Penetration Rate and Disaster Relief

	1989–2000 (N=526)[2]		1982–2000 (N=796)[2]	
Variable Name	Mean	Std. Dev.	Mean	Std. Dev.
Any FEMA individual assistance	0.29[1]	0.46	—	—
Any family assistance grants	0.28[1]	0.45	—	—
Any SBA loans	0.60[1]	0.49	0.55	0.50
Individual assistance ($ per capita)	1.00	7.10	—	—
Family grants ($ per capita)	0.16	0.90	—	—
SBA loans ($ per capita)	1.83	12.72	1.45	10.42
Income ($1000s per capita)	25.93	4.12	24.57	4.25
Fraction of population below poverty level	0.13	0.04	0.13	0.04
Average housing price ($1000s)	103.2	26.2	93.2	28.2
Flood policies in force per single-family unit	0.03	0.05	0.03	0.05
Annual precipitation (inches)	39.08	14.78	37.31	14.70

[1]The mean of this variable measures the frequency that the type of assistance indicated was provided in a state during a year. It is the proportion of state-year observations in which the indicated assistance was provided.
[2]Unit of observation is a state-year combination.

As discussed above, the SBA requires that recipients of disaster assistance loans purchase a flood insurance policy if flooding was the cause of the loss and FEMA provides flood insurance (with a state cost share) to recipients of family assistance grants. For this reason, if we regressed current-year disaster assistance payments on the number of policies in force, we might expect the coefficient to be biased upwards. (Suppose a disaster occurred in January; then, we would expect to observe an increase in flood insurance policies over the course of the year.) For this reason, in our analysis we use the number of policies in force per single-family unit from the previous year to proxy for current-year market penetration rate.

From Table 6.3 we see that, on average, only 3 percent of single-family units in the United States have flood insurance policies (consistent with our findings in Chapter 4). Note that the market penetration levels are similar in the two time periods, suggesting that market

[108]These data were accessed at the following web site on May 2, 2005: http//www.census.gov/hhes/www/housing/ahs/ahs99/tab322.html.

penetration has not changed dramatically (despite reforms to the mortgage purchase requirement in the mid-1990s). Average annual precipitation is also similar in the two samples, about 37 to 40 inches per year. Of course, given the overlap between much of the two samples, we would not expect dramatic differences between the averages.

6.2.2. Results

Flood insurance could affect disaster assistance on two different margins: the frequency with which disaster assistance is awarded, and the size of the awards per capita. These effects might go in the same direction, but not necessarily. For instance, it could be that flood insurance decreases the amount of disaster assistance necessary for a given disaster, but leads to a greater likelihood of a disaster being declared because it encourages development in the floodplain.[109]

To allow for these differing effects of flood insurance coverage on disaster assistance, we estimate a two-part empirical model. In the first, we predict the probability that disaster assistance is awarded in a state during a year as a function of flood insurance and the other independent variables[110]. In the second, we regress the size of disaster assistance awards per capita on flood insurance coverage and the other independent variables (i.e., we drop all the observations with zero disaster assistance payments). These should allow us to identify separately the impact of flood insurance on the incidence and magnitude of disaster assistance, respectively. The key assumption underlying this two-part analysis is that, conditional on flood losses, the size of the disaster assistance payments is independent of the likelihood that disaster assistance is awarded. We cannot directly test these assumptions, so we also employ an alternative specification in which we simply estimate a regression model that jointly considers both the incidence and magnitude.

Table 6.4 presents the results of our model of the effect of flood insurance coverage on the incidence of disaster assistance payments. The first column illustrates the results where the dependent variable indicates whether any FEMA individual assistance payments were made. In the second column the dependent variable is whether any family assistance grants were paid. Finally, the rightmost column illustrates whether any flood-related SBA disaster assistance loans were made to individuals or businesses. The coefficients of the logit model are presented as odds ratios.[111] Fixed state and year effects are also included in all regressions.

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[109]A good portion of the development in the floodplain might be covered by insurance, but as shown in Chapter 4, a sizable portion of development probably would not be covered. Thus, even though the flood insurance program likely increases the proportion of development in the floodplain that is insured, it may well increase the value of structures in the floodplain that are uninsured. The higher amount of uninsured losses may increase the likelihood that a disaster is declared.

[110]The type of model used is a logit model. See Chapter 5 and Appendix F for a description of a logit model.

[111]Note that interpreting the relationship between odds ratios and standard errors are slightly different than models estimated using ordinary least squares. Standard errors for odds ratios are computed using a mathematical technique called the delta method, which results in a standard error that is equal to the odds ratio multiplied by the coefficient in the logit model. However, there is an alternative method for generating confidence intervals for the odds ratios that involves taking the exponent of the upper and lower bounds of the confidence interval of the coefficient. Asymptotically, these should have the same implications for the statistical significance of the odds ratio, but results may differ in small samples. In practice, the sampling distribution of the coefficient is likely to better approximate

TABLE 6.4: The Effect of Market Penetration Rate on the Incidence of Disaster Relief (odds ratios)

Independent Variable	Individual Assistance	Family Assistance Grants	SBA Loans
Policies in force (multiplied by 100) per single-family unit (lagged one year)	0.991	0.992	1.000**
	(0.009)	(0.009)	(0.000)
Natural logarithm of per-capita income (log ($1000/state population))	0.006	0.029	5.414
	(0.020)	(0.103)	(8.830)
Percent of the population below the poverty line	0.883	0.913	0.809
	(0.239)	(0.246)	(0.132)
Natural logarithm of average housing prices (single-family units, lagged one year)	2.850	2.097	1.232
	(6.049)	(4.443)	(1.164)
Total annual precipitation (inches)	1.132**	1.131**	1.065**
	(0.025)	(0.025)	(0.020)
Number of observations	526	526	796

NOTE: Statistical significance of the coefficients is denoted by the following symbols: + significant at 10 percent; * significant at 5 percent; ** significant at 1 percent.

The results of Table 6.4 suggest that the number of flood insurance policies in force per single-family unit (lagged one year) appears to have little effect on the incidence of disaster assistance. The odds ratio for the two FEMA assistance variables is approximately 0.99. Because we represent market share penetration rate as a percentage between 0 and 100 in the logit model, this odds ratio suggests that a 1 percentage point increase in policies per capita causes a slight decrease in the odds of FEMA assistance.[112] However, neither coefficient is statistically significant. For the SBA loans, the odds ratio is slightly greater than 1 (its estimated value is actually 1.000216) and is significant at the 1 percent level. This odds ratio suggests that a 1 percentage point increase in the market penetration rate will lead to an *increase* in the odds of SBA loans being granted of about two-hundredths of one percent. This effect is extremely small, and overall it appears that market penetration rate has virtually no effect on the likelihood of assistance being granted.

As expected, annual precipitation has a positive and statistically significant correlation with the likelihood of disaster assistance, supporting its use as a proxy for flood risk and losses. There is no consistent relationship between per-capita income and the various measures of disaster relief. The poverty rate is negatively associated with disaster assistance, though the effect is not statistically significant. As expected, average housing prices are positively correlated with disaster assistance, though again the effect is not statistically significant.

normal than that of the odds ratio (which might be skewed), so it is better to check the significance of the odds ratio using the transformed confidence interval rather than the standard error. Thus, when we report the significance of the odds ratio in this and other tables, we are really reporting whether the underlying logit coefficient is statistically different than zero.

[112]While we describe the odds ratios as reflecting the effect of the variables on the odds of our outcome of interest (in this case the granting of disaster assistance), we note that an increase or decrease in the odds is also synonymous with an increase or decrease, respectively, in the likelihood of the outcome occurring.

In Table 6.5, we examine the effect of flood insurance on the size of disaster assistance payments when the payments are greater than zero. The first column reports the results for FEMA individual assistance per capita, the second column for just family assistance grants per capita, and the third column for SBA loans per capita. In all cases, we take the natural logarithm of dollar values per capita of the dependent variables. In this analysis, lagged policies in force are logged, so the reported coefficient represents the elasticity.[113] Fixed state and year effects are also included in the regressions but not reported in the table.

TABLE 6.5: Effect of Market Penetration Rate on the Amount of Disaster Relief

Independent Variable	Log of Individual Assistance per Capita	Log of Family Assistance Grants per Capita	Log of SBA Loans per Capita
Natural logarithm of policies in force per single-family unit (lagged one year)	–0.010 (0.012)	–0.022* (0.009)	–0.003 (0.006)
Natural logarithm of per-capita income (log($1000/capita))	0.386 (5.159)	–2.778 (5.010)	0.016 (2.054)
Percent of the population below the poverty line	–0.153 (0.484)	–0.083 (0.448)	–0.135 (0.171)
Natural logarithm of average housing prices (single-family units, lagged one year)	1.323 (2.976)	2.142 (2.834)	–1.973 (1.234)
Annual precipitation (inches)	0.072* (0.029)	0.051* (0.025)	0.111** (0.022)
Constant	–16.476 (67.252)	–70.210 (61.464)	17.809 (29.866)
Number of observations	154	149	452
R-squared	0.57	0.60	0.29

NOTE: Statistical significance of the coefficients is denoted by the following symbols: + significant at 10 percent; * significant at 5 percent; ** significant at 1 percent.

This analysis suggests that the number of flood insurance policies per unit in force has a negative effect on the size of disaster assistance payments. As we might expect, the only significant effect comes from the family assistance grants. The estimated coefficient for this relationship suggests that a 10 percent increase in market penetration rate is associated with a 0.22 percent reduction in family assistance grants. This effect is small: Raising the overall market penetration rate from 3 percent to 4 percent (a 33 percent increase) would decrease per-capita family assistance grants by just 0.66 percent (about $0.002 per person). Nevertheless, the result does indicate that there is a negative relationship between market penetration and at least some components of disaster assistance.

The performance of the other variables in the model is mixed. Annual precipitation is positively and significantly associated with the size of disaster assistance payments. However, per-capita income and housing prices have an inconsistent effect on disaster assistance and are not statistically significant. Poverty has a consistently negative effect, which is reasonable in the case of SBA loans (since the poor are more likely to receive aid than loans) but is surprising for the FEMA assistance. However, the effect is not significant in any of the models.

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[113]Usually we would not bother to take the natural logarithm of policies in force, since it represents a percentage. However, there is a single observation (Florida in 2000) that has an extreme effect on the estimated coefficient if we do not take logs.

Finally, Table 6.6 presents our analysis that jointly considers the impact of flood insurance on the incidence and magnitude of disaster assistance payments. In this specification, we employ a linear model with state and year fixed effects (we eschew an alternative specification, such as a tobit, so we can include the state fixed effects). This can be thought of as predicting the expected value of disaster assistance payments for a given state in a given year.

TABLE 6.6: Effect of Market Penetration Rate on Expected Disaster Relief

Independent Variable	Log of Individual Assistance per Capita	Log of Family Assistance Grants per Capita	Log of SBA Loans per Capita
Natural logarithm of policies in force per single-family unit (lagged one year)	–0.074 (0.058)	–0.010 (0.007)	–0.052 (0.048)
Natural logarithm of per-capita income (log($1000/capita))	3.397 (5.328)	0.541 (0.846)	9.749 (6.375)
Percent of the population below the poverty line	–0.493 (0.300)	–0.054 (0.041)	–0.681+ (0.400)
Natural logarithm of average housing prices (single–family units, lagged one year)	5.477 (4.621)	0.800 (0.601)	0.909 (1.609)
Annual precipitation (inches)	0.107** (0.033)	0.016** (0.006)	0.113** (0.035)
Constant	–49.852 (97.079)	–6.645 (12.760)	89.303 (58.712)
Number of observations	573	573	866
R-squared	0.26	0.19	0.13

NOTE: Statistical significance of the coefficients is denoted by the following symbols: + significant at 10 percent; * significant at 5 percent; ** significant at 1 percent.

The results of this model reinforce those obtained previously. Flood insurance policies per single-family unit have a consistent negative effect on the expected size of disaster assistance payments, but the effect is not statistically significant for any of the three models. The only variable that has a significant effect in each model is precipitation, with higher precipitation predicting more disaster assistance payments.

6.3. Estimating the Effect of Market Penetration Rate on Compliance with Floodplain Management Requirements

The objective of this next analysis is to determine whether higher market penetration rates are associated with increased (or decreased) efforts in communities to enforce floodplain management requirements. It is not clear whether higher market penetration rates should be associated with greater enforcement of floodplain management requirements. On the one hand, higher market penetration rates may reflect greater awareness of flood risks, which may, in turn, be associated with more vigorously enforcing floodplain management requirements by the community. Higher penetration rates may also create more situations where buildings that do not comply with floodplain management requirements (e.g., post-FIRM structures that are built below BFE) have insurance and the high insurance premiums that apply to such structures.

Complaints about these high premiums may cause communities to tighten up on enforcement and floodplain management requirements. Higher market penetration rates may also provide increased incentives for the communities to adopt the CRS activities that can lead to lower premiums for their residents. On the other hand, enforcement in the community may have little to do with market penetration rates and be driven by other characteristics, such as community size or entrenched attitudes on building codes or zoning.

6.3.1. Data and Methods

As in the case with disaster assistance, a critical part of our analysis is measuring the outcome of interest, in this case compliance. Given that there are numerous actions that likely go into ensuring that a community has a "good" floodplain man\agement policy, we consider a number of different measures of compliance in our analysis.

Whereas in the last section we examined the impact of the market penetration rate on disaster assistance using the results of states over time, we have no such panel for measuring compliance. Instead, we focus on an analysis for the 100 communities for which we have detailed information on market penetration, as well as information on potential compliance measures. While this analysis is limited because we do not have sufficiently large samples to estimate an effect with precision, it at least provides a framework and some informative results for the impact of the market penetration rate on compliance with the NFIP's hazard mitigation and floodplain management policies.

The measures of compliance that we utilize fall into four categories:

- building permits and building permit variances in the SFHA
- building Code Effectiveness Grading Schedule score
- problems identified in Community Assistance Contacts and Community Assistance Visits
- ratio of pre-FIRM to post-FIRM losses per dollar of coverage.

We describe each in turn.

Building Permits and Variances in the SFHA. We use data from the 1998 Biennial Report on the number of variances granted per permit issued in the SFHA. The Biennial Report asks respondents for the number of variances (or exceptions) granted in the SFHA for structures with the lowest floor below the BFE. We expect the number of variances per permit issued to be low for communities that make the most effort to comply with NFIP requirements. In addition to the number of variances per permit, we also examine the number of building permits in the SFHA per single-family unit in each community. This should provide us with some information about whether higher market penetration appears to be associated with development in the SFHA.

