The Financial Impact of the Oil Pollution Act:

Do the Penalties Resulting from Oil Spills Fulfill the Purpose of the OPA?

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Abstract. This paper explores the financial impact of the Oil Pollution Act (OPA) on oil companies for oil spills. Total penalty per barrel, including civil and criminal penalties, and total cost per barrel for oil spills are analyzed prior OPA and post OPA. Difference-in-differences estimation is used to determine if penalties and costs for an oil spill increased post OPA in accordance with the purpose of the OPA to hold companies more financially responsible for oil spills, especially damaging ones. With the exception of criminal penalty per barrel, the analysis suggests that the OPA is not achieving the desired financial impact.

I. Introduction

In March 1989, the supertanker Exxon-Valdez left the port of Valdez, Alaska and ran aground on the rocks of Bligh Reef, spilling 11 million gallons of crude oil into Prince William Sound. This accident was to become one of the worst environmental disasters in United States history.[1] Not only did this incident cost billions of dollars, but it also had important legal ramifications. Early in 1989, the Department of Interior (DOI) created a new set of regulations governing Superfund, which allowed for more extensive monetary damages to be obtained from companies in the event of an environmental accident. [2] Whether these new regulations would be put into effect for the Exxon-Valdez oil spill quickly became a heated topic.

Acting in support of these new regulations and primarily as a response to the Exxon-Valdez incident, Congress passed the Oil Pollution Act (OPA) in 1990. The OPA created a

[1] Carson (2003) and others recount the Exxon-Valdez incident.
[2] Portney (1994) recounts the history of Superfund.

whole new system for dealing with prevention, response, liability, and compensation for oil spills. The OPA set new requirements for vessels and crews, developed detailed plans for the government's response to oil spills, instituted research and development programs, and created a fund to help pay for oil spills. This act ultimately provided federal and state governments with the opportunity to sue companies for not only actual losses suffered but also for lost existence values in the specific case of an oil spill. An existence value, the value that the individual derives from an item's mere existence, without any use component, could now be used in assessing companies for damages in lawsuits. In addition, the OPA mandated new requirements for vessel construction, such as the transition from single hull tankers to the safer double hull tankers by the year 2015, and new regulations for crew licensing and manning (U.S. Coast Guard, *Oil Pollution Act of 1990 (OPA)*, 2005). The purpose of this act was two-fold – to help prevent future oil spills and, in the event of a spill, to provide funds to recover from the damages incurred. Ultimately, this act raised the stakes for companies vulnerable to oil spills. Now, these companies could face higher damage penalties in lawsuits resulting from oil spills in addition to the costly new regulations on vessels and crews.

The institution of the OPA had a significant impact on marine policy and economics literature. Since 1990, academic scholars have debated the overall degree of the OPA's success and the accuracy of contingent valuation - the sole economic method available to estimate existence values (Boyle et al., 1996; Diamond and Hausman, 1994; Kim, 2002; Anderson and Labelle, 2000). Marine policy scholars and some economists have focused on evaluating the success of the OPA as a whole. In general, these scholars have attributed positive results, such as reduced volume and number of oil spills, to this act (Kim, 2002;

Anderson and Labelle, 2000). In addition, some debate exists over whether the benefits of each of the OPA's provisions outweigh its costs to oil companies (Ketkar, 1995).

Many economists have concentrated on the more specific provision of contingent valuation with respect to the OPA. As the sole method for determining existence values to assess companies for damage penalties, contingent valuation was suddenly thrust into the spotlight by the OPA. While the accuracy of existence values obtained by contingent valuation is still hotly debated, at the very least, the consensus is that contingent valuation surveys must be performed under a very stringent set of guidelines and use conservative estimates in order to be reliable (Portney, 1994). Despite these debates, contingent valuation still stands under the OPA as a sanctioned tool for assessing oil companies for damages resulting from lost existence values incurred from oil spills.

Both the marine policy and economics literatures have ignored the financial implications of the OPA. In his study, Ketkar (1995) estimated the costs and benefits of each of the OPA's provisions and determined that the costs of many of the provisions outweighed its benefits. However, none of the studies have analyzed oil spill data to determine the actual financial impact of the OPA as a whole. "Has the OPA been successful in preventing oil spills due to the financial impact of its provisions?" While additional research is required to answer this question, this is the broader question that my paper takes a step towards answering. I will answer this question by determining if there is an increased financial impact on oil companies resulting from the provisions of the OPA. Specifically, I will examine the penalties assessed to oil companies by state and federal governments for oil spills prior OPA and post OPA. If I find increased penalties post OPA, then I will examine the characteristics of these oil spills, such as damages to natural resources that could explain

these increased penalties. If I find a financial impact on firms due to the OPA, research concerning the behavior of firms in response to the OPA could determine if this policy has actually played a role in preventing oil spills and, furthermore, if the possible benefit of prevention of oil spills resulting from this policy has outweighed its costs.

In order to determine the financial impact of the OPA on oil companies, I examine the penalties assessed by the state and federal governments for oil spills post OPA and prior OPA. I look at these penalties for two separate periods – eight years before the OPA (1980-1988) and eight years after the OPA (1992-2000). I leave a buffer period of two years around the passage of the OPA in 1990 in order to exclude oil spills during the First and Second Persian Gulf Wars and to allow the OPA to take full effect. I adjust for confounding variables such as oil spill size, natural resources affected, and the type of oil spilled. If I find increased penalties, I will then determine what characteristics of an oil spill lead to these increased penalties. For example, since the OPA was passed in part to hold companies accountable for natural resource damages, one would expect the penalties post OPA to increase more for spills in which there were extensive natural resources damaged than spills in which damage to natural resources was minimal.

I hypothesize that there will be increased penalties for oil spills after the enactment of the OPA. Furthermore, I hypothesize that penalties for oil spills in which natural resource damage was extensive will increase more post OPA than spills in which little natural resource damage took place. By comparing these two sets of changes, the change in oil spill penalties for spills with extensive natural resource damage and spills with minimal natural resource damage post OPA, I can control for confounding variables. By making this comparison, I control for factors that could have affected penalties besides the OPA that

occurred at the same time. For instance, by comparing the differences in penalty increases for the two types of spills post OPA, I weed out the effect of outside factors such as increased penalties due to a new Presidential administration. However, this comparison is only one step in the direction of determining whether the OPA has in fact prevented spills. It seems that companies would take more steps to avoid these kinds of spills if they are in fact more damaging post OPA. This would imply the success of the OPA in making companies take steps to prevent more damaging oil spills; however, additional research must be done on the behavior of firms to determine if this has indeed been the case.

Section II of my paper presents a review of the related literature on the OPA policy as a whole and its provisions including contingent valuation. **Section III** is the theoretical framework surrounding my hypothesis, along with a description of the difference-in-differences estimation methodology that will be used to test it. **Section IV** details the data set I have compiled from various sources such as Department of Justice (DOJ) Press Releases, Environmental Protection Agency (EPA) Press Releases, National Oceanic and Atmospheric Administration's (NOAA's) oil spill case histories and a paper for the 1999 International Oil Spill Conference, and old news articles. **Section V** presents my empirical analysis on the data. **Section VI** summarizes my findings and the implication of these findings on the success of the OPA.

II. Literature Review

There are two relevant sources of literature that contribute to my topic – discussion of the OPA and contingent valuation. The OPA literature concerns the degree of success enjoyed by the OPA in the United States in relation to each of its provisions, while the

contingent valuation literature concerns the debate on the accuracy of using contingent valuation to estimate existence values. Both of these literatures aim to decide issues concerning policy; the OPA literature debates the success of the act in accomplishing its purposes while the contingent valuation literature seeks to decide if it is reasonable to use existence values obtained from the method of contingent valuation in valuing resources. My paper intends to provide additional evidence concerning the financial implications of the OPA on oil companies after an oil spill to help advance each debate.

The Oil Pollution Act

Marine policy scholars and some economists have focused on the success of the OPA since its enactment, and there is a variety of opinions on the degree of its success. However, it is important to know first what the OPA entailed regarding each of its provisions. With the passage of the OPA, a whole new system regarding the prevention, response, liability, and compensation in the case of an oil spill came into existence. Not only did the OPA increase liabilities for oil companies by allowing the use of contingent valuation to estimate existence values in lawsuits, but the OPA also specified new requirements regulating oil companies. For example, the OPA mandated the changing out of single hull vessels over a period of twenty five years to safer double hull vessels. In addition to increased liability and safer vessel construction, the OPA required vessels to have detailed plans for their response to an oil spill, to maintain tougher licensing standards for crews, and to have more crew on duty. It also provided for the help of the Coast Guard in navigation of tankers through the Vessel Traffic Service (VTS), for more extensive research and development programs on oil spill clean-up technologies, and for the creation of the Oil Spill Liability Trust Fund (OSLTF) to

help pay for oil spills (U.S. Coast Guard, *Oil Pollution Act of 1990 (OPA)*, 2005). These multiple provisions of the OPA make it difficult to determine whether or not increased fines reduced the number of spills, as these provisions would have a confounding effect.

In addition to the OPA's provisions, it is important to know the OPA's history, especially its relationship to Superfund. While Superfund, which along with the Exxon Valdez oil spill, initiated the debate on contingent valuation by allowing the use of existence values, the OPA is legislation that dealt specifically with oil spills in U.S. waters. Superfund is a blanket policy that, among other things, allows the use of contingent valuation to estimate lost existence values for all hazardous substances, pollutants, and contaminants released in any U.S. environment (U.S. Coast Guard, *OPA Facts*, 2005). Therefore, while Superfund is a blanket policy on the use of contingent valuation in estimating damages in all types of environmental disasters, the OPA enforces the use of contingent valuation to estimate existence values in the specific case of oil spills.

Marine policy scholars cite the success of the OPA according to a variety of factors, most notably the reduction in the amount of oil spilled. For example, Kim (2002) compares the volume of oil spilled from two periods of 1988 to1992 and the volume of oil spilled from 1993 to 1997 and finds that volume of oil spilled has decreased in recent years. He further examines the volume of oil spilled by type of vessel and finds that the number and volume of oil spills by tank vessels has decreased post OPA by analyzing data from 1973 to 1997. This provides support for the OPA and the provision involving the switching of single hull tank vessels to safer double hull tank vessels in order to reduce spills. Anderson and Labelle (2000) perform a similar study. They examine data from 1964 to 1999 and look at a variety of variables, such as geography and vessel and examine oil spill occurrence rates to

determine the effectiveness of the OPA. For example, they examine the number of oil spills over 1000 gallons from 1964 to 1999 and find that the spills have decreased. Several more similar studies have been done. [3] The consensus seems to be that most attribute to the OPA some degree of success in reducing oil spill size and volume.

