Moral Hazard and The National Flood Insurance Program

Mary McGee
Colgate University, ECON 490
Sponsor: Michael O'Hara
April 30, 2014

Abstract
The number of National Flood Insurance Program (NFIP) policies in force, the number of claims the program pays, and the value of these claims are associated with properties located in a floodplain. If the insurance program is structured so that the availably of insurance encourages people to live in dangerous flood prone areas they are incentivizing risky behavior and thus there is moral hazard present. The Flood Insurance Reform Acts of 1994 and 2004 were enacted to reduce damages caused by flood events. In this paper I find evidence to suggest that the Reform Act of 1994 was associated with an increase in the number of claims paid by the NFIP, not reducing the moral hazard problem. The 2004 Act was successful in reducing the value of claims paid by the NFIP and the number of policies in force, reducing the moral hazard present. Additionally, the Reform Act of 2004 authorized two grant programs that were not funded until 2006. These grant programs are associated with a decrease in the number of NFIP policies in force, further reducing the moral hazard problem.

Acknowledgements
I would like to thank Professor Michael O'Hara and the students of ECON 489, ECON 490, and ECON 428 for all their help in developing this project. This research would also not have been possible without the help of dedicated librarians Peter Rogers and Mary-Jane Walsh. Alan Escobar at the Small Business Administration and Susan Bernstein from the Federal Emergency Management Agency were also an integral part of the data collection process.

JEL Classifications:
G22: Insurance; Insurance Companies
Q54: Climate; Natural Disasters; Global Warming
Q58: Environmental Economics: Government Policy
Keywords: Moral Hazard, Flood Insurance

1. Introduction

The National Flood Insurance Program (NFIP) is one of the main suppliers of aid to disaster victims (Holladay and Schwartz, 2010), and is practically the sole provider of flood insurance for homeowners and small businesses (Cleetus, 2014). Since its establishment in 1968, the program has paid out more than $43 billion in claims and more than 5.5 million people hold NFIP policies across the country (Flood Smart, 2013). In 1978 the NFIP came under the jurisdiction of the Federal Emergency Management Agency (FEMA). The main goals of the program are to: (1) identify flood risk areas across the country, (2) minimize the economic impact of flood events using floodplain management, and (3) provide affordable flood insurance to individuals and businesses (King, 2011). To do this the NFIP provides highly subsidized flood insurance to homeowners, renters, condo owners/renters, and commercial owners/renters (SBA, 2013a), and policyholders pay just 10% of the actual cost of flood insurance (Platt, 1976).

These highly subsidized rates have inadvertently encouraged people to live in vulnerable flood-prone areas, leading to a moral hazard problem. Homeowners are not paying the full costs associated with living in these hazardous areas (Cleetus, 2014). Moral hazard is present if the NFIP encourages risky behavior creating incentives for people to live in flood prone areas. Unless there are incentives to move out of a floodplain or to mitigate future flood damages moral hazard is present. I find evidence that changes that have been made to the NFIP have not always been successful in reducing this problem.

Throughout the history of the NFIP there have been a number of significant changes to the program. I focus on two Acts, which were designed to reduce insurance claims: the Flood Insurance Reform Act of 1994 (FIRA 1994) and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (FIRA 2004) (EDEN, 2014).

If these two Acts, FIRA 1994 and FIRA 2004, were successful in reducing the number of insurance polices, the number of claims paid, or the value of these insurance claims they would also reduce the moral hazard problem. To my knowledge, there is no existing academic literature that evaluates flood insurance using a moral hazard lens. The newspaper articles and scientific reports that do focus on this issue do not use data to back up their claims. In this paper I conduct a multivariate regression and present results that suggest FIRA 1994 is associated with an increase in the number of claims paid by the NFIP, not reducing the moral hazard problem. On the other hand, FIRA 2004 was successful in achieving its goal. This Act is associated with a decrease in the number of NFIP policies in force and in the value of claims paid, and thus reduced the moral hazard present. Additionally, the 2006 grant programs, which were created from FIRA 2004, are associated with a decrease in the number of new NFIP policies in force, providing further evidence for a reduction in moral hazard.

2. Background

2.1 Flooding and the National Flood Insurance Program (NFIP)

Since 1953 natural disasters have caused over $723 billion of damage in the U.S. (EM-DAT, 2013). Of natural disasters, floods have been the most costly in the United States in the 20th century based on lives lost and property damage (King, 2011; Perry, 2000). Nearly 90% of presidential disaster declarations are associated with flood events (Jenkins, 2004). According to the National Science and Technology Council, flooding caused by weather-related coastal hazards, such as hurricanes, is predicted to increase in severity and frequency (King, 2011). This continues to be a serious problem since now more than 50% of the U.S. population lives in coastal areas or floodplains, and nearly 50% of the national GDP comes from coastal zones.

Before the creation of the NFIP in 1968, there was no standardized floodplain management strategy throughout the country and flood insurance was not widely available through private companies. If insurance was offered rates were generally too high to be afforded by the majority of the population (Platt, 1976). During the 50s and 60s there were some major flood events that encouraged a more comprehensive disaster plan. Notably, the Great Flood of 1951 in Kansas and Missouri, Hurricane Carla in 1962, the Alaskan earthquake and subsequent flood in 1964, and finally Hurricane Betsy in 1965 (Felton et. al, 1971). Hurricane Betsy was the first natural disaster to generate more than a billion dollars in damages. At the time there was not a flood insurance program in place; individuals could apply for disaster loans but there was no guarantee of federal support. Hurricane Betsy was the final push for the creation of national flood legislation (Holladay and Schwartz, 2010).

The implementation of the NFIP was intended to make flood insurance more affordable, but also to manage development in floodplains. Coverage is only available to consumers with a federally insured mortgage in communities that have implemented floodplain management strategies (King, 2011). If a community has a greater than 1% chance of flood occurrence in a given year then it is eligible to participate in this program, and once a community has been identified as eligible the purchase of flood insurance is mandatory (Department of the Treasury, 2013). Management strategies can include anything from land use restrictions to improved building standards, with intent to discourage floodplain development and increase building safety. However, due to the extremely high subsidies, and the presence of moral hazard, the flood insurance program could actually end up encouraging floodplain development (Platt, 1976).

A lot of the existing research about the NFIP gives a historical account of the program, including information on why it was implemented and why it went through different changes. Platt (1976) praises the NFIP, claims its superiority over the previous structure and encourages its widespread implementation. Felton et al. (1971) also clearly state some benefits of the program and break down these benefits into different sectors of the economy. On the other hand, the more recent literature details some of the problems with the flood program, especially after the events of Hurricane Katrina and Rita in 2005.

In a median year the NFIP can balance its budget through premium payments and claim losses. However, during a year with catastrophic events this program loses money. As these events continue, without time for the program to recover and balance its budget, the NFIP generates

debt. Due to the severity of Hurricane Katrina and the subsequent demand on the NFIP it now has a deficit of over $20 billion (Cleetus, 2014). The NFIP is one of the United States government's largest financial commitments (Cleetus, 2014). The debt is supposed to be paid back to the U.S. Treasury with interest, but as the program is currently structured it will never be able to do this. Congress has set statutory limits on the insurance rates so the program cannot charge rates high enough to build reserve funds that would cover demand during years with catastrophic events (Holladay and Schwartz, 2010). Additionally, the NFIP does not increase rates for properties that have flooded in the past (Cleetus, 2014).

In addition to detailing the current financial situation of the NFIP, Holladay and Schwartz (2010) discuss the geographic distribution, by state, of the program's policies and benefits. The authors focus on the finances of the program and conclude that subsidizing new and existing development in flood zones is financially unsound.

Michel-Kerjan (2010) also describes the distribution of NFIP policies by state and explains that the program is not designed to handle catastrophic events. The author identifies five challenges the NFIP faces and provides some suggestions for improvement. In addition to improving flood maps, increasing participation rates, and encouraging investment in risk reduction measures, Michel-Kerjan presents reducing repetitive losses as one way to improve the effectiveness of the program.

Many reports have also been written to inform congress about the status of the program and to help them make informed decisions about the future of the program. R.O. King authors many of these reports for the Congressional Research Service. The report published in 2011 provides a detailed background of the program including the current challenges it faces and its financial status. King specifically identifies repetitive losses as a primary reason the program cannot pay back its debt. The author also mentions the overall problem of moral hazard associated with federal disaster aid, which unintentionally lowers incentive to avoid risks.

The Congressional Budget Office (CBO, 2009) has also published reports to congress on the NFIP, similar to the King (2011) report. This report addresses the general problem with disaster relief as subsidizing risky behavior. The CBO also explains Repetitive Loss Properties (RLP) and compares the growth rate of the number of these claims to the total growth rate of all claims.

2.2 Changes to the NFIP

2.2a Flood Insurance Reform Act of 1994

According to FEMA, the goal of the Flood Insurance Reform Act of 1994 (FIRA 1994) was to "make the NFIP more effective in achieving its goals of reducing the risk of flood damage to properties and reducing Federal expenditures for uninsured properties that are damaged by floods" (FEMA, 2009c). The main purpose of this Act was to make general improvements to the NFIP and increase participation for eligible individuals, which could increase the number of total NFIP policies in force.