The number of variances may not be a perfect measure of enforcement of floodplain management requirements, because some communities may poorly monitor the elevations of new construction and thus underreport circumstances where buildings are built below BFE. Thus, they may have a low number of variances even though they weakly enforce floodplain requirements. However, if communities with low market penetration rates were also less likely to monitor elevations than communities with high market penetration rates, then the estimated effect of the market penetration rate on compliance would also be biased toward zero in this regression specification. Therefore, any relationship that is found could underestimate the "true" relationship between enforcement of floodplain management requirements and market penetration.

Table 6.7 offers descriptive statistics for our compliance measures. The first part of the table summarizes the data we obtained from the 1998 Biennial Report on variances and building permits in the SFHA for the 100 communities in the sample. The table shows that variances in the SFHA are relatively rare, occurring in just 2 percent of a community's permits in the SFHA on average. Note that we only have 51 observations for this variable. Only 82 of our 100 communities provided any data on permits or variances in the 1998 Biennial report. The remainder may not have answered these questions on the survey or had no permits or variances in the reporting period. Of the 82 with data on permits or variances, 31 reported variances but no permits so we could not calculate variances per permit. We have data on the number of permits per single-family structure for 75 of the 100 communities. We lose 7 of the 82 communities because, based on the parcel data for each community, we project that there are no SFHs in the SFHAs of these communities. We see from the table that an average of just over 1 permit is granted for every four existing SFHs.

Building Code Effectiveness Grading Schedule Score. Our second source of information on community compliance is the ISO's Building Code Effectiveness Grading Schedule (BCEGS) questionnaire.[114] BCEGS assesses the building codes in effect in a particular community and the resources a community uses to enforce its codes, with special emphasis on mitigation of losses from natural hazards. Municipalities with up-to-date and well-enforced building codes should tend to experience less loss in a natural disaster event.[115] ISO sends a trained representative to ask an extensive list of questions, many of which deal with floodplains specifically. BCEGS then assigns an overall score (between 1 and 10) to each community indicating the extent of the community's effort to mitigate risks from natural hazards. (Flood risk is considered along with risks from windstorm, earthquakes, etc.) Lower scores indicate better mitigation efforts. If expanding NFIP participation improves compliance, we would expect the likelihood of a lower score to increase as the market penetration rate increases.

[114]ISO provides information about property and liability risk to insurers, government regulators, and other companies and organizations (see http://www.iso.com/about_iso/about03.html).

[115]The link between up-to-date and well-enforced building codes and lower flood losses is not automatic. Building code would presumably have little effect on flood losses in communities where there has been little economic growth if nearly all structures were built before the community began updating and enforcing its codes.

TABLE 6.7: Summary Statistics for the Analysis of the Relation Between Market Penetration Rate and Compliance with NFIP Floodplain Management Requirements

Compliance Measures	Mean	Std. Dev.	Sample Size
Building Code Permits and Variances			
Variances per permit in SFHA	0.020	0.128	51
Permits in SFHA per single-family home in overall Community	0.255	1.280	75
BCEGS Score			
BCEGS < 4	0.393	0.491	84
Results of CACs and CAVs			
Violation identified during CAC or CAV	0.258	0.441	62
Problem identified during CAC or CAV	0.565	0.500	62
Minor problem	0.516	0.504	62
Serious problem	0.161	0.371	62
Ratio of Losses per Dollar of Coverage for Post-FIRM Structures to Pre-FIRM Structures			
3-year average (1999–2002)	0.307	0.642	54
5-year average (1997–2002)	0.418	1.169	63

Of the 100 communities in our sample, we were able to obtain a BCEGS score for 84. The community scores range from 8 (less effort to mitigate risk) to 2 (more effort to mitigate risk). To simplify our analysis, we consider only whether a community scored lower than a 4. Thus, we in effect turn the BCEGS score into a dichotomous variable that is 1 if the BCEGS score is less than 4 (better risk mitigation) and 0 otherwise. Table 6.7 shows that approximately 39 percent of communities in our sample scored lower than 4.

Problems Identified in Community Assistance Contacts and Community Assistance Visits. Our third source of information on community compliance comes from the results of FEMA and state review of community floodplain management programs during Community Assistance Contacts (CACs) and Community Assistance Visits (CAVs). The results are recorded in the NFIP's Community Information System (CIS), and the CIS makes a distinction between "problems" and "violations." Problems can occur in any of four areas:

- regulations
- administrative and enforcement procedures
- engineering or map related
- other.

Floodplain management specialists investigate whether there are any problems in each of these four areas and, if so, whether the problems are minor or serious. CAVs are more thorough than CACs and more likely to identify problems, but problems are occasionally identified during CACs and recorded in the CIS database. Violations occur if an actual structure is found in potential violation of an ordinance and are reported if they are found or only suspected. The results of CACs and CAVs probably represent our most direct measure of compliance, and we investigate whether problems or violations are less likely in areas with higher market penetration than in areas with lower market penetration.

The frequency of violations and problems for our sample is reported in Table 6.7. For our analysis we use only the results of CACs or CAVs that occurred in 1997 or later, which limits us to 62 communities. Violations are identified (or suspected) in approximately 26 percent of the communities during CAC or CAV conducted since 1997. Problems are much more common, found in over 56 percent of the 62 communities. We see, however, that most of the problems are considered minor. Serious problems occur in only 16 percent of the communities.

Ratio of Pre-FIRM to Post-FIRM Losses Per Dollar of Coverage. As our final source of information on compliance, we use data on losses per dollar of coverage for pre- and post-FIRM structures in the SFHA. We expect community enforcement of floodplain management requirements to be closely related to losses per dollar of coverage, other things being equal. For instance, if a community vigorously enforces the elevation requirements for post-FIRM structures in the SFHA, we might expect the losses per dollar of coverage for post-FIRM structures in the SFHA to be low relative to those for pre-FIRM structures.[116] In contrast, the losses per dollar of coverage for post-FIRM structures should be comparable on average to those for insured pre-FIRM structures in communities that do not enforce building elevation requirements vigorously.

To compute the average losses for pre- and post-FIRM structures we use historical data on losses from NFIP claims paid per dollar of coverage. To control for the fact that not all communities experience flooding in a given year, we estimate the model using three-year (1999 to 2002) and five-year (1997 to 2002) payments per dollar of coverage by community.[117]

The bottom rows of Table 6.7 display the average three-year and five-year payment ratios that we use in our analysis. We observe only 54 communities with the three-year payment ratio and 63 communities with the five-year ratio. The primary reason that we fail to observe the ratio in a community is that there is no coverage for pre-FIRM structures (and hence the payment ratio is missing). Consistent with the findings in Table 5.4 of Chapter 5, the table shows that the post-FIRM losses per dollar of coverage are significantly lower than pre-FIRM. Over three years, the average losses per dollar of coverage for post-FIRM structures were just 31 percent of those for pre-FIRM structures; over five years, it was about 42 percent.

The first three measures of community enforcement of floodplain requirement presented above focus on the extent to which floodplain management complies with the mandates of the NFIP. This last measure essentially captures how well efforts in floodplain management reduce the adverse impact of flooding. Note, however, that the ratio of post-FIRM to pre-FIRM losses per dollar of coverage does not capture the effects of all floodplain management efforts to reduce losses. The ratio would not capture community policies that direct construction of post-FIRM structures away from the floodplain or policies that affect both pre- and post-FIRM properties (such as building a levee), for example. Unfortunately, we have been unable to identify any reliable measures of these kinds of loss control efforts.

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[116]This measure does not consider the feedback of lower losses on the amount of coverage. Lower losses could reduce the amount of insurance purchased in the community, thus increasing the ratio of losses per dollar of coverage. Another measure of enforcement that merits investigation is the ratio of losses per post-FIRM structure in the community (whether or not the structure has flood insurance) to the losses per pre-FIRM structure.

[117]We only have estimates of market penetration in each community in 2004 and thus do not want to go back too far in time when constructing the ratio of pre-FIRM to post-FIRM loses per dollar of coverage. However, three or five years is not a long time when examining the losses of low-frequency, high-impact events such as floods. The most telling comparison of pre-FIRM and post-FIRM losses might be for a major flood event.

Other Independent Variables. Once we have developed appropriate measures for compliance, we must identify other independent variables that influence compliance efforts. There are multiple variables that could explain or drive a community's efforts to comply with the requirements of the NFIP, with market penetration in the SFHA being but one. The percentage of structures in the community that are in the SFHA could influence how much attention a community pays to the NFIP requirements. Additionally, some variables that we think help determine the market penetration rate, such as community size (as measured by the number of SFHs in the SFHA), region, and whether the community is subject to coastal flooding, might have independent effects on compliance efforts. An additional variable that might be of some importance is whether the community is in the CRS. However, CRS status is potentially endogenous (greater compliance efforts would increase the likelihood that the community is in the CRS), so we consider our analysis with and without this variable.

We do not report descriptive statistics for the community features we use in our analysis here (size, region, etc.), because they are available elsewhere in the report. In our empirical analyses we use the community-level sampling weights described in Chapter 3 to provide us with nationally representative estimates.

6.3.2. Results

Table 6.8 illustrates the effect of the market penetration rate for flood insurance on the permit and variance data from the CIS using an ordinary least squares (OLS) regression model. The results are generally weak. A one percentage point increase in the market penetration rate is associated with a 0.040 increase in number of variances per permit, which is contrary to one would expect if communities with greater market penetration more vigorously enforce floodplain management requirements. As discussed above, however, such a positive relationship could occur if communities with low market penetration do not monitor elevation requirements during the permitting process and do not catch problems that require variances. Permits per SFHs in the SFHA are negatively associated with market penetration, suggesting that communities with higher market penetration have less development in the floodplain. Unfortunately, none of the coefficients are statistically significant for market penetration rate or other variables, and strong conclusions cannot be made about the relationship between market penetration and these measures of compliance.

TABLE 6.8: The Estimated Effect of Market Penetration Rate on the Number of Variances per Permit and the Number of Permits in the SFHA per Single-Family Home

	Variances per Permit		Permits per Single-Family Home	
	Model 1	Model 2	Model 1	Model 2
Market Penetration Rate for Single-Family Homes in SFHA[1]	0.040 (0.051)	0.075 (0.085)	–0.337 (0.451)	–0.339 (0.456)
Region				
Northeast	0.002 (0.006)	–0.012 (0.017)	–0.362 (0.358)	–0.361 (0.360)
South	reference	reference	reference	reference
Midwest	0.084 (0.094)	0.127 (0.115)	–0.254 (0.254)	–0.255 (0.257)
West	–0.000 (0.013)	0.016 (0.027)	–0.288 (0.325)	–0.308 (0.348)
Community Size (single-family homes in SFHA)				
<=500	–0.005 (0.025)	–0.133 (0.117)	0.210 (0.382)	0.338 (0.585)
>500 and <=5,000	0.005 (0.016)	–0.071 (0.065)	0.049 (0.231)	0.120 (0.324)
<=5,000	reference	reference	reference	reference
Source of Flooding in Community				
Subject to coastal flooding	–0.031 (0.035)	–0.059 (0.057)	0.519 (0.603)	0.525 (0.618)
Not subject to coastal flooding	reference	reference	reference	reference
CRS Status of Community				
Not in CRS or in CRS Class 10		reference		reference
CRS Class 1 through 9		–0.137 (0.125)		0.126 (0.238)
Observations	51	51	75	75
R^2	0.10	0.23	0.07	0.07

[1]Market penetration rate ranges between zero and 100.
NOTE: Heteroskedasticity-consistent standard errors are given in parentheses. Statistical significance of the coefficients is denoted by the following symbols: + significant at 10 percent; * significant at 5 percent; ** significant at 1 percent.

In Table 6.9, we present the analysis using the ISO's BCEGS score as the dependent variable. Because the dependent variable is binary, we estimate the probability that the BCEGS score is less than four using a logistic model and report the coefficients as odds ratios.[118] There is more evidence of a relationship between market penetration rates and enforcement of floodplain management requirements using this proxy for enforcement. The odds ratios for both specifications, with and without the variable for CRS status, are 1.119. We enter market penetration as a percentage in the statistical model (rather than as a fraction), so the odds ratio can be interpreted as the effect of a one percentage point increase in market penetration. In both cases, the effect is statistically significant at the one percent level and large. A one-percentage

[118]The logistic model and odds ratios are discussed in Appendix F and the "Influences of Various Factors on Market Penetration and Compliance Rates" section of Chapter 5, respectively.

TABLE 6.9: The Estimated Effect of Market Penetration Rate on the Likelihood of Achieving a Favorable BCEGS Score (odds ratios relative to reference category)

	Likelihood BCEGS < 4	
	Model 1	Model 2
Market Penetration Rate for Single-Family Homes in SFHA	1.119** (0.033)	1.119** (0.033)
Region		
Northeast	2.875 (4.398)	2.877 (4.442)
South	reference	reference
Midwest	0.118 (0.159)	0.118 (0.159)
West	12.032 (42.188)	12.040 (42.786)
Community Size (single-family homes in SFHA)		
<=500	3.340 (6.939)	3.377 (8.307)
>500 and <=5,000	4.245 (9.004)	4.270 (10.204)
<=5,000	reference	reference
Source of Flooding in Community		
Subject to coastal flooding	0.020+ (0.041)	0.020+ (0.045)
Not subject to coastal flooding		reference
CRS Status of Community		
Not in CRS or in CRS Class 10		reference
CRS Class 1 through 9		1.014 (1.970)
Observations	77	77

NOTE: Heteroskedasticity-consistent standard errors are given in parentheses. Statistical significance of the coefficients is denoted by the following symbols: + significant at 10 percent; * significant at 5 percent; ** significant at 1 percent.

point increase in the market penetration increases the odds that the BCEGS score in the community is favorable (less than four) by 12 percent. Most of the other independent variables in the regression are associated with an increase in the odds of a high BCEGS score. However, only the variable indicating that the community is not subject to coastal flooding is statistically significant.

The results of the model using the data on compliance from the CACs and the CAVs are presented in Table 6.10. Again, we employ a logitistic specification and report the odds ratios. We consider the effect of market penetration on three variables: whether there is a violation, whether there is any kind of problem (minor or serious), and whether there is a serious problem. The results show that both the odds of a violation and a problem being reported increase as market penetration increases. Moreover, the difference is statistically significant at the five percent level for violations. As shown in the rightmost two columns of Table 6.10, the odds of a serious problem decreases with market penetration (odds ratios less than one), but the results are statistically insignificant.