There are two major criticisms of the OPA. Firstly, since the OPA was only enacted fifteen years ago, it has yet to be tested by a major spill in the United States (Kim, 2002). Secondly, another major criticism of the OPA lies in the benefit-cost analysis of this policy. Ketkar (1995) cautions that the costs of many of the OPA's provisions to firms frequently exceed their benefits. More specifically, Ketkar found that only one provision of the OPA, the Vessel Traffic Service provided by the Coast Guard, has a benefit-cost ratio greater than one, meaning its benefits are greater than its costs. While Ketkar questions whether the costs of the OPA exceed the benefits, this does not contradict the evaluation of the OPA literature by others as successful in preventing oil spills. He is merely questioning whether this benefit of prevention is worth its additional cost to firms. Therefore, with some reservations, the agreement is that the reduction in oil spills provides evidence in favor of the OPA and its provisions.

Contingent Valuation

While marine policy scholars and some economists have focused on the OPA as a whole and its success, the majority of economic debate over the OPA centers on contingent valuation. The contingent valuation debate rests on the central disagreement of the accuracy of using contingent valuation to estimate existence values and possible ways to improve contingent valuation surveys by changing the existing regulations. Contingent valuation

[3] Other studies include Talley, Jin, & Kite-Powell (2001) and Ketkar (2002).

surveys measure a respondent's willingness to pay for a certain program. Contingent valuation is so-called because the value obtained from the survey, the respondents' willingness to pay, is contingent upon the program presented in the survey (Portney, 1994). These surveys are good for determining value when no market exists to determine value, such as in the case of oil spills when natural resources are damaged and existence value is lost. In cases where a market can be used to determine value, revealed preference techniques are usually considered better. Today, contingent valuation surveys are used to measure existence values to determine the value of a certain item to individuals who derive no benefit from this item besides its existence. In other words, "the utility derived [for these individuals] does not depend on any direct or indirect interaction with the resource or good in question" (Portney, 1994, p. 5). Existence values are commonly measured for a variety of items ranging from the existence of a rare species to the existence of natural wonders such as the Grand Canyon. In order to understand the debate concerning contingent valuation and its measurement of existence values, it is important to know its history.

The debate over contingent valuation has a relatively short history, with its origins in the twentieth century and with the debate heating up in the last fifteen years due to the OPA. Ciriacy-Wantrup first suggested the method of contingent valuation in 1947 with his work on preventing soil erosion. He noticed the favorable effects of soil erosion and suggested one way to find out the value of the favorable effects was to ask individuals how much they would be willing to pay for these effects. It was not until two decades later that someone actually implemented his suggestion. In 1963, Davis conducted the first contingent valuation survey, in which he estimated the value of a particular recreational area for hunters and wilderness lovers. It was also here that the first test of the accuracy of contingent valuation

was applied. Davis compared the value obtained for the recreational area from his contingent valuation survey to a value for the same recreational area obtained by another method, the "travel cost" approach, and found the values to be similar. By finding similar values from both approaches, he found evidence endorsing the accuracy of contingent valuation surveys (Portney, 1994).

Next, Krutilla (1967) provided two very important insights into contingent valuation – the difference in willingness-to-pay and willingness-to-accept and the notion of an existence value. He noted that a person's willingness-to-accept payment for a loss could be much higher than his willingness-to-pay to avoid the loss of an irreplaceable phenomena, such as natural geographic wonders like the Grand Canyon, preserving genetic variation, or preserving the wilderness. He also came up with the idea that individuals have existence values for certain items. After this initial suggestion of existence values, many studies in the next decade used contingent valuation to estimate these existence values.[4]

Resulting from the more serious treatment of contingent valuation by Superfund and the OPA in 1989 and 1990 and the Exxon Valdez incident, the debate over contingent valuation and the accuracy of its techniques has become much more heated. From these laws and regulations, the once theoretical debate on contingent valuation has been transformed into an application to the real world in lawsuits. A group of experts was asked by the National Oceanic and Atmospheric Administration (NOAA) to address the question of the reliability of using contingent valuation to estimate existence values to use in natural resource damage assessments. The panel created a set of guidelines where contingent valuation could be reliable enough "to be the starting point of a judicial process of damage assessment," including the estimation of existence values (qtd. in Portney, 1994, p. 8). The

[4] Examples of studies include Cicchetti and Smith (1973), and Randall, Ives, and Eastman (1974).

NOAA, in making the regulations about the OPA, took the advice of this panel; thus, it called for the use of existence values obtained from contingent valuation in assessing companies for damages in oil spill lawsuits. [5]

The ambiguity of this report by the NOAA panel has spurred much debate in recent times, including the accuracy of determining existence values from contingent valuation and its regulations (Boyle et al., 1996; Diamond and Hausman, 1994). For example, one study examined the difference in values obtained from contingent valuation where the survey was conducted in two different ways; in one, respondents were asked open-ended questions on how much they would pay for a given item, and in another, respondents were given a choice to make. The study found that either open-ended questions underestimate values or dichotomous choice questions lead to overestimated values (Boyle et al., 1996); the NOAA directs contingent valuation methods to use a referendum format, a variation on the dichotomous choice structure format (Portney, 1994). This implies that the technique used by the NOAA in contingent valuation surveys avoids underestimates of existence values. Diamond and Hausman (1994), instead of refining the techniques of contingent valuation to reflect accurate values like Boyle et al., debate the use of existence values obtained from contingent valuation versus not estimating existence values at all due to the inaccuracies of contingent valuation surveys (1994). They find that contingent valuation does not measure the preferences it attempts to measure, and therefore, they state the use of contingent valuation in government decision making as “misguided" (Diamond and Hausman, 1994, p. 46).

[5] An extensive literature review is given by Portney (1994) on contingent valuation through 1994 including the findings of the NOAA panel.

Currently, scholars are divided on the use of contingent valuation. Many express their reservations about this method, but agree that it should be the object of further research since it has been applied successfully in many cases. The difficulty is that no other method exists to measure existence values, an important characteristic to measure in cases of environmental damages in lawsuits. The current aim of contingent valuation literature is first to determine if contingent valuation surveys are accurate enough to determine existence values for the purposes of lawsuits and then, secondly, to determine what regulations on contingent valuation surveys would yield these results.

My Research Question

In their analysis, academic scholars of both of these literatures need to take into account an additional element - the financial implication of the OPA. This key factor would help evaluate the OPA's success and to some extent contingent valuation's success by determining if the OPA's provisions have a financial impact on oil companies - an implication that both economists and marine policy scholars fail to consider. Regardless of its accuracy, the potential use of contingent valuation could be responsible for the success of the OPA. Richard Carson et al. (2003) hints at this benefit when he states of contingent valuation, "its potential use may be playing an important role in preventing such oil spills" (p. 279). Furthermore, increased penalties paid by oil companies for oil spills could be a result of the use of this new method to calculate existence values. If I can determine that there is a greater financial impact - increased penalties overall and greater increased penalties for more damaging spills - on an oil company after the passage of the OPA, this would provide evidence in favor of the success of the OPA, and the potential use of contingent

valuation would be a likely factor to explain this impact. However, additional research would be required to determine exactly which provisions are responsible for this greater financial impact. It would also need to be determined if these provisions are actually affecting the behavior of oil companies by taking further steps to prevent spills.

The financial impact of the OPA and its provisions is an important policy consideration, and I aim to determine if these provisions are indeed playing a role in preventing oil spills. However, I only take one step in this direction – to determine whether the OPA in the case of an oil spill has had a financial impact on oil companies. By examining the size of oil spill penalties assessed to oil companies prior and post OPA, I can provide evidence either in support of or against this question. If the penalties provide evidence that the provisions of the OPA such as the potential use of contingent valuation in estimating existence values are in fact having a financial impact on oil companies, this would provide another aspect for economists to consider when evaluating the use of contingent valuation, and thus, it would contribute to the debate on the use of contingent valuation in lawsuits. Now, not only reliability, but the implications of the OPA and the possible financial impact of the potential use of contingent valuation policy would enter the debate. As for OPA policy, its financial impact would prove yet another reason to support the success of the OPA and would resolve some of the reservations about the OPA. The OPA could be considered successful in part by creating a financial impact on oil companies while the accuracy of the method of contingent valuation could remain in question. Therefore, a positive response to my research question, "Do the provisions of the OPA have a financial impact on oil companies after a spill in the form of increased penalties, and do greater increases in penalties go hand in hand with more damaging spills?" would do much to

contribute to the two literatures. On the other hand, a negative response to my question would allow economists to be more critical of contingent valuation and give marine scholars a reason to question the OPA's success in failing to have a financial impact on oil companies. A negative response to my research question would signify the failure of the OPA to hold companies financially more responsible for oil spills, especially damaging ones. However, even with a failure to have a financial impact on oil companies, some provisions of the OPA such as the switch from single hull tankers to safer double hull tankers could be preventing oil spills, and in this way, the OPA could still be viewed as successful. Either way, by filling the gap on the financial impact of the OPA, I can work towards resolving each debate by contributing evidence in favor of or against the OPA and its provisions.

III. Theoretical Framework

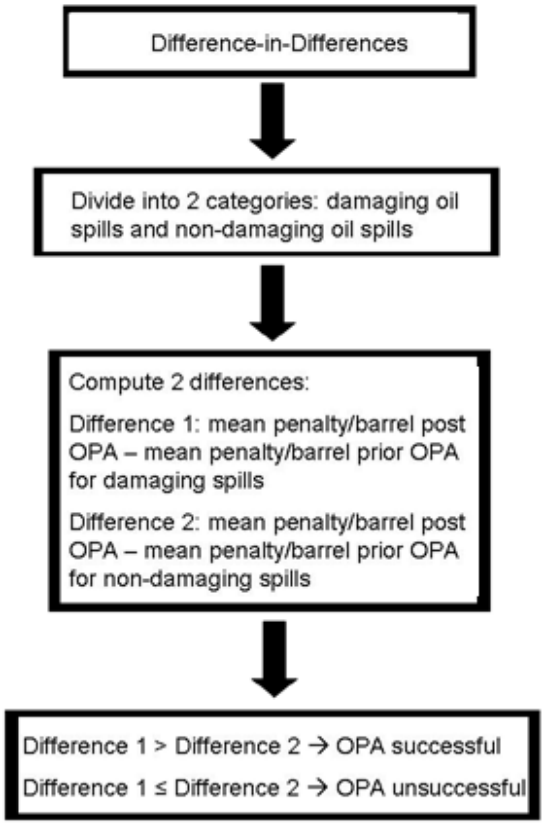
In order to determine whether penalties increased due to the OPA and if these increases were greater for more damaging oil spills, I will employ difference-in-differences estimation. With this method, I will first look at the means and standard deviations of the penalties assessed per barrel of oil spills prior OPA and compare these means and standard deviations to the mean penalty assessed per barrel post OPA. If the mean penalty per barrel within two standard deviations is greater post OPA than prior OPA, the difference, that is, the increase in penalties could be attributed to the OPA.

