Does National Flood Insurance Program Participation Induce Housing Development?

Carolyn A. Dehring
Department of Insurance, Legal Studies and Real Estate
Terry College of Business
University of Georgia
cdehring@uga.edu

William D. Lastrapes
Department of Economics
Terry College of Business
University of Georgia
last@uga.edu

David L. Eckles
Department of Insurance, Legal Studies and Real Estate
Terry College of Business
University of Georgia
deckles@uga.edu

Mark J. Browne
School of Risk Management
Tobin College of Business
St. John's University
brownem1@stjohns.edu

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Abstract

The objective of this study is provide estimates of the economic effects of the National Flood Insurance Program. In particular, we estimate the response of county-wide housing development in Florida to community-level participation in the program, and find that housing permits and starts were up to 30 percent higher in member communities compared to non-members. This increase in development is driven by housing activity in non-coastal counties; we find no evidence that housing construction increased in coastal counties where greater flooding is expected. We speculate that higher compliance costs explain this result, but further research is needed to verify this claim.

1 Introduction

Large scale government insurance programs, of which there are many in the US and other developed countries, can have consequences that are undesirable, albeit predictable. By insuring against loss, all forms of insurance can lead to moral hazard and inefficient increases in risky behavior. But government-sponsored insurance programs – usually with below-cost premiums determined through the political process under interest-group pressure, and ultimately subsidized by taxpayers – are likely to distort behavior and increase risk more than private insurance. The extent to which flood insurance provided by the government increases risk and affects economic decisions is an empirical question, and one that we examine in this paper.

We estimate the effect of community-level participation in the National Flood Insurance Program (NFIP), which allows owners of property in member communities to insure their property from flooding, on local housing development and activity. It is well-known that flood insurance premiums offered through the program have often under-estimated the expected property losses from flooding. If the opportunity to buy flood insurance at low rates has induced development – put more property in harm's way – we would expect the data to show that housing activity in participating communities occurs at a faster rate than in non-participating communities, all else the same.

We use data on housing activity and community-level NFIP membership in the state of Florida over the period 1975 to 2000, during which time almost all communities in the state joined the NFIP. Although the NFIP covers the nation as a whole, Florida accounts for 37% of the nation's active flood insurance policies and 40% of total property exposure. Lessons learned from Florida thus can have important policy implications for the program as a whole.

We run panel data regressions to explain how variation in housing starts and permits is related to variation across years and counties in community-level membership in the NFIP. We describe the empirical model in section 3 below. For the model to be properly identified, we must account for the possibility that participation in the NFIP is endogenous with respect to a community's development and growth: fast-growing communities might be more likely to choose membership in the program than slow-growing communities. However, we claim in section 2 of the paper, and provide supporting evidence in section 4, that community membership was likely to be *exogenous* over our sample. Our claim is that, because of institutional factors, membership in the program was randomly assigned to communities, or at least assigned in a way not correlated with housing activity and growth. In this sense, the NFIP experience in Florida provides a 'natural experiment' for examining how housing markets respond to the availability of subsidized government flood insurance, which validates our causal inference.

We are aware of only two studies that have examined the relationship between the NFIP and housing development. The first is a report from the US Government Accountability Office (GAO) which examined the rate of development and the availability of flood insurance coverage (GAO (1982)). The GAO did not find a relationship between the two; however, it did not undertake a rigorous statistical analysis of its data to address this question because it felt "this approach offered a low probability of success at an acceptable level of precision." As part of this same study, the GAO surveyed 115 people who were familiar with NFIP coverage and coastal and barrier island development. Based on survey responses, including the finding that 98 out of the 115 people surveyed felt that flood insurance fostered development, the report states that the NFIP, "offers a marginal added incentive for development in coastal and barrier island communities, which have a high potential for loss of life and destruction of property."

The other study to consider flood insurance and housing development is Cordes and Yezer (1998). Their study of federal shore-protection activities examines the development response to NFIP participation in 42 beachfront communities across seven states. Using standard regression analysis, they find that participation in the initial "emergency" phase of the NFIP increased single family housing permits by around 50%, but had no additional effect on development with participation in the regular program. Our paper complements and adds to this earlier work.

As reported in section 4, we find that NFIP membership increased housing permits and starts in Florida at the county level by 25 to 30 percent, depending on how NFIP membership is measured. We also find that some of this increase came on the extensive margin: population in member communities was about 1 percent greater than in non-member communities. However, these effects occurred primarily in non-coastal counties; housing activity increased in non-coastal counties from 50 to 70 percent, while the response of housing in coastal counties was statistically insignificant. This seemingly counterintuitive result is most likely due to higher costs of compliance associated with the program's building code in coastal, high flood-risk areas. Such costs can offset the benefits of insurance in driving the demand for housing.[1]

Our estimates are reduced-form, so we cannot isolate the particular channels through which membership in the flood insurance program might have affected housing behavior. We also cannot claim that the response of housing activity was inefficient – the NFIP might have satisfied the demand for flood insurance that was not provided by the private sector. But quantitative assessments of how a national insurance program like the NFIP influences housing development and real resource allocation in general are rare. Having such estimates is a necessary step to gaining deeper understanding of how the program works and whether it can be improved.

[1]Dehring (2006) finds that land prices decline in coastal high-hazard areas of the floodplain following NFIP participation, suggesting that the expected costs of compliance with NFIP building standards are greater than any expected benefits of program participation in these high risk areas. Several hedonic studies find floodplain land to be associated with lower property values, such as MacDonald, Murdoch, and White (1987), Holway and Burby (1990), and Bin, Kruse, and Landry (2008).

2 The NFIP

2.1 Background

The National Flood Insurance Program was established by the US federal government in 1968 to provide property insurance against the peril of flood. The goals of the NFIP were to better indemnify individuals for flood losses through insurance, reduce future flood damages through state and community floodplain management regulations, and reduce federal expenditures for disaster assistance and flood control (FEMA (2002)). The immediate political impetus for the enactment of the legislation creating the NFIP came from the destruction wrought by Hurricanes Carla and Betsy in the 1960s.[2] Carla made landfall between Port O'Connor and Port Lavaca, Texas in September 1962 as a Category 4 hurricane, while "Billion-Dollar Betsy" ravaged the Bahamas, Florida, and Louisiana in September 1965.

At the time and continuing to the present, private insurance markets in the United States provided almost no coverage against flood peril. Browne and Halek (2010) discuss reasons for the apparent failure of private markets to serve as a mechanism through which flood risk could be transferred, including the potentially catastrophic nature of the risk, the inherent difficulty faced by insurers in estimating the probability that there will be a loss, asymmetric information regarding the probability of loss, and charity hazard.[3] Browne and Hoyt (2000) provide empirical evidence consistent with demand issues, including the underestimation of the risk of loss by property owners, which also plagues the market for flood insurance. As of August 2012, roughly 5.5 million NFIP flood insurance policies were active in the US, with \$3.5 billion in annual premiums covering over \$1.2 trillion in property value.[4]

The NFIP provides owners the opportunity to buy flood insurance on property located

[2]http://www.fema.gov/about/history.shtm.

[3]For additional discussion of why comparatively little private insurance is purchased against hurricane risk, see (Michel-Kerjan and Kousky, 2010, p.4).

[4]Policy counts are reported at http://www.fema.gov/business/nfip/statistics/pol.shtm. Insurance in force is reported at http://www.fema.gov/business/nfip/statistics/ins.shtm.

in qualifying communities. A community qualifies for the program when a Flood Insurance Rate Map (FIRM) is completed for the community. After completion of the FIRM, the community must demonstrate that flood plain management regulations, such as building elevation requirements, have been adopted and detailing how such regulations will be enforced. Once the community has joined the program, owners, renters and builders of single family homes and multi-family structures are eligible to buy flood insurance. The amount of insurance is currently limited to $250,000 for a single-family home or for a single unit in a multi-family structure. The standard flood policy contains additional coverage for contents, with a maximum limit of $100,000. Coverage limits have increased several times since the program's inception, but the real value of these limits has tended to decrease over time owing to inflation (Kunreuther and Michel-Kerjan (2009)).