TABLE 6.10: The Estimated Effect of Market Penetration Rate on the Likelihood of Having a Violation or Problem Identified During a CAC or CAV (odds ratios relative to reference category)

	Violation Identified		Problem Identified		Serious Problem Identified	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Market Penetration Rate for Single-Family Homes in SFHA	1.081*	1.078*	1.038	1.036	0.910	0.907
	(0.037)	(0.036)	(0.028)	(0.028)	(0.093)	(0.100)
Region						
Northeast	20.994	21.853	7.656	8.650^{+}	51,602**	54,674**
	(41.989)	(44.248)	(9.531)	(10.719)	(143,528)	(158,109)
South	reference	reference	reference	reference	reference	reference
Midwest	905.5**	1,366.7**	8.363	8.699	291,763**	338,377**
	(990.8)	(1,794.0)	(12.763)	(13.312)	(765,030)	(977,935)
West	45.711**	31.147**	5.315	4.716	990,271*	3,788,153^{+}
	(64.985)	(39.382)	(7.900)	(7.213)	(6,214,358)	(30,619,239)
Community Size (single-family homes in SFHA)						
<=500	232.0*	2,117.1**	27.359**	47.125**	1.482	0.204
	(547.8)	(4,694.1)	(33.985)	(67.727)	(4.730)	(1.015)
>500 and <=5,000	1.319	2.507	0.784	1.052	1.350	0.668
	(2.261)	(4.098)	(0.699)	(1.088)	(4.264)	(2.529)
<=5,000	reference	reference	reference	reference	reference	reference
Source of Flooding in Community						
Subject to coastal flooding	0.180^{+}	0.330	0.525	0.588	0.392	0.126
	(0.183)	(0.347)	(0.386)	(0.429)	(0.563)	(0.323)
Not subject to coastal flooding		reference		reference		reference
CRS Status of Community						
Not in CRS or in CRS Class 10		reference		reference		reference
CRS Class 1 through 9		10.958		1.926		0.062
		(18.287)		(2.114)		(0.286)
Observations	58	58	58	58	58	58

NOTE: Heteroskedasticity-consistent standard errors are given in parentheses. Statistical significance of the coefficients is denoted by the following symbols: $^{+}$ significant at 10 percent; * significant at 5 percent; ** significant at 1 percent.

Table 6.10 shows a number of factors that have a significant effect on the odds of a violation or problem being reported. Smaller communities are much more likely to have either a violation or a problem reported than larger communities. Violations and problems are also much more likely to be identified outside the South than in the South.[119]

Before moving on to the next analysis, it is worth noting that there are some reasons to be concerned with the CACs and CAVs as a measure of compliance. FEMA directs regions and states to target communities for inspection where it is suspected that Before moving on to the next analysis, it is worth noting that there are some reasons to be concerned with the CACs and CAVs as a measure of compliance. FEMA directs regions and states to target communities for inspection where it is suspected that there are problems. Such targeting could induce an upward bias on the estimate of the effect of market penetration rate on compliance if FEMA was better

[119]One possible explanation suggested by reviewers of the draft report is that slab foundations are more common in the South and that it is easier to verify that slabs meet elevation requirements than other types of construction.

informed about potential problems in communities that have greater market penetration rates. In this case, the targeting would be more effective in communities with higher market penetration, and this could lead to a positive coefficient even if the true relationship between compliance issues and market penetration is negative. While we cannot say for sure, this is a potential problem that merits consideration (and potentially further study).

In Table 6.11 we present the results of our final analysis, the effect of market penetration on the ratio of losses per dollar of coverage for post- and pre-FIRM structures. Unlike the analysis reported in Table 6.9 and 6.10, here the dependent variables are continuous, so we employ OLS. Once again, the results are not strong. When we examine the ratio of the average losses per dollar of coverage for post-FIRM structures in the SFHA and the average losses per dollar of coverage for pre-FIRM structures in the SFHA over the previous three years, we find a weak positive correlation with the market penetration rate. In contrast, when we go back to five years, which provides a few additional observations, we find a much more substantial negative correlation. However, in neither case are the estimated coefficients for market penetration statistically significant.

Turning to the other independent variables, the ratio of average losses per dollar of coverage for post-FIRM structures to average losses per dollar of coverage for pre-FIRM structures over the previous five years is lower in communities subject to coastal flooding than in communities that are not. However, no such relationship holds for the three-year average.

There do appear to be some difference across regions when other factors are controlled for (some of the estimated coefficients on the region variables are statistically different from zero), but the effects are not consistent for the three-year and five-year averages.

6.4. Summary

Flood insurance was introduced in part to reduce government disaster assistance payments, and we find some empirical evidence that higher market penetration rates are associated with lower amounts of disaster assistance. However, the impact is not large and is statistically significant only for that relatively small part of overall disaster assistance that most overlaps with the insurance coverage available from the NFIP. This makes it seem unlikely that increasing flood insurance market penetration would cause substantial reductions in disaster assistance, unless flood insurance policies were broadened to cover other types of losses, particularly temporary housing assistance. One possible reason for the lack of relationship is that people who receive disaster assistance by and large do not have the means to buy flood insurance. If this were the case, the variation in the percent of structures with flood insurance (within the ranges observed in this sample) will have little effect on the disaster assistance of this group and disaster assistance overall.

TABLE 6.11: The Estimated Effect of Market Penetration Rate on the Ratio of Losses per Dollar of Flood Insurance Coverage for Post- and Pre-Firm Structures in the SFHA

	3-Year Average		5-Year Average	
	Model 1	Model 2	Model 1	Model 2
Market Penetration Rate for Single-Family Homes in SFHA	0.157 (0.151)	0.125 (0.128)	–5.132 (3.815)	–5.690 (3.890)
Region				
Northeast	–0.156+ (0.082)	–0.133+ (0.068)	3.327 (2.072)	3.554+ (2.082)
South	reference	reference	reference	reference
Midwest	–0.092+ (0.051)	–0.085+ (0.050)	–0.629 (1.200)	–0.391 (1.175)
West	–0.236+ (0.128)	–0.254+ (0.135)	2.162 (1.892)	1.975 (1.995)
Community Size (single-family homes in SFHA)				
<=500	–0.213 (0.244)	–0.092 (0.310)	–3.361 (2.173)	–1.557 (2.147)
>500 and <=5,000	–0.232 (0.238)	–0.145 (0.280)	–0.980 (1.257)	0.353 (1.655)
<=5,000	reference	reference	reference	reference
Flood Source in Community				
Subject to coastal flooding	0.170 (0.121)	0.168 (0.121)	–3.668+ (1.958)	–3.665+ (1.925)
Not subject to coastal flooding	reference	reference	reference	reference
CRS Status of Community				
Not in CRS or in CRS Class 10		reference		reference
CRS Class 1 through 9		0.146 (0.179)		2.349 (1.967)
Observations	53	53	62	62
R^2	0.22	0.24	0.50	0.52

NOTE: Payment ratios are defined as the ratio of losses per dollar of coverage for post-FIRM structures over the losses per dollar of coverage for pre-FIRM structures at 3-year and 5-year averages. Heteroskedasticity-consistent standard errors are given in parentheses. Statistical significance of the coefficients is denoted by the following symbols: + significant at 10 percent; * significant at 5 percent; ** significant at 1 percent.

We found little evidence of a strong relationship between market penetration rates and enforcement of floodplain management requirements. We did find that higher market penetration rates are associated with more favorable BCEGS scores, which assesses a community's building codes and the resources the community uses to enforce them. However, the results using our other measures of compliance either showed the opposite relationship or were statistically insignificant. In some cases, other factors such as the size of the community or the region in which it is located had more impact on the measure of compliance than market penetration rate.

There are a number of factors that limit our analysis. For instance, even though we attempt to control for the amount of losses using rainfall, unobserved flood risk could cause higher market penetration rates to be associated with higher disaster relief. This would create an upward bias to our estimate of the effect of market penetration rate on disaster assistance. Our analysis of compliance also faced some limitations. As mentioned previously, small sample sizes and potential biases in some of our measures probably limited our ability to detect the true relationship between market penetration and compliance with NFIP standards. In addition, we had no direct data on one of the most important components of floodplain management in the 100 communities selected for this study: how regularly post-FIRM structures are built at or above BFE. Ensuring that structures are built at or above BFE is likely to be one of the most critical loss-control efforts that a community could take, and determining the effect of market penetration on compliance in this area would provide critical insight into the effectiveness of expanding flood insurance coverage on improving hazard mitigation.[120]

[120]As part of the ongoing evaluation of the NFIP, Dewberry and Davis are examining compliance of post-FIRM structures with NFIP building requirements. At the time of this writing, data had been collected on 1,250 structures in 10 clusters of communities. However, there is very little overlap between these communities and the 100 communities selected for this study. Thus, we are not able to investigate the relationship between market penetration and this measure of compliance.

7. THE GEOGRAPHIC DISTRIBUTION OF FLOOD INSURANCE POLICIES AND THE VARIABILITY OF LOSSES

In this chapter, we examine how the geographic distribution of flood policies can affect the variability in total NFIP losses (claims paid) from year to year. The variation in total losses is important because it plays an important role in determining how frequently premiums fall short of losses in any given year. The NFIP can borrow from the Department of the Treasury if reserves are exhausted, but there are likely to be political costs of doing so. This analysis can help the NFIP understand how policy growth in different areas can affect overall variation in losses and the likelihood that it will need to borrow from the Treasury. Such an understanding may be useful in developing regional growth goals for the program.

Our analysis evaluates the relation between policy growth and variation in total annual losses by examining the correlation between flood losses in different regions over time. Based on data provided by the BSA, we have constructed a database of annual information on number of claims, losses, and policies-in-force by state over the 21–year period from 1982–2002. Using these data, we examine the historic correlation of losses from flooding in different regions and use these correlations to study the effect of raising the level of insurance coverage in each region. While 21 years is not a long period from a meteorological point of view, this analysis does provide a framework for identifying areas in which the NFIP could target growth to build a diversified portfolio of insurance coverage that dampens annual variation in losses.

Our analysis does not consider premiums collected, the relationship between premiums and losses paid, or whether the rates charged by the NFIP are actuarially fair (i.e., premiums are equal to expected losses plus claims processing and other administrative costs, and an average return on capital). To reduce the probability that premiums will fall short of losses and other program costs in any given year, it would clearly make the most sense to target policy growth in regions where premiums were high relative to expected losses. However, rates will presumably change over time, and it is useful to understand how losses are correlated across the United States.

Generally, our results show that geography does matter for determining the variability of NFIP losses. Our results suggest that to limit the effects of policy growth on loss variability, the NFIP should focus efforts to increase NFIP coverage outside the Southeast and Gulf Coast states. The remainder of this chapter describes our analytic approach, the data used, and the results of the analysis.

7.1. Analytic Framework

The primary question underlying our analysis is whether the NFIP could reduce the variance in annual losses per dollar of coverage by *diversifying* its holdings across geographic areas. Basic investment theory states that if returns are uncertain, balancing investment across assets for which the expected returns are negatively correlated can reduce the risk of a portfolio. For example, suppose one type of crop does well in wet weather while another does well in dry weather. If a farmer plants all of one type of crop, he or she will have a successful harvest only if the season turns out favorably. However, if the farmer splits his or her land between both types of crops, the farmer can be assured that half of the harvest will turn out well (barring other factors). Thus, planting both types results in a diversified portfolio of crops and reduces the annual variance in returns.

The same principle could apply to the NFIP if the operating losses in different regions are correlated with each other. In Appendix 7, we use a formal statistical model of flood losses to show that the variance of total average losses per dollar of insurance coverage is a function of the variances in the individual regions and the covariance between regions. It is important to consider both the variance and the covariance of individual regions; even if losses in one region are negatively correlated with others, increasing coverage in that region will not decrease the overall variability of losses if the variance in that region is sufficiently high.

How losses in different regions are correlated can have a significant impact on the overall level of risk to the insurer. If an insurer is interested in increasing its overall holdings and wants to do so in the "least risky" manner, it would be better off by targeting the increase in areas where the variance of losses is lower or where losses tend to be negatively correlated, or uncorrelated, with losses from pre-existing policies in other areas.

In our empirical analysis, we estimate the variability of losses in different regions and the correlations of losses across regions using historical data and then examine how the total losses across all regions responds to simulated changes in the number of policies in each region. This allows us to study how the NFIP could fashion goals for policy growth by region so as to limit the overall variability of losses.

7.2. Data Used for the Analysis

For our analysis, we use historical data between 1982 and 2002 by state from the BSA. We use annual data on the dollar value of policies in force, the number of policies in force, the number of claims, and the total dollar value of claims paid adjusted for inflation (which we refer to as flood losses). As in the rest of this report, we focus our analysis on coverage and losses for SFHs. Our analysis excludes Alaska and Hawaii.[121]

In Figure 7.1, we illustrate the annual NFIP claims paid for all states and separately for Florida, Louisiana, and Texas. We separate out the losses for these three states because they combine to form a substantial portion of all losses. Dollar values for the figure are in millions of year 2000 dollars. The figure shows that annual flood losses tend to be highly variable, with several large peaks. NFIP loss payments are less than $400 million in most years, though there are several years in which loss payments are more than $600 million and two years in which they exceed $1 billion. The losses for the three states are also highly variable. In fact, total losses in the two most extreme years appear to be largely driven by losses in the three states. Overall, the three states account for just over half the total NFIP losses.

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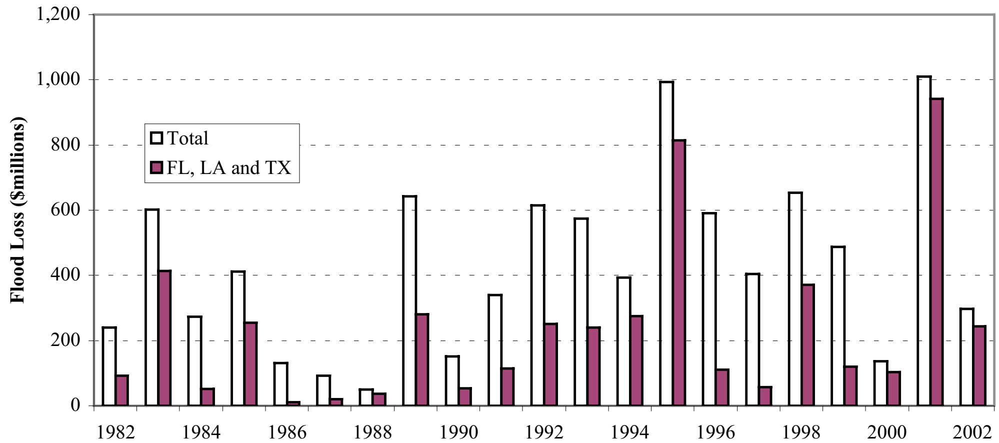
[121]Note that Alaska and Hawaii were not excluded from the analysis in previous chapters.

