A Real-Options Approach to Post-Hurricane Loss Valuation of Damage Property: Rebuild or Repair?

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Abstract

In this paper, we investigate the rebuild or repair decision that property owners face after damages caused by catastrophic hurricanes such as Katrina in New Orleans. In particular, we consider how the degree of risk aversion and uncertainty affect the decision-making process. A theoretical model is developed using the real-options framework of Dixit and Pindyck (1994). According to the model, the decision to rebuild a property is reached much later when there is a high degree of uncertainty over future social costs and a high discount rate. We demonstrate these effects using simulations with actual numbers from Hurricane Katrina.

KEYWORDS: loss valuation, hurricane damages, Hurricane Katrina

Author Notes: The authors wish to thank the participants of the 2009 Asia-Pacific Risk and Insurance Association meeting for their helpful comments on an earlier draft of this article.
1. Introduction

Recent hurricanes in the United States have caused catastrophic property losses. These losses are, on average, very large for individual homeowners (Born and Viscusi, 2006) and have risen significantly in the last thirty years (Ewing et al., 2007). Property damages are not limited to flooding and high winds, as subsequent environmental contamination cause tremendous destruction as well. For example, in the aftermath of Hurricane Katrina, 6.5 million gallons of residual flood water that was pumped into Lake Pontchartrain contained a toxic mix of raw sewage, bacteria, heavy metals, pesticides and other harmful chemicals.

For property owners affected by such calamities, the decision to rebuild or repair property involves multiple notions of cost from dealing with environmental damage and hence, cannot be addressed within a conventional cost-benefit framework that simply compares the present value of the stream of benefits to the stream of costs. This decision must also take into account the uncertainties over future benefits and costs and partial or total irreversibilities stemming from environmental damage. Furthermore, this decision is not as simple as a now-or-never decision as repairs can be made while delaying the decision to rebuild in the future when more information becomes available (for instance, from insurance companies regarding payouts or the government regarding aid). In this paper, we explore the rebuild-or-repair decision based on the timing of environmental policy by Dixit and Pindyck (1994).

From the insurance industry’s perspective, these decisions can significantly impact the overall cost of claims. Table 1 shows insured losses from 1998 to 2007 from catastrophic hurricanes which have been on the rise. These losses do not follow a predictable pattern each year and tend to be lumpy, potentially straining the capacity of insurance companies and their ability to cover such losses (Born and Viscusi, 2006). When catastrophic hurricanes did occur, personal property losses ranged from 35% to 75% of all losses. These losses primarily affected the states on the Gulf coast and the East coast. It is noteworthy that eight out of ten worst hurricanes in U.S. history, as measured by insured losses, occurred in 2004 and 2005 alone, as Table 2 indicates. Changing weather patterns have caused an increase in the number of named storms that affect the United States. Between 1971 and 1994, there was an average of only 8.5 name storms per year. However, from 1994 to 2005, there was an average of 15 named storms per year (Born and Viscusi, 2006).
Table 1. Catastrophic Hurricane Losses in the United States: 1998-2007

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Catastrophic Hurricanes</th>
<th>Estimated Insured Loss (in millions of 2007 dollars)</th>
<th>Personal Property Losses¹ (% of All Losses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>2</td>
<td>$4,200</td>
<td>34.9%</td>
</tr>
<tr>
<td>1999</td>
<td>5</td>
<td>$2,900</td>
<td>39.4%</td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2001</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2002</td>
<td>1</td>
<td>$496</td>
<td>66.5%</td>
</tr>
<tr>
<td>2003</td>
<td>2</td>
<td>$2,000</td>
<td>74.9%</td>
</tr>
<tr>
<td>2004</td>
<td>5</td>
<td>$25,100</td>
<td>65.7%</td>
</tr>
<tr>
<td>2005</td>
<td>6</td>
<td>$61,900</td>
<td>49.8%</td>
</tr>
<tr>
<td>2006</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2007</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Source: ISO’s Property Claim Service Unit (The Insurance Factbook 2009)