In order for the NFIP to achieve these goals, the FIRA 1994 implemented fines for mortgage lenders that did not ensure mandatory purchase of flood insurance for properties located in

hazard areas (FEMA, 2009a). This act increased coverage limits for the NFIP and established "cost of compliance coverage" for property owners trying to improve their property in accordance with local regulations (FEMA, 2009a). FIRA 1994 also created the Flood Mitigation Assistance Grant Program, to help communities develop and implement strategies to reduce future damages, and the Community Rating System, which provides financial incentives (above those set by the NFIP) to adopt management practices (FEMA, 2009a).

Additionally, this reform act created a two year Flood Insurance Task Force to develop a plan to increase insurance enforcement, reassess flood maps every five years, and complete regular erosion reports. Lastly, the act instructed the director to determine the economic impact of charging actuarially-based premium rates for structures that had been grandfathered in to the insurance program (Govtrack.us, 2014a).

2.2b Bunning – Bereuter – Blumenauer Flood Insurance Reform Act of 2004

The goal of the Flood Insurance Reform Act of 2004 (FIRA 2004) was "to reduce or eliminate future losses to properties in the National Flood Insurance Program" (FEMA, 2009a pg. 2). With the passing of this law, the Director of the NFIP can offer financial assistance to states and communities that are making an effort to reduce future flood damages (Govtrack.us, 2014b). FIRA 2004 authorized the federal government to allocate an increased amount of funding to states and local governments. After the funds were allocated to these local jurisdictions the respective governments could use these funds however they chose in order to mitigate the risk of flood damage. This additional funding should help decrease the number of claims paid and the value of these claims.

The main provision included in this Act was the authorization of funding for the Repetitive Flood Claims Grant Program and the Severe Repetitive Loss Grant Program. The purpose of the Repetitive Flood Claims Grant Program was to "help states and communities reduce flood damages to insured properties that have had one or more claims to the National Flood Insurance Program" (FEMA, 2009a pg. 7-8). This program was allocated $10 million a year from 2006 – 2010 (FEMA, 2009b). From the total allocation, states and local governments may receive different amounts of money based on their needs.

The purpose of the Severe Repetitive Loss Grant Program was to "reduce or eliminate claims under the NFIP through project activities that will result in the greatest savings to the NFIP in the shortest period of time" (FEMA, 2009a pg. 6). This grant program was allocated $40 million in 2006 and 2007, and $80 million in 2008 and 2009 (FEMA, 2009a; FEMA, 2009b). These grants are awarded to state and local governments to mitigate flood damages. If a SRL property owner refuses to make changes to reduce their vulnerability, their insurance premiums can now increase up to 150% of the previous rate (Govtrack.us, 2014b). Ninety percent of the grant program has been targeted to 17 states[1], which each contain 51 or more Severe Repetitive Loss Properties (FEMA implementation, 2009).

[1] Connecticut, Massachusetts, New Jersey, New York, Pennsylvania, Virginia, Alabama, Florida, Kentucky, Mississippi, North Carolina, Illinois, Louisiana, Oklahoma, Texas, Missouri, and California

2.3 Repetitive Loss Properties (RLP) and Severe Repetitive Loss Properties (SRLP)

FEMA defines a Repetitive Loss Property (RLP) as one that has received at least two claim payments of over $1,000 each, within a ten year period (FEMA, 2012). A Severe Repetitive Loss Property (SRLP) is subsequently defined as one that has received at least four claim payments of over $5,000 each, or at least two payments with the cumulative amount exceeding the market value of the property. At least two of these payments must have occurred within a ten-year period (FEMA, 2013).

RLPs and SRLPs are concentrated in just a few states; 43% of RFC properties and 59% of SRLP are in Florida, Louisiana, and Texas (FEMA, 2009a). Historically, these repetitive loss claims account for just 1% of total insured properties but nearly 30% of claim payments made by the NFIP (FEMA, 2009a). These properties are also largely concentrated in coastal and river areas, as to be expected (FEMA, 2009a). More than 50% of RLP are located in three states (Florida, Louisiana, and Texas) (Jenkins, 2004).

3. Literature Review

3.1 Moral Hazard

The idea of moral hazard is common in the insurance literature, but most concentrated in the car insurance market and the health insurance market. Lee (2013) tests for the presence of moral hazard in the Korean car insurance market. In order to assess whether or not regulatory reform was effective in increasing safety incentive Lee conducts a multivariate regression using individual level market data in the years surrounding the reform. The author uses the number of accident claims as the dependent variable. The main research question is, did the regulatory reform have a significant effect on the number of accident claims and thus decrease the moral hazard present? The author does not find the program to have a significant effect but this may be due to the limited amount of data he used (one year before the change, the year of the change, and one year after the change). The author also did not control for the existing trend in accident claims and thus was not able to separate the effect of the trend from the effect of the policy.

Dionne et al. (2005) conducts a similar study to Lee (2013), evaluating a reform change in a car insurance market and testing for moral hazard. In addition to the number of accident claims, the authors also use the number of traffic violations as a dependent variable. Importantly, these authors do account for the existing trend in number of claims.

Winkelmann (2004) and Chiappori et al. (1998) both use the health insurance market, number of doctor visits, and co-payments to test for moral hazard. The basis for moral hazard in this market is the idea that co-payments should increase the incentive to act responsibly, and reduce excessive use of prescription drugs (and thus reduce moral hazard). Winkelmann (2004) uses number of doctor visits as the dependent variable because it is closely related to demand for prescription drugs. This paper uses a health care reform that increased co-payments as the basis for analysis. Additionally, the author is also able to analyze the effect of this reform on different parts of the distribution. Winkelmann finds an overall 10% reduction in the number of doctor visits after this reform. However, this effect is much larger in the lower part of the distribution

(choosing between no visits and one visit), than in the upper part of the distribution (more than one visit).

Chiappori, Durand, and Geoffard (1998) analyzes moral hazard in the French health insurance market using two groups. The first group was faced with a 10% increase in co-payments and the control group, which experienced no change. Again the number of doctor visits is used as the dependent variable. The authors find that moral hazard is present in demand for some physician services, most significantly in home visits.

3.2 Flood Insurance and Moral Hazard

After hurricane Katrina and Rita in 2005, and more recently Sandy in 2012, the NFIP got a lot of press coverage. Numerous newspaper articles and scientific reports made claims about the moral hazard problem within flood insurance. However, besides the program's level of debt none of these articles use any data to support their arguments (Editorial Board, 2012; Gillis and Barringer, 2012; Paul 2012; Cleetus, 2014). Additionally, there is no peer-reviewed academic literature that looks at flood insurance and moral hazard together. This is the gap I intend to fill. Using the Flood Insurance Reform Acts of 1994 and 2004 I will be able to evaluate the effectiveness of these Acts in reducing the number of new NFIP policies in force, the number of claims paid, and the value of these claims, and thus the presence of moral hazard.

4. Model Specification and Data

To test for the presence of moral hazard and the effectiveness of NFIP policy changes I use the change in the number of NFIP policies in force, the number of insurance claims they paid, and the value of these as my dependent variables. Taken together, my dependent variables can provide evidence for moral hazard because these claims are associated with the value of property located in the floodplain. If the NFIP's policies provide incentives for people to increase, or even maintain, the value of their property in a floodplain the insurance is encouraging risky behavior which creates moral hazard.

All variables have one value per year for time *t* 1978-2010, reported at the national level. Since the NFIP only became part of FEMA in 1978 that is how far back they report statistics on flood claims. 2010 is the most recent year I could get information on all the variables for.

In the regressions on the number of claims paid and the value of these claims I control for other sources of funding that flood victims might use such as Small Business Administration (SBA) Disaster Loans, and in the case of a disaster declaration the Presidential Disaster Relief Fund. SBA Disaster Loans, and the Presidential DRF can be employed after any type of disaster, not just floods. The NFIP only provides flood insurance, and thus only pays claims for flood damage. Due to these differences I will control for damages caused by all natural disasters as well as the number of significant flood events in each year.

In regressions on the change in the total number of NFIP policies in force the value of damages caused by natural disasters and the number of significant flood events are lagged. These variables are included to account for events in the previous year that may have influenced

people's decision to purchase flood insurance. These variables are not lagged in the regressions on number of claims paid and value of claims paid because claims are usually filed immediately after a flood event. A dummy variable for Hurricane Katrina is also included in all regressions because this event had a dramatic impact on the NFIP.

Dummy variables for FIRA 1994 (*fira94)* and FIRA 2004 (*fira04*) are included to capture the effect of these major policy changes on claims paid by the NFIP. A dummy variable for 2006 (*grant06*) is included because two of the major grant programs authorized by FIRA 2004 were not funded until 2006. Each of these law variables is also interacted with *year* in order to control for the pre-existing trend in NFIP claim payments.

4.1 Data Sources

Data for the number of NFIP policies in force, the number of flood insurance claims paid, and the value of flood insurance claims paid by the NFIP all came from the 2013 Congressional Research Service Report, *The National Flood Insurance Program: Status and Remaining Issues for Congress* (King, 2013).

Information on the value of Small Business Administration Disaster Loans came from Freedom of Information Act Request (FOIA Request # 2013-1202-1) (FOIA, 2013).