Much insight into the makeup of the penalties assessed by the government to oil companies can be gained from the use of difference-in-differences estimation. After determining the mean difference between the penalty per barrel prior OPA and post OPA, it can be determined if the characteristics of an oil spill impact the penalties assessed. The

OPA was designed to hold oil companies more accountable for the damage they inflict on the environment. Therefore, it stands that if the oil spill is damaging to the environment, the company should face a greater increase in penalty post OPA than a company post OPA whose spill had minimal environmental effects.

The technique of difference-in-differences estimation can be employed in this case to address whether the OPA is accomplishing its aims. If the OPA is accomplishing its purpose of punishing companies for damaging spills, the difference in penalties prior OPA and post OPA for significantly damaging oil spills should be greater than the difference in penalties prior OPA and post OPA for non-damaging oil spills. Graphically, I will use difference-in-differences estimation as follows (**Figure 1**):

Figure 1: The Methodology of Difference-in-Differences Estimation



By comparing the two differences, difference-in-differences estimation is used to control for confounding factors. For instance, in the case of oil spills, I use difference-in-differences estimation to control for other factors that might have made penalties increase. For example, by subtracting the increased penalties of non-damaging spills from damaging spills, I subtract out the increases in penalties that could have resulted from other factors. If the difference for damaging spills is significantly greater than the difference for non-damaging spills, this provides evidence in favor of the OPA since the OPA's purpose was to increase penalties for damaging spills. If the difference for damaging spills is not greater than the difference for non-damaging spills, this provides evidence against the OPA in that the purpose of the OPA to hold companies more financially responsible for oil spills, especially damaging ones, is not being fulfilled. Using my data set, I will be able to determine these differences and thus assess whether the penalties assessed post OPA reflect the success of the OPA by fulfilling its purpose of punishing companies for damaging oil spills.

IV. Data

In order to determine whether the OPA had a financial impact on oil companies, I compile a data set based on several sources on oil spills which include the Department of Justice (DOJ), the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), a paper written for the 1999 International Oil Spill Conference, and news databases.

The Department of Justice issues press releases whenever a settlement is made in an oil spill case in which it has jurisdiction. These cases are either federal or joint, both state

and federal. These press releases include the amount of the penalty and how the penalty will be used. For example, a penalty will often be divided into natural resource projects, natural resource damages, and federal and state investigative costs. In addition, these press releases often include specifics on the oil spill such as oil spill size, location, total cost of the spill, cause of the spill, company responsible, type of oil spilled, source of the spill, and resources affected by the spill. The EPA also issues press releases for the oil spill cases it handles and includes penalty information and specifics on the oil spill similar to the DOJ.

The NOAA's "Oil Spill Case Histories" gives a detailed report of all major oil spills within the United States and abroad from 1967-1991. In this report, spills were considered major if they had one or more of the following characteristics: exceeded one-hundred thousand barrels of oil spilled internationally, exceeded ten thousand barrels of oil in American waters, or involved severe environmental impacts.[6] The report on each oil spill includes its location, the company responsible, the date of the spill, the type of oil spilled, the number of barrels spilled, the source of the spill, the impact on animals, and the weather conditions. Furthermore, the NOAA's "Oil and Hazardous Materials Response Reports" include the exact same information on each oil spill, but in addition, it reports all minor and major oil and chemical spills in the United States from 1993-1999. However, these case histories lack penalty and cost information for oil spills.

I have also used a 1999 paper written for the International Oil Spill Conference titled, "Putting Response and Natural Resource Damage Costs in Perspective." In this paper, Douglas Helton and Tony Penn of the NOAA (1999, p. 21-22) disclose in two tables various information on thirty different oil spills including the date of the spill, the source of the spill,

[6] A severe environmental impact was defined as "more than 500 birds killed, more than 100 mammals killed, smothering of over a mile of intertidalzone [or] closure of fisheries" (NOAA, "Oil Spill Case Histories," 1992, p. 2).

location, type of oil spilled, amount of oil spilled, natural resource damage assessment costs, third party costs, penalties, and total known costs.

I have used news databases, mainly ProQuest and Lexus-Nexus, to fill in gaps not addressed by DOJ, EPA, or NOAA. Frequently, I find penalty information for oil spills not handled by the DOJ or EPA, or I find specifics on oil spills not included in the NOAA case histories. In addition, these news articles provide penalty and oil spill information for spills prior OPA, since neither the EPA nor the DOJ press releases have penalty information available for spills in the 1980s.

From the information provided by the DOJ, EPA, NOAA, and news databases on oil spills, I compile my own data set including penalty information, cost information, and characteristics of each oil spill. All penalties and costs in my data set are adjusted for inflation. [7] Basically, I include any variable on an oil spill that may have an effect on penalties assessed or costs of an oil spill. Here is a chart summarizing the information I include in my data set (**Table 1**):

Table 1: Variables Included in my Data Set

Information	Explanation
Name of Spill	
Date of Spill	
Company Responsible	
Location	
Oil Product Spilled	Examples: gasoline, diesel fuel, kerosene
Type of Oil Spilled	Oil Type coded by the NOAA There are 4 types: Type 1, 2, 3 or 4
Oil Viscosity Code (OVC)	Coded 0: lightweight oils, oil types 1 and 2

[7] All penalty and cost information in my data set have been adjusted for inflation using the Consumer Price Index available from the Bureau of Labor Statistics Website with the base year 1982-1984 (CPI = 100). Since the date the penalties and costs are incurred are often unknown for an oil spill, inflation was adjusted for by finding the average price for a basket of goods for the period 1980-1988 (CPI = 102.5) and the average price for a basket of goods 1992-2000 (CPI = 156.1). These averages were used to deflate all penalties and costs for prior OPA spills by a single number and all post OPA spills by a single number to convert spills to 1982-1984 dollars.

	(oils less damaging to the environment) Thick: medium and heavyweight oils, oil types 3 and 4 (oils more damaging to the environment)
Size of Spill (barrels)	
Source of Spill	Tank vessel, barge, pipeline, storage facility, or other
Resources at Risk	Number and type of animals killed, endangered or threatened animals harmed, facilities injured (recreational facilities, water supply, houses), people killed
Natural Resource Code (NRC)	Coded 0,1, or 2 0 = no resources at risk noted 1 = 0 to 100 animals killed or only one resource affected 2 = more than 100 animals killed, endangered / threatened animals harmed, water supply affected, people killed
Natural Resource Projects	Money for specific projects noted
Investigative Costs	Cost incurred by state and federal governments to assess penalty for oil spills
Natural Resource Damages	Money to be used towards improving natural resources or to go into the Oil Spill Liability Trust Fund (OSLTF)
Additional Penalties	
Total Civil Penalties	Money assessed for natural resource projects, investigative costs, natural resource damages, and any additionally penalties
Criminal Penalty	Money assessed for negligence
Criminal Punishment	Probation, prison term
Spill Response Costs by State and Federal	
Spill Response Costs by Responsible Party	
Other Costs	Third party costs
Total	All known costs, civil and criminal penalties
Case Type	State, federal, or joint
Penalty/Barrel	
Cost/Barrel	

I am only looking at oil spills that occurred from 1980-1988 and 1992-2000. In this way, I can exclude both the First and Second Persian Gulf Wars, and furthermore, I can leave a buffer zone for the Oil Pollution Act to take effect. Possible weaknesses in my data include

that not all oil spills from 1980-1988 and 1992-2000 are included and that some of the spills lack sufficient cost information. All known costs are included in my data set for each oil spill. However, costs for oil spills often extend years beyond the spill date, and sometimes spill costs, especially third party spill costs, are not reported. This could systematically underestimate the costs of these oil spills. In addition only spills with sufficient penalty information could be included in my analysis. This could have led to an over sampling of large or damaging oil spills.

V. Empirical Findings

In order to determine if the OPA served its purpose, I analyze oil spill penalties and costs per barrel prior OPA and post OPA. With the OPA, lawmakers hoped to penalize companies more for oil spills, especially ones damaging to the environment. The OPA allowed lawmakers to assess increased criminal and civil penalties (U.S. Environmental Protection Agency, *Penalties for Oil Discharges*, 2006). I analyze spills looking at total penalty per barrel, civil penalty per barrel, criminal penalty per barrel, and total known costs per barrel. In this way, I study the makeup of oil spill penalties and costs prior and post OPA. If the OPA has indeed increased penalties, I should find increased total penalty per barrel, increased civil penalty per barrel, increased criminal penalty per barrel, and increased costs per barrel post OPA. In addition, all increases in penalties and costs should be more for damaging spills than non-damaging spills. I consider damaging spills those with a natural resource code of two (NRC = 2) in my data set or an oil viscosity code of one (OVC = 1) in my data set. Non-damaging spills are spills with a natural resource code of zero (NRC = 0) or an oil viscosity code of zero (OVC = 0) in my data set.

Overall Penalties and Costs

Chart A illustrates the rising total penalty per barrel post OPA for oil spills. To control for the size of the oil spill, the total penalty assessed for each spill was divided by the number of barrels spilled. Three spills are excluded from the graph below (**Chart A**) with total penalties per barrel greater than nine thousand dollars. These three outliers are the Tank Barge *Apex Houston* Oil Spill in 1986, the Curtis Bay Oil Spill in 1994, and the Southern California Oil Spill in 1997. The mean total penalty per barrel post OPA is $350 greater than the mean total penalty per barrel prior OPA (**Table 3**). However, this increase in total penalty per barrel is not significant due to large standard deviations of the mean difference. This large standard deviation of the mean largely results from the three spills with total penalty per barrel greater than nine thousand dollars per barrel.