FIGURE 7.1: Total NFIP Losses by Year, 1982-2002 (millions of year 2000 dollars)

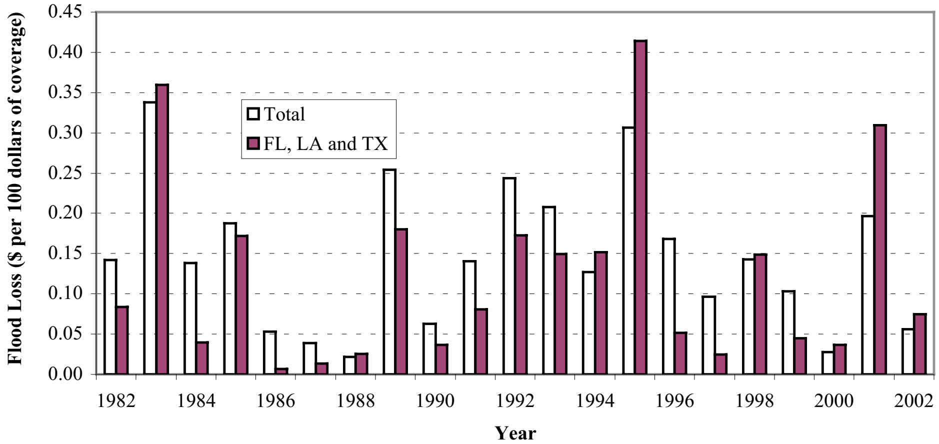


Total losses depend on the amount of insurance coverage provided, which has varied over time, and we are interested in using the historical data to predict average losses and the variability of losses given current coverage levels. Toward this end, we calculate the dollars of flood losses per dollar of insurance coverage. In principle, we might be interested in losses per dollar of premium, but this is problematic for historical data because the NFIP premium structure has changed over time from a subsidized rate to more of an actuarially fair rate. Figure 7.2 displays the average losses per dollar of coverage by year, again separately for the 48 contiguous states and the three states. Because losses tend to be relatively small relative to coverage levels, we illustrate the dollars of losses per $100 of coverage.

Figure 7.2 shows that, unsurprisingly, the years in which losses are high are also the years in which losses per hundred dollars of insurance coverage are high. Losses per hundred dollars of insurance coverage for the 48 contiguous states combined range from a low of about $0.02 to a high of $0.34.[122] The losses per hundred dollars of insurance coverage for Florida, Louisiana, and Texas are slightly more variable, ranging from a low of about $0.01 to a high of $0.41. Perhaps surprisingly, the losses per hundred dollars of coverage are lower on average for the three states than for the other states over the entire period. The lower losses are consistent with the finding in Chapters 4 and 5 that market penetration rates are higher in the South (which includes Florida, Louisiana, and Texas) than in the other regions, where perhaps only those at high risk are likely to purchase coverage. Using the data and projection methods discussed in Chapter 4, the percentage of structures in SFHAs that were built pre-FIRM is lower in the South than in the rest of the country (51 percent versus 63 percent). Losses per $100 of coverage are considerably higher for pre-FIRM structures, and the lower percentage of pre-FIRM structures in the South provides another explanation of why the losses per $100 of coverage in Florida, Louisiana, and Texas are lower than in other states.

[122]As noted in Chapter 5, the rates for a pre-FIRM single-family home with no basement or enclosure are $0.68 per hundred dollars of structure coverage for the first $50,000 of coverage and $0.25 per hundred dollars for additional coverage up to the $250,000 limit. See Chapter 4 for post-FIRM rates.

FIGURE 7.2: Total NFIP Losses per $100 of Insurance Coverage by Year, 1982-2002



To consider the geographic spread of risk, we break the data down for different areas of the country. Our data are at the state level, but we aggregate the states into larger, regional areas to make the analysis more manageable.[123] The regions we use were selected both in consultation with NFIP staff and by examining the data to select states that had similar historical profiles of losses. The seventeen regions that we use are described in Table 7.1. Most regions have three or four states in them, with the largest region containing six states. There are four states that we consider in isolation: Florida, Louisiana, Texas, and California. The first three are considered separately primarily because they account for such a large portion of losses in the NFIP. California is considered separately because of its large size.

Also reported in Table 7.1 is the historical correlation in the annual loss per dollar of coverage between each state and the combined annual losses per dollar of coverage in the other states in the region.[124] To illustrate what we mean, consider the case of the Northeast. The table shows that there is little correlation between Connecticut's annual flood losses per dollar of insurance coverage and the combined losses per dollar of insurance coverage for Maine, Massachusetts, New Hampshire, and Rhode Island. (The correlation coefficient is 0.04.) In contrast, the losses per dollar of coverage for Maine have a substantial positive correlation (0.55) with the losses per dollar of coverage for Connecticut, Massachusetts, New Hampshire, and Rhode Island.

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[123]In principle, there is no reason we could not simply conduct this analysis at the state level. However, the same problems that may be present at the regional level, namely the possibility of poor correlation of losses within regions, may also be present at the state level. Since we view this analysis as illustrating more the concept than the details, we focus on the smaller set of regions for ease of exposition.

[124]Correlations can range between –1 and 1. The correlation measures the degree of linearity between two variables. If the correlation is 1, then there is a perfect linear relationship (i.e., $y = ax + b$ where x and y are the random variables and a is greater than zero). Thus, an increase in one variable by a given amount is always associated with the same increase in the other variable. When the correlation is –1, there is a perfect negative linear relationship between the two variables. When it is 0, there is no linear relationship (although there could be a non-linear relationship) (Meyer, 1970, pp. 144-147).

TABLE 7.1: State Groupings Used in Analysis of the Variability of NFIP Losses and Intra-Region Loss Correlations Between 1982 and 2002*

Region and State	Correlation	Region and State	Correlation
Northeast		**Great Lakes Region**	
Connecticut	0.04	Illinois	0.35
Maine	0.55	Michigan	0.34
Massachusetts	0.25	Wisconsin	0.18
New Hampshire	0.68	**Lower Plains States**	
Rhode Island	0.93	Arkansas	0.07
Inland Mid Atlantic		Iowa	0.59
New York	0.06	Kansas	0.56
Pennsylvania	0.26	Missouri	0.41
Vermont	–0.03	Nebraska	0.70
West Virginia	0.44	Oklahoma	0.17
Coastal Mid Atlantic		**Midwest**	
Delaware	0.69	Indiana	0.19
Maryland	0.47	Kentucky	0.30
New Jersey	0.22	Ohio	0.34
Virginia	0.12	Tennessee	0.67
Southern Atlantic Coast		**Inland Northwest**	
North Carolina	0.05	Idaho	0.37
South Carolina	0.05	Montana	0.37
Southern Inland		Wyoming	–0.13
Alabama	0.38	**California**	—
Georgia	0.04	**Pacific Northwest**	
Mississippi	0.41	Oregon	0.40
Florida	—	Washington	0.40
Louisiana	—	**Desert Southwest**	
Texas	—	Arizona	–0.07
Upper Plains States		New Mexico	–0.07
Minnesota	0.95	**Mountain States**	
North Dakota	0.91	Colorado	0.29
South Dakota	0.80	Nevada	0.10
		Utah	0.07

* The table reports the within-region correlation between losses per dollar of insurance coverage of each state with that of all other states in the region. There is no such correlation for single-state regions.

In general, Table 7.1 suggests that the losses per dollar of coverage for most states are reasonably well correlated with the losses in the other states in their region. Only four states have losses that are negatively correlated with the other states in the region, with the most severe case being Wyoming, with a –0.13 correlation coefficient. The median value for the correlation coefficient is approximately 0.34. Note that we cannot compute any correlations for the single-state regions. In general, all the qualitative results that we discuss in this chapter can be replicated with a state-level analysis. In fact, any application of the principles we discuss here might be best considering smaller geographic units, as long as there are enough policies in each geographic unit so that losses can be predicted with some reliability.

Finally, it is important to realize that we are basing our analysis on only 21 years of data, which is a very short period of time from a meteorological perspective. Unfortunately, the data simply do not exist over a longer time period. However, we do note that if the data we use are insufficient for these analyses, it raises questions about whether they are useful in terms of setting premiums. In general, the quality of predictions of this sort should improve over time as more data are collected.

7.3. Results

One of the first questions we must ask is whether flood losses display any form of correlation across different regions. If not, then options for limiting overall variation in losses by geographically spreading insurance coverage are limited.[125] In Table 7.2, we display the matrix of correlation coefficients of historical losses per dollar of insurance coverage by region. Specifically, the number reported in each cell is the correlation of losses per dollar of coverage for the region listed in that row with the losses per dollar of coverage for the region listed in that column. The entries in the diagonal cells of the matrix are 1, because the value of losses per dollar of coverage for each region is perfectly correlated with itself.[126] Correlation coefficients that are marked with an asterisk are statistically significant at the 10 percent level

Table 7.2 clearly indicates that there are correlations between flood losses in the different geographic regions. Relatively few of the coefficients are statistically significant, but this is not surprising given the small number of observations. (The correlation coefficients are computed on a pairwise basis, so each is based on 21 annual observations.) All the statistically significant correlation coefficients are positive. However, there are a number of negatively correlated regions, the most substantial of which is –0.29 between Texas and Florida. The largest positive correlation is 0.72 (which occurs twice, between the Inland Mid Atlantic and Coastal Mid Atlantic regions and between the Great Lakes and the Lower Plains States regions).

The first column of Table 7.3 shows the historical losses per $100 of insurance coverage by region. The average losses are equal to $0.14 per $100 of insurance coverage overall. Historically, Florida is actually one of the regions with the lowest losses per $100 dollars of coverage, at just under five cents. The Lower Plains States have the highest losses per $100 of coverage on average, approximately $0.67. Texas and Louisiana have somewhat larger than average losses. The results of the table seem consistent with the idea that insurance coverage in Florida is much more widespread than in other regions.

The second column of Table 7.3 reports the predicted losses in our model for each region using the historical losses per dollar of insurance coverage and the 2002 coverage levels. These are the losses that would be expected in 2002 if losses per dollar of coverage equaled their long-term average. All values are presented in millions of year 2000 dollars. The table illustrates that there is significant variation in the predicted losses, ranging from a low of $700,000 in the Inland

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[125]Total variance could still be limited by focusing coverage in regions that have the least variance.
[126]No values are reported in the upper portion of the matrix because the matrix is symmetric.

TABLE 7.2: Correlation of Loss per Dollar of Coverage by Region, 1982–2002

	Northeast	Inland Mid Atlantic	Coastal Mid Atlantic	Southern Atlantic Coast	Southern Inland	Florida	Louisiana	Texas	Upper Plains States	Great Lakes Region	Lower Plains States	Midwest	Inland Northwest	California	Pacific Northwest	Desert Southwest	Mountain States
Northeast	1.00																
Inland Mid Atlantic	0.37	1.00															
Coastal Mid Atlantic	0.24	0.72*	1.00														
Southern Atlantic Coast	–0.11	0.06	–0.01	1.00													
Southern Inland	–0.08	–0.18	–0.18	–0.17	1.00												
Florida	0.03	0.43*	0.37*	–0.11	–0.18	1.00											
Louisiana	0.00	–0.14	–0.15	–0.02	0.31	0.41*	1.00										
Texas	–0.11	–0.21	–0.15	0.14	0.35	–0.29	0.01	1.00									
Upper Plains States	–0.13	–0.03	–0.11	–0.02	–0.08	–0.14	–0.15	–0.11	1.00								
Great Lakes Region	–0.13	0.13	–0.16	–0.14	–0.01	0.35	0.00	–0.26	–0.02	1.00							
Lower Plains States	–0.13	–0.04	–0.07	–0.16	–0.03	0.35	–0.08	–0.21	–0.10	0.72*	1.00						
Midwest	–0.12	–0.04	0.14	–0.02	–0.07	–0.28	–0.18	–0.15	0.63*	–0.01	0.12	1.00					
Inland Northwest	–0.03	0.54*	0.01	0.11	–0.06	0.01	–0.07	–0.28	0.36	0.31	–0.16	0.22	1.00				
California	-0.15	-0.25	–0.25	–0.20	0.48*	0.07	0.62*	–0.06	–0.02	0.27	0.13	–0.13	–0.01	1.00			
Pacific Northwest	–0.11	0.27	–0.08	0.12	0.00	–0.05	0.00	–0.24	0.04	–0.02	–0.10	0.05	0.53	0.00	1.00		
Desert Southwest	–0.09	0.02	–0.03	–0.13	0.61*	0.23	0.21	0.08	–0.09	0.36	0.52*	–0.15	–0.15	0.38*	–0.06	1.00	
Mountain States	–0.15	–0.10	0.08	–0.16	0.46*	–0.32	0.09	–0.05	0.53*	–0.01	0.09	0.64*	0.10	0.39*	–0.10	0.40*	1.00

NOTE: *Represents statistical significance at the 10 percent level.

Northwest region to a high of over $170 million in Texas. In the aggregate, this amounts to approximately $738 million in predicted losses (equal to about $0.14 for every hundred dollars of coverage).

The table also presents the width of the 95 percent confidence intervals for the predicted losses, based on the historical variability of losses per dollars of coverage.[127] Clearly, the data are highly variable, since the 95 percent confidence interval includes zero for all regions except Louisiana.[128] The width of the interval also varies significantly, with a low of $3.6 million (Inland Northwest) and a high of approximately $988 million (Texas).

TABLE 7.3: Historical and Predicted Losses by Region[1]

Region	Historical Losses per $100 of Coverage, 1982–2002 ($)	Predicted Losses in 2002 ($ Millions)[2]	Width of 95% Confidence Interval for Predicted Losses ($ Millions)	Coefficient of Variation of Predicted Losses
Northeast	0.22	24.3	236	2.44
Inland Mid Atlantic	0.23	44.5	240	1.35
Coastal Mid Atlantic	0.12	43.3	318	1.84
Southern Atlantic Coast	0.20	65.9	640	2.43
Southern Inland	0.24	41.2	257	1.56
Florida	0.05	99.6	542	1.36
Louisiana	0.27	109.8	184	0.42
Texas	0.25	170.1	988	1.45
Upper Plains States	0.46	9.2	95	2.59
Great Lakes Region	0.27	22.3	117	1.31
Lower Plains States	0.67	38.3	247	1.61
Midwest	0.30	23.2	133	1.43
Inland Northwest	0.05	0.7	3	1.27
California	0.07	29.0	205	1.78
Pacific Northwest	0.20	13.8	118	2.13
Desert Southwest	0.04	1.9	17	2.19
Mountain States	0.05	0.9	6	1.61
National Total	0.14	738.2	1,983	0.67

[1]Predicted losses assume 2002 insurance coverage levels.
[2] Values are in 2000 dollars.