Table 2. Top Ten Most Costly Hurricanes in the United States

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Hurricane</th>
<th>Estimated Insured Loss (in millions of 2007 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 August 25-20, 2005</td>
<td>AL, FL, GA, LA, MS, TN</td>
<td>Katrina</td>
<td>$43,625</td>
</tr>
<tr>
<td>2 August 24-26, 1992</td>
<td>FL, LA</td>
<td>Andrew</td>
<td>$22,902</td>
</tr>
<tr>
<td>3 October 24, 2005</td>
<td>FL</td>
<td>Wilma</td>
<td>$10,933</td>
</tr>
<tr>
<td>4 August 13-14, 2004</td>
<td>FL, NC, SC</td>
<td>Charley</td>
<td>$8,203</td>
</tr>
<tr>
<td>5 September 12-14, 2008</td>
<td>AR, IL, IN, KY, LA, MO, OH, PA, TX</td>
<td>Ike</td>
<td>$8,100</td>
</tr>
<tr>
<td>7 September 17-22, 1989</td>
<td>GA, NC, PR, SC, VA, U.S. Virgin Islands</td>
<td>Hugo</td>
<td>$7,013</td>
</tr>
<tr>
<td>8 September 20-26, 2005</td>
<td>AL, AR, FL, LA, MS, TN, TX</td>
<td>Rita</td>
<td>$5,973</td>
</tr>
<tr>
<td>9 September 3-9, 2004</td>
<td>FL, GA, NC, NY, SC</td>
<td>Frances</td>
<td>$5,043</td>
</tr>
<tr>
<td>10 September 1-29, 2004</td>
<td>DE, FL, GA, MD, NJ, NY, NC, PA, PR, SC, VA</td>
<td>Jeanne</td>
<td>$4,011</td>
</tr>
</tbody>
</table>

Source: ISO’s Property Claim Service Unit; Insurance Information Institute (The Insurance Factbook 2009)

¹ Excludes vehicle losses.
This paper considers factors that influence property owners’ decisions to repair or rebuild structures damaged by hurricane forces. In particular, we consider the amount of risk aversion property owners have about environmental contamination resulting from water damage and how their view of future uncertainty influences the rebuild/repair decision. The literature suggests that individuals typically have difficulty assessing risk when the frequency of occurrence is low (Camerer and Kunreuther, 1989; Shogren, 1990; Kunreuther and Pauly 2004; Kunreuther and Pauly 2006; Smith et al., 2006; Viscusi and Zeckhauser, 2006), when there is ambiguity concerning the size of the loss (Hogarth and Kunreuther, 1989), when the time horizon is not static (Kunreuther et al. 1998; Born and Viscusi, 2006; Camerer and Kunreuther, 1989; Dixit and Pindyck, 1994; Shogren, 1990; Anthoff et al., 2009; Yanochik and Kumazawa, 2009) and when there are other psychological factors to take into consideration (Camerer and Kunreuther, 1989; Kunreuther and Pauly, 2004). This paper extends the existing research on this topic.

The paper proceeds as follows. After considering the previous literature, the theoretical model is developed to incorporate the risk aversion of the property owners within a dynamic framework. The empirical analyses will focus on simulations that are run using the derived model.

2. Literature Review

Loss valuation of property by homeowners is impacted by the perception of risk through subjective evaluation and assessment. Viscusi and Zeckhauser (2006) find that most people believe their risk for experiencing a natural disaster is either average or below-average, similar to events that are within personal control, such as an auto fatality. With hurricanes and tornadoes, personal past experience with the natural disaster, in conjunction with residential location in a hurricane state (Florida, Louisiana, Mississippi and Texas), raises the risk beliefs.

Kunreuther and Pauly (2004 and 2006) argue that consumers have difficulties assessing “low-probability high-loss” events and misjudge the risks by believing that the likelihood of such events is zero even though the severity of the potential disaster is high. For many, the problem is one of interpretation – they cannot even interpret probabilistic information about low frequency events because they have no context with which to do so. Hogarth and Kunreuther (1989) contend that the ambiguity concerning the size of the loss is important, in addition to the probability of the loss. When ambiguity is substantial, individuals only focus on the potential losses and as a result, show a lack of interest in purchasing protection through insurance. In the aftermath of Hurricane Katrina, it was found that many homeowners had not purchased flood insurance even though they qualified for one through the National Flood Insurance Program (NFIP).
Kunreuther and Pauly, 2006). With such low probabilities of occurring, individuals expect a low return from searching for information on the benefits of obtaining insurance (Kunreuther and Pauly, 2004).