Chart A: Total Penalty/Barrel

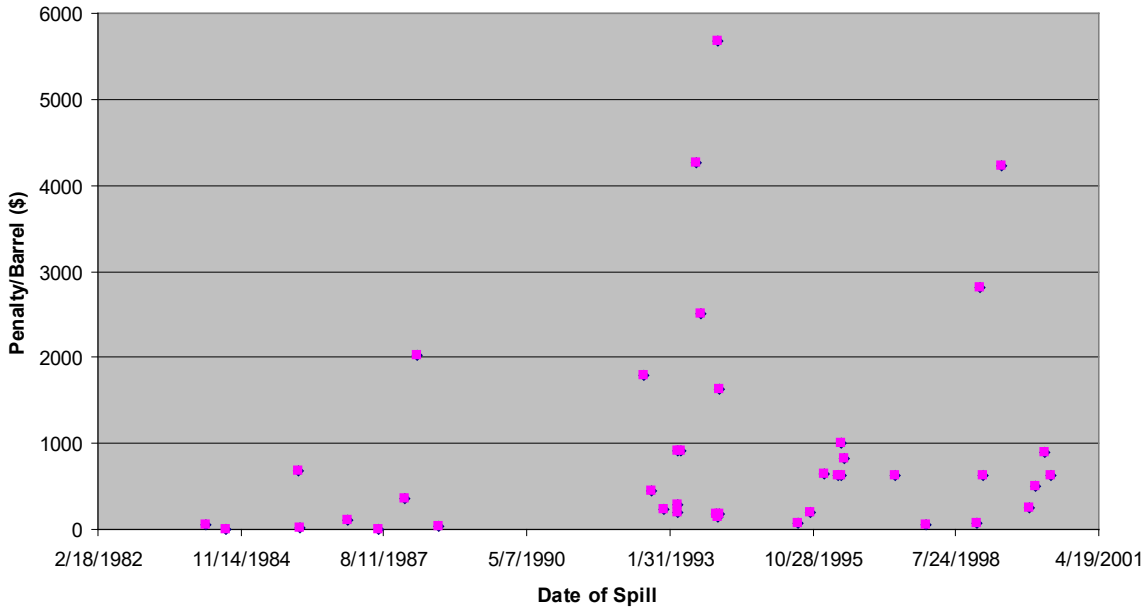


Table 2: Overall Total Penalty/Barrel

	Mean Penalty/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
overall mean penalty/ barrel for prior OPA spills ($)	1376.1512	1032.268	[-688.3849643,3440.687421]
overall mean penalty/ barrel for post OPA spills ($)	1725.4807	503.1165	[719.2476838,2731.71369]

Table 3: Difference in Total Penalty/Barrel

	Mean Difference in Penalty/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff}$ ± 2 * SD_{diff})
mean difference in penalty/ barrel (post - prior) ($)	349.32946	1075.081	[-1800.831594,2499.490511]

It is useful to break the total penalty per barrel into civil and criminal penalties in order to determine if either of these two kinds of penalties increased significantly post OPA. **Chart B** represents the rising civil penalties resulting from oil spills over time. The same three oil spills are once again excluded from the graph. The mean civil penalty/barrel in the sample prior OPA for an oil spill was only $1364 while post OPA the mean civil penalty/barrel in the sample increased to $1537 (**Table 4**). While this is a $173 increase in sample mean penalty/barrel, the standard deviation of the mean difference is too large again to conclude that oil spill penalties increased significantly post OPA (**Table 5**). However, **Chart B** illustrates the jump in oil spill penalties per barrel after the OPA for my data set.

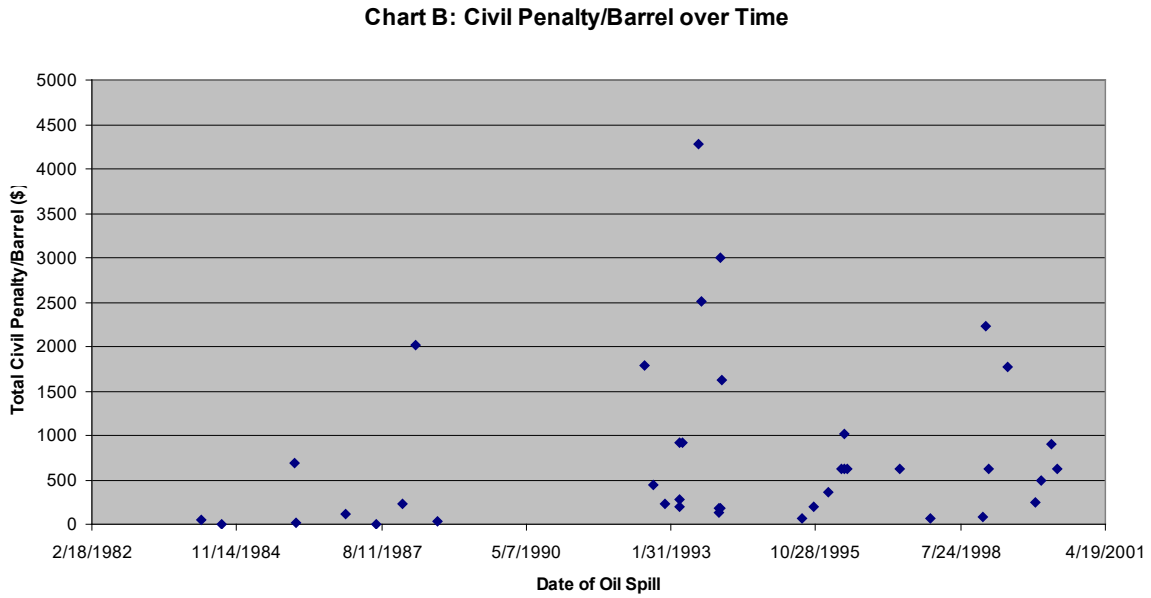


Table 4: Mean Civil Penalty/Barrel

	Mean Civil Penalty/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
overall mean civil penalty/ barrel for prior OPA spills ($)	1363.719383	1033.706596	[-703.6938081,3431.132575]
overall mean civil penalty/ barrel for post OPA spills ($)	1537.094968	488.6833016	[559.728365,2514.461571]

Table 5: Mean Difference in Civil Penalty/Barrel

	Mean Difference in Civil Penalty/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff}$ ± 2 * SD_{diff})
mean difference in civil penalty/ barrel (post - prior) ($)	173.375585	1143.398747	[-2113.421909, 2460.173079]

In respect to criminal penalties, **Chart C** shows that many spills lack criminal penalties. The graph excludes two spills, an oil spill off Puerto Rico in 1994 and an oil spill in Bellingham Park in Washington in 1999, due to criminal penalties in excess of two thousand dollars per barrel (**Chart C**). The graph illustrates a jump in the criminal penalty per barrel in cases where a criminal penalty was administered post OPA. The mean criminal

penalty per barrel prior OPA was a mere $12 while the mean criminal penalty per barrel post OPA jumped to $188 (**Table 6**). Once again the standard deviation of the mean difference in criminal penalty per barrel is too large to conclude significance (**Table 7**). However, the criminal penalty per barrel is by far the type of penalty that comes closest to being a significant increase post OPA.

Chart C: Criminal Penalty/Barrel over Time

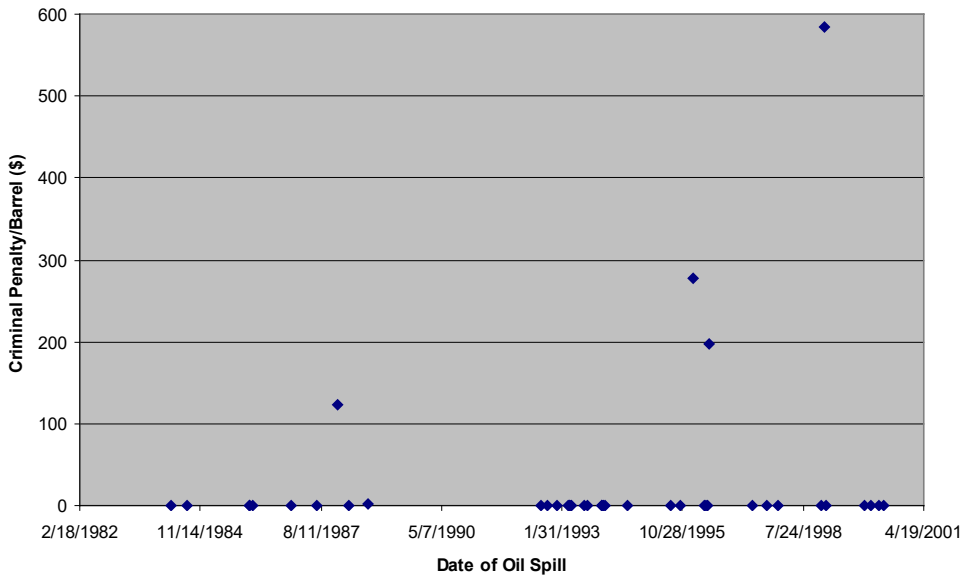


Table 6: Mean Criminal Penalty/Barrel

	Mean Criminal Penalty/ Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
overall mean criminal penalty/ barrel for prior OPA spills ($)	12.43185	12.278	[-12.1241534,36.98784412]
overall mean criminal penalty/ barrel for post OPA spills ($)	188.3857	109.2915	[-30.1973664,406.968804]

Table 7: Mean Difference in Criminal Penalty/Barrel

	Mean Difference in Criminal Penalty/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff} \pm 2 * SD_{diff}$)
mean difference in criminal penalty/ barrel (post - prior) ($)	175.9539	109.979	[-44.0042185,395.9119653]

By looking at total penalty, civil, and criminal penalties per barrel, I find that while penalties have increased post OPA they have not done so significantly. However, in looking at penalties, it is also important to consider costs per barrel. If total costs, including penalties, do not increase post OPA, then the OPA would not have served its purpose. For example, if the penalties per barrel increase while other costs decrease, then, financially the OPA would not have served its purpose of holding companies more financially responsible for oil spills. In the graph below (**Chart D**), it appears that costs per barrel have increased post OPA. However, the mean cost per barrel post OPA for an oil spill is actually $566 dollars less than prior OPA spills (**Table 9**). There are six spills ranging from about $9,400 to $18,800 per barrel excluded from the graph, two prior OPA and four post OPA. This difference suggests that the OPA while increasing penalties decreased other costs. This suggests that the OPA's mandated increase in penalties is not fulfilling its aim of financially punishing oil companies for their oil spills. However, in this analysis and the three previous analyses, the characteristics of each individual oil spill have not been taken into account.