Unlike insurance obtained in the private market, where premium rates fully reflect the costs of risk and insurer administrative costs, flood insurance is often not priced adequately. Already-subsidized rates were explicitly lowered in 1972, and again in 1974, to encourage community participation in the program. Over 20% of the policies presently in force are for properties that, because of their date of construction, are eligible for rates that are below the actuarially fair price of the risk (GAO (2013a)). NFIP insurance for these 'grandfathered' properties that do not have to adhere to NFIP building standards until expansion or redevelopment is priced at substantially subsidized rates; (FEMA, 2002, p.26) estimates that the premiums for subsidized polices are only 35 to 40% of the actuarially fair rate. After a community joins the NFIP, owners of new construction are not eligible for explicitly subsidized rates; however, there is parameter uncertainty in hurricane loss estimation models, particularly around extreme events. The GAO reports that the methods for developing rates – even for full-risk premium properties that are not grand-fathered – likely results in rates that are insufficient given the risk transferred to the NFIP. The Property Casualty Insurers Association of America estimates that on average full-risk premium properties would be charged rates 23.3% higher if coverage were provided through the private market.

Not surprisingly, as it stands today the NFIP is not actuarially sound. The operational history of the program includes years in which the program was in the black, typically because hurricane activity was minimal, and years in which there were significant losses, mostly notably 2005, the year of Hurricane Katrina. The NFIP has the ability to borrow from the United States Treasury to cover shortfalls. In January 2013 the NFIP's borrowing authority temporarily increased to $30.4 billion from $20.7 billion, in part to address claims from Superstorm Sandy in 2012. Even the smaller amount, however, is sufficiently high that the program has not been able to meet the yearly cost of interest on this debt (GAO (2010) and GAO (2013b)).

In addition to its inability to charge premiums sufficient to cover the risks that are being insured, the NFIP is restricted in other ways that make the profitable writing of insurance difficult, if not impossible. Due to the nature of the flood risk, reinsurance coverage, a primary risk management tool for private insurance companies, is not practical for the NFIP. Underwriting, which allows for variation of premium levels and the rejection of risks in the private market, is severely limited. Variation in premium levels is possible within limits; however, rejection of risks is not, even in the case of property that suffers repeated losses (GAO (2008)). This impediment to profitability, or even a breakeven level, is demonstrated by the fact that repetitive loss properties account for approximately 1 percent of the NFIP's policies but 25 to 30 percent of claims (GAO (2010)).

The debt of the program currently stands at $24 billion, and the issue of rate subsidization has been front and center as modifications to the program are proposed. The intent of the recent Biggert-Waters Flood Insurance Reform Act, which Congress passed in 2012, was to end the NFIP's federal subsidies to property owners in flood-prone coastal areas of the US. Under Biggert-Waters, subsidies to existing owners of grandfathered houses, those built before flood maps were produced or later re-classified to a higher risk zone, are to be phased out over a 5-year period, while new buyers of such properties will no longer eligible for a subsidized rate.

In January 2014, against a consumer backlash over rising insurance premiums and housing market stability, the Senate voted for a 4-year delay in any major changes to the program concerning either the sale of, or rate increases on, grandfathered property. The version of the relief act approved by the US House in March of 2014 allows for rate increases, but on a smaller scale than that proposed under Biggert-Waters. Specifically, rate increases to owners of subsidized property must be less than 18% annually (5-15% on average) until the actuarially fair rate is reached, with an imposed minimum annual increase of 5%. The House bill also eliminates the reset to actuarially fair rates for new buyers of grandfathered property, and refunds any increased premium paid by these buyers.

2.2 NFIP participation as a natural experiment

Participation in the NFIP happens at the community level (city or town, generally), although the actual decision to buy flood insurance rests with individuals living in member communities. For our purposes, the date that a *community* joins the NFIP is important. We do not rely on observations of actual insurance purchases or take-up rates because our objective is to estimate the effects of community membership, which determines the *opportunity* to buy flood insurance, on local housing markets. To appropriately estimate these effects we also need to know if the determination of the date communities join the NFIP depends on factors that drive growth and development in local communities and counties. If they do, our estimates will be susceptible to endogeneity bias.

Community membership in the NFIP ultimately depends on the execution of a Flood Insurance Study by the Federal Emergency Management Agency (FEMA), from which FIRMs are produced.[5] FEMA is required by law to provide such maps for flood-prone communities,

[5] The precursor to the FIRM was the Flood Hazard Boundary Map. Based on flood insurance studies,

regardless of whether a community formally requests an insurance study.[6] These maps depict "base flood elevations" throughout the community, which measure the distance above mean sea level that the floodwaters of a base (or 100-year) flood – one having a one percent chance of being equaled or exceeded in any year – are expected to rise. Membership in the NFIP imposes elevation requirements in designated high hazard areas, which stipulate that the lowest floor of both new structures and substantially improved old structures cannot lie below the base level elevation for the area in which the structures are located. A community is eligible for regular membership in the NFIP once that community's initial FIRM is identified and flood plain management plans are submitted, with the exception of the 'emergency' phase noted above.[7] Once the FIRMs have been determined, communities in the emergency program switch to the regular program, with increased coverage and less-subsidized rates.

FEMA's *Community Status Book Report* includes, for each community in each state in the country, the initial FIRM date and the date the community formally joined the NFIP. For Florida from 1970 to 2000, the period of our empirical analysis, the report shows FIRM dates and membership dates for all but just a handful of communities, meaning that almost all communities joined the NFIP at some point during this period. These dates vary across time and communities, variation we exploit in our analysis to identify the effects of membership on local housing development.

Our empirical analysis estimates the effects of NFIP on housing development by comparing housing market indicators in communities that are NFIP members with those in non-member communities. We cannot, however, identify the difference as reflecting a 'causal' effect of NFIP membership if the timing of membership was determined by community-level growth and development, or more generally, determined by variables correlated with growth

the latter was a less detailed version of the FIRM.

[6]See FEMA (2002) p. 4.

[7]The initial FIRM date determines eligibility; FIRMs are periodically updated so current maps may differ from the original.

and development that we cannot control for in the regression models. Ideally, we would like the 'treatment' – NFIP participation – to be randomly assigned across communities.

While purely random assignment seems unlikely, the weaker assumption that the timing and extent of NFIP membership was not linked to community growth is reasonable. Of the 445 communities in our Florida sample, most (around 75%) are reported to have joined the NFIP on the same day their FIRM was identified. But FEMA, not the communities themselves, essentially determined the join date.[8]

While communities interested in joining the program could have requested that a flood insurance study be undertaken, this was not the typical order of events. In the first 5 years of the program, mapping order was determined in part by community demand, but mostly by the availability of flood data through the Army Corps of Engineers and USGS. In 1973 engineering firms were hired by the Federal Insurance Administration (FIA), the precursor to FEMA, to prepare boundary maps for communities with flood data, and to identify communities in need of study. As more communities were identified as being flood-prone, and as more communities joined, mapping demands exceeded the capabilities of the FIA. Communities were first notified that FIRMs were available, and were then strongly encouraged to join the NFIP.[9] Indeed, by 1975 there were almost 3000 appeals against flood-zone designation in process nation-wide, suggesting that much of the push to join came from FEMA, not the communities themselves.

If FEMA had decided to give priority to the fastest growing communities, then our inference would indeed suffer from endogeneity bias. However, FEMA representatives who participated in rate map construction in Florida during our sample period, and to whom we

[8]Only 11% formally joined the NFIP through the emergency program; i.e. their reported 'join' date preceded the identification of their FIRMs. We provide details and definitions regarding communities and NFIP membership dates below.

[9]The Flood Disaster Protection Act of 1973 required program participation as a condition of federal financial assistance, and required flood insurance for properties in flood areas financed by mortgages issued by federally regulated lenders.

spoke, indicated that projected community growth was only one of many factors, including the availability of flood data and other information on the potential for destructive floods, that went into selecting communities for mapping. Below, we show that the chronological order in which communities joined the NFIP was not related to past economic growth. This evidence supports our claim for the plausibility of NFIP membership as a 'natural experiment' in which the treatment was exogenously assigned.