Smith and Desvousges (1987) surveyed households regarding the risk of exposure and death from hazardous waste. Contrary to their hypothesis, they find that the estimated marginal valuation of risk decreases with higher risk levels. They attribute this finding to a lack of public understanding of the risks of hazardous waste compared to other risk factors. Camerer and Kunreuther (1999) find that people’s biases in judgment may be the result of constant media reporting which puts more emphasis on the reporting of disasters which alter perceptions regarding the probability of death more so than the reporting of any other risk factor such as illnesses. Therefore, individuals tend to become overly sensitive to changes in the probabilities of low-probability events (Shogren, 1990).

Shogren (1990) maintains that the misperception of perceived risk is the result of self-assessment within a static framework. Others argue that myopia and a bias in risk perception (Camerer and Kunreuther, 1989; Kunreuther and Pauly, 2004) play a role when longer time frames are considered. In non-static or inter-temporal models, the discount rate captures time preference and the opportunity cost of the investment (Anthoff et al., 2009). Camerer and Kunreuther (1989) argue that risk creates a “flow of worry” or dread in people’s psyche over time. When the experience is going to be bad (such as a dental visit), they prefer earlier consumption to later consumption so that the amount of dread will be minimized. They also pose that individuals act as though discount rates get smaller in future years making them impatient about the near future and myopic about the distant future. Myopia and impatience lead to individuals preferring quick fixes and avoiding long-term investments especially if the costs in the short-run are high (Camerer and Kunreuther, 1989). Indeed, Yanochik and Kumazawa (2009) find that a high discount rate distorts the decision to rebuild in favor of repairing damaged properties for homeowners.

Misperceptions regarding risk also arise when dealing with externalities because they involve both private and social risks that affect others (Camerer and Kunreuther, 1989) and social costs (Anthoff et al., 2009; Dixit and Pindyck, 1994). Next, we show that the loss valuation of property is impacted by the perception of risk discussed in this section through subjective evaluation and assessment of homeowners.

3. Theoretical Model

At the moment of landfall, Hurricane Katrina caused property damage from water and wind. In addition to these immediate causes of damage, the resulting
flooding meant that property owners also faced losses over time in the form of environmental contamination. The time dimension in play would cause property owners to evaluate the rebuild or repair options differently than if the damage incurred from excessive force alone. Negative externalities resulting from progressive contamination (for example, from asbestos, lead and arsenic from older structures that were destroyed and household hazardous waste) would have to be accounted for by property owners (Fronstein and Holtmann, 1995; Congressional Research Service, 2008). Below, we consider the impact that uncertainty plays in the property owners’ decisions to rebuild or repair properties damaged by hurricane forces.

We examine this decision to rebuild or repair in the face of uncertainty of future costs and benefits using a theory centered on the problem of irreversible investment. The timing of decision-making becomes critical when considering irreversible investment because the time element in both directions (backward and forward) contains an opportunity cost. In one direction, the decision maker must consider the fact that at the point in time when the decision is made, no additional information may be used. In the other direction, waiting to make a decision, in the hopes of gaining additional information, means losing possible net present benefits. In this section we develop a theoretical model that describes how variations in uncertainty can impact property owners’ decisions to rebuild or repair damaged properties when environmental contamination has to be considered.

This paper is based on the theoretical model by Dixit and Pindyck (1994) and the application of the model by Yanochik and Kumazawa (2009). We assume that when property owners decide to rebuild damaged properties, a sunk cost is made in the present. On the other hand, repairing in our model means to delay rebuilding the property to the future. The remainder of this section is an elaboration of Dixit and Pindyck’s theory.

Assume that the contamination level is \( M \), the rate of contamination emission is \( E \), and \( \lambda \) is the rate at which \( M \) decays. The progression of environmental contamination becomes:

\[
\frac{dM}{dt} = \gamma E(t) - \lambda M(t)
\]

(1)

where \( \gamma \) is a parameter that gives the rate of increase in \( E_t \). The flow of social cost from the contaminated property (or negative benefit), if assumed a linear combination, is then given by:

\[
B(M_t, \theta_t) = -\theta_t M_t
\]

(2)
where $\theta$ is a variable that accounts for changes in technology and tastes. An example of this variable is increased moral hazard through increased insurance that caused a rise in demand in lower quality housing (Fronstin and Holtmann, 1994). Newer technology allowed for cheaper yet flimsy materials to be used in the construction of new homes which are less likely to withstand catastrophic hurricanes. Kunreuther (1996) argues that building codes are frequently not enforced even in areas that are prone to hazards and that a quarter of the losses incurred in the aftermath of Hurricane Andrew could have been prevented.