Chart D: Cost/Barrel over Time

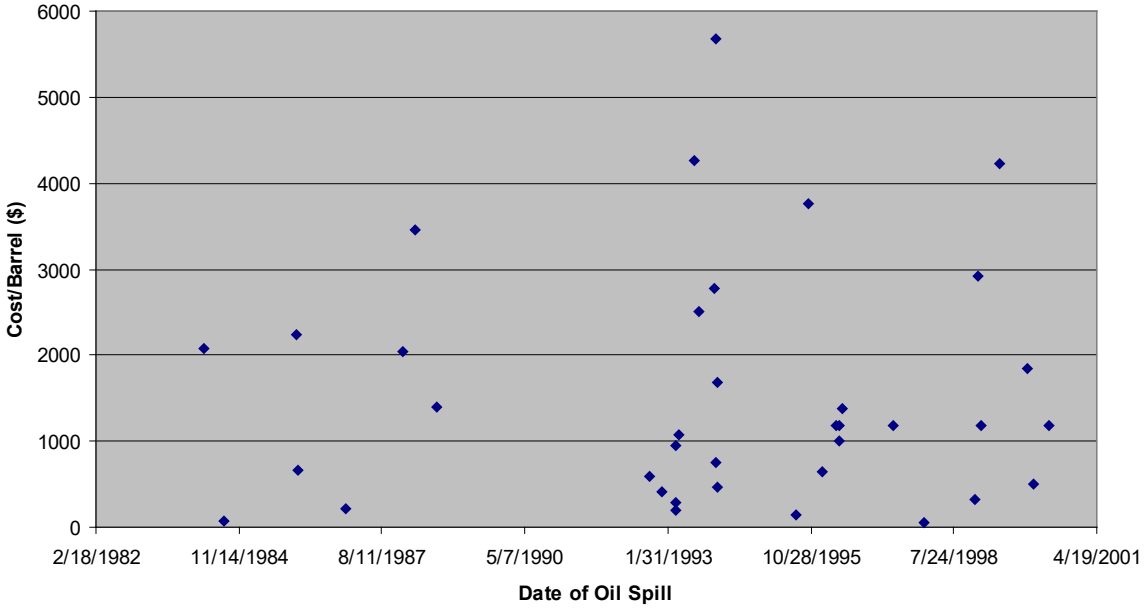


Table 8: Mean Cost/Barrel

	Mean Total Cost /Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
overall mean total cost/ barrel for prior OPA spills ($)	3591.586	1421.889	[747.8066594,6435.364544]
overall mean total cost/ barrel for post OPA spills ($)	3025.322	776.1741	[1472.973759,4577.67033]

Table 9: Mean Difference in Cost/Barrel

	Mean Difference in Cost/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff}$ ± 2 * SD_{diff})
mean difference in cost/ barrel (post - prior) ($)	-566.264	1516.285	[-3598.833675,2466.30656]

In looking at overall penalties and costs per barrel, I find that total penalty per barrel, civil penalty per barrel, and criminal penalty per barrel have all increased post OPA, but only criminal penalties come close to being a significant increase. Furthermore, I find that total

costs have decreased post OPA for oil spills. This suggests that while penalties may have increased post OPA, OPA is not fulfilling its purpose of making spills more financially damaging for oil companies.

Penalties and Costs by Natural Resource Code

In order to determine whether penalties increased more for damaging spills than for non-damaging spills, one variable I use to separate the spills into these two types is natural resource code. The most damaging spills to natural resources are coded NRC = 2 while the least damaging spills to natural resources are coded NRC = 0.

In looking at total penalty per barrel by natural resource code, as expected, both prior OPA and post OPA total penalty per barrel is higher for spills that caused extensive harm to natural resources (**Table 10**). However, the total penalty per barrel post OPA increased more for non-damaging spills than for damaging spills (**Table 11**). This is counter to the logic of the OPA and opposite of what is expected. If the aim was to increase penalties more for damaging spills, then the mean difference in penalty per barrel between post OPA and prior OPA spills should have increased more for spills designated NRC = 2 than spills designated NRC = 0.

The increase in oil spill penalty per barrel for non-damaging spills is $1,320 while the in oil spill penalty per barrel for damaging spills decreases by $105 post OPA (**Table 11**). **Chart E** once again excludes the three oil spills with penalties exceeding nine thousand dollars per barrel. A case can be made for excluding the Curtis Bay Oil Spill in 1994 with a natural resource code of zero from the analysis. This spill consisted of only ten gallons of oil spilled. Therefore, while the penalty for the spill was only $3,200 once adjusted for inflation,

the total penalty per barrel was $13,500. However, the exclusion of this spill fails to make a difference. The mean total penalty per barrel for non-damaging post OPA spills falls to $677 and the difference in mean total penalty per barrel for non-damaging spills prior and post OPA falls to $647 from $1320 (**Table 11**). However, this lower increase in total penalty per barrel of $647 for spills post OPA with NRC = 0 is still much greater than a decrease in total penalty per barrel of $105 for spills post OPA with NRC = 2 (**Table 11**).

Chart E: Total Penalty/Barrel over Time by Natural Resource Code

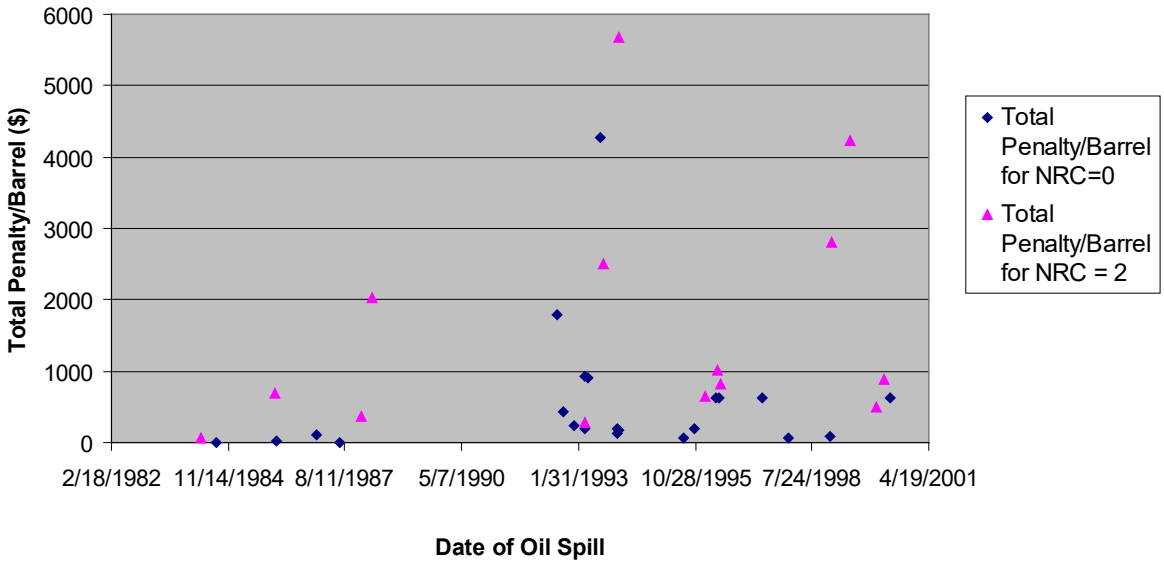


Table 10: Mean Total Penalty/Barrel by Natural Resource Code

	Mean Total Penalty/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
mean total penalty/barrel for prior OPA spills with NRC = 0 ($)	29.43461	25.94734	[-22.46007926,81.32930015]
mean total penalty/barrel for prior OPA spills with NRC = 2 ($)	2723.219	1971.649	[-1220.078037,6666.516429]

mean total penalty/barrel for post OPA spills with NRC = 0 ($)	1349.286	708.158	[-67.03045375,2765.60174]
mean total penalty/barrel for post OPA spills with NRC = 2 ($)	2618.276	857.8265	[902.6234911,4333.929313]

Table 11: Mean Difference in Total Penalty/Barrel by Natural Resource Code

	Mean Difference in Total Penalty/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff} \pm 2 * SD_{diff}$)
difference in mean total penalty/barrel between prior OPA and post OPA NRC = 0 ($)	1319.851	708.6333	[-97.41547193,2737.117537]
difference in mean total penalty/barrel between prior OPA and post OPA NRC = 2 ($)	-104.943	2150.178	[-4405.298358,4195.41277]

In addition, I break total penalties into civil and criminal penalties and examine them individually in relation to natural resource code. Since the OPA aimed to increase both these types of penalties, especially for damaging spills, both these penalties should increase post OPA, and they should increase more for damaging spills. However, the civil penalty per barrel for spills designated NRC = 2 actually decreased by $646 post OPA while the civil penalty for those coded NRC = 0 increased by $1320 (**Table 13**). Again, removing the Curtis Bay Oil Spill still leaves an increase in civil penalty for post OPA spills of $647 for spills coded NRC = 0. The civil penalty per barrel is the same as the total penalty per barrel for spills designated NRC = 0 because in all these cases no criminal penalties were administered. Clearly, civil penalty per barrel in this sample is not increasing more for damaging spills than non-damaging spills post OPA.

Chart F: Civil Penalty/Barrel over Time by Natural Resource Code

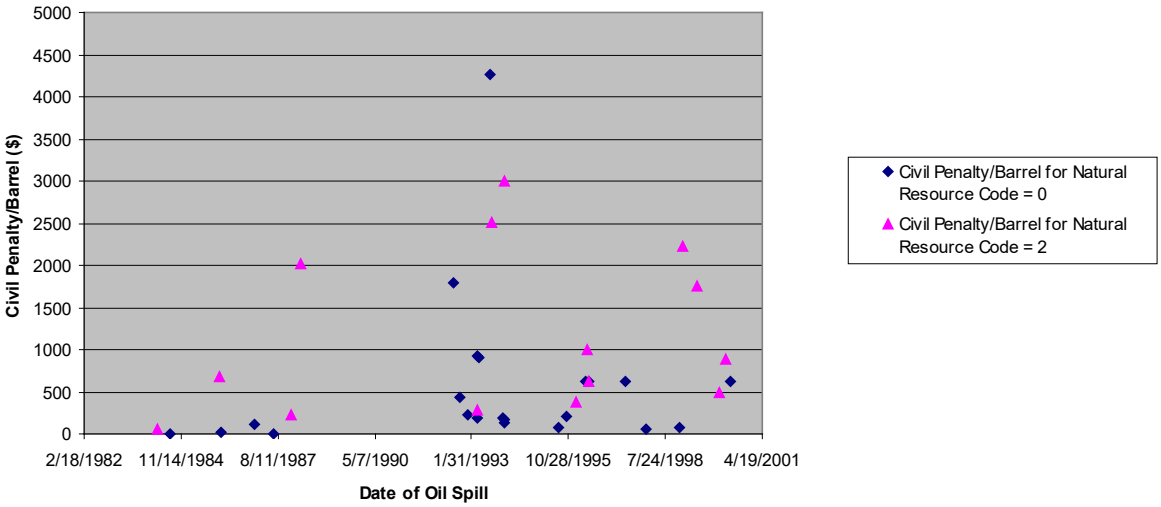


Table 12: Mean Civil Penalty/Barrel by Natural Resource Code

	Mean Civil Penalty/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
mean civil penalty/barrel for prior OPA spills with NRC = 0 ($)	29.43461	25.94734	[-22.46007926,81.32930015]
mean civil penalty/barrel for prior OPA spills with NRC = 2 ($)	2698.634	1979.159	[-1259.683652,6656.951312]
mean civil penalty/barrel for post OPA spills with NRC = 0 ($)	1349.286	708.158	[-67.03045375,2765.60174]
mean civil penalty/barrel for post OPA spills with NRC = 2 ($)	2053.119	788.168	[476.7833184,3629.455173]