Data on the total amount of appropriations to the Presidential Disaster Relief Fund came from two sources. Data for 1978 – 1988 is from the 2005 Congressional Research Service Report, *Federal Stafford Act Disaster Assistance: Presidential Declarations, Eligible Activities, and Funding* (Bea, 2005). Data for years 1989 – 2010 was retrieved from the 2011 Congressional Research Service Report, *Disaster Relief Funding and Emergency Supplemental Appropriations* (Lindsay and Murray 2011). Both reports provide the same type of information, just for different years.

The number of significant flood events per year is recorded by FEMA (FEMA, 2014). Each event is recorded along with the date it occurred. I counted the number of events in each year and created an annual number of significant flood events for 1978 – 2010.

Data on the total value of damages caused by any type of U.S. natural disaster was retrieved from the International Disaster Database (EM-DAT, 2013). These data are based on official reports published after each disaster and are recorded in thousands of U.S. dollars.

For easier interpretation, I converted all nominal values to real values using the Bureau of Labor Statistics' February 2014, *CPI Detailed Report*. Table 27, entitled: "Historical Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI_W): U. S. city average, all items" reports annual average CPI (Crawford and Church, 2014). Using the formula: *current item price = (base year price)*(current CPI)/(base year CPI)* I converted all my nominal value data to 2010 dollars.

Figure 1 is a graph of the value variables in 2010 US Dollars for 1978 - 2010, the spike at 2005 is a result of catastrophic Hurricane Katrina; Figure 1a just shows years 2000 - 2010. Figure 2

shows the fluctuations in the number of significant flood events over time. Figure 3 displays the total number of NFIP policies in force, Figure 4 the change in the number of policies in force, Figure 5 the total number of claims paid, and Figure 6 the average value of these claims (1978 – 2010).

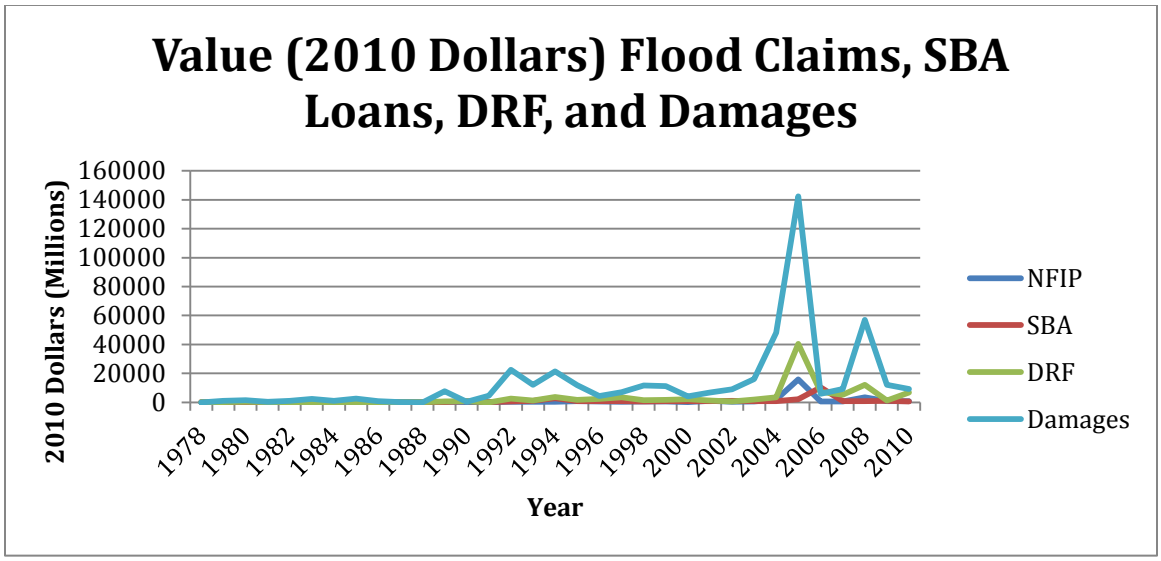

Figure 1: Claims paid by the NFIP, SBA disaster Loans, DRF, and damages caused by Natural Disasters 1978 – 2010

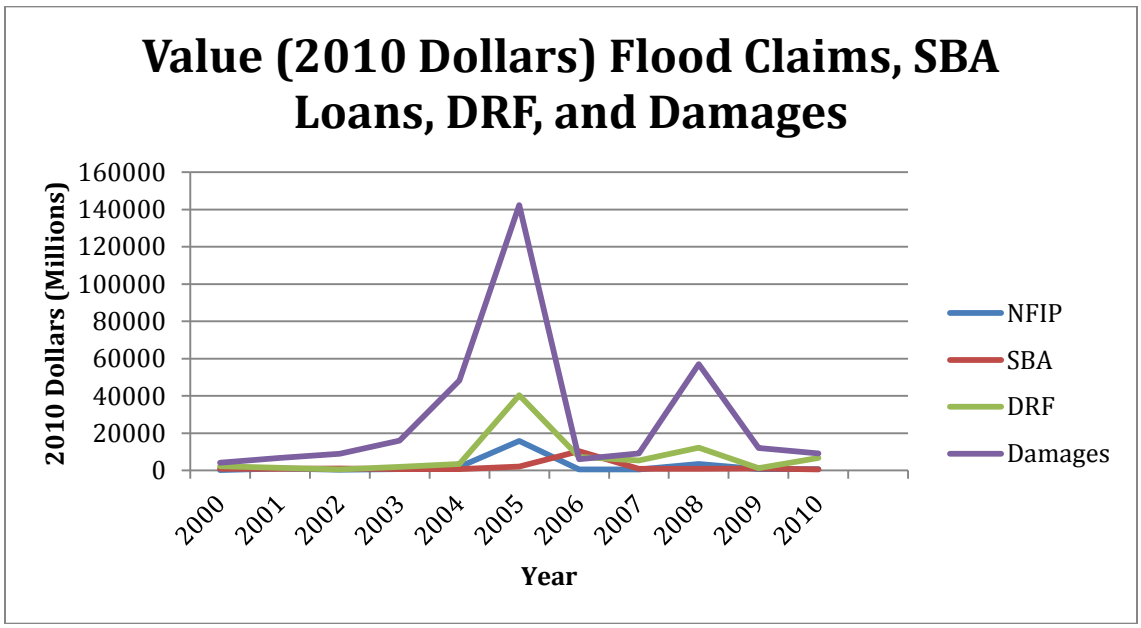

Figure 1a: Claims paid by the NFIP, SBA disaster Loans, DRF, and damages caused by Natural Disasters 2000 - 2010