As in Dixit and Pindyck (1994), we assume that such variations in tastes and technology follow a geometric Brownian motion and satisfy the following stochastic differential equation.

$$d\theta = \alpha \theta dt + \sigma \theta dz$$

(3)

The anticipated social cost per unit of environmental contamination $M$ is given by $\alpha$. The term $\sigma$ represents the amount of uncertainty regarding the future social cost of contamination. As the value of $\sigma$ increases, the level of uncertainty increases.

For property owners, the decision to rebuild ultimately depends on the net present value (NPV) of the investment in equation 4.

$$W = \varepsilon_0 \int_0^\infty B(M_t, \theta_t) e^{-rt} dt - \varepsilon_0 [Ke^{-rT}]$$

(4)

The term, $\varepsilon_0$, refers to current expectations, $r$ the discount rate, and $T$ the decision point. We can now state the problem that this model attempts to solve. Given changes in tastes and technology ($\theta_t$), and the relationship between the contamination level ($M_t$) and the rate of emissions ($E_t$), the property owners must find the optimal point in time in which to incur the sunk cost to eliminate contamination altogether. We also assume that until $T$ (or until homeowners rebuild or while repairing), the rate of contamination remains constant at $E$.

Dixit and Pindyck (1994) use dynamic programming to optimize the above NPV function (equation 4). Utilizing necessary conditions for optimization (Bellman equations) and boundary conditions, they arrive at the following solutions to the problem.3 The authors define two solutions, the “no-adopt policy region” (where $E_t = E$), and the “adopt policy region” where ($E_t = 0$). In our framework, repairing properties is the equivalent of their “no-adopt policy region”

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2 This is a continuous-time stochastic process that is commonly used in the field of option pricing.

3 See Dixit and Pindyck (1994) for a complete step-by-step derivation of the theoretical model.
and has a value function, \( W^N(\theta, M) \) and rebuilding properties is the equivalent of their “adopt policy region” and has a value function, \( W^A(\theta, M) \).

\[
W^N(\theta, M) = \frac{\theta M}{r + \lambda - \alpha} - \frac{\gamma E \theta}{(r - \alpha)(r + \lambda - \alpha)} \tag{5}
\]

\[
W^A(\theta, M) = -\frac{\theta M}{r + \lambda - \alpha} \tag{6}
\]

In equation 5, the value function for repairing the property, \( W^N(\theta, M) \), has three components. The first term gives the value of rebuilding in the future, the second term gives the social cost sustained from the current level of pollution and the last term gives the present value of the social cost from continued emission indefinitely at \( E \). The terms, \( A \) and \( \beta \), are additional parameters that will be determined in the model.\(^4\)

When property owners decide to rebuild, the rate of contamination \( E \) is eliminated through the sunk cost. Hence, the value function for rebuilding, \( W^A(\theta, M) \), in equation 6 includes only the second term in equation 5.

We derive the critical value \( \theta^* \), the policy adoption level, as follows.\(^6\)

\[
\theta^* = \left( \frac{K}{\beta - 1} \right) \left[ (r - \alpha)(r + \lambda - \alpha) \beta \right] \frac{\gamma E}{(r - \alpha)(r + \lambda - \alpha) \beta} \tag{7}
\]

A higher degree of uncertainty over future social cost of pollution, \( \sigma \), will raise \( \theta^* \), implying that homeowners will have more incentive to wait and repair rather than rebuild their properties. A higher discount rate, \( r \), will also raise \( \theta^* \) and the value of the option to adopt the investment decision in the future. We argue that for homeowners affected by catastrophic hurricanes, both \( \sigma \) and \( r \) will be high, thereby delaying the decision to rebuild properties. Yanochik and Kumazawa (2009) found that the discount rate from a change in monetary policy greatly impacts the loss valuation of homeowners. In this paper, we further argue that the higher discount rate also decreases the present value of the sunk cost, \( K \), implying

\(^4\) The term, \( A \), is a constant that is determined by the equation, \( A = \left( \frac{\beta - 1}{K} \right)^{\frac{\gamma E}{(r - \alpha)(r + \lambda - \alpha) \beta}} \).

\(^5\) The term, \( \beta \), is a positive root of the quadratic equation, \( \frac{1}{2} \alpha \beta (\beta - 1) + \alpha \beta - r = 0 \).