3 Empirical Model

The aim of this paper is to estimate the response of housing development in Florida to county-level participation in the NFIP. To do so, we rely on observed variation in housing activity and NFIP membership across both years and communities. We estimate reduced form, as opposed to structural, models of housing activity, and therefore cannot make claims about the effects of the flood insurance program on the *efficiency* of housing and insurance markets, or the specific channels through which housing development might respond to the availability of such insurance. Nonetheless, having a quantitative understanding of induced development from the availability of flood insurance can help guide future policy reform.

The equilibrium, reduced-form effects of the NFIP on housing market activity reflect the combined responses of the supply and demand for housing. The response of housing supply to NFIP participation is ambiguous. In high hazard areas, NFIP membership forces developers to comply with costly elevation requirements and other enhanced building standards aimed at reducing flood damage, which, all else the same, will cause the supply of new housing units to fall as construction costs rise. At the same time, anticipation of increased house prices in the future, driven by the perceived benefits of flood insurance to homeowners, could lead to a speculative increase in current supply. The demand for housing is likely to depend positively on community-level NFIP participation. If the costs of potential flood damage are borne by risk averse property owners, then local NFIP membership, and the opportunity such participation provides to buy subsidized flood insurance, will increase the demand for housing. If the positive effects of NFIP participation outweigh the negative effects of higher costs on supply, we would expect equilibrium housing market activity to increase as membership in the program rises.

Such increases in housing activity can be realized along an intensive margin – increases in housing units per capita – or an extensive margin – increases in housing units for new residents from out of the state or other Florida counties not covered by the program. For this reason, we do not rely solely on per capita measures of housing market activity. Instead, in our regression analysis we treat both aggregate (county-level) measures of housing development and population as dependent variables.

Because NFIP participation is determined at the community level within each county, we begin by modeling the equilibrium quantity of housing at that level:

$$\begin{aligned} y_{jit} &= \beta_0 + \beta_1 f_{jit} + \beta_2 f_{jit} m_{jit} + \beta_3 m_{jit} + \beta_4 x_{jit} + e_{jit} \\ &= X_{jit}\beta + e_{jit}, \end{aligned} \tag{1}$$

where y_{jit} is a measure of the quantity of housing activity (or population) in community j of county i during year t, f_{jit} is a binary variable equal to one if community j of county i is a member of the NFIP in year t and 0 otherwise, m_{jit} is a community-level variable that potentially causes variation in the effect of NFIP membership on housing development (accounted for by the interaction term), and x_{jit} is a vector of community-level control variables. We measure housing activity as the flow of new housing construction during the year. Equation (1) is the reduced form of a structural model of the community-level housing market.[10]

[10] Cordes and Yezer (1998) rely on a similar model for their estimation of the effects of NFIP on housing development in coastal communities in the US.

If each of the variables in equation (1) is observable at the community level, we can estimate it to identify the effects of NFIP membership on housing development as

$$E(y|f=1,m,x) - E(y|f=0,m,x) = \beta_1 f_{jit} + \beta_2 f_{jit} m_{jit}$$

However, we have data on housing construction only at the county level, not the community level. To estimate the parameters in (1) given the available data, we sum both sides of the equation over communities to obtain county-level aggregates, then divide by the number of communities:

$$\begin{aligned} y_{it} &= \beta_0 + \beta_1 f_{it} + \beta_2 fm_{it} + \beta_3 m_{it} + \beta_4 x_{it} + e_{it} \\ &= X_{it}\beta + e_{it} \end{aligned} \tag{2}$$

$y_{it} \equiv \frac{1}{n_{it}} \sum_{j=1}^{n_{it}} y_{jit}$ is average community-level housing activity in county i, where n_{it} is the number of communities in county i in year t, $f_{it} \equiv \frac{1}{n_{it}} \sum_{j=1}^{n_{it}} f_{jit}$ is the fraction of county i's communities covered by the NFIP in year t, m_{it} and x_{it} are defined analogously to y_{it}, and $fm_{it} \equiv \frac{1}{n_{it}} \sum_{j=1}^{n_{it}} f_{jit} m_{jit}$ is the value of m aggregated only over communities in county i covered by NFIP, relative to total communities in that county.[11] Note that the coefficients in (2) are identical to those in (1). Equation (2), estimated over the county sample $i = 1, \cdots, N$, serves as our basis for making inference about the effects of NFIP on housing development in Florida.

Under the strict exogeneity assumption that $E(e_{jit}|X) = 0$, ordinary least-squares (OLS) estimation of (1), if feasible, correctly identifies the causal effects of NFIP membership on housing development. Because $e_{it} = \frac{1}{n_{it}} \sum_{j=1}^{n_{it}} e_{jit}$, it follows that $E(e_{it}|X) = 0$ and OLS

[11]For our purposes, to determine n_{it} we count for each county in Florida the number of incorporated towns, cities and municipalities, as well as unincorporated areas. The latter do not typically join the NFIP on their own, but become eligible for flood insurance when the county in which they reside joins. Thus, we count all unincorporated areas in a county as a single and separate 'community'.

estimation of (2) is also correctly identified. Under the weaker assumption that the regressors are orthogonal to the errors at the community level, rather strictly exogenous, $Ee_{jit}X_{jit} = 0$ for all i, j, t, and OLS estimates of (1) are consistent. However, this condition is not sufficient for consistency of OLS estimation of the county-level model. For OLS estimates of (2) to be consistent, $Ee_{it}X_{it} = \frac{1}{n_i}E\left(\sum_j e_{jit}\right)\left(\sum_j X_{jit}\right) = 0$ for all i, t, which is not necessarily implied by the community-level orthogonality condition above. The stronger condition that $Ee_{jit}X_{hit} = 0$, for all $j, h = 1, \cdots, n_{it}$, and for all i, t, is sufficient; that is, the error term for any community j in county i must be uncorrelated with all regressors in all the other communities in county i. But if orthogonality at the community level is reasonable, the stronger cross-country assumption also seems reasonable.[12] We control for time-constant unobserved heterogeneity across counties using typical fixed effects (FE) estimation methods.

We consider two alternative measures of the flow of new housing units at the county-level – housing permits and housing starts. We also decompose each of these overall measures into single-family units and multi-family units. In light of the rules of NFIP coverage, participation might have different effects on each.[13] As noted above, we treat county population as a dependent variable as well. In addition, we have (limited) data on county-level housing prices, so we also estimate how equilibrium real housing prices respond to NFIP membership.

The explanatory variable of primary interest is f_{it}, the proportion of a county's communities in the NFIP. To construct this variable, we use information from the *Community Status Book Report* published by FEMA to select an NFIP membership period for each community. Then, for each county i and year t we add the number of communities identified to be NFIP participants and divide by the total number of communities to get f_{it}. For any given year, this variable will measure variation across counties in the intensity of county-wide participa-

[12] Aggregation bias is also a potential problem, but the assumption in (1) that β is constant across communities and counties eliminates such bias. See (Theil, 1971, p. 558).

[13] Multi-family housing includes both condominiums and apartments, which differ both in insurance coverage and legal interest.

tion. For any given county, it will account for variation in the county's participation as new communities join the program (or current participants drop out).[14]

We use two alternative dates for the start of a community's membership period. The first is the date the community's initial Flood Insurance Rate Map was identified for participation in the "Regular" phase of NFIP (we call this the 'FIRM' date). The second is the date the report lists as the community's start date in the Regular or Emergency program (the 'membership' date). Our presumption is that a membership date that precedes the FIRM date reflects participation in the Emergency program. The membership date may more accurately reflect the timing of community participation, but may also be more susceptible to endogeneity bias since it reflects community, not necessarily FEMA, behavior. On the other hand, the FIRM date will be less likely to lead to biased estimates, as discussed above. Since it is not clear which measure is ideal, we consider both to gauge whether our results are robust to the different dates. The membership period ends when the community chooses or is forced to exit the program; however, in our sample there are no instances of Florida communities leaving the NFIP.