The fact that the width of the 95 percent confidence intervals is the highest and lowest for the two variables that have the highest and lowest predicted losses, respectively, illustrates a common problem with measures of variance: They are scale-dependent. In other words, it is not necessarily true that Texas is considerably more variable than the Inland Northwest just because it has a broader 95 percent confidence interval. To normalize our variability measures to the different scales of losses in the different regions we also present the *coefficient of variation* in the last column of Table 7.3. The coefficient of variation is defined as the standard deviation of a

[127]The width of the 95 percent confidence interval is 2*1.96*(standard deviation in each region).
[128] The 95-percent confidence interval includes zero if one-half the width of the confidence interval is greater or equal to the predicted losses in the second column.

variable (the square root of the variance) divided by its mean. By controlling for the size of average losses, we are able to obtain a measure of the variability that is less dependent of the average level of the variable.

By examining the coefficient of variation in Table 7.3, we see that there are considerable differences in the level of variability across different regions. The Upper Plains States have the highest coefficient of variation, at 2.59. This number tells us that the standard deviation is more than twice the mean value for this region, making it the most variable (and hence the most difficult to predict) in our sample. Louisiana has the lowest coefficient of variation, at 0.42. This makes Louisiana the least variable region in our sample by a wide margin; no other single region has a coefficient of variation less than 1. Interestingly, while Texas, Florida, and Louisiana account for a large portion of total damages, none is particularly variable (all have coefficients of variation below the median value of 1.61). This suggests that losses in these states are consistently high, but seemingly not as variable in the other regions. This might explain why the overall coefficient of variation is considerably lower than we would expect from looking at the individual averages.

The primary focus of our analysis is to consider how changes in the level of insurance coverage in different areas affect the variability of total NFIP losses. With that in mind, Table 7.4 illustrates the impact on the predicted losses, the width of the 95 percent confidence interval for predicted losses, and the coefficient of variation of an increase of 5,000 policies in each region, holding the number of polices in other regions constant.[129,130] We calculate the resulting increase in losses in each region using the historical average amount of coverage per policy and the average amount of losses per dollar coverage in each region. If a region is negatively correlated or uncorrelated with a number of the other regions, then an increase in the number of policies in that region should have a relatively small effect on the variance and 95 percent confidence interval for total NFIP losses. Conversely, if losses in a region are highly correlated with the losses in other regions, then an increase in policies in that region should lead to a relatively large increase in the variance.

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[129]Similar findings would result if the number of policies were increased by a number other than 5,000. What is important is the effect of increasing the number of policies in one region relative to the effect of increasing the number of polices in other regions, not the absolute size of the effect in each region.

[130]Note that this analysis assumes that the increase in insurance coverage has no effect on the average losses per dollar of coverage. This assumption would be violated if, for example, the individuals who were on the margin of purchasing insurance coverage had systematically lower risk than those who had it already. Given that one of the most important factors in whether an individual has coverage is likely the existence of a mandatory purchase requirement, it is unclear whether we would expect such a possibility to be a problem.

TABLE 7.4: Predicted Impact of Increasing the Number of Policies by 5,000 in Each Region, Holding Policies in Other Regions Constant*

Region	Number of Policies Before Increase	Predicted Increase in Total Losses Base=$738 (Millions)	Change in Width of 95% Confidence Interval for Total NFIP Losses Base =$1,983 (Millions)	Ratio of % Change In Confidence Interval to % Change in Policies	Change in the Coefficient of Variation *Base=0.6714*
Northeast	74,255	1.6	0.51	0.0038	–0.0011
Inland Mid Atlantic	159,123	1.4	1.47	0.0236	–0.0006
Coastal Mid Atlantic	243,819	0.9	0.87	0.0215	–0.0003
Southern Atlantic Coast	190,847	1.7	4.67	0.0900	0.0002
Southern Inland	132,571	1.6	2.66	0.0356	–0.0003
Florida	1,219,991	0.4	2.37	0.2914	0.0006
Louisiana	353,879	1.6	3.16	0.1129	–0.0002
Texas	460,964	1.8	7.12	0.3311	0.0009
Upper Plains States	19,076	2.4	–3.38	–0.0065	–0.0032
Great Lakes Region	81,603	1.4	0.21	0.0018	–0.0010
Lower Plains States	82,152	2.3	0.70	0.0058	–0.0017
Midwest	95,438	1.2	–1.22	–0.0117	–0.0013
Inland Northwest	10,593	0.3	–0.32	–0.0003	–0.0002
California	288,730	0.5	0.62	0.0181	–0.0001
Pacific Northwest	52,772	1.3	–0.71	–0.0038	–0.0013
Desert Southwest	41,962	0.2	0.33	0.0014	0.0001
Mountain States	14,143	0.3	–0.24	–0.0003	–0.0002

*Dollar values are in year 2000 dollars.

Table 7.4 illustrates the number of policies for each region, which varies considerably. Florida has by far the most policies, with a total of over 1.2 million. The Inland Northwest has the fewest number of policies, about 11,000. Thus, a 5,000-policy increase would translate into nearly a 50 percent risk in the number of policies in the Inland Northwest while it would have a trivial effect on coverage in Florida. The largest increase in predicted losses comes from the Upper Plains States, with an increase of $2.4 million. The smallest increase is approximately $200,000 from the Desert Southwest.

The third column of Table 7.4 shows the impact of the increase in each region in the width of the 95 percent confidence interval for NFIP losses as a whole when the number of policies (and amount of coverage) in other regions remains unchanged. As can be seen, the largest increase occurs when the number of policies is increased in Texas—the 95–percent confidence interval for all NFIP losses grows by $7.12 million (from $1,983 million to $1,990 million). The upper bound of the confidence interval increases by half the $7.12 million, and the lower bound decreases by the same amount.

The fourth column shows the ratio between percent increase in the width of the 95 percent confidence interval and the percent increase in policies. The largest ratios are in the Southern Atlantic Coast region and in the three Gulf States. There are a few opportunities to reduce variation in total NFIP losses through policy growth. Policy growth in the Upper Plains States, the Midwest, and the Pacific Northwest will cause variability of total NFIP losses to decrease; however, the declines are not large relative to the increase caused by policy growth in the Southeast and the Gulf States.

In the final column of Table 7.4, we show the change in the coefficient of variation that results from the increase in coverage in different regions. As opposed to the results for the 95 percent confidence interval, when we look at the effect of increasing policies on the coefficient of variation, increases in only four of the regions lead to an increase in variability. Three of these four regions are in the Southeast or the Gulf States (Southeastern Atlantic Coast, Florida, and Texas). The largest such increase is for policy growth in Texas, where increasing the number of policies leads to an increase in the coefficient of variation of about 0.0009 (about 1.3 percent). Most of the decreases are small: The most substantial change is in the Lower Plains States (–0.0032, or about one–half of one percent of the baseline coefficient of variation).

7.4. Summary

In this chapter, we have examined how the geographic distribution of insurance coverage for flood losses affects the risk to the NFIP as measured by the variability of losses. Our measure of risk focused not on the size of predicted losses, because these can be covered by higher premiums. Rather, we focus on the variability, or predictability, of losses. Variability is a better measure of risk to the NFIP because a higher variability indicates an increased possibility that losses will be higher than premiums (or vice versa).

The geographic distribution of policies can affect the variability of losses in two ways. One is simply that some areas may have more or less variable outcomes. The other is that flood losses in different areas might be correlated with each other (perhaps because of weather patterns). Correlations across regions create the potential to manage overall variability, analogous to reducing variability in overall returns by investing in two ventures whose returns are negatively correlated. We use historical data on flood losses to examine the correlation in losses, and then study how increasing the number of policies in one region would affect the variability of overall losses.

Generally, our results show that geography does matter for determining the variability of NFIP losses. Different regions of the country do appear to have both positive and negative correlations with each other. These correlations lead to different effects on the variability of outcomes depending on where policy growth occurs. Our results suggest that the NFIP could limit the effects of policy growth on loss variability by focusing efforts to increase market penetration outside the Southeastern part of the county and the Gulf States. As shown in Chapter 4, market penetration rates are already higher in the South than in other parts of the country, which perhaps creates another argument for focusing efforts to expand the policy base outside the South. It should be noted, however, that there might be other more important objectives for expanding market penetration other than reducing the variability in losses. The effects we discuss here must be considered in the context of the overall objectives of the NFIP when deciding on the appropriate targets for increasing penetration.

8. IMPLICATIONS FOR MARKET PENETRATION GOALS AND NEXT STEPS

The findings in the previous chapters raise several issues that are important for NFIP managers and policymakers to consider as they evaluate alternative targets for market penetration rates and strategies for achieving them. They also suggest several promising topics for additional research.

8.1. Implications of Findings for Setting Market Penetration Targets and Developing Strategies to Achieve Them

The low market penetration rate in communities with 500 or fewer homes in the SFHA presents a potential marketing opportunity for the NFIP. Just under 95 percent of the roughly 20,000 communities in the NFIP have fewer than 500 SFHs in the SFHA, and the market penetration rates in these communities as a whole are low, ranging between 16 and 30 percent, depending on the estimate of market penetration used. Overall, these communities account for roughly 25 percent of SFHs in SFHAs nationwide. Policymakers need to better understand what causes the market penetration rate in these communities to be so low. Is it the lack of insurer presence in these communities, pervasive under-appreciation of risk, or less vigorous enforcement of the mandatory purchase requirement? Does the complexity of writing NFIP policies discourage agents in these communities from writing policies? While communities with relatively few homes in the SFHA present a growth opportunity for the NFIP, the sheer number of such communities presents challenges. The costs and expected payoffs of strategies that can target the enormous number of small communities should be evaluated. Similarly, market penetration rates are lower in communities where a smaller share of homes are in the SFHA, and the costs and benefits of strategies to increase market penetration in these communities should also be investigated.

NFIP managers should also try to better understand why market penetration rates are so much lower in communities not subject to coastal flooding (mainly inland communities) and what can be done to increase those market penetration rates. An estimated 1.7 million SFHs are in inland communities. NFIP managers should examine whether features of NFIP policies make them less attractive in inland areas (e.g., limited basement coverage), whether residents in inland areas systematically underestimate risk, or whether the nature of the risk in inland areas (e.g., less variance in annual losses) makes flood insurance relatively less attractive.

The results of this study suggest that the decision to purchase flood insurance is not particularly sensitive to the price of flood insurance, at least over the range of flood insurance prices currently observed. Thus, in developing strategies to achieve market penetration targets, NFIP managers do not need to be overly focused on how moderate changes in insurance premiums (e.g., 25 percent or less) would affect market penetration rates. However, large changes in prices may well have proportionately much larger impacts on market penetration rates than the findings in this study suggest.

Financial regulators and NFIP managers should evaluate whether and how to improve compliance with the mandatory purchase requirement in important submarkets. Particular attention should be paid to how to improve compliance in communities with a relatively small number or percent of structures in the SFHA, that are not subject to coastal flooding, and that are in the Northeast.

Market penetration rates remain very low among homes not subject to the mandatory purchase requirement (on the order of 20 percent), and attention should be paid to what might be done to increase penetration in this segment of the market. The unwillingness of homeowners to purchase flood insurance has been an ongoing problem for the NFIP and was the primary reason for the mandatory purchase requirement. The low rates among homes that are not likely to be subject to the mandatory purchase requirement suggest that little has changed over the years and point to the importance of the mandatory purchase requirement in maintaining the market penetration rates that are observed today. While increasing market penetration rates in the voluntary market will continue to be a challenge, NFIP managers should continue to assess strategies and their costs. Offering increased flexibility in the types of the losses that are covered and the amount of coverage available might be attractive in the voluntary market.

8.2. Topics for Further Research

The results of this study suggest a number of areas where additional research would be useful. These topics include the following:

- **Investigation of reasons for low market penetration rates in communities with a low number or proportion of homes in the SFHA.** A number of hypotheses have been posed about why market penetration rates might be lower in communities with 500 or fewer homes in the SFHA or in communities with a relatively low percentage of homes in the SFHA. Collecting additional data on the communities in the sample would provide greater insight into which hypotheses are the most plausible. For example, information might be collected on the number of insurance agents in the communities who write flood insurance, the number of banks, and the percent of banks that are federally regulated. Such information could be incorporated into the quantitative analysis done in this report and used to identify the characteristics of these communities that are most closely associated with low market penetration rates. A systematic set of qualitative interviews with various stakeholders knowledgeable about the market for flood insurance would also provide valuable information on the challenges to increasing market penetration rates in communities with a low number or proportion of homes in the SFHA.

- **Additional examination of market penetration rates in inland communities.** Greater understanding of why market penetration rates are lower in inland communities could be gained by investigating whether market penetration rates are consistently lower in inland communities across the United States or whether the effects are observed primarily in certain regions. The existing database would provide a good start on this analysis. Analysis of how the variance of flood losses differs in the two sets of communities would also provide insight into how demand for insurance might differ.

- **Refinement of data used to estimate compliance with mandatory purchase requirement.** We were not able to identify whether a substantial number of homes in the sample had mortgages. Review of when the tax assessors for each of the 100 communities in the sample began reporting information on mortgages and how frequently that information is updated may allow a better assessment of whether homes actually have mortgages. We were also not able to determine which mortgages are subject to the mandatory purchase requirement. The feasibility of using lender name (which is recorded in the database) to determine whether a mortgage is subject to the mandatory purchase requirement might be investigated. Property address matching might also be used to determine if the mortgage had been sold to Fannie Mae or Freddie Mac.

- **More detailed investigation of effect of CRS participation on market penetration rates.** Information is available on the activities that communities in the CRS have adopted to generate CRS credits. Further analysis could be done to better understand whether particular programs, such as community mailings or other education programs, have an effect on market penetration rates. Approaches that appear to be successful might be adopted more broadly to increase market penetration rates.

- **Analysis of retention.** There is substantial turnover in the flood insurance policies in effect from year to year. This study has looked only at market penetration rate at one point in time. It may not be difficult for the NFIP's BSA to determine whether there was a policy in place at each of the property parcels in the sample over time. The factors that determine turnover could then be examined.

- **Expansion of number of communities in sample.** This study has demonstrated the feasibility and power of using property parcel data based on tax assessor records to estimate market penetration rates. The current study examined properties in 100 communities, but a larger sample would provide more confidence in some of the results. The current sample provides adequate representation for Florida, so additional communities should be added outside Florida, particularly in the Midwest.

- **Extension of analysis to other types of structures.** This study was restricted to SFHs, but data were also collected for other residential and nonresidential structures. These data can be used to estimate market penetration rates on the approximately 40 percent of structures that are not SFHs.