\(^6\) Dixit and Pindyck (1994) show that \( K \), the sunk cost, is proportional to \( E \) but that \( \theta^* \), the critical value to adopt the policy, is independent of \( E \).
that rebuilding should be delayed for the future. The higher discount rate may stem from the self-assessment of risk and the uncertainty surrounding the decision. In such a scenario, homeowners will have more of an incentive to repair than rebuild their properties. In the next section, we demonstrate these effects with simulations.

4. Simulations

Tables 3 and 4 show simulations of the model derived in the previous section. The discount rate, \( r \), equals 0.125 (a low value) in Table 3 and 0.25 (a high value) in Table 4. The other parameters have the following values. The term, \( \alpha \), equals zero (the expected social cost per unit of \( M \) is zero given that individuals underestimate risk), the rate of decay of contamination, \( \lambda \), equals 1, the current level of contamination, \( M \), equals 8,057.2465 tons, the rate of emissions, \( E \), equals 1,000 tons per year and the sunk cost, \( K \), equals $32.5239 billion.

We base the value of \( M \) on the Congressional Research Service (CRS) Report (2008) which finds that the amount of hazardous waste in the wake of Hurricane Katrina amounted to 16,114,493 pounds (8,057.2465 tons). We base the value of \( K \) on the building replacement value that is generated by the Hazard U.S. Multihazard (HAZUS-MH), a GIS based software that was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). It estimates potential losses from hazards such as earthquakes, hurricane winds and floods. According to the HAZUS-MH, New Orleans, Louisiana, spans 350.04 square miles with over 188,000 households and population of 485,674. There are 150,551 buildings of which 77.6% are residential. The total building replacement value (excluding contents) is estimated to be $27.263 billion in 2002 dollars for all residential homes. We convert this value to $32.5129 billion in current dollars and use this number for our value of \( K \), sunk costs. Comparisons of simulations are made when the degree of uncertainty over future social costs are low (\( \sigma=0.05 \)) to high (\( \sigma=0.5 \)).

Table 3 shows the simulations when individuals have a low discount rate of 0.125. When there is less future uncertainty (column 3), the NPV of repairing has a value of -$33 billion while the NPV of rebuilding has a value of -$4.5 billion. A higher degree of uncertainty over future social costs (column 4) distorts the decision to rebuild. The decision is reached much later when \( \theta^* \) equals ten times the previous amount. The distortion is higher for the NPV of rebuilding which is now -$10.6 billion. In other words, there is greater incentive to wait and repair rather than rebuild because there is a larger current cost to trigger the rebuilding process.
Table 3. Simulations for r=0.125 (low discount rate)

<table>
<thead>
<tr>
<th>Estimations:</th>
<th>Definitions:</th>
<th>Scenario 1: Low Degree of Uncertainty over Future Social Cost of Contamination ($\sigma=0.05$)</th>
<th>Scenario 2: High Degree of Uncertainty over Future Social Cost of Contamination ($\sigma=0.5$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Miscellaneous Term</td>
<td>10.51</td>
<td>1.62</td>
</tr>
<tr>
<td>$\theta^*$ (per ton)</td>
<td>Critical Value at Which Policy Should be Adopted</td>
<td>$80,843</td>
<td>$191,515</td>
</tr>
<tr>
<td>$A\theta^*$</td>
<td>Value of Option to Adopt Investment Decision in the Future</td>
<td>$3,418,557,338</td>
<td>$52,616,847,280</td>
</tr>
<tr>
<td>$-\frac{\theta M}{r + \lambda - \alpha}$</td>
<td>Present Value of Social Cost from Contaminated Properties</td>
<td>-$4,492,194,667</td>
<td>-$10,641,980,910</td>
</tr>
<tr>
<td>$-\frac{\gamma E\theta}{(r - \alpha) + (r + \lambda - \alpha)}$</td>
<td>Present Value of Social Cost if Emission Continued at $E$ Forever</td>
<td>-$35,937,557,338</td>
<td>-$85,135,847,280</td>
</tr>
<tr>
<td>$W^N(\theta,M)$</td>
<td>Net Present Value of No-Adopt Solution (Repair)</td>
<td>-$37,011,194,667</td>
<td>-$43,160,980,910</td>
</tr>
<tr>
<td>$W^4(\theta,M)$</td>
<td>Net Present Value of Adopt Solution (Rebuild)</td>
<td>-$4,492,194,667</td>
<td>-$10,641,980,910</td>
</tr>
</tbody>
</table>

Table 4 shows the simulations when individuals have a high discount rate 0.25\(^7\) (double the amount of the low discount rate), which implies a reduction in the present value of the sunk cost, $K$. Therefore, the option to rebuild is worth more and be chosen later. Again, the comparison is made between a low $\sigma$ and a high $\sigma$. The values of NPV of rebuilding are significantly different than those in Table 3. When the degree of uncertainty over future social costs is high and the discount rate is high, then, the NPV of rebuilding has a value of -$16.3 billion.