We expect that the costs and benefits of flood insurance, and thus the response of housing market activity to NFIP participation, to differ for communities containing high flood-hazard areas compared to those less prone to flooding. In our empirical work, we allow for this possibility in two ways. First, we estimate the model separately for coastal counties (those with a border on the Gulf of Mexico or the Atlantic Ocean) and non-coastal counties (those without such a border), which should generally differ in terms of the risk of flooding and costs of flood protection. Second, we set m_{it} to be land acreage in county i that is located in a flood zone, or in a flood zone with specified building elevations. To properly translate the interaction term in (1) to the county level model requires observing flood zone acreage

[14] An alternative measure would account for the number of people or households covered in communities and counties. However, since we treat population as a dependent variable, such a measure for f_{it} would be inappropriate.

only in NFIP communities, but such data are not available. We thus proxy the term fm_{it} in the county regressions with a standard interaction term: $fm_{it} = f_{it}m_{it}$.

We include as control variables in (2) the log of real county-level income, the growth rate of real income, the log of real wages, lagged population, and a complete set of year-specific dummy variables to account for fixed individual effects. We also include the floodzone variable (m) as a control, but because our floodzone data do not vary over time, β_3 is unidentified in the fixed-effects models we estimate.[15]

4 Estimates of the effect of NFIP on housing

4.1 Data

We have a balanced panel of all 67 Florida counties annually, from 1976 to 1998 for the housing development and population variables (1,541 observations), and from 1981 to 1998 for the house price variable (1,206 observations). Although we have data on all variables through 2000, by 1998 almost all counties that would participate by 2000 had joined the NFIP. We drop the final two years because of the lack of variation in f_{it}. Table 1 contains sample means and standard deviations of the variables used in our analysis over the full sample period for all 67 counties, as well as for coastal and non-coastal county sub-samples.[16]

We have mentioned FEMA's Community Status Book report (fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book) as our source for determining membership dates. The report gives the initial FIRM (under the column 'Init FIRM Identified') and the starting membership date (under the column 'Reg-Emer Date'). We use these dates as described above. In a very few cases, the initial FIRM date is later than the end of our sample, which mostly reflects newly incorporated towns or cities.

[15]FIRMs are updated at regular intervals. Our study uses data from current maps, as historical FIRM data are unavailable.

[16]Because we included a lagged variable (population) as a regressor, the sample for the housing variables runs from 1977 to 1998, or 1,474 observations.

When a new city is incorporated during our sample period, we appropriately adjust n, the number of communities in the county, and the number of members in the county.

In our sample, 462 towns, cities and unincorporated county areas participated in the NFIP during some period between 1970 and 2000. For almost 75% the FIRM dates and membership dates are the same. Figure 1 shows the number of communities that joined the NFIP in each year of our sample, while Figure 2 shows the cumulative state-wide percentage of community membership and population living in member communities and eligible for NFIP insurance. There was an initial surge in new community membership in the early 1970's, a lull from 1973 to 1976, and a pick-up until the late 1980's. New memberships declined toward the end of the sample as most of the state's communities were already in the program. According to Table 1, 69% of the communities in the average county/year were members of NFIP for both of our measures of participation. This percentage differed significantly across coastal and non-coastal counties.

Annual data on county-level single- and multi-family building permits and starts, as well as county population, are from the University of Florida's Bureau of Economic and Business Research.[17] Over our sample, average county-level starts and permits are 2,216 and 2,130 units annually. Over 60% of these starts and permits are for single family units. During this time Florida's population grew at an average annual rate of 2.5%.

For housing prices we take county averages of "just-value" of existing single family housing parcels – the county tax assessor's estimate of total market value – and divide by the number of such parcels. Both series are provided by the Florida Department of Revenue and are available beginning only in 1981. We then divide this measure of housing price by the national CPI to obtain real housing prices. The average county's just-value housing price (in 1982-84 dollars) over our sample period was just over $40,000.

Data on developable, non-conservation flood plain land by county are provided by the

[17] http://edr.state.fl.us/Content/population-demographics/data/Methodology_Estimates.pdf.

Florida Division of Emergency Management, while county land area data are obtained from the US Census Bureau. We use two variables to account for the quantity of floodplain acreage in each county. The first is total floodplain land, which includes land in NFIP zones 'A', 'AE', 'AH', 'AO', and 'VE'. These classifications denote moderate to high flood risk. Flood insurance is available in these zones and is required if the homeowner has a federally backed mortgage. The second measure is a subset of the first, and includes only those flood zones having established base flood elevations in their building codes (zones 'AE', 'AO', and 'VE'). We make this distinction because, other things equal, we expect the incentive to develop to be less when there are high costs of code compliance.

4.2 Main findings

Valid inference relies on our assumption that community level participation is exogenous with respect to the effects of the NFIP on housing. Our claim is that the timing of flood insurance studies and rate map identification was primarily determined, *de facto*, by FEMA, with community-level requests playing a much less significant role, and that FEMA's decisions were uncorrelated with unobserved factors driving community and county growth. Although we can't test the exogeneity assumption definitively, we can examine whether the order of NFIP participation was systematic in a way that might invalidate our inferences. An informal spatial analysis of initial FIRM dates in the first ten years of the program indicates that coastal counties in Florida were somewhat more likely to have communities with FIRMs in the early years of the program. Otherwise, the spatial pattern of participation suggests random assignment of membership throughout the state.[18]

[18] The first FIRM in the state was mapped on April 20, 1970 for the Town of Longboat Key in Sarasota and Manatee Counties. By the end of 1971, other communities in counties in Florida's southwest (Pinellas, Charlotte, Collier and Monroe), west (Levy) and southeast (Palm Beach) had FIRMs. Communities in the southeast counties of Miami Dade and Broward, northwest Escambia, mid-north Alachua, and in the upper-mid Atlantic coast (St. John's, Volusia, and Brevard) were first mapped between 1972 and 1973. In 1976, the first communities in central Sumter County and in northern Leon County were mapped. In 1977, coastal communities in the Panhandle (Santa Rosa, Okaloosa, Walton and Bay), the far northeast (Nassau

To look at this issue more precisely, we ordered all communities in the state by their selected start date (based on each of our measures), and computed the rank correlation of NFIP membership with the growth rate of county-wide real income, lagged by one year. If income is a good proxy for housing market growth, growth tends to be persistent, fast-growing communities tend to be in fast-growing counties, and FEMA (over our sample) selected fast-growing communities for mapping before others, we would expect the rank correlation coefficient to be strongly negative.[19] The Spearman rank correlation for NFIP membership and lagged growth is $-.083$ with a p-value of 0.144 when we use the date joined as the start date, and is essentially the same (-0.087, 0.132) for the FIRM date. These rank correlations are small in magnitude, and statistically not different from zero, which is consistent with our assumption. The rank correlation between NFIP membership and whether a community sits in a coastal county, however, is significantly negative in both the magnitude and statistical senses (-0.42 and -0.48, respectively), which is consistent with the 'eyeball' account above. We also find statistically significant negative correlations with flood zone acreage, of about half the size of that found for the coastal ordering. Thus, FEMA tended to map coastal communities first and flood zone areas before others. However, we control for these factors in our regression models discussed below.

Estimates of the parameters of interest for the full county sample appear in Table 2. Panel A contains results for the FIRM measure of participation, while panel B contains those for the membership measure. We estimate and report separate regressions for total housing permits and starts, and consider two specifications for the interaction terms that account for potentially different effects of NFIP participation in floodplain areas. The first specification interacts the NFIP variable with total floodplain acres and total floodplain

and Duval), and the southeast (Indian River, St. Lucie and Martin) were first mapped, in addition to Hillsborough and Hendry counties. It was not until 1978 and 1979 that communities in non-coastal counties – Clay, Putnam, Marion, Seminole, Orange and Polk – were mapped for the first time.

[19]The smaller the numerical rank for membership, the sooner the community joins.

acres with base flood elevations (columns 1 and 3); the second specification first scales the floodplain measures by total acres of developable land (columns 2 and 4). Heteroskedasticity-robust standard errors are in parentheses. As implied by the model in equation (2), all variables are relative to the number of communities in the county.