Table 13: Mean Difference in Civil Penalty/Barrel by Natural Resource Code

	Mean Difference in Civil Penalty/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff}$ ± 2 * SD_{diff})
difference in mean civil penalty/barrel between prior OPA and post OPA NRC = 0 ($)	1319.851	708.6333	[-97.41547193,2737.117537]
difference in mean civil penalty/barrel between prior OPA and post OPA NRC = 2 ($)	-645.515	2130.323	[-4906.161512,3615.132343]

All spills that received criminal penalties were those in which there were extensive natural resource damages. In all, six spills involved criminal penalties. Criminal penalties for spills lacking natural resource damages remained at $0 post OPA while criminal penalties increased $541 per barrel post OPA for spills with extensive natural resource damages (**Table 15**). This greater increase for spills with natural resource damages conforms to the goals of the OPA. Furthermore, it barely falls short of being a significant difference.

Chart G: Criminal Penalty/Barrel over Time by Natural Resource Code

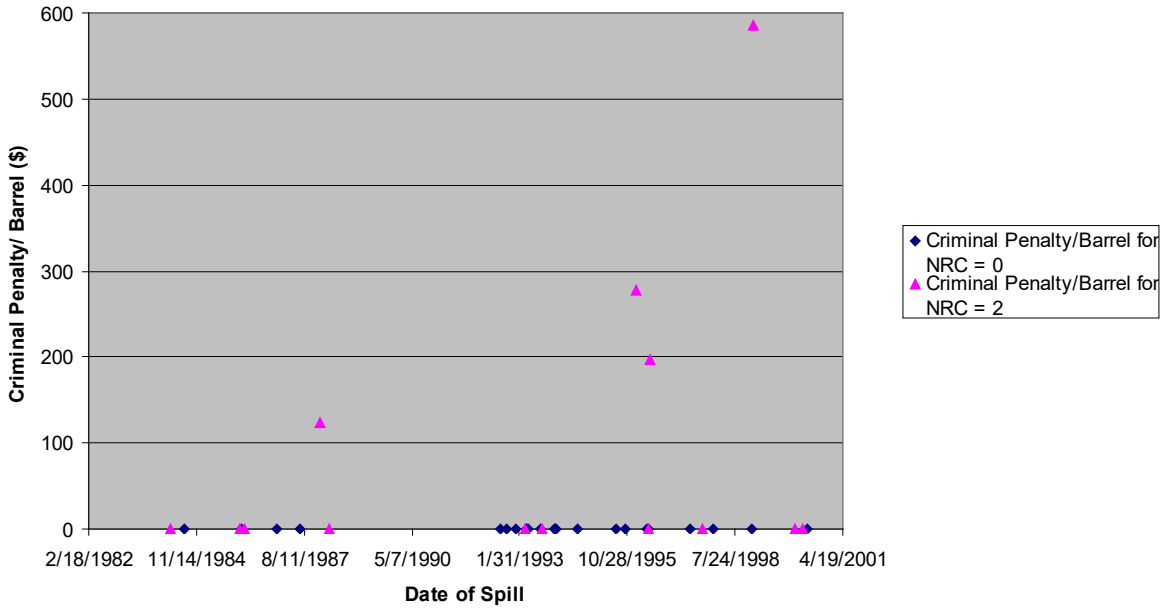


Table 14: Mean Criminal Penalty/Barrel by Natural Resource Code

	Mean Criminal Penalty/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
mean criminal penalty/barrel for prior OPA spills with NRC = 0 ($)	0	0	[0, 0]
mean criminal penalty/barrel for prior OPA spills with NRC = 2 ($)	24.58537	24.58537	[-24.58536585,73.75609756]
mean criminal penalty/barrel for post OPA spills with NRC = 0 ($)	0	0	[0, 0]
mean criminal penalty/barrel for post OPA spills with NRC = 2 ($)	565.1572	305.5733	[-45.9894672,1176.30378]

Table 15: Mean Difference in Criminal Penalty/Barrel by Natural Resource Code

	Mean Difference in Criminal Penalty/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff}$ ± 2 * SD_{diff})
difference in mean criminal penalty/barrel between prior OPA and post OPA NRC = 0 ($)	0	0	[0,0]
difference in mean criminal penalty/barrel between prior OPA and post OPA NRC = 2 ($)	540.5718	306.5607	[-72.54969529,1153.693276]

Chart H illustrates total known costs per barrel in relation to natural resource code. Six spills, two prior OPA and four post OPA with costs in excess of nine thousand dollars, are excluded from the chart. Total known costs per barrel in relation to natural resource code should have also increased post OPA. In this case, I do not find this relationship for damaging oil spills or non-damaging oil spills. I find that total known costs per barrel for non-damaging oil spills have actually decreased post OPA by $630 and total known costs per barrel for damaging oil spills have decreased by $327 (**Table 17**).

Chart H: Total Known Costs/Barrel over Time by Natural Resource Code

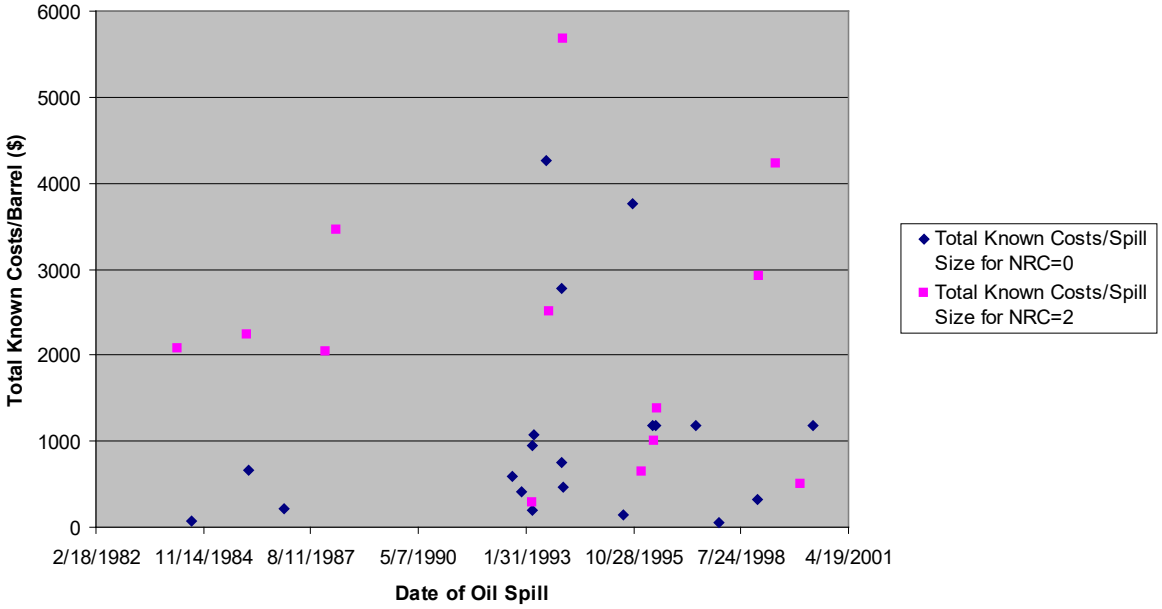


Table 16: Mean Total Known Cost/Barrel by Natural Resource Code

	Mean Total Known Costs/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
mean total known costs/barrel for prior OPA spills with NRC = 0	3407.249	3092.503	[-2777.756343,9592.253951]
mean total known costs/barrel for prior OPA spills with NRC = 2	4177.318	1739.874	[697.5712299,7657.065514]
mean total known costs/barrel for post OPA spills with NRC = 0	2777.577	1130.298	[516.9803049,5038.1727]
mean total known costs/barrel for post OPA spills with NRC = 2	3850.019	1293.404	[1263.210433,6436.828195]

Table 17: Mean Difference in Total Known Cost/Barrel by Natural Resource Code

	Mean Difference in Total Known Costs/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff}$ ± 2 * SD_{diff})
difference in mean total known costs/barrel between prior OPA and post OPA NRC = 0	-629.672	3292.59	[-7214.851406,5955.506803]
difference in mean total known costs/barrel between prior OPA and post OPA NRC = 2	-327.299	2167.961	[-4663.221147,4008.623031]

By breaking oil spills into two categories by natural resource code, I find that only criminal penalty per barrel accords with the purpose of the OPA to punish companies financially to a greater extent for oil spills, especially damaging oil spills (**Table 15**). Total penalty per barrel and civil penalty per barrel have increased more for non-damaging spills post OPA (**Tables 11 and 13**). Civil penalty per barrel actually decreased post OPA for damaging spills and costs per barrel decreased for both damaging and non-damaging spills - all counter to the purpose of the OPA (**Tables 13 and 17**).

Penalties and Costs by Oil Viscosity

An alternative way to break oil spills into damaging and non-damaging spills is to break them into two categories by oil viscosity and then examine the penalties and costs in relationship to the OPA. In my data set, oil spills in which the oil product spilled was relatively thin and thus less environmentally damaging were designated OVC = 0 while spills where the product was relatively thick and thus more environmentally damaging were designated OVC = 1. More specifically, spills involving gasoline, diesel fuel, light crude oil, and number two fuel oil were coded OVC = 0. Spills involving crude oil, heavy crude oil, and number six fuel oil were coded OVC = 1. However, oil spills are overwhelmingly crude oil spills. Therefore, dividing the spills into oil viscosities in this way results in having only one observation for a spill with OVC = 0 for prior OPA in my data set. Key insights into penalties and costs can still be gained even with this weakness.