8.3. Moving Forward

While a substantial number of SFHs in SFHAs across the nation have flood insurance, an equally large number do not. This study has identified opportunities for increasing market penetration rates and attempted to identify some of the potential benefits of doing so. It has aimed to inform discussions by NFIP managers and stakeholders more generally about what the goals for annual policy growth and market penetration should be. As policymakers and NFIP managers evaluate goals for growth in the number of polices and strategies for achieving them, they should consider both the costs and benefits of higher market penetration. Benefits should be measured against overall social objectives for the program and costs should be broadly defined. It should not be automatically assumed that the goal should be universal or nearly universal NFIP coverage. For example, high market penetration rates may not be desirable if the cost of achieving them is high and if, as the results of this study suggest, they do not lower disaster assistance payments much or induce greater compliance with NFIP requirements. However, higher market penetration rates may be socially desirable to the extent that there are failures on the demand side of the market (e.g., homeowners systematically underestimate flood risks) or on the supply side (e.g., few insurance agents with experience writing flood policies in small communities or prices in some regions that does not reflect actuarial risk) that limit the desirability or restrict the accessibility of flood insurance.

As this report has illustrated, many complex considerations need to be addressed in setting goals for policy growth. It may be infeasible to develop analytically based goals for policy growth or market penetration. A more practical approach may be to work to remove imperfections on the supply and demand sides of the market and let market penetration fall where it may. Even so, careful thought will still need to be given to how much investment is warranted to remove different market imperfections.

9. APPENDICES

APPENDIX 1: MAP OF FEMA REGIONS

Figure A1.1 shows the regions into which the Federal Emergency Management Agency (FEMA) divides the United States.

FIGURE A1.1: FEMA Regions

The following four geographic regions are used in this study:

Northeast = FEMA regions 1, 2, and 3
South = FEMA regions 4 and 6
Midwest = FEMA regions 5, 7, and 8
West = FEMA regions 9, and 10.

APPENDIX 2: NFIP COMMUNITIES SELECTED FOR THE STUDY

Table A2.1 lists the 100 National Flood Insurance Program (NFIP) communities selected for the study, ordered by region, size, and primary source of flooding. The communities are mapped in Figure A2.1.

TABLE A2.1: Communities in Sample

No.	Community ID Number	Community Name[1]	County	ST	Region	Size[2]	Flood Source[3]	In CRS[4]
1	360642	Carlton, Town of	Orleans County	NY	NE	1	C	0
2	340007	Egg Harbor, Township of	Atlantic County	NJ	NE	1	C	0
3	420036	Fox Chapel, Borough of	Allegheny County	PA	NE	1	R	0
4	90022	Berlin, Town of	Hartford County	CT	NE	1	R	0
5	361633	Malverne, Village of	Nassau County	NY	NE	1	R	0
6	360296	Prattsville, Town of	Greene County	NY	NE	1	R	0
7	422191	St. Clair, Township of	Westmoreland County	PA	NE	1	R	0
8	250208	Newton, City of	Middlesex County	MA	NE	1	R	0
9	90076	East Haven, Town of	New Haven County	CT	NE	2	C	0
10	365337	Islip,Township of	Suffolk County	NY	NE	2	C	0
11	240061	Somerset County*	Somerset County	MD	NE	2	C	0
12	345523	Elizabeth, City of	Union County	NJ	NE	2	C	0
13	360584	Manlius, Town of	Onondaga County	NY	NE	2	R	0
14	361590	Kenmore,Village of	Erie County	NY	NE	2	R	0
15	360867	Wawarsing, Town of	Ulster County	NY	NE	2	R	0
16	360226	Amherst, Town of	Erie County	NY	NE	2	R	1
17	250001	Barnstable, Town of	Barnstable County	MA	NE	3	C	0
18	345310	Ocean City, City of	Cape May County	NJ	NE	3	C	1
19	360467	Hempstead, Town of	Nassau County	NY	NE	3	C	0
20	120649	Medley, Town of	Dade County	FL	S	1	C	0
21	125089	Belleair Beach, City of	Pinellas County	FL	S	1	C	1
22	470377	New Hope, City of	Marion County	TN	S	1	R	0
23	120414	Lake Hamilton, Town of	Polk County	FL	S	1	R	0
24	120257	Seminole, City of	Pinellas County	FL	S	1	R	0
25	480804	Anthony,Town of	El Paso County	TX	S	1	R	0
26	480130	Collin County*	Collin County	TX	S	1	R	0

[1]An asterisk at the end of a community name means that NFIP member is a county. Counties belonging the NFIP typically represent the unincorporated parts of the county.

[2]Size Category 1: <=1,000 structures in SFHA according to the 1998 Biennial Survey; Size Category 2: >1,000 and <=10,000 structures in SFHA; Size Category 3: >=10,000 structures in SFHA.

[3]Flood Source = 'C' if community is subject to coastal flooding and 'R' (for Riverine) if community is not subject to coastal flooding.

[4]In CRS = 1 if community is in the Community Rating System and 0 otherwise.

TABLE A2.1: Communities in Sample (Continued)

No.	Community ID Number	Community Name[1]	County	ST	Region	Size[2]	Flood Source[3]	In CRS[4]
27	480637	Victoria County*	Victoria County	TX	S	1	R	0
28	130466	Hall County*	Hall County	GA	S	2	C	0
29	120274	Santa Rosa County*	Santa Rosa County	FL	S	2	C	1
30	125122	Largo, City of	Pinellas County	FL	S	2	C	1
31	455416	Isle Of Palms, City of	Charleston County	SC	S	2	C	1
32	120168	Key West, City of	Monroe County	FL	S	2	C	1
33	125130	Naples, City of	Collier County	FL	S	2	C	1
34	120143	Leon County*	Leon County	FL	S	2	R	0
35	485467	Freeport, City of	Brazoria County	TX	S	2	R	0
36	120219	Pahokee, City of	Palm Beach County	FL	S	2	R	0
37	370031	Buncombe County*	Buncombe County	NC	S	2	R	0
38	485466	El Lago, City of	Harris County	TX	S	2	R	0
39	480338	Edinburg,City of	Hidalgo County	TX	S	2	R	0
40	480347	Pharr, City of	Hidalgo County	TX	S	2	R	0
41	120049	North Lauderdale, City	Broward County	FL	S	2	R	1
42	120055	Pompano Beach, City of	Broward County	FL	S	3	C	1
43	120119	Indian River County*	Indian River County	FL	S	3	C	1
44	125144	Sarasota County*	Sarasota County	FL	S	3	C	1
45	120058	Tamarac, City of	Broward County	FL	S	3	C	1
46	455412	Charleston, City of	Charleston County	SC	S	3	C	1
47	125113	Hollywood, City of	Broward County	FL	S	3	C	1
48	125148	St. Petersburg, City of	Pinellas County	FL	S	3	C	1
49	125095	Cape Coral, City of	Lee County	FL	S	3	C	1
50	120192	Palm Beach County*	Palm Beach County	FL	S	3	C	1
51	120054	Plantation, City of	Broward County	FL	S	3	C	1

[1]An asterisk at the end of a community name means that NFIP member is a county. Counties belonging the NFIP typically represent the unincorporated parts of the county.

[2]Size Category 1: <=1,000 structures in SFHA according to the 1998 Biennial Survey; Size Category 2: >1,000 and <=10,000 structures in SFHA; Size Category 3: >=10,000 structures in SFHA.

[3]Flood Source = 'C' if community is subject to coastal flooding and 'R' (for Riverine) if community is not subject to coastal flooding.

[4]In CRS = 1 if community is in the Community Rating System and 0 otherwise.

TABLE A2.1: Communities in Sample (Continued)

No.	Community ID Number	Community Name[1]	County	ST	Region	Size[2]	Flood Source[3]	In CRS[4]
52	120061	Charlotte County*	Charlotte County	FL	S	3	C	1
53	120067	Collier County*	Collier County	FL	S	3	C	1
54	130030	Chatham County*	Chatham County	GA	S	3	C	1
55	120643	Hialeah, City of	Dade County	FL	S	3	C	1
56	480287	Harris County*	Harris County	TX	S	3	C	0
57	120230	Pasco County*	Pasco County	FL	S	3	C	1
58	120112	Hillsborough County*	Hillsborough County	FL	S	3	C	1
59	125093	Broward County*	Broward County	FL	S	3	C	1
60	125105	Fort Lauderdale, City of	Broward County	FL	S	3	C	1
61	120635	Miami Dade County*	Dade County	FL	S	3	C	1
62	125124	Lee County*	Lee County	FL	S	3	C	1
63	120328	Sunrise, City of	Broward County	FL	S	3	R	1
64	480214	El Paso, City of	El Paso County	TX	S	3	R	1
65	120047	Margate, City of	Broward County	FL	S	3	R	1
66	120261	Polk County*	Polk County	FL	S	3	R	1
67	260218	Brownstown, Charter Township of	Wayne County	MI	M	1	C	0
68	390156	Sandusky, City of	Erie County	OH	M	1	C	0
69	390831	Hanover, Village of	Licking County	OH	M	1	R	0
70	390215	Fairfax, Village of	Hamilton County	OH	M	1	R	0
71	80193	Estes Park,Town of	Larimer County	CO	M	1	R	0
72	290380	Richmond Heights, City	St. Louis County	MO	M	1	R	0
73	260909	Roseville, City of	Macomb County	MI	M	1	R	0
74	170169	Tinley Park, City of	Will County, Cook County	IL	M	1	R	0
75	80102	Fort Collins, City of	Larimer County	CO	M	1	R	1
76	390104	Cleveland, City of	Cuyahoga County	OH	M	2	C	0
77	260123	Harrison, Township of	Macomb County	MI	M	2	C	0

[1]An asterisk at the end of a community name means that NFIP member is a county. Counties belonging the NFIP typically represent the unincorporated parts of the county.

[2]Size Category 1: <=1,000 structures in SFHA according to the 1998 Biennial Survey; Size Category 2: >1,000 and <=10,000 structures in SFHA; Size Category 3: >=10,000 structures in SFHA.

[3]Flood Source = 'C' if community is subject to coastal flooding and 'R' (for Riverine) if community is not subject to coastal flooding.

[4]In CRS = 1 if community is in the Community Rating System and 0 otherwise.

TABLE A2.1: Communities in Sample (Continued)

No.	Community ID Number	Community Name[1]	County	ST	Region	Size[2]	Flood Source[3]	In CRS[4]
78	170158	Schaumburg, Village of	Du Page County, Cook County	IL	M	2	R	0
79	290318	St. Charles, City of	St. Charles County	MO	M	2	R	0
80	490102	Salt Lake County*	Salt Lake County	UT	M	2	R	0
81	390210	Cincinnati, City of	Hamilton County	OH	M	2	R	0
82	80024	Boulder, City of	Boulder County	CO	M	2	R	1
83	260292	Berkley, City of	Oakland County	MI	M	2	R	0
84	260323	Oak Park, City of	Oakland County	MI	M	2	R	0
85	60061	Arcata, City of	Humboldt County	CA	W	1	C	0
86	60759	Lake Forest, City of	Orange County	CA	W	1	C	0
87	60101	Bell, City of	Los Angeles County	CA	W	1	R	0
88	60217	Cypress, City of	Orange County	CA	W	1	R	0
89	60321	Menlo Park, City of	San Mateo County	CA	W	2	C	0
90	60195	Monterey County*	Monterey County	CA	W	2	C	1
91	530153	Burlington, City of	Skagit County	WA	W	2	R	1
92	60720	West Hollywood, City of	Los Angeles County	CA	W	2	R	0
93	60001	Alameda County*	Alameda County	CA	W	2	R	1
94	325276	Las Vegas, City of	Clark County	NV	W	2	R	1
95	65058	San Rafael, City of	Marin County	CA	W	3	C	0
96	60136	Long Beach, City of	Los Angeles County	CA	W	3	C	1
97	60262	Sacramento County*	Sacramento County	CA	W	3	C	1
98	40073	Pima County*	Pima County	AZ	W	3	R	1
99	60349	San Jose, City of	Santa Clara County	CA	W	3	R	1
100	60266	Sacramento, City of	Sacramento County	CA	W	3	R	1

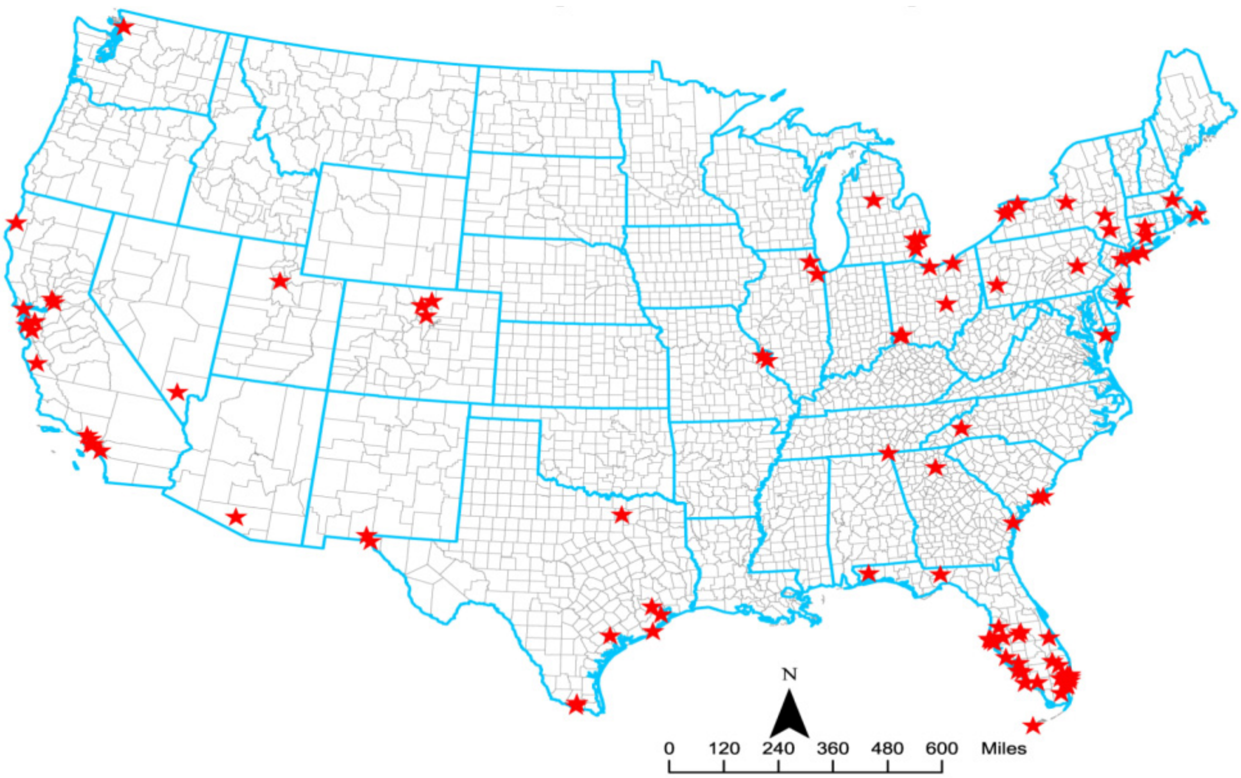
[1]An asterisk at the end of a community name means that NFIP member is a county. Counties belonging the NFIP typically represent the unincorporated parts of the county.