To interpret the magnitude of these estimates, note that our regression model implies the overall effect of NFIP membership on housing is

$$\Delta y = \beta_1 \Delta f + \beta_2 \Delta f \cdot m. \tag{3}$$

Suppose that the average county in Florida goes from zero participation in the flood insurance program to complete participation; i.e. $\Delta f = 1$. Our estimates of β_1 in equation (2) imply that, if the county has no flood zone acreage ($m = 0$), total housing permits will rise by 81 units based on the FIRM date in panel A (column 2), or by 102 units per community based on the membership date in panel B. The average county in our sample had 6.5 communities and issued 2,217 annual permits during the sample period; thus, the estimates imply an average county-wide increase of between 527 and 663 housing permits, or a 24 to 30 percent increase. These effects are statistically significant at conventional levels. The responses of housing starts are generally smaller than for permits, but are of a similar order of magnitude, with a maximum percentage increase in starts of 28 percent. The flood-risk interaction terms are generally small and insignificantly different from zero for both measures of housing activity and floodplain.

Tables 3 and 4, for the FIRM and membership measures of NFIP respectively, report results after splitting the sample into non-coastal and coastal counties, and include separate results for single-family housing unit permits and starts. The tables make clear that the positive effects of NFIP membership on local development are primarily driven by the 32 *non-coastal* counties in the state. The coefficient estimate of 115 in the FIRM table implies an increase in permits of 56 percent, while the estimate of 140 in the membership table implies an increase of almost 70 percent. Again, the effects on housing starts are generally smaller than on permits.

The magnitude of these effects are large, but are comparable to those of Cordes and Yezer (1998), who find that NFIP membership increases housing permits in coastal communities along the US east coast by just over 50 percent. On the other hand, our results are inconsistent with their paper in that NFIP membership in *coastal* counties in Florida appears to have no effect on housing activity. The coefficient estimates are negative for both permits and starts in non-coastal counties, albeit not statistically significant. One explanation for these somewhat counterintuitive findings is that while the ability of homeowners to insure property in coastal counties is potentially large, so are building and renovation costs because of burdensome regulation and land-use codes. If these costs outweigh the benefits in coastal communities but not in non-coastal communities, then we would expect the reduced form effects that we find.[20]

We might expect NFIP membership to affect housing permits and starts differently for single-family and multi-family units. According to Panel A of Table 3, columns 2 and 6, of the 115 new permits issued per non-coastal community because of membership, 67 (58%) were for single family units and 48, therefore, were for multi-family units. These percentages are roughly the same – in the 60% range – across all regressions. The tables also reveal that floodplain land might lead to greater development in response to NFIP membership, at least for single-family units. Columns 6 and 8 of the two tables show that, for the comprehensive floodzone measure as a percentage of developable land, the NFIP-floodzone interaction term is statistically significant for single-family housing permits and starts. For

[20]Most studies of housing development find increased regulation – such as water quantity restrictions, water screening policies, minimum lots size restrictions, critical habitat designation, wetlands regulations, subdivision requirements, zoning, and composite measures – to be associated with *decreased* development. See (Thorson (1997), Zabel and Paterson (2006), Hanak and Chen (2007), Hanak (2008), Glaeser and Ward (2009), Mayer and Somerville (2000), Quigley and Raphael (2005), and Hwang and Quigley (2006)).

example, the coefficient estimate of 173 in column 6 of Table 3 implies that, at the sample mean of relative floodplain area (10%), single-family permits will rise by an additional 17.3 units when a community joins NFIP, for a total increase of 84.3 (see equation 2). We find no such effect for the narrower floodplain measure, where compliance costs are high; indeed the coefficient estimate on this interaction term is negative (yet statistically insignificant). This finding is consistent with the claim that NFIP membership imposed a greater cost than benefit on developers in communities with high compliance costs.[21]

Finally, we see similar patterns for population and our limited measure of house prices across coastal and non-coastal counties (see Table 5). For non-coastal counties, and depending on how housing and start dates are measured, NFIP membership causes population to rise from 150 to 200 persons per community, or 740 to 988 per county on average, which is equivalent to a one percent increase in population. Thus, much of the new housing development induced by the NFIP in non-coastal areas comes at the intensive margin – more structures per person. This result might reflect speculative motives from housing developers, or new housing demand from seasonal-residents who don't show up in Florida's population numbers; e.g. citizens of other states buying second homes or rental homes along the coast. Population declines insignificantly in the coastal sample with NFIP participation.

Real single-family house prices also rise in the non-coastal sample, with statistically significant estimates in the range of $1,800 per square foot, which is around 6 percent of the average house price in these counties. This result is consistent with the responses of starts and permits for single-family houses if membership in the NFIP causes an increase in new housing demand and the supply of housing is elastic for communities in non-coastal .

[21]Since Cordes and Yezer (1998) do not distinguish housing type, this pattern in the data cannot be discerned from their work.

5 Conclusion

The National Flood Insurance Program was created more than forty years ago to address what was perceived as a failure of private markets to provide flood insurance to property owners in floodplains. Our paper is one of the first to study the economic effects of this federal program designed to insure against catastrophic risk. We find that community membership in the NFIP increased county-wide development, as measured by housing permits and starts, in Florida by 25 to 30 percent on average from 1976 to 1998, during which period most of the communities in the state joined the NFIP. Population and real house prices also rose with program participation. We find weak evidence that these effects increased with a county's flood zone acreage, but much stronger evidence that induced development occurred primarily in non-coastal counties: the average effects for these counties were twice the magnitude of the average, while the effects on development in coastal counties were not statistically different from zero.

One of the objectives of the NFIP was to provide subsidized flood insurance for existing property in exchange for community and state commitments to restrict development in high flood-risk areas Michel-Kerjan (2010). Incentives for restricted development were provided by actuarially fair premiums on new construction, and floodplain management regulations that reduced the likelihood of flood damage but increased the costs of construction. Our results suggest that the program might have achieved some success in this regard. The benefits of NFIP's insurance provision likely outweighed the costs of compliance in non-coastal regions where those costs were relatively low, leading to the positive effects of participation in those counties. On the other hand, since coastal counties are more likely to lie in flood prone areas and flood plain management is likely to be costly (although, see Dehring and Halek (2012)), we find no such effects for the coastal counties. Our results do not provide strong evidence that construction actually declined in coastal areas; they do suggest, however, that construction did not increase in coastal communities that signed up for the NFIP.

We must be careful in how we interpret the findings. First, the claim that our estimates appropriately measure the response of housing activity to the availability of flood insurance is based on the plausible (as we show), but strong, assumption that NFIP membership was essentially exogenous. Second, estimates come from a reduced form model that cannot sort out the precise channels through which the program induced housing development. Finally, we can make no claims about the *efficiency* of the response of housing markets to the NFIP; that is, how much of the development response was caused by the elimination of market failure. For example, some of the increase in non-coastal community develop may have been an efficient response to the provision of insurance. On the other hand, the well-publicized incidence of program premiums falling below their actuarially fair values for existing property supports the presumption that some of this response reflects over-development in flood-prone areas – too much property put in harm's way. Future research, perhaps using structural models of housing and insurance or effective instruments for program membership decisions, is needed to sort out these issues.

Nonetheless, our study of large scale government intervention in insurance markets can help shape current policy. The 2014 Homeowner Flood Insurance Affordability Act, which significantly weakened the reforms of Biggert-Waters Flood Insurance Reform Act of 2012, is certainly not the last word on policy reforms to the NFIP. The program remains insolvent, and the environmental consequences of land development will continue to be an important and contentious issue. Having quantitative assessments of how people respond to flood insurance and regulatory changes is essential to good policy. Our work contributes to this debate, but further research than enhances our estimates of the economic effects of NFIP is clearly warranted.