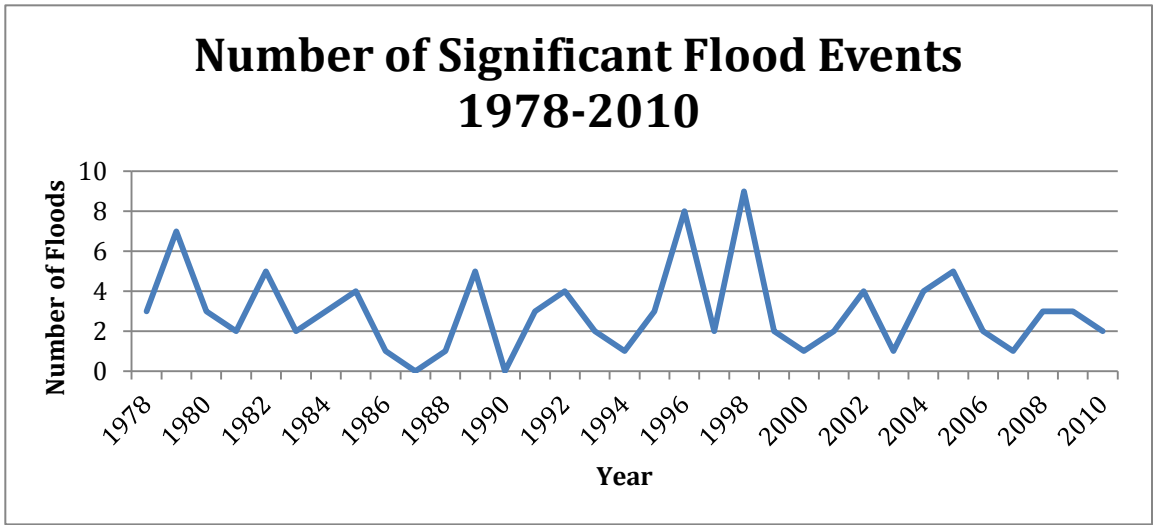

Figure 2: Number of Significant Flood Events

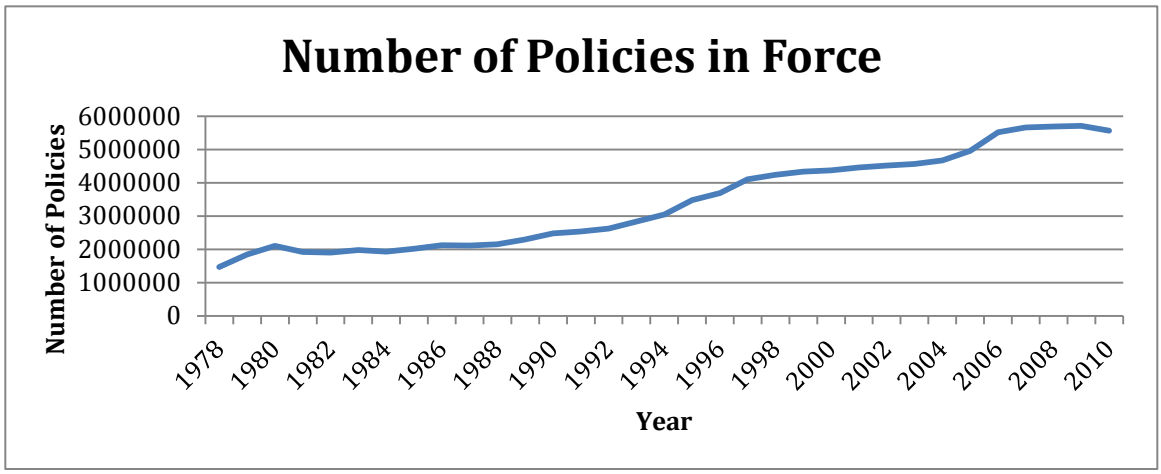

Figure 3: Number of NFIP Polices in Force

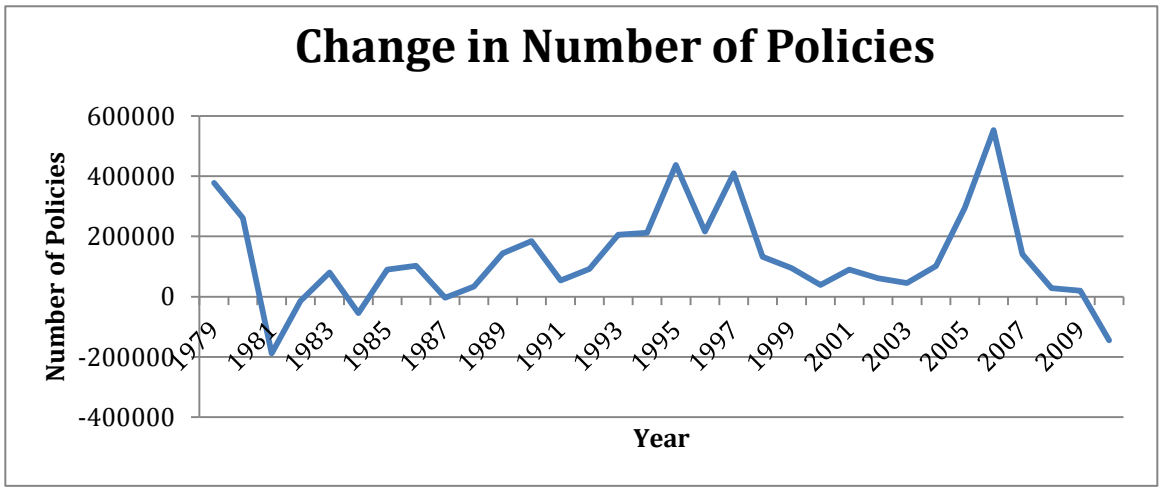

Figure 4: Change in the Number of NFIP Policies in Force

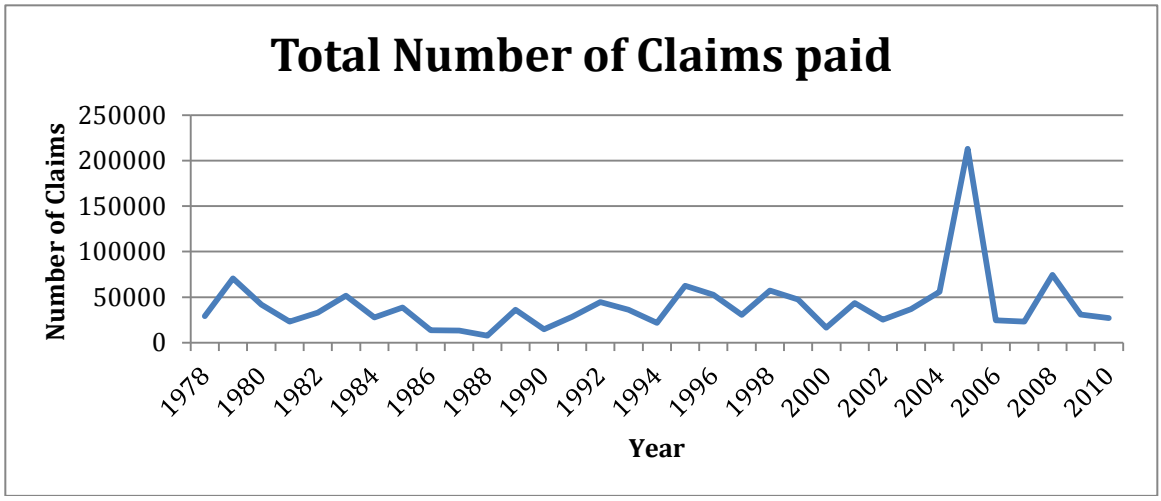

Figure 5: Total Number of Claims paid by NFIP

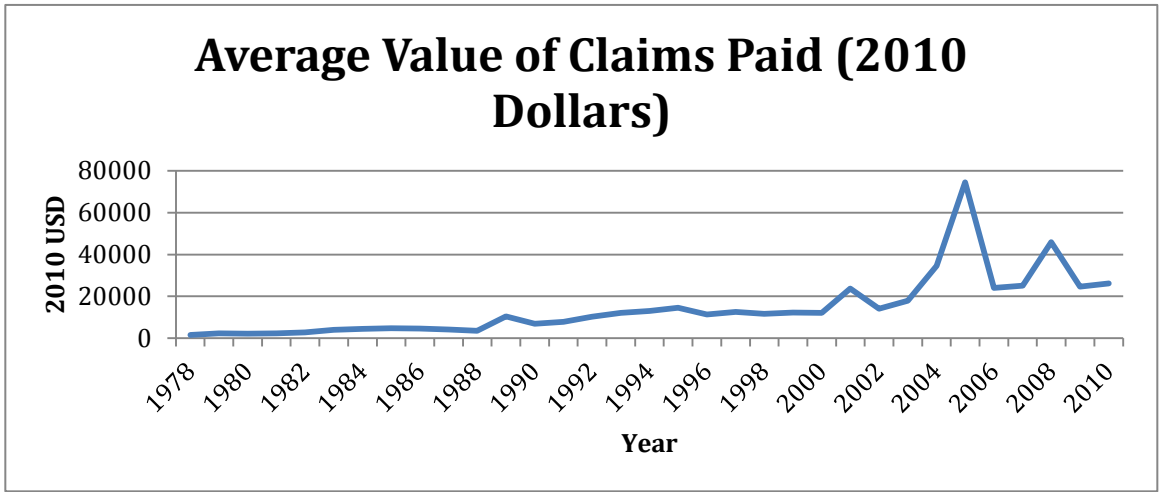

Figure 6: Average Value of NFIP Claims Paid (2010 USD)

I conducted a Dickey-Fuller test for unit root, with a trend, on each variable (results of the test are included in appendix, Table A1). For all variables except the number of NFIP policies in force the p-value was less than 0.01, therefore I reject the null. There is no unit root. With a p-value of 0.8023 I found evidence of a unit root in the number of NFIP policies. This result provides evidence for persistence in this variable, which the trend does not remove. It is likely that individuals who already have an NFIP insurance policy are not dropping out in the next year, but that more people are signing up for these policies. For this reason, I found the difference in the number of policies each year and conducted a first difference regression using the change in the number of policies as the dependent variable.

I also conducted Breusch-Godfrey tests, to test estimates for serial correlation (results of the test are included in the appendix, Table A2). After running this test, with 1, 5, and 10 lags for each dependent variable, I determined that the estimates are serially correlated when using *nfip_claims* and *nfip_claimvlaue* as the dependent variable. To deal with this correlation I report Newey-West standard errors for these regressions.

I took the natural log of each variable except *floods*, *nfip_policies*, and Δ*nfip_policies* before continuing my analysis. Summary statistics for level variables are included below.

Table 1: Summary Statistics – Level Variables

	nfip_policies	***Δnfip_policies***	***nfip_claims***	***nfip_claimvalue****	***sba****	***drf****	***Damages****	***floods***
Min	1466354	-188786	7758	27.7	59.1	0	0	0
Max	5704198	552884	212778	15900	10300	40400	142000	9
Mean	3419090	127905	41006.24	975	930	3140	13500	2.97
Standard Deviation	1400266	160298.3	34997.22	2750	1780	7190	26400	2.11
N	33	32	33	33	33	33	33	33

Note: * = Statistics reported in millions

4.2 Model Specification

To examine the effect of policy changes made to the NFIP, and to test for the presence of moral hazard I specify the following models. I run the three different regressions. The first uses the change in the number of NFIP policies in force (Δ*nfip_policies*) as the dependent variable. The remaining two regressions use the number of claims paid by the NFIP (ln*claims*), and the value of claims paid by the NFIP (ln*claimvalue*) as the dependent variables.