[2]Size Category 1: <=1,000 structures in SFHA according to the 1998 Biennial Survey; Size Category 2: >1,000 and <=10,000 structures in SFHA; Size Category 3: >=10,000 structures in SFHA.

[3]Flood Source = ‘C’ if community is subject to coastal flooding and ‘R’ (for Riverine) if community is not subject to coastal flooding.

[4]In CRS = 1 if community is in the Community Rating System and 0 otherwise.

FIGURE A2.1: Map of Communities in Sample



APPENDIX 3: METHODS USED TO IMPUTE MISSING VALUES

This appendix describes the procedures used to impute missing values and to group observations into the categories used in the analysis.

There were a number of observations in the sample of 74,368 property parcels supplied by First American Real Estate Solutions (FARES) where the parcel was classified as residential but where it was not assigned to a specified residential land use (e.g., single-family home or apartment). For a few communities, all residential properties were listed as *Residential Not Elsewhere Classified* (RNEC)*,* indicating that the property tax assessor did not distinguish among different residential land uses. We used logistic regression to estimate the probability that the residential properties not in the RNEC category in each of the 21 cells used to select the 100 community sample were single-family homes (SFHs).[131,132] Each of the observations in the RNEC category was then reclassified as a SFH using the resulting probability.

The first row of Table A3.1 shows that approximately 10 percent of the observations in the sample were reclassified in this way. The second row of Table A3.1 shows that a similar procedure was used to reclassify a proportion of observations whose land use was unknown or missing according to FARES.

Property parcels with incomplete address information could not be sent to Transamerica or the Bureau and Statistical Agent (BSA) because complete address information is needed to determine the flood zone and whether there is a National Flood Insurance Program (NFIP) policy at the parcel. The third row of Table A3.1 describes how the roughly 9 percent of the 49,065 SFHs (after the first two imputations already covered) were categorized as inside or outside the 100 NFIP communities in the analysis. Flood zones were then assigned to the 2,321 observations that were in the sample communities but that were missing flood zone.

The final step of the process for imputing missing values concerns single-family homes (SFHs) in the correct NFIP community that were not sent to the BSA (and thus whether a policy exists at the address is unknown). There are likely NFIP policies on some of these parcels. For these parcels we used the remaining observations in each of the 21 cells used to estimate the probability that each observation had a policy based on whether the observation was in the Special Flood Hazard Area (SFHA). Each of the observations not sent to the BSA was assigned an NFIP policy using the resulting probability.

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[131]The cells are the three-way combinations of geographic region, community size, and source of flooding. As discussed in Chapter 2, three cells with few communities were collapsed with other cells.
[132]In this case, a logistic regression was run for each of the cells with only a constant term as an explanatory variable. When the only variable in the logit is a constant, the logit assigns missing values using the probability that the characteristic of interest occurs among those observations where the value of the variable is not missing.

TABLE A3.1: Procedures Used to Impute Missing Values

Type of Missing Value	Operation	Number of Observations Affected	Method
Observations with land use reported as Residential NEC by FARES	Classify observations as SFH or non-SFH	7,779 of 74,368 parcels (10%)	Logit done by sampling cell with a constant as the explanatory variable
Land use unknown or missing in FARES database	Classify observations as SFH or non-SFH	692 of 74,368 parcels (1%)	Logit done by sampling cell with a constant as the explanatory variable
Single-family homes without flood or NFIP community determinations	Classify observations as in or out of the 100 communities selected for study	4,215 of 49,056 SFHs (9%)	Logit done by sampling cell with a constant as the explanatory variable
SFHs with incomplete addresses or with addresses for which Transamerica could not make flood determinations	Classify observations as in or out of the Special Flood Hazard Area (SFHA)	2,321 of 27,667 of SFHs in correct community (8%)	Logit done by sampling cell with a constant as the explanatory variable
SFHs with incomplete addresses not sent to BSA	Classify observations as with or without NFIP policies	2,261 of 27,667 SFHs in correct community (8%)	Logit done by sampling cell with a constant and flood zone as explanatory variables

APPENDIX 4: STATISTICAL EXTRAPOLATION METHODS

Statistical weights were used to extrapolate the findings for the sample of single-family homes (SFHs) to the nation as a whole. The weight for each of the 74,368 observations across the 100 National Flood Insurance Program (NFIP) communities is the inverse of the probability that the observation was selected for the sample. This probability has three components:

$$P_i = P(i \mid c_j) * P(c_j \mid f_s) * P(f_s)$$

where

P_i	is the probability that parcel i is selected (i= 1 . . . 74,368)
$P(i \mid c_j)$	is the probability that home i is selected given that it is in community c_j (j=1. . .100). The probability is equal to roughly 750 divided by the number of property parcels in the census tracts that overlay community c_j.
$P(c_j \mid f_s)$	is the probability that community c_j is selected given that it is a community in sample strata s (s=1. . .21) for which First American Real Estate Solutions (FARES) has parcel data.
$P(f_s)$	is the probability that FARES has parcel data for a community in sample strata s.

The weights are identical for all observations in a particular community.

The number of single-family homes in NFIP communities nationwide is estimated by adding the weights for the 27,667 single-family homes in the 100 NFIP communities in the sample. Similarly, the number of single-family homes inside or outside of Special Flood Hazard Areas (SFHAs) is estimated by summing the weights for the appropriate subsamples of SFHs (5,472 and 22,195 observations respectively).[133]

The market penetration rate for single-family homes was estimated in three ways: (1) address matching; (2) Bureau and Statistical Agent (BSA) policy totals for entire NFIP; and (3) BSA policy totals for sampled communities.

To estimate the market penetration rate using address matching, each SFH is assigned a value of one or zero depending on whether the BSA found a flood insurance policy at the

[133]The projections are done using the SAS SURVEYMEANS procedure. The standard errors and confidence intervals are calculated using adjustments for clustering and the stratification scheme used to select the 100 communities for the sample. The following SAS code was used: PROC SURVEYMEANS DATA=<datasetname> NOBS MEAN CLM SUM CLSUM; VAR <variable names>; STRATA <sampling strata ID numbers>; CLUSTER <community ID number>; WEIGHT <sampling weight for observations>;RUN;.

address. The national estimate of the market penetration rate is then the weighted mean of the resulting variable, using the same weights as discussed above.

As discussed in Chapter 3, the second method for estimating market penetration combines data from the BSA on the number of policies in force with projections of the number of structures using the statistical weights described above.

The third approach uses the same projection for the number of structures as the second approach but projects the total number of policies based on the number of policies according to the BSA in each of the 100 sampled communities. The number of policies in the sample communities is extrapolated nationwide using weights equal to the inverse of $P(c_j \mid f_s) * P(f_s)$.

APPENDIX 5. CONSISTENCY OF BSA AND FARES DATABASES

Projections of the number of flood insurance policies on single-family homes (SFHs) in Special Flood Hazard Areas (SFHAs) based on address matching could diverge from totals in the Bureau and Statistical Agent (BSA) policies-in-force database (which is based on records submitted by the companies writing flood insurance policies) because of disagreements between the BSA database and the property parcel database over land use, flood zone, or National Flood Insurance Program (NFIP) community. This appendix investigates the degree of agreement between the two databases and how much of the difference between projections on the number of policies based on address matching and BSA policy totals could be explained by disagreements between the databases.

A5.1. Agreement on Land Use

Table A5.1 shows a cross-tabulation of land-use according to First American Real Estate Solutions (FARES) as reported in the BSA database. The comparison is done for parcels in the sample (regardless of land use) where BSA found a flood insurance policy using address matching. There is a high degree of agreement between the two databases. The databases agreed on land use 92 percent of the time (sum of the cells on the main diagonal of the table). There is a slight tendency for the BSA to consider more parcels SFHs than FARES. BSA classifies 5.2 percent of the parcels as SFHs when FARES does not (4.6 plus 0.6 percent) versus 2.1 percent of parcels that FARES classifies as single-family homes when the BSA does not (2.0 plus 0.1 percent). The difference in how land use is coded could thus cause the number of policies projected from the study sample to be 3.1 percent lower than the number of policies according to the BSA.

TABLE A5.1: Comparison of Land Use According to FARES and the BSA (Percent of Parcels with Structure Policies) (N=8,272)

	Land Use According to BSA		
Land Use According to FARES	Single-Family Homes (Not Condos)	Other Residential	Nonresidential
Single-family homes (not condos)	83.5	2.0	0.1
Other residential	4.6	6.1	0.7
Nonresidential	0.6	0.1	2.3

A5.2. Agreement on Flood Zones

The degree of agreement between the two databases is reported in Table A5.2. Overall, the databases agree 92 percent of the time. The BSA is slightly more likely to report that a property is in the SFHA than FARES (5.5 versus 2.3 percent). As a result, the table suggests that flood zone discrepancies could cause the number of polices predicted from the study sample based on address matching to be 3.2 percent lower than the number of policies according to the BSA.

TABLE A5.2: Comparison of Flood Zone According to Transamerica and the BSA (Percent of Parcels with Structure Policies) (N=8,272)

	Flood Zone According to BSA		
Flood Zone According to Transamerica	In SFHA	Not In SFHA	Missing
In SFHA	77.7	2.1	0.2
Not in SFHA	4.7	14.3	0
Missing	0.8	0.2	0

A5.3. Agreement on Community Identification Number

Table A5.3 reports agreement the NFIP community in which the parcels selected for the sample lie (using community ID number or CID). The CID listed in the BSA database agreed with that reported by Transamerica 93 percent of the time. There is slight tendency for the BSA to consider a parcel in the CID more frequently than Transamerica does (3.4 verses 3.1 percent). This tendency would cause projections based on the study sample to be 0.3 percent lower than the number of policies according to the BSA.

TABLE A5.3: Comparison of CID According to Transamerica and the BSA (Percent of Parcels with Structure Policies) (N=8,272)

	CID According to BSA	
CID According to Transamerica	In Sample Communities	Not In Sample Communities
In Sample Communities	69.9	3.1
Not in Sample Communities	2.7	23.3
Missing	0.7	0.4

A5.4. Combined Effect of Database Discrepancies

Overall, the three differences between the BSA database and the data from FARES and Transamerica on parcel characteristics could cause projections of the number of policies based on address matching to be between 3.2 (magnitude of the largest single effect) and 6.7 percent (the product of all three effects) lower than the number of policies according to the BSA. The magnitude of the actual effect will depend on how much overlap there is between the three differences.

APPENDIX 6. SPECIFICATION AND ESTIMATION OF THE MODEL FOR THE PURCHASE OF FLOOD INSURANCE

This appendix describes the statistical approach used to estimate the effects of community and parcel characteristics on the decision to purchase flood insurance. The method used to predict the price of insurance for homes that did not purchase flood insurance is first described. Then, a logistic model for the purchase of flood insurance is presented.

A6.1. Predicted Insurance Prices

As discussed in Chapter 5, insurance prices are only observed for homeowners in the sample who bought insurance. To estimate prices for homeowners who did not buy insurance, a relationship between price and variables observed for all homes in the sample was estimated using those homes with flood insurance. Prices were then predicted using this relationship for both homes with and without insurance, and the predicted price was subsequently used in the logistic model of the decision to buy insurance.

This approach is similar to the generated regressor approach used in Kriesel and Landry (2004). Variables known to be associated with the price of insurance (such as whether the home has a basement) are included in the regression. But in a departure for Kriesel and Landry, other variables used in the demand model are also included. These variables increase the explanatory power of the estimated price relationship. Adding the additional variables is also consistent with two-stage-least-squares regression techniques where all predetermined variables in a model are used in predicting values of an endogenous variable. (In this case, price, which is determined in part by who buys insurance over time, is the endogenous variable.)

Most of the variables used to predict price are described in Chapter 5. Additional variables used in the price regression are as follows:

- **Ground Elevation.** Geographic information software was used to determine the land elevation at the location of each structure. However, these data do not necessarily reflect the elevation of the lowest building floor, because the home may be elevated above ground level. The difference of a home’s elevation from the mean elevation of all the sampled homes in community in which the home is located was calculated. This variable is at best only a crude proxy of the elevation measure used to determine insurance price for post-flood insurance rate map (FIRM) structures (elevation relative to base flood elevation, BFE). One might still expect, however, a negative relationship between elevation difference and price.

- **Number of Stories.** The First American Real Estate Solutions (FARES) database contains a variable on the number of stories for the structure. This variable is often missing (blank) from the FARES database and other times set to zero. When zero, it is coded as missing in the regression below. Flood insurance rates are lower for multi-story homes than for single-story homes, so the expected sign on this variable is negative.

- **Existence of a Basement.** The FARES database also contains two variables that indicate whether the building has a basement. Again, it appears that values for these variables are often missing. Unfortunately, it is not possible to tell whether the absence of any indication of a basement is because there is no basement or because basement data were not collected (the basement indicator is zero is both cases). National Flood Insurance Program (NFIP) rates are higher for buildings with basements, other things equal.

- **Improved Value Greater than $50,000.** Rates for the first $50,000 of builder coverage are higher than rates for subsequent coverage. To better capture the effect of this declining block rate structure, an indicator variable was included in the regression that indicates whether a home's improved value is greater than $50,000. More coverage is likely purchased as the value of the home increases, so the expect sign of the coefficient on this variable is negative.

Summary statistics for the variables used in the price model (and the subsequent demand equation) are reported in Table A6.1. The regression results for price equation using ordinary least squares are reported in Table A6.2. Also reported is the expected sign for those coefficients for which a sign is hypothesized. As can be seen, the coefficient signs are all as expected. Note that the rates for pre-FIRM structures are higher, consistent with the NFIP rate manual. As expected, the coefficients on the log of improved value and the variable indicating whether the improved value is greater than $50,000 are negative.

The standard errors of the regression coefficients have been corrected for clustering using the SAS GENMOD procedure. Some parcel-level variables are significant, but the community-level variables are not significant. The R-squared for the regression is 31 percent, indicating that the regression is explaining a considerable part of the variation in price.