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Table 1: Summary Statistics

Variable	Description	Full Sample Mean	Full Sample Std. Dev.	Non-Coastal Counties Mean	Non-Coastal Counties Std. Dev.	Coastal Counties Mean	Coastal Counties Std. Dev.
n	Communities per county	6.50	7.00	4.94	4.14	7.94	8.59
Y	County-wide real income (log)	7.77	0.66	7.82	0.60	7.72	0.71
ΔY	County-wide real income growth	0.01	0.04	0.01	0.04	0.02	0.03
W	County-wide real wage (log)	7.99	0.68	8.11	0.61	7.88	0.73
$NFIP_1$/n	NFIP participation (FIRM) per n	0.69	0.42	0.53	0.43	0.83	0.37
$NFIP_2$/n	NFIP participation (membership) per n	0.69	0.42	0.55	0.42	0.82	0.37
$Flood_1$	Flood acreage, zones A,AE,AH,AO,VE	398.67	827.78	501.25	1091.42	304.89	452.89
$Flood_2$	Flood acreage, zones AE,AO,VE	124.40	171.40	81.19	116.12	163.91	201.67
$Flood_{\%1}$	Flood acreage, A,AE,AH,AO,VE % land	0.10	0.16	0.11	0.20	0.09	0.11
$Flood_{\%2}$	Flood acreage, AE,AO,VE, % land	0.04	0.09	0.02	0.03	0.06	0.12
Permits/n	Permits per community	325.40	460.72	183.05	313.14	455.55	530.51
Permits	County-wide permits	2,216.95	3,599.05	1,000.60	1,983.75	3,329.04	4,315.22
SFpermits/n	Single-family permits per community	215.64	272.53	135.00	217.17	289.37	296.23
SFpermits	County-wide single-family permits	1,366.79	1,907.50	706.96	1,226.37	1,970.06	2,198.11
Starts/n	Starts per community	314.77	435.51	178.10	299.10	439.72	498.78
Starts	County-wide starts	2,129.95	3,385.75	969.51	1,880.48	3,190.93	4,045.37
SFstarts/n	Single-family starts per community	214.79	270.64	134.79	216.50	287.93	293.66
SFstarts	County-wide single-family starts	1,360.60	1,890.83	704.89	1,220.69	1,960.11	2,175.46
Pop/n	Population per community	24,480.36	31,723.42	15,803.95	19,998.66	32,413.08	37,817.18
Pop	County-wide population	180,497.50	315,970.36	83,218.82	131,379.44	269,438.01	398,588.30
SFprice	Real price of single-family units	40,050.46	18,628.76	30,808.12	11,002.18	48,500.60	20,110.27

Notes: The data are annual from 1976 to 1998 (except for SFPrice, which begins in 1981). The full sample includes all of Florida's 67 counties, of which 32 are non-coastal and 35 are coastal.

Table 2: Estimation results for permits and starts from the full county sample.

	Permits/n 1	Permits/n 2	Starts/n 3	Starts/n 4
Panel A: FIRM Date				
$NFIP$	70.90*	81.24**	65.42*	71.85*
	(39.22)	(39.88)	(36.42)	(36.91)
$NFIP \times Flood_1$	0.01		0.01	
	(0.03)		(0.03)	
$NFIP \times Flood_2$	0.28		0.22	
	(0.30)		(0.24)	
$NFIP \times Flood_{\%1}$		57.17		66.92
		(99.46)		(92.77)
$NFIP \times Flood_{\%2}$		612.01		557.76
		(887.12)		(780.19)
$pop/n(lag)$	-0.44	-0.39	-0.50	-0.47
	(0.38)	(0.34)	(0.38)	(0.36)
Y/n	152.34	144.95	134.39	127.91
	(151.64)	(150.27)	(147.59)	(146.80)
$\Delta Y/n$	17.52	18.52	-33.99	-31.98
	(105.33)	(103.45)	(96.43)	(93.91)
W/n	40.72	34.47	69.38	63.13
	(134.37)	(134.99)	(121.06)	(121.57)
Constant	-1,162.68	-1,073.59	-1,240.85	-1,155.20
	(1,356.13)	(1,343.46)	(1,274.90)	(1,264.32)
R^2	0.14	0.14	0.16	0.15
F stat	2.74	2.99	3.53	3.78
Panel B: Membership Date				
$NFIP$	89.65*	102.33**	82.47*	90.63**
	(46.26)	(47.43)	(43.34)	(44.52)
$NFIP \times Flood_1$	0.01		0.01	
	(0.03)		(0.03)	
$NFIP \times Flood_2$	0.28		0.22	
	(0.31)		(0.25)	
$NFIP \times Flood_{\%1}$		59.52		70.20
		(83.96)		(77.47)
$NFIP \times Flood_{\%2}$		615.14		542.90
		(913.12)		(796.31)
$pop/n(lag)$	-0.44	-0.39	-0.50	-0.46
	(0.37)	(0.34)	(0.38)	(0.35)
Y/n	137.35	128.18	121.41	113.22
	(151.70)	(150.35)	(147.56)	(146.78)
$\Delta Y/n$	18.48	20.79	-32.99	-30.08
	(105.86)	(103.60)	(97.24)	(94.43)
W/n	51.68	46.36	79.50	73.99
	(135.46)	(136.55)	(122.41)	(123.29)
Constant	-1,153.72	-1,057.80	-1,238.88	-1,144.84
	(1,330.32)	(1,316.35)	(1,252.65)	(1,240.85)
R-squared	0.15	0.15	0.16	0.16
F stat	2.87	3.03	3.90	4.13

Notes: ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parenthesis. The models presented above include county and year fixed effects. The coefficients for the counties and years are omitted. There are 1474 observations in each regression.

Table 3: Estimation results for coastal and non-coastal sub-samples (FIRM date measure of NFIP participation.)

Panel A: Non-Coastal Counties								
	Permits/n	Permits/n	Starts/n	Starts/n	SF Permits/n	SF Permits/n	SF Starts/n	SF Starts/n
	1	2	3	4	5	6	7	8
$NFIP$	107.68**	114.81**	93.19**	98.54**	65.16**	66.89**	59.73**	60.93**
	(43.62)	(44.37)	(38.24)	(38.52)	(30.93)	(29.67)	(28.94)	(27.74)
$NFIP \times Flood_1$	-0.01		-0.00		0.02		0.02	
	(0.05)		(0.04)		(0.04)		(0.04)	
$NFIP \times Flood_2$	0.20		0.17		-0.09		-0.04	
	(0.43)		(0.35)		(0.29)		(0.28)	
$NFIP \times Flood_{\%1}$		123.14		114.52		172.69**		155.03*
		(95.66)		(86.09)		(81.79)		(76.59)
$NFIP \times Flood_{\%2}$		-325.21		-222.99		-741.05		-501.01
		(1,027.86)		(871.32)		(828.55)		(781.67)
$pop/n(lag)$	0.69	0.75*	0.64	0.68*	0.62*	0.65**	0.60**	0.63**
	(0.43)	(0.44)	(0.38)	(0.39)	(0.30)	(0.31)	(0.29)	(0.29)
Y/n	-66.39	-64.24	-69.48	-67.26	-66.20	-59.23	-63.49	-58.29
	(121.29)	(114.85)	(116.06)	(110.89)	(95.10)	(91.81)	(90.89)	(88.69)
$\Delta Y/n$	-116.85*	-111.94	-105.15*	-100.58*	-40.63	-39.23	-38.05	-36.08
	(66.50)	(67.50)	(58.74)	(59.26)	(42.92)	(44.02)	(40.65)	(41.75)
W/n	34.78	50.85	34.43	47.17	11.41	19.13	14.16	20.08
	(121.84)	(126.00)	(111.64)	(114.99)	(82.79)	(80.72)	(78.60)	(77.56)
Constant	252.17	99.76	299.64	174.77	431.06	311.60	395.53	304.70
	(1,581.67)	(1,554.69)	(1,480.13)	(1,461.01)	(1,129.21)	(1,074.93)	(1,075.50)	(1,044.35)
R-squared	0.17	0.17	0.19	0.19	0.24	0.24	0.25	0.25
F stat	172.35	165.03	42.68	59.72	39.16	42.10	33.42	37.09
Panel B: Coastal Counties								
$NFIP$	-91.76	-66.11	-71.71	-53.87	-58.73	-57.74	-56.55	-53.31
	(88.60)	(80.92)	(83.09)	(76.87)	(52.15)	(54.13)	(50.87)	(52.51)
$NFIP \times Flood_1$	0.02		0.01		-0.02		-0.02	
	(0.02)		(0.02)		(0.01)		(0.01)	
$NFIP \times Flood_2$	0.52		0.45		0.18		0.17	
	(0.38)		(0.32)		(0.12)		(0.11)	
$NFIP \times Flood_{\%1}$		84.42		73.80		-43.28		-50.59
		(126.25)		(127.65)		(82.50)		(77.27)
$NFIP \times Flood_{\%2}$		1,423.84		1,287.66		650.54		574.45
		(1,028.93)		(913.21)		(552.29)		(495.02)
$pop/n(lag)$	-0.98***	-0.89***	-1.05***	-0.97***	-0.41*	-0.38*	-0.32	-0.30
	(0.32)	(0.25)	(0.34)	(0.28)	(0.21)	(0.20)	(0.21)	(0.20)
Y/n	589.40**	593.53**	531.58**	536.83**	264.13*	268.51*	272.25*	275.90*
	(243.13)	(235.46)	(230.20)	(223.80)	(151.65)	(150.74)	(150.10)	(148.98)
$\Delta Y/n$	156.24	169.59	-33.87	-22.19	-33.02	-28.44	-50.42	-46.75
	(266.89)	(253.10)	(273.63)	(261.09)	(194.78)	(193.82)	(183.23)	(181.99)
W/n	-358.13	-396.73	-239.15	-271.50	-292.23	-295.29	-298.08*	-300.40
	(281.36)	(271.77)	(253.41)	(244.79)	(174.21)	(178.61)	(174.74)	(177.98)
Constant	-1,056.29	-832.77	-1,496.88	-1,324.71	667.69	639.76	629.86	603.20
	(1,986.97)	(1,855.11)	(1,816.73)	(1,714.11)	(1,171.34)	(1,172.49)	(1,146.24)	(1,142.67)
R-squared	0.24	0.23	0.27	0.26	0.21	0.21	0.21	0.21
F stat	42.48	67.34	25.24	30.46	23.89	21.53	12.47	10.88