Model 1:

$$NFIP_t = \beta_0 + \beta_1 lagged\ natural\ disasters_t + \beta_3 laws\ + \varepsilon$$

Where:

- NFIP
  - *Δnfip_policies* is the change in the total number of NFIP policies in force from the previous year
- *lagged natural disasters*
  - lagln*damages* is the log of the real value (2010 USD) of damages caused by natural disasters in the United States in the previous year (t-1)
  - lag*floods* is the number of significant flood events that occurred in the previous year
  - *katrina* is a dummy variable taking a 1 for 2005, and a 0 for all other years
- *laws*
  - *year* is an index variable taking values 1 – 33 (1 = 1978, … 33 = 2010)
  - *fira94* is a dummy variable taking a 1 after 1994 and a 0 before
  - *fira94*trend* is *fira94* interacted with *year*, it takes a 0 before 1994, and the value of each year after that
  - *fira04* is a dummy variable taking a 1 after 2004 and a 0 before
  - fira*04*trend* is *fira04* interacted with *year*, it takes a 0 before 2004, and the value of each year after that
  - *grant06* is a dummy variable taking a 1 after 2006 and a 0 before
  - *grant06*trend* is *grant06* interacted with *year*, it takes a 0 before 2006, and the value of each year after that

Model 2:

$$NFIP_t = \beta_0 + \beta_1\ alternate\ \ funding_t + \beta_2\ natural\ disasters_t + \beta_3\ laws + \varepsilon$$

Where:

- *NFIP*
  - ln*claims* is the log of the number of claims paid by the NFIP
  - ln*claimvalue* is the log of the real value (2010 USD) of flood insurance claims paid by the NFIP
- *alternate funding*
  - ln*sba* is the log of the real value (2010 USD) of disaster loans provided by the Small Business Administration
  - ln*drf* is the log of the real value (2010 USD) of money allocated to the Presidential Disaster Relief Fund
- *natural disasters*
  - ln*damages* is the log of the real value (2010 USD) of damages caused by natural disasters in the United States
  - *floods* is the number of significant flood events that occurred in year t
  - *katrina* is a dummy variable taking a 1 for 2005, and a 0 for all other years
- *laws* (see Model 1)

5. Results

Below are results from the regressions of models using Δ*nfip_policies*, ln*claims*, and ln*claimvalue* as the dependent variables; Newey-West standard errors reported for ln*claims* and ln*claimvalue*. I found that the value of damages caused by natural disasters (ln*damages*) and the number of significant flood events (*floods*) in a particular year are important predictors for the number of claims paid and the value of these claims but not for the number of policies in force. Additionally, I found that FIRA 1994 was associated with an increase in the number of NFIP claims paid, but it had no effect on the value of these claims or on the number of policies in force. FIRA 2004 was associated with a decrease in the value of claims paid and the number of policies in force, but had no effect on the number of claims paid. Additionally, the grant programs funded in 2006 were associated with a decrease in the number of NFIP policies in force, but had no significant effect on the number of claims paid or on their value.

Table 2a: Results from Model 1 – dependent variable: *Δnfip_policies*

Variable	*Δnfip_policies* (I)	*Δnfip_policies* (II)	*Δnfip_policies* (III)	*Δnfip_policies* (IV)
lagln*damages*	22300.88 (44088.64)	6643.635 (46820.55)	10757.06 (43401.78)	5507.692 (40937.65)
lag*floods*	21325.62 (17366.16)	21552.11 (17254.54)	24807.86 (18938.58)	21493.34 (17850.22)
year	-2169.739 (6455.948)	763.5008 (13518.24)	922.878 (6990.771)	1685.892 (6732.975)
katrina	120098.9 (73299.38)	160246.7* (93716.51)	-19709.61 (151283.7)	114413.5 (72002.73)
fira94	--	422468.1 (273726.8)	--	--
*fira94*trend*	--	-15580.25 (15399.14)	--	--
fira04	--	--	1971184.0 (1205741.0)	--
*fira04*trend*	--	--	-65878.36* (38272.27)	--
grant06	--	--	--	4472582.0*** (855427.8)
*grant06*trend*	--	--	--	-145427.5*** (26874.44)
intercept	-398673.3 (858147.2)	-122919.0 (905447.1)	-202005.4 (838500.2)	-88513.01 (782548.2)

Notes:
N = 31
Robust standard errors reported
*** p value < 0.01, ** p value < 0.05, * p value ≤ 0.1

Table 2b: Results from Model 2 - dependent variable: ln*claims*

Variable	ln*claims* (I)	ln*claims* (II)	ln*claims* (III)	ln*claims* (IV)
ln*sba*	-0.0525 (0.0848)	-0.0309 (0.0658)	-0.0312 (0.0726)	-0.0271 (0.0844)
ln*drf*	0.0332 (0.0827)	0.0392 (0.0670)	0.0502 (0.0788)	0.0479 (0.0770)
ln*damages*	0.1706** (0.0698)	0.2323*** (0.0610)	0.2318*** (0.0668)	0.2291*** (0.0673)
floods	0.1105*** (0.0312)	0.0937*** (0.0262)	0.0943*** (0.0267)	0.0942*** (0.0269)
year	-0.0161 (0.0094)	-0.0704*** (0.0223)	-0.0720*** (0.0222)	-0.0714*** (0.0228)
katrina	1.1462*** (1.6380)	0.9482*** (0.1510)	0.9304*** (0.1585)	0.8687*** (0.1980)
fira94	--	-0.7309** (0.3175)	-0.9892 (0.7388)	-0.9275 (0.6089)
*fira94*trend*	--	0.0608*** (0.0177)	0.0733** (0.0325)	0.0700** (0.0265)
fira04	--	--	0.2982 (1.0629)	--
*fira04*trend*	--	--	-0.0140 (0.0413)	--
grant06	--	--	--	-0.0416 (2.0216)
*grant06*trend*	--	--	--	-0.0022 (0.0664)
intercept	6.9530*** (1.6380)	5.5881*** (1.3114)	5.4024*** (1.3766)	5.4218*** (1.4575)

Notes:
N = 30
Newey-West standard errors reported, 2 lags
*** p value < 0.01, ** p value < 0.05, * p value < 0.1

Table 2c: Results from Model 2 - dependent variable: ln*claimvalue*

Variable	ln*claimvalue* (I)	ln*claimvalue* (II)	ln*claimvalue* (III)	ln*claimvalue* (IV)
ln*sba*	-0.0722 (0.0811)	-0.0606 (0.0768)	-0.0847 (0.0754)	-0.0993 (0.0957)
ln*drf*	0.0844 (0.0918)	0.0868 (0.0998)	0.0818 (0.0914)	0.0849 (0.0953)
ln*damages*	0.3324*** (0.0829)	0.3575*** (0.0877)	0.3311*** (0.0862)	0.3372*** (0.0930)
floods	0.0893*** (0.0313)	0.0833** (0.0299)	0.0877*** (0.0301)	0.0890** (0.0320)
year	0.0471*** (0.0111)	0.0257 (0.0305)	0.0440*** (0.0151)	0.0476*** (0.0149)
katrina	1.8357*** (0.2434)	1.7508*** (0.2724)	1.5853*** (0.2168)	1.8609*** (0.2410)
fira94	--	-0.3243 (0.5498)	--	--
*fira94*trend*	--	0.0250 (0.0299)	--	--
fira04	--	--	2.4614* (1.2182)	--
*fira04*trend*	--	--	-0.0752* (0.0429)	--
grant06	--	--	--	2.5881 (2.7238)
*grant06*trend*	--	--	--	-0.0817 (0.0887)
intercept	10.8366*** (1.6495)	10.2248*** (1.9457)	11.1884*** (1.7138)	11.2437*** (1.8064)

Notes:
N = 30
Newey-West standard errors reported, 2 lags
*** p value < 0.01, ** p value < 0.05, * p value < 0.1

6. Discussion

The value of Disaster Loans provided by the Small Business Administration and the value of appropriations to the Presidential Disaster Relief Fund are never significant, individually or jointly. As alternative sources of funding for flood victims I thought they would be important in determining aid provided by the NFIP because victims might use them to either supplement or replace funding from the NFIP. Based on my results it turns out that these alternative funding sources may not be as important to flood victims as I originally thought, but they are still important to include as controls. These variables are not included in the regression on Δ*nfip_policies* because they are only relevant for people who have experienced flood damage and not everyone with a flood insurance policy has experienced damage.

The coefficients on the dummy variables, used to capture the effects of the laws (*fira94*, *fira04*, and *grant06*), show the change in the intercept for the line that represents the existing trend in the

dependent variable. The coefficients on the interaction terms (*fira94*trend, fira04*trend,* and *grant06*trend*) account for the slope in this line and capture any break in the pre-existing trend. A negative sign on these interaction terms provides evidence for either a reduction in slope or a downward trend; the coefficient on the associated dummy variable would be positive. This positive coefficient does not suggest a jump in the outcome variable but rather is a change in the y-intercept as a result of the change in the trend.

In regressions III and IV on Δ*nfip_policies* and ln*claimvalue* I drop the 1994 law variables because they are not significant in regression II. I keep *fira94* and *fira94*trend* in regressions III and IV on ln*claims* because they are significant in regression II at the 5% and 1% level respectively. I cannot include all four variables associated with FIRA 2004 (*fira04, fira04*trend, grant06, grant06*trend*) in the same regression while controlling for Katrina because of co-linearity, *katrina* is omitted.