\(^7\) A value greater than 0.2 was used as an example of a high discount rate in Kunreuther (1996) and Kunreuther et al. (1998).

Published by The Asia-Pacific Risk and Insurance Association, 2010
Table 4. Simulations for $r=0.25$ (high discount rate)

<table>
<thead>
<tr>
<th>Estimations:</th>
<th>Definitions:</th>
<th>Scenario 1: Low Degree of Uncertainty over Future Social Cost of Contamination ($\sigma=0.05$)</th>
<th>Scenario 2: High Degree of Uncertainty over Future Social Cost of Contamination ($\sigma=0.5$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Miscellaneous Term</td>
<td>14.65</td>
<td>2.00</td>
</tr>
<tr>
<td>$\theta^a$ (per ton)</td>
<td>Critical Value at Which Policy Should be Adopted</td>
<td>$292,386$</td>
<td>$544,859$</td>
</tr>
<tr>
<td>$A\theta^a$</td>
<td>Value of Option to Adopt Investment Decision in the Future</td>
<td>$2,382,174,743$</td>
<td>$32,519,000,000$</td>
</tr>
<tr>
<td>$-\frac{\theta M}{r+\lambda-\alpha}$</td>
<td>Present Value of Social Cost from Contaminated Properties</td>
<td>-$8,725,293,686$</td>
<td>-$16,259,500,000$</td>
</tr>
<tr>
<td>$-\frac{\gamma E \theta}{(r-\alpha) + (r+\lambda-\alpha)}$</td>
<td>Present Value of Social Cost if Emission Continued at E Forever</td>
<td>-$34,901,174,743$</td>
<td>-$65,038,000,000$</td>
</tr>
<tr>
<td>$W^N(\theta,M)$</td>
<td>Net Present Value of No-Adopt Solution (Repair)</td>
<td>-$41,244,293,686$</td>
<td>-$48,778,500,000$</td>
</tr>
<tr>
<td>$W^A(\theta,M)$</td>
<td>Net Present Value of Adopt Solution (Rebuild)</td>
<td>-$8,725,293,686$</td>
<td>-$16,259,500,000$</td>
</tr>
</tbody>
</table>

5. Conclusion

Whether it is hurricanes in the Caribbean, typhoons in East Asia, or monsoons in South Asia, the damage generated by these natural disasters creates numerous problems for property owners, including having to decide whether to repair or rebuild. In this paper, we explore this problem using a real-options type model given by Dixit and Pindyck (1994). We extend Dixit and Pindyck’s environmental damage model, focusing on the role that risk aversion has on the decision to repair or rebuild. Finally, simulations are run for various hurricane scenarios that affect loss valuation and damage estimates.

A shortcoming of this paper is that it does not take into account how people adjust to natural disasters. Smith et al. (2006) found that income and other
income-related factors such as education and race matter in the process. For instance, low-income households move into damaged areas due to relatively lower rent. On the other hand, middle-income households move away from these areas to avoid risk while the high-income households remain because self-protection and insurance are both affordable. Our model did not take income and other background characteristics into account. In the future, as more data becomes available, this theoretical model of rebuild or repair decision can be developed empirically while controlling for such socio-economic characteristics.

A potential area of future research would be to investigate the impact of government assistance provisions on the decision to repair or rebuild as private insurers have increasingly become more reluctant to provide hurricane and flood coverage (Kunreuther, 1996). For example, once a state and the Federal Emergency Management Agency (FEMA) determine that a facility is eligible for FEMA’s Public Assistance Program, an assessment of damages is required. The Code of Federal Regulations states that, “A facility is considered repairable when disaster damages do not exceed 50 percent of the cost of restoring a facility to its pre-disaster condition and it is feasible to repair the facility so that it can perform the function for which it was being used immediately prior to the disaster.”

6. References