Notes: ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parenthesis. The models presented above include county and year fixed effects. The coefficients for the counties and years are omitted. There are 704 and 770 observations in the regressions of panels A and B, respectively.

Table 4: Estimation results for coastal and non-coastal sub-samples (Membership date measure of NFIP participation.)

Panel A: Non-Coastal Counties								
	Permits/n	Permits/n	Starts/n	Starts/n	SF Permits/n	SF Permits/n	SF Starts/n	SF Starts/n
	1	2	3	4	5	6	7	8
$NFIP$	134.76***	139.59***	117.10***	120.26***	84.86**	85.50**	77.92**	77.90**
	(42.21)	(43.04)	(37.13)	(37.38)	(31.66)	(31.41)	(29.81)	(29.59)
$NFIP \times Flood_1$	-0.01		-0.01		0.02		0.02	
	(0.04)		(0.04)		(0.03)		(0.03)	
$NFIP \times Flood_2$	0.27		0.23		-0.06		-0.01	
	(0.38)		(0.30)		(0.24)		(0.22)	
$NFIP \times Flood_{\%1}$		78.10		76.85		126.37**		115.91**
		(58.22)		(51.96)		(50.88)		(46.32)
$NFIP \times Flood_{\%2}$		12.78		79.87		-505.29		-277.64
		(903.90)		(748.90)		(716.60)		(669.92)
$pop/n(lag)$	0.65	0.70*	0.60	0.64*	0.60**	0.62**	0.58**	0.60**
	(0.40)	(0.41)	(0.36)	(0.37)	(0.27)	(0.28)	(0.26)	(0.27)
Y/n	-76.73	-77.59	-78.38	-78.90	-73.70	-69.58	-70.29	-67.72
	(120.48)	(116.39)	(115.18)	(112.05)	(93.88)	(91.85)	(89.71)	(88.67)
$\Delta Y/n$	-108.29	-101.52	-97.58*	-91.47	-34.02	-32.48	-32.03	-29.86
	(64.58)	(64.14)	(56.90)	(56.28)	(41.40)	(42.38)	(39.01)	(40.03)
W/n	55.43	70.91	52.70	64.77	26.34	32.85	28.12	32.87
	(126.38)	(130.85)	(114.95)	(118.56)	(84.86)	(83.51)	(80.45)	(79.84)
Constant	165.20	42.02	220.73	123.60	367.93	280.95	334.93	274.57
	(1,541.92)	(1,538.19)	(1,441.83)	(1,444.22)	(1,091.28)	(1,055.14)	(1,040.98)	(1,026.41)
R-squared	0.19	0.18	0.20	0.20	0.25	0.26	0.26	0.27
F stat	356.34	391.78	53.81	59.02	34.76	38.79	20.75	25.75
Panel B: Coastal Counties								
$NFIP$	-85.19	-54.58	-68.22	-46.39	-61.00	-58.71	-58.42	-53.92
	(87.76)	(78.84)	(81.49)	(74.24)	(49.66)	(51.31)	(48.58)	(49.89)
$NFIP \times Flood_1$	0.02		0.02		-0.02		-0.02	
	(0.02)		(0.02)		(0.01)		(0.01)	
$NFIP \times Flood_2$	0.53		0.45		0.19		0.18	
	(0.40)		(0.34)		(0.12)		(0.11)	
$NFIP \times Flood_{\%1}$		79.78		73.73		-34.48		-42.70
		(124.96)		(125.88)		(78.63)		(73.60)
$NFIP \times Flood_{\%2}$		1,398.24		1,253.22		643.78		562.38
		(1,075.36)		(939.93)		(560.88)		(505.02)
$pop/n(lag)$	-0.99***	-0.88***	-1.05***	-0.97***	-0.41*	-0.38*	-0.33	-0.30
	(0.33)	(0.25)	(0.34)	(0.28)	(0.21)	(0.20)	(0.21)	(0.20)
Y/n	587.13**	588.50**	529.83**	533.00**	273.46*	277.13*	281.33*	284.20*
	(249.50)	(241.55)	(236.38)	(230.24)	(156.00)	(155.73)	(154.49)	(153.91)
$\Delta Y/n$	143.66	158.28	-43.90	-31.66	-38.17	-33.91	-55.34	-51.80
	(267.22)	(251.75)	(274.60)	(260.52)	(195.19)	(193.55)	(183.76)	(181.88)
W/n	-352.90	-391.18	-236.33	-268.64	-295.05*	-298.96	-300.91*	-303.92*
	(284.86)	(275.14)	(255.55)	(247.08)	(174.23)	(178.34)	(174.79)	(177.86)
Constant	-1,084.55	-836.58	-1,508.46	-1,315.12	620.08	607.01	584.13	571.34
	(2,003.70)	(1,857.13)	(1,842.90)	(1,730.73)	(1,188.08)	(1,186.02)	(1,160.94)	(1,153.97)
R-squared	0.24	0.23	0.27	0.26	0.21	0.21	0.21	0.21
F stat	44.88.71.97	28.42.36.44	26.00.22.30	13.56.11.98				

Notes: ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses. The models presented above include county and year fixed effects. The coefficients for the counties and years are omitted. There are 704 and 770 observations in the regressions of panels A and B, respectively.

Table 5: Estimation results for population and house prices coastal and non-coastal county sub-samples for both measures of NFIP participation.