Chart I illustrates the rising total penalty per barrel post OPA by oil viscosity. Two spills, one prior OPA and one post OPA, both coded OVC = 1, are excluded from the graph

with total penalty per barrel greater than nine thousand dollars. The mean total penalties per barrel are higher for damaging spills prior and post OPA than non-damaging spills (**Table 18**). Since oil spills are more damaging to the environment if the type of oil spilled is thick, the higher total penalty per barrel for thick oil spills for both prior OPA and post OPA oil spills makes logical sense. However, the mean difference in total penalty per barrel is greater for spills with an oil viscosity of zero at $673 than for spills with an oil viscosity of one at $116 (**Table 19**). If the OPA is really punishing companies for more damaging spills with higher penalties, the increase in total penalty per barrel post OPA should have been more for spills with high oil viscosity than low oil viscosity.

Chart I: Total Penalty/Barrel over Time by Oil Viscosity

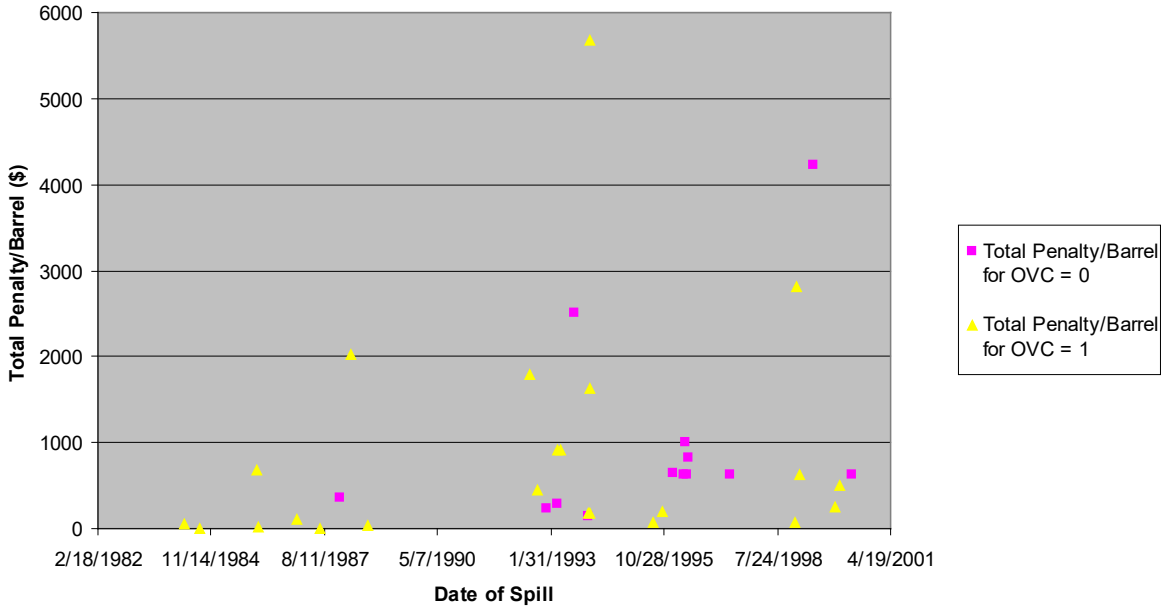


Table 18: Mean Total Penalty/Barrel by Oil Viscosity

	Mean Total Penalty/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
mean total penalty/barrel for prior OPA spills with OVC = 0	358.6732		
mean total penalty/barrel for prior OPA spills with OVC = 1	1489.204	1082.012	[-674.8194933,3653.228186]
mean total penalty/barrel for post OPA spills with OVC = 0	1031.592	339.711	[352.169873,1711.013702]
mean total penalty/barrel for post OPA spills with OVC = 1	1605.378	633.2817	[338.8140412,2871.941025]

Table 19: Mean Difference in Total Penalty/Barrel by Oil Viscosity

	Mean Difference in Total Penalty/Barrel
difference in mean total penalty/barrel between prior OPA and post OPA spills with OVC = 0	672.9186
difference in mean total penalty/barrel between prior OPA and post OPA spills with OVC = 1	116.1732

In dividing oil spills into damaging and non-damaging spills and looking at total penalty per barrel in two different ways - by natural resource code and oil viscosity code - I found the same results. While total penalty per barrel is greater for damaging spills than non-damaging spills, the increase in total penalty per barrel post OPA for non-damaging spills is greater than damaging spills.

It is helpful to examine total penalty per barrel by oil viscosity more thoroughly by breaking the penalty into civil and criminal penalties per barrel. In this way, I can determine whether civil or criminal penalties increased more for damaging spills post OPA. **Chart J** illustrates civil penalties by oil viscosity, and two post OPA spills with unusually high civil penalties per barrel are excluded from the graph. As with total penalty, both civil penalties post OPA and prior OPA for spills with a high oil viscosity (OVC=1) are higher than spills with a low oil viscosity (OVC=0) (**Table 20**). However, when looking at the mean

difference in civil penalties post OPA compared to prior OPA, civil penalties increased more for spills with low oil viscosity than high oil viscosity (**Table 21**). In fact, civil penalties for spills with high oil viscosity actually decreased by $88 per barrel post OPA (**Table 21**).

Chart J: Civil Penalty/Barrel over Time by Oil Viscosity

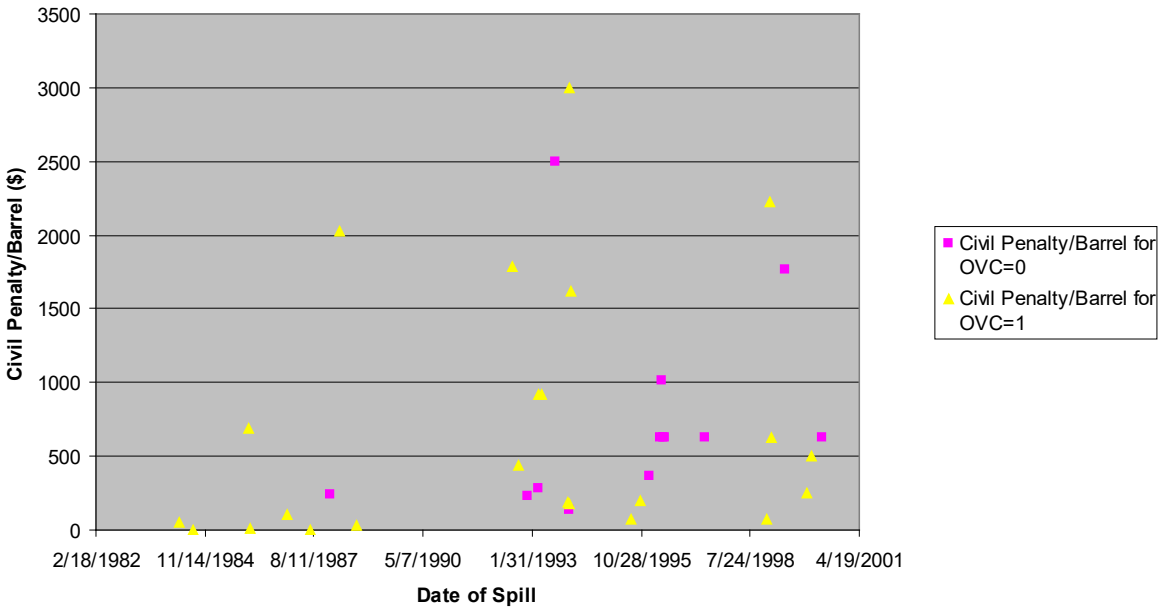


Table 20: Mean Civil Penalty/Barrel by Oil Viscosity

	Mean Civil Penalty/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
mean civil penalty/barrel for prior OPA spills with OVC = 0	235.7463		
mean civil penalty/barrel for prior OPA spills with OVC = 1	1489.05	1147.193	[-805.3365065,3783.435949]
mean civil penalty/barrel for post OPA spills with OVC = 0	786.4888	199.0198	[388.4490687,1184.528436]
mean civil penalty/barrel for post OPA spills with OVC = 1	1400.659	576.6152	[247.4289561,2553.889573]

Table 21: Mean Difference in Civil Penalty/Barrel by Oil Viscosity

difference in mean civil penalty/barrel between prior OPA and post OPA spills with OVC = 0	550.7424
difference in mean civil penalty/barrel between prior OPA and post OPA spills with OVC = 1	-88.3905

In examining civil penalties in two different ways, by oil viscosity and by natural resources damaged, I reach the same conclusion - civil penalties for damaging spills did not increase more post OPA than for non-damaging spills. In fact, in both methods - natural resource code and oil viscosity code - I find a decrease in civil penalty per barrel post OPA for damaging spills while finding an increase in civil penalty per barrel post OPA for non-damaging spills.

I also examine criminal penalty per barrel by oil viscosity and exclude two post OPA oil spills from the graph (**Chart K**). In this case, I find that criminal penalties for spills with low oil viscosity prior OPA are actually higher than criminal penalties for spills with high oil viscosity prior OPA (**Table 22**). However, this unusual occurrence is probably due to only having one spill with low oil viscosity prior OPA in my sample. In my post OPA sample, I find the expected relationship - criminal penalties for spills with high oil viscosity are higher post OPA than criminal penalties for spills with low oil viscosity post OPA (**Table 22**). The increase in criminal penalty per barrel post OPA for damaging spills, those with OVC=1, is $205 per barrel while the increase in criminal penalty post OPA for non-damaging spills, those with OVC=0, is only $122 (**Table 23**). This greater increase for damaging spills, although insignificant, holds with the purpose of the OPA. In this case, I observe, as the OPA suggests, that companies are punished more financially for damaging spills than non-damaging spills post OPA and criminal penalties increase for both types of spills post OPA.