6.1 Δnfip_policies as Dependent Variable

The change in the total number of NFIP policies in force is the dependent variable because of the total of number of policies in force is persistent year to year. In these regressions the value of damages caused by natural disasters and the number of significant flood events are lagged. These variables are not significant in any of the regressions but are included to account for events in the previous year that may have influenced people's decision to purchase flood insurance.

The negative sign on *fira04*trend* provides evidence that this Act is associated with a decrease in the number of policies in force, suggesting a downward trend. This result is only marginally significant and it is likely that FIRA 2004 did not have a huge effect on the number of policies in force since the major provisions of this law were not enacted or funded until 2006. The coefficients for the 2006 variables are significant at the 1% level. These results suggest that the grant programs funded in 2006 are associated with a significant decrease in the number of NFIP policies.

Few other variables are significant in these regressions. There are likely other external factors that I have not accounted for in my regressions that influence the total number of NFIP policies in force.

6.2 *lnclaims as Dependent Variable*

The value of damages cause by natural disasters and significant flood events are both positively and significantly correlated with ln*claims* in all regressions. This result makes sense since these variables are most likely causing people to file insurance claims. This is also true for *katrina*, which had a large and positive impact on the number of claims paid by the NFIP.

The results suggest that FIRA 1994 had a significant and positive impact on the trend in the number of claims paid. The *fira94* and *fira94*trend* variables are included in regressions III and IV because of their significance in regression II; *fira94*trend* remains significant at the 5% level. Neither FIRA 2004 nor its subsequent grant programs had a significant effect on the number of claims paid.

6.3 *lnclaimvalue as Dependent Variable*

Again the number of significant flood events, damages caused by natural disasters, and Katrina are all associated with a significant and positive increase in the value of claims paid by the NFIP. The year variable alone is also highly significant in all regressions except regression II. These results provide evidence that there is an increasing trend in the value of claims paid by the NFIP from 1978 – 2010. In regression II this significance seems to disappear, but when tested together, *year* and *fira94*trend* are jointly significant and positive, confirming the increasing trend found in the other three regressions.

The results show that FIRA 1994 had no effect on the value of claims paid by the NFIP. In regression III, *fira04* and *fira04*trend* come out significant at the 10% level. The trend variable is negative and the magnitude of its coefficient is larger than the magnitude on *year*, which suggests not only a reduction in slope, but also a change from the previous positive trend to a negative trend. This result is particularly important because it occurs even while controlling for Hurricane Katrina in 2005, which had a significant and positive effect on the value of claims paid by the NFIP. However, the main provisions of FIRA 2004 were not funded until 2006, yet neither *grant06* nor *grant06*trend* is significant.

The 2006 variables were included to capture the effect of the grant programs that were created by the FIRA 2004, but not funded until 2006. However, the results suggest that these programs did not have a significant effect on the value of claims paid by the NFIP. These results are contrary to my expectations. Something occurred in 2004 to cause a significant decrease in the existing trend of the value of claims paid by the NFIP. There is nothing in the literature surrounding the implementation of FIRA 2004 that references any changes that were actually enacted in 2004 so I speculate that some external factor caused this change in trend.

Overall, my results suggest that FIRA 1994 was associated with an increase in the number of claims paid by the NFIP, but it had no effect on the value of these claims or on the number of policies in force. Since the 1994 provisions did not reduce the number of policies, the number of claims paid, or the value of claims it did not reduce the moral hazard problem. This result could have been expected because FIRA 1994 just made general improvements to the NFIP and even encouraged participation. FIRA 1994 was not particularly focused on reducing claims made to the NFIP. On the other hand, FIRA 2004 was associated with a decrease in the value of claims paid by the NFIP, and in the number of policies in force, but it had no effect on the number of claims paid. These results provide evidence that that FIRA 2004 was effective in reducing incentives to live in floodplains, and thus in reducing moral hazard. Additionally, the grant programs funded in 2006 were associated with a decrease in the number of policies in force but had no significant effect on the number of claims paid or on their value. A reduction in the number of policies could suggest that individuals are moving out of hazardous areas, therefore reducing moral hazard.

7. Conclusion

Besides the financial problems and massive debt the NFIP has incurred, the moral hazard problem associated with subsiding flood insurance is a major flaw in the structure of the NFIP. Historically, the NFIP has made changes to its policy in an effort to reduce flood claims and encourage smart flood-plain practices. As this paper has shown, some of these policy changes have achieved these goals, while others have not. FIRA 1994 was associated with an increase in the number of claims paid by the NFIP, while FIRA 2004 was successful in reducing the number of policies in force and the value of claims paid by the NFIP. Furthermore, the subsequent 2006 grant programs were associated with a decrease in the number of NFIP policies in force.

Policy changes to the NFIP must reduce incentives to live in floodplains in order to reduce moral hazard. If the insurance structure encourages people to increase, or even maintain, the value of their property in a floodplain the program is encouraging risky behavior and as such creating a moral hazard problem. Taken together, the number of NFIP policies in force, the number of claims paid, and the value of these claims can be used as evidence for moral hazard because they are associated with property located in a floodplain. In order to further reduce the presence of moral hazard, more policy changes similar to FIRA 2004 and its subsequent grant programs must be put in place.

The results of my study are somewhat limited due to the nature of the data. At a national level my analysis can only go so far and with such few data points robust results are difficult to obtain. For future research I hope to continue to investigate moral hazard and the National Flood Insurance Program but on a state level. Major changes were also made to the program in 2012 as part of the Biggert-Waters Flood Insurance Reform Act of 2012. As the program continues to change its structure and face the challenges associated with huge levels of debt it will be a continually interesting program to study.

References

Association of State Floodplain Managers. 2004. Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004. Retrieved from: http://www.trac4la.com/flood_insurance_reform_2004.pdf

Bea, K. 2005. *Federal Stafford Act Disaster Assistance: Presidential Declarations, Eligible Activities, and Funding.* Congressional Research Service Report.

Department of the Treasury. 2013. "Full Text of Proposed Rule on Mandatory Purchase of Flood Insurance." Retrieved from: http://www.federalreserve.gov/newsevents/press/bcreg/bcreg20131011a1.pdf

Chiappori, P.A., Durand, F., and Geoffard, P.Y. 1998. Moral Hazard and the Demand for Physician Services: First Lessons from a French Natural Experiment. *European Economic Review.* 42: 499-511.

Cleetus, R. 2014. Overwhelming Risk: Rethinking Flood Insurance in a World of Rising Seas. *Union of Concerned Scientists.* Retrieved from: http://www.ucsusa.org/assets/documents/global_warming/Overwhelming-Risk-Full-Report.pdf

Crawford, M. and Church, J. 2014. *CPI Detailed Report: Data for February 2014.* Bureau of Labor Statistics. Retrieved from: http://www.bls.gov/cpi/cpid1402.pdf

Dionne, G., Maurice, M., Pinquet, J., and Vanasse, C. 2005. The Role of Memory in Long-Term Contracting with Moral Hazard: Empirical Evidence in Automobile Insurance. Retrieved from: SSRN - http://papers.ssrn.com/sol3/papers.cfm?abstract_id=764705

Editorial Board. 2012. Federal Flood Insurance is Underwater, too. *The Washington Post.* Retrieved from: http://www.washingtonpost.com/opinions/hurricane-sandy-highlights-financial-woes-of-federal-flood-insurance/2012/11/02/813e3358-244d-11e2-ba29-238a6ac36a08_story.html

EM-DAT. 2013. The International Disaster Database: Centre for Research on the Epidemiology of Disasters. Retrieved from: http://cred01.epid.ucl.ac.be:5317/?after=1953&before=2013&continent%5B%5D=Americas&region%5B%5D=Northern+America&iso%5B%5D=USA&dis_group%5B%5D=Natural&agg1=year&agg2=

Extension Disaster Education Network (EDEN). 2014. National Flood Insurance Program and Reforms. *Floods and Flooding.* Retrieved from: http://eden.lsu.edu/Topics/Hazards/Floods/NFIP/Pages/NationalFloodInsurance(NFIP).aspx

Federal Emergency Management Agency (FEMA). 2009a. *FEMA's Implementation of the Flood Insurance Reform Act of 2004.* Department of Homeland Security: Office of Inspector General.

Federal Emergency Management Agency (FEMA). 2009b. Hazard Mitigation Assistance Unified Guidance: Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, Repetitive Flood Claims Program, Severe Repetitive Loss Program. Washington, D.C. Retrieved from: http://www.fema.gov/media-library-data/20130726-1708-25045-5766/fy_10_hma_guidance_final_september_2009.pdf

Federal Emergency Management Agency (FEMA). 2009c. *National Flood Insurance Reform Act of 1994.* Retrieved from: http://www.fema.gov/media-library/assets/documents/7281?id=2217

Federal Emergency Management Agency (FEMA). 2012. *Flood Insurance: Definitions.* Retrieved from: http://www.fema.gov/national-flood-insurance-program/definitions

Federal Emergency Management Agency (FEMA). 2013. *Hazard Mitigation Assistance: Severe Repetitive Loss Program.* Retrieved from: http://www.fema.gov/severe-repetitive-loss-program

Federal Emergency Management Agency (FEMA). 2014. *Flood Insurance Statistics: Significant Flood Events.* Retrieved from: http://www.fema.gov/significant-flood-events

Felton, R.S., Ghee, W.K., and Stinton, J.E. 1971. A Mid-1970 Report on the National Flood Insurance Program. *The Journal of Risk and Insurance,* 38(1): 1-14.