	Non-Coastal Counties				Coastal Counties			
	pop/n	pop/n	sfprice	sfprice	pop/n	pop/n	sfprice	sfprice
Panel A: FIRM Date								
$NFIP$	150.11**	171.72**	1,876.56**	1,835.16**	-226.67	-112.01	-586.79	-249.70
	(63.27)	(64.29)	(880.85)	(891.79)	(220.86)	(222.02)	(4,135.82)	(4,559.26)
$NFIP \times Flood_1$	-0.06		1.68		-0.02		-2.58	
	(0.08)		(2.50)		(0.09)		(1.63)	
$NFIP \times Flood_2$	0.79		-9.93		1.73*		-15.02	
	(0.84)		(17.20)		(0.95)		(26.64)	
$NFIP \times Flood_{\%1}$		62.71		5,595.85		-414.39		-12,753.35
		(148.03)		(5,795.22)		(600.95)		(9,114.65)
$NFIP \times Flood_{\%2}$		290.45		-27,701.11		5,166.67*		-52,053.35
		(1,642.81)		(47,493.95)		(2,688.53)		(129,550.61)
$pop/n(lag)$	100.46***	100.58***	10.10	10.32	98.10***	98.37***	-3.96	-4.38
	(0.31)	(0.38)	(6.88)	(6.77)	(0.56)	(0.62)	(11.15)	(10.75)
Y/n	3.37	-7.54	6,001.60	6,149.63	1,285.26*	1,260.23*	60,016.59***	60,054.34***
	(211.48)	(209.68)	(4,430.74)	(4,455.99)	(691.27)	(667.70)	(15,677.62)	(15,605.62)
$\Delta Y/n$	-835.88**	-824.10**	-6,771.17	-6,795.56	9,083.85	9,149.22	-65,864.20***	-66,374.07***
	(375.32)	(372.95)	(4,411.11)	(4,421.78)	(7,410.27)	(7,443.93)	(10,400.95)	(10,397.74)
W/n	120.54	157.88	5,467.83	5,529.04	1,535.20	1,483.60	1,104.35	2,034.18
	(281.81)	(296.75)	(4,732.10)	(4,734.67)	(1,922.48)	(1,965.60)	(15,585.86)	(15,692.14)
Constant	-770.98	-1,002.28	-62,347.21	-64,049.57	-21,178.91	-20,758.08	-418,033.93**	-424,637.11**
	(3,372.98)	(3,466.77)	(66,367.50)	(66,495.56)	(16,245.29)	(16,283.00)	(162,326.57)	(160,458.21)
R-squared	1.00	1.00	0.39	0.40	0.99	0.99	0.54	0.54
F stat	56462.52	46390.74	35.31	53.75	40008.57	33822.35	20.08	16.39
Panel B: Membership Date								
$NFIP$	186.95**	204.37***	1,744.80	1,704.43	-204.66	-74.66	-731.03	-1,241.34
	(71.82)	(73.11)	(1,035.24)	(1,038.16)	(214.65)	(215.24)	(4,297.32)	(4,783.39)
$NFIP \times Flood_1$	-0.06		0.48		-0.02		-2.40	
	(0.07)		(1.60)		(0.09)		(1.63)	
$NFIP \times Flood_2$	0.90		-0.74		1.80*		-25.28	
	(0.85)		(13.02)		(1.03)		(26.73)	
$NFIP \times Flood_{\%1}$		16.63		2,309.56		-463.66		-11,895.90
		(115.01)		(3,282.09)		(582.55)		(8,919.44)
$NFIP \times Flood_{\%2}$		717.37		-573.85		5,195.24*		9,085.83
		(1,720.37)		(39,413.28)		(2,877.40)		(133,703.81)
$pop/n(lag)$	100.40***	100.51***	8.56	8.63	98.08***	98.38***	-3.09	-5.90
	(0.33)	(0.42)	(7.08)	(7.05)	(0.56)	(0.61)	(11.28)	(11.37)
Y/n	-11.63	-25.00	6,099.43	6,184.78	1,258.22*	1,216.78*	61,304.03***	60,838.00***
	(219.74)	(220.49)	(4,453.81)	(4,463.39)	(680.62)	(656.34)	(16,017.77)	(15,775.87)
$\Delta Y/n$	-826.37**	-809.53**	-6,493.58	-6,519.02	9,049.67	9,120.19	-65,902.49***	-66,547.79***
	(373.74)	(370.50)	(4,417.74)	(4,422.23)	(7,414.70)	(7,451.99)	(10,491.57)	(10,700.25)
W/n	147.72	186.27	5,904.13	5,963.07	1,553.80	1,507.13	480.25	1,923.57
	(285.14)	(300.58)	(4,843.09)	(4,842.88)	(1,904.76)	(1,944.63)	(15,610.63)	(15,685.97)
Constant	-874.85	-1,094.68	-66,439.58	-67,644.39	-21,134.28	-20,608.75	-421,720.42**	-432,456.34**
	(3,338.92)	(3,456.93)	(67,345.11)	(67,298.18)	(16,114.79)	(16,069.28)	(161,830.45)	(161,456.69)
R-squared	1.00	1.00	0.39	0.39	0.99	0.99	0.55	0.54
F stat	83276.21	65735.58	34.04	64.66	43279.53	35227.18	20.02	17.74

Notes: ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses. The models presented above include county and year fixed effects. The coefficients for the counties and years are omitted. There are 704 observations in the non-coastal regressions and 770 observations in the coastal regressions for the permits and starts data. In the house price regressions, there are 576 and 630 observations, respectively.

Figure 1: Initial Florida Community Participation in NFIP

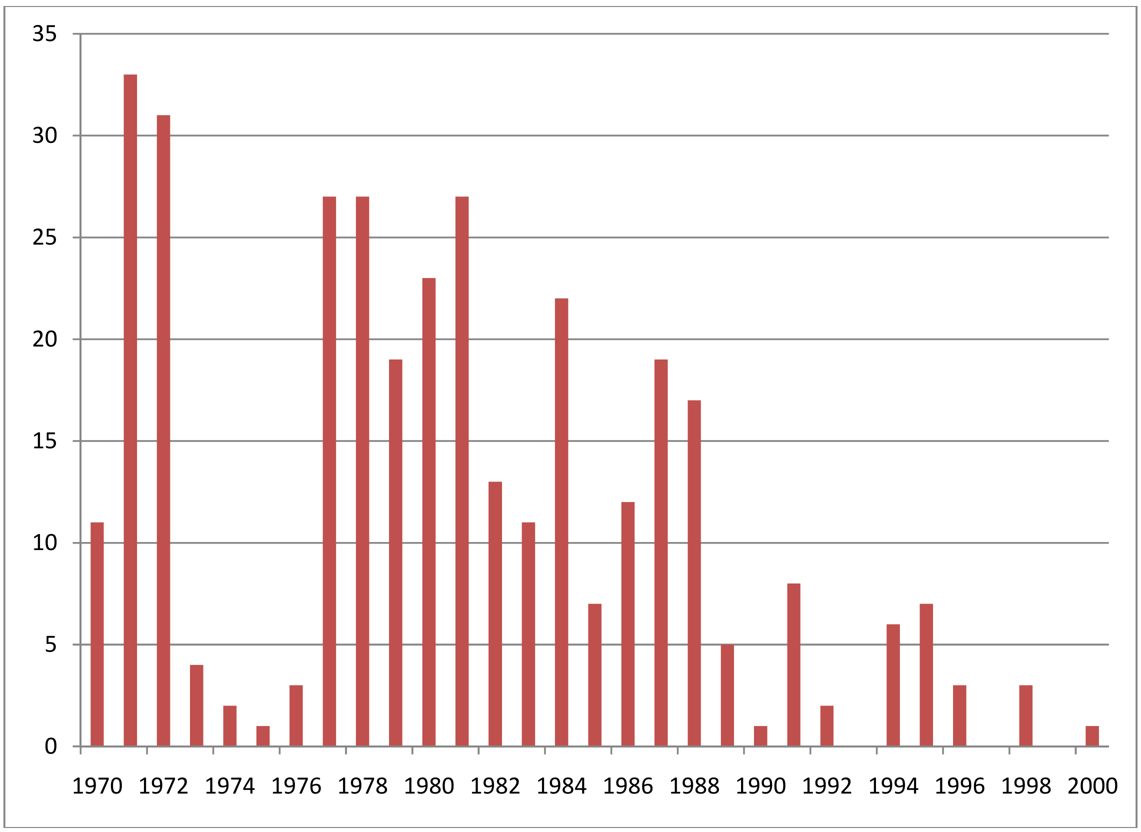

Figure 2: Percent of county population eligible for NFIP and percent of communities in a county participating in the NFIP