Chart K: Criminal Penalty/Barrel over Time by Oil Viscosity

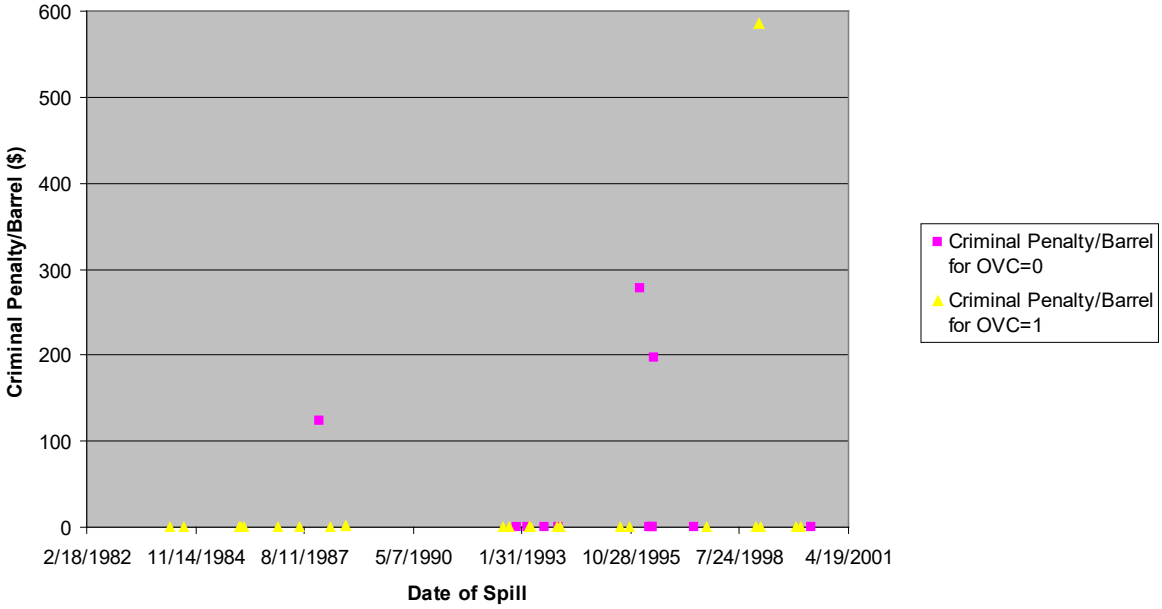


Table 22: Mean Criminal Penalty/Barrel by Oil Viscosity

	Mean Criminal Penalty/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
mean criminal penalty/barrel for prior OPA spills with OVC = 0	122.9268		
mean criminal penalty/barrel for prior OPA spills with OVC = 1	0.154625	0.154625	[-0.154624942,0.463874827]
mean criminal penalty/barrel for post OPA spills with OVC = 0	245.103	203.7977	[-162.4923722,652.6984424]
mean criminal penalty/barrel for post OPA spills with OVC = 1	204.7183	169.6909	[-134.6635833,544.1001206]

Table 23: Mean Difference in Criminal Penalty/Barrel by Oil Viscosity

	Mean Difference in Criminal Penalty/Barrel	Standard Deviation of Mean Difference	Interval for Mean Difference ($mean_{diff}$ ± 2 * SD_{diff})
difference in mean criminal penalty/barrel between prior OPA and post OPA spills with OVC = 0	122.1762		
difference in mean criminal penalty/barrel between prior OPA and post OPA spills with OVC = 1	204.5636	169.691	[-134.8183491,543.9456366]

When looking at criminal penalties by natural resource code, I also found a greater increase in criminal penalty post OPA for damaging spills, but I did not find any increase in criminal penalty per barrel post OPA for non-damaging spills (**Table 15**). However, both types of analyses suggest that, in relation to criminal penalty, the OPA could be fulfilling its purpose of punishing companies more for damaging spills. However, the increases in criminal penalty post OPA in both analyses were also found to be insignificant.

Chart L pictures total known costs per barrel by oil viscosity, and it excludes four damaging oil spills (OVC = 1) from the graph. Dividing spills into high and low oil viscosities, I observe that total known costs per barrel as expected is higher for spills with high oil viscosity than for spills with low oil viscosity both prior and post OPA (**Table 24**). However, I find that costs per barrel have actually decreased post OPA by $717 for oil spills with low oil viscosity and by $505 for oil spills with high oil viscosity (**Table 25**). These decreases suggest that, even if some penalties are increasing due to the OPA, other costs are simultaneously decreasing; therefore, the OPA is not fulfilling its purpose of punishing companies more for oil spills, especially damaging ones.

Chart L: Total Known Cost/Barrel over Time by Oil Viscosity

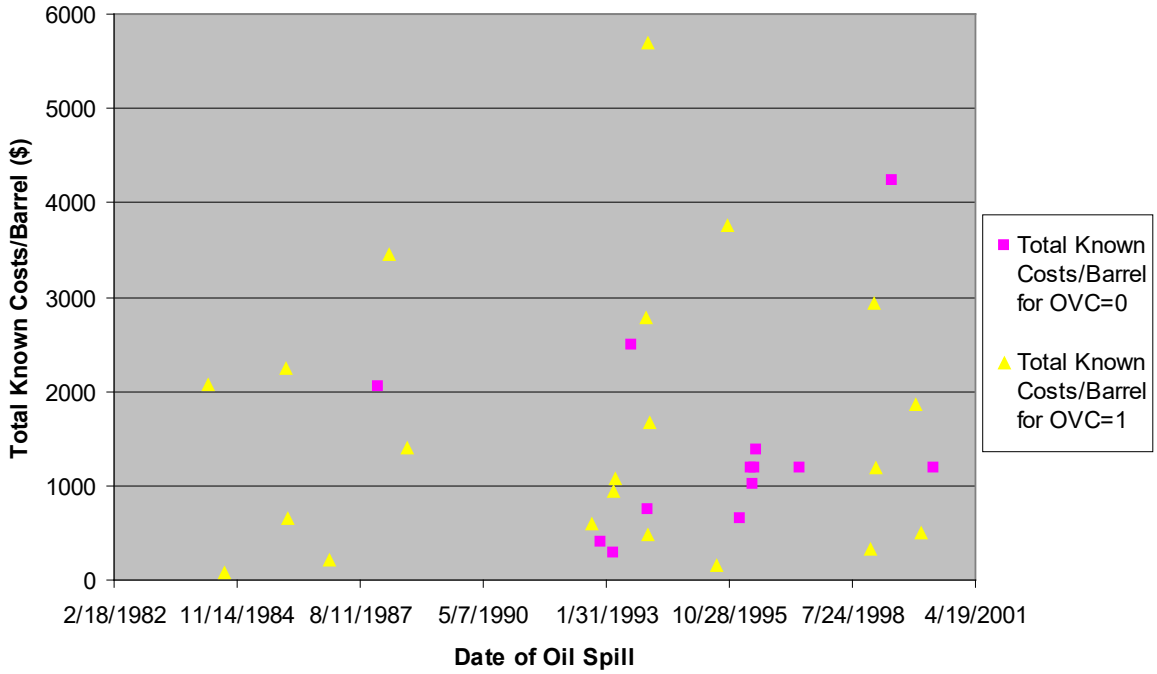


Table 24: Mean Total Known Cost/Barrel by Oil Viscosity

	Mean Total Cost/Barrel	Standard Deviation of Mean	Interval for mean (mean ± 2 * SD_{mean})
mean total known cost/barrel for prior OPA spills with OVC = 0	2047.415		
mean total known cost/barrel for prior OPA spills with OVC = 1	3763.16	1578.105	[606.9505271,6919.369781]
mean total known cost/barrel for post OPA spills with OVC = 0	1329.642	310.4151	[708.8112955,1950.471809]
mean total known cost/barrel for post OPA spills with OVC = 1	3257.99	1199.957	[858.0758057,5657.905049]

Table 25: Mean Difference in Total Known Cost/Barrel by Oil Viscosity

difference in mean total known cost/barrel between prior OPA and post OPA spills with OVC = 0	-717.773
difference in mean total known cost/barrel between prior OPA and post OPA spills with OVC = 1	-505.17

By dividing spills into damaging and non-damaging spills by both oil viscosity and natural resource code, I found the same result in respect to costs; total known costs for both damaging and non-damaging spills decreased post OPA. However, since oil spill costs often extend for years, it is possible that the total cost, especially for post OPA spills in my sample, is systematically underestimated since some costs have yet to be incurred by oil companies.

When looking at overall penalties, including civil and criminal penalties, and overall costs for my entire sample, I found that total penalty per barrel, civil penalty per barrel, and criminal penalty per barrel increased post OPA while total known costs per barrel decreased (**Tables 3, 5, 7, 9**). This suggests that, even if the OPA is increasing penalties, the act is not accomplishing its purpose to punish companies more financially for oil spills since total costs per barrel have decreased. Dividing spills into two categories, damaging and non-damaging spills, by two methods, natural resource code and oil viscosity code, gives an even clearer picture of the OPA.

Dividing these spills into damaging and non-damaging spills by both methods reveals that total penalty per barrel and civil penalty per barrel for non-damaging spills has increased more than damaging spills contrary to the purpose of the OPA (**Tables 11, 13, 19, and 21**). In fact, in some instances, penalties for damaging spills have actually decreased post OPA. In addition, total known costs per barrel for damaging and non-damaging spills by both methods have decreased post OPA (**Tables 17, 25**). The purpose of the OPA - to punish companies more for oil spills in general and especially for damaging spills - is not being fulfilled since overall costs have actually decreased and the penalties that have increased the most are for non-damaging oil spills. However, in respect to criminal penalty, evidence

suggests that the purpose of the OPA is being fulfilled. In both methods, I find higher criminal penalties post OPA for damaging oil spills (**Tables 15, 23**).

VI. Conclusion

By looking at changes in oil spill penalties assessed by the government to oil companies prior OPA and post OPA, I determine the financial impact of the OPA in respect to penalties and costs of oil spills. I have found that some penalties increased post OPA, but that more damaging spills were not penalized to a greater extent for total penalties or civil penalties. Only in the case of criminal penalties do I find a greater increase in penalty post OPA for damaging spills. However, due to large standard deviations in the sample, my findings were insignificant. Since I am unable to find a significant financial impact in favor of the OPA in relation to costs and penalties for oil spills from my data set, I find little support for the success of the OPA in regards to fulfilling its purpose of holding companies more financially accountable for oil spills, especially damaging ones.

However, the OPA literature and its evaluation of the OPA as a success in regards to reducing the number and volume of spills is still a possibility. While the OPA might not be achieving the desired financial impact in respect to penalties and costs, the new regulations imposed by the OPA could still be preventing spills. However, additional research to more clearly determine the OPA's effects could include a larger sampling of oil spills or a comparison to increases in oil spill penalties internationally over this same period of time.

Regardless of my findings, additional research is needed to answer the broader question, "Has the OPA been successful in preventing oil spills due to the financial impact of its provisions?" While I empirically determine the financial impact of the OPA on oil

companies after an oil spill in respect to penalties and costs, I neither address if the OPA actually prevents oil spills nor the financial impact of the other costly new regulations of the OPA. In order to determine whether the OPA prevents oil spills due to its provisions, it must be shown that companies take additional steps to prevent oil spills. Additional research on the behavior of firms needs to be conducted in order to determine if the OPA actually prevents oil spills and furthermore which provisions of the OPA are leading to prevention. However, with my empirical study, I have taken a step towards answering this important question by determining the financial impact of the OPA in respect to penalties and costs of an oil spill for an oil company.

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