Flood Smart. 2013. "Resources: Flood Facts." *The Official Site of the NFIP*. Retrieved from: http://www.floodsmart.gov/floodsmart/pages/flood_facts.jsp

Freedom of Information Act (FOIA). 2013. *Table of SBA Disaster Loan Approvals by Fiscal Year.* Small Business Administration. Retrieved from Alan Escobar, FOIA Request # 2013-1202-1.

Gillis, J. and Barringer, F. 2012. As Coasts Rebuild and the U.S. Pays, Repeatedly, the Critics Ask Why. *The New York Times.* Retrieved from: http://www.nytimes.com/2012/11/19/science/earth/as-coasts-rebuild-and-us-pays-again-critics-stop-to-ask-why.html?_r=0

Govtrack.us. 2014a. H.R. 3191 (103rd): National Flood Insurance Reform Act of 1994. *Library of Congress Summary.* Retrieved from: https://www.govtrack.us/congress/bills/103/hr3191#summary

Govtrack.us. 2014b. S. 2238 (108th): Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004. *Library of Congress Summary.* Retrieved from: https://www.govtrack.us/congress/bills/108/s2238#summary

Holladay, J. S. and Schwartz, J.A. 2010. "Flooding the Market: The Distributional Consequences of the NFIP." *Institute for Policy Integrity,* New York: New York.

Jenkins, W. O. 2004. National Flood Insurance Program: Actions to Address Repetitive Loss Properties. *United States General Accounting Office.* Retrieved from: http://www.gpo.gov/fdsys/pkg/GAOREPORTS-GAO-04-401T/pdf/GAOREPORTS-GAO-04-401T.pdf

King, R.O. 2011. National Flood Insurance Program: Background, Challenges, and Financial Status. *Congressional Research Service.* Retrieved from: https://www.fas.org/sgp/crs/misc/R40650.pdf

King, R.O. 2013. The National Flood Insurance Program: Status and Remaining Issues for Congress. *Congressional Research Service.* Retrieved from: https://www.fas.org/sgp/crs/misc/R42850.pdf

Lee, Y.W. 2013. Testing for the Presence of Moral Hazard Using the Regulatory Reform in the Car Insurance Market. *The Japanese Economic Review.* 64 (3): 414-429.

Lindsay, B. R. and Murray, J. 2011. *Disaster Relief Funding and Emergency Supplemental Appropriations*. Congressional Research Service.

Paul, R. 2012. Federal Flood Insurance: A Moral Hazard We Can't Afford. Retrieved from: http://www.ronpaul.com/2012-11-05/ron-paul-federal-flood-insurance-a-moral-hazard-we-cant-afford/

Platt, R. H. 1976. The National Flood Insurance Program: Some Midstream Perspectives. *Journal of the American Institute of Planners,* 42 (3): 303-313.

Perry, C.A. 2000. Significant Floods in the United States During the 20th Century– USGS Measures a Century of Floods. *U.S. Geologic Survey.* Retrieved from: http://ks.water.usgs.gov/pubs/fact-sheets/fs.024-00.pdf

U.S. Small Business Administration (SBA). 2013a. "Disaster Loans." Retrieved from: http://www.sba.gov/category/navigation-structure/loans-grants/small-business-loans/disaster-loans

Winkelmann, R. 2004. Health Care Reform and the number of Doctor Visits: An Econometric Analysis. *Journal of Applied Econometrics.* 19: 455-472.

Appendix:

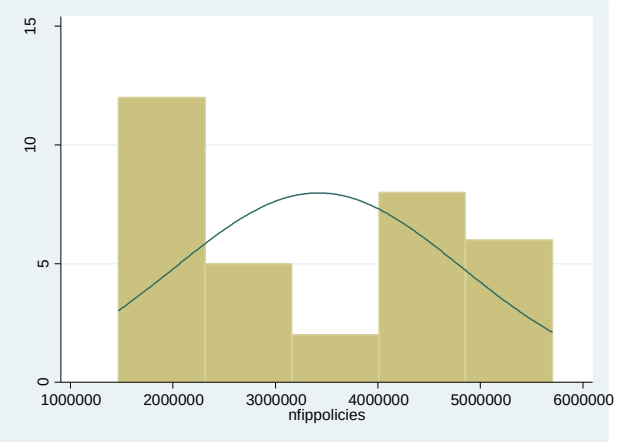

Figure A1: *nfip_policies* histogram

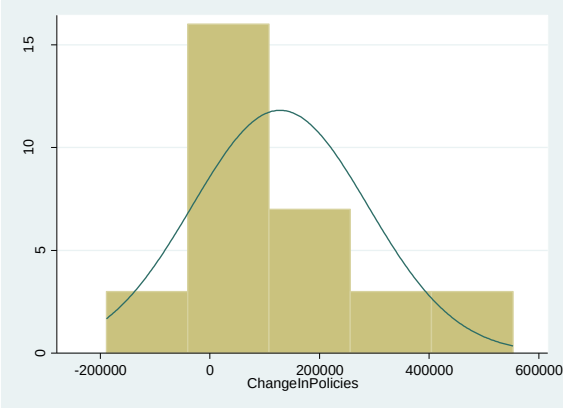

Figure A2: Δ*nfip_policies* histogram

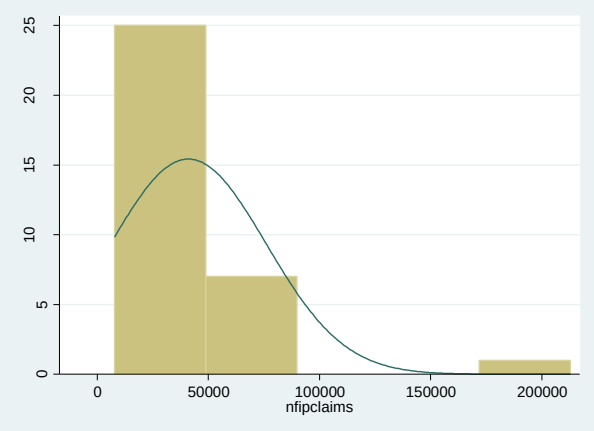

Figure A3: *nfip_claims* histogram

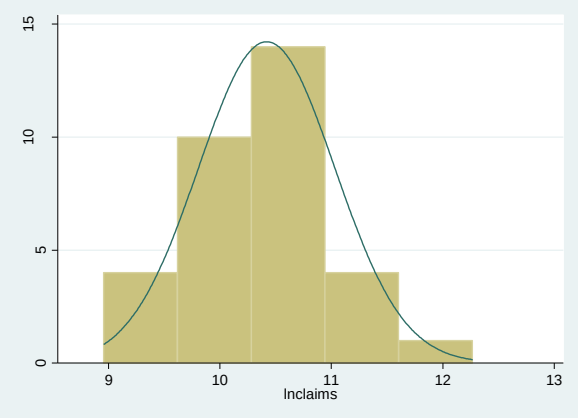

Figure A4: ln*nfip_claims* histogram

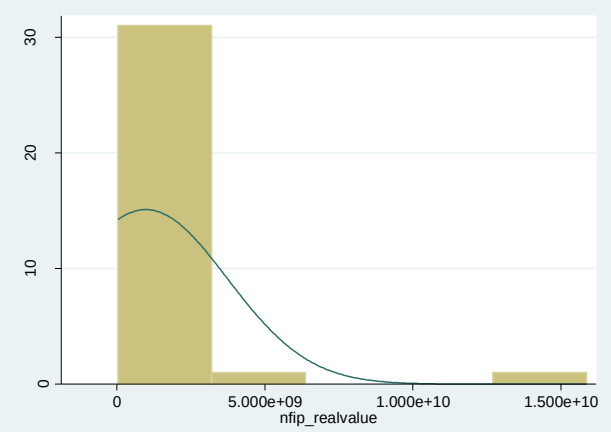

Figure A5: *nfip_claimvalue* histogram

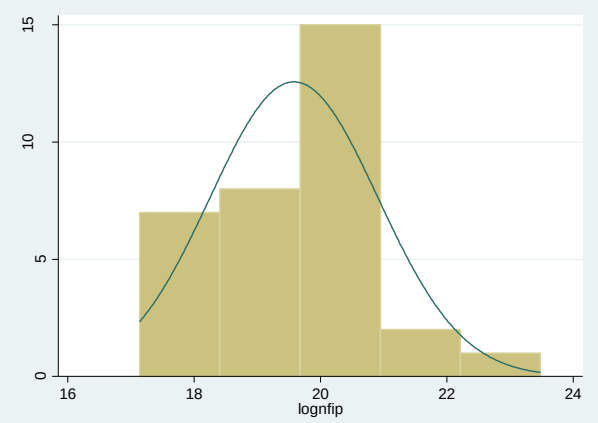

Figure A6: ln*nfip_claimvalue* histogram

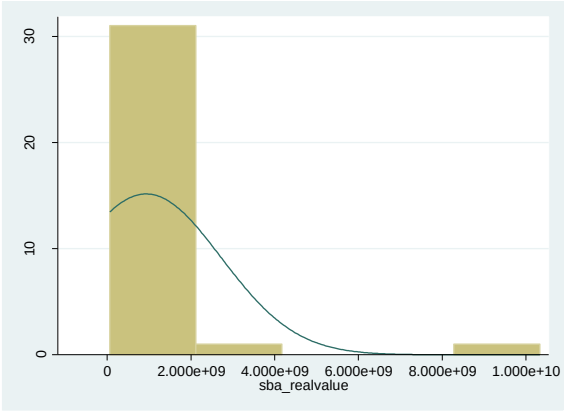

Figure A7: *sba* histogram

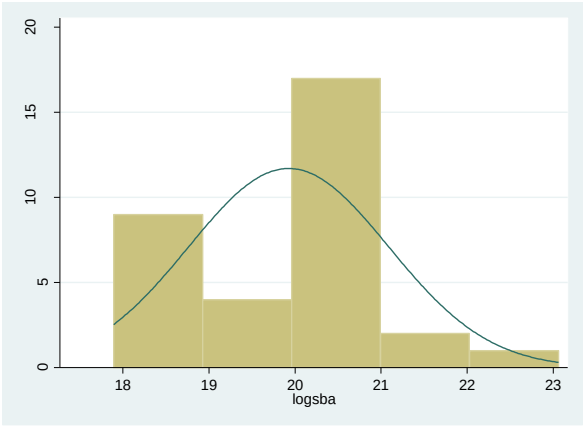

Figure A8: ln*sba* histogram

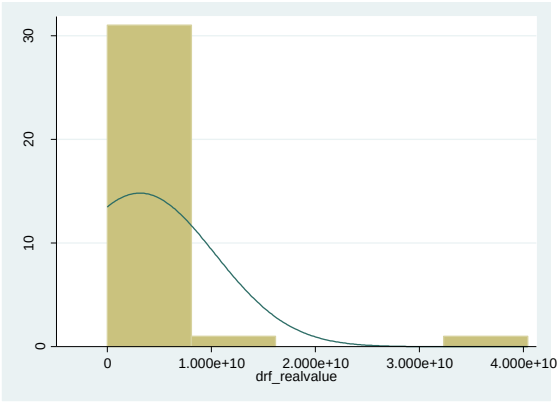

Figure A9: *drf* histogram

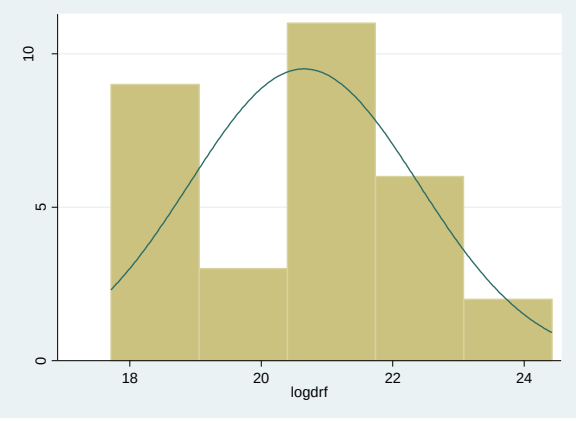

Figure A10: ln*drf* histogram

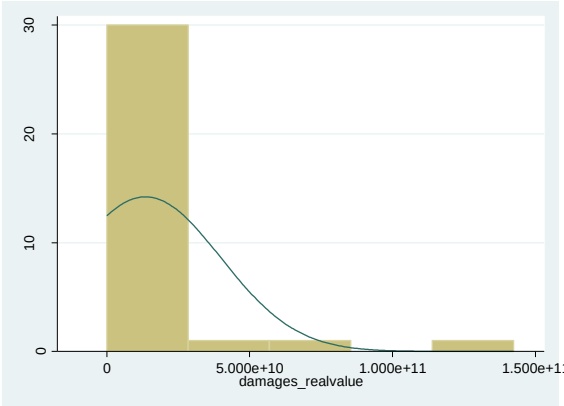

Figure A11: *damages* histogram

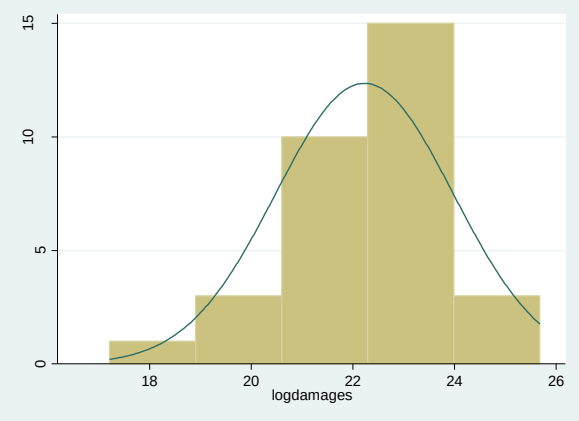

Figure A12: ln*damages* histogram

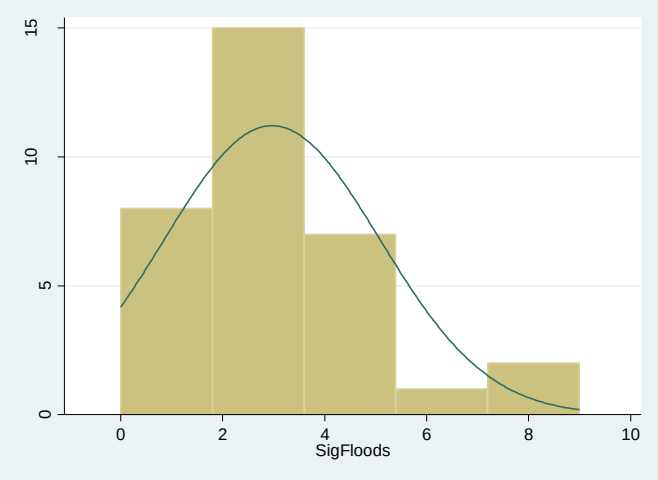

Figure A13: *floods* histogram

Table A1: Dickey-Fuller Test Results (using trend option)

Variable	Test Statistic	P-Value
nfip_policies	-1.574	0.8023
Δnfip_policies	-3.508	0.0386
nfip_claims	-5.553	0.0000
nfip_claimvalue	-5.629	0.0000
sba	-5.297	0.0001
drf	-5.459	0.0000
damages	-5.057	0.0002
floods	-6.170	0.0000

Notes:
N=32
1% critical value = -4.316
5% critical value = -3.572
10% critical value = -3.223

Table A2: Breusch-Godfrey Test Results

Dependent Variable	Chi-squared	Degrees of Freedom (lags)	P-Value
Δnfip_policies	0.397	1	0.5287
--	2.045	5	0.8430
--	4.690	10	0.9109
nfip_claims	4.768	1	0.0290
--	11.465	5	0.0429
--	15.082	10	0.1291
nfip_claimvalue	0.555	1	0.4563
--	6.395	5	0.2697
--	25.579	10	0.0043

Table A3: Variable definitions and Sources

Variable	**Definition**	**Missing Values**	**Source**
Δnfip_policies	Change in the total number of NFIP policies in force from the previous year	0/33	2013 Congressional Research Service Report, *The National Flood Insurance Program: Status and Remaining Issues for Congress* (King, 2013)
ln*claims*	Number of claims paid by the NFIP, logged	0/33	2013 Congressional Research Service Report, *The National Flood Insurance Program: Status and Remaining Issues for Congress* (King, 2013)
ln*claimvalue*	2010 value of claims paid by the NFIP, logged	0/33	2013 Congressional Research Service Report, *The National Flood Insurance Program: Status and Remaining Issues for Congress* (King, 2013)
ln*sba*	2010 value of Disaster Loans paid by the SBA, logged	0/33	Freedom of Information Act Request (FOIA Request # 2013-1202-1) (FOIA, 2013)
ln*drf*	2010 value of total appropriations to the Presidential Disaster Relief Fund, logged	2/33	1978-1988: 2005 Congressional Research Service Report, *Federal Stafford Act Disaster Assistance: Presidential Declarations, Eligible Activities, and Funding* (Bea, 2005) 1989-2010: 2011 Congressional Research Service Report, *Disaster Relief Funding and Emergency Supplemental Appropriations* (Lindsay and Murray 2011)
ln*damages*	2010 value of total amount of damages caused by natural disasters, logged	1/33	The International Disaster Database: Centre for Research on the Epidemiology of Disasters (EM-DAT, 2013)
lagln*damages*	ln*damages* lagged 1 year (t-1)		
floods	Number of significant flood events	0/33	*Flood Insurance Statistics: Significant Flood Events* (FEMA, 2014)
lag*floods*	*floods* lagged 1 year (t-1)		
year	each year 1978-2010		
fira94	dummy variable taking a 1 after 1994 and a 0 before		
*fira94*trend*	*fira94* interacted with *year*, it takes the value of each year after 1994 and a 0 before		
fira04	dummy variable taking a 1 after 2004 and a 0 before		
*fira04*trend*	*fira04* interacted with *year*, it takes the value of		

	each year after 2004 and a 0 before		
grant06	dummy variable taking a 1 after 2006 and a 0 before		
*grant06*trend*	*grant06* interacted with *year*, it takes the value of each year after 2006 and a 0 before		