A6.2. Logistic Model of Demand for Flood Insurance

The decision to purchase flood insurance is modeled using a logistic regression. In the logistic model, the outcome is a Bernoulli random variable with values of 0 or 1. In this case, the outcome is whether there is a flood insurance policy providing coverage for the structure (and possibly the contents) of the single-family home. The expected value of the outcome, $E(Y_{ij}) = \Pr(I_{ij} > 0)$, is the probability that the outcome for the i^{th} single-family home in community *j* takes the value 1 and is a function of a set of explanatory variables:

$$(1)\quad \Pr(I_{ij} > 0) = \frac{\exp(B'X_{ij})}{1 + \exp(B'X_{ij})}$$

where B is the vector of coefficients to be estimated and X is a vector of community and parcel characteristics. Equation (1) simplifies to (2), where the natural logarithm of the odds ratio is a linear function of the variables in the model:

TABLE A6.1: Summary Statistics for Variables Used in Model

Variable	Observations w/o Missing Values	Observations w/ Missing Values	Mean	Standard Deviation
Pre-firm home	5,085	387	0.596	0.491
Home in a V zone	5,472	0	0.018	0.131
Elevation difference from community mean (meters)	4,964	508	0.000	13.637
Home has more than one story	4,826	646	0.192	0.394
Building has a basement*	5,472	0	0.021	0.143
Community in CRS class 8–9	5,472	0	0.530	0.499
Community in CRS class 1–7	5,472	0	0.316	0.465
Home improved value ($1000s)	5,084	388	119	155
Improved value greater then $50K	5,084	388	0.781	0.413
Home in Region 1	5,472	0	0.115	0.319
Home in Region 3	5,472	0	0.035	0.184
Home in Region 4	5,472	0	0.106	0.308
Community not subject to coastal flooding	5,472	0	0.266	0.442
<=500 homes in community SFHA	5,472	0	0.043	0.203
501 to 5,000 homes in community SFHA	5,472	0	0.255	0.436
County small metro or non-metro	5,148	324	0.463	0.499
Less than 50% of homes in community in SFHA	5,472	0	0.376	0.485
10 years or less since last FICO event	5,472	0	0.901	0.299
Total payments per $100 coverage between 1982 and 2002 ($/$100 of coverage)	5,002	470	0.093	0.145
High probability of a mortgage	5,472	0	0.478	0.500
Price per $100 of coverage ($/$100 of cov)	3,315	2,157	0.309	0.266

*Data on basement may actually be missing for many observations where there was no indication that the home had a basement.

$$(2)\quad \log\left(\frac{\Pr(I_{ij} > 0)}{1-\Pr(I_{ij} > 0)}\right) = B'X_{ij} \ .$$

For categorical variables, one category is chosen as the reference for each characteristic. The categories are then specified as a series of indicator variables (variables that take on a value of zero or one), excluding an indicator variable for the reference category. So for example, we use three categories for the number of single-family homes in the Special Flood Hazard Area (SFHA). One indicator variable is constructed that takes on a value of 1 for communities with 500 or fewer single-family home in the SFHA and 0 otherwise. A second indicator variable is constructed that takes on a value of 1 for communities with 501 to 5,000 single-family homes in the SFHA and zero otherwise. The indicator variable for communities with more than 5,000 single-family homes in the SFHA is omitted from the logistic regression. The natural logarithms of improved property value, premium per $100 of coverage, claim payments per $100 of coverage, and distance to a city with a population of at least 500,000 enter as continuous variables in the regression.[134] In cases where value for a characteristic is missing, a separate indicator variable is created to capture the missing values.

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[134]Natural logarithms are often used in regression analysis because when variable values are spread over a wide range, the logarithm of the variable is more symmetrically distributed.

TABLE A6.2: Regression Used to Predict Price (Dependent Variable is Natural Logarithm of Price In Dollars Per $100 of Building Coverage)

Variable	Expected Sign	Coefficient	Standard Error
Intercept		1.146	1.004
Pre-firm home	+	0.160	0.113
Data on FIRM status missing		–0.113	0.229
Home in a V zone	+	0.286**	0.109
Elevation difference from community mean (meters)	−	–0.007*	0.004
Interaction of elev diff with post-FIRM		0.003	0.006
Elevation data missing		–0.176**	0.041
Homes has more than one story	−	–0.055	0.044
Data on number of stories missing		–0.148	0.114
Building has a basement	+	0.140	0.110
Community in CRS class 8–9	−	–0.281	0.186
Community in CRS class 1–7	−	–0.108	0.157
Log of home improved value	−	–0.159**	0.053
Improved value greater then $50K	−	–0.077	0.061
Data on improved value missing		–2.020**	0.597
Home in Region 1		–0.209	0.132
Home in Region 3		–0.074	0.221
Home in Region 4		–0.053	0.172
Community not subject to coastal flooding		0.005	0.133
501 to 5,000 homes in community SFHA		0.174	0.121
<=500 homes in community SFHA		0.290	0.237
Log of distance from city with pop >= 500,000		–0.059	0.078
Less than 50% of homes in community in SFHA		0.238	0.088
10 years or less since last FICO event		–0.065	0.184
Log of total payments per $100 coverage between 1982 and 2002[1]		0.050	0.050
High probability of a mortgage		–0.120**	0.021

[1]No missing value variable was created for log of payments per $100 because the observations with missing values are the same as those that are missing FIRM status.

+Statistically significant at 10 percent; *statistically significant at 5 percent; **statistically significant at 1 percent.

NOTE: Regression estimated using 3,314 observations. R-squared = 30.8 percent.

The SAS GENMOD procedure was used to estimate the equations. The procedure accounts for clustering of the observation in the NFIP communities selected for the study (as opposed to selecting the sample randomly from single-family homes in all NFIP communities).[135] Table A6.3 reports the results for all single-family homes in the SFHA. Both the coefficients and the odds ratios (the exponents of the coefficients) are reported. Tables A6.4 and A6.5 report the results for the two subsamples of homes shown in Table A6.3.

TABLE A6.3: Logit Model for Decision to Purchase Building Coverage for All Homes in the Sample

Variable	Expected Sign	Coefficient	Standard Error	Odds Ratio
Intercept		–1.412	1.481	
Home in Region 1		–0.678+	0.384	0.507
Home in Region 3		–0.337	0.542	0.714
Home in Region 4		–0.171	0.319	0.843
Pre-firm home		0.100	0.268	1.105
Data on FIRM status missing		0.363	0.533	1.438
Community not subject to coastal flooding	−	–0.426**	0.186	0.653
501 to 5,000 homes in community SFHA	−	0.254	0.267	1.289
<=500 homes in community SFHA	−	–0.931+	0.489	0.394
Community in CRS class 1–9		–0.075	0.320	0.928
Less than 50% of homes in SFHA	−	–0.581**	0.194	0.559
Log of distance from city with pop >= 500,000	−	–0.064	0.153	0.938
Predicted log of price per $100 coverage	−	–0.318+	0.186	0.728
10 years or less since last FICO event	+	0.408	0.309	1.503
Log of total payments (in cents) per $100 coverage between 1982 and 2002[1]	+	0.057	0.111	1.059
Log of home improved value		0.161+	0.086	1.174
Data on improved value missing		1.609	1.071	4.995
High probability of a mortgage	+	0.774**	0.132	2.168

[1]No missing value variable was created for log of payments per $100 because the observations with missing values are the same as those that are missing FIRM status.

+Statistically significant at 10 percent; *statistically significant at 5 percent; **statistically significant at 1 percent.
NOTE: Model estimated using 5,472 observations.

[135]The "repeated subject" option in the GENMOD procedure is used to correct for clustering. The GENMOD procedure is also run using the sampling weight for each observation. The following SAS code was used to run the logit: PROC GENMOD DATA=<datasetname> DESCENDING; CLASS <community id number>; MODEL <dependent variable = independent variables> / LINK=LOGIT DIST=B; REPEATED SUBJECT = <community ID number> / TYPE=INDEP; WEIGHT = <sampling weight for observations>; RUN;.

TABLE A6.4: Logit Model for Decision to Purchase Building Coverage for Homes Where the Likelihood of a Mortgage is High

Variable	Expected Sign	Coefficient	Standard Error	Odds Ratio
Intercept		1.965	2.251	
Home in Region 1		–0.677	0.639	0.508
Home in Region 3		0.392	0.782	1.480
Home in Region 4		0.421	0.442	1.524
Pre-firm home		0.642+	0.383	1.900
Data on FIRM status missing		1.427+	0.859	4.167
Community not subject to coastal flooding	–	–0.906**	0.286	0.404
501 to 5,000 homes in community SFHA	–	0.378	0.341	1.459
<=500 homes in community SFHA	–	–0.799	0.756	0.450
Community in CRS class 1–9		0.045	0.426	1.046
Less than 50% of homes in SFHA	–	–0.748**	0.302	0.473
Log of distance from city with pop >= 500,000	–	–0.092	0.231	0.912
Predicted log of price per $100 coverage	–	–0.523	0.979	0.593
10 years or less since last FICO event	+	–0.271	0.508	0.763
Log of total payments (in cents) per $100 coverage between 1982 and 2002[1]	+	–0.261+	0.142	0.770
Log of home improved value		–0.153	0.249	0.858
Data on improved value missing		–2.325	3.098	0.098
Mortgage >1 and <=6 years old	–	0.275	0.321	1.317
Mortgage >6 and <=11 years old	–	0.476	0.361	1.610
Mortgage > 11 years old	–	–0.052	0.298	0.950
Mortgage data missing	–	–3.470**	1.193	0.031

[1]No missing value variable was created for log of payments per $100 because the observations with missing values are the same as those that are missing FIRM status.

+ Statistically significant at 10 percent; * statistically significant at 5 percent; ** statistically significant at 1 percent.

NOTE: Model estimated using 2,613 observations.

TABLE A6.5: Logit Model for Decision to Purchase Building Coverage for Homes Where the Likelihood of a Mortgage is Low or Uncertain

Variable	Expected Sign	Coefficient	Standard Error	Odds Ratio
Intercept		–2.198	1.526	
Home in Region 1		–0.717*	0.365	0.488
Home in Region 3		–0.528	0.478	0.590
Home in Region 4		–0.549+	0.317	0.577
Pre-firm home		–0.142	0.254	0.868
Data on FIRM status missing		–0.156	0.523	0.855
Community not subject to coastal flooding	–	–0.384+	0.223	0.681
501 to 5,000 homes in community SFHA	–	0.341	0.278	1.407
<=500 homes in community SFHA	–	–0.775+	0.479	0.461
Community in CRS class 1–9		0.054	0.291	1.055
Less than 50% of homes in SFHA	–	–0.390+	0.223	0.677
Log of distance from city with pop >= 500,000	–	–0.119	0.117	0.888
Predicted log of price per $100 coverage	–	–0.445**	0.144	0.641
10 years or less since last FICO event	+	0.523+	0.323	1.687
Log of total payments (in cents) per $100 coverage between 1982 and 2002[1]	+	0.179+	0.106	1.196
Log of home improved value		0.258**	0.103	1.294
Data on improved value missing		2.795*	1.279	16.354

[1]No missing value variable was created for log of payments per $100 because the observations with missing values are the same as those that are missing FIRM status.

+ Statistically significant at 10 percent; * statistically significant at 5 percent; ** statistically significant at 1 percent.
NOTE: Model estimated using 2,859 observations.

APPENDIX 7. STATISTICAL FRAMEWORK FOR ANALYSIS OF THE VARIABILITY OF NFIP LOSSES

The model we use to analyze the relationship between the geographic distribution of flood insurance policies and the variability of NFIP loss is one in which the annual losses per dollar of coverage in each region j is a random variable with mean equal λ_j and variance equal to $\sigma_j^{\,2}$, j= 1. . . N. Thus, if an insurer in area j sold C total dollars of coverage, the insurer's expected losses for the year would be equal to $E(L_j) = \lambda_j C_j$. Total expected losses across all N regions would be $E(L) = \sum_{j=1}^{N} L_j = \sum_{j=1}^{N} \lambda_j C_j$. An additional dollar of insurance coverage in any given area will have no impact on the insurer's expected net operating results if the National Flood Insurance Policy (NFIP) sets actuarially fair rates in each region. However, the geographic distribution of coverage *can* have an effect on the variability of insurer net losses.

Basic statistical theory tells us that the variance of total losses in a given year in area j will be equal to $C_j^2 \sigma_j^{\,2}$. The variance in total losses across all areas for an insurer providing coverage in multiple areas will depend on the covariance of losses in different regions. Consider a case in which the insurer sells coverage in two areas: m and k. On the one hand, if losses in the two areas are independent, meaning that they are uncorrelated, then the variance in total losses for the insurer will equal $\sigma_T^{\,2} = C_m^{\,2}\sigma_m^{\,2} + C_k^2\sigma_k^{\,2}$. On the other hand, if the losses in areas m and k have a covariance of σ_{mk}, then the variance in total losses will be equal to $\sigma_T^{\,2} = C_m^{\,2}\sigma_m^{\,2} + C_k^2\sigma_k^{\,2} + 2C_m\, C_k\sigma_{mk}$.

This variance formula illustrates how diversification can reduce risk. If the losses in areas m and k are negatively correlated, then the covariance is negative, and the variance in total losses will be less than it would be if the losses were independent. In contrast, if the losses are positively correlated, then the variance in total losses will be higher than if they were independent. With positively correlated risks, the variance of combined losses is lower the smaller the covariance between losses in the two areas.

If we consider the more general case of N geographic areas, the aggregate variance in total losses is given by the formula

$$\sigma_T^2 > \sum_{j>1}^{N} C_j^2 \sigma_j^2 + 2\sum_{j=k}^{N} \sum_{j=k}^{N} C_j C_k \sigma_{jk}.$$

The implication of this formula is that the covariance between losses in different areas will have a significant impact on the overall level of risk to the insurer. Moreover, if an insurer is considering increasing its overall holdings, then it could be better off by targeting the increases in areas where the variance of losses is lower or where losses tend to be negatively correlated, or uncorrelated, with other areas.

In our analysis, we estimate λ_j, σ^2_j, and σ_{mk} using historical data, and then examine how the aggregate variance σ^2_T changes as we change the level of coverage in different areas. This allows us to study how the NFIP could encourage new growth by region in such a way as to limit its overall risk.

10. ACRONYMS

Acronym	**Definition**
AHS	American Housing Survey
AIR	American Institutes for Research
BCEGS	Building Code Effectiveness Grading Schedule
BFE	Base Flood Elevation
BSA	Bureau and Statistical Agent
CAC	Community Assistance Contacts
CAV	Community Assistance Visits
CI	Confidence Interval
CIS	Community Information System
CRS	Community Rating System
DFIRM	Digital Flood Insurance Rate Map
FARES	First American Real Estate Solutions
FEMA	Federal Emergency Management Agency
FICO	Flood Insurance Claims Office
FIRM	Flood Insurance Rate Map
GAO	Government Accountability Office
GIS	Geographical Information System
NFIP	National Flood Insurance Program
OFHEO	Office of Federal Housing Enterprise Oversight
PWC	PricewaterhouseCoopers
SBA	Small Business Administration
SFH	Single-Family Home
SFHA	Special Flood Hazard Area

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FEMA—see U.S. Federal Emergency Management Agency

GAO—see U.S. Government Accountability Office

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