SOCIAL BENEFITS AND COSTS OF THE NATIONAL FLOOD INSURANCE PROGRAM

by

James Patrick Howard, II

Dissertation proposal
December 30, 2011

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

AIR American Institutes for Research

BCA benefit-cost analysis

BCR benefit-cost ratio

BEA Bureau of Economic Analysis

BOB Bureau of the Budget

BOR Bureau of Reclamation

CBRA Coastal Barrier Resources Act

CFHA Coastal Flood Hazard Area

CPI Consumer Price Index

CRS Community Rating System

DOC United States Department of Commerce

DOJ United States Department of Justice

DRA Disaster Relief Act of 1974

EO 12127 Executive Order 12127

EO 12866 Executive Order 12866

EO 13563 Executive Order 13563

FDPA Flood Disaster Protection Act of 1973

FEMA Federal Emergency Management Agency

FFIA Federal Flood Insurance Act of 1956

FIRA Flood Insurance Reform Act of 2004

FIRM Flood Insurance Rate Map

FIRMA Flood Insurance Reform and Modernization Act of 2008

FIRPA Flood Insurance Reform Priorities Act of 2010

FMA Flood Mitigation Assistance

FY Fiscal Year

ICC Increased Cost Compliance

METB marginal excess tax burden

MLS Multiple Listing Service

MMC Multihazard Mitigation Council

NAS National Academy of Science

NFIA National Flood Insurance Act of 1968

NFIF National Flood Insurance Fund

NFIP National Flood Insurance Program

NIBS National Institute of Building Sciences

NIPA National Income and Product Accounts

NRC National Research Council

NRCS Natual Resources Conservation Service

OMB Office of Management and Budget

SDR social discount rate

SFHA Special Flood Hazard Area

TVA Tennessee Valley Authority

USACE United States Army Corps of Engineers

USCB United States Census Bureau

WRC United States Water Resources Council

WTP willingness-to-pay

WYO Write Your Own

CHAPTER 1

INTRODUCTION

The National Flood Insurance Program (NFIP) is a federal insurance program established in 1968 to reduce the costs to the federal budget for flood recovery and share those costs with the beneficiaries of disaster relief. The proposed dissertation will analyze the NFIP using benefit-cost analysis (BCA). The Federal Emergency Management Agency (FEMA) mandated an evaluation of the NFIP in 2000 but a benefit-cost approach was not taken. To fill that gap, this dissertation proposes to develop the methodology and generate initial estimates to extend the evaluation of the program. Three analyses will be completed. The first is a pure retrospective BCA of the NFIP covering all available years with complete data. The second analysis is a distributionally weighted BCA, where impacts are weighted according to the socioeconomic context of the recipient. The third analysis will consider the impact of the NFIP on the federal budget.

The NFIP is managed by FEMA. Participants purchase flood insurance through their property insurance provider which receives a portion of the premium for overhead costs

and passes the rest to FEMA. The original program objective was to reduce the strain of *ad hoc* disaster assistance on the federal budget and force beneficiaries to absorb some of the costs related to rebuilding following a flood event. Some beneficaries are enrolled in the insurance program involuntarily and they may prefer not to participate. A required component of the program are changes in planning and building codes to reduce damages in jurisdictions where insurance policies are in force. Since its establishment in 1968, the NFIP has grown into a large monoline insurer with more than $1 trillion in policies in force.[1]

BCA is designed to determine whether or not the NFIP provides social benefits sufficient to justify its costs to society, when treating all impacts equally, though this is only effective under a set of strict assumptions. The net social benefits are considered from an economic viewpoint and collect together direct costs and benefits achieved through the program. Additionally, to determine the net social benefit, BCA also includes indirect costs and benefits that may be realized from the program and compares the aggregate with the aggregate net social benefits of other potential solutions to a problem, including no action at all. Through BCA, it is possible to quantify "in monetary terms the value of all consequences of a policy to all members of society."[2] When the impacts are weighted according to distributional concerns, BCA can be used to evaluate the a program according to its social and political objectives.

The NFIP's role as a public program to manage risk makes understanding the program

1. Congressional Budget Office, *The National Flood Insurance Program: Factors Affecting Actuarial Soundness* (Washington: Congressional Budget Office, November 2009), 1.

2. Anthony E. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*, 4th ed., Pearson series in economics (Upper Saddle River, NJ: Prentice Hall, 2010), 2.

and its implications an appropriate public policy question for study. In addition, understanding the NFIP provides a window to understand the impact of other disaster insurance programs, both in the United States and internationally.

1.1 Background of the National Flood Insurance Program

The NFIP was conceived by Gilbert F. White, a geologist who wrote about floodplain management in his dissertation.[3] In 1966, White managed a task force for the Bureau of the Budget (BOB) that recommended a comprehensive national approach to mitigating flood losses through an insurance program.[4] However, the task force's report also included a note suggesting that if incorrectly implemented, such an insurance scheme may lead to aggravated flood losses as insurance might cause inappropriate building in flood-prone areas.[5] In addition, the report recommended many of the other features associated with the NFIP today, such as improved knowledge of the floodplain and sounder management of floodplain development.[6]

The NFIP's operating characteristics are important to understanding how the program works. The program is primarily self-financed through premiums and in the event of a shortfall, its only recourse is a loan from the United States Treasury. The program uses

3. Gilbert F. White, "Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States" (PhD diss., University of Chicago, 1942), 202–204.

4. Melissa A. Rumsey, "Beyond Bigger and Better: Gilbert White and America's New Approach to Floodplain Management" (master's thesis, Mississippi State University, 2010), 56, 62.

5. Ibid., 62–63.

6. Ibid., 58–59.

a mapping system to estimate risk in geographic zones and sets premiums for invidual properties based on the zone inwhich the property exists. Finally, the program's implementation requires policyholders to participate in a program of flood damage mitigation. Each of these factors contribute to the effects of the NFIP on society. Policies are only granted within jurisdictions that take certain flood management actions.

The NFIP is a self-funded program within FEMA and has not used taxpayer funds to pay for claims against the program, though the program has exercised an option to borrow from the United States Treasury to address shortfalls. The NFIP holds within the Treasury of the United States a National Flood Insurance Fund (NFIF) which collects the premiums for the Program and also pays out claims against the plan.[7] The unencumbered proceeds of the NFIF may only be invested in obligations of the United States government or which are guaranteed by the United States. The NFIF is considered an enterprise activity by the Congress and the budget for the NFIP is not included with the rest of the United States's annual budget.

However, by design, the NFIP is not actuarially sound for two reasons that will be elaborated upon in this proposal.[8] The first is that older dwellings may be provided a subsidized premium rate; the second is that extremely rare and severe events may not be adequately accounted for in the premium. The program does not collect sufficient revenue through premiums collected and investment of retained assets to meet expected expenses incurred through

7. Orice Williams Brown, *National Flood Insurance Program: Continued Actions Needed to Address Financial and Operational Issues* (Washington: Government Accountability Office, 2010), 5.

8. Congressional Budget Office, *The National Flood Insurance Program: Factors Affecting Actuarial Soundness*, 3.

losses on claims and administrative overhead. This is because properties constructed prior to 1978 are not required to meet certain building standards and are grandfathered into the program. Properties constructed after 1978 are required to meet those standards. However, NFIP rates are actuarially determined based on the assumption all insured properties meet the the post-1978 building standards.

This design allows the NFIP to provide a subsidized insurance program to program participants without requiring an explicit commitment of funds through a budgetary appropriation. However, there are limitations on subsidies provided and policies issued for buidlings constructed after the local flood map was created are not eligible for subsidized flood insurance rates.

When necessary, the NFIP has access to a line of credit through the Treasury.[9] If the proceeds of the NFIP held in the NFIF are insufficient to cover current claims against against the program, the Director of the NFIP may borrow from the Treasury sufficient funds to pay existing claims. The NFIP does not purchase reinsurance through the private market to reduce dependency on Treasury loans, though it is not prohibited by law from doing so.

FEMA provides other flood mitigation programs. The ability to purchase flood insurance through the NFIP by private participants is limited to those located in communities working with FEMA to reduce potential flood damage. This includes designating building standards, reducing development to higher-risk areas, and floodplain management programs. Risk reduction measures allow the NFIP to reduce the overall costs of insurance to both the

9. Brown, *National Flood Insurance Program: Continued Actions Needed to Address Financial and Operational Issues*, 5.

program and participants.

FEMA also implements a program for flood damage mitigation as part of the NFIP. FEMA partners with states and local communities through the Flood Mitigation Assistance (FMA) Program to develop methods of reducing the risk of flood damage.[10] The FMA Program, like the NFIP, was created through the National Flood Insurance Act of 1968 (NFIA) to reduce disaster assistance costs to the federal government caused by flooding. The FMA Program operates through grants for flood mitigation planning and implementation made by FEMA to states and local communities. These grants are funded through the regular federal appropriations process.

FEMA assesses risk and determines premiums for the NFIP through the Flood Insurance Rate Map (FIRM). FEMA's model for the FIRM estimates the flood risk and potential flood damage for each area using aggregate historical data. This is similar to techniques used by both the private insurance market. Contiguous areas with similar are then collected into areas called flood zones and participants in the NFIP are assessed a premium based on their zone and associated risk profile.

Use of the FIRM to set actuarially sound policy rates is limited by two major factors. First, Congress, through statute, limited the ability of the NFIP to raise premiums in response to changes in risk. Second, FEMA has explicitly discounted some historical data, such as the extreme hurricane-related flooding of 2005, from the FIRM in order to decrease

10. Jane A. Bullock et al., *Introduction to Homeland Security*, 2nd ed., Butterworth-Heinemann Homeland Security Series (Burlington, MA: Elsevier Butterworth-Heinemann, 2006), 277.

the estimated risk for policy holders.[11] These two policy decisions have been implemented to increase the affordability of flood insurance for NFIP participants and encourage new participants to join the program.

1.2 The NFIP, Benefit-Cost Analysis, and Government Objectives

The BCA perspective provides unique insights to a public policy question. In balancing both economic and social impacts of a program, BCA quantifies and measures the impacts to determine whether the program has a net social benefit. Put simply, BCA is a tool to determine if a program contributes more to society than it takes. In the case of the NFIP, this is different from testing the original objective, reducing the burden on the federal budget from flood events.

The economic and social impacts measured allow BCA to consider direct transfers, economic losses or gains caused by a program, and the value of social objectives that may be inherent in a program. This evaluation will provide both a BCA with unweighted impacts, showing the economic benefits and costs to society. This evaluation will also provide a distributionally weighted BCA, which measures the social effects of those economic impacts and values them based on noneconomic social goals.

11. Kevin Bingham et al., *The Role of Actuarial Soundness in the National Flood Insurance Program* (Washington: American Institutes for Research, October 2006), 61.

However, there are impediments to use BCA for policy analysis, which will be elaborated upon in chapter 2. A significant obstacle is understanding willingness-to-pay (WTP) based on consumer demand for a good or serbice. The WTP for a good is difficult to measure when there is no functioning market for the good or, as in the case of the NFIP, when purchase is required for a significant subset of participants. Many public policies provide public goods for which no functioning market can be created. As a result, many analysts are forced to divine a willingness to pay for some good based on information available in secondary markets or surveys of potential program participants. The WTP is also a variable figure, and it depends on whom is paying, their perception of the perceived impact of a good, and whether their has been a recent impact. All of this means that WTP is a challenge for the BCA practitioner who must find reasonable and defensible solutions to WTP questions.

Another obstacle in the BCA process is measuring the distributional effects of a policy program. The default analysis of a BCA is that monetary transactions are weighted equally for whomever is affected.[12] However, distributional concerns are major focus of public policy and the political process. Because a program can impact different individuals identically, but have different effects depending upon the persons socioeconomic class, there is a desire to understand how those impacts are quantified and measured differently for different classes. This is complicated by the fact impacts can be hidden or difficult to measure directly. Further, the different impacts are derived from theoretical implications

12. Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, A-94, technical report (Washington, October 1992).

based on socioeconomic class and estimating impact weights for different socioeconomic classes is a politically charged question. In an unweighted BCA, this may not matter. However, a distributionally weighted BCA will be impacted by the measures of social effects. For while there are a variety of approaches to weighting distirbutional impacts, there is no universally accepted standard.

These two obstacles to the BCA process have a particular importance when measuring the costs and benefits associated with the NFIP. Estimating the WTP for flood protection is a particular challenge as flood protection is is required for some and part of its purpose is to reduce *ad hoc* payments from the public budget. In addition, flood protection is a public good in that it is neither excludable nor rivalrous. Additionally, there are disparate and diffuse impacts of the program across the many socioeconomic divisions. Both problems must be addressed before a BCA of the NFIP can be successfully completed. Despite these issues, a BCA of the program will provide information useful for understanding how the program operates, whom it affects, how they are affected, and how the program might be changed to better serve society.

CHAPTER 2

LITERATURE REVIEW

2.1 The National Flood Insurance Program

2.1.1 Policy and Political History of the Program

Public relief for private disasters are not new in the American political arena. Early in the republic, as early as 1794, Congress passed a bill providing compensation to unidentified victims of disasters.[1] This political environment led to Congress passing a relief bill compensating victims for each major disaster that struck, including flood disasters. Between 1803 and 1947, the Congress passed "at least 128 specific legislative acts offering *ad hoc* relief" from flood, fire, and other disasters.[2]

A significant political problem with the National Flood Insurance Program (NFIP) is based in the implementation of the program. The effectiveness of the program's flood miti-

1. Michele L. Landis, ""Let Me Next Time Be 'Tried By Fire:"' Disaster Relief and the Origins of the American Welfare State," *Northwestern University Law Review* 92 (1998): 967–1034.

2. David A. Moss, "Courting Disaster? The Transformation of Federal Disaster Policy since 1803," chap. 8 in *The Financing of Catastrophe Risk*, ed. Kenneth A. Froot (Chicago: University of Chicago Press, 1999), 307–355.

gation goals is impeded by the ability and willingness of community planners and property owners to use floodplain maps. In a comprehensive study of disaster insurance conducted in 1978, a decade after the establishment of the NFIP, Kunreuther et al. established concerns about the political environment of the NFIP. Using a survey conducted among residents in communities participating in the NFIP, 12 percent or fewer of responding individuals were aware of building codes to mitigate flood damage or land use regulations to mitigate flood damage. Only one percent were aware of insurance mechanisms to manage flood risk.[3] Of those who purchased flood insurance policies through the NFIP, only a quarter were aware of the subsidies provided by the government.[4] This study shows that homeowners are not apparently well-informed or directly effected by the effects of either the NFIP nor floodplain management techniques.

Though early in the history of the NFIP, the political environment of Kunreuther et al.'s study have not changed as the program matured. One case study, focusing on Pierce County, Washington, during its 2001 comprehensive planning process discovered that while flooding is the hazard most faced by the region, land use planning efforts did not take that into account. One planning professional admitted to not knowing "that Pierce County was participating in the National Flood Insurance Programme's Community Rating System (CRS) programme"[5] This planner was also responsible for implementing the comprehensive

3. Howard Kunreuther et al., *Disaster Insurance Protection: Public Policy Lessons*, Wiley-Interscience (New York: John Wiley & Sons, 1978), 213–214.

4. Ibid., 236.

5. David R. Godschalk, Samuel Brody, and Raymond Burby, "Public Participation in Natural Hazard Mitigation Policy Formation: Challenges for Comprehensive Planning," *Journal of Environmental Planning and Management* 46, no. 5 (September 2003): 733–754.

plan for development and was not taking into account floodplain management. The comprehensive plan was instead developed by a community task force which ignored floodplain management issues. Because of this disregard of floodplain management, Pierce County's comprehensive plan likely increased the risk of flood damage to new development.

Pierce County is not alone in this respect. Kousky found in her doctoral research that real estate development in Chesterfield County, Missouri, may have been driven by poor information about the flood risk.[6] Development was initially driven by those who underestimate the risk of flood in the area. Following the initial development, new development patterns may take hold and those patterns may be driven by a changed threat perception following a catastrophic flood.[7] Kousky notes that Federal Emergency Management Agency (FEMA) has made great strides to make more information about flood risk to specific parcels of land available, however, there is no research available to determine its effectiveness in modifying homeowner behavior.

Despite the problems in implementing floodplain management, the courts have limited the enforceability of federal requirements for local jurisdictions to manage the floodplain responsibly. In 1985, the United States Department of Justice (DOJ) sued the Parish of St. Bernard (later devastated by Hurricane Katrina) to enforce the community flood mitigation requirements of the NFIP. In this case, the courts limited the enforceability of NFIP flood control measures to the claim the government can sue on behalf of its policyholders, which

6. Carolyn M. Kousky, "Responding to Risk: Information and Decision Making in the Floodplains of St. Louis County, Missouri" (PhD diss., Harvard University, 2008), 186.

7. Ibid., 182.

is economically weak and difficult to claim in the general case.[8] This left FEMA and the DOJ with almost no judicial solution to communities that fail to comply with flood mitigation requirements.

Problems with the implementation of the NFIP are not limited to the planning process. Hurricane Katrina in 2005 demonstrated that federal flood insurance was insufficient to secure policy holders following a major flood incident. Limitations on federal claims and the unwillingness of private insurers to pay for storm-related damage left some policy holders unable to rebuild.

Following Katrina, there were numerous claims made against both private insurers and the NFIP. Claims made against private insurance plans were met with resistance by the insurers which claimed the entirety of the damage to homes in Louisiana and Mississippi was caused by flooding.[9] However, an existing $250,000 limit on insurance through the NFIP left many without sufficient coverage to be made whole, a desirable function of an insurance policy. Horne cites the case of Senator Trent Lott of Mississippi who formulated a legal strategy centered on the requirement that wind damage was necessary to cause the amount of damage done to his home,[10] though these efforts were largely unsuccessful.[11]

Both private insurance and additional federal assistance have been necessary for the

8. John Herke, "Teething Pains at Age 25: Developing Meaningful Enforcement of the National Flood Insurance Program," *Tulane Environmental Law Journal* 7 (1993): 165–196.

9. Jed Horne, *Breach of Faith: Hurricane Katrina and the Near Death of a Great American City* (New York: Random House, 2006), 249–253.

10. Ibid., 252.

11. Uwe Luebken, "Die Natur der Gefahr. Zur Geschichte der Überschwemmungsversicherung in Deutschland und den USA," *Behemoth. A Journal on Civilisation* 3 (2008): 4–20.

rebuilding of New Orleans. Despite the limitations on federal flood insurance claims, Hurricane Katrina still led to almost $17 billion in payments to NFIP policy holders.[12] This was approximately one-third of the federal spending on recovery for Katrina. Further, private insurance policies paid approximately $30 billion to policy holders in the wake of Katrina. According to Comfort et al., private insurance and federal recovery efforts combined with emergency spending and philanthropic efforts for more than $150 billion in Katrina-related spending. The NFIP was approximately one-tenth of all spending for recovery.[13]

Because Katrina brought the NFIP to the front of the policy agenda, the future of flood insurance in the United States is a current political question and there are a range of policy presciptions have been suggested. A study conducted by Anderson considered the effects of development on floodplain management and recommended that policies to improve floodplain development.[14] One suggestion was to require all property owners within a 100-year floodplain to purchase insurance through the NFIP. Another suggestion was to set federal requirements on permissible uses for development on the floodplain. Finally, the author suggested an incentive scheme to guide state and local jurisdictions in implementing better floodplain management schemes.

In response to concerns about wind damage versus flood damage, a move to add wind damage coverage to the NFIP failed in 2008 when when the Flood Insurance Reform and

12. Christopher Cooper and Robert Block, *Disaster: Hurricane Katrina and the Failure of Homeland Security* (New York: Henry Holt / Company, 2006), 289.

13. Louise K. Comfort et al., "Retrospectives and Prospectives on Hurricane Katrina: Five Years and Counting," *Public Administration Review* 70, no. 5 (2010): 669–678.

14. Pamela S. Anderson, "Floodplain Development and Considerations for Better National Policies" (master's thesis, South Dakota State University, 2006), 92–93.

Modernization Act of 2008 (FIRMA) passed both houses of Congress but was vetoed by President George W. Bush. As illustrated by Horne, separating wind damage from flood damage can be difficult or even arbitrary in some cases, so a joint insurance scheme does not seem unreasonable on its face.

A legal researcher notes that due to the financial instability of the NFIP, adding multiple peril will drive the NFIP further into debt.[15] A further concern held by Brown is the potential for political pressure to drive the price of wind insurance below actuarial rates. This will have political effects as the NFIP adds to its borrowing and the program fails to bring sufficient revenue to meet its obligations and losses. The NFIP may be unable to borrow from the United States Treasury as the debt grows beyond its capacity to repay and leading to a potential bailout from Congress.

Browne and Halek, in a 2010 essay on the role of government in private insurance markets, addressed the question of alternatives to the NFIP. Among the alternatives the authors suggest are the development of catastrophe bonds, which allows risk of natural disaster to be securitized through the selling of bonds on the open market, and the development of a functioning market for private insurance.[16] When the rates for flood insurance through the NFIP are actuarially sound, private market rates should be competitive. Because the NFIP limit for insurance on single-family homes is $250,000, a market for excess loss insurance

15. Michael A. Brown, "Anything but a Breeze: Moving Forward Without NFIP Wind Coverage," *Boston College Enivronmental Affairs Law Review* 37, no. 2 (2010): 365–392.

16. Mark J. Browne and Martin Halek, "Managing Flood Risk: The National Flood Insurance Program and Alternatives," in *Public Insurance and Private Markets*, ed. Jeffrey R. Brown (Washington: The AEI Press, 2010), 143–172.

from flood damages has emerged to provide protection for higher-value properties. This, coupled with the existance of private flood insurance in other countries,Hung suggests that some private flood risk transfer through the private market is feasible.

Kunreuther and Michel-Kerjan, in a related essay, address the question of insuring against natural catastrophes. They propose long-term contracts for managing long-term insurance risk.[17] The authors note that some natural disasters, such as the 500-year flood, are outside the decision-making time frame, or so unlikely, that the average homeowner cannot realistically measure the risk associated with the event. Long-term contracts, instead of one year renewable policies, can help homeowners manage the risk by placing a long-term outlook on the matter. The authors select the NFIP as an obvious place to test long-term insurance due to the simpler political environment, a lack of state regulators, and the natural levelling of the average risk profile associated with flooding, when addressed at the national level.

Other proposals to consider include giving FEMA, through the NFIP, the ability to restrict floodplain development by purchasing land and dedicating it as open space. Barnhizer advocates using federal funds to compensate existing landowners and targeting properties deemed high-risk or environmentally sensitive for the program.[18] Through such a program, the net risk to the NFIP could be reduced. However, it is worth noting FEMA already has

17. Howard C. Kunreuther and Erwann O. Michel-Kerjan, "Market and Government Failure in Insuring and Mitigating Natural Catastrophes: How Long-Term Contracts Can Help," in *Public Insurance and Private Markets*, ed. Jeffrey R. Brown (Washington: The AEI Press, 2010), 115–142.

18. Daniel D. Barnhizer, "Givings Recapture: Funding Public Acquisition of Private Property Interests on the Coasts," *The Harvard Environmental Law Review* 27 (2003): 295–375.

the power to purchase some repetitive loss properties rather than sustaining continueds losses. Other proposals to reduce floodplain development through market action have been proposed, as well.[19]

2.1.2 Economic Implications of the Program

When purchasing insurance, an individual implicitly evaluates their risk tolerance. Insurance is a type of bet; in the case of the NFIP, it is a bet regarding the likelihood of a flood during the term of insurance. The betting analogy lends itself to understanding risk tolerance.[20]

Suppose an individual is given two fair betting opportunities and further assume the expected value of both options is $0. However, in the first bet, the individual puts a small amount of money at stake. In the second, the individual puts a larger amount at stake. The person stands to loose more in the second, though the expected value of both is still $0. If an individual refuses the greater bet, then the person is said to be risk averse.[21] An individual who would accept either bet is said to be risk neutral.

This analogy applies to insurance because assuming insurance is actuarially sound, it is a fair bet. That fair bet consisted of a policyholder paying a small amount to the insurance each period and in the event the policyholder experiences a loss, insurance will make the

19. James G. Titus, "Rising Seas, Coastal Erosion, and the Takings Clause: How to Save Wetlands and Beaches without Hurting Property Owners," *Maryland Law Review* 57 (1998): 1279–1399.

20. Walter Nicholson, *Microeconomic Theory: Basic Principles and Extensions*, 9th ed. (Thomson South-Western College Pub, 2004), 239-41.

21. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*, 173.

policyholder whole. If an individual is risk averse, they will accept the insurance bet. Even if the potential outcomes are equal, the policyholder no longer risks a large loss in exchange for the insurance premium.

Economically, the decision to purchase flood insurance can be modeled using two formulae. The first, R_N, represents a potential policyholder who purchases no insurance:

$$\mathrm{E}\left(R_N\right) = \frac{\sum_{t=0}^{n} L_1 + L_2 + \cdots + L_n}{n} \tag{2.1}$$

where L_t represents the expect loss in the given time period, t, and n represents the number of periods. For most years, the value of $L_t = 0$. However, for loss years, L_t is large. In general, the expected losses for a given year are small. But the maximum possible value is L, the maximum loss size. The second, R_I, represents an NFIP policyholder. In this case,

$$\mathrm{E}\left(R_I\right) = \frac{\sum_{t=0}^{n} L_1 + L_2 + \cdots + L_n}{n} \tag{2.2}$$

But the maximum possible value is L/n, the insurance premium. When an individual is risk averse, they will purchase the insurance policy. This also stems from the utility of wealth ($U(W)$) for the individual. The utility of wealth is assumed to be a concave function. As a result:[22]

$$U''(W) < U'(W) \tag{2.3}$$

22. Nicholson, *Microeconomic Theory*, 239.

Where $U'(W)$ is the utility of wealth for the policyholder and $U''(W)$ is the utility of wealth for the nonpolicyholder. This process is described as smoothing the income of the policyholder.

In the case of the NFIP, policyholders fall into two classes. For the first class, voluntary participants, this analysis likely holds. For the second class, required participants, the premimum is a fixed cost necessary to acquire property in the floodplain. As a result, holding an insurance policy through the NFIP may provide some value, but does not necessarily equal or exceed the premium.

However, purchasing insurance can lead to moral hazard, a condition "which occurs when insurance creates incentives for people to behave in inefficient or even fraudulent ways."[23] Since Hurricane Katrina in 2005, a series of studies have been conducted as theses or dissertations and have addressed the question of how the NFIP has driven development potentially leading to moral hazard.

Boulware argues the NFIP creates a moral hazard by encouraging development by underpricing insurance in developable areas with increased flood risk. Through survey results, Boulware finds that those who perceive a greater flood risk than exists are more likely to voluntarily purchase flood insurance through the NFIP, which the author calls the "operational definition of adverse selection."[24] The author uses this evidence to suggest the NFIP is used by homeowners and developers to subsidize a reduction in the potential losses caused

23. Robert H. Frank, *Microeconomics and Behavior*, 6th ed. (Boston: McGraw-Hill Irwin, 2006), 211.

24. Gary William Boulware, "Public Policy Evaluation of the National Flood Insurance Program (NFIP)" (PhD diss., University of Florida, 2009), 163.

by flood.

Boulware also claims the NFIP has failed to meet its goals, and has left a wake of unintended consequences.[25] Beyond encouraging development where it may not make economic sense, the NFIP may have encouraged development where it did not make ecological sense, such as expansive development of areas within the Special Flood Hazard Area (SFHA), areas determined to be at or above a one percent risk of flood during any given year. Through a survey of floodplain administrators in 17 jurisdictions across six states, Boulware found the NFIP had not prevented development in the floodplain nor had it protected environmental concerns such as water quality or open space. Boulware goes on to suggest "the NFIP has in fact 'normalized' development in the SFHA"[26] to the level of development otherwise expected.

In contrast, in a case study focusing on Ocean City, Maryland, Martin found no proof that development was directly encouraged by the flood insurance subsidy, Ocean City's high-rise cityscape was built largely after the NFIP made flood insurance available at a discount.[27] Buildings built after 1974 are required to be actuarially sound, but those built prior are not. Prior to the NFIP, the replacement cost for major structures in Ocean City made them prohibitively expensive to construct.[28] This change allowed Ocean City and other cities on Maryland's Eastern Shore, to become vacation destinations for residents in

25. Boulware, "Public Policy Evaluation of the National Flood Insurance Program (NFIP)."
26. Ibid., 126–127.
27. Melissa A. Martin, "The Impact of Flood Insurance on Development in Ocean City, Maryland" (master's thesis, Salisbury University, 2008), 40–42.
28. Ibid., 54.

the Baltimore-Washington corridor. Martin goes on to explain how Congress and FEMA stepped in with new rules to reduce the subsidy provided by the NFIP in these high risk areas with the Coastal Barrier Resources Act (CBRA).

The availability of, and market for, private flood insurance plays a role in the NFIP. Homeowners subject to the CBRA are not permitted to participate in the NFIP and if flood insurance is purchased, it must be through a private insurer.[29] A 2006 study investigated the effects of the CBRA on flood insurance rates in North Bethany Beach, Delaware. The author found that the rates of NFIP insurance are lower than the rates for private insurance at statistically significant levels, demonstrating the existence of a federal subsidy for NFIP policy holders, a "hidden subsidy"[30] for homeowners eligible to receive NFIP coverage. While the results were statistically valid at conventional levels, the author suggested the relationship reported could be weaker than reality due to the small sample size of 47 survey respondents. Despite these limitations, the results support the statements that the NFIP is not actuarially sound.

During the early part of the 1900s, fire insurance providers provided some private flood insurance similar to general accident policies. However, private insurers essentially abandoned the flood insurance market after a series of floods along the Mississippi River in the late 1920s.[31] Scales argues this abandonment is market failure due to several aspects of the

29. "Coastal Barrier Resources Act," Public Law 97–348, *U. S. Statutes at Large* 96 (1968): 1653, codified at U. S. Code 16 (2010), §3501.

30. Andrea Lynn Geiger, "Private vs. Public Flood Insurance Rates: Is There a National Flood Insurance Subsidy?" (Master's thesis, University of Delaware, 2006), 39–40.

31. Howard Kunreuther, "Has the Time Come for Comprehensive Natural Disaster Insurance?" In *On Risk and Disaster: Lessons from Hurricane Katrina*, ed. Ronald J. Daniels, Donald F. Kettl, and Howard Kun-

flood insurance market.[32] The first is the general inability of insurers to accurately measure risk of flood, though this has improved since the NFIP has been introduced. The second is adverse selection inherent in any insurance program: Those with little to no flood risk are highly unlikely to purchase flood insurance. Additionally, there may be an assumption by some that the Disaster Relief Act of 1974 (DRA) will provide sufficient disaster relief in the form of direct payments to victims of a significant flood event. Scales discounts this possibility as unlikely based on the work of Kunreuther.

The economic effects of the NFIP also appear to include altering the prices of existing homes. In 1994, Griffith studied the effects of mandatory flood insurance purchase requirements on the real estate market. She supposed that floodplain mapping and purchase requirements should work together to reduce real estate development on the floodplain and constructed a hedonic pricing model for homes based on this assumption. However, she discovered that though home purchasers do not discount their purchases in the floodplain in response to risk, they do discount their price in response to required insurance purchases.[33] She also found that mortgage lender-enforcement of flood insurance reduced the purchase price by an average of $4000.

This contrasts with a later study conducted by Bin, Kruse, and Landry which showed a significant decrease in the property prices declared on the designated floodplain. Their

reuther (Philadelphia: University of Pennsylvania Press, 2006), 175–201.

32. Adam F. Scales, "A Nation of Policyholders: Governmental and Market Failure in Flood Insurance," *Mississippi College Law Review* 26 (2006): 3–47.

33. Rebecca Sue Griffith, "The Impact of Mandatory Purchase Requirements for Flood Insurance on Real Estate Markets" (PhD diss., The University of Texas at Arlington, 1994), 124.

results showed a 7.3 percent discount in housing sales values for a property on the 100-year floodplain compared to properties located on the 500-year floodplain, generally a lower-risk designation.[34] At the same time, there is also a strong correlation between coastal amenities (beachfront property, views, and cultural activities) and flood risk. An earlier study by Bin and Polaskyalso found the effects of Hurricane Floyd (1999) increased the discount for properties located on the floodplain.

The place of the NFIP in the complete insurance picture is also striking. A 1997 dissertation on the government-mandated insurance programs found the NFIP does not compete directly with private insurance firms, since private insurance firms do not directly insure against flood damage.[35] Due to the NFIP's Write Your Own (WYO) program structure where private insurers manage the specifics of insurance policy implementation, the NFIP scores well on insurance industry benchmarks, such as expense ratio.[36] Because it is an agency of the United States government, the NFIP is not subject to either dividend payments nor taxation and the program can build its reserve against losses unimpeded by business concerns.[37]

The potential addition of wind damage coverage to the NFIP raises economic issues similar to those posed by floods-only coverage. This issue is important because hurricanes

34. Okmyung Bin, Jamie Brown Kruse, and Craig E. Landry, "Flood Hazards, Insurance Rates, and Amenities: Evidence from the Coastal Housing Market," *The Journal of Risk and Insurance* 75, no. 1 (2008): 63–82.

35. David C. Marlett, "An Evaluation of Legislatively Mandated Residual Market and Catastrophe Financing Programs" (PhD diss., Florida State University, 1997), 139.

36. Ibid., 137.

37. Ibid., 138.

and other severe wind events can occur concurrently with flood events. The proposed addition of wind insurance policies to the NFIP raises concerns with direct competition against private insurers. Brown explains the market provides wind insurance to homeowners and it may not be proper for the federal government to provide wind insurance in competition with private providers.[38] Except for excess coverage insurance, there are no private flood insurance plans.

Opening the NFIP to insure against multiple perils can ensure the viability of the program, as this is how private insurers reduce their net risk against losses stemming from a single event.[39] However, this multiple peril strategy is only effective if those perils are uncorrelated. The possibility that wind and flood damage should happen at the same time seems obvious as tropical storms and hurricanes bring both to coastal areas and riverine flooding is associated with overland wind storms. As a result, wind coverage is unlikely to reduce the NFIP's net risk exposure.

Another option to reduce an outstanding risk position, used by reinsurers, is to use geographic dispersion of risk,[40] which is effective because it is less likely that it would flood in different regions at the same time. This is complex because the NFIP is a nationwide program and is inherently geographically dispersed. But in practice, the policy that federally

38. Brown, *National Flood Insurance Program: Continued Actions Needed to Address Financial and Operational Issues*.

39. Christine M. McMillan, "Federal Flood Insurance Polices: Making Matters Worse," *Houston Law Review* 44 (2008): 471–505.

40. David M. Cutler and Richard J. Zeckhauser, "Reinsurance for Catastrophes and Cataclysms," chap. 6 in *The Financing of Catastrophe Risk*, ed. Kenneth A. Froot (Chicago: University of Chicago Press, 1999), 233–274.

regulated mortgage granting institutions require flood insurance for mortgages on properties on the floodplain coupled with the breadth of the floodplain in Florida means that more than 40 percent of all NFIP policies are located in Florida.[41] A broader requirement for purchasing flood insurance or a reduction in building in Flordia's floodplain would be necessary for the NFIP to gain the advantages inherent in being a nationwide program.

There are also reasons not to participate in the NFIP under federal law. In a 1994 law review article, Griffith argues the DRA, which gives the president power to declare federal disasters and disburse aid following such a declaration, provides a disincentive to potential NFIP participants.[42] The author explains that because individuals are permitted to use disaster assistance under the DRA multiple times without taking mitigation measures, that the DRA provides the disaster aid that should be provided by the NFIP (local governments, however, must hold insurance policies when seeking subsequent aid under the DRA). The author also notes that it is feasible for the DRA and NFIP programs to complement each other rather than working at cross purposes since, at the time of the article, seven percent of the U.S. population lived on land declared on the floodplain while ninety percent of all federally declared disasters were flood related.

41. Erwann O. Michel-Kerjan and Carolyn Kousky, "Come Rain or Shine: Evidence on Flood Insurance Purchases in Florida," *The Journal of Risk and Insurance* 77, no. 2 (2010): 369–397.

42. Griffith, "The Impact of Mandatory Purchase Requirements for Flood Insurance on Real Estate Markets."

2.1.3 Distributional Implications of the Program

Sociological factors come into play with the NFIP, as well. At the start of 2010, there were 8.6 million people living within the 100-year Coastal Flood Hazard Area (CFHA), coastal areas where $\frac{1}{100}$-year flood or larger every year as established by the Flood Insurance Rate Map (FIRM).[43] This does not include the population subject to potential riverine flooding. With such a large population subject to potential flood hazard, there is significant opportunity for the macrosociological effects of both the flood hazard and the NFIP to become apparent.

First, there is a reduction in costs to the government and individuals through the program.[44] With the NFIP in place, Congress no longer needs to provide direct compensation to affected individuals after a flood disaster. Further, because the funds for insurance come from a dedicated source, premiums, there is no burden on the general federal budget to provide this compensation. Further, there is a significant savings to individuals. Because they are unable to purchase flood insurance on the private market, they are not forced to self insure or go without. When a flood disaster strikes, they are compensated for losses appropriately.

As shown through section 2.1.2, there is a clear subsidy granted to homeowners in communities that choose to participate in the NFIP and those who have purchased insurance

43. Mark Crowell et al., "An Estimate of the U.S. Population Living in 100-Year Coastal Flood Hazard Areas," *Journal of Coastal Research* 26, no. 2 (2010): 201–211.

44. Camilo Sarmiento and Ted R. Miller, *Costs and Consequences of Flooding and the Impact of the National Flood Insurance Program* (Washington: American Institutes for Research, October 2006), 65.

through the program. With such a benefit inuring, social inequality issues in how that benefit is distributed can be suspected. Problems with the distribution of NFIP benefits have been known for more than two decades. A study by Shilling, Sirmans, and Benjamin in the late 1980s studied the effects of wealth transfer through the NFIP.[45] Their research used data provided by the Multiple Listing Service (MLS)[46] to estimate the effects on property values of the availability of flood insurance. The data show two key results on wealth transfer patterns.

First, a house sitting in a floodplain is estimated by Shilling, Sirmans, and Benjamin to sell at an 8 percent discount compared to the same house not located in a floodplain. This result shows that how FEMA declares the floodplain to lie can directly impact the valuation of homes in those locations. Purchases, however might trade off risk for property character, such as those who would purchase waterfront property with a view knowing there is an increased risk of flooding. A home that is spared the floodplain declaration because the likelihood of a flood is estimated at once in every 101 years versus 100 years, is on average worth eight percent more than a comparable property on the 100-year floodplain.

Second, in 1987, there was a $4 billion wealth transfer nationally in favor of NFIP policyholders through the National Flood Insurance Fund (NFIF),[47] or approximately $2000 per insured property when the homeowner is subject to subsidized insurance. Homeowners paying actuarially sound rates for flood insurance through the NFIP are expected to repay

45. James D. Shilling, C. F. Sirmans, and John D. Benjamin, "Flood Insurance, Wealth Redistribution, and Urban Property Values," *Journal of Urban Economics* 26 (1989): 43–53.

46. The MLS is a system for cataloging real estate available for sale.

47. Ibid.

their real losses in terms of premium. Homeowners with subsidized insurance through the NFIP are paying less than their real losses, based on largely arbitrary standards.

Other studies of pricing models for homes located in floodplains tell a similar story. Kousky, discovered that homes within the 100-year floodplain around St. Louis were priced at a discount apparently reflective of the relative risk of flooding following the 1993 Midwest Floods. Given that homes in the 500-year floodplain showed no discount reflective of risk, Kousky suggests the discount may stem from the insurance requirement imposed on homes within the 100-year floodplain imposed by the NFIP. Regardless of the discount's cause, Kousky argues that providing more information to purchasers gives home purchasers better pricing information and suggests that FEMA's 100-year floodplain may not be accurate enough for these purposes.[48]

Other flood control measures can alter the value of a home. Holway and Burby found that for vacant land protected by a flood control structure, such as a levee, the land value increased by almost $700 per one thousand square feet of land.[49] This increase to vacant land values can drive up the value of a home as the cost of land under a structure can be a significant portion of housing costs.[50] In addition, those vacant lots that had experienced a flood during the five years prior to the study lost almost $300 in valuation per one thousand square feet of land.

48. Kousky, "Responding to Risk: Information and Decision Making in the Floodplains of St. Louis County, Missouri," 44–46.

49. James M. Holway and Raymond J. Burby, "The Effects of Floodplain Development Controls on Residential Land Values," *Land Economics* 66, no. 3 (August 1990): 259–271.

50. G. Stacy Sirmans, David A. Macpherson, and Emily N. Zietz, "The Composition of Hedonic Pricing Models," *Journal of Real Estate Literature* 113, no. 1 (2005): 3–43.

Sociological factors also play a role in determining how individuals react to the option to purchase flood insurance. Early in the history of the NFIP, a researcher at Mississippi State University researched the differences in perception between flood losses and fire losses. Cheatham discovered in a survey of businessmen in Columbus, Mississippi, that flood damage is perceived to be less than a total loss and there tends to be advanced warning of a pending flood hazard whereas fires are perceived as a total loss and occur spontaneously. In addition, "individual disasters like fire, theft, etc., do not qualify a business for federal disaster relief like natural disasters."[51] These differences in expectations between traditional insurable events and flood losses explain some of the reason individuals or homeowners may be less willing to purchase flood insurance when mortgage lenders do not explicitly require it.

The next year, researchers discovered that experience with prior floods was positively correlated to purchasing insurance through the NFIP. Moore and Cantrell found that experience with Hurricane Agnes in 1972 increased the likelihood of community involvement in the NFIP through both floodplain management planning and NFIP adoption rates.[52] Experience with prior flood events remains a constant theme when studying NFIP adoption rates.

A 1997 study of homeowners in Sparks and Reno, Nevada, also looked into their reasons for purchasing or not purchasing flood insurance. The survey found that of those who

51. Leo R. Cheatham, *A Case Study of Some Economic Aspects of the National Flood Insurance*, technical report (Starkville: Water Resurces Research Institute, Mississippi State University, June 1975), 47.

52. Dan E. Moore and Randolph L. Cantrell, "Community Response to External Demands: An Analysis of Participation in the Federal Flood Insurance Program," *Rural Sociology* 41, no. 4 (1976): 484–508.

were NFIP policyholders, the most important reason was the mortgage requirement, followed by actual concern about flood risk. Less than ten percent of policyholders suggested mentioned the cost of insurance or the use of governmental aid.[53] Those who were not NFIP policyholders gave reasons ranging from a lack of requirement for a mortgage and that damage would not likely exceed the premium for insurance. Less than half of those who had previously endured a flood had purchased flood insurance.[54]

With more than 40 percent of the NFIP policyholders in the United States, Florida residents' flood insurance purchase patterns are a significant source of information about NFIP beneficiaries and the greatest single source of risk within the NFIP.[55] Michel-Kerjan and Kousky used anonymized policyholder data provided by FEMA to answer questions about the flood insurance market. They found that 80 percent of all NFIP policies were for single family homes. Further, while the NFIP has deep penetration within the 100-year floodplain where there are mandatory purchase requirements, more than 18 percent of the policies in force in Florida were in outside the 500-year floodplain, where there is essentially no risk of flooding. In addition, Michel-Kerjan and Kousky found that 73 percent of homeowners had policies reflecting less than the maximum coverage. Finally, Michel-Kerjan and Kousky note, consistent with other studies linking purchases to flood experience, the number of policyholders increased following the 2004, a year with an exceptionally high number of hurricanes striking the state.

53. Unal Yildirim, "The Decision to Purchase Flood Insurance: A Case Study of Reno and Sparks" (master's thesis, University of Nevada, Reno, 1997), 47.
54. Ibid., 50.
55. Michel-Kerjan and Kousky, "Come Rain or Shine: Evidence on Flood Insurance Purchases in Florida."

Multiple hazards also affect potential purchasers. Rennhack used a public choice perspective to analyze NFIP policyholders and determine who purchased flood insurance who did not. This tested for potential flood hazard by looking at floodplain management plans for both rivers and coastal areas. Rennhack discovered that while communities with coastal hazards and communities with river hazards are both more likely to participate in the NFIP, communities with both are less likely to participate in the NFIP.[56]

When looking at the market for flood insurance in the United Kingdom, Green and Penning-Rowsell discussed the distributional issues with government-sponsored flood insurance at length.[57] In particular, Green and Penning-Rowsell point out that as with any class of insurance, those most likely to purchase insurance are those who are most able to recover on their own. Those among the bottom ten percent of income are less likely to be insured than another group, caused likely by a lack of available funds due to household budget curves. In the case of the NFIP, this suggests flood insurance amounts to a government-sponsored bailout for those who could afford to pay the premium for insurance without outside support.

In addition to encouraging development where it may not otherwise be logical, the NFIP has shown instances where other flood mitigation tools have caused unsound decisions with respect to the patterns of flood insurance purchases. Kousky found those with increased risk are not necessarily more likely to purchase flood insurance, except those who are di-

56. Joan Lee Rennhack, "The Flooding of America: A Study of Government Characteristics and Responses" (PhD diss., University of South Carolina, 2004), 84-86.

57. Colin Green and Edmund Penning-Rowsell, "Flood Insurance and Government: 'Parasitic' and 'Symbiotic' Relations," *The Geneva Papers on Risk and Insurance* 29, no. 3 (2004): 518–539.

rectly adjacent to a body of water.[58] Significantly, Kousky also found that those protected by a levee are less likely to purchase flood insurance despite the failures of the levees to protect New Orleans following Hurricane Katrina or to protect St. Louis during the 1993 Midwest Floods.[59] These two findings seem to suggest a certain degree of complacency among prospective policyholders when a flood threat is not readily apparent or when those prospective policyholders believe their risk has already been mitigated or eliminated.

However, the findings regarding levees are open to challenge. Kriesel and Landry found in 2004 that for coastal residents, a levee, seawall, or other flood protection structure encourages potential NFIP participants to purchase a policy, while like Kousky, Kriesel and Landry does conclude that homeowners are more likely to purchase insurance as property moves closer to a potential flood source. There is still room for interpretation. Kriesel and Landry's results apply to residents in coastal areas whereas Kousky's results were derived from flood risk in St. Louis, Missouri, a riverine flood risk. Homeowners may be more willing to interpret the flood control structure for a coastal flood risk as a warning than they are for a riverine flood risk.

One of the more alarming aspects of flood events is the effect it can have on personal finances. Research conducted in 2005 reviewed eighteen major hurricanes and tropical storms from 1983 through 2004 and determined that personal bankruptcy filings increase almost fifty percent more quickly in states that are directly impacted by hurricanes.[60] Im-

58. Kousky, "Responding to Risk: Information and Decision Making in the Floodplains of St. Louis County, Missouri," 105.

59. Ibid., 124–125.

60. Robert M. Lawless, "Bankruptcy Filing Rates after a Major Hurricane," *Nevada Law Journal* 6 (2005):

portantly, Lawless found that larger claims following a hurricane was correlated with a smaller increase in bankruptcy filings, though the analytical techniques used were crude. Without greater information about the relationship between bankruptcy filers and flood insurance policyholders, it is not possible to draw firm conclusions, but this suggests an avenue of future research on how the NFIP mitigates bankruptcy filings or otherwise protects the personal finances of policyholders.

Other distributional issues are raised by the pattern of land use decision making processes therefore. Green and Penning-Rowsell point out that some flooding is caused by land use decisions made in other areas, such as elimination of barriers to erosion, and the burden of flood is not borne by those who caused the increased risk.[61] Green and Penning-Rowsell suggest that in these cases, those damaged may be able to seek compensation from the upstream landowners, but that such challenges are "unenforceable in practice" because of cost concerns and the burden of proof. Because of this, the NFIP helps smooth some of the distributional issues surrounding flooding.

There are interesting complications to the United States government participating in insurances markets, which are otherwise regulated by the individual states. Because of the regulatory environment surrounding insurance, there is an extensive body of law available through the state courts addressing insurance matters and there is little common law at the federal level on the matter. This sends federal judges in cases involving the NFIP to the state courts for guidance. In one case, a federal judge ruled "that even though federal law governs

7–20.

61. Green and Penning-Rowsell, "Flood Insurance and Government: 'Parasitic' and 'Symbiotic' Relations."

the interpretation of the flood insurance policy, state law provides the rule of decision in cases involving claims handling."[62] This opens a new class of disparity as state legislatures and individual state insurance regulators are given the opportunity to dictate how the federal government treats its citizens and this may vary from state to state. However, this potential disparity is largely hypothetical and could be eliminated by Congress through legislative actions to require uniform treatment of litigants at flood insurance matters.

The sociological effects of flooding and flood insurance also cut across age-based demographics. Individuals can be harmed as Davila discovered when he analyzed the effects of fraud on the elderly following a flood.[63] He found that while these effects are relatively small, with only two percent of survey respondents noting fraud in rebuilding, these disproportionately were among the elderly and Davila expects this problem to grow worse as the aged move to the southern United States, an area disproportionately affected by flood disasters.[64] This is complicated by a study showing those over the age of 60 are less likely to buy flood insurance on their primary homes;[65] this study suggests this is caused by those of retirement age being less likely to hold a mortgage and not required to hold flood insurance. However, this study is limited by only focusing on residents of Grand Forks, North Dakota.

62. Craig M. Collins, "Flood Insurance is not All Created Equal," *North Dakota Law Review* 74 (1998): 35–44.

63. Mario A. Davila, "After the Flood: Fraud Among the Elderly After Natural Disasters" (PhD diss., Sam Houston State University, 2005).

64. Ibid., 67–69.

65. Ronald Pynn and Greta M. Ljung, "Flood Insurance: A Survey of Grand Forks, North Dakota, Homeowners," *Applied Behavioral Science Review* 7, no. 2 (1999): 171–180.

Finally, research have investigated the environmental impacts of the NFIP. Because the program has lowered the economic barrier to floodplain development, that development has occured and may be offsetting environmental protection goals laid out elsewhere in public policy. One example of this is provided in as part of the American Institutes for Research (AIR) evaluation of the NFIP where the NFIP is credited with removing barriers to entry for the development of endangered species habitat leading to multiple lawsuits.[66] The authors of the AIR study also note that other environmental impacts are no documented and may be more extensive than reported.[67]

2.2 Benefit-Cost Analysis

2.2.1 Benefit-Cost Analysis of Flood Programs

Flood risk measures are a natural application for benefit-cost analysis (BCA) and historically fitting since BCA was introduced into the Federal policy-making process by the Flood Control Act of 1936. With that act, Congress required the use of BCA when evaluating potential flood control projects by the United States Army Corps of Engineers (USACE). Arnold goes so far as to state "[t]he only limitations on federal flood control projects were that the economic benefits had to exceed the costs" other than other certain limitations on

66. Walter A. Rosenbaum and Gary Boulware, *The Developmental and Environmental Impact of the National Flood Insurance Program: A Summary Research Report* (Washington: American Institutes for Research, October 2006), 59–61.

67. Ibid., 52.

local support for the project.[68]

Beyond this historical basis, BCA for federal programs is well supported by policy. The Office of Management and Budget (OMB) requires that new federal rules be supported by BCA (or in the alternative, cost effectiveness analysis, with both being the preferred case).[69] This has been supported by presidential Executive Order 12866 (EO 12866) and and reaffirmed by Executive Order 13563 (EO 13563). Pursuant to the requirements, FEMA requires that new flood control efforts sponsored under the Flood Mitigation Assistance (FMA) be supported by a BCA conducted in accordance with OMB regulations. As a result, FMA projects have already been subject to a BCA, but importantly, those projects have only been analyzed individually. This leaves open the question of the aggregate costs and benefits of the FMA.

Despite the requirements for BCA covering flood projects, the guidance standards from the federal government are more complex for flood mitigation activities. A circular from OMB[70] sets the guidelines for federal BCA estimates, but specifically excludes water projects, which includes flood mitigation projects developed under both FEMA and USACE. BCA for water projects are required to use separate guidelines developed by the United States Water Resources Council (WRC),[71] a governmental advisory panel composed of several federal

68. Joseph L. Arnold, *The Evolution of the 1936 Flood Control Act* (Fort Belvoir, Virginia: United States Army Corps of Engineers, 1988), 91.

69. Office of Management and Budget, *Regulatory Analysis*, A-4, technical report (Washington, September 2003).

70. Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, 4.

71. Water Resources Council, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, technical report (Washington, March 1983).

department heads.

The standards developed by the WRC focus on economic development, a goal not inconsistent with the goals of the NFIP, generally. The WRC document, however, only applies to USACE, Bureau of Reclamation (BOR), Natual Resources Conservation Service (NRCS), and the Tennessee Valley Authority (TVA). This legally changes the requirements for BCA of flood mitigation projects conducted by federal agencies based solely on the agency involved. Beginning in 2008, USACE began a comprehensive revision to water project assessment designed to provide principles and standards which can then be implemented by federal agencies in a mission-specific manner.

The National Academy of Science (NAS), through the National Research Council (NRC), has commented on the prposed revisions to BCA for water projects. In particular, the NAS has noted BCA is a required component of the decision making framework, but does not specify how it is to be used.[72] The NAS further criticizes the implemention of BCA by USACE in noting that the revisions continue historical practices of assuming *a priori* which benefits and costs can be monetized and by miscounting certain zero-sum transfers as benefits accruing in favor of a project. NAS has a previously challenged USACE on its implementation of BCA for water projects, going so far as to criticize its over-reliance on monetized benefits and costs and lack of independent focus on social and environmental costs and benefits of USACE-managed projects.[73]

72. National Research Council, *A Review of the Proposed Revisions to the Federal Principles and Guidelines Water Resources Planning Document*, technical report (Washington, 2010), 12-13.

73. National Research Council, *Analytical Methods and Approaches for Water Resources Project Planning*, technical report (Washington, 2004), 70-72.

There have been other attempts to estimate the value of flood protections through BCA independently of the FMA and USACE processes. Ramirez et al. analyzed the value of a flood control project in Rushford, Minnesota. A flood control project was authorized by the 1958 Flood Control Act due to roughly annual damages in the city due to its proximity to two rivers. The authors found this project suitable for an *ex post* BCA. Importantly, Ramirez et al. discovered the *ex post* BCA flood benefits were higher than the *ex ante* BCA benefit estimates.[74] According to the authors, this was because revised damage estimates were available after economic growth within the subject community since the original project was estimated. Within their sensitivity analysis, the authors acknowledge the uncertainty surrounding community growth. It is not known if the community would have experienced the same growth without the flood control measures in place.

This gives rise to specific applications of BCA to projects involving flood mitigation. One such project is the Three Gorges project on the Yangtze River in China.[75] This project, to dam the Yangtze, will provide many diverse benefits from power generation, navigational improvements, to flood control at the cost of tourism, fishing, and land losses, plus the construction costs and human resettlement. The Three Gorges project is a large extreme example of engineering, the model presented by Morimoto and Hope gives values for the costs and benefits that would stem from a flood mitigation project in the United States.

Through the AIR evaluation of the NFIP, Jones et al. used BCA to analyze the net social

74. Jorge Ramirez et al., "Ex Post Analysis of Flood Control: Benefit-Cost Analysis and the Value of Information," *Water Resources Research* 24, no. 8 (August 1988): 1397–1405.

75. Risako Morimoto and Chris Hope, "Applying a cost-benefit analysis model to the Three Gorges project in China," *Impact Assessment and Project Appraisal* 22, no. 3 (September 2004): 205–220.

benefits of the building standards component of the program. This component is part of the requirements for participating communities and requires that communities set building standards to be able to withstand a minimum intensity flood before participants in the community can join the insurance component. Jones et al. found that buildings constructed to new NFIP-mandated standards had reduced damages compared to pre-FIRM buildings and those benefits generally outweighed the costs on an individual building level.[76]

This does not necessarily mean BCA is the only nor the best option for analyzing risk assessment in environmental programs. Yasui analyzed the traditional methodology of BCA with respect to risk management in the context of ecological regulatory decision making. Yasui argues BCA presents minima and maxima from potential implementations at regulatory options without significantly considering points in between and also argues that stakeholders with relatively small benefits or costs may be ignored from an analytical perspective. This strikes at the heart of the questions of sensitivity and standing, and though Yasui argues for alternative regulator decision making frameworks, actually point to more circumspect analysis within the BCA process, especially in the standing determination.

Ultimately, the measure of risk is the combined effect of the probability the event will occur and the damage that is likely to be caused by the event. With flood risk, both are difficult to estimate.[77] Flood probability stems from hydrological and other environmental factors. Bouma, François, and Troch point out that it is difficult to estimate flood risk

76. Christopher P. Jones et al., *Evaluation of the National Flood Insurance Programs Building Standards* (Washington: American Institutes for Research, October 2006), 89–90.

77. Jan Jaap Bouma, Delphine François, and Peter Troch, "Risk assessment and water management," *Environmental Modelling & Software* 20, no. 2 (2005): 141–151.

without some major flood to anchor their perceptions. On the other hand, it is very difficult to measure the socioeconomic value of the damage a flood can cause. Because of this, actual flood risk, a key component of any measure of the potential costs of a flood, can be very difficult to measure.

These dual problems of measuring risk point focus the problem of measuring the value of flood mitigation projects. This problem comes from the fact flood mitigation programs require a more detailed analysis than is provided by an environmental impact statement. A flood mitigation program will have diffuse impacts, beyond the immediately protected homeowerns.[78] There will be environmental impacts as certain areas are protected. There will be costs imposed on local governments that gain or lose revenue, face expenditures, but are not forced with the major costs following a flood. There will also be impacts on the property values depending on protection levels. These diffuse impacts are difficult to identify because of their far reaching effects.

Brown et al. argues for a multidisciplinary approach to measuring the net benefits of a dam project for these reasons and the argument is applicable to other flood control devices. This agrees with the work of Godschalk et al. who when looking at all FEMA disaster mitigation strategies concluded understanding broad social implications of a disaster was necessary and could include qualitative studies in addition to quantitative.Godschalk et al. This suggests a BCA incorporating sociological and political impacts, combined with the economic impacts of the program, is the best methodological approach for analyzing the

78. Philip H. Brown et al., "Modeling the costs and benets of dam construction from a multidisciplinary perspective," *Journal of Environmental Management* 90 (2008): S303–311.

NFIP from the policymakers perspective. From this, the policymaker and determine the effects of the program not just on participants but also compared to the intended consequences, especially when those consequences were planned to relieve the administrative and financial burden on certain named groups of program participants.

Godschalk et al. also found that a larger analytical basis is necessary when looking at disaster mitigation.[79] Geographic and temporal spreading allow risk to smooth through both space and time, creating more accurate averages for measuring risk. While there is some concentration of both participation and risk to the NFIP in Florida, the program is accessible and required in some circumstances across the United States. This geographic dispersion and the forty year history of the program gives large universe of data for understanding the impacts of the NFIP.

2.2.2 Benefit-Cost Analysis and Willingness to Pay

A complex problem in economic literature surrounding the NFIP is establishing the willingness to pay for reduced flood risk and for insurance against that flood risk. While there has been little work to establish what that willingness to pay is and how it affects the NFIP, there has been work in other countries on this matter. Hung established a method for estimating willingness to pay for flood insurance in Taiwan using random utility functions

79. David R. Godschalk et al., "Estimating the Value of Foresight: Aggregate Analysis of Natural Hazard Mitigation Benefits and Costs," *Journal of Environmental Planning and Management* 52, no. 6 (September 2009): 739–756.

and fuzzy utility functions.[80] Using these methods, the author found that using fuzzy utility functions results in a broad swath of possible willingness to pay values. This suggests that willingness to pay for flood insurance is a highly personal choice and this agrees with reasons for purchasing flood insurance outlined in 2.1.3, though willingness to pay is highly determined by both perceived risk and distance to a potential flood hazard.

Freeman looks at two ways of considering the value of protection in *ex ante* and *ex post* measures of social welfare from the policy-maker's perspective.[81] defines *ex post* social welfare based on the "expected value of the social value of the social welfares realized in alternative states of nature." The *ex post* measurement reflects the potential cost of clean up after an events occurrence. With regard to the NFIP, this corresponds to the payments made to policyholders on claims through the insurance component of the program. Because the *ex post* measures are tied directly to the costs of an event, the *ex post* measures are relatively easy to capture and have the added benefit of estimating willingness-to-pay (WTP) independent of the NFIP premiums many of which are not the result of market behavior but instead mandated by regulation.

In contrast to *ex post* measurements, Freeman defines *ex ante* social welfare based on the "expected utilities of the individuals in the society." This *ex ante* measurement represents the willingness to pay for a reduction in risk prior to an event's occurrence and is frequently called the "option price." The *ex ante* measure of willingness to pay is preferable

80. Hunh-Chih Hung, "The attitude towards flood insurance purchase when respondents preferences are uncertain: a fuzzy approach," *Journal of Risk Research* 12, no. 2 (March 2009): 239–258.

81. A. Myrick Freeman III, "*Ex Ante* and *Ex Post* Values for Changes in Risks," *Risk Analysis* 9, no. 3 (1989).

to the *ex post* because it is not dependent upon the probability a certain event will occur.[82] With regard to the NFIP, this corresponds to flood protection strategies embodied in the FMA that are required for participation in the NFIP.

Freeman found that the *ex post* measures of risk reduction are not comparable to the *ex ante* measurements cannot generally be used be used to predict *ex ante* willingness to pay. This squares with a common sense approach to the question that insurance can only cover material losses and cannot reimburse for nonmaterial losses such as peace of mind or personal items that are not replaceable.[83] As a result, individuals may be willing to pay more for mitigation strategies than expected losses would suggest, though Freeman notes that *ex post* measures may be greater than or less than the related *ex post* measure, depending on the nature of the application.

This is problematic as the *ex ante* measurement requires understanding the preferences of the individuals making the payments whereas the *ex post* measures can be seen directly in the accounting of a program. While it may be preferable to use the *ex ante* measures of willingness to pay, the *ex post* measures are readily available. Sen claims individuals can be reluctant to provide information on their willingness to pay for a good or service. Additionally, revealed preferences may be distorted due to external factors including free riding.[84] These are exacerbated in the case of flood protection because there is no function-

82. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*, 202–203.

83. Philip J. Cook and Daniel A. Graham, "The Demand for Insuranceand Protection: The Case of Irreplaceable Commodities," *The Quarterly Journal of Economics* 91, no. 1 (February 1977): 142–156.

84. Amartya Sen, "The Discipline of Cost-Benefit Analysis," *Journal of Legal Studies* 29, no. S2 (June 2000): 931–952.

ing market for providing that protection and it is difficult to imagine how such a market would function.

Estimating *ex ante* willingness to pay strikes at heart of these questions by moving beyond purely statistical measures of risk. When looking at waste water treatment programs, Fisher collected studies showing that individuals change their tolerance for risk depending upon non-economic characteristics of the risk. Specifically noted are concerns about a risk could be "potentially catastrophic leading to greater concern from individuals, regardless of the actual probability the catastrophic event could happen. As floods are generally perceived to be catastrophic, this suggests individuals are willing to pay more to prevent a flood than their expected losses would dictate.

Nevertheless, this has direct application to the NFIP program because of the way the program is designed. Farrow has constructed models for estimating the willingness to pay for flood protection by estimating economic losses from flood risk in Maryland. Preliminary results from this work[85] suggest the *ex ante* measurement for flood risk is approximately 115 percent of the *ex post* expected values for damages due to flooding. When considering the results of Freeman, Farrow notes this may not be the expected case for flood risk, and adjusting *ex post* measures for flood risk for *ex ante* assumptions may not be necessary for the purposes of policy-makers.

Small scale attempts to find the willingness to pay for flood protection have been made. MacDonald et al. estimated the willingness to pay for flood protection using a hedonic

85. Scott Farrow and Michael Scott, "Estimating the Ex-Ante Willingness to Pay for Flood Protection" (2011), presented at the Association of Environmental and Resource Economists summer workshop.

model for home prices.[86] Using house value data from Monroe, Lousiana, the authors constructed their model to include flood risk and determined that those houses outside the floodplain sold for a slightly higher amount, when controlling for other variables. This increase corresponds into the likelihood that someone will pay more for a house that has some manner of protections. However, this study was flawed by lacking important information for the hedonic model, such as crime rate and school quality, that affects the results. Importantly, MacDonald et al. also noted that a property in the floodplain will require flood insurance, if the mortgage is issued through a federally regulated institution, and this cost also affects the model.

Other methods for finding the willingness to pay for flood protection have also appeared. Daun and Clark used the contingent valuation method estimate the willingness to pay for flood protection using a telephone survey of Milwaukee, Wisconsin, residents.[87] Daun and Clark found that both years of education and income contributed to increases in willingness to pay, but also so do political philosophy and as well a desire to help others in the community. They also found that homeowners were willing to pay more for flood protection than renters. Interestingly, Daun and Clark suggests there may be a role for social pressure in increasing willingness to pay for flood protection.

Work has also been done outside the United States to estimate the willingness to pay for

86. Don N. MacDonald et al., "Flood Hazard Pricing and Insurance Premium Differentials: Evidence From the Housing Market," *The Journal of Risk and Insurance* 57, no. 4 (1990): 654–663.

87. Margaret C. Daun and David Clark, *Flood Risk and Contingent Valuation Willingness to Pay Studies: A Methodological Review and Applied Analysis*, TR-6, technical report, Institute for Urban Environmental Risk Management (Milwaukee, WI: Marquette University, August 2000).

flood protection. Fuks and Chatterjee used the contingent valuation method to estimate the willingness to pay for flood protection in Brazil.[88] Their study showed the median and average willingness to pay was about 1.6 percent of median income, which was significantly lower than the actual cost of the flood protection project being analyzed. However, this study was limited to a single flood control project to protect a relatively poor metropolitan neighborhood and may not necessarily be generalizable across the population or to other countries.

2.2.3 Distributional Implications of Benefit-Cost Analysis

One of the greatest concerns of applied BCA is the fact a program can impact two groups, but for nominally equivalent impacts, the real impact can differ substantially. A dollar is worth more to a person with lower wealth and income because of a greater need to purchase necessities whereas a wealthier person may save or spend on something beyond a basic expense. At the same time, a dollar in the community may have objectively the same value regardless of the holder under traditional BCA since it contributes the same amount to society. These differing viewpoints on equity complicate the application of BCA.

This distributional analysis turns around a key underlying assumption of BCA, the Kaldor-Hicks criterion.[89] Kaldor-Hicks is premised on the idea that an option is economically efficient if those made better off in the transaction compensate those worse off and

88. Mauricio Fuks and Lata Chatterjee, "Estimating the Willingness to Pay for a Flood Control Project in Brazil Using the Contingent Valuation Method," *Journal of Urban Planning and Development* 134, no. 1 (March 2008): 42–52.

89. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*, 32.

there is still a net gain for society. This is implicit in a proper BCA calculation. By including the notion that not all effects have the equal impact, maintaining an economically efficient outcome becomes more difficult.

Equity concerns, however, justify the use of distributionally weighted BCA by using weighted costs and benefits to distinctly value the impacts on diverse groups with standing. It is important to make sure the benefits and costs are "fairly distributed across society at large. This is handled by tying distributional weights to income..[90] The advantage of this is that an individuals costs and benefits are directly tied to their general price elasticity. Therefore, someone with greater wealth will receive less weight to a cost associated with purchasing food, for instance, since their needs will have already been met.

In reference to health hazards, Viscusi points out "[m]ore affluent individuals will have a greater willingness to pay for protection than those with lesser means.[91] This would logically also apply to catastrophe hazards. Conversely, the benefits of a program like the NFIP are of greater value to those less able to protect themselves. Again, this follows from the premise that those with greater resources are able to self-insure or find other avenues of self protection than those with lesser means. In practice, this distinction differentiates BCA from distributionally weighted BCA.

Farrow examined the requirements of OMB for distributional analysis in BCA. and discovered those requirement lack details and leave implementation to the analyst.[92] However,

90. Arnold C. Harberger, "On the Use of Distrubtional Weights in Social Cost-Benefit Analysis," *Journal of Political Economy* 86, no. 2 Part 2: Research in Taxation (April 1978): S87–S120.

91. W. Kip Viscusi, "Risk Equity," *Journal of Legal Studies* 29, no. S2 (June 2000): 843–871.

92. Scott Farrow, "Incorporating Equity in Regulatory and Benefit-Cost Analysis Using Risk Based Prefer-

in the course of study, Farrow provided simple recommendations for analysts including the use of a distributional sensitivity test when conducting BCA. The distributional sensitivity test, like other sensitivity tests, subjects the assumptions of the BCA to a range of values to determine how the net social value changes. But rather than adjusting an input, the distributional sensitivity test focuses on the impacts assessments by social group. Using this, it is possible to see how the net social value of a project changes depending upon the make up of impact groups.

In addition, Farrow and Toman argues that BCA should be used in environmental regulation, a side effect of the NFIP. The authors note important objections to the use of BCA, but the most important is that BCA does not take into account the equity concerns of those affected by a proposed regulation or project.[93] Farrow and Toman go on to state the ability of BCA to highlight "both the distributional effects and the potential trade offs between cost and equity considerations. That highlighting can lead to better information about a programs impact beyond the immediate social value that an accounting perspective would yield. Understanding the impacts across social classes, including local government and business, gives policymakers additional tools measuring whether or not a program is reaching the intended participants when a governmental program has specific social aims.

There are multiple methods for implementing distributional analysis into a BCA and Loomis lists several in his summary of the topic. Two methods that standout as relevant

ences," *Risk Analysis: An International Journal* (2010): In print.

93. Scott Farrow and Michael Toman, "Using Benefit-Cost Analysis to Improve Environmental Regulations," *Environment* 41, no. 2 (1999): 12–38.

to BCA as applied to the NFIP are contingent valuation method and the hedonic property method.[94] The contingent valuation method is a non market method and used to quantify the willingness to pay for goods. Using surveys, analysts can ask respondents about their willingness to pay for the good and aggregate the information to create a societial willingness to pay for the good. This is the method used for several willingness to pay studies for flood protection in section 2.2.2. To gather distributional issues, the respondent information can be separated based on demographic information. However, contingent valuation methods are subject to all the flaws common in survey methodologies.[95]

A second option for Loomis notes for gathering distributional information is the hedonic property method. This option uses the information apparent in statistical multiple regression methods to determine if gender, race, or other demographic factors affect the price of a good. In the case of the NFIP, hedonic methods were shown in section 2.2.1 to demonstrate the effects locating on a floodplain had on property values. Loomis points out that hedonic property methods can be used to "monetize the distributio of costs or benefits"to minority or low income populations.[96] This is then a powerful tool for analyzing distributional impacts.

There are concerns about the distributional effects of the NFIP. Bin, Bishop, and Kousky studied the income and expenses of the NFIP and discovered that the premiums charged to

94. John B. Loomis, "Incorporating Distributional Issues into Benefit Cost Analysis: Why, How, and Two Empirical Examples Using Non-market Valuation," *Journal of Benefit-Cost Analysis* 2, no. 1 (2011): Art. 1.

95. Elizabethann O'Sullivan, Gary R. Rassel, and Maureen Berner, *Research Methods for Public Administrators*, 4th ed. (New York: Longman, 2003).

96. Loomis, "Incorporating Distributional Issues into Benefit Cost Analysis: Why, How, and Two Empirical Examples Using Non-market Valuation."

policy holders is regressive, meaning amounts charged decreased with income. In contrast, the amounts the NFIP paid on claims were progressive.[97] The authors found that in neither case was the regressivity nor the progressivity extreme and over time, the differences between the payments, premiums, and income smoothed. These results suggest the insurance component of the program is not subject to distributional pressures and it may be considered, for some definition, fair to program participants.

97. Okmyung Bin, John A. Bishop, and Carolyn Kousky, *Redistributional Effects of the National Flood Insurance Program*, Discussion paper, DP 11-14, technical report (Washington, March 2011).

CHAPTER 3

RESEARCH QUESTIONS AND HYPOTHESES

The primary research question of this dissertation is to determine whether or not the National Flood Insurance Program (NFIP) has provided a net benefit to society and its distirbutional implications. With more than forty years of history behind it and the results well documented, the experience with the NFIP can be measured quantitatively and benefit-cost analysis (BCA) techniques can be applied to determine the net benefit to society to date. There are several ways that question can be asked and answered using BCA taking into account factors relating to how benefits and costs are measured. As a result, this dissertation will consider three hypotheses directed at the research question.

Each alternative hypothesis tested will inform the answer to the research question in a different way and different hypothesis tests may yield contradictory responses to the primary research question. Because of this, each alternative hypothesis is independent and evaluated against a separate null hypothesis which is distinct from the other null hypotheses. The results of the several analyses also provide information to analyze key sociological

and political dimensions of the program.

3.1 Retrospective Net Social Benefits

The first hypothesis will test whether the NFIP has provided net social benefits to society from 1996 to 2009, while reporting all available data from 1977 to 2009. This hypothesis establishes a baseline for the NFIP analysis and provides context to other hypotheses. The time frame from 1996 to 2009 is used due to availablility of data for both the Flood Mitigation Assistance (FMA) and insurance component. Of note, this time frame includes the extreme hurricane events of 2005, specifically Hurricane Katrina. Because of the severity of the 2005 hurricane season, it may be necessary to provide a secondary analysis omitting the events of 2005.

To consider this hypothesis, the net social benefits of the NFIP (the alternative hypothesis) are compared to a hypothetical situation where the National Flood Insurance Act of 1968 (NFIA) did not exist and no comparable private program emerged (the null hypothesis). If the net social benefits of the NFIP are greater than zero (0), then the null hypothesis is rejected in favor of the alternative hypothesis. Formally stated, the null and alternative hypotheses are:

H_0^a: The net present value of the social benefits of the NFIP from 1996 to 2009 were less than or equal to zero (0).

H_1^a: The net present value of the social benefits of the NFIP from 1996 to 2009 were

greater than zero (0).

3.2 Net Social Benefits with Distributional Analysis

The second hypothesis is whether or not the NFIP has provided net social benefits to society when the distributional effects of the NFIP are introduced into consideration from 1996 to 2009.

To consider this hypothesis, the net social benefits, when calculated with distributional effects appropriately considered, of the NFIP (the alternative hypothesis) are compared to a hypothetical situation where the NFIA were not enacted (the null hypothesis). Like the first hypothesis, if the net social benefits of the NFIP are greater than zero (0), then the null hypothesis is rejected in favor of the alternative hypothesis. Formally stated, the null and alternative hypotheses are:

H_0^b: The net present value of the social benefits from 1996 to 2009 with distributional impacts of the NFIP considered were less than or equal to zero (0).

H_1^b: The net present value of the social benefits from 1996 to 2009 with distributional impacts of the NFIP considered were greater than zero (0).

3.3 Historical Impact on Government Income

The third hypothesis tests whether or not the NFIP has provided benefits to the United States government from 1996 to 2009 by considering the distributional impacts of the program on the federal budget. To consider this hypothesis, the net social benefits with respect to the federal government will be considered by estimating the costs of the program and anticipated costs of *ad hoc* disaster aid if the program were not in place. Formally stated, the null and test hypotheses are:

H_0^c: The net present value of the distributional impact of the NFIP on the United States government from 1996 to 2009 were less than or equal to zero (0).

H_1^c: The net present value of the distributional impact of the NFIP on the United States government from 1996 to 2009 were greater than zero (0).

If the null hypothesis is rejected, then the program has provided a benefit to the federal government by reducing the potential costs of a flood disaster, but shifting the burden of disaster aid onto NFIP program participants.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

The analytical method used in this dissertation will be benefit-cost analysis (BCA). The process behind BCA seems deceptively simple to apply to a policy or proposed policy. Information on the social benefits of a policy are collected and valued. The social costs of the same policy are collected and valued. The sum of the social costs is subtracted from the sum of the social benefits, discounted to present, and the value is the net discounted social benefit, which can be negative. The net social benefit of a policy can be compared against the status quo if that is not the current policy, other proposed policies, and against no policy whatsoever.

In practice, BCA is a tool that can be complex to implement due to the many assumptions necessary for a comprehensive and meaningful analysis. Determining whose benefits and costs to value can have political and empirical ramifications. Valuing those impacts, which may or may not occur directly in markets, stretches the limits of economics and forecasting impacts for a state of the world which does not exist can be difficult. Other

issues arise depending on the specifics of the analysis. Because of this, most analyses are open to critique based on the decisions made by the analyst, although guidance exists from federal agencies and professional practice.[1]

Before moving into the steps of the BCA process, it is first necessary to define the characteristics of the National Flood Insurance Program (NFIP) that are to be analyzed. This dissertation will consider the the two core components of the NFIP together. The first component is the insurance program itself. This program is the financial component. The second component represents the various flood mitigation activities Federal Emergency Management Agency (FEMA) funds through grant programs. This includes construction of preventative barriers, such as dams, building code revisions, and other nonfinancial activities.

These two components should be considered together because the effects of the flood insurance program cannot be separated from the flood damage mitigation programs due to their programatic interdependencies, such as the requirement for communities participate in the flood damage mitigation program before property owners can purchase flood insurance. This definition leads to the set of alternatives to be considered.

The base case for this BCA will be current status of the NFIP program in place and operating as it did from 1996 to 2009. The alternative to NFIP considered is the hypothetical situation where the program did not exist and no comparable private flood insurance. This provides the baseline for establishing the social benefits delivered by the program.

1. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*; Office of Management and Budget, *Regulatory Analysis*.

4.1 Retrospective Net Social Benefits

The net social benefits of the NFIP are the sum of the net social benefits of the financial part, which is called the "insurance program" below and the Flood Mitigation Assistance (FMA) program. This dissertation will benefit from the recent research into the FMA and will add to the literature by completing new analysis of the insurance component. In addition, where appropriate, the benefit-cost ratio (BCR) will also be estimated from historical data.

To start the analysis, it is necessary to establish who has standing to have costs and benefits counted. This research hypothesis is broadly construed and designed to be broadly inclusive. As a result, many parties are broadly defined and represented equally. The first is consumers, who purchase insurance through the NFIP. The second party is producers, who sell insurance plans on behalf of the NFIP. The third party is the federal government, which must manage the program. And the final party is third parties affected broadly by externalities such as environmental impacts of the program. These definitions give rise to the social surplus model for the insurance component and mirror the analytic techniques of microeconomics, generally.

4.1.1 Insurance Program

Social Surplus Model

BCA methodology typically defines the net social benefit in terms of benefits less total costs of the sum of economic surpluses.[2] Social surplus (S) is the sum of the consumer surplus (C), the producer surplus (P), government surplus (G), and the external surplus (E), each of which have their own definitional components:

$$S = C + P + G + E \tag{4.1}$$

In addition, the incremental shift in social benefit due to a policy change is:

$$\Delta S = \Delta C + \Delta P + \Delta G + \Delta E. \tag{4.2}$$

The consumer surplus measures the net benefit due to consumers from acquiring goods and services in the market. In general, the consumer surplus represents the net amount consumers are willing to spend for a given good or service minus the actual price paid.[3] In the case of the NFIP, it is assumed that consumers would be unable to purchase flood insurance if the program did not exist, as was the case at the time the National Flood Insurance Act of 1968 (NFIA) was enacted. The base case, where the NFIP provides insurance to consumers is represented by C^* and the alternative, where the NFIP no longer provides service

2. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*, 62.
3. Frank, *Microeconomics and Behavior*, 160–162.

is represented by C'. Based on this, the total change in consumer surplus due to the NFIP is:

$$\Delta C = C^* - C'. \tag{4.3}$$

In the event the NFIP does not exist, it is reasonable to assume the government would make payments to those affected by flood disasters on an *ad hoc* basis. This was the stance of the Congress prior to the enactment of the NFIA. In addition, Congress still makes *ad hoc* aid available in response to other disasters and certain extreme flood events, such as Hurricane Katrina. In this case, such *ad hoc* aid is represented by a. Therefore,

$$C' = a. \tag{4.4}$$

To calculate the consumer surplus due to the NFIP, it is necessary to find the willingness-to-pay (WTP) for insurance services (w), to estimate the premium payments consumers are likely to pay for flood insurance through the NFIP (ϖ), and to find the difference between the two. In a given year, this would be given by

$$C^* = w - \varpi. \tag{4.5}$$

Combining the equations for C^* and C' with equation 4.3 yields a final form for ΔC:

Variable	Description
a	Amount of *ad hoc* disaster aid payments
C	Consumer surplus
κ	Claims made against the NFIP
E	External surplus
e	The *ex ante* adjustment for WTP
G	Government surplus
φ	Write Your Own (WYO) fees to insurers
λ	The loss-ratio for the NFIP
m	the marginal excess tax burden (METB)
P	Producer surplus
ϖ	Premiums paid to the NFIP
π	Profit ratio for the insurance industry
R	The BCR for the FMA
S	Net social surplus
w	willingness-to-pay for flood insurance

Table 4.1: Variable list included in social surplus

$$\begin{aligned}\Delta C &= C^* - C' \\ &= (w - \varpi) - a \\ &= w - \varpi - a. \end{aligned} \tag{4.6}$$

This final equation, 4.6, shows the complete change in the consumer surplus is represented by the willingness to pay for flood insurance minus the premiums actually paid to the insurance fund and the estimated *ad hoc* disaster aid the government may sponsor. The producer surplus measures the net benefit due to producers and their suppliers from providing goods and services to the market. The NFIP however, is a government program and the program is managed through a dedicated fund, the National Flood Insurance Fund (NFIF). As a consequence, the main "producer" is better considered as a part of the government

surplus, below. However, general insurance companies do benefit under the terms of the WYO program.

It is assumed that consumers would be unable to purchase flood insurance if the program did not exist. The base case, where the NFIP provides insurance to consumers is represented by P^* and the alternative, where the NFIP no longer provides service is represented by P'. Based on this, the total change in producer surplus due to the NFIP is:

$$\Delta P = P^* - P'. \tag{4.7}$$

Because it is assumed no producer would enter a hypothetical open market for flood insurance, then $P' = 0$. In the case where the NFIP is extant and being serviced by individual insurance companies, a simple multiplier (φ) is applied to the value ϖ, representing the gross industry revenue from servicing NFIP programs on behalf of FEMA. However, the producer surplus is only the profit to the insurance industry, which is only a portion of that revenue. Therefore, the gross revenue will be multiplied by an estimate for insurance industry profitability which is represented by π. As a result, P^* represents the producer surplus across the entire industry due to the NFIP. The estimate for the producer surplus is:

$$P^* = \varphi \varpi \pi. \tag{4.8}$$

Using these estimates for the producer surpluses in each case leads to an estimate for the net change in the producer surplus due to the NFIP:

$$\begin{aligned}\Delta P &= P^* - P' \\ &= \varphi\varpi\pi - 0 \\ &= \varphi\varpi\pi. \end{aligned} \tag{4.9}$$

The government surplus measures the benefits and costs due to the government as part of a policy change. The government of the United States, through the NFIF, sees inflows and outflows directly stemming from the program. Continuing the assumption program participants would be unable to purchase flood insurance if the program did not exist, The base case, where the NFIP provides insurance to consumers is represented by G^* and the alternative, where the NFIP no longer provides service is represented by G'. Based on this, the total change in the government surplus due to the NFIP is:

$$\Delta G = G^* - G'. \tag{4.10}$$

While the government did routinely provide disaster assistance to flood victims prior to the enactment of the NFIA, that assistance was provided on an *ad hoc* basis was not a given as it each instance was mandated by an act of Congress. Because it is assumed the government would compensate the victims of flooding, per C', the government surplus must balance this in the case where the NFIP did not exist. Therefore, $G' = -a$.

In the existing case of the NFIP, represented by G^*, government experiences inflows in the form of premium payments from program participants. It experiences outflows from

claims payments made to policyholders after a flood event. Therefore, $G^* = \varpi - \kappa$ and the complete equation for the net change in the government surplus is:

$$\begin{aligned} \Delta G &= G^* - G' \\ &= (\varpi - \kappa) - (-a) \\ &= \varpi - \kappa + a. \end{aligned} \tag{4.11}$$

Finally, the external surplus is the sum of benefits and costs due to third parties caused by the actions of consumers, producers, and the goverment. Like the other surpluses, the change in external surplus is the difference between the external surplus with the NFIP, E^*, and the case where the NFIP did not exist, E':

$$\Delta E = E^* - E'. \tag{4.12}$$

In the case where the NFIP does not exist, there is no action from consumers and producers, per the above analysis. However, government is likely to give distaster relief aid and this may cause some beneficiaries to rebuild in environmentally sensitive areas. Therefore, the ecological impact, β, must be accounted for. In addition, there is the externality of the impact of taxation required to pay for *ad hoc* payments in C'. This impact is a multiplier, m, against the revenue to pay for the *ad hoc* payments, a. This externality is known to be a negative externality. As a result,

$$E' = \beta - ma. \tag{4.13}$$

In the case where the NFIP does exist, the interactions are more complex. There are again no producer nor consumer surpluses, but there is an environmental impact of the NFIP funding redevelopment in environmentally senstive areas and there is ongoing debate about whether the existence of the NFIP may create inefficient use of the floodplain. This ecological impact, B, must also be accounted for. As a result, $E^* = B$ and:

$$\begin{aligned} \Delta E &= E^* - E' \\ &= B - (\beta - ma) \\ &= B - \beta + ma. \end{aligned} \tag{4.14}$$

It is possible other externalities exist, however, given the data available from FEMA regarding the NFIP, it is not currently possible to identify or estimate them in this analysis.

Using equation 4.2, the consumer, producer, government, and external surplus estimates are combined to provide the net social surplus given by the NFIP:

$$\begin{aligned} \Delta S &= \Delta C + \Delta P + \Delta G + \Delta E \\ &= (w - \varpi - a) + (\varphi\varpi\pi) + (\varpi - \kappa + a) + (B - \beta + ma) \\ &= w + \varphi\varpi\pi - \kappa + B - \beta + ma. \end{aligned} \tag{4.15}$$

Begining with equation 4.15, several variables must be resolved to calculate the net social surplus for the insurance component of the NFIP. Finding the WTP is a complex matter, as shown in chapter 2, that differentiates between the *ex ante* and *ex post* values for the WTP. The *ex post* value represents how much an insured is willing to pay for insurance after an event and is equivalent to the expected amount received in response to

an insurance claim. Because insurance policies are normally rolled over from year to year and policyholders are not likely to make a claim each year, the expected amount due to policyholiders due to claims is the long run average over the lifetime of the policy.

The *ex ante* value is the amount an insured is willing to pay before a claim is made and is generally believed to be greater than the *ex post* value, based on the value of smoothing any large changes in wealth.[4] While the *ex post* value is simpler to find based on existing data, the *ex ante* estimate better represents the value insurance program participants place on participation.

Research by Farrow and Scott has shown the expected *ex ante* estimates of WTP for flood insurance is 15 percent greater than the known *ex post* values for Baltimore, Maryland. The analysis behind this was limited to Baltimore, a city built on the Chesapeake Bay, a major body of water. However, if this estimate reflects the national WTP for flood insurance, calculating the *ex ante* WTP is no more difficult than finding the *ex post* WTP, represented by κ here:

$$w = (1 + e)\kappa. \tag{4.16}$$

This estimate is, however, of limited purpose and ripe for additional analysis through the sensitivity analysis.

The estimate for the *ad hoc* disaster aid, a must also be estimated. The best estimate for it derives from the impetus behind the NFIA, to relieve pressure on the federal budget

4. Farrow and Scott, "Estimating the Ex-Ante Willingness to Pay for Flood Protection."

for disaster aid. As a result, it is possible to assume that the *ad hoc* disaster aid is replaced by the claims against the program following a flood event. Therefore, $a = \kappa$ is the best estimate for *ad hoc* disaster aid if the NFIP were not available.

Finally, it is necessary to estimate B and β, the ecological impacts in the external surplus. Because B and β are both the ecological damages caused by the rebuilding in sensitive areas and because the funding for those damages are presumed equal, though derived from different sources, it is reasonable to assume the ecological impacts would also be equal. Therefore, $B = \beta$ and $B - \beta = 0$.

Begining with equation 4.15, this allows the value of ΔS to be further simplified:

$$\begin{aligned}
\Delta S &= w + \varphi\varpi\pi - \kappa + B - \beta + ma \\
&= (1 + e)\kappa + \varphi\varpi\pi - \kappa + m\kappa \\
&= \kappa + e\kappa + \varphi\varpi\pi - \kappa + m\kappa \\
&= e\kappa + \kappa m + \varphi\varpi\pi \\
&= \kappa(e + m) + \varphi\varpi\pi
\end{aligned} \tag{4.17}$$

Data and Methods

Equation 4.17 includes six variables necessary for calculating the net change in social surplus due ot the NFIP. Much of the estimates for these analyses will be calculated based on the history of the NFIP from Fiscal Year (FY) 1996 to FY 2009, using data provided to the author by FEMA, hereinafter called the FEMA Dataset. The FEMA Dataset consists of two components. The first part, FEMA Dataset A, is described in table 4.2 and the second, FEMA

Variable	Description
state	State name
state_code	A numerical identifier for the state
county	County name
county_number	A numerical identifier for the county
year	Year, 1978-2009 inclusive
pif	Number of policies in force
cif	Number of contracts in force
coverage	Amount of total covered exposure
premiums	Amount of premiums paid

Table 4.2: Variable Description for FEMA Dataset A

Variable	Description
state	State name
county	County name
year	Year, 1978-2009 inclusive
num_claims	Total number of claims made
pay_bldg	NFIF payments for property damage
pay_cont	NFIF payments for contents damage
pay_icc	NFIF payments for Increased Cost Compliance (ICC)

Table 4.3: Variable Description for FEMA Dataset B

Dataset B, is described in table 4.3. These two datsets are drawn directly from FEMA financial databases and as official government financial data, are generally likely to be accurate and valid, and will be investigated further by considering the data quality policies of FEMA.

The first variable, ϖ, represents the premiums paid to the NFIF by policy holders. For this analysis, ϖ is calculated using the data described in table 4.2, it is possible to calculate the actual premiums paid to the NFIP during the analytical time fame. Prior to summing the historical premiums, two adjustments must be made.

First, because this is a retrospective analysis and premiums are given in nominal dollars, the effects of inflation must be accounted for. Each premium datapoint will be adjusted to real terms using the Consumer Price Index (CPI) to find 2009 dollars.[5] This measures all dollar values on an equal basis.

The second adjustment is more complex and is the social discount rate (SDR). Social discounting provides a mechanism to track the assumption that something in the future is inherently worth less than the samething today. This concept is also known as the time value of money. In a typical prospective BCA, the SDR is applied to future years' net social benefits to provide the adjustment. Because this is a retrospective BCA, the SDR is applied backwards, to older balances to increase the effects in prior years.

Selecting an appropriate SDR is a controversial topic,[6] but the retrospective aspect of this proposal aids the process. One method suggested by Boardman et al. is to use the governmental borrowing rate. This is especially viable method in a retrospective analysis as the government's actual borrowing rates for the time period in question are observable and known. Therefore, for each year in the analytical period, the SDR will be the average monthly yield on 10-year Treasury bonds.

Follwoing these two analytical adjustments, the premiums for each year will be summed

5. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*, 144–7.
6. Ibid., 241–4.

to find the total inflation-adjusted socially-discounted premium paid to the NFIP:

$$\varpi = \sum_{t=1996}^{2009} premiums_t. \tag{4.18}$$

Using the same data as described in table 4.3, it is possible to calculate the actual claims paid by the NFIP during the analytical time frame. This figure will also be adjusted for inflation and the SDR, as described above.

$$\kappa = \sum_{t=1996}^{2009} payments_t, \tag{4.19}$$

where $payments_t$ is the sum of of pay_bldg, pay_cont, and pay_icc for the given year.

The next variable to estimate is φ, representing the percentage of the premium earned by the insurance companies participating in the WYO program for administering the NFIP. This percentage is defined in regulations governining the WYO program to be 15 percent with a potential 2 percent bonus for meeting certain targets for administration and sales. Because the value of φ is fixed within a single narrow band only 2 percent wide, this analysis will select the midpoint of the band, 16 percent, as the baseline for analysis.

The variable e, reprsenting the additional sum policyholders are willing to pay prior to a flood event for coverage has been researched by Farrow and Scott and estimated to be 15 percent. [7]

To calculate π, the expected profit ratio attributable to the insurance industry, two ad-

7. This will need to be beefed up per Farrow.

ditional datasets are necessary. The National Income and Product Accounts (NIPA) data is continuously updated by Bureau of Economic Analysis (BEA), part of the United States Department of Commerce (DOC). The NIPA dataset includes a breakdown of corporate profits before tax by industry in Tables 6.17A-D ("Corporate Profits Before Tax by Industry"), which will be denoted as $insprofit$. Also include is the Industry Economics Accounts dataset, also provided by BEA, provides "Gross Output by Industry," which is economically equivalent to gross revenue to the industry, denoted as $insrevenue$. Using both series, at the yearly frequency, the value for π can be estimated using the equation

$$\mathrm{E}\left(\hat{\pi}\right) = \mathrm{avg}\,\frac{insprofit}{insrevenue}, \tag{4.20}$$

providing a simple estimate for the insurance industry profit ratio suitable for inclusion in the social surplus model. The standard deviation can be discovered experimentally from this data, as well.

Finally, m, representing the effects of the METB related to revenue for *ad hoc* payments in the absence of the NFIP, is a single value which can be derived from other sources. The Office of Management and Budget (OMB) justifies this on the basis that taxes "generally distort relative prices" and the revenue necessary for *ad hoc* payments requires a source. OMB recommends using a fixed value of 25 percent for public benefit projects,[8] though some variation can be used if there is substantial evidence a the marginal excess burden is

8. Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, 13.

different from the 25 percent estimate. There is no evidence for this in the case of the NFIP.

At the same time, other studies have suggested other values for METB, in the general case. Boardman et al. summarize several studies looking at the METB and claim that for income tax funded projects, such as *ad hoc* disaster relief, the best estimate for the METB is 23 percent with a range of 18 to 28 percent..[9] Given that the OMB recommendation is so close to the estimate of Boardman et al., the 25 percent value will be used for m.

In this part of the proposed analysis, the values of various variables need to be calculuated. When these values are specific to the NFIP, such as the revenue to the program, this information is drawn directly from financial data provided by FEMA. When more general information is needed, such as the METB, the estimate is drawn from the best available sources. This adds to the accessibility and simplicity of the analysis, and increases the portability of the final estimates.

4.1.2 Flood Mitigation Activities

A BCA of the FMA is already available. It was completed in 2005 by the Multihazard Mitigation Council (MMC) at the National Institute of Building Sciences (NIBS) as part of a larger study on the costs and benefits of natural hazard mitigation programs conducted by the federal government to reduce losses from earthquakes, wind damage, and flood events.[10] This review was performed at the request of FEMA to quantify the future benefits

9. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*, 432–3.

10. Multihazard Mitigation Council, *Natural Hazard Mitigation Saves: An Independent Study to Asses the Future Savings from Mitigation Activities* (Washington: National Institute of Building Sciences, 2005).

of the three primary natural hazard mitigation programs conducted by FEMA. The FMA is the flood mitigation program conducted by FEMA and was included in the MMC analysis.

In considering three mitigation programs, the MMC looked at both natural hazard mitigation programs and at building code improvements designed to reduce the effective damages from the hazard in question. However, with respect to flood events, the MMC only looked at mitigation programs designed to reduce flooding overall. In doing so, the MMC considered two types of flood mitigation. The first is "project mitigation," which consists of grants used to pay for the reduction of risk in a particular site, often through a buyout system which dedicates formerly privately owned land to public use. The second is "process mitigation," which may include the development of warning systems, advanced mitigation plans, and revised building codes.

Review of the Mitigation Grants Analysis

The BCA conducted by the MMC is premised on a large statistical analysis of more than 5000 flood mitigation projects engaged funded through the FMA from 1993 through 2003. Those projects, selected at random, were evaluated individually for costs and benefits and using those results, the authors of the MMC report extrapolate to create a standard view of all FMA-funded projects' benefits and costs to create a net social benefit for the program.

Several decisions made by the MMC report authors are notable when analyzing the results. The first is that the costs of an individual flood mitigation project are estimated based on the grant size. This is a reasonable estimate as almost all costs associated with

such a project are financial in nature and would be paid for using grant funds. When that is not the case, the authors adjusted the cost of a project to include other expenditures.

From an analytical perspective, the MMC uses the Hazus-MH modelling software produced under the direction of FEMA to estimate the benefits and costs of each of the projects in the sample space. This is a reasonable step because the Hazus-MH software system is used to estimate the costs and benefits of individual flood mitigation projects as part of the proposal phase. However, the authors deviated from the Hazus-MH system in modelling the impact of businesses losses and other areas where the system was not sufficiently capable.

By using the Hazus-MH system, the authors of the MMC report do commit to using the data sets provided by FEMA for estimating both benefits and costs. This was unavoidable as it is the most comprehensive data set available on flood risk. However, the authors alleviate concerns about bias in the calculation process by conducting a number of case studies on randomly selected FMA projects to test their benefits and costs independently and use that information as an independent check on the integrity of the estimates provided through the Hazus-MH system.

An important result produced by the MMC authors is discovering, using sensitivity analysis, that the net social benefits of a flood mitigation project are highly dependent up on the discount rate selected for future benefits. In their conclusion, the authors found a net social benefit of $11 billion but with a high standard deviation of $3.8 billion. The authors assumed a log-normal distribution of net social benefits and found there is greater than a 99 percent probability the benefits exceed the costs for the entire FMA program.

Variable	Description
state	State name
county	County name
subgrantee	Grant recipient agency
program.area	Grant program, only FMA considerd
program.fy	Fiscal year of grant
federal.share.obligated	Amount of grant

Table 4.4: Variable Description for FEMA Dataset C

Overall, the analysis conducted by the MMC is sound and well presented and suitable for use in the context of "benefits transfer," where the results of a BCA are included as a component in a separate BCA. As a result, the conclusions of the MMC will be used to determine the net social benefits of the flood mitigation component of the FMA in this dissertation.

Inclusion of the Mitigation Grants Analysis

At the end of their analysis, the authors of the MMC study create an estimate for the benefit cost ratio, R of the FMA process and project grants. This estimate allows the authors to estimate the net social benefits of FMA program in 2004 constant dollars. This will be incorporated in the final estimate of the net social benefits of the NFIP by using benefit-cost ratio and applying it to the FMA program data for the subject time period using data provided by FEMA. This dataset, FEMA Dataset C, is described in 4.4. FEMA Dataset C, like the other FEMA-provided datasets, is drawn directly from government financial databases and as official government financial data, is generally presumed to be accurate.

In addition to the estimate of the benefit-cost ratio, the authors of the MMC report provided a standard deviation for the estimate as well as a presumed distribution, log-normal. This distribution and standard deviation can be used to set the terms of the sensitivity analysis for this section of the complete BCA of the NFIP.

4.2 Net Social Benefits with Distributional Analysis

The distributional analysis of the net social benefits of the NFIP will be completed by analyzing the distribution of payments made under both the NFIP insurance program and the FMA. Ideally, an analysis of each policyholder complete with income and asset information would provide the best analysis of the distributional impacts of the NFIP. However, FEMA does not make policyholder level data available. Information is provided at the county level for both the flood insurance and FMA components of the NFIP. Given the differences in income and inequality between different counties, this would be a reasonable level of analysis.

However, the FMA grants are not necessarily given at the county level. Some grants are awarded to cities and some are awarded to counties. Aggregating city level grants to their respective counties is possible. However, some grants are awarded to state agencies, such as a state natural resources department, for statewide impact. Others FMA grants are categorized by FEMA for statewide applicability. These are more difficult to allocate to counties within their respective states because the allocation scheme would introduce a bias into any

distributional analysis. For instance, allocating a statewide grant by population would increase the equity in the final analysis. In the alternative, distributing them by population would decrease the equity in the final analysis. This suggests a state level distributional analysis is the best solution.

The amounts of payments vary widely from state to state, under both the insurance and FMA components. In addition, each state has different income levels and different degrees of income inequality driven by each state's unique economic patterns. As a result, the NFIP insurance payments and FMA grants have a different economic impact in each state. The net social benefits with distributional analysis is the sum of the net social benefits with distributional analysis for both the insurance and FMA programs. In addition, where appropriate, relevant BCRs will also be estimated from historical data.

4.2.1 State-by-State Summaries

For both the insurance program and the FMA, the models provided in section 4.1 hold. However, these models will be calculated on a state-by-state basis, including the District of Columbia, for each analytical year. These yearly summaries will then be multiplied by a distributional weight before being summed into the total net social benefits.

	Atkinson Distributional Weight				
Quintile	$e = 0.0$	$e = 0.25$	$e = 0.50$	$e = 0.75$	$e = 1.0$
First (0-20%)	1.0	1.4	2.1	3.0	4.1
Second (20-40%)	1.0	1.1	1.3	1.5	1.7
Third (40-60%)	1.0	1.0	1.0	1.0	1.0
Fourth (60-80%)	1.0	0.9	0.8	0.7	0.6
Fifth (80-100%)	1.0	0.7	0.5	0.4	0.3

Table 4.5: Atkinson distributional weights[12]

4.2.2 Distributional Weights

Distributional weights will be calculated for each state based on each state's relative per-househouse mean income, using figures available from the United States Census Bureau (USCB). This is effective because even at the coarse level of the state, there is strong differentiation between political jurisdictions in income and relative inequality. To accomplish this weighting, the states will be rank-ordered based income and appropriate weights established for each state based on rank and relative income. Weights will be based on the work of Farrow where each state's average income will serve as a proxy for personal income.[11]

The states shall be grouped by quintiles and weights selected from table 4.5. In particular, from the table, the column for $e = 0.5$ will be used in the principal distributional analysis. In addition, states will be reordered for each year of analysis to allow for relative changes in income that may shift relative weights.

11. Farrow, "Incorporating Equity in Regulatory and Benefit-Cost Analysis Using Risk Based Preferences."

4.3 Historical Impact on Government Income

The impact on government revenue stems from the question of whether or not the NFIP has reduced the cost, to the government, of flood events. This was, per chapters 1 and 2, a key reason for creating the NFIP. This analysis will refer to the time period from 1996 to 2009, like the other retrospective analyses included in the proposed dissertation.

Unlike the other analyses, standing is highly restricted to just the federal government. This might seem awkward from the position of traditional BCA, but it allows the estimate for change in the government surplus, from equation 4.11, to resolve the question of the impacts on government revenue. The net impact of the NFIP on government income, like other analyses, is the sum of the impacts due to the insurance program and the the FMA.

4.3.1 Insurance Program

Social Surplus Model

Beginning with 4.11, the effect on government revenue from the insurance program includes the *ad hoc* payments which are represented by a. From before, a can be estimated with κ, so the final form of ΔG is,

$$\begin{aligned} \Delta G &= \varpi - \kappa + a \\ &= \varpi - \kappa + \kappa \\ &= \varpi. \end{aligned} \tag{4.21}$$

In brief, the impact on income is the revenue from the NFIP itself. The value of ϖ will be calculated using the same methods as in section 4.1.

4.3.2 Flood Mitigation Activities

Conveniently, the analysis by the MMC of the FMA program includes a discussion of the impact on government revenue caused by the FMA. This figure, after adjusted into constant dollars for 2010 and reduced to a single year's benefit, will be included with the estimate of the insurance program to find the expected impact of the NFIP during a sample year.

4.4 Sensitivity Analysis

Because each of the component factors in this analysis consists of a point estimate, there is a potential for statistical error to corrupt the final result. Sensitivity analysis provides an opportunity to analyze the errors involved and test the statistical assumptions included in the analysis. For this analysis, the sensitivity analysis will consist of a stochastic simulation over the input variables described in table 4.6. This is also known as a Monte Carlo analysis.[13] These variables are the core analytical variables included in this dissertation and will show the general form of costs and benefits in the program beyond the base case. Begining with equation 4.17,

$$\Delta S = \kappa(e + m) + \varphi\varpi\pi, \tag{4.22}$$

13. Boardman et al., *Cost-Benefit Analysis: Concepts and Practice*, 183–7.

several variables must be addressed in the sensitivity analysis.

Several variables are measured directly from historical data. The variable κ, ϖ, and π are directly measured and are not estimates. While there can be some possible measurement error due to miscategorized filings, or other problems, these are derived directly from financial statements are considered to be accurate. As noted elsewhere, the presumed accuracy of these measurements will be investigated and if necessary, they can be adopted into the simulation.

The first variable to be investigated through the sensitivity analysis is e, the *ex ante* WTP multiplier. This multiplier is based on the work of Farrow and Scott, but does not give a discovered distribution. Therefore, this analysis will assume a uniform distribution with endpoints at 0.09 and 0.25 based on the results of the study.

The second variable to be analyzed is m, the METB. Based upon the work of Boardman et al., there is a range given for potential values from 0.18 to 0.28. The sensitivity of this on that range will be tested assuming a uniform distribution.

A third variable to be analyzed during the sensitivity analysis is φ, the WYO fee to insurers. This can range from 15 percent to 17 percent. This will also be analyzed using a uniform distribution.

The final varible to be analyzed as part of the sensitivity analysis is R, the BCR of the FMA program grants. The authors of the report note the distribution is log-normal and provide a standard deviation to include in the analysis.

Following the sensitivity analysis of the net social benefits, a second sensitivity analysis

Variable	Assumed Distribution	Range
e	Uniform	$[0.09 - 0.25]$
m	Uniform	$[0.18 - 0.28]$
φ	Uniform	$[0.15 - 0.17]$
R	Log-Normal	

Table 4.6: Expected distributions of factors in the net social surplus

will be completed on the distributional analysis. This will consist of, in addition to the variable testing per table 4.6, an additional check by testing the values of e per table 4.5. This will allow the distributional weighting scheme to be checked via sensivity analysis.

It is not possible to eliminate the uncertainty inherent in BCA, however, the use of sensitivity analysis, specifically the use of stochastic simulation, provides a tool for understanding the uncertainty and its implications.

CHAPTER 5

SIGNIFICANCE AND OUTCOMES OF THE TOPIC

5.1 The Significance of the Proposed Topic

This analysis of the National Flood Insurance Program (NFIP) is significant due to the political, economic, and social context of the program. In addition, as shown in chapter 2, the NFIP is frequently and well studied. However, this type of analysis showing the net social benefits of the NFIP has never been attempted before.

The constituency group of beneficiaries of the NFIP is nationwide. There are approximately 5.6 million policyholders through the NFIP and approximately one-quarter of those policyholders received subsidized premium rates.[1] In underprivileged communities, it may be desirable to provide subsidized premiums, however as the sociological context shows, subsidies trend toward higher value properties. In effect, Congress may have created a subsidy for the relatively wealthy.

1. Orice W[illiams] Brown, *Information on Proposed Changes to the National Flood Insurance Program* (Washington: Government Accountability Office, February 2009).

In addition, the economic benefits being disbursed through the NFIP, there is the issue of the actual service provided. The NFIP provides the only source of flood insurance generally available in the United States as privately-underwritten flood insurance is essentially nonexistent.[2] Without the NFIP and the guarantees it provides, policy holders and their communities would be less able to bear the burden of rebuilding.

Because, by design and unlike private insurance, the NFIP is not actuarially sound.[3] The program does not collect sufficient revenue through premiums and investments to meet the expenses incurred through losses on claims and administrative overhead. When costs exceed assets, the NFIP is authorized to borrow from the United States Treasury.[4] This places a potential burden on the Treasury's financial position as the program is unlikely to repay its debts if it is not actuarially sound.

Finally, there are issues with intergenerational equity inherent in the funding of the NFIP. Because the program is not operated in an actuarially sound manner, the program may receive more in premiums in a year than it requires to operate. In other years, the program may be forced to borrow from the United States Treasury. Following Hurricane Katrina, Congress raised the NFIP's borrowing limit from $1.5 billion to $18.5 billion.[5] Repayment schedules for loans and large asset holdings during years with fewer claims

2. Kunreuther and Michel-Kerjan, "Market and Government Failure in Insuring and Mitigating Natural Catastrophes: How Long-Term Contracts Can Help."

3. Congressional Budget Office, *The National Flood Insurance Program: Factors Affecting Actuarial Soundness*, 6.

4. Brown, *National Flood Insurance Program: Continued Actions Needed to Address Financial and Operational Issues*, 5.

5. Donald B. Marron, *The Budgetary Treatment of Subsidies in the National Flood Insurance Program* (Washington: Congressional Budget Office, January 2006).

can lead funding disparities between years and program participants may be repaying prior years.

5.2 Expected Outcomes of the Research Project

The outcomes of this research will be a deeper understanding of both the NFIP and governmental insurance programs, generally. This knowledge will enable policymakers to make more informed judgements about how insurance can affect the private market for goods in the United States.

In particular, if the hypothesis tests suggest that the NFIP has provided benefits exceeding costs over its lifetime, it is likely to continue doing so provided no substantial changes are made to the program's implementation and objectives. It also suggests that the model provided by the NFIP could be replicated in providing insurance against other types of natural disasters. It may also provide a model for other nations in creating flood or disaster insurance programs in other nations with underdeveloped private insurance markets or chronic occurrence of certain types of disasters. This permits societies and communities to find the most efficient allocation of resources.

If the hypothesis tests suggest that the NFIP has not provided sufficient benefits to exceed the costs to society, the program is then opened to questions about its efficiency, its efficacy, and its place in society. In addition to challenging the NFIP and expansions to NFIP, similar programs should also come under greater scrutiny before being adopted and

implemented. Finally, if the NFIP does not pass the benefit-cost test, then the role of the private market and its ability to deliver services demanded by customers should also be analyzed to determine the most effective means of service provision.

A split in the results provides the most interesting results from a public policy perspective. If the results are split such that the benefit-cost analysis (BCA) is negative and the distributionally weighted BCA is positive, then the program is providing support and services to disadvantaged groups at the expense of those who are able to provide support and services to themselves. In converse, if the results are split such that the BCA is positive and the distributionally weighted BCA is negative, then the program is providing support and services to those who can support themselves at the expense of the disadvantaged.

Policy makers may use this information to determine whether or not it is appropriate for the government to be involved in this market. However, the effects of these findings on that determination are subject to the whims of whatever political climate is in effect at the time of that determination, in addition to the findings themselves.

Understanding the NFIP limns related questions. Other nations implement catastrophic flood insurance programs, using methods such as reinsurance or grants for redevelopment.[6] Knowing how the the NFIP has affected the United States will provide information to those nations and enable a better informed decisions with respect to overall benefits and unforeseen costs of their own programs. In parallel with this, understanding the NFIP will also assist policymakers in creating and implementing similar programs. As discussed in section

6. David Crichton, "Role of Insurance in Reducing Flood Risk," *Geneva Papers on Risk & Insurance–Issues & Practice* 33 (January 2008): 117–132.

2.1.1, Congress is considering adding wind insurance to the NFIP framework. In other areas, such as earthquake insurance, there may be applicable lessons as earthquake insurance is currently ably provided by the private market despite the damage pattern's resemblance to that of flood damage.[7] Finally, there may be information applicable to creating other types of monoline insurers of last resort, for example, a terrorism insurance fund.[8]

Finally, this dissertation will set the path for future research on the NFIP. It would be unreasable to expect this research to encompass the all possible aspects of the program, despite its relatively small size because of its far reaching effects. This dissertation can be the framework for more detailed analyses of the distributional effects if the NFIP or more detailed analyses of the financial and economic implications of the program. Also, if the program should change, this analytical framework can be reapplied to understand both the social costs and the new distributional effects.

7. Erwann O. Michel-Kerjan, "Catastrophe Economics: The National Flood Insurance Program," *Journal of Economic Perspectives* 24, no. 4 (2010): 165–186.

8. Lucien J. Dhooge, "A Previously Unimaginable Risk Potential: September 11 and the Insurance Industry," *American Business Law Journal* 40 (2003): 687–779; Mark Boran, "To Insure or Not to Insure, That is the Question: Congress' Attempt to Bolster the Insurance Industry After the Attacks of September 11," *St. John's Journal of Legal Commentary* 17 (2003): 523–584.

CHAPTER 6

ORGANIZATION OF THE DISSERTATION

The proposed dissertation will be organized into six chapters. This format permits the author to follow a standard and recognizable format without sacrificing freedom to present information in a clean and coherent manner.

This format is important as the proposed dissertation will include three complete embedded benefit-cost evaluations which are the critical analytical method of the dissertation. These benefit-cost evaluations will not be distinct but the weights of the measures changed in order to evaluate the information in different ways. This chapter of the dissertation proposal outlines the organization of the final dissertation.

6.1 Introduction

The introduction will establish the key reasons for the proposed dissertation's existence. It will outline the research problem in general terms. It will provide a brief outline of the methods used in the dissertation. It will explain the significance of the dissertation and why

it is important research. Finally, it will provide a very brief outline of each of the following chapters. This chapter will be composed of chapters 1, 5, and 6 of this dissertation proposal plus additional material as may be necessary.

6.2 Literature Review

The literature review will be divided into two high-level section. The first section will address the National Flood Insurance Program (NFIP) and will be divided into three large subsections. The first of these subsections will provide information on the political context surrounding the NFIP and what the current policy agenda entails. The second of these subsections will focus on the microeconomic effects of the NFIP. The last subsection will explore some of the macrosociologial issues and literature focusing on distributional issues around the NFIP.

The second section of the literature review will address benefit-cost analysis (BCA) and, like the first section, be divided into three subsections. The first of these subsections will address the applications of BCA to flood programs. The second will look at prior literature on the the applications of BCA to risk and risk management, within a policy or insurance context[1]

The literature review in the proposed dissertation will be wholly derived from the literature review presented in chapter 2 of this proposal. The literature review will also include

1. General risk management, such as for project management, is well beyond the scope of this dissertation.

additional material, as necessary, to focus the proposed dissertation as new material becomes available.

6.3 Materials and Methodology

This chapter will present two key sections of the proposed dissertation. The first section will be the research hypotheses to be tested and describe how they inform the research question. The second section will cover the methodology of the BCA and distributional analysis and explain how it will be implemented and provide insight into subjective aspects of the analysis. This will include a discussion of any potential impacts those judgements may incur. These two sections will be wholly derived from the research questions and research methods presented in chapters 3 and 4 of this proposal.

6.4 Analysis and Results

This chapter will include the three hypothesis tests and their results, including relevant calculations. The hypothesis tests will also include any relevant discussion of how those results are altered by the sensitivity analysis. Given the complexity of this chapter, it may be split into multiple chapters.

6.5 Discussion

This chapter will examine the results of the hypothesis tests and how those results affect the primary research question. In particular, this chapter will discuss the impact distributional effects have on the analysis of net benefits and other analyses. In addition to the discussion of the primary research question, this chapter will also consider the impacts of the results and what implications they may have in other areas such as expansion of the NFIP or the implementation of similar programs in other nations. Those areas of significance to the proposed dissertation topic should be considered ripe for discussion.

6.6 Conclusions

The final chapter of the proposed dissertation will contain the conclusions. The conclusions will analyze the research project's results and determine an answer to the research question. In addition, the conclusions section will analyze the dissertation itself and establish whether or not the dissertation met its goal and answered the research question. The final stage of the conclusions will be to recommend future directions for research suggested by these results.

APPENDIX A

TIMELINE OF FEDERAL FLOOD INSURANCE

1956 The Federal Flood Insurance Act of 1956 (FFIA) creates a pilot federal flood insurance program

1968 The National Flood Insurance Act of 1968 (NFIA) establishes the National Flood Insurance Program (NFIP)

1973 The Flood Disaster Protection Act of 1973 (FDPA) mandates flood insurance for high-risk properties securing a mortgage from a federally-regulated institution

1974 The Disaster Relief Act of 1974 (DRA) creates a mechanism for handling disasters and emergencies at the federal level

1979 Executive Order 12127 (EO 12127) transfers authority over the NFIP to the Federal Emergency Management Agency (FEMA)

1982 The Coastal Barrier Resources Act (CBRA) reduces availability of insurance for new and improved properties

1989 NFIP losses from Hurricane Hugo exceed $375 million

1993 Midwest Floods cause more than $270 million in claims against the NFIP

2004 The Flood Insurance Reform Act of 2004 (FIRA) aims to reduce repetitive losses on high-risk properties

2005 NFIP losses from all hurricanes, including Katrina, exceed $17 billion

2008 The Flood Insurance Reform and Modernization Act of 2008 (FIRMA), to extend the NFIP to provide wind coverage, is passed by Congress but vetoed by the President

2010 The Flood Insurance Reform Priorities Act of 2010 (FIRPA), to reauthorize the NFIP and increase maximum coverage, is passed by the House of Representatives and currently pending before the Senate

APPENDIX B

DATASETS

This appendix includes data from the primary data sources used in calculating the benefits and costs of the National Flood Insurance Program (NFIP). Tables B.1 and B.2 both show a representative sample, selected at random, of Federal Emergency Management Agency (FEMA) Dataset A and FEMA Dataset B, respectively. The small sample was chosen to provide sense of the data and its structure, without including the entire data set. FEMA Dataset A is 88555 rows and FEMA Dataset B is 30127 rows. Each sample shown is 20 rows.

FEMA Dataset B is roughly a third the size of the FEMA Dataset A because FEMA Dataset B represents only claims information. Both datasets provide information about the NFIP with key columns represent the state, county, and year, with the actual program data represented as addition columns. For FEMA Dataset B, if there were no claims within a given county during a given year, then a row is omitted, rather than provided with empty or zero value entries.

state	fips_state	county	fips_county	year	pif	cif	coverage	premiums
OKLAHOMA	40	WASHITA COUNTY	149	2001	2	2	94	963
NEVADA	32	LANDER COUNTY	15	1980	4	4	144	388
MONTANA	30	GLACIER COUNTY	35	1985	13	13	483	6056
NEW YORK	36	HAMILTON COUNTY	41	1988	26	26	630	4676
GEORGIA	13	TWIGGS COUNTY	289	2000	1	1	11	255
OKLAHOMA	40	JACKSON COUNTY	65	1998	19	19	1599	5343
MINNESOTA	27	NORMAN COUNTY	107	1989	56	56	1925	12629
OKLAHOMA	40	OSAGE COUNTY	113	2005	2323	2246	337125	1015185
MISSISSIPPI	28	HOLMES COUNTY	51	2009	101	101	15108	88274
MICHIGAN	26	ALGER COUNTY	3	2004	21	21	2484	11789
NEW YORK	36	CATTARAUGUS COUNTY	9	1990	827	827	36049	184864
NORTH CAROLINA	37	JACKSON COUNTY	99	2004	171	171	24618	91899
NORTH CAROLINA	37	HENDERSON COUNTY	89	2006	247	224	49525	164583
FLORIDA	12	WASHINGTON COUNTY	133	1997	112	112	6403	37017
TEXAS	48	HOCKLEY COUNTY	219	1990	21	21	717	4973
OKLAHOMA	40	MARSHALL COUNTY	95	2005	21	21	2564	13050
COLORADO	8	PITKIN COUNTY	97	1979	108	108	3573	10796
NORTH CAROLINA	37	WAYNE COUNTY	191	1992	240	240	10781	63484
NEW JERSEY	34	GLOUCESTER COUNTY	15	1996	1069	1069	80817	410922
MISSOURI	29	SALINE COUNTY	195	1983	7	7	350	1604

Table B.1: Sample data from FEMA Dataset A

state	year	county	num_claims	pay_bldg	pay_cont	pay_icc
MISSISSIPPI	1997	LEE COUNTY	1	1419.75	49.50	0.00
VIRGINIA	1985	KING WILLIAM COUNTY	2	4355.35	0.00	0.00
RHODE ISLAND	2008	PROVIDENCE COUNTY	20	344986.05	237303.24	0.00
TENNESSEE	1998	WEAKLEY COUNTY	1	10770.09	974.96	0.00
MONTANA	1980	LEWIS & CLARK COUNTY	2	1235.50	101.25	0.00
CALIFORNIA	1995	TRINITY	2	1228.63	0.00	0.00
DELAWARE	2001	SUSSEX COUNTY	4	36246.56	16713.85	0.00
MAINE	1997	KNOX COUNTY	2	10264.29	164.02	0.00
NEW MEXICO	2001	SANDOVAL COUNTY	1	3120.60	5675.50	0.00
KANSAS	1990	ELLSWORTH COUNTY	2	4788.58	0.00	0.00
MISSISSIPPI	2005	HANCOCK COUNTY	5084	514771860.80	156259442.50	12895382.11
LOUISIANA	2009	IBERVILLE PARISH	6	84379.45	12499.45	0.00
INDIANA	2008	CRAWFORD COUNTY	10	310911.55	47158.79	0.00
GEORGIA	1998	DOUGHERTY COUNTY	396	3768181.00	697035.62	0.00
TENNESSEE	1995	MARION COUNTY	1	3050.00	0.00	0.00
LOUISIANA	1979	EAST FELICIANA PARISH	6	7033.47	680.00	0.00
GEORGIA	2009	WHITFIELD COUNTY	2	24215.39	400.00	0.00
NEBRASKA	1982	BURT COUNTY	1	1571.55	790.60	0.00
MASSACHUSETTS	1996	NANTUCKET COUNTY	14	231768.89	21904.08	0.00
MICHIGAN	2004	WASHTENAW COUNTY	8	144706.20	4866.54	0.00

Table B.2: Sample data from FEMA Dataset B

Table B.3 provides a representative sample, selected at random, of FEMA Dataset C. FEMA Dataset C is 2108 rows. The sample size shown in the table is, again, 20 rows. Table B.4 contains data directly from the Bureau of Economic Analysis (BEA), the United States agency responsible for providing official statistics on a variety of economic matters. The column labeled "profit" represents the total profits for the entire insurance industry, from table 6.17D of the National Income and Product Accounts (NIPA) dataset. The column labeled "output" originates with the "Gross Output by Industry" for the entire insurance industry, also provided by BEA.

State	County	Subgrantee	Program_Area	Program_FY	Federal_Share_Obligated
Louisiana	Statewide	Terrebonne Parish*	FMA	2002	49700.00
Mississippi	Warren	Vicksburg, City Of	FMA	1997	13128.00
New York	Suffolk	Southampton, Village Of	FMA	2000	68000.00
New York	Nassau	Freeport, Village Of	FMA	1998	555880.00
Pennsylvania	–	PEMA	FMA	2004	33320.25
Rhode Island	Providence	Pawtucket, City Of	FMA	1998	12200.00
North Carolina	Statewide	Statewide	FMA	1998	3960.00
Wisconsin	Statewide	Crawford County *	FMA	1998	13000.00
Wyoming	Converse	Douglas, City Of	FMA	1999	20000.00
Massachusetts	–	City of Quincy, MA Dept of Planning & Community Development	FMA	2007	132525.00
Oregon	–	–	FMA	2001	143370.00
Kentucky	Christian	Hopkinsville, City Of	FMA	2001	35933.00
Florida	Statewide	Escambia County*	FMA	2001	102936.00
Idaho	Statewide	Kootenai County *	FMA	2003	63594.00
West Virginia	–	–	FMA	1998	21900.00
Ohio	–	–	FMA	1999	5625.00
Florida	–	Volusia County	FMA	2008	669055.00
Iowa	Guthrie	Guthrie Center,city Of	FMA	1999	2625.00
Wyoming	Big Horn	Greybull, Town Of	FMA	1997	9300.00
Mississippi	Statewide	Pearl River County *	FMA	2005	73122.75

Table B.3: Sample data from FEMA Dataset C

year	profit	revenue
1987	–	195700.00
1988	–	219100.00
1989	–	239400.00
1990	–	257200.00
1991	–	268400.00
1992	–	280200.00
1993	–	301600.00
1994	–	323600.00
1995	–	333000.00
1996	–	339500.00
1997	–	353300.00
1998	26382.00	378400.00
1999	18323.00	398400.00
2000	15771.00	432000.00
2001	10683.00	450600.00
2002	24034.00	471000.00
2003	52019.00	512900.00
2004	85292.00	574300.00
2005	97490.00	611600.00
2006	103488.00	639000.00
2007	84237.00	683600.00
2008	-10962.00	696300.00
2009	–	669200.00
2010	–	–

Table B.4: Insurance industry data from BEA

PRELIMINARY BIBLIOGRAPHY

Anderson, Pamela S. "Floodplain Development and Considerations for Better National Policies." Master's thesis, South Dakota State University, 2006.

Arnold, Joseph L. *The Evolution of the 1936 Flood Control Act*. Fort Belvoir, Virginia: United States Army Corps of Engineers, 1988.

Barnhizer, Daniel D. "Givings Recapture: Funding Public Acquisition of Private Property Interests on the Coasts." *The Harvard Environmental Law Review* 27 (2003): 295–375.

Bin, Okmyung, John A. Bishop, and Carolyn Kousky. *Redistributional Effects of the National Flood Insurance Program*. Discussion paper. DP 11-14. Technical report. Washington, March 2011.

Bin, Okmyung, Jamie Brown Kruse, and Craig E. Landry. "Flood Hazards, Insurance Rates, and Amenities: Evidence from the Coastal Housing Market." *The Journal of Risk and Insurance* 75, no. 1 (2008): 63–82.

Bin, Okmyung, and Stephan Polasky. "Effects of Flood Hazards on Property Values: Evidence before and after Hurricane Floyd." *Land Economics* 80, no. 4 (November 2004): 490–500.

Bingham, Kevin, et al. *The Role of Actuarial Soundness in the National Flood Insurance Program*. Washington: American Institutes for Research, October 2006.

Boardman, Anthony E., et al. *Cost-Benefit Analysis: Concepts and Practice*. 4th ed. Pearson series in economics. Upper Saddle River, NJ: Prentice Hall, 2010.

Boran, Mark. "To Insure or Not to Insure, That is the Question: Congress' Attempt to Bolster the Insurance Industry After the Attacks of September 11." *St. John's Journal of Legal Commentary* 17 (2003): 523–584.

Boulware, Gary William. "Public Policy Evaluation of the National Flood Insurance Program (NFIP)." PhD diss., University of Florida, 2009.

Bouma, Jan Jaap, Delphine François, and Peter Troch. "Risk assessment and water management." *Environmental Modelling & Software* 20, no. 2 (2005): 141–151.

Brown, Michael A. "Anything but a Breeze: Moving Forward Without NFIP Wind Coverage." *Boston College Enivronmental Affairs Law Review* 37, no. 2 (2010): 365–392.

Brown, Orice W[illiams]. *Information on Proposed Changes to the National Flood Insurance Program*. Washington: Government Accountability Office, February 2009.

Brown, Orice Williams. *National Flood Insurance Program: Continued Actions Needed to Address Financial and Operational Issues*. Washington: Government Accountability Office, 2010.

Brown, Philip H., et al. "Modeling the costs and benets of dam construction from a multidisciplinary perspective." *Journal of Environmental Management* 90 (2008): S303–311.

Browne, Mark J., and Martin Halek. "Managing Flood Risk: The National Flood Insurance Program and Alternatives." In *Public Insurance and Private Markets*, edited by Jeffrey R. Brown, 143–172. Washington: The AEI Press, 2010.

Bullock, Jane A., et al. *Introduction to Homeland Security*. 2nd ed. Butterworth-Heinemann Homeland Security Series. Burlington, MA: Elsevier Butterworth-Heinemann, 2006.

Cheatham, Leo R. *A Case Study of Some Economic Aspects of the National Flood Insurance*. Technical report. Starkville: Water Resurces Research Institute, Mississippi State University, June 1975.

"Coastal Barrier Resources Act." Public Law 97–348. *U. S. Statutes at Large* 96 (1968): 1653. Codified at U. S. Code 16 (2010), §3501.

Collins, Craig M. "Flood Insurance is not All Created Equal." *North Dakota Law Review* 74 (1998): 35–44.

Comfort, Louise K., et al. "Retrospectives and Prospectives on Hurricane Katrina: Five Years and Counting." *Public Administration Review* 70, no. 5 (2010): 669–678.

Congressional Budget Office. *The National Flood Insurance Program: Factors Affecting Actuarial Soundness*. Washington: Congressional Budget Office, November 2009.

Cook, Philip J., and Daniel A. Graham. "The Demand for Insuranceand Protection: The Case of Irreplaceable Commodities." *The Quarterly Journal of Economics* 91, no. 1 (February 1977): 142–156.

Cooper, Christopher, and Robert Block. *Disaster: Hurricane Katrina and the Failure of Homeland Security*. New York: Henry Holt / Company, 2006.

Crichton, David. "Role of Insurance in Reducing Flood Risk." *Geneva Papers on Risk & Insurance–Issues & Practice* 33 (January 2008): 117–132.

Crowell, Mark, et al. "An Estimate of the U.S. Population Living in 100-Year Coastal Flood Hazard Areas." *Journal of Coastal Research* 26, no. 2 (2010): 201–211.

Cutler, David M., and Richard J. Zeckhauser. "Reinsurance for Catastrophes and Cataclysms." Chap. 6 in *The Financing of Catastrophe Risk*, edited by Kenneth A. Froot, 233–274. Chicago: University of Chicago Press, 1999.

Daun, Margaret C., and David Clark. *Flood Risk and Contingent Valuation Willingness to Pay Studies: A Methodological Review and Applied Analysis*. TR-6. Technical report. Institute for Urban Environmental Risk Management. Milwaukee, WI: Marquette University, August 2000.

Davila, Mario A. "After the Flood: Fraud Among the Elderly After Natural Disasters." PhD diss., Sam Houston State University, 2005.

Dhooge, Lucien J. "A Previously Unimaginable Risk Potential: September 11 and the Insurance Industry." *American Business Law Journal* 40 (2003): 687–779.

Farrow, Scott. "Incorporating Equity in Regulatory and Benefit-Cost Analysis Using Risk Based Preferences." *Risk Analysis: An International Journal* (2010): In print.

Farrow, Scott, and Michael Scott. "Estimating the Ex-Ante Willingness to Pay for Flood Protection." 2011. Presented at the Association of Environmental and Resource Economists summer workshop.

Farrow, Scott, and Michael Toman. "Using Benefit-Cost Analysis to Improve Environmental Regulations." *Environment* 41, no. 2 (1999): 12–38.

Fisher, Ann. "Using benefit-cost analysis for better environmental policies." *Journal of the Air & Waste Management Association* 41, nos. 1- (October 1991): 1319–1322.

Frank, Robert H. *Microeconomics and Behavior*. 6th ed. Boston: McGraw-Hill Irwin, 2006.

Freeman, A. Myrick, III. "*Ex Ante* and *Ex Post* Values for Changes in Risks." *Risk Analysis* 9, no. 3 (1989).

Fuks, Mauricio, and Lata Chatterjee. "Estimating the Willingness to Pay for a Flood Control Project in Brazil Using the Contingent Valuation Method." *Journal of Urban Planning and Development* 134, no. 1 (March 2008): 42–52.

Geiger, Andrea Lynn. "Private vs. Public Flood Insurance Rates: Is There a National Flood Insurance Subsidy?" Master's thesis, University of Delaware, 2006.

Godschalk, David R., Samuel Brody, and Raymond Burby. "Public Participation in Natural Hazard Mitigation Policy Formation: Challenges for Comprehensive Planning." *Journal of Environmental Planning and Management* 46, no. 5 (September 2003): 733–754.

Godschalk, David R., et al. "Estimating the Value of Foresight: Aggregate Analysis of Natural Hazard Mitigation Benefits and Costs." *Journal of Environmental Planning and Management* 52, no. 6 (September 2009): 739–756.

Green, Colin, and Edmund Penning-Rowsell. "Flood Insurance and Government: 'Parasitic' and 'Symbiotic' Relations." *The Geneva Papers on Risk and Insurance* 29, no. 3 (2004): 518–539.

Griffith, Charles T. "The National Flood Insurance Program: Unattained Purposes, Liability in Contract, and Takings." *William and Mary Law Review* 35 (1994): 727–765.

Griffith, Rebecca Sue. "The Impact of Mandatory Purchase Requirements for Flood Insurance on Real Estate Markets." PhD diss., The University of Texas at Arlington, 1994.

Harberger, Arnold C. "On the Use of Distrubtional Weights in Social Cost-Benefit Analysis." *Journal of Political Economy* 86, no. 2 Part 2: Research in Taxation (April 1978): S87–S120.

Herke, John. "Teething Pains at Age 25: Developing Meaningful Enforcement of the National Flood Insurance Program." *Tulane Environmental Law Journal* 7 (1993): 165–196.

Holway, James M., and Raymond J. Burby. "The Effects of Floodplain Development Controls on Residential Land Values." *Land Economics* 66, no. 3 (August 1990): 259–271.

Horne, Jed. *Breach of Faith: Hurricane Katrina and the Near Death of a Great American City*. New York: Random House, 2006.

Hung, Hunh-Chih. "The attitude towards flood insurance purchase when respondents preferences are uncertain: a fuzzy approach." *Journal of Risk Research* 12, no. 2 (March 2009): 239–258.

Jones, Christopher P., et al. *Evaluation of the National Flood Insurance Programs Building Standards*. Washington: American Institutes for Research, October 2006.

Kousky, Carolyn M. "Responding to Risk: Information and Decision Making in the Floodplains of St. Louis County, Missouri." PhD diss., Harvard University, 2008.

Kriesel, Warren, and Craig Landry. "Participation in the National Flood Insurance Program: An Empirical Analysis for Coastal Properties." *The Journal of Risk and Insurance* 71, no. 3 (2004): 405–420.

Kunreuther, Howard. "Has the Time Come for Comprehensive Natural Disaster Insurance?" In *On Risk and Disaster: Lessons from Hurricane Katrina*, edited by Ronald J. Daniels, Donald F. Kettl, and Howard Kunreuther, 175–201. Philadelphia: University of Pennsylvania Press, 2006.

Kunreuther, Howard, et al. *Disaster Insurance Protection: Public Policy Lessons*. Wiley-Interscience. New York: John Wiley & Sons, 1978.

Kunreuther, Howard C., and Erwann O. Michel-Kerjan. "Market and Government Failure in Insuring and Mitigating Natural Catastrophes: How Long-Term Contracts Can Help." In *Public Insurance and Private Markets*, edited by Jeffrey R. Brown, 115–142. Washington: The AEI Press, 2010.

Landis, Michele L. ""Let Me Next Time Be 'Tried By Fire:"' Disaster Relief and the Origins of the American Welfare State." *Northwestern University Law Review* 92 (1998): 967–1034.

Lawless, Robert M. "Bankruptcy Filing Rates after a Major Hurricane." *Nevada Law Journal* 6 (2005): 7–20.

Loomis, John B. "Incorporating Distributional Issues into Benefit Cost Analysis: Why, How, and Two Empirical Examples Using Non-market Valuation." *Journal of Benefit-Cost Analysis* 2, no. 1 (2011): Art. 1.

Luebken, Uwe. "Die Natur der Gefahr. Zur Geschichte der Überschwemmungsversicherung in Deutschland und den USA." *Behemoth. A Journal on Civilisation* 3 (2008): 4–20.

MacDonald, Don N., et al. "Flood Hazard Pricing and Insurance Premium Differentials: Evidence From the Housing Market." *The Journal of Risk and Insurance* 57, no. 4 (1990): 654–663.

Marlett, David C. "An Evaluation of Legislatively Mandated Residual Market and Catastrophe Financing Programs." PhD diss., Florida State University, 1997.

Marron, Donald B. *The Budgetary Treatment of Subsidies in the National Flood Insurance Program*. Washington: Congressional Budget Office, January 2006.

Martin, Melissa A. "The Impact of Flood Insurance on Development in Ocean City, Maryland." Master's thesis, Salisbury University, 2008.

McMillan, Christine M. "Federal Flood Insurance Polices: Making Matters Worse." *Houston Law Review* 44 (2008): 471–505.

Michel-Kerjan, Erwann O. "Catastrophe Economics: The National Flood Insurance Program." *Journal of Economic Perspectives* 24, no. 4 (2010): 165–186.

Michel-Kerjan, Erwann O., and Carolyn Kousky. "Come Rain or Shine: Evidence on Flood Insurance Purchases in Florida." *The Journal of Risk and Insurance* 77, no. 2 (2010): 369–397.

Moore, Dan E., and Randolph L. Cantrell. "Community Response to External Demands: An Analysis of Participation in the Federal Flood Insurance Program." *Rural Sociology* 41, no. 4 (1976): 484–508.

Morimoto, Risako, and Chris Hope. "Applying a cost-benefit analysis model to the Three Gorges project in China." *Impact Assessment and Project Appraisal* 22, no. 3 (September 2004): 205–220.

Moss, David A. “Courting Disaster? The Transformation of Federal Disaster Policy since 1803.” Chap. 8 in *The Financing of Catastrophe Risk*, edited by Kenneth A. Froot, 307–355. Chicago: University of Chicago Press, 1999.

Multihazard Mitigation Council. *Natural Hazard Mitigation Saves: An Independent Study to Asses the Future Savings from Mitigation Activities*. Washington: National Institute of Building Sciences, 2005.

National Research Council. *A Review of the Proposed Revisions to the Federal Principles and Guidelines Water Resources Planning Document*. Technical report. Washington, 2010.

———. *Analytical Methods and Approaches for Water Resources Project Planning*. Technical report. Washington, 2004.

Nicholson, Walter. *Microeconomic Theory: Basic Principles and Extensions*. 9th ed. Thomson South-Western College Pub, 2004.

Office of Management and Budget. *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. A-94. Technical report. Washington, October 1992.

———. *Regulatory Analysis*. A-4. Technical report. Washington, September 2003.

O’Sullivan, Elizabethann, Gary R. Rassel, and Maureen Berner. *Research Methods for Public Administrators*. 4th ed. New York: Longman, 2003.

Pynn, Ronald, and Greta M. Ljung. “Flood Insurance: A Survey of Grand Forks, North Dakota, Homeowners.” *Applied Behavioral Science Review* 7, no. 2 (1999): 171–180.

Ramirez, Jorge, et al. “Ex Post Analysis of Flood Control: Benefit-Cost Analysis and the Value of Information.” *Water Resources Research* 24, no. 8 (August 1988): 1397–1405.

Rennhack, Joan Lee. “The Flooding of America: A Study of Government Characteristics and Responses.” PhD diss., University of South Carolina, 2004.

Rosenbaum, Walter A., and Gary Boulware. *The Developmental and Environmental Impact of the National Flood Insurance Program: A Summary Research Report*. Washington: American Institutes for Research, October 2006.

Rumsey, Melissa A. "Beyond Bigger and Better: Gilbert White and America's New Approach to Floodplain Management." Master's thesis, Mississippi State University, 2010.

Sarmiento, Camilo, and Ted R. Miller. *Costs and Consequences of Flooding and the Impact of the National Flood Insurance Program*. Washington: American Institutes for Research, October 2006.

Scales, Adam F. "A Nation of Policyholders: Governmental and Market Failure in Flood Insurance." *Mississippi College Law Review* 26 (2006): 3–47.

Sen, Amartya. "The Discipline of Cost-Benefit Analysis." *Journal of Legal Studies* 29, no. S2 (June 2000): 931–952.

Shilling, James D., C. F. Sirmans, and John D. Benjamin. "Flood Insurance, Wealth Redistribution, and Urban Property Values." *Journal of Urban Economics* 26 (1989): 43–53.

Sirmans, G. Stacy, David A. Macpherson, and Emily N. Zietz. "The Composition of Hedonic Pricing Models." *Journal of Real Estate Literature* 113, no. 1 (2005): 3–43.

Titus, James G. "Rising Seas, Coastal Erosion, and the Takings Clause: How to Save Wetlands and Beaches without Hurting Property Owners." *Maryland Law Review* 57 (1998): 1279–1399.

Viscusi, W. Kip. "Risk Equity." *Journal of Legal Studies* 29, no. S2 (June 2000): 843–871.

Water Resources Council. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. Technical report. Washington, March 1983.

White, Gilbert F. "Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States." PhD diss., University of Chicago, 1942.

Yasui, Shojiro. "A Critical Review of the Tradition MEthodology of Cost-Benefit Analysis and a Proposed Alternative." *Human and Ecological Risk Assessment* 11 (2005): 411–432.

Yildirim, Unal. "The Decision to Purchase Flood Insurance: A Case Study of Reno and Sparks." Master's thesis, University of Nevada, Reno, 